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PROCEEDINGS OF 2020/2021 CHINA INTERNATIONAL CONFERENCE ON INSURANCE AND RISK MANAGEMENT

# 2020/2021 中国保险与风险管理国际年会论文集


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# EDITORIAL PREFACE TO THE PROCEEDINGS OF THE CHINA INTERNATIONAL CONFERENCE ON INSURANCE AND RISK MANAGEMENT

This special Conference Proceedings contains papers presented at the 11th China International Conference on Insurance and Risk Management (CICIRM 2020/2021), which was held on July 14-17, 2021 in Harbin, China. The conference was jointly organized by Tsinghua University's China Center for Insurance and Risk Management (CCIRM) and the Cass Business School of City University, London, and hosted by Northeast Agricultural University College of Economics and Management. This event follows upon the successful meetings held in Xining (July 2010), Beijing (July 2011), Qingdao (July 2012), Kunming (July 2013), Shenzhen (July 2014), Hangzhou (July 2015), Xi'an (July 2016) and Guilin (July 2017), Baoding (2018) and Chengdu (2019), which launched an annual forum in China for international communication and cooperation in the studies of insurance, risk management, and actuarial science. The CICIRM is the unique international conference in the fields of insurance and risk management in China.

Credit for the quality of the Conference Proceedings goes first and foremost to the authors, most of whom hold appointments at key universities and institutes in China. These authors contributed a great deal of effort and creativity to the Conference Proceedings, and we are very grateful that they chose CICIRM as the venue for presenting their work.

The Conference Program Committee is comprised of 23 members from both Chinese and international universities. The members of the program committee have given their time to provide excellent reviews for 159 papers and abstracts submitted to the conference. We are sincerely grateful to them.

We are pleased to present 73 papers in this Conference Proceedings, covering topics of current importance in insurance, risk management, and actuarial science, and coming from 10 different countries and regions.

Our thanks go to many others as well for their help in making the conference highly successful. In particular, we would like to thank Professor George Zanjani (The University of Alabama) and Professor M. Martin Boyer (HEC Montréal) who served as keynote speakers at the conference.

It is our sincere hope that the Conference Proceedings will provide fresh intellectual stimulus to readers in different countries and regions with a variety of cultural and socio-economic backgrounds, thereby generating enhanced motivation for the study of insurance and risk management.

Bingzheng Chen
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# Table of Contents

**Preface**……i
**Conference Program Committee**……ii
**Table of Contents**……iii

**Chapter 1. Development and Regulation of Insurance Market**

1. Regulatory Tolerance, Inefficient Investment and Risk-taking by Life Insurance
.....CHU Liping 2

2. Market-Consistent or Market Sentiment: An Examination of the Informativeness of Embedded Value Accounting.....Derrick W. H. FUNG, Charles C. YANG, Jason J. H. YEH 25

3. Research on the Ways of Green Insurance's Effect on Realizing the Target of Peaking Carbon Dioxide Emissions and Carbon Neutrality.....HUANG Jie, WANG Kai 59

4. Research on Corporate Governance Supervision and Problem-solving Financial Institutions:Taking the Case of Dissolution and liquidation of Anbang Insurance Group as an Example
.....KONG Yuehong, WANG Lili, HAN Sailan 75

5. Study on the Impact of Insurance Corporate Governance on Solvency
.....KONG Yuehong, HAN Sailan,WANG Lili 86

6. Systemic Importance Assessment of Insurance Group Based on Complex Network
..... LI Guozhen, ZHOU Feng, ZHANG Lin 98

7. Anti Poverty Function and Spatial Spillover of Digital Inclusive Insurance
..... LI Wangye, HE Xiaoxia 118

8. Study on the Role of Commercial Insurance in Municipal Solid Waste Treatment
.....LIU Chang 147

9. The Introspection of Network Mutual Assistance --Taking the Water Drop Mutual Assistance as an Example
.....XU Minmin, HOU Jingchuan 156

10. Research on the High-Quality Development Model and Path of Shaanxi's Insurance Industry under the Background of "Strong Supervision"
.....YAN Weizhong, ZHAO Xing, JIA Yuanfei, ZHANG Caihong, NI Shiyuan 183

11. The Spatial Measurement Analysis of Insurance Agglomeration to the Innovation Efficiency of High-tech Industry--Based on Panel Data of 31 Provinces and Cities in China..... YIN Shiwen, JI Hao 199

## Chapter 2. Risk Management


12. Temporary Advantage or Insurtech？ – Research on Efficiency and Fairness of Online Mutual Aid .....CHEN Ze, FENG Runhuan, WEI Li, ZHAO Jiaqi 224
13. Study of the Stability of Different Interbank Networks .....DU Xuyan, WANG Haiyan 238
14. The Impact of Climate Change on the Credit Risk of Chinese Listed Companies in the Mining Industry .....HAN Jinmian, XIA Shuang 264
15. Fintech, Popularity Index and the Vulnerability of Life Insurance Companies ..... JIANG Yujie 279
16. The Construction and Improvement of Risk Sharing Mode of Sci-Tech Finance: Based on Comparative Analysis of the Modes between “Government-Bank-Insurance” Model and “Government-Bank-Assurance” Model.....KONG Yuehong, LI Xinyang 291
17. Does Grass-roots Government Make Residents Accept Catastrophe Insurance?-- A Case Study of Rural Areas in Lincang, Yunnan.....LI Qiang, LIU Wei 304
18. Risk Management Analysis of COVID-19 in America Based on EEMD Model .....LI Zhouyawen, ZUO Minghui 317
19. Factors Associated with Chinese Residents Engaging in Environmental Protection Activities: based on the 2013 CGSS Data..... LIN Wenyi, LI Shuang, CHENG Jianxin, LIAO Leilei, HUANG Wei 328
20. Analysis on the Spatial and Temporal Pattern Evolution and Driving Factors of Urban Informal Employment In China --an Empirical Study Based on Provincial Panel Data from 2011 to 2018 ..... LIU Haiying, DONG Yujing 337
21. Model risk of anti- COVID-19 policy making in the Early Stage in Wuhan: an Analysis Based on the Logistic Growth Model..... LIU Xueping 361
22. Research on the Systemic Risk Spillover Effect of the Insurance Industry under the Impact of Asset-driven Business Model --Based on GARCH-Copula-CoVaR model.....SHANG Ying, LUO Zidan 373
23. Analysis of the Impact of Monetary Policy on Stock Market Volatility—Based on the GARCH-MIDAS Model .....YANG Tianxing, LIU Liping 389
24. Research on Local Government Fiscal Risk and Sustainability.....YANG Yifei, LI Yanting 403
25. Research on the Impact of Equity Change on the Operation Risk of Life Insurance .....ZHANG Bohua 451

## Chapter 3. Life and Health Insurance


26. Family Situation and Supplementary Health Insurance Needs Analysis
..... HE Baojun 463

27. Does Basic Medical Insurance Crowd Out Commercial Medical Insurance --Analysis based on CHARLS data
.....HU Mengdan, ZHOU Haizhen 471

28. Exploration on the "Channel" Payment Mode of Individual Account of Medical Insurance for Employees in Shanghai.....LI Jing, SONG Zhanjun 489

29. The Impact of Basic Medical Insurance for Urban and Rural Residents on Residents' Health
.....LIU Suchun, YAN Xiaojing, HAN Xu 495

30. Research on the Impact of Environmental Pollution on the Demand for Commercial Health Insurance
..... LIU Suchun, ZHAO Xinyu, LIU Juan 522

31. Research on the Impact of Commercial Medical Insurance on Health Inequality..... MA Jiali 548

32. The Impact of the Long-term Care Insurance Policy on the Health Level of Middle Age and Elderly People
..... SHEN Yuling, ZHANG Junru, WU Haibo, CHEN Yuqian 564

33. Does the Qianhai Shenzhen-Hong Kong Modern Service Industry Cooperation Zone Promote the Development of the Health Insurance? Counterfactual Analysis Based on Province-Level Panel Data.....WU Xiangyou 584

34. Effect of Basic Medical Insurance & Critical Illness Insurance on Health and Poverty Alleviation—Take the Hospital Costs of Rural Patients With Cardiovascular Diseases in Henan Province as an Example
..... XU Minmin, DONG Xiaoding 596

35. Investigation and Research on the Purchase Behavior and Satisfaction of Million Medical Insurance in Hebei
.....YIN Chengyuan, ZHONG Weidong, ZHONG Yu 606

36. The Influence of Women's Marital Status on the Decision of Supplementary Medical Insurance
..... ZHOU Haizhen, SONG Sijie 631


## Chapter 4. Pension and Social Security


37. The Impact of Basic Endowment Insurance on Family Intergenerational Support for the Disabled Elderly: An Empirical Study Based on CHARLS Data.....FAN Hongli, QI Rui 653

38. Fertility Policy, Delayed Retirement and Secondary Demographic Dividend
.....GENG Lei, GAO Jianwei, LI Shuqing 673

39. How Top Management Team Capability and Heterogeneity Influence the Decision-making of Corporate Pension Plan..... HE Jing 691

40. Population Ageing, Industrial Structure and Export Growth.....HE Xiaoxia, AN Chaofan 701

41. Postponing Retirement, Fertility Rate and Optimal Social Security Tax Rate .....JIN Boyi 715

42. Does Deferred Incentive Promote Enterprise Innovation? —Empirical Evidence Based on Supplementary Pension Plan..... LIANG Lu 733

43. An Empirical Analysis on the Impact of Urban and Rural Residents' Basic Endowment Insurance on the Labor Supply of Rural Population--Based on the CHARLS data..... SHEN Luyao, HUANG Jiahui 755

44. Research on the Balanced Premium Rate of Long-term Care Insurance Based on the Elderly's Health Transition Probability Matrix..... TANG Wei, SU Fang 777

45. How to Provide For the Elderly without Raising a Baby? --Innovative Plan Design of "Insurance + Old-Age Service" under the Background of Sterile Culture .....WANG Xinmiao, ZHAO Yue, LI Yangzhen, BAI Yun, PENG Yuanhong 796

46. Longevity Risk and the Basic Pension Insurance: A Review..... WANG Zhonghan 832

47. Research on the Supplementary Effect of Xianmen Individual Tax Deferred Endowment Insurance on the Basic Endowment Insurance..... XU Minmin, LI Ying 846

48. A Study on the Impact of Delayed Retirement on the Employees'and Residents' Pension Wealth .....YANG Mu, HAN Minghui, ZHANG Hui 866

49. Operational Efficiency Evaluation of Urban and Rural Residents' Basic Pension Insurance System and Influencing Factors —Based on DEA-Tobit Analysis .....YIN Chengyuan, ZHONG Weidong, HAN Rui, YE Xiaomiao, YIN Qiutian 900

50. A study on the Preference of Annuity Insurance for Family-- based on the Education of Children ..... ZHANG Siman 919

51. Study of Basic Pension Insurance on Financial Risk Asset Allocation of Urban Households ..... ZHOU Haizhen, GONG Yichao 936

52. Analysis of the Effect of Basic Endowment Insurance on Delayed Retirement Intention Based on Population Differences.....ZHOU Haizhen, LIU Xianjia 951

53. Delayed Retirement Intention, Retirement-Medical Service and Health Benefits .....ZHU Minglai, SHEN Yupeng 972

## Chapter 5. Actuarial Science


54. Research on Design and Pricing of Shaanxi Winter Wheat Remote Sensing Index Insurance on Kilometer Grid.....CHEN Yan, HUANG Ruoqing, JI Bianbian, WANG Junrao 1003

55. Individual Optimal Consumption and Investment Decision under Longevity Risk ..... HU Shiqiang, BAO Songqi 1019

56. Optimal Retirement Age under Longevity Risk -- Based on Bayesian MCMC Method .....HU Shiqiang, LIN Zhengde, DOU Xueyan 1036

57. Dynamic Mortality Forecasting and Mortality-Linked Structured Pricing - Based on a Jump Diffusion Stochastic Mortality Model..... HU Shiqiang, LONG Yu 1060

58. Research on the Dynamic Relationship of Stock Market Fluctuations in Various Countries under the Epidemic..... JI Nannan, LIU Liping 1080

59. Deep Learning Algorithm Modeling for Outstanding Claim Reserves ..... LIU Leping, LIU Fang, WANG Linchen 1094

60. Typhoon Catastrophe Bond Pricing Based on Mixed Copula Model .....LIU Suchun, FENG Ke, WANG Zhishuai, LIANG Zimin 1105

61. Prediction of Mortality Rate of Elderly Population Based on Lee-Carter Model .....WU Xiaokun, LIU jiangtao, SU Yutong, GAO Jianwei 1125

62. The Gap of Basic Pension Insurance in China .....ZHENG Di, ZHENG Haitao, JIANG Yunyun, GU Dongfang 1139


## Chapter 6. Insurance Economics


63. Comparative Research on the Development Characteristics and Policy Effects of National Forestry Insurance ..... DING Shaoqun, ZHANG Jue 1158

64. Analysis of Urban Insurance High-Quality Development Evaluation System: Based on 19 Vice-provincial and Municipalities Cities..... GAO Jun, XING Hongyang 1179

65. Efficiency Research of Corporate Governance Supervision on the Captive Insurance Companies in China .....KOU Yefu, SUN Yizhu, WEI Fangze 1192

66. Dynamic Evolution of Insurance cycle and Economic Cycle under the Background of Insurance Technology .....LI Shilong, WANG Yueqi 1210

67. Specific-cause Mortality Prediction Model Based on Coherence Test..... LIU Leping, SHI Jin 1221

68. History and Analysis of Natural Catastrophe ILS Issues 2001-2020..... Morton N. Lane 1230

69. Analysis on Product Innovation Dynamic Mechanism of Insurance Company--Based on Game Theory Model .....WANG Xiang, CHEN Long, WANG Ben 1272

70. Effects of Social Relations on Family Business Insurance Participation Decision-making --- Based on the Perspective of Strong-Weak perspective.....WANG Xiaoquan, HUANG Dandan 1288

71. Research on the Impact of Family Members' Economic Discourse Power on the Decision-making of Commercial Insurance Purchase.....WANG Yating, ZHANG Mingzhu 1310

**Chapter 7. Behavioral Insurance**

72. Factors Associated With Risk Perception of COVID-19 among Guangzhou Residents: A Psychological Typhoon Eye Perspective .....LIN Wenyi, YIN Wanxia, ZHANG Lifeng, YU Siqin, ZHAO Dongxu, CHENG Jianxin 1334

73. A Research on Commercial Endowment Insurance Decision-making Based on Financial Literacy Overconfidence.....ZHAI Ziyang, ZHOU Haizhen 1345

# Chapter 1. Development and Regulation of Insurance Market

# Regulatory Tolerance, Inefficient Investment and Risk-taking by Life Insurance

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**Keywords:** Regulatory Tolerance, Risk-taking, Inefficient Investment.

**Abstract：** The regulatory tolerance represented by US government assistance plays a pivotal role in alleviating AIG's plight and reducing financial systemic risks. In recent years, the integration of the financial industry and the deepening of innovation have gradually increased the importance of the insurance industry in the financial system. However, the marketization of rates and the broadening of capital utilization channels have also become the fuse of risk events while achieving the development of investment products. This article will take the panel data of 74 life insurance companies in my country from 2010 to 2019 as a research sample, and judge whether there is regulatory tolerance in the life insurance market from the two dimensions of breadth and depth, and whether regulatory tolerance will affect life insurance companies' risk-taking, and whether Through the mechanism of inefficient investment. The study found that, in terms of breadth and depth, life insurance companies in my country do have regulatory tolerance, especially in recent years. The more tolerant the regulation, the greater the operating and underwriting risks of life insurance companies, while the greater the investment risk. Small, especially in the regulatory boundary; this effect is mainly realized through the intermediary effect of inefficient investment. Compared with the under-invested group, the over-invested group of inefficient investment deduces the complete intermediary effect. Further heterogeneous research shows that the characteristics of the above-mentioned regulatory tolerance's impact on life insurance companies' risk exposure are more obvious in companies with high pure protection attributes, low equity checks and balances, and multiple business types. Finally, in practice, it promotes regulatory tolerance as a qualification to identify different investment and financing motives of life insurance companies, so as to help the supervisory authorities to conduct differentiated supervision of different investment and financing activities.

## 1. 引言

美国国际集团(AIG)作为美国最大的保险公司，在2008年爆发的金融危机中由于过度冒险行为遭到大批客户的挤兑，例证了那句老话“精于风险，却毁于风险”。AIG神话的破灭引起各界对保险业过度承担风险行为的原因进行广泛而深入的讨论，比较一致的观点认为保险业风险的过度承担与保险公司内外部治理有着极其重要的关系( Baranoff and Sager，2002)。

监管是健全保险公司治理、推动保险业向高质量发展转变的重要武器。随着金融混业融合和保险业创新深化，保险业在金融体系中的系统重要性不断加深，治理风险工作愈发复杂艰巨。保险公司作为经营风险的金融机构，是社会“稳定器”和经济“助推器”，其风险分摊机制是维护社会和金融稳定的重要力量(Borch，1962)。而保险公司的经营管理与风险密不可分，保险事故的随机性、损失程度的不可知性、理赔的差异性使得保险经营本身存在着不确定性，加上激烈的同业竞争和保险道德风险及欺诈的存在，使得保险成了高风险行业。鉴于保险业具有极强的公众性和社会性，国家对保险业进行严格的监管。

保险监管的永恒主题是防范保险给付风险，始终强化“有多大本钱，做多大业务”的金融规则（刘生福和韩雍，2020），这就要求保险公司应当具有与其风险和业务规模相适应的资本，使得偿付能力监管成为保险监管的核心。而对于偿付能力充足率不达标的保险公司，我国监管机构普遍采取“适时监管干预”而非“即时强制纠正”（赵桂芹和仲赛末，2019）。实际上，“即时纠正”的概念是20世纪80年代提出的，并于1991年被纳入美国法律，作为一种监管机构对于偿付能力不足银行做出关门决定的减少宽容方式，目标是通过即时纠正措施来降低偿付能力不足银行的数量，联邦存款保险公司因为关闭/解散破产机构的损失也会随之减少（Cole and White，2017）。与此同时，Barnes（2016）证实了在金融危机期间美国寿险公司由于许可的会计惯例使得州层面的监管宽容得以存在，并且这种监管宽容起到了替代接受问题资产救助计划资金的作用。

本文将试图从偿付能力监管角度研究我国寿险公司的风险承担。虽然寿险公司的经营管理受到诸多因素的影响，比如险种多元化通过资源共享机制和分散风险机制对寿险公司经营效率产生影响（卓志和孟祥艳，2018），以及整体经济环境走向、公司成立时间长短、规模大小、是否具有银行背景或大企业资源背景等均与寿险公司的经营效率息息相关（吴望春和李春华，2020），但是风险承担也是一个重要考量因素，而偿付能力监管作为外部治理因素可能会影响到寿险公司的风险承担。与其密切相关的监管制度自然是“偿一代”与“偿二代”，而且均沿用“分类监管”措施，允许监管机构视情况弹性决定处置方式，是“有选择性”的监管措施，这是否意味着存在着监管宽容呢？从理论上讲，一方面，监管宽容可能诱使保险公司选择激进的发展策略，无论是承保业务还是投资业务，以致产生极其不利的社会影响，也可能让有问题的保险公司抱有侥幸心理，延误处置时机与提高处置成本，增加了保险公司的风险承担；另一方面，监管宽容也可能为保险公司赢得宝贵的缓冲空间，促使保险公司合理规划业务结构，无论是产品设计还是资金运用，继而有效地降低了风险水平。实际上，监管宽容不止存在于保险公司，同样发生在银行，而且针对银行的监管宽容的形式可以是放松资本充足率要求等监管标准，如果监管部门认为金融机构的关闭清算对金融体系或经济有

较大的影响，就可能采取监管宽容政策，尽管监管宽容能够减少当前清算的经济成本，却以增加银行的风险承担为代价，因此常常被称之为“为了复苏的赌博”（杨军华，2011）。现有文献通常关注了监管宽容的存在性（赵桂芹和仲赛末，2019），忽略与寿险公司的风险承担之间的关系。因此，本文的第一个具体研究问题：监管宽容是否对寿险公司风险承担有影响。

进一步地，为什么在相同的监管环境下不同保险公司的决策行为存在着明显的差异呢？行为决策理论认为，在风险型决策中，与经济利益的考虑相比，决策者对待风险的态度起着更为重要的作用。即便在监管宽容的环境下，保险公司的决策行为依然存在着很大的差异，包括对待监管的态度以及投融资行为，而这些也直接影响到保险公司层面的风险承担。相对不存在监管宽容的情形，监管宽容的存在为保险公司赢得了缓冲的时间和空间，尤其为保险公司是否以及如何补充资本等决策行为提供了更多的缓冲。而且这些决策行为差异取决于如何判断监管宽容的广度和深度。一般来说，监管宽容的广度越宽泛、深度越明显，保险公司越可能无视监管，越不愿意采取及时补充资本的举措，越倾向于激进的投资策略，从而将更多的市场风险纳入到保险公司经营函数当中，提高保险公司的风险承担水平。我们认为在不同风险态度下，保险公司即便在相同的监管宽容环境下也可能采取不同的投资策略，主要表现为非效率投资，可能会影响保险公司的风险承担。为此，本文的第二个具体研究问题：监管宽容对寿险公司风险承担的影响是否通过非效率投资这一作用机制而产生。

国内已有文献考察了监管宽容存在性及其后果的影响（赵桂芹和仲赛末，2019），但还没有文献深入分析监管宽容存在的深度（主要表现在偿付能力充足率不达标所持续的时间长度）以及在不同的监管宽容状态下保险公司的经营状况。按照现有监管制度，只有偿付能力充足率高于150%的保险公司，才不会被监管部门特别关注。那么接下来的问题是，保险公司偿付能力充足率不足150%，其下一年的做法无外乎是：第一类是未补充任何资本，偿付能力充足率依然不足；第二类是尽管补充资本，但仍然不足；第三类是通过补充资本或者调整业务结构使其偿付能力充足率达标。相对于第二类公司而言，第一类公司存在着过度利用监管宽容的可能性。可见，在保险公司偿付能力充足率已经低于监管标准但还未被监管部门实施强制措施时，保险公司如何调整资本结构和业务规划及其承担的风险水平对于包括投保人在内的利益相关者和监管部门来说是十分重要的问题。

如果把保险的经济效果看作是风险转移、赔偿和金融中介，那么非寿险和健康险的主要特征应该是风险转移和赔偿功能，而寿险的主要特征是金融中介职能（Ward and Zurbruegg，2000），特别是寿险经常被视为传统金融资产如权益和债券的替代品（Li et al.,2007）。换言之，作为金融服务和资本市场投资基金的提供者的寿险的日益重要性已在发达经济体中得到认可，然而在一些发展中国家依旧很低（Beck and Webb，2002），再加上保险经济效益的实现是以国家监管、经济体系及文化氛围为条件的。鉴于此，本文以 2009－ 2019 年在我国经营业务的74家寿险公司为研究样本，考察我国寿险市场上监管宽容的存在性和持续性，若存在监管宽容，那么存在的范围和幅度有多大，这些寿险公司是否会及时补充资本，以及监管宽容对寿险公司的风险承担行为产生怎样的影响，是否通过非效率投资这一作用机制呢？本文结论有利于进一步完善监管机构对偿付能力充足率不足公司采取有效的监管措施，有助于推动保险业向高质量发展转变，尤其是随着现代经济体系的构建，保险业已迎来战略机遇期，不论是经济高质量发展、完善风险处置机制，还是养老、医疗等民生保障，都需要保险公司的深度参

与。

本文结构安排如下：第二部分为监管宽容、非效率投资和风险承担的研究假设；第三部分是研究设计；第四部分进行实证结果及分析，旨在验证研究假设是否成立，并基于实证结果予以剖析；第五部分为结论和建议，对全文进行总结并提出相关政策建议。

## 2.研究假设

事实上，监管宽容并非个例。特别是随着科技创新和社会进步，各种金融产品及其引发的风险事件层出不穷，比如从上个世纪七八十年代日本因高收益率先后导致了9家公司破产的寿险产品，到2008年AIG大量出售并最终引发全球金融危机的CDS产品；从1999年我国开始第一张投资型保单，到最近几年博人眼球的高收益率型保险理财产品，再到2018年蚂蚁金服联合信美人寿推出的“相互保”。这些产品及其所在金融机构在发展中不断涌现的风险，有着史无前例的复杂性和长期性，成为监管部门开展工作中的重大挑战。回顾过去，从日本和美国可以看出，相同的是，政府对于保险公司都是出手相救的态度，是以监管宽容的形式来处理问题。此外，监管支持下的许可会计惯例也被用作一种监管宽容的形式，正如Gao (2013)估计，由于2008年的许可会计惯例，使得寿险公司总共获得了约89亿美元的法定资本救济，这一数额远远超过了以前的总水平，将其视为一种监管宽容，而且Barnes（2015）也证实了在金融危机期间对于寿险公司由于许可的会计惯例使得州层面的监管宽容得以存在，并且这种监管宽容起到了替代接受问题资产救助计划资金的作用，为寿险公司提供了资本缓冲。而且Valencia和Laeven（2008）指出，在国际背景下监管宽容是危机管理的共同特征，单就在42个跨国危机事件中，有三分之二左右的事件发生了延长的宽容。在我国，备受关注的“宝万之争”与“安邦保险被接管”这两个风险事件中同样演绎着监管宽容，因为对于偿付能力充足率低于150%的保险公司，监管机构普遍采取“适时监管干预”而非“即时强制纠正”的措施，这给保险公司留下是否以及如何补充资本的选择空间，但也会延长了保险公司补充资本的时间与降低补充资本的压力。需要注意的是，保险公司的高管层也是自然人，其在决策中不可避免地与监管部门进行博弈，尤其是那些处于临界值的保险公司，其更有动机去调整业务结构，会进一步加剧这类公司融入监管宽容的可能性。基于此，我们提出研究假设H1：我国寿险业的监管宽容不仅存在着不断扩大的趋势性，而且呈现出较长的持续性，特别是对于处于监管临界值的寿险公司更可能融入监管宽容的区间。

当监管部门发现保险公司陷入困境时，一个选择就是允许其继续经营，寄希望保险公司能自动纠正问题，以及为保护保单持有人利益、防范系统性风险发生的监管导向才会导致“监管宽容”的存在，这将对保险公司的风险行为产生一定影响。具体会产生怎样影响，视保险公司的处境与反应而论，正如Buser et al.（1981）的监管成本理论认为，监管当局会通过改变商业银行触犯监管原则的显性或隐性成本，引导其合理调整资本和风险水平。实际上，监管宽容也是一把“双刃剑”，在为保险公司提供缓冲的同时也要发生额外的成本，因为在现实生活中，由于不同利益主体的立场不同，保险公司所采取的具体举措未必与监管初衷吻合，甚至是假借监管宽容谋取不当利益，不乏存在着“以小博大”的行为。Grace et al.（2003）发现，若在流动性问题上对保险公司予以监管宽容，则会导致保险保障基金成本上升，降低社会总体福利。Lai et al.（2015）发现，监管宽容

的存在可能会增加破产成本，还发现在RBC监管制度下若存在监管宽容或者延长监管宽容时间，不仅会削弱保险公司恢复偿付能力的动力，还会造成监管干预的延迟。更为严重的是，若监管机构对问题公司没有及时采取强制措施，保险保障基金的征缴又使用固定费率制，则容易引发严重的道德风险问题。又比如，以存款保险制度为例，从监管当局角度看，即便金融机构倒闭，最后也有存款保险机构兜底；从存款保险机构角度看，基于其政府色彩以及非营利性质，可能存在监管容忍的情形。正如Dekle and Kletzer（2004）指出，为削减保险基金的支付，对问题银行采取容忍的态度使得金融风险不断累积，最终为解决问题付出了更大的代价，导致整体经济效益下降。基于此，我们提出假设H2：存在监管宽容的寿险公司所承担的整体经营风险要明显高于不存在监管宽容的寿险公司，而且监管宽容持续的时间越长，使得寿险公司所承担的经营风险也越大。

风险承担与保险经理人的行为选择密切相关，而保险公司经理人的决策行为受到内部治理和外部监管的影响。内部治理的监督与激励强调经理人的行为能够满足股东财富水平的最大化；而来自外部的监管则强调保险公司经营的稳健性，会对保险公司经营的风险进行控制，因此保险公司经理人的风险承担行为决策受到外部监管和内部治理的双重约束，二者之间可能存在“替代效应”（Shleifer and Vishny，1997）或“促进效应”（Becher and Fye，2011)。部分学者研究外部监管和内部治理对财险公司风险承担的影响（徐华和李思荟，2013），但很少有学者关注对寿险公司的影响。同时，投资行为作为内部治理的表现形式之一，其与外部监管共同对寿险公司的风险承担产生怎样的影响，也有部分学者予以关注，比如周桦和张娟（2017）指出，在偿二代下保险公司的业务结构、承保质量、资产配置风险等因素均会反映在最低资本要求中，保险公司必须要考虑选择不同的产品线、投资策略或交易对手所带来的最低资本的增加，考虑除去资本成本增加后的真实收益；刘玮等（2018）在计划行为理论基础上构建了一个分析寿险公司权益类投资行为的分析框架并进行实证分析，结果表明偿付充足率,寿险责任准备金等约束信念类指标对寿险公司权益类资产配置的影响并不显著。赖周静（2020)指出，寿险公司投资业务越多，风险承担越大。更有趣的是，张志宏（2014）考察了缺乏强制监管干预下的台湾寿险公司，发现偿付能力不足的台湾寿险公司会在监管宽容期间增加投资风险来提高隐含选择权的价值，表现出较强的投机倾向，可能引发过度投资问题。即便在偿付能力不达标的情况下监管部门非采取“及时纠正措施”，给予寿险公司一定程度上的监管宽容，尤其是延长监管宽容的持续时间，同时寿险公司也会适当地降低非效率投资，继而改善其风险承担状况。为此，我们提出研究假设 H3：监管宽容对寿险公司风险承担的影响主要是通过非效率投资这一中介效应实现的，尤其对于监管宽容深度更是如此。

## 3．研究设计

### 3.1 数据来源

本文基于2010年至2019年在我国境内经营业务的74家寿险公司来考察其风险承担，主要侧重从监管宽容的广度和深度两个维度进行剖析。本文原始数据主要来自于银保监会网站、历年《中国保险年鉴》以及各寿险公司的官网，并基于其各自含义经作者计算整理所得，形成了独具特色的寿险公司风险承担数据库。

### 3.2 变量定义

1）被解释变量和主要解释变量

本文的被解释变量是风险承担，既包括总体经营风险又包括承保风险与投资风险。本文的第一个关键解释变量是监管宽容的广度，主要是判别监管宽容的存在性；第二个关键解释变量是监管宽容的深度，主要是量化监管宽容的持续性。以上变量的具体计算方法如下：

被解释变量：风险承担

风险承担是企业股东或管理者为了追逐高额利润愿意为之付出代价的倾向(Lumpkin et al.，1996)，本质上是一种决策行为取向。综合参考Baranoff and Sager(2002)、 Cheng et al. (2011)、Hu and Yu(2014)和孙祁祥等（2015）等文献对寿险公司风险承担的考量及分析，本文将从如下两个层级来测度寿险公司的风险承担。第一个层级是从总体上来量化寿险公司的经营风险(Risk1)，选用资产调整后的净现金流的三年滚动标准差，区别于以往的净资产收益率的标准差，原因在于：寿险公司在很多方面与银行相似，其资金流动性相对于存量经营成果而言更重要。第二层级是从业务方面来量化，主要是承保业务和投资业务两个方面，其中承保业务方面的风险主要是指退保率(Risk2)，即寿险公司财务报表上的退保金除以保费收入，该指标越大，承保风险越高；投资业务方面的风险是用投资风险资产占比来量化（Risk3）,即投资风险资产除以总资产，而投资风险资产是通过交易性金融资产、衍生金融资产、买入返售金融资产、保户质押贷款、可供出售金融资产、持有至到期投资、存出资本保证金和投资性房地产加总取得，该指标越大，说明寿险公司的投资风险越高。

解释变量：监管宽容的广度和深度

Mcshane et al.(2010)将单独一个州监管的二元变量作为监管容忍的代理变量，但限于国情差别，很难效仿。在参考赵桂芹和仲赛末（2019）的基础上，并基于我国的监管制度要求，本文将基于两个分界点来定义监管宽容的广度，分别是偿付能力充足率不足150%和偿付能力充足率不足160%，因为后者存在着管理层操纵业务的动机和可能性。如此一来，监管宽宽容的广度用两个哑变量来测度，第一个哑变量为Twide1，即如果偿付能力充足率不足150%，下一年仍未能补充资本或者补充后仍不足150%，则表明存在监管宽容，该变量取1，否则为0；第二个哑变量为Twide1，即如果偿付能力充足率不足160%，下一年仍未能补充资本或者补充后仍不足160%，则表明存在监管宽容，该变量取1，否则为0。

相比之下，学者们关注了监管宽容存在性，忽略了持续性，显然这是不够的。为此，本文将考虑到监管宽容的深度，该指标也是反映了监管宽容的程度。同上文借助两个分界点相似，这里依然有两个变量量化监管宽容的深度，一个变量是Tdeep1，是指一家寿险公司从首次出现偿付能力充足率不足150%到这一比率再次达到150%以上的时间长度，这个数值越大，说明监管越宽容；另一个变量是Tdeep2，是指一家寿险公司从首次出现偿付能力充足率不足160%到这一比率再次达到160%以上的时间长度。

2）中介变量：非效率投资

借鉴Richardson（2006）和任广乾等（2020），本文将选用如下投资回归模型的残差来量化非效率投资（IIN），如果残差为正，则说明投资过度；如果残差未负，则说明投资不足。将投资回归模型设定为：

$$\mathrm{Invest}_{it} = \propto_i + \beta_1 Growth_{it} + \sum \gamma_j Control_{it} + \sigma_{it} \quad (1)$$

其中：Invest为投资风险资产的自然对数；Growth为保费增长的自然对数，

而Control则是一些控制变量；$\sigma_{it}$为该模型残差，即用来量化非效率投资IIN。

3）控制变量

其他控制变量包括：（1）总资产收益率（ROA），是衡量寿险公司经营业绩的常用指标，该指标越大，说明经营越好，承担的风险水平越低；（2）财务杠杆（Leverage）,是负债除以总资产，该比率越大，说明还债风险越高，破产概率也加大，风险承担越高；（3）第一大股东持股比例（First）,该指标越大，说明股权集中度越大，一股独大的可能性越大，风险承担可能越高；（4）公司规模（Size），选用总资产的自然对数，公司规模越大，越有能力承担更高的风险水平（赵桂芹和仲赛末，2019）；（5）是否上市（List），为哑变量，如果为上市公司，则取1，否则为0；（6）是否为中资公司（China），为哑变量，如果为中资公司，则取1，否则为0。

### 3.3 计量模型

1）监管宽容对寿险公司风险承担的影响回归模型

为更好地理清监管宽容与寿险公司风险承担之间的关系，本文将设定如下模型：

$$\mathrm{Risk}_{it} = \propto + \beta_1 Tolerance_{it} + \sum \gamma_j Control_{it} + \varepsilon_{it} \quad (2)$$

其中，Risk代表寿险公司的风险承担水平，分别由总体经营风险Risk1、承保风险Risk2和投资风险Risk3来量化;Tolerance代表监管宽容，包括监管宽容的广度和深度，分别由 Twide1/Twide2）和 Tdeep1/Tdeep2 来测度。$\propto$代表常数项；$Control$代表控制变量，是其他影响寿险公司风险承担的公司层面特征变量。

2）非效率投资的中介效应检验模型

参考许志勇等（2020）的做法，本文将设定如下模型来检验非效率投资的中介效应：

$$\mathrm{IIN}_{it} = \tau + \varphi_1 Tolerance_{it} + \sum \gamma_j Control_{it} + \epsilon_{it} \quad (3)$$

$$\mathrm{Risk}_{it} = c + \beta_2 Tolerance_{it} + \vartheta \mathrm{IIN}_{it} + \sum \gamma_k Control_{it} + v_{it} \quad (4)$$

具体的检验流程如下：模型（3）中如果系数$\varphi_1$显著，说明监管宽容会影响到非效率投资，接下来如果$\vartheta$也显著，则说明存在中介效应。进一步检验，如果模型（4）中的系数$\beta_2$不显著则表明存在完全中介效应，若显著则说明存在部分中介效应，可通过计算$\varphi_1\vartheta/\beta_2$报告中介效应占总效应的比例。

3）内生性检验模型

同时为保证回归结果的可靠性和准确性，本文选用工具变量进行内生性检验。效仿Chen et al.（2013）的做法，本文选用两阶段残差包容法（two-stage residual inclusion，2SRI）。在第一阶段的回归模型中，本文考虑的是影响监管宽容广度的因素，即在哪些情形下监管部门会给予寿险公司宽容，并选用Logit模型进行估计，于是将内生性检验模型设定为：

$$\mathrm{Prob}[\mathrm{Twide1}(/\mathrm{Twide2}) = 1] = \varphi\left(\vartheta \mathrm{Gap}_{i0} + \gamma_j \mathrm{control}_{it} + \tau\right) \quad (5)$$

其中Gap代表寿险公司在整个样本期间第一次出现的时间与成立时间之间的时间间隔，这里$\varphi(\cdot)$则表示为对数累计分布函数。

由于第一阶段是非线性模型（Logit），决定了不能使用两阶段最小二乘法进

行估计，相反可以选用两阶段残差包容法，该方法最早是由Hausman（1978）提出的，于是将第二阶段的回归模型设定为：

$$Risk_{it} = \propto + \beta_1 Twide1(/Twide2)_{it} + \sum \gamma_j Control_{it} + \pi F_Residual_{it} + \varepsilon_{it} \quad (6)$$

其中，F_Residual是第一阶段回归中的残差，其系数π如果是显著的，则说明不存在内生性，因为这个系数代表了一个增强的回归检验，而它的显著性则表明数据支持模型规范的内生效应。

### 3.4 描述性统计

各变量进行统计分析，主要报告相关变量的均值及其标准差（表1）。样本个数为610，其中以偿付能力充足率150%为界限不存在监管宽容的样本数仅是566，存在监管宽容的样本数为44；有趣的是，若以偿付能力充足率160%为界限，存在监管宽容的样本数为62，这说明不乏有一些公司的偿付能力充足率处于监管临界线。从监管宽容广度来看，无论是以偿付能力充足率150%还是160%为界限，存在监管宽容的寿险公司的经营风险和承保风险的均值明显高于不存在监管宽容；然而，投资风险在两类中未能存在明显差异。初步推测，监管宽容会加剧寿险公司的风险承担，尤其是经营风险和承保风险。其他变量不再赘述。

表1变量的描述性统计

| | 全样本 | Twide1=0 | Twide1=1 | Twide2=0 | Twide2=1 |
|---|---|---|---|---|---|
| | 610 | 566 | 44 | 548 | 62 |
| Risk1 | 0.859 | 0.511 | 4.410 | 0.524 | 3.261 |
| | (8.751) | (5.699) | (22.872) | (5.806) | (19.556) |
| Risk2 | 0.150 | 0.126 | 0.448 | 0.128 | 0.341 |
| | (0.316) | (0.267) | (0.614) | (0.269) | (0.549) |
| Risk3 | 0.691 | 0.691 | 0.691 | 0.693 | 0.676 |
| | (0.291) | (0.299) | (0.160) | (0.301) | (0.187) |
| Roa | -0.010 | -0.010 | -0.008 | -0.011 | -0.005 |
| | (0.035) | (0.035) | (0.033) | (0.035) | (0.029) |
| Leverage | 0.830 | 0.820 | 0.954 | 0.810 | 1.010 |
| | (0.246) | (0.251) | (0.107) | (0.204) | (0.441) |
| First | 0.505 | 0.519 | 0.363 | 0.523 | 0.374 |
| | (0.250) | (0.251) | (0.188) | (0.252) | (0.194) |
| Size | 10.052 | 9.954 | 11.307 | 9.931 | 11.117 |
| | (1.930) | (1.927) | (1.491) | (1.946) | (1.402) |
| Age | 9.144 | 9.122 | 9.432 | 9.082 | 9.694 |
| | (5.489) | (5.573) | (4.305) | (5.623) | (4.115) |
| List | 0.170 | 0.166 | 0.227 | 0.166 | 0.210 |
| | (0.376) | (0.372) | (0.424) | (0.372) | (0.410) |
| China | 0.611 | 0.588 | 0.909 | 0.584 | 0.855 |
| | (0.488) | (0.493) | (0.291) | (0.493) | (0.355) |

注：（ ）为对应变量的标准差。

## 4．实证结果及分析

本文实证分析的顺序是：首先，分别为偿付能力充足率150%和160%为界限，从广度和深度两个维度来判别监管宽容的存在性；其次，在对监管宽容与寿险公司风险承担进行双变量分析的基础上，借助于固定效应模型进行实证研究，旨在探究监管宽容对寿险公司风险承担的影响效果；再次，利用回归分析来检测这一影响是否通过非效率投资这一中介效应实现；最后，利用两阶段残差包容法进行内生性检验，确保结论的可靠性。

### 4.1 监管宽容存在性

按照现行监管制度，如果保险公司的偿付能力充足率达不到150%，监管部门就可能对其采取特别措施予以关注。然而，现实并非如此，存在着一定程度上的延迟监管，也可视为一种监管宽容的形式。正如上文所述，本文将从广度和深度两个维度上来界定监管宽容，并基于我国寿险公司的实际情况来进行检测。从广度来看，图1展示了我国寿险公司中存在监管宽容的数量，最近几年呈现上市趋势，而且以160%为界限更加凸显，这也生动地诠释了存在着部分公司的偿付能力充足率处于监管临界线；图2呈现的是，存在监管宽容的寿险公司数量占全年所有寿险公司的比重，同样我们发现，2017以来这一比例都高达20%，这说明平均来看，五家寿险公司中就有一家存在监管宽容现象，一方面解释了监管宽容的普遍性，另一方面也诠释了偿付能力充足率不是很乐观。

图 1 存在监管宽容的寿险公司数量

图 2 存在监管宽容的寿险公司比重

显然，偿付能力充足率不达标理应受到监管部门的特别关注，这样寿险公司应该基于偿付能力状况及时采取措施，最常见的举措应该是补充资本，继而提升偿付能力充足率，那么实际上又如何呢？我们分别统计了偿付能力充足率不足150%和160%的寿险公司，当年及下一年的资本补充情况（见表2）。可以看到，当偿付能力充足率小于150%或者160%时，当年未补充的公司数目相对于补充的两倍，而且下一年仍然未补充的公司数目也较多，尤其是在偿付能力充足率小于150%的情形下，这说明这些公司可能受制于融资约束或者可能未正视监管制度。

表2 寿险公司资本补充情况（单位：年度—公司数量）

| | 当年未补充 | 当年补充 | 下年未补充 | 下年补充 |
|---|---|---|---|---|
| 偿付能力充足率小于 150% | 63 | 24 | 45 | 26 |
| 偿付能力充足率小于 160% | 84 | 35 | 60 | 40 |

同时，从深度上来检测寿险公司的监管宽容程度，主要是借助于从第一次偿付能力充足率未达到150%或者160%到再次达到150%或者160%的时间长度（见表3），这也在一定程度上揭示了监管宽容的持续性，也诠释了寿险公司对待监管制度的态度和立场。不难看出，大部分寿险公司在偿付能力充足率不达标的情况下，第二年通过补充资本或者调整业务结构使其符合监管要求，但也有部分寿险公司需要两年甚至三年的时间才能改善其处境，甚至有个别公司需要四年时间。

表3 寿险公司偿付能力充足率达标所需时间

| 持续时间（年） | 偿付能力充足率小于 150% | 偿付能力充足率小于 160% |
|---|---|---|
| 1 | 22 | 30 |
| 2 | 13 | 18 |
| 3 | 8 | 12 |
| 4 | 1 | 2 |

综合来看，寿险公司的监管宽容不仅具有普遍的存在性，还有着较长的持续性，尤其是接近监管临界值，支持本文提出的假设1。接下来，有必要深入分析监管宽容会给寿险公司的风险承担带来怎样的影响，进而提出相关的监管政策导向。

## 4.2 分组分析检验

在进行回归分析之前，本文分别依据偿付能力充足率为150%和160%所判定的监管宽容广度进行分组，表3中汇报了各组寿险公司风险承担的均值及组间差异的T检验。

可以看出，按照偿付能力充足率为150%进行分组后，无论是经营风险Risk1，还是承保风险Risk2，组别之间均存在着显著差异，即存在监管宽容的寿险公司比不存在的承担更高的风险水平，但这两组在投资风险Risk3上未能存在显著差异。类似地，对于偿付能力充足率为160%，也有相似的发现。如此一来，我们可以看出，存在监管宽容的寿险公司所承担的风险水平略高一些，尤其是经营风险和承保风险。

表4 分组检验结果

| | | Risk1 | Risk2 | Risk3 |
|---|---|---|---|---|
| 偿付能力充足率为150% | Twide1=1 | 4.41 | 0.448 | 0.691 |
| | Twide1=0 | 0.511 | 0.126 | 0.69 |
| | T值 | 2.81*** | 6.77*** | 0.01 |
| 偿付能力充足率为160% | Twide2=1 | 3.261 | 0.341 | 0.676 |
| | Twide2=0 | 0.524 | 0.127 | 0.692 |
| | T值 | 2.26** | 5.15*** | -0.42 |

注：***、**、*分别表示在1%、5%、10%的水平下显著。下文同上。

## 4.3 监管宽容对寿险公司风险承担影响的主回归分析

为更健全地探析监管宽容对寿险公司风险承担的影响，本文将从监管宽容的广度和深度两个维度出发进行实证研究。

一方面，从监管宽容广度来看，本文基于模型（2）进行回归分析（见表5）。

需要指出的是，考虑到监管宽容对寿险公司风险承担的影响存在滞后性，本文所有回归分析均是基于滞后一期实现的。可以看出，无论是经营风险还是承保风险，监管宽容对其都产生了显著正向影响，这说明对寿险公司越宽容，他们在经营过程中越可能采取激进的发展策略，尤其是承保业务方面，而监管宽容对投资风险影响是负的，尽管在以偿付能力充足率150%为界限判别监管宽容的情形下不显著，依然可以看出，存在监管宽容的寿险公司已意识到自身的处境，继而合理调整投资结构，适当地降低投资风险资产的比重，这与赵桂芹和仲赛末（2019）的研究一致。

表5 监管宽容广度对寿险公司风险承担的影响效果

| | (1) Risk1 | (2) Risk2 | (3) Risk3 | (4) Risk1 | (5) Risk2 | (6) Risk3 |
|---|---|---|---|---|---|---|
| L.Twide1 | 4.648*** | 0.213*** | -0.007 | | | |
| | (3.49) | (3.80) | (-0.20) | | | |
| L.Twide2 | | | | 2.704** | 0.123** | -0.059** |
| | | | | (2.35) | (2.53) | (-2.08) |
| L.Roa | 12.928 | -0.319 | -1.048*** | 9.925 | -0.450 | -1.060*** |
| | (0.95) | (-0.56) | (-3.12) | (0.72) | (-0.78) | (-3.18) |
| L.Leverage | 2.230 | 0.252*** | -0.084 | 2.704 | 0.273*** | -0.058 |
| | (1.04) | (2.86) | (-1.62) | (1.24) | (3.04) | (-1.11) |
| L.First | 0.643 | -0.059 | -0.042 | 0.468 | -0.067 | -0.055 |
| | (0.44) | (-0.98) | (-1.18) | (0.31) | (-1.08) | (-1.4) |
| L.Size | -0.400 | 0.022 | 0.047*** | -0.362 | 0.023 | 0.049*** |
| | (-1.17) | (1.51) | (5.60) | (-1.05) | (1.61) | (5.77) |
| L.Age | -0.024 | -0.006 | 0.006*** | -0.036 | -0.006* | 0.006*** |
| | (-0.28) | (-1.59) | (2.98) | (-0.40) | (-1.72) | (2.80) |
| L.List | 0.004 | -0.061 | -0.049** | -0.004 | -0.062 | -0.053** |
| | (0.00) | (-1.61) | (-2.21) | (-0.00) | (-1.61) | (-2.38) |
| L.China | 1.227 | 0.086** | 0.009 | 1.229 | 0.087** | 0.011 |
| | (1.28) | (2.15) | (0.38) | (1.27) | (2.14) | (0.48) |
| Intercept | 1.305 | -0.293** | 0.350*** | 0.695 | -0.320*** | 0.326*** |
| | (0.46) | (-2.50) | (5.07) | (0.25) | (-2.70) | (4.76) |
| Year | Y | Y | Y | Y | Y | Y |
| N | 395 | 398 | 400 | 395 | 398 | 400 |
| $R^2$ | 0.071 | 0.172 | 0.238 | 0.054 | 0.155 | 0.246 |
| F-Value | 1.797 | 4.952 | 7.474 | 1.361 | 4.369 | 7.826 |

另一方面，从监管宽容深度来看，同样利用模型（2）进行类似的回归分析（见表6）。同监管宽容广度相似，监管宽容深度影响主要体现在承保风险上，监管宽容持续的时间越长，寿险公司越可能选择铤而走险的承保业务，这一点与现实很吻合。很多寿险公司选择提供高收益率的产品来博取投保人的眼球，可以实现短期内保险业务快速发展的目标，但同时也会加剧了保险公司的经营风险，尤其是如何兑现这么高的收益率，如果不能按时兑现，将会引发一系列问题，最具代表性的则是安邦保险在被接管之前的几年，以及作为“宝万之争”中姚振华进攻万科的先锋前海人寿。而且，也发现，监管宽容的深度对寿险公司经营风险产生正向影响，尽管以偿付能力充足率160%为判别标准的时候不是很显著，这可能

是由于其符合监管要求，未能对其经营效果产生很明显的影响。

表6　监管宽容深度对寿险公司风险承担的影响效果

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Risk1 | Risk2 | Risk3 | Risk1 | Risk2 | Risk3 |
| L.Tdeep1 | 1.421* | 0.135*** | -0.009 | | | |
| | (1.77) | (4.05) | (-0.44) | | | |
| L.Tdeep2 | | | | 0.627 | 0.080*** | -0.034** |
| | | | | (0.92) | (2.80) | (-2.07) |
| L.Roa | 11.600 | -0.252 | -1.058*** | 9.581 | -0.421 | -1.071*** |
| | (0.84) | (-0.44) | (-3.14) | (0.69) | (-0.73) | (-3.21) |
| L.Leverage | 3.274 | 0.259*** | -0.082 | 3.548 | 0.266*** | -0.058 |
| | (1.52) | (2.97) | (-1.59) | (1.62) | (2.97) | (-1.11) |
| L.First | 0.181 | -0.061 | -0.043 | 0.031 | -0.066 | -0.054 |
| | (0.12) | (-1.00) | (-1.22) | (0.02) | (-1.08) | (-1.51) |
| L.Size | -0.364 | 0.020 | 0.048*** | -0.324 | 0.023 | 0.049*** |
| | (-1.05) | (1.41) | (5.62) | (-0.93) | (1.60) | (5.76) |
| L.Age | -0.043 | -0.006 | 0.006*** | -0.050 | -0.006* | 0.006*** |
| | (-0.49) | (-1.63) | (2.97) | (-0.56) | (-1.71) | (2.82) |
| L.List | -0.069 | -0.059 | -0.050** | -0.121 | -0.062 | -0.053** |
| | (-0.08) | (-1.55) | (-2.23) | (-0.13) | (-1.60) | (-2.37) |
| L.China | 1.295 | 0.087** | 0.009 | 1.291 | 0.086** | 0.012 |
| | (1.34) | (2.18) | (0.39) | (1.33) | (2.12) | (0.49) |
| Intercept | 0.433 | -0.284** | 0.347*** | -0.056 | -0.313*** | 0.326*** |
| | (0.15) | (-2.43) | (5.02) | (-0.02) | (-2.65) | (4.75) |
| Year | Y | Y | Y | Y | Y | Y |
| N | 395 | 398 | 400 | 395 | 398 | 400 |
| R2 | 0.049 | 0.176 | 0.238 | 0.043 | 0.158 | 0.246 |
| F-Value | 1.206 | 5.098 | 7.486 | 1.057 | 4.474 | 7.821 |

概述地讲，本文的实证研究，无论是从监管宽容的广度还是深度上看，均加剧了寿险公司风险承担水平，尤其是体现在承保业务上，支持本文提出的假设2。这也在一定程度上揭示了寿险公司在经营过程中存在着利用监管宽容进行“以小博大”的可能性，正所谓如果赌赢了，那就是柳暗花明又一村，不仅使自己可以达到监管标准，而且也有力地开拓了市场；如果赌输了，那就要监管部门出面来处理，显然这与监管宽容的初衷是相悖的。因此有效的监管宽容不应该一刀切，应该区别对待。接下来，本文将进行异质性检验，旨在探析不同特征的寿险公司如何应对监管宽容，进而提出更加明确的监管宽容导向建议。

### 4.4 监管宽容对寿险公司风险承担影响的异质性检验

1）基于股权制衡度进行异质性分析，主要是考虑到股权制衡一方面降低了控股股东的保守投资行为，另一方面又加强了对管理层的监管从而提高了公司的风险承担行为（王振山和石大林，2014）。Faccioetal. (2011)研究发现，在那些没有其他大股东对控股股东约束的公司来说，投资策略更加保守。为此，本文选择用第二大股东到第五大股东的持股比例之和与第一大股东持股比例的比值来衡量股权制衡度，按照这一比值的中位数将所有样本分成两组，即股权制衡度低和股权制衡度高，分别进行回归分析（见表 6）。限于篇幅，这里仅汇报监管

宽容对寿险公司经营风险的影响效果。可以看出，这一影响在股权制衡度低的一组并未得以体现，存在着一种负向倾向，尽管不够显著，这说明大股东在公司决策中有着较强的话语权，不愿意以公司的未来发展状况为赌注而是选择合理调整发展布局实现良性发展趋势。相比之下，对于股权制衡度高的一组来说，监管宽容对寿险公司风险承担有着较为明显的正向影响，尤其是监管宽容的广度，说明监管越宽容，这类公司越会主动地承担更高的风险水平，很可能这类公司的投资者更加注重市场的调节机制，更青睐于借助监管宽容提供的空间来及时调整业务结构，继而实现资本逐利的目标。

表7 监管宽容对寿险公司经营风险承担的影响效果：基于股权制衡度的异质性检验

| | 股权制衡度低 | | | | 股权制衡度高 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| L.Twide1 | -0.203 | | | | 11.715*** | | | |
| | (-0.35) | | | | (2.68) | | | |
| L.Twide2 | | -0.490 | | | | 7.776* | | |
| | | (-1.03) | | | | (1.95) | | |
| L.Tdeep1 | | | -0.356 | | | | 2.325 | |
| | | | (-1.00) | | | | (0.95) | |
| L.Tdeep2 | | | | -0.466* | | | | 1.603 |
| | | | | (-1.70) | | | | (0.67) |
| L.Roa | 3.172 | 3.375 | 2.841 | 3.236 | 38.516 | 25.963 | 9.060 | 4.920 |
| | (0.55) | (0.59) | (0.50) | (0.57) | (0.76) | (0.51) | (0.17) | (0.09) |
| L.Leverage | 1.653* | 1.850* | 1.710* | 2.013** | 10.259 | 11.601 | 12.119 | 12.488 |
| | (1.68) | (1.86) | (1.76) | (2.03) | (1.05) | (1.17) | (1.20) | (1.24) |
| L.First | -2.681 | -2.679 | -2.670 | -2.602 | 1.618 | 0.790 | 0.545 | 0.271 |
| | (-1.53) | (-1.53) | (-1.53) | (-1.50) | (0.29) | (0.14) | (0.09) | (0.05) |
| L.Size | 0.094 | 0.113 | 0.121 | 0.129 | 0.126 | 0.240 | 0.445 | 0.502 |
| | (0.49) | (0.59) | (0.63) | (0.68) | (0.10) | (0.19) | (0.35) | (0.40) |
| L.Age | -0.072 | -0.080 | -0.077 | -0.086 | 0.136 | 0.069 | 0.041 | 0.021 |
| | (-1.31) | (-1.44) | (-1.40) | (-1.56) | (0.53) | (0.27) | (0.16) | (0.08) |
| L.List | 1.467*** | 1.478*** | 1.503*** | 1.509*** | -4.913 | -5.045 | -5.822 | -5.961 |
| | (2.92) | (2.95) | (2.99) | (3.03) | (-1.16) | (-1.16) | (-1.32) | (-1.34) |
| L.China | -0.758 | -0.746 | -0.772 | -0.727 | 4.646 | 4.379 | 4.241 | 4.152 |
| | (-1.43) | (-1.41) | (-1.46) | (-1.38) | (1.38) | (1.28) | (1.22) | (1.20) |
| Intercept | -0.613 | -0.907 | -0.886 | -1.206 | -13.422 | -14.375 | -16.096 | -16.530 |
| | (-0.37) | (-0.55) | (-0.54) | (-0.73) | (-0.98) | (-1.03) | (-1.14) | (-1.16) |
| Year | Y | Y | Y | Y | Y | Y | Y | Y |
| N | 221 | 221 | 221 | 221 | 116 | 116 | 116 | 116 |
| R2 | 0.150 | 0.153 | 0.153 | 0.161 | 0.203 | 0.176 | 0.153 | 0.149 |
| F-Value | 2.243 | 2.311 | 2.308 | 2.446 | 1.575 | 1.326 | 1.116 | 1.083 |

2）按照经营属性，将寿险公司分为两大类：纯保障程度低和纯保障程度高，主要是借助于纯保障型产品保费收入占总保费收入的比重。正如魏华林（2018）所强调，保险应该是金融属性和保障属性的统一，保险公司过分强调金融属性忽视保障属性时，才会干扰市场发展的方向，为此“保险姓保”要求“保险回归保障”、“保险回归本源”。同样地，进行类似上文的分析（见表7）。可以看出，对于纯保障程度低的一组来说，监管宽容对寿险公司风险承担有着显著为负的影响，这说明监管越宽容，这类公司越主动地降低风险承担水平，真正意义上将监

管宽容政策导向视为缓冲资本的空间，继而不断调整业务结构来实现这一目标。相比之下，这一影响在纯保障程度高的一组并未得以体现，原因在于，这类公司可能更加倾向于经营纯粹的保险业务，更加尊重保险姓保的属性，监管导向对其经营方式的影响甚微。

表8　监管宽容对寿险公司经营风险承担的影响效果：基于经营属性的异质性检验

| | 纯保障程度低 | | | | 纯保障程度高 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| L.Twide1 | -0.121** | | | | -0.012 | | | |
| | (-2.43) | | | | (-0.44) | | | |
| L.Twide2 | | -0.090*** | | | | -0.020 | | |
| | | (-2.69) | | | | (-0.86) | | |
| L.Tdeep1 | | | -0.100** | | | | -0.003 | |
| | | | (-2.53) | | | | (-0.19) | |
| L.Tdeep2 | | | | -0.069*** | | | | -0.008 |
| | | | | (-3.05) | | | | (-0.60) |
| L.Roa | 0.157 | 0.188 | 0.076 | 0.158 | -0.110 | -0.094 | -0.117 | -0.107 |
| | (0.49) | (0.59) | (0.23) | (0.50) | (-0.42) | (-0.36) | (-0.45) | (-0.41) |
| L.Leverage | 0.174*** | 0.167*** | 0.184*** | 0.175*** | 0.020 | 0.027 | 0.017 | 0.023 |
| | (3.38) | (3.35) | (3.49) | (3.52) | (0.42) | (0.57) | (0.37) | (0.48) |
| L.First | 0.054 | 0.042 | 0.056 | 0.041 | -0.015 | -0.019 | -0.013 | -0.016 |
| | (1.45) | (1.11) | (1.50) | (1.12) | (-0.55) | (-0.69) | (-0.47) | (-0.59) |
| L.Size | 0.002 | 0.006 | 0.002 | 0.006 | -0.015** | -0.015** | -0.016** | -0.015* |
| | (0.30) | (0.71) | (0.28) | (0.74) | (-2.00) | (-1.99) | (-2.00) | (-1.97) |
| L.Age | -0.009*** | -0.009*** | -0.009*** | -0.009*** | -0.002 | -0.002 | -0.002 | -0.002 |
| | (-3.25) | (-3.19) | (-3.25) | (-3.29) | (-1.19) | (-1.26) | (-1.16) | (-1.22) |
| L.List | -0.047* | -0.057** | -0.047* | -0.058** | 0.042** | 0.041** | 0.042** | 0.041** |
| | (-1.97) | (-2.38) | (-1.98) | (-2.45) | (2.32) | (2.27) | (2.29) | (2.24) |
| L.China | 0.015 | 0.011 | 0.015 | 0.011 | 0.018 | 0.019 | 0.018 | 0.019 |
| | (0.72) | (0.53) | (0.72) | (0.54) | (0.82) | (0.87) | (0.83) | (0.86) |
| Intercept | -0.030 | -0.045 | -0.038 | -0.052 | 0.236*** | 0.232*** | 0.236*** | 0.233*** |
| | (-0.41) | (-0.62) | (-0.52) | (-0.71) | (3.82) | (3.76) | (3.82) | (3.76) |
| Year | Y | Y | Y | Y | Y | Y | Y | Y |
| N | 129 | 129 | 129 | 129 | 149 | 149 | 149 | 149 |
| R2 | 0.203 | 0.211 | 0.206 | 0.225 | 0.260 | 0.263 | 0.260 | 0.261 |
| F-Value | 1.777 | 1.877 | 1.811 | 2.029 | 2.905 | 2.951 | 2.892 | 2.920 |

3）考虑到业务集中度对寿险公司风险承担的影响，特别是孙祁祥等（2015）指出，产品集中度对寿险公司的利润和风险有正反两方面的作用：一方面，不同的寿险产品在产品开发设计、精算、承保理赔、投资和风险管理等方面有不同特点和要求，而集中于经营某些产品能够加强在该业务线上的数据和经验积累，逐步形成公司在特定产品上的专业优势，进而增加收益、降低风险；另一方面，不同的保险产品能满足消费者不同的需求，保险公司同时经营这些产品可以通过交叉营销、共享品牌来降低成本、增加收益。为此，本文将基于前五位保险产品的保费收入占总保费收入的比重将寿险公司分为业务集中度低和业务集中度高两大类（见表 8）。同样看出，对于业务集中度低的一组来说，监管宽容对寿险公司风险承担未能产生显著，而这一影响在业务集中度高的一组是显著为负的，说

明这类公司集中优势发展特定产品，继而显著降低其风险承担水平，即便是存在监管宽容，他们依然坚持自身的产品竞争优势，而非假借监管政策来谋求其他利益，也在一定程度上诠释出这类公司更加尊重自身的产品属性，更好地在监管框架下合理布局。

表9 监管宽容对寿险公司经营风险承担的影响效果：基于业务集中度的异质性检验

| | 业务集中度低 | | | | 业务集中度高 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| L.Twide1 | -0.017 | | | | -0.079** | | | |
| | (-0.58) | | | | (-2.05) | | | |
| L.Twide2 | | 0.008 | | | | -0.087*** | | |
| | | (0.35) | | | | (-2.71) | | |
| L.Tdeep1 | | | -0.004 | | | | -0.047* | |
| | | | (-0.26) | | | | (-1.92) | |
| L.Tdeep2 | | | | 0.001 | | | | -0.057*** |
| | | | | (0.11) | | | | (-2.84) |
| L.Roa | 0.261 | 0.260 | 0.257 | 0.260 | 0.295 | 0.319 | 0.309 | 0.309 |
| | (1.06) | (1.06) | (1.05) | (1.06) | (0.78) | (0.87) | (0.82) | (0.84) |
| L.Leverage | 0.068 | 0.060 | 0.065 | 0.062 | 0.059 | 0.065 | 0.057 | 0.066 |
| | (1.50) | (1.30) | (1.43) | (1.36) | (1.06) | (1.18) | (1.02) | (1.22) |
| L.First | -0.015 | -0.012 | -0.014 | -0.013 | 0.009 | 0.001 | 0.011 | -0.001 |
| | (-0.74) | (-0.61) | (-0.70) | (-0.66) | (0.18) | (0.02) | (0.22) | (-0.03) |
| L.Size | 0.000 | -0.000 | 0.000 | 0.000 | -0.022* | -0.020* | -0.022* | -0.019 |
| | (0.06) | (-0.00) | (0.06) | (0.02) | (-1.83) | (-1.67) | (-1.82) | (-1.58) |
| L.Age | -0.007*** | -0.006*** | -0.006*** | -0.006*** | 0.001 | 0.002 | 0.001 | 0.001 |
| | (-4.93) | (-4.81) | (-4.90) | (-4.85) | (0.38) | (0.46) | (0.34) | (0.36) |
| L.List | -0.007 | -0.005 | -0.007 | -0.006 | 0.037 | 0.028 | 0.034 | 0.026 |
| | (-0.52) | (-0.35) | (-0.48) | (-0.40) | (1.09) | (0.86) | (1.01) | (0.78) |
| L.China | 0.004 | 0.003 | 0.003 | 0.003 | 0.039 | 0.041 | 0.038 | 0.037 |
| | (0.30) | (0.23) | (0.27) | (0.25) | (1.20) | (1.26) | (1.15) | (1.14) |
| Intercept | 0.093** | 0.101** | 0.095** | 0.098** | 0.249** | 0.226** | 0.252** | 0.220** |
| | (2.04) | (2.18) | (2.08) | (2.13) | (2.50) | (2.30) | (2.52) | (2.24) |
| Year | Y | Y | Y | Y | Y | Y | Y | Y |
| N | 178 | 178 | 178 | 178 | 111 | 111 | 111 | 111 |
| R2 | 0.171 | 0.170 | 0.170 | 0.170 | 0.171 | 0.197 | 0.167 | 0.203 |
| F-Value | 2.081 | 2.064 | 2.060 | 2.056 | 1.215 | 1.442 | 1.178 | 1.494 |

简言之，基于不同角度的异质性分析，我们可以发现，监管宽容对寿险公司风险承担的影响并非存在着简单的正向影响，而是要视寿险公司的具体特征来论，特别是对于纯保障程度低和业务集中度高的组别来说，监管宽容显著地降低了寿险公司风险承担水平，也生动地诠释了这一类公司正视监管宽容这一制度，与段军山等（2018）的结论保持一致。这样也再次演绎了监管宽容对寿险公司风险承担影响的两面性，那么接下来的问题则是监管宽容是通过何种路径影响到寿险公司风险承担，以及到底应该对哪些寿险公司给予监管宽容呢？这些都有待证实。

## 5．进一步检验

### 5.1 中介效应检验

监管宽容对寿险公司风险承担的影响效果不尽相同，那么是否与传导机制有关呢？为此，本文利用模型（3）和（4）进行中介效应检验，主要是检测这一影响是否是通过非效率投资这一机制实现（见表9）。较为可观的是，我们发现，监管宽容广度和深度均显著地降低了非效率投资，也体现了监管宽容政策的正外部性。相比监管宽容广度，非效率投资在监管宽容深度对寿险公司风险承担影响中扮演着更加显著的中介效应角色，尤其是处于监管临界的状态下，支持本文提出的假设3。

表10 中介效应检验的回归结果

| | 非效率投资 | | | | 经营风险 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| L.Twide1 | -0.207** | | | | 9.531*** | | | |
| | (-2.23) | | | | (4.72) | | | |
| L.Twide2 | | -0.242*** | | | | 4.307*** | | |
| | | (-3.37) | | | | (2.64) | | |
| L.Tdeep1 | | | -0.117** | | | | 2.860** | |
| | | | (-2.14) | | | | (2.34) | |
| L.Tdeep2 | | | | -0.120*** | | | | 0.868 |
| | | | | (-2.92) | | | | (0.93) |
| IIN | | | | | -1.896 | -1.981 | -2.255* | -2.414* |
| | | | | | (-1.52) | (-1.54) | (-1.77) | (-1.87) |
| L.Roa | 0.482 | 0.555 | 0.446 | 0.514 | 7.886 | 6.591 | 8.956 | 7.975 |
| | (0.56) | (0.65) | (0.52) | (0.60) | (0.42) | (0.34) | (0.46) | (0.41) |
| L.Leverage | 0.140 | 0.172 | 0.132 | 0.169 | 3.067 | 3.818 | 4.320 | 4.716* |
| | (1.20) | (1.48) | (1.14) | (1.45) | (1.18) | (1.43) | (1.63) | (1.74) |
| L.First | 0.056 | 0.033 | 0.064 | 0.049 | 1.189 | 0.731 | 0.334 | 0.055 |
| | (0.71) | (0.42) | (0.81) | (0.62) | (0.68) | (0.41) | (0.19) | (0.03) |
| L.Size | -0.042** | -0.040** | -0.041** | -0.042** | -0.558 | -0.497 | -0.507 | -0.449 |
| | (-2.22) | (-2.14) | (-2.20) | (-2.24) | (-1.36) | (-1.19) | (-1.21) | (-1.06) |
| L.Age | 0.007 | 0.007 | 0.007 | 0.007 | 0.012 | -0.020 | -0.016 | -0.036 |
| | (1.52) | (1.45) | (1.52) | (1.44) | (0.12) | (-0.19) | (-0.15) | (-0.33) |
| L.List | -0.002 | -0.008 | -0.003 | -0.004 | -0.142 | -0.174 | -0.234 | -0.323 |
| | (-0.03) | (-0.16) | (-0.05) | (-0.08) | (-0.13) | (-0.16) | (-0.21) | (-0.29) |
| L.China | 0.201*** | 0.203*** | 0.200*** | 0.204*** | 2.035* | 2.051* | 2.163* | 2.181* |
| | (3.87) | (3.95) | (3.85) | (3.94) | (1.76) | (1.73) | (1.82) | (1.82) |
| Intercept | 0.072 | 0.044 | 0.072 | 0.054 | 0.982 | 0.219 | 0.034 | -0.572 |
| | (0.46) | (0.28) | (0.46) | (0.35) | (0.29) | (0.06) | (0.01) | (-0.16) |
| Year | Y | Y | Y | Y | Y | Y | Y | Y |
| N | 321 | 321 | 321 | 321 | 317 | 317 | 317 | 317 |
| R2 | 0.061 | 0.080 | 0.060 | 0.071 | 0.132 | 0.089 | 0.085 | 0.070 |
| F-Value | 1.228 | 1.647 | 1.203 | 1.460 | 2.685 | 1.717 | 1.625 | 1.333 |

实际上，保险公司经理人的风险承担行为决策受到外部监管和内部治理的双重约束。本文的实证结果，证实对于我国寿险公司来说，外部监管与内部治理二者之间很可能存在促进效应，二者联合对寿险公司风险承担水平产生影响。此外，对外部监管的理解应该更宽泛一些，比如官方监管和市场约束实际上都是保险监管的外部风险控制手段，两者互有优势，亦可互补。我国长期以来单独依靠官方

监管的模式不利于保险监管目标的实现，监管部门可以逐步引导市场发挥其约束作用，积极参与保险监管，这样才更有利于全面防范和控制保险公司的风险。

## 5.2 内生性检验

本文发现，在不同情形下，监管宽容对寿险公司风险承担的影响不尽相同，那么是否会存在着内生性呢？于是，本文借助于工具变量来予以深入剖析。这里选择企寿险公司在整个样本期间第一次出现的时间与成立时间之间的时间间隔为工具变量，原因在于：相对于既有寿险公司市场规模而言，其在市场上存续的时间越长，自身竞争力越强的同时越能满足监管要求，越不会陷入监管宽容的区间，即监管宽容的可能性越小。因此，第一阶段是利用公式（5）检验影响寿险公司监管宽容的因素，主要是考察工具变量的影响（见表 10）。可以看出，工具变量$Gap_0$对无论是对监管宽容广度还是深度的影响均在 1%的水平下显著，说明寿险公司在市场上存续的时间越长，则陷入监管宽容区间的可能性越小。同时，借助这个回归分析，我们可以看到，具备哪些特征的公司更可能陷入监管宽容呢？我们发现，Roa和 Age 同样对监管宽容广度和深度产生了显著正向，意味着经营绩效越好、公司年龄越大，则越可能需要监管宽容，与既有认知有些分歧，深入思考，可能是由于最近几年寿险市场竞争异常激烈，成立了许多新公司，这对于既有公司来说既是机遇又是挑战，需要不断调整业务结构，也需要监管部门能为其提供一定的缓冲空间；First均在 1%的水平下显著为负，意味着第一大股东持股比例越低，给予其监管宽容的可能性越大，因为在这样情形下公司决策中更加民主，其他股东更加有话语权，更应该尊重市场的竞争规则。较为有趣的是，对于处于监管临界值的寿险公司，Leverage 和 Size 也都分别产生了显著为正和负的影响，即对于高杠杆、小公司来说，监管部门更可能给予一定的宽容政策，鼓励他们通过调整业务结构在提升自身竞争力的同时促进寿险市场的良性发展。

表11 内生性检验的第一阶段回归结果

| | (1)<br>Twide1 | (2)<br>Twide2 | (3)<br>Tdeep1 | (4)<br>Tdeep2 |
|---|---|---|---|---|
| Gap | -0.458*** | -0.394*** | -0.458*** | -0.394*** |
| | (-4.04) | (-3.99) | (-4.04) | (-3.99) |
| L.Roa | 13.576* | 15.255** | 13.576* | 15.255** |
| | (1.86) | (2.29) | (1.86) | (2.29) |
| L.Leverage | 0.913 | 2.886*** | 0.913 | 2.886*** |
| | (0.81) | (2.58) | (0.81) | (2.58) |
| L.First | -4.729*** | -4.101*** | -4.729*** | -4.101*** |
| | (-3.61) | (-3.64) | (-3.61) | (-3.64) |
| L.Size | -0.191 | -0.353*** | -0.191 | -0.353*** |
| | (-1.39) | (-2.66) | (-1.39) | (-2.66) |
| L.Age | 0.302*** | 0.253*** | 0.302*** | 0.253*** |
| | (3.19) | (3.05) | (3.19) | (3.05) |
| L.List | -0.246 | -0.053 | -0.246 | -0.053 |
| | (-0.47) | (-0.11) | (-0.47) | (-0.11) |
| L.China | 0.614 | 0.855 | 0.614 | 0.855 |
| | (0.93) | (1.48) | (0.93) | (1.48) |

简言之，工具变量$Gap_0$对监管宽容广度和深度均产生了显著为负的影响，说明本文选择的工具变量很有解释力。基于此，利用公式（6）进行第二阶段的回

归分析（见表 11）。这样在控制了内生性后，依然发现监管宽容广度和深度对寿险公司风险承担的影响仍显著为正，再次支持本文提出的假设 1。正如上文所述，F_Residual的回归系数在 1%的水平下显著为负，代表了这是一个增强的回归检验，表明数据支持模型规范的内生效应（Hauseman，1978）。

表12　内生性检验的第二阶段回归结果

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| L.Twide1 | 11.017*** | | | |
| | (7.06) | | | |
| L.Twide2 | | 6.967*** | | |
| | | (4.98) | | |
| L.Tdeep1 | | | 11.087*** | |
| | | | (7.19) | |
| L.Tdeep2 | | | | 7.168*** |
| | | | | (5.18) |
| L.Roa | -1.463 | -0.445 | -1.898 | -0.821 |
| | (-0.31) | (-0.09) | (-0.40) | (-0.17) |
| L.Leverage | 0.205 | 0.156 | 0.291 | 0.420 |
| | (0.21) | (0.15) | (0.30) | (0.39) |
| L.First | 1.188** | 0.598 | 1.173** | 0.585 |
| | (2.15) | (1.05) | (2.13) | (1.03) |
| L.Size | -0.046 | 0.022 | -0.039 | 0.024 |
| | (-0.40) | (0.18) | (-0.33) | (0.19) |
| L.Age | 0.016 | -0.003 | 0.016 | -0.004 |
| | (0.56) | (-0.10) | (0.54) | (-0.13) |
| L.List | 0.520* | 0.404 | 0.499* | 0.380 |
| | (1.81) | (1.34) | (1.73) | (1.27) |
| L.China | -0.219 | -0.230 | -0.219 | -0.210 |
| | (-0.67) | (-0.66) | (-0.67) | (-0.61) |
| ..First_Residual | -11.382*** | -7.600*** | -11.433*** | -7.723*** |
| | (-7.34) | (-5.40) | (-7.40) | (-5.52) |
| Intercept | -0.586 | -0.710 | -0.730 | -0.967 |
| | (-0.53) | (-0.62) | (-0.66) | (-0.85) |
| Year | Y | Y | Y | Y |
| N | 321 | 321 | 321 | 321 |
| R2 | 0.219 | 0.162 | 0.221 | 0.170 |
| F-Value | 5.317 | 3.671 | 5.405 | 3.887 |

## 6．结论与建议

近年来，金融混业融合和创新深化使保险业在金融体系中的重要性逐渐增强，但费率市场化与资金运用渠道拓宽在成就投资型产品发展的同时也成为风险事件的导火索，比如轰动整个金融市场的“宝万之争”、曾与平安保险齐名的安邦保险被接管。而保险监管对于降低保险公司风险、切实维护投保人的合法权益十分重要。从引发 2008 年全球金融危机的 AIG 来看，以美国政府援助为代表的监管宽容在缓解 AIG 困境以及降低金融系统性风险方面扮演着举足轻重的角色。本文将以 2010 年至 2019 年我国 74 家寿险公司的面板数据为研究样本，分别以偿付能力充足率 150%和 160%为界限从广度和深度两个维度来判别寿险市场是否

存在监管宽容的基础上，探究监管宽容对寿险公司风险承担的影响效果与影响机制。结果发现，（1）无论是从广度上还是从深度上，我国寿险公司确实存在着监管宽容，尤其是最近几年更加明显；（2）监管宽容对寿险公司总体经营风险和承保风险产生显著正向影响，但是对投资风险产生负向影响，特别是处于监管边界；（3）这一影响主要是通过非效率投资这一中介效应实现，相对监管宽容广度来说，监管宽容深度对寿险公司风险承担的影响过程中非效率投资的中介效应更加明显。同时异质性研究表明，相对于股权制衡度低的公司来说，监管宽容对股权制衡度高的寿险公司的风险承担产生显著正向影响；但是相对于纯保障属性高和业务集中度低的公司来讲，监管宽容对纯保障属性低和业务集中度高的寿险公司的风险承担则产生显著负向影响，这一方面说明监管宽容对寿险公司风险承担的影响存在着非线性，另一方面也说明这一影响存在着非对称性。在上述基础上，还采用两阶段残差包容法对实证结果进行了内生性检验，而且甄别出盈利能力高、财务杠杆高、第一个股东持股低、公司年龄大等具备这些画像的公司，越可能被给予监管宽容。

本文的核心结论对寿险公司的差异化监管与优化风险承担具有重要意义。为此，本文主要提出如下三方面建议：一是从给予监管宽容的对象来看，应该是具备较强的盈利能力、较大的公司年龄和较低的第一股东持股比例等这些特征的寿险公司，而不是“一刀切式”的处理，尤其是处于监管边界的话，可以拓展到较高的财务杠杆和较小的公司规模，这主要是由于寿险公司的发展壮大需要一定的时间，更需要监管部门提供可观的制度安排，真正意义上发挥外部治理的作用；二是处于降低系统性风险角度来说，应实施差异化监管宽容政策，重点适用于纯保障属性低和业务集中度高的寿险公司而非股权制衡度高，否则将会适得其反；三是从投资者角度来看，应该甄别寿险公司不同投资动机，合理判断寿险公司是否存在投资过度，继而避免遭受不必要的投资损失，也益于寿险业的健康有序发展。

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# 监管宽容、非效率投资与寿险公司风险承担

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**关键词:** 监管宽容； 风险承担；非效率投资

**中文摘要:** 以美国政府援助为代表的监管宽容在缓解 AIG 困境以及降低金融系统性风险方面扮演着举足轻重的角色。近年来，金融混业融合和创新深化使保险业在金融体系中的重要性逐渐增强，但费率市场化与资金运用渠道拓宽在成就投资型产品发展的同时也成为风险事件的导火索。本文将以 2010 年至 2019 年我国 74 家寿险公司的面板数据为研究样本，从广度和深度两个维度来判别寿险市场是否存在监管宽容，以及监管宽容是否会对寿险公司风险承担产生影响。结果发现，无论是从广度上还是从深度上，我国寿险公司确实存在着监管宽容，尤其是最近几年更加明显；监管越宽容，寿险公司的经营风险和承保风险越大，而投资风险则越小，特别是处于监管边界；这一影响主要是通过非效率投资这一中介效应实现，相对监管宽容广度来说，监管宽容深度对寿险公司风险承担的影响过程中非效率投资的中介效应更加明显。异质性研究表明，监管宽容对寿险公司风险承担的影响特征在股权制衡度高、纯保障属性低和业务集中度高的公司较为明显。最后，在实践上助推监管宽容作为甄别寿险公司不同投融资动机的资质，以帮助监管层对不同投融资行为进行差异化监管。

# Market-Consistent or Market Sentiment:

# An Examination of the Informativeness of Embedded Value Accounting

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**Keywords:** embedded value accounting, price to embedded value ratio, market sentiment, insurer profitability

**Abstract.** Regulators and practitioners tend to consider embedded value reporting to be market consistent and to reflect a life insurer's realistic valuation. Using a sample of European public life insurers, we examine whether embedded values fully reflect market prices' information. We use the Heckman two-stage regression to control for life insurers' endogenous decision to disclose embedded values on a voluntary basis, and find that life insurers with market prices higher (lower) than their embedded values have higher (lower) profitability. The results suggest that embedded values do not capture all dimensions of market prices' information. Further investigation reveals that the above results are mainly driven by market sentiment. We find that market prices over-react to life insurers' profitability, resulting in lower (higher) future stock returns for life insurers with high (low) price-to-embedded-value (PEV) ratios. This argument is also supported by the finding that PEV ratios are not related to future profitability but are positively associated with analysts' overestimation of insurers' earnings in the long run. Overall, although embedded values do not fully reflect market price's information, they are less vulnerable to market sentiment than market prices are. This study complements the literature on the informativeness and value relevance of embedded value accounting.

JEL classification: M41, G22

## 1. Introduction

Since the late 1990s, industry practitioners and shareholders have begun to realize that the International Financial Reporting Standards (IFRS) and regulatory reporting standards fail to capture the realistic valuation of insurers due to mismatches between the insurers' economic performance and accounting measures (Horton, 2007; Klumpes, 1999). The mismatches are more severe for life insurers, given that most of their liabilities involve opaque and nontraded long-term insurance contracts. Accordingly, on a voluntary basis, some life insurers have begun to supplement their reporting with a forward-looking measure that reflects the realistic valuation of their consolidated shareholders' interest, namely embedded value. The objective of embedded value accounting is to capture the market-consistent value of life insurers. After nearly two decades of such developments, around 100 life insurers across the world now voluntarily disclose their embedded values (Jacob, El-Gazzar, & McGregor, 2017). Against this backdrop, we study the value relevance of embedded

value accounting and examine whether it fully reflects market price's information. Moreover, we also explore why embedded values disclosed by life insurers are different from their market prices, which represent the consolidated shareholders' interest from the market participants' perspective.

Studying embedded value accounting is important for at least two reasons. First, practitioners often use embedded value as a yardstick for making mergers and acquisitions decisions, as they perceive embedded value to represent the consolidated shareholders' interest of life insurers (Harewood et al., 2009). The life insurance literature (e.g., Malafronte, Starita, & Pereira, 2018) also gauges the firm value of life insurers with embedded value, assuming that embedded value captures the realistic valuation of life insurers. However, to the best of our knowledge, no academic study has been conducted to provide solid evidence supporting the claim that embedded values fully reflect information of market prices. Second, we observe substantial variations of embedded values from market prices for listed life insurers, a phenomenon that has not been addressed by the literature. Based on Milliman's survey, the price-to-embedded-value (PEV) ratios of life insurers listed in Europe ranged from 0.61 to 1.82 in 2016 (Reynolds & Simpson, 2017). The source of this deviation of embedded value from market price remains an under-researched area. Thus, our research complements the literature on embedded value accounting by examining its informativeness at the stock market level and attempting to identify the force behind its deviation from market price.

In this paper, we draw on a sample of European public life insurers and use the Heckman two-stage regression model to address the potential endogeneity of life insurers' decision to voluntarily disclose embedded value. We find that life insurers with embedded values lower (higher) than market prices experience higher (lower) profitability, suggesting that embedded value does not capture all dimensions of market price's information. Further examination reveals that this association is substantially lessened after controlling for market sentiment, as gauged by the crisis sentiment index. In addition, life insurers with lower (higher) PEV ratios have higher (lower) future stock returns, accompanied with under-estimated (over-estimated) earnings forecasts by analysts. Moreover, the PEV ratio is only positively associated with current profitability, but not future profitability. All these findings support the claim that embedded value does not fully reflect market price's information, and its deviation from market price can be explained by market sentiment. Investors overreact to current performance and overestimate (underestimate) future cash flows of life insurers with good (poor) current profitability, resulting in a market price higher (lower) than the embedded value and

leading to a positive association between the PEV ratio and profitability. As analysts are also under the influence of market sentiment, their forecasts of earnings are overestimated (underestimated) for insurers with high (low) PEV ratios. However, as time passes, the investors realize the actual cash flows in the future and correct their biased expectation by decreasing (increasing) the market price of life insurers with high (low) PEV ratios, resulting in lower (higher) future stock returns. Lastly, we conduct robustness checks to rule out the political cost theory and the systematic difference between embedded value and market price as explanations for the baseline empirical results.

This study contributes to the stream of embedded value accounting research. One of the earliest studies by Prefontaine, Desrochers, & Godbout (2009) suggests that embedded value reporting provides value relevance to investors, because they find a significant association between market price and embedded value. Serafeim (2011) reports a decrease in information asymmetry for investors of life insurers that disclose embedded values. Wu & Hsu (2011) find that embedded value reporting has incremental explanatory power for the market prices of life insurers listed on the Taiwan Stock Exchange, the London Stock Exchange, and the Euronext exchanges. El-Gazzar, Jacob, & McGregor (2015) further extend the conclusion to life insurers cross-listed in the United States. Whereas these studies generally conclude that embedded value can explain market price, our study differs from them by addressing the question of whether embedded value captures all dimensions of market price's information. Moreover, we also examine the force that drives the deviation of embedded value from market price.

The remainder of this paper is organized as follows. In Section 2, we review the literature on embedded value accounting and construct our hypotheses. In Section 3, we discuss the data and develop the empirical framework. We report the main results in Section 4 and conduct various robustness analyses in Section 5. Section 6 concludes the paper.

## 2. Literature review and hypothesis setting

### 2.1 Informativeness of embedded value at the stock market level

As industry practitioners consider embedded value to represent the realistic consolidated shareholders' interest of life insurers and often use it as a yardstick for making mergers and acquisition decisions (Harewood et al., 2009), and some academic studies use embedded value to gauge life insurer's firm value (e.g.,

Malafronte et al., 2018), our study examines the informativeness of embedded value at the stock market level.

When studying whether two valuation standards are consistent with each other, the literature usually compares the financial figures of firms under the two valuation standards and examines whether any of the difference is associated with firm characteristics or performance. For example, Laas & Siegel (2017) examine whether Basel III and Solvency II are consistent with each other by comparing the capital charges for a stylized portfolio under the two frameworks. They find substantial discrepancies and raise concerns about their consistency. Following the same approach, we investigate the informativeness of embedded value by comparing embedded value with market price to examine if any of the difference is related to financial performance. If embedded value captures all dimensions of market price's information, any deviation of embedded value from market price should not be associated with the financial performance of insurers. Hence, we construct Hypothesis 1 as follows:

HYPOTHESIS 1. *Embedded value fully reflects market price's information and any deviation of embedded value from market price should not be associated with the insurer's financial performance.*

### 2.2 Market sentiment

If the deviation of embedded value from market price is associated with the insurer's financial performance, then market price contains information not captured by embedded value. In this subsection, we hypothesize how market sentiment drives the deviation of embedded value from market price.

The behavioral finance literature asserts that the market is inefficient and investors are either too optimistic or pessimistic about the future cash flows of firms, leading to biased expectations and causing the market price to deviate from intrinsic value. For instance, Liang (2003) examines post-earnings announcement drift and concludes that investors' overconfidence is an important cause of the drift. Baker, Wurgler, & Yuan (2012) find that when investor sentiment is high, future returns are low on stocks that are difficult to value and arbitrage. Stambaugh, Yu, & Yuan (2012) suggest that overpricing is the primary source of abnormal profits for short-selling following high market sentiment. Irresberger, König, & Weiß (2017) find that investors sell insurer stocks according to crisis sentiment rather than insurers' exposure to the crisis. Engelberg, McLean, & Pontiff (2018) report that investors'

biased expectations drive the abnormal stock returns on corporate news days and earnings announcement days. In general, there is a consensus in related empirical studies that market prices are biased by market sentiment.

To illustrate how market sentiment drives the deviation of embedded value from market price, we refer to the sentiment asset pricing model proposed by Yang & Zhang (2013). Based on the one-period consumption-based asset pricing framework, they incorporate an exponent sentiment function into the aggregate demand function of a representative sentiment investor. By optimizing the demand function subject to the market clearing condition, they show that the equilibrium market price *P** at the end of the period is given by

$$P^* = P_r e^{f(SI)} \tag{1}$$

where $P_r$ is the rational price determined by fundamental value, *SI* is investor sentiment with positive (negative) value for call (put) sentiment, and *f*(.) is a monotonically increasing function of *SI*. As embedded value measures the realistic consolidated value of shareholders' interests in life insurers, it should be close to the rational price determined by fundamental value.[1] However, embedded value is not equivalent to rational price because embedded value is subject to calculation errors. Hence, we assume $P_r$ to be the difference between the observed embedded value *EV* and calculation error *ER*. A positive (negative) value of *ER* implies that the observed embedded value is overstated (understated) and is larger (smaller) than the rational price. In addition, as investors overreact to insurers' fundamentals, we assume that *SI* = *g*(.) is a monotonically increasing function of fundamentals *FU*, where *FU* is positive (negative) for favorable (unfavorable) fundamentals. In other words, investors overreact to favorable (unfavorable) fundamentals, resulting in call (put) sentiment. The more favorable (unfavorable) the fundamentals, the higher the call (put) sentiment. Based on the above, equation (1) is modified as

$$P^* = (EV - ER)e^{f(g(FU))} \tag{2}$$

Dividing both sides of equation (2) by *EV* and subsequently differentiating both sides with respect to *FU*, we get

[1] In the theoretical model proposed by Evans & Sridhar (2002), shareholder litigation, capital markets, and product markets are considered together as disclosure-disciplining mechanisms. Their model suggests that these mechanisms induce firms to provide truthful disclosures.

$$\frac{d\frac{P^*}{EV}}{dFU} = \left(1 - \frac{ER}{EV}\right) e^{f(g(FU))} \frac{df(g(FU))}{dg(FU)} \frac{dg(FU)}{dFU} \quad (3)$$

Without loss of generality, we assume the absolute value of *ER* to be less than *EV*, because it is not realistic for the calculation error to be larger than the observed embedded value itself. As *f*(.) is a monotonically increasing function of *SI* (or *g*(*FU*)) and *g*(.) is a monotonically increasing function of *FU*, we observe from equation (3) that the derivative of the PEV ratio with respect to fundamentals is positive. Hence, with the presence of investor sentiment, the PEV ratio is positively associated with insurers' fundamentals, and we construct Hypothesis 2 as follows:

HYPOTHESIS 2. *The positive association between the PEV ratio and insurers' fundamentals can be explained by market sentiment.*

## 3. Data and methodology

As there are no universal accounting standards for embedded value reporting, its rules and assumptions vary by country, making it difficult to conduct international empirical studies on embedded value reporting. To increase the comparability of embedded values across insurers, this paper focuses on listed members of the European Insurance CFO Forum (CFO Forum), which was formed by the Chief Financial Officers (CFOs) of major European insurance companies in 2002 to influence the development of financial reporting for insurance enterprises. Since 2004, the CFO Forum has published guidelines for reporting embedded values, which its members are expected to follow when preparing embedded value statements. Therefore, the embedded values disclosed by CFO Forum members should be more comparable than those disclosed by other insurers. However, as some members are not listed and others only disclose embedded values on a company basis instead of a group basis, not all members are included in our study. After screening, our sample consists of 13 listed members of the CFO Forum that disclose embedded values on a group basis, which are calculated as the summation of embedded values for their life businesses and book values for their non-life businesses. Their names and countries are reported in Panel A of Table 1. In addition, to address the self-selection problem of insurers disclosing embedded values voluntarily, we also include other listed European life insurers with data available from Thomson Reuters Datastream (Datastream) in our sample. Their names and countries are reported in Panel B of Table 1. As embedded value reporting was proposed in the early 2000s and none of the insurers in our sample disclosed

embedded value earlier than 2000, our sample period is from 2000 to 2018. Most insurers in our sample started reporting embedded values in the late 2000s. To avoid survivorship bias, we also include European life insurers that have been listed during the sample period but were delisted before the end of the period in the dataset. The final sample consists of 38 listed insurers from 10 European countries.

**[Table 1 inserted here]**

We manually extract the embedded values of insurers from their annual statements because data on embedded values are not available in commonly used financial databases. Data on insurer characteristics, hostile takeovers, and market characteristics are downloaded from Datastream, the DealScan database, and the statistics database maintained by the Organisation for Economic Cooperation and Development (OECD), respectively. The crisis sentiment index is constructed with data downloaded from Google Trends, and analyst forecast errors are obtained from I/B/E/S Estimates. Data from the above sources are merged, resulting in a sample consisting of 526 firm-year observations. The summary statistics of the sample are reported in Table 2.

**[Table 2 inserted here]**

The sample size of other similar empirical studies on embedded value is usually small, because only a limited number of insurers disclose their embedded values on a voluntary basis. For instance, Prefontaine et al. (2009) analyze the data of four Canadian life insurers from 2000 to 2008 to investigate the value relevance of embedded values. In Serafeim's (2011) study on the determinants and consequences of embedded value reporting, there are 553 firm-year observations for insurers that disclose embedded values. To examine embedded value's explanatory power over market price, Wu & Hsu (2011) analyze 122 observations for life insurers listed on the Taiwan Stock Exchange, the London Stock Exchange, and the Euronext exchanges, and El-Gazzar et al. (2015) examine 76 observations for 10 cross-listed life insurers on the New York Stock Exchange. A recent study by Malafronte et al. (2018) analyzes 100 observations to investigate the impact of the risk disclosure index on the embedded values of European insurers. Compared with previous related empirical studies on embedded value, we believe the sample size in this current paper to be appropriate.

As noted in Table 2, insurers that disclose embedded values are fundamentally different from other insurers. At first glance, they are larger in size, experience lower but steadier premium and income growth, have larger market share, engage in fewer non-insurance activities, reinsure fewer businesses, and have lower variability in profitability. The above suggests that insurers' decision to disclose embedded value may be endogenous, and hence we address this self-selection problem by using the Heckman two-stage regression, which has been widely applied in the accounting literature (e.g., Ahn, Drake, Kyung, & Stice, 2019; Bonacchi, Marra, & Zarowin,

2019; Broadstock, Collins, Hunt, & Vergos, 2018; Li, Gong, Zhang, & Koh, 2018).

The first-stage selection equation is used to estimate life insurers' likelihood of voluntarily disclosing embedded values. The following probit regression is run for the whole sample:

$$EV\ dummy\ (1/0)_{ijt} = \beta_0 + \beta_1\ Earnings\ variability_{it} + \beta_2\ Firm\ size_{it} + \beta_3\ Hostile\ takeover_{jt} + \beta_4 Product\ market\ regulation\ index_{jt} + v_{ijt} \quad (4)$$

where *i* represents the firm, *j* represents the country, *t* represents the year, *EV dummy (1/0)* is the embedded value disclosure dummy, and *v* is the error term. We choose the determinants of embedded value disclosure based on the findings in the literature, which are summarized below:

- *Earnings variability*. The accounting literature (e.g., Francis, Nanda, & Olsson, 2008; Rezaee & Tuo, 2019) suggests that firms with better earnings quality make more voluntary disclosures because investors consider such disclosures more credible than those of firms with poor earnings quality. As earnings variability is commonly used in the literature as a proxy for earnings quality (e.g., Garcia-Teruel, Martinez-Solano, & Sanchenz-Ballesta, 2014; Parte-Esteban & Garcia, 2014), we include the standard deviation of net profit scaled by premium for the last five years as a determinant of embedded value disclosure. Higher earnings variability indicates poorer earnings quality.
- *Firm size.* As large firms have deeper pockets, they are more susceptible to lawsuits, and therefore managers of large firms disclose more information to reduce lawsuit settlement costs. This argument is consistent with the positive link between firm size and disclosure documented in the literature (e.g., Karim, Pinsker, & Robin, 2013; Kasznik & Lev, 1995). Accordingly, we include the logarithm of total assets as one of the determinants of embedded value disclosure.
- *Hostile takeover.* As IFRS accounting does not fully reflect the realistic profitability of insurance contracts, there is a widespread concern that life insurers are undervalued by valuation methods based on accounting measures (Horton & Macve, 1998). Consequently, managers have an incentive to report their performance on a realistic basis in embedded value reporting and this incentive is stronger when the intensity of hostile takeover is higher. In fact, Serafeim (2011) documents that hostile takeover activity is a determinant of

embedded value disclosure. Therefore, we measure the intensity of hostile takeover with the average number of hostile life insurer takeovers announced in the last five years, scaled by the number of life insurers authorized by the regulator to conduct insurance business in the country. We expect the likelihood of embedded value disclosure to increase with the intensity of hostile takeover.

- *Product market regulation index.* When insurance regulators have the authority to intervene in the policy conditions and pricing of insurance contracts, insurers may be less willing to disclose their realistic profitability to avoid regulatory interventions in the product market. As embedded value measures the realistic valuation of an insurance business, we expect insurers in countries with more stringent product market regulations to be less likely to disclose embedded values. In fact, Serafeim (2011) finds empirical results consistent with the above argument. Thus, we consider the Product Market Regulation Index developed by the OECD as a determinant of embedded value disclosure.

After running the probit regression (4) on the whole sample, the coefficient estimates are used to construct the selection bias correction term, the inverse Mills ratio, to control for insurers' endogenous decision to disclose embedded value. Subsequently, the inverse Mills ratio is added to the equation of interest as a control variable. As we are interested in examining whether the deviation of embedded value from market price is associated with insurers' financial performance, the second-stage regression described below is run on the subsample of insurers with embedded value disclosure:

$$Profitability_{ijt} = \alpha_0 + \alpha_1 PEV\ ratio_{it} + \alpha_2 Capital\ asset\ ratio_{it} + \alpha_3 Firm\ size_{it} + \alpha_4 Income\ growth_{it} + \alpha_5 Insurance\ penetration_{jt} + \alpha_6 Liquidity_{it} + \alpha_7 Market\ share_{it} + \alpha_8 Non\text{-}insurance\ activities_{it} + \alpha_9 Premium\ growth_{it} + \alpha_{10} Use\ of\ reinsurance_{it} + \alpha_{11} Inverse\ Mills\ ratio_{it} + f_i + e_{ijt} \quad (5)$$

where *Profitability* is measured by net profit margin, return on assets, and return on equity, which are commonly used in the literature (e.g., Berg, Marrewijk, & Tamminen, 2018; Elango, Ma, & Pope, 2008) to gauge profit level. *e* is the error term, *Inverse Mills ratio* is calculated based on the estimated coefficients in the probit regression (4), and *f* is the firm-fixed effect. As we add market sentiment as an explanatory variable to regression (5) in Section 4.2, which is strongly correlated with time-fixed effects, we follow the practice of other market sentiment studies (e.g., Da, Engelberg, & Gao, 2015; Dang & Xu, 2018; Irresberger et al., 2017) and do not include the time-fixed effect in regression (5). *PEV ratio* is our variable of interest. If embedded value fully reflects market price's information, it should be

close to market price, and its deviation from market price should not be associated with insurers' profitability. Therefore, if Hypothesis 1 is true, we expect the PEV ratio not to be associated with profitability and the estimated coefficient of $\alpha_1$ to be statistically insignificant.

The choice of control variables in equation (5) is based on the findings in the insurance literature, which are summarized below:

- *Capital asset ratio*. Sommer (1996) suggests that insurers with higher insolvency risk are penalized for default risk through lower premium rates. With less premium income for the same amount of insurance coverage, we expect insurers with higher insolvency risk to have lower profitability. Hence, we follow Pooser & Browne (2018) in using the capital asset ratio to measure insolvency risk.
- *Firm size*. As firm size potentially captures benefits of scale and administrative efficiencies, we include the logarithm of total assets as a control variable. We expect firm size to be positively linked to profitability. In fact, the above argument is supported by Born's (2001) empirical finding that insurers' profitability is significantly related to firm size.
- *Income growth and premium growth.* Although market price incorporates investors' expectation of insurers' future growth, embedded value explicitly excludes any expected value of new business written in the future. For this reason, growth opportunities can drive the difference between embedded value and market price. To control for growth opportunities, we include the percentage increases of income and premium in the current year as control variables.
- *Insurance penetration.* Arena (2008) finds that insurance penetration is positively associated with economic growth and the demand for insurance products, which is beneficial for insurers' profitability. Therefore, we follow Ma, Pope, & Yeung (2013) in controlling for insurance penetration in insurers' profitability regressions.
- *Liquidity.* The effect of liquidity on profitability is twofold. On the one hand, if liquidity is too low, insurers have to fund the liquidity shortfall through external financing, but the cost of debt and equity is likely to be high if the liquidity shortfall is unexpected. On the other hand, having too much cash on hand is a waste of investment opportunities, which has an adverse effect on profitability. This is consistent with the empirical findings of Dong, Girardone, & Kuo (2017) that liquidity negatively affects profit. In this study, we measure liquidity with cash scaled by total assets and follow Pooser, Ping, & Barrese (2017) to include liquidity in insurers' profitability regressions.
- *Market share.* Under the relative market power hypothesis, firms with large

market shares have more market power in pricing because customers follow a "herd" instinct to purchase from the market leader (Choi & Weiss, 2005). Hence, we measure market share with the ratio of premium written by the insurer to the total premium written by the insurance industry, and expect profitability to increase with market share.

- *Non-insurance activities*. Shim (2011) finds that the profitability of more focused insurers is higher than that of diversified insurers, suggesting that insurers can maximize value by focusing on the core businesses in which they have a comparative advantage. Therefore, we use the ratio of non-insurance liabilities to total liabilities as a proxy for diversification in our study and expect profitability to decrease with diversification.
- *Use of reinsurance*. Profitable life insurers may be subject to higher marginal tax rates, and Adams, Hardwick, & Zou (2008) find that insurers with higher marginal tax rates tend to use less reinsurance due to the higher tax liabilities induced by the income level enhancement effect. Thus, as a control variable we add the ratio of reinsurance premium paid to the total premium written.

## 4. Empirical results

### 4.1 Main results

We perform the Heckman two-stage regression and report the results in columns (1) to (3) of Table 3. Specifically, we run probit regression (4) on the whole sample of insurers to estimate the likelihood of embedded value disclosure and construct the inverse Mills ratio with the estimated coefficients. Equation (5) is run on the sub-sample of insurers that disclose embedded values, with the inverse Mills ratio as an independent variable to control for the potential self-selection problem. As columns (1) to (3) of Table 3 indicate, all of the estimated coefficients for *PEV ratio* are positive and statistically significant, implying that insurers with market prices higher than embedded values have higher profitability. In addition, this positive association is economically significant. When the PEV ratio is one standard deviation (0.306) higher, net profit margin, return on assets, and return on equity are 1.767% (5.773 × 0.306), 0.082% (0.267 × 0.306), and 3.055% (9.985 × 0.306) higher, respectively.

**[Table 3 inserted here]**

For comparison, we also estimate equation (5) with ordinary least squares (OLS) on the sub-sample of insurers with embedded value disclosure and document the results

in columns (4) to (6) of Table 3. The t-statistics reported in the table are calculated based on robust standard errors.[2] Regardless of whether profitability is measured by net profit margin, return on assets, or return on equity, we find that the PEV ratio is positively associated with profitability. If Hypothesis 1 is true and embedded value fully reflects market price's information, any deviation of embedded value from the market price should not be related to firm performance. Hence, we do not find evidence supporting Hypothesis 1.

As embedded value does not capture all dimensions of market price's information, a follow-up question arises: what kind of information is captured by market price but not embedded value? We examine this issue in Section 4.2.

### 4.2 Market sentiment's impact on PEV ratio

In this subsection, we argue that the positive association between PEV ratio and profitability can be explained by market sentiment. When the performance of the insurer is good (poor) during a bull (bear) market, investors' sentiment is usually high (low). Accordingly, investors overreact to insurers' good (poor) performance, resulting in over-estimation (under-estimation) of their future cash flows and overvalued (undervalued) market prices. Thus, PEV ratios are higher for insurers with good performance during a bull market, and lower for insurers with poor performance during a bear market.

To test whether Hypothesis 2 is correct, we construct a crisis sentiment index based on Internet search volume data obtained from Google Trends,[3] which provides a Search Volume Index for any given word or phrase for selected jurisdictions after January 2004. The higher the Search Volume Index for a particular phrase, the more frequently users in that jurisdiction searched for the phrase on Google. As Google's search engine is commonly used in Europe, the Search Volume Index reflects the time-varying interest of the European market on specific topics. In fact, Google's Search Volume Index has been applied extensively in related studies to gauge market sentiment (e.g., Da, Engelberg, & Gao, 2011; Da et al., 2015; Irresberger, Mühlnickel, & Weiß, 2015; Irresberger et al., 2017). In general, these studies consider Internet search volume data to be better than other market sentiment measures because it is anonymous and can be easily accessed by the public.
We follow Irresberger et al. (2017) to download the monthly Search Volume Indices

[2] We also cluster standard errors at the firm level and find similar empirical results.

[3] Accessible at www.google.com/trends.

for the crisis-related search terms "credit crisis", "financial crisis", "subprime crisis", and "bank crisis" for each European country from 2004 to 2018. As the four crisis-related search terms are correlated and capture similar market sentiment, we estimate the first principal component of the four time-series of monthly Search Volume Indices. Subsequently, the values of the first principal component are averaged each year for each jurisdiction to construct the crisis sentiment index, which serves as a proxy for market sentiment. Finally, we repeat the Heckman two-stage regressions and OLS panel regressions with the crisis sentiment index as an additional independent variable in equation (5). The results are reported in columns (1) to (6) of Table 4.

**[Table 4 inserted here]**

As columns (1), (2), (4), and (5) of Table 4 show, when profitability is measured by net profit margin and return on assets, the positive association between PEV ratio and profitability disappears after we control for market sentiment. When profitability is measured by return on equity, the magnitude of the positive association is significantly attenuated, and it decreases by 44% (5.634/9.985 − 1) and 47% (6.054/11.382 − 1) for the Heckman two-stage regression in column (3) and the OLS panel regression in column (6), respectively, after we control for the crisis sentiment index.

In addition, we control for the effect of market sentiment on PEV ratio and examine whether the sentiment-adjusted PEV ratio still has any association with profitability. Specifically, we regress the PEV ratios on the crisis sentiment index and construct the sentiment-adjusted PEV ratios as residuals of the regression. Next, we replace the PEV ratio in equation (5) with the sentiment-adjusted PEV ratio for the Heckman two-stage regression. If market sentiment drives the positive relationship between PEV ratio and profitability, then the sentiment-adjusted PEV ratio should not be related to profitability at all. The results are reported in columns (7) to (9) of Table 4. As expected, none of the estimated coefficients for the sentiment-adjusted PEV ratio is statistically significant. Hence, the findings documented above support the view that market sentiment contributes a substantial portion of the positive link between PEV ratio and profitability.

## 5. Robustness checks

In this section, we conduct various robustness checks to further substantiate

Hypothesis 2, i.e., the positive association between PEV ratio and profitability can be explained by market sentiment. We also examine whether the positive association is caused by spurious correlations and factors other than market sentiment.

### 5.1 Ex-post stock returns after portfolio formation based on PEV ratio

If investors overreact to insurers' current performance, resulting in an overvalued (undervalued) market price and high (low) PEV ratio for more (less) profitable insurers, we expect that investors will adjust the market valuation of these insurers downwards (upwards) when future cash flows are realized. Thus, if market sentiment can explain the positive association between PEV ratio and profitability, we expect the ex-post stock returns to be lower (higher) for insurers with high (low) PEV ratios. Based on the above arguments, we examine insurers' ex-post stock returns in this sub-section.

The sub-sample of insurers with embedded value disclosure is divided into five quintile portfolios based on the value of the PEV ratio at the end of each year. Subsequently, insurers in the portfolios are rebalanced at the end of each year. The one- to five-year unadjusted stock returns after portfolio formation are reported for each portfolio in Panel A of Table 5. Next, to control for the correlation between market returns and insurers' stock returns, we follow Halek and Eckles (2010) to regress unadjusted stock returns on the returns of the MSCI Europe Index. The residuals are defined as market-adjusted returns. Furthermore, similar regressions are conducted to obtain the price-to-book (PB) ratio-adjusted returns, the size-adjusted returns, and the market-, PB-, and size-adjusted returns. The notes under Tables 5 and 6 describe the construction of these adjusted returns. The ex-post adjusted stock returns for each quintile portfolio are reported in Panels B, C, D, and E of Table 5, respectively.

**[Table 5 inserted here]**

Regardless of how the ex-post stock returns are adjusted, we still observe a decreasing trend for stock returns when the PEV ratio increases. Moreover, the decreasing trend holds no matter whether the holding period is short (i.e., one year), medium (i.e., three years), or long (i.e., five years). The findings suggest that investors correct their previous overreaction by adjusting market prices when the actual cash flows are realized, resulting in low (high) ex-post stock returns for

insurers with high (low) PEV ratios.

In addition, we also follow Irresberger et al. (2017) to perform OLS panel regressions of insurers' stock returns on a variable of interest (PEV ratio in our case) with firm-fixed effects to examine the relationship between PEV ratios and stock returns. The results are presented in Table 6. The estimated coefficients for PEV ratio are highly statistically significant at the 1% level for all 25 panel regressions. These results strongly suggest that PEV ratio is negatively correlated with future stock returns, regardless of the time horizon and the kinds of adjustment made, and they substantiate our finding that market sentiment is a convincing explanation for the positive association between PEV ratio and profitability.

**[Table 6 inserted here]**

### 5.2 Can the political cost theory explain the empirical results?

According to the political cost theory, profitable firms tend to report lower profits to steer away attention from regulators, who might otherwise place more stringent regulations on high earning firms and intervene in their product pricing (Watts & Zimmerman, 1990). Therefore, profitable insurers may understate embedded values, and the positive association between PEV ratio and profitability could be driven by political costs instead of market sentiment. To explore this possibility, we examine the earnings forecasts of analysts, who are less biased by political costs but are potentially subject to the influence of market sentiment (Walther & Willis, 2013).

We follow Leung & Srinidhin (2006) to construct the one-year earnings forecast error as the difference between median earnings forecasted and actual earnings per share in the fiscal year, using data obtained from I/B/E/S Estimates. Next, to facilitate comparisons across firms, we scale the forecast error by the market price. A positive (negative) forecast error implies that analysts overestimate (underestimate) the insurer's earnings. In addition, to examine the long-term impact of PEV ratios on analyst forecast errors, we also construct the t-year earnings forecast error as the cumulative one-year earnings forecast error in the subsequent t years, where $2 \leq t \leq 5$. Subsequently, the Heckman two-stage regression is repeated for the whole sample, with the dependent variable in equation (5) replaced by the earnings forecast error. If insurers understate embedded value due to political costs, and this drives the positive association between PEV ratio and profitability, we should expect PEV

ratios to be uncorrelated with earnings forecast errors because analysts are less biased by political costs. However, if market price is biased by market sentiment, which drives the positive association between PEV ratio and profitability, we should expect PEV ratios to be positively associated with earnings forecast errors because analysts are not immune from market sentiment. The results are documented in Table 7.

**[Table 7 inserted here]**

Although the estimated coefficient is not statistically significant in column (1), it is for columns (2) to (5) of Table 7, implying that the PEV ratio is associated with the earnings forecast error in the medium to long run. Analysts tend to over-estimate future earnings for insurers with good current performance, resulting in positive earnings forecast errors in the medium to long run. Moreover, the empirical results are also economically significant. When the PEV ratio is one standard deviation (0.306) higher, analysts' earnings forecast error increases by 0.975% (3.186 × 0.306), 1.815% (5.931 × 0.306), 1.854% (6.058 × 0.306), and 1.696% (5.543 × 0.306) in the two-, three-, four-, and five-year horizon, respectively. As analysts are less biased by political costs but are subject to the influence of market sentiment, the above findings support the argument that the positive association between PEV ratio and profitability is driven by market sentiment, instead of political costs.

### 5.3 Is embedded value systematically different from market price?

It is possible that embedded value places less emphasis on performance than market price does. Based on this argument, the positive association between PEV ratio and profitability documented in Section 4.1 may be driven by the systematic difference between embedded value and market price, instead of market sentiment. As both embedded value and market price take into consideration the insurers' future profits generated from existing insurance contracts, the above argument holds if the PEV ratio is correlated not only with current profitability but also with future profitability. Thus, we repeat the Heckman two-stage regression, with the dependent variable in equation (5) replaced by future profitability. The results are reported in Table 8.

**[Table 8 inserted here]**

Columns (1) to (5) of Table 8 correspond to the results of regressions with profitability in years t+1 to t+5, respectively, as the dependent variable. Profitability is measured by net profit margin, return on assets, and return on equity in Panels A, B, and C, respectively. The estimated coefficients of control variables are not

reported to conserve space. Out of the 15 regressions, none of the estimated coefficients of PEV ratio is statistically significant, implying that the PEV ratio is not related to future profitability. Hence, we do not find supporting evidence for the claim that the positive association between the PEV ratio and profitability is driven by the systematic difference, if any, between embedded value and market price.

## 6. Conclusion

Regulators and practitioners tend to consider embedded value reporting to reflect a life insurer's realistic valuation. Using a sample of public life insurers in Europe, this research analyzes the value relevance of embedded value accounting and examines whether embedded value fully reflects market price's information. Based on the nature of voluntary data disclosure, we use the Heckman two-stage regression model to control for life insurers' endogenous decision to disclose embedded value, and find that PEV ratio is positively associated with profitability and that embedded value does not capture all dimensions of market price's information. Furthermore, we investigate the force behind the deviation of embedded value from market price. Substantiated by various robustness checks, our results suggest that market sentiment, instead of the political cost theory or the systematic difference between embedded value and market price, best explains the deviation.

Additionally, we find that insurers with high (low) PEV ratios have low (high) future stock returns, accompanied with overestimated (underestimated) analysts' earnings forecasts. The analyses suggest that investors overreact to life insurers' current performance, leading to a biased expectation of their future cash flows. Accordingly, this biased expectation drives the positive association between PEV ratio and profitability. However, as time passes and the actual cash flows are realized, investors correct their biased expectation by adjusting the market price, resulting in a negative association between PEV ratio and the future stock return.

This research complements the literature on the relationship between embedded value and market price. Although previous studies (e.g., El-Gazzar et al., 2015; Prefontaine et al., 2009; Serafeim, 2011; Wu & Hsu, 2011) indicate that embedded value has explanatory power over market price and reduces information asymmetry, our primary conclusion is that embedded value does not capture all dimensions of market price's information. Moreover, this research highlights that embedded value, when compared to market price, is less influenced by market sentiment. These results provide valuable insight for investors and practitioners who make mergers

and acquisitions decisions on insurers.

Future research could examine whether the PEV ratio is an anomaly in life insurers' asset pricing framework. Although we find a negative association between the PEV ratio and future stock return, more robust asset pricing studies should be conducted to examine whether alpha portfolios can be constructed based on the PEV ratio, which is a more common valuation indicator than the PB ratio among life insurance industry practitioners.

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**Table 1. Names of listed insurers in the sample**

| Name | Country | Thomson Reuters Datastream Identifier |
|---|---|---|
| **Panel A: Members of the European Insurance CFO Forum that disclose embedded values on a group basis** | | |
| Aegon N.V. | Netherlands | H:AGN |
| Ageas SA | Belgium | B:AGS |
| Allianz SE | Germany | D:ALV |
| Aviva plc | United Kingdom | AV. |
| AXA SA | France | F:MIDI |
| CNP Assurances | France | F:CNP |
| Assicurazioni Generali SPA | Italy | I:G |
| Legal & General Group plc | United Kingdom | LGEN |
| Phoenix Group Holdings plc | United Kingdom | PHNX |
| Prudential plc | United Kingdom | PRU |
| SCOR SE | France | F:SCO |
| Swiss RE AG | Switzerland | S:SREN |
| Zurich Insurance Group Limited | Switzerland | S:ZURN |
| **Panel B: Listed insurers in Europe that do not disclose embedded value on a group basis** | | |
| Alleanza Assicurazioni S.P.A. | Italy | I:AL |
| Banca Mediolanum SPA | Italy | I:BMED |
| Cash.Life AG | Germany | D:SGS |
| Cattolica Assicurazioni S.C.A.R.L. | Italy | I:CASS |
| Chesnara plc | United Kingdom | CSN |
| Delta Lloyd NV | Netherlands | H:DL |
| Ergo Previdenza SPA | Italy | I:BV |
| Friends Life Group Ltd | United Kingdom | FLG |
| Friends Provident Group plc | United Kingdom | 257581 |
| GBGI Ltd | United Kingdom | GBGI |
| Generali (Schweiz) Holding | Switzerland | S:GENN |
| International Life General Insurance SA | Greece | CP:INL |
| Just Group plc | United Kingdom | JUST |
| Just Retirement Holdings plc | United Kingdom | JR. |
| Mercurius AG | Germany | D:MR8 |
| NN Group NV | Netherlands | H:NN |
| Partnership Assurance Group plc | United Kingdom | PA. |
| Phoenix Group Holdings plc | United Kingdom | PHNX |
| Poste Italiane SPA | Italy | I:PST |
| Salusansvar AB | Sweden | W:SALH |
| Skandia Forsakrings AB | Sweden | W:SX@G |
| St. James's Place plc | United Kingdom | STJ |
| Storebrand ASA | Norway | N:STB |
| Swiss Life Holding AG | Switzerland | S:SLHN |
| Württembergische Lebensversicherung AG | Germany | D:WLVX |

This table presents the names, countries, and Thomson Reuters Datastream Identifiers for our sample of listed insurers. To increase the comparability of embedded values across insurers, we only include members of the European Insurance CFO Forum, which develops and maintains principles of embedded value reporting, in Panel A. Its members follow these principles to prepare embedded value reporting and disclose their embedded values on a voluntary basis. We exclude members that are not listed or do not report embedded values on a group basis from Panel A. To address the self-selection problem of life insurers disclosing embedded values on a voluntary basis, we also include listed European life insurers with data available from Thomson Reuters Datastream in our sample. Their names, countries, and Thomson Reuters Datastream Identifiers are reported in Panel B. European life insurers that were listed during the sample period but were delisted before the end of the period are also included in the sample to avoid survivorship bias. The final sample consists of 38 listed insurers from 10 European countries. Although the sample period is from 2000 to 2018, most insurers in our sample started reporting embedded values in the late 2000s.

**Table 2. Summary statistics**

| Variable | | Mean | Std. dev | Percentiles 25th | 50th | 75th | N |
|---|---|---|---|---|---|---|---|
| ***Panel A: Profitability measures*** | | | | | | | |
| Net profit margin (%) | Whole sample | 23.177 | 158.844 | 1.670 | 4.623 | 8.772 | 478 |
| | Insurers that disclose EV | 2.849 | 29.589 | 3.134 | 5.179 | 8.524 | 142 |
| | Insurers that do not disclose EV | 31.768 | 187.906 | 1.460 | 4.164 | 9.402 | 336 |
| Return on assets (%) | Whole sample | 0.591 | 2.261 | 0.200 | 0.471 | 0.860 | 513 |
| | Insurers that disclose EV | 0.490 | 0.771 | 0.262 | 0.451 | 0.763 | 142 |
| | Insurers that do not disclose EV | 0.629 | 2.616 | 0.149 | 0.477 | 0.904 | 371 |
| Return on equity (%) | Whole sample | 9.928 | 28.420 | 5.024 | 10.532 | 16.439 | 513 |
| | Insurers that disclose EV | 8.900 | 16.058 | 7.278 | 11.046 | 14.190 | 142 |
| | Insurers that do not disclose EV | 10.321 | 31.919 | 4.569 | 10.315 | 17.248 | 371 |
| ***Panel B: Firm characteristics*** | | | | | | | |
| Capital asset ratio | Whole sample | 0.111 | 0.120 | 0.065 | 0.090 | 0.121 | 526 |
| | Insurers that disclose EV | 0.100 | 0.053 | 0.065 | 0.089 | 0.117 | 142 |
| | Insurers that do not disclose EV | 0.116 | 0.136 | 0.065 | 0.090 | 0.125 | 384 |
| EV dummy variable (1/0) | Whole sample | 0.270 | 0.444 | 0 | 0 | 1 | 526 |
| | Insurers that disclose EV | 1 | 0 | 1 | 1 | 1 | 142 |
| | Insurers that do not disclose EV | 0 | 0 | 0 | 0 | 0 | 384 |
| Firm size | Whole sample | 17.831 | 2.383 | 16.651 | 18.425 | 19.733 | 526 |
| | Insurers that disclose EV | 19.725 | 0.754 | 19.296 | 19.875 | 20.200 | 142 |
| | Insurers that do not disclose EV | 17.131 | 2.399 | 15.870 | 17.609 | 18.968 | 384 |
| Income growth | Whole sample | 2.771 | 53.550 | -0.296 | 0.099 | 0.678 | 513 |
| | Insurers that disclose EV | 0.136 | 2.965 | -0.213 | 0.068 | 0.342 | 142 |
| | Insurers that do not disclose EV | 3.780 | 62.937 | -0.336 | 0.115 | 0.762 | 371 |
| Insurance penetration | Whole sample | 0.092 | 0.032 | 0.067 | 0.088 | 0.110 | 508 |
| | Insurers that disclose EV | 0.102 | 0.028 | 0.086 | 0.092 | 0.117 | 139 |
| | Insurers that do not disclose EV | 0.089 | 0.032 | 0.065 | 0.078 | 0.110 | 369 |
| Liquidity | Whole sample | 0.034 | 0.063 | 0.009 | 0.023 | 0.038 | 517 |
| | Insurers that disclose EV | 0.030 | 0.022 | 0.017 | 0.024 | 0.041 | 142 |
| | Insurers that do not disclose EV | 0.036 | 0.073 | 0.008 | 0.021 | 0.036 | 375 |
| Market share | Whole sample | 0.169 | 0.211 | 0.006 | 0.080 | 0.280 | 507 |
| | Insurers that disclose EV | 0.261 | 0.199 | 0.089 | 0.270 | 0.407 | 142 |
| | Insurers that do not disclose EV | 0.133 | 0.205 | 0.003 | 0.030 | 0.184 | 365 |
| Non-insurance activities | Whole sample | 0.419 | 0.301 | 0.176 | 0.319 | 0.632 | 507 |
| | Insurers that disclose EV | 0.356 | 0.210 | 0.198 | 0.312 | 0.453 | 142 |
| | Insurers that do not disclose EV | 0.443 | 0.327 | 0.160 | 0.328 | 0.682 | 365 |
| PEV ratio | Whole sample | - | - | - | - | - | - |
| | Insurers that disclose EV | 0.950 | 0.306 | 0.730 | 0.947 | 1.129 | 142 |
| | Insurers that do not disclose EV | - | - | - | - | - | - |
| Premium growth | Whole sample | 0.065 | 0.598 | -0.093 | 0.025 | 0.156 | 465 |
| | Insurers that disclose EV | -0.014 | 0.431 | -0.086 | 0.019 | 0.119 | 140 |
| | Insurers that do not disclose EV | 0.099 | 0.655 | -0.097 | 0.031 | 0.180 | 325 |
| Sentiment-adjusted PEV ratio | Whole sample | - | - | - | - | - | - |
| | Insurers that disclose EV | 0 | 0.283 | -0.196 | 0.004 | 0.167 | 132 |
| | Insurers that do not disclose EV | - | - | - | - | - | - |
| Use of reinsurance | Whole sample | 0.101 | 0.499 | 0.004 | 0.012 | 0.029 | 433 |
| | Insurers that disclose EV | 0.014 | 0.015 | 0.004 | 0.010 | 0.016 | 135 |
| | Insurers that do not disclose EV | 0.141 | 0.598 | 0.003 | 0.014 | 0.042 | 298 |
| ***Panel C: Determinants of embedded value disclosure*** | | | | | | | |
| Earnings variability | Whole sample | 0.178 | 1.028 | 0.012 | 0.028 | 0.065 | 422 |
| | Insurers that disclose EV | 0.048 | 0.121 | 0.011 | 0.020 | 0.055 | 134 |
| | Insurers that do not disclose EV | 0.239 | 1.238 | 0.012 | 0.032 | 0.072 | 288 |
| Firm size | Whole sample | 17.831 | 2.383 | 16.651 | 18.425 | 19.733 | 526 |
| | Insurers that disclose EV | 19.725 | 0.754 | 19.296 | 19.875 | 20.200 | 142 |
| | Insurers that do not disclose EV | 17.131 | 2.399 | 15.870 | 17.609 | 18.968 | 384 |
| Hostile takeover | Whole sample | 0.019 | 0.017 | 0.007 | 0.015 | 0.025 | 526 |
| | Insurers that disclose EV | 0.020 | 0.018 | 0.008 | 0.015 | 0.027 | 142 |
| | Insurers that do not disclose EV | 0.019 | 0.017 | 0.007 | 0.014 | 0.025 | 384 |
| Product market regulation index | Whole sample | 1.517 | 0.403 | 1.208 | 1.477 | 1.801 | 526 |
| | Insurers that disclose EV | 1.381 | 0.255 | 1.208 | 1.468 | 1.517 | 142 |
| | Insurers that do not disclose EV | 1.568 | 0.434 | 1.208 | 1.504 | 1.804 | 384 |
| ***Panel D: Crisis sentiment index*** | | | | | | | |
| Crisis sentiment index | Whole sample | 0.582 | 16.243 | -7.624 | -2.869 | 4.536 | 391 |
| | Insurers that disclose EV | 2.054 | 15.734 | -6.242 | -1.404 | 5.701 | 132 |
| | Insurers that do not disclose EV | -0.168 | 16.476 | -8.594 | -4.025 | 2.328 | 259 |

This table presents the summary statistics for the variables used in the study. The sample consists of listed European life insurers with data available from Thomson Reuters Datastream from 2000 to 2018. European life insurers that were listed during the sample period but were delisted before the end of sample period are included in the sample to avoid survivorship bias. The sample also covers data of the members of the European Insurance CFO Forum that disclose embedded values voluntarily. They follow these principles to prepare embedded value reporting and disclose their embedded values on a group basis. The final sample consists of 38 listed insurers from 10 European countries. Although the sample period is from 2000 to 2018, most insurers in our sample started reporting embedded values in the late 2000s. The variables are defined in Table 9.

**Table 3. Heckman two-stage regressions and OLS panel regressions of profitability on PEV ratios**

| | **Dependent variable** | | | | | |
|---|---|---|---|---|---|---|
| **Variable** | Heckman two-stage regression | | | OLS panel regression | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | Net Profit Margin (%) | Return on Assets (%) | Return on Equity (%) | Net Profit Margin (%) | Return on Assets (%) | Return on Equity (%) |
| PEV ratio | 5.773** | 0.267** | 9.985*** | 4.869* | 0.450*** | 11.382*** |
| | (2.16) | (2.31) | (3.81) | (1.82) | (3.59) | (3.99) |
| Capital asset ratio | 41.200 | 9.142*** | 43.670 | 87.097* | 6.971* | 50.604 |
| | (0.79) | (4.19) | (0.86) | (1.70) | (1.93) | (1.00) |
| Firm size | 9.670** | 0.541*** | 11.708*** | 7.886*** | 0.310*** | 7.863*** |
| | (2.25) | (2.94) | (2.78) | (2.98) | (2.80) | (2.63) |
| Income growth | 0.701*** | 0.041*** | 1.356*** | 0.641** | 0.046*** | 1.376** |
| | (3.37) | (4.46) | (6.58) | (2.38) | (2.87) | (2.60) |
| Insurance penetration | 45.915 | -1.787 | 2.028 | 32.125 | -0.595 | 9.962 |
| | (1.23) | (-1.07) | (0.05) | (0.58) | (-0.35) | (0.23) |
| Liquidity | 30.166 | -7.972*** | -103.063* | -12.895 | -5.365** | -51.722 |
| | (0.71) | (-4.44) | * (-2.49) | (-0.19) | (-2.42) | (-1.52) |
| Market share | -1.351 | -0.100 | 3.984 | -4.033 | 0.359 | 6.396 |
| | (-0.11) | (-0.19) | (0.33) | (-0.50) | (0.65) | (0.61) |
| Non-insurance activities | 4.514 | 0.431 | 11.669 | 15.115* | 0.186 | 7.937 |
| | (0.50) | (1.07) | (1.31) | (1.79) | (0.51) | (1.00) |
| Premium growth | -9.237*** | 0.145 | -1.668 | -2.270 | -0.210* | -3.164** |
| | (-2.82) | (1.04) | (-0.52) | (-0.66) | (-1.85) | (-1.98) |
| Use of reinsurance | -130.337* | -5.260* | 17.374 | -122.543 | -4.613 | 27.791 |
| | (-1.66) | (-1.65) | (0.23) | (-1.10) | (-1.40) | (0.49) |
| ***Determinants of embedded value disclosure in first-stage regression*** | | | | | | |
| Earnings variability | -0.391 | -0.391 | -0.391 | | | |
| | (-0.97) | (-0.97) | (-0.97) | | | |
| Firm size | 0.730*** | 0.730*** | 0.730*** | | | |
| | (9.03) | (9.03) | (9.03) | | | |
| Hostile takeover | 13.879*** | 13.879*** | 13.879*** | | | |
| | (2.90) | (2.90) | (2.90) | | | |
| Product market regulation index | -1.056*** | -1.056*** | -1.056*** | | | |
| | (-4.38) | (-4.38) | (-4.38) | | | |
| Inverse Mills ratio | 3.724 | 0.355 | 5.227 | | | |
| | (0.67) | (1.50) | (0.96) | | | |
| Firm-fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 413 | 413 | 413 | 131 | 131 | 131 |

This table reports the results of Heckman two-stage regressions and OLS panel regressions for a sample of listed European life insurers. The sample period is from 2000 to 2018. Members of the European Insurance CFO Forum that disclose their embedded values on a group basis and all of the listed life insurers that were active in Thomson Reuters Datastream (Datastream) in the sample period are included. European life insurers that were listed during the sample period but were delisted before the end of the period are also included in the sample to avoid survivorship bias. The dependent variables are net profit margin, return on assets, and return on equity, which are measures of profitability commonly used in the literature (e.g., Berg et al., 2018; Elango et al., 2008). Embedded values are manually extracted from insurers' annual statements, and data on other insurer characteristics are downloaded from Datastream. The hostile takeover data are downloaded from the DealScan database, and market statistics (i.e., insurance penetration, product market regulation index, and market share) are downloaded from the statistics database maintained by the Organisation for Economic Co-operation and Development (OECD). Firm-fixed effects are included. The two-step variance estimator derived by Heckman is used to calculate standard errors for Heckman two-stage regressions and robust standard errors are calculated for OLS panel regressions. z-statistics and t-statistics are reported in parentheses for Heckman two-stage regressions and OLS panel regressions, respectively. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. The variables are defined in Table 9.

**Table 4. Heckman two-stage regressions of profitability on PEV ratios after controlling for market sentiment**

| | Dependent variable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Variable** | Heckman two-stage regression | | | OLS panel regression | | | Heckman two-stage regression | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| | Net Profit Margin (%) | Return on Assets (%) | Return on Equity (%) | Net Profit Margin (%) | Return on Assets (%) | Return on Equity (%) | Net Profit Margin (%) | Return on Assets (%) | Return on Equity (%) |
| PEV ratio | 2.694 | 0.086 | 5.634** | 1.544 | 0.241 | 6.054*** | | | |
| | (1.00) | (0.75) | (2.40) | (0.81) | (1.54) | (2.85) | | | |
| Crisis sentiment index | -0.203*** | -0.009*** | -0.253*** | -0.149** | -0.009*** | -0.240*** | | | |
| | (-5.05) | (-5.27) | (-7.24) | (-2.29) | (-3.90) | (-4.26) | | | |
| Sentiment-adjusted PEV ratio | | | | | | | 1.461 | 0.033 | 4.030 |
| | | | | | | | (0.48) | (0.23) | (1.35) |
| Capital asset ratio | -3.821 | 7.213*** | -17.534 | 76.075 | 5.709* | 17.997 | 90.593* | 11.311*** | 105.278** |
| | (-0.08) | (3.40) | (-0.41) | (1.42) | (1.97) | (0.43) | (1.71) | (4.78) | (2.11) |
| Firm size | 0.298 | 0.091 | -0.246 | 5.828 | 0.050 | 0.701 | 2.586 | 0.190 | 2.730 |
| | (0.07) | (0.48) | (-0.06) | (1.35) | (0.39) | (0.26) | (0.52) | (0.81) | (0.56) |
| Income growth | 0.548*** | 0.035*** | 1.174*** | 0.557** | 0.041** | 1.222** | 0.632*** | 0.039*** | 1.285*** |
| | (2.91) | (4.42) | (7.22) | (2.04) | (2.42) | (2.21) | (2.99) | (3.77) | (6.02) |
| Insurance penetration | 57.747* | -1.429 | 14.045 | 42.141 | -0.065 | 22.156 | 23.860 | -2.900 | -30.034 |
| | (1.67) | (-0.98) | (0.47) | (0.92) | (-0.05) | (0.80) | (0.62) | (-1.55) | (-0.77) |
| Liquidity | 82.314** | -5.871*** | -48.607 | 10.104 | -3.711 | -13.943 | 41.787 | -7.630*** | -101.323* |
| | (2.06) | (-3.41) | (-1.39) | (0.14) | (-1.58) | (-0.47) | (0.93) | (-3.77) | * (-2.38) |
| Market share | 17.025 | 0.860* | 27.606*** | 6.955 | 1.383*** | 29.279*** | -2.293 | 0.021 | 2.477 |
| | (1.40) | (1.66) | (2.61) | (0.82) | (2.83) | (3.28) | (-0.17) | (0.03) | (0.19) |
| Non-insurance activities | 0.021 | 0.088 | 2.878 | 12.766 | -0.050 | 1.225 | 1.793 | 0.165 | 5.182 |
| | (0.00) | (0.25) | (0.40) | (1.28) | (-0.14) | (0.17) | (0.19) | (0.36) | (0.54) |
| Premium growth | -7.676*** | 0.214* | 0.161 | -1.909 | -0.144 | -1.583 | -8.142** | 0.194 | -0.446 |
| | (-2.59) | (1.69) | (0.06) | (-0.54) | (-1.54) | (-1.43) | (-2.43) | (1.25) | (-0.14) |
| Use of reinsurance | -139.189* | -4.294 | 32.754 | -126.666 | -2.630 | 69.907 | -181.893* | -6.147* | -22.794 |
| | (-1.94) | (-1.38) | (0.52) | (-1.13) | (-0.90) | (1.62) | * (-2.24) | (-1.76) | (-0.31) |
| ***Determinants of embedded value disclosure in first-stage regression*** | | | | | | | | | |
| Earnings variability | -0.388 | -0.388 | -0.388 | | | | -0.388 | -0.388 | -0.388 |
| | (-0.96) | (-0.96) | (-0.96) | | | | (-0.96) | (-0.96) | (-0.96) |
| Firm size | 0.729*** | 0.729*** | 0.729*** | | | | 0.729*** | 0.729*** | 0.729*** |
| | (8.67) | (8.67) | (8.67) | | | | (8.67) | (8.67) | (8.67) |
| Hostile takeover | 17.438*** | 17.438*** | 17.438*** | | | | 17.438*** | 17.438*** | 17.438*** |
| | (3.51) | (3.51) | (3.51) | | | | (3.51) | (3.51) | (3.51) |
| Product market regulation index | -1.353*** | -1.353*** | -1.353*** | | | | -1.353*** | -1.353*** | -1.353*** |
| | (-4.95) | (-4.95) | (-4.95) | | | | (-4.95) | (-4.95) | (-4.95) |
| Inverse Mills ratio | -4.381 | 0.076 | -2.432 | | | | 3.954 | 0.438* | 8.410* |
| | (-0.92) | (0.38) | (-0.59) | | | | (0.77) | (1.82) | (1.68) |
| Firm-fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 403 | 403 | 403 | 121 | 121 | 121 | 403 | 403 | 403 |

This table reports the results of Heckman two-stage regressions and OLS panel regressions for a sample of listed European life insurers. The sample period is from 2000 to 2018. Members of the European Insurance CFO Forum that disclose their embedded values on a group basis and all of the listed life insurers that were active in Thomson Reuters Datastream (Datastream) in the sample period are included. European life insurers that were listed during the sample period but were delisted before the end of the period are also included in the sample to avoid survivorship bias. The dependent variables are net profit margin, return on assets, and return on equity, which are measures of profitability commonly used in the literature (e.g., Berg et al., 2018; Elango et al., 2008). Embedded values are manually extracted from insurers' annual statements, and data on other insurer characteristics are downloaded from Datastream. The hostile takeover data are downloaded from the DealScan database, and market statistics (i.e., insurance penetration, product market regulation index, and market share) are downloaded from the statistics database maintained by the Organisation for Economic Co-operation and Development (OECD). We follow Irresberger et al. (2017) to construct the crisis sentiment index as the first principal component of the search volume for the terms "financial crisis", "credit crisis", "bank crisis", and "subprime crisis" on Google. To control for the correlation between PEV ratios and market sentiment, we regress PEV ratios of life insurers on the crisis sentiment index and construct the sentiment-adjusted PEV ratios as the residuals of the regression. Firm-fixed effects are included. The two-step variance estimator derived by Heckman is used to calculate standard errors for Heckman two-stage regressions and robust standard errors are calculated for OLS panel regressions. z-statistics and t-statistics are reported in parentheses for Heckman two-stage regressions and OLS panel regressions, respectively. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. The variables are defined in Table 9.

**Table 5. Ex-post stock returns of the PEV ratio quintile portfolios**

| Variable | Q1 (Low PEV ratio) | Q2 | Q3 | Q4 | Q5 (High PEV ratio) | All insurers | N |
|---|---|---|---|---|---|---|---|
| | | | | ***Panel A: Future unadjusted return*** | | | |
| One-year unadjusted return | 0.208 | 0.204 | 0.104 | 0.063 | -0.043 | 0.106 | 138 |
| Two-year unadjusted return | 0.399 | 0.461 | 0.236 | 0.130 | -0.051 | 0.234 | 133 |
| Three-year unadjusted return | 0.601 | 0.654 | 0.489 | 0.194 | 0.0003 | 0.388 | 125 |
| Four-year unadjusted return | 0.903 | 1.069 | 0.521 | 0.225 | 0.164 | 0.574 | 113 |
| Five-year unadjusted return | 1.165 | 1.505 | 0.752 | 0.272 | 0.144 | 0.762 | 101 |
| | | | | ***Panel B: Future market-adjusted return*** | | | |
| One-year market-adjusted return | 0.161 | 0.160 | 0.050 | 0.012 | -0.085 | 0.059 | 138 |
| Two-year market-adjusted return | 0.217 | 0.294 | 0.059 | 0.027 | -0.124 | 0.093 | 133 |
| Three-year market-adjusted return | 0.327 | 0.380 | 0.199 | -0.047 | -0.238 | 0.124 | 125 |
| Four-year market-adjusted return | 0.505 | 0.664 | 0.160 | -0.145 | -0.249 | 0.185 | 113 |
| Five-year market-adjusted return | 0.358 | 0.675 | 0.177 | -0.200 | -0.103 | 0.178 | 101 |
| | | | | ***Panel C: Future PB-adjusted return*** | | | |
| One-year PB-adjusted return | 0.078 | 0.097 | 0.026 | 0.024 | -0.048 | 0.035 | 138 |
| Two-year PB-adjusted return | 0.106 | 0.214 | 0.036 | 0.001 | -0.100 | 0.051 | 133 |
| Three-year PB-adjusted return | 0.149 | 0.251 | 0.165 | -0.053 | -0.124 | 0.077 | 125 |
| Four-year PB-adjusted return | 0.260 | 0.506 | 0.035 | -0.144 | -0.067 | 0.117 | 113 |
| Five-year PB-adjusted return | 0.359 | 0.791 | 0.126 | -0.201 | -0.174 | 0.177 | 101 |
| | | | | ***Panel D: Future size-adjusted return*** | | | |
| One-year size-adjusted return | 0.096 | 0.139 | 0.072 | 0.051 | -0.074 | 0.056 | 138 |
| Two-year size-adjusted return | 0.147 | 0.295 | 0.130 | 0.056 | -0.155 | 0.094 | 133 |
| Three-year size-adjusted return | 0.182 | 0.360 | 0.285 | 0.032 | -0.192 | 0.133 | 125 |
| Four-year size-adjusted return | 0.282 | 0.612 | 0.218 | -0.033 | -0.109 | 0.193 | 113 |
| Five-year size-adjusted return | 0.373 | 0.930 | 0.351 | -0.045 | -0.218 | 0.273 | 101 |
| | | | | ***Panel E: Future market-, PB-, and size-adjusted return*** | | | |
| One-year market-, PB-, and size-adjusted return | 0.067 | 0.106 | 0.034 | 0.039 | -0.034 | 0.042 | 138 |
| Two-year market-, PB-, and size-adjusted return | 0.059 | 0.191 | 0.019 | 0.050 | -0.044 | 0.054 | 133 |
| Three-year market-, PB-, and size-adjusted return | 0.106 | 0.258 | 0.186 | -0.003 | -0.122 | 0.085 | 125 |
| Four-year market-, PB-, and size-adjusted return | 0.154 | 0.474 | 0.116 | -0.072 | -0.073 | 0.120 | 113 |
| Five-year market-, PB-, and size-adjusted return | 0.116 | 0.587 | 0.169 | -0.119 | -0.020 | 0.145 | 101 |

This table reports the ex-post stock returns of the PEV ratio quintile portfolios. Stocks of a sample of European Insurance CFO Forum members that disclose their embedded values on a group basis are assigned to five quintile portfolios based on the value of the PEV ratio. Panel A reports the means of the one- to five-year future unadjusted returns for the quintile portfolios. To control for the correlation between market returns and insurers' stock returns, we follow Halek & Eckles (2010) to regress unadjusted stock returns on the returns of the MSCI Europe Index. The residuals are defined as market-adjusted returns. Panel B reports the means of the one- to five-year future market-adjusted returns for the quintile portfolios. To control for the correlation between price-to-book value ratio and insurers' stock returns, we regress unadjusted stock returns on price-to-book value ratio. The residuals are defined as PB-adjusted returns. Panel C reports the means of the one- to five-year future PB-adjusted returns for the quintile portfolios. To control for the size effect on insurers' stock returns, we regress unadjusted stock returns on the logarithm of market prices. The residuals are defined as size-adjusted stock returns. Panel D reports the means of the one- to five-year future size-adjusted returns for the quintile portfolios. To control for the combined effect of market return, price-to-book value ratio, and size on insurers' stock returns, we also regress unadjusted stock returns on the returns of the MSCI Europe Index, price-to-book ratio, and logarithm of market prices. The residuals are defined as market-, PB-, and size-adjusted stock returns. Panel E reports the means of the one- to five-year future market-, PB-, and size-adjusted returns for the quintile portfolios. The variables are defined in Table 9.

**Table 6. OLS panel regressions of ex-post stock returns on PEV ratios**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | **One-year return** | **Two-year return** | **Three-year return** | **Four-year return** | **Five-year return** |
| | | | ***Panel A: Future unadjusted stock returns*** | | |
| PEV ratio | -0.610*** | -1.035*** | -1.379*** | -1.879*** | -2.395*** |
| | (-4.82) | (-7.87) | (-7.98) | (-10.18) | (-10.96) |
| N | 138 | 133 | 125 | 113 | 101 |
| R-square | 0.311 | 0.420 | 0.506 | 0.622 | 0.783 |
| | | | ***Panel B: Future market-adjusted stock returns*** | | |
| PEV ratio | -0.600*** | -0.936*** | -1.282*** | -1.889*** | -1.303*** |
| | (-4.73) | (-6.71) | (-7.21) | (-10.17) | (-6.25) |
| N | 138 | 133 | 125 | 113 | 101 |
| R-square | 0.307 | 0.362 | 0.456 | 0.613 | 0.571 |
| | | | ***Panel C: Future PB-adjusted stock returns*** | | |
| PEV ratio | -0.482*** | -0.788*** | -1.045*** | -1.435*** | -1.873*** |
| | (-3.71) | (-6.17) | (-6.25) | (-7.71) | (-8.11) |
| N | 138 | 133 | 125 | 113 | 101 |
| R-square | 0.262 | 0.365 | 0.440 | 0.564 | 0.708 |
| | | | ***Panel D: Future size-adjusted stock returns*** | | |
| PEV ratio | -0.552*** | -0.928*** | -1.211*** | -1.625*** | -2.082*** |
| | (-4.40) | (-7.13) | (-7.03) | (-9.26) | (-10.69) |
| N | 138 | 133 | 125 | 113 | 101 |
| R-square | 0.280 | 0.389 | 0.479 | 0.607 | 0.751 |
| | | | ***Panel E: Future market-, PB-, and size-adjusted stock returns*** | | |
| PEV ratio | -0.461*** | -0.690*** | -0.996*** | -1.397*** | -1.121*** |
| | (-3.56) | (-5.08) | (-5.83) | (-7.80) | (-5.80) |
| N | 138 | 133 | 125 | 113 | 101 |
| R-square | 0.250 | 0.321 | 0.413 | 0.561 | 0.600 |

This table reports the results of OLS panel regressions of stock returns on PEV ratios. Stocks of a sample of European Insurance CFO Forum members that disclose their embedded values on a group basis are included in the sample. Panel A reports results with future unadjusted stock returns as the dependent variable. To control for the correlation between market returns and insurers' stock returns, we follow Halek & Eckles (2010) to regress unadjusted stock returns on the returns of the MSCI Europe Index. The residuals are defined as market-adjusted returns. Panel B reports results with future market-adjusted returns as the dependent variable. To control for the correlation between price-to-book value ratio and insurers' stock returns, we regress unadjusted stock returns on price-to-book value ratio. The residuals are defined as PB-adjusted returns. Panel C reports results with future PB-adjusted returns as the dependent variable. To control for the size effect on insurers' stock returns, we regress unadjusted stock returns on the logarithm of market prices. The residuals are defined as size-adjusted stock returns. Panel D reports results with future size-adjusted returns as the dependent variable. To control for the combined effect of market return, price-to-book value ratio, and size on insurers' stock returns, we also regress unadjusted stock returns on the returns of the MSCI Europe Index, price-to-book ratio, and logarithm of market prices. The residuals are defined as market-, PB-, and size-adjusted stock returns. Panel E reports results with future market-, PB-, and size-adjusted returns as the dependent variable. Firm-fixed effect is included and robust standard errors are used to calculate the t-statistics, which are reported in parentheses. *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively. The variables are defined in Table 9.

**Table 7. Heckman two-stage regressions of earnings forecast errors on PEV ratios**

| | Dependent variable | | | | |
|---|---|---|---|---|---|
| **Variable** | **Earnings forecast error** | | | | |
| | (1) 1-year earnings forecast error (%) | (2) 2-year earnings forecast error (%) | (3) 3-year earnings forecast error (%) | (4) 4-year earnings forecast error (%) | (5) 5-year earnings forecast error (%) |
| PEV ratio | 0.784 | 3.186* | 5.931*** | 6.058*** | 5.543** |
| | (0.65) | (1.65) | (2.77) | (2.83) | (2.04) |
| Capital asset ratio | -141.894*** | -175.788*** | -147.033*** | -116.587*** | -55.830 |
| | (-5.96) | (-4.83) | (-3.57) | (-2.90) | (-1.11) |
| Firm size | -0.002 | 5.847* | 6.620* | 8.217** | 8.663* |
| | (-0.00) | (1.86) | (1.81) | (2.22) | (1.80) |
| Income growth | -0.054 | -0.035 | -0.060 | -0.057 | -0.104 |
| | (-0.57) | (-0.22) | (-0.36) | (-0.34) | (-0.54) |
| Insurance penetration | 49.671*** | 93.997*** | 111.190*** | 105.918*** | 94.415** |
| | (2.95) | (3.33) | (3.62) | (3.42) | (2.47) |
| Liquidity | 12.171 | 18.005 | 13.764 | -29.003 | -48.903 |
| | (0.63) | (0.61) | (0.41) | (-0.89) | (-1.24) |
| Market share | 30.843*** | 54.072*** | 63.457*** | 57.145*** | 37.412*** |
| | (5.51) | (5.99) | (6.02) | (5.41) | (2.89) |
| Non-insurance activities | -7.824* | -4.332 | -1.094 | 3.082 | 2.529 |
| | (-1.92) | (-0.64) | (-0.15) | (0.42) | (0.27) |
| Premium growth | -1.192 | 0.028 | -0.610 | -1.391 | 3.219 |
| | (-0.80) | (0.01) | (-0.23) | (-0.55) | (0.84) |
| Use of reinsurance | 14.763 | -79.405 | -157.526** | -218.820*** | -167.410** |
| | (0.41) | (-1.47) | (-2.45) | (-3.61) | (-2.25) |
| ***Determinants of embedded value disclosure in first-stage regression*** | | | | | |
| Earnings variability | -0.391 | -0.383 | -0.369 | -0.334 | -0.293 |
| | (-0.97) | (-0.96) | (-0.94) | (-0.90) | (-0.85) |
| Firm size | 0.730*** | 0.722*** | 0.711*** | 0.704*** | 0.724*** |
| | (9.03) | (8.93) | (8.79) | (8.58) | (8.25) |
| Hostile takeover | 13.879*** | 13.993*** | 14.311*** | 14.657*** | 15.679*** |
| | (2.09) | (2.92) | (2.98) | (3.03) | (3.14) |
| Product market regulation index | -1.056*** | -1.054*** | -1.052*** | -1.041*** | -0.992*** |
| | (-4.38) | (-4.37) | (-4.35) | (-4.28) | (-4.02) |
| Inverse Mills ratio | -0.170 | 6.775* | 5.767 | 6.994 | 8.628 |
| | (-0.07) | (1.67) | (1.22) | (1.47) | (1.43) |
| Firm-fixed effect | Yes | Yes | Yes | Yes | Yes |
| Observations | 413 | 410 | 406 | 399 | 388 |

This table reports the results of Heckman two-stage regressions for a sample of listed European life insurers. The sample period is from 2000 to 2018. Members of the European Insurance CFO Forum that disclose their embedded values on a group basis and all of the listed life insurers that were active in Thomson Reuters Datastream (Datastream) in the sample period are included. European life insurers that were listed during the sample period but were delisted before the end of the period are also included in the sample to avoid survivorship bias. The dependent variables are earnings forecast errors, which are downloaded from I/B/E/S Estimates. Embedded values are manually extracted from insurers' annual statements and data on other insurer characteristics are downloaded from Datastream. The hostile takeover data are downloaded from the DealScan database, and market statistics (i.e., insurance penetration, product market regulation index, and market share) are downloaded from the statistics database maintained by the Organisation for Economic Co-operation and Development (OECD). Firm-fixed effects are included. The two-step variance estimator derived by Heckman is used to calculate standard errors for Heckman two-stage regressions, and z-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. The variables are defined in Table 9.

**Table 8. Heckman two-stage regressions of future profitability on PEV ratios**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| **Year** | **t+1** | **t+2** | **t+3** | **t+4** | **t+5** |
| **Variable** | **Dependent Variable** | | | | |
| | ***Panel A: Net profit margin (%)*** | | | | |
| PEV ratio | -0.289 | -1.892 | -1.940 | 4.179 | 4.487 |
| | (-0.12) | (-0.81) | (-0.85) | (1.53) | (1.46) |
| N | 410 | 406 | 399 | 388 | 377 |
| | ***Panel B: Return on asset (%)*** | | | | |
| PEV ratio | 0.014 | -0.195 | -0.188 | 0.141 | 0.217 |
| | (0.11) | (-1.11) | (-1.52) | (0.99) | (1.46) |
| N | 410 | 406 | 399 | 388 | 377 |
| | ***Panel C: Return on equity (%)*** | | | | |
| PEV ratio | 2.802 | -4.312 | -3.292 | 4.538 | 6.612 |
| | (0.94) | (-1.50) | (-1.10) | (1.34) | (1.39) |
| N | 410 | 406 | 399 | 388 | 377 |

This table reports the results of Heckman two-stage regressions for a sample of listed European life insurers. The sample period is from 2000 to 2018. Members of the European Insurance CFO Forum that disclose their embedded values on a group basis and all of the listed life insurers that were active in Thomson Reuters Datastream in the sample period are included. European life insurers that were listed during the sample period but were delisted before the end of the period are also included in the sample to avoid survivorship bias. The dependent variables are net profit margin, return on assets, and return on equity, which are measures of profitability commonly used in the literature (e.g., Berg et al., 2018; Elango et al., 2008). The independent variables are the same as those in Table 3. Except for the estimated coefficients of PEV ratio, the estimated coefficients of the other independent variables are not reported to conserve space. Firm-fixed effects are included. The two-step variance estimator derived by Heckman is used to calculate standard errors for Heckman two-stage regressions, and z-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. The variables are defined in Table 9.

**Table 9. Definitions of the variables**

| **Variables** | **Definitions** (Codes of Thomson Reuters Datastream items in brackets) |
|---|---|
| **Profitability measures** | |
| Net profit margin (%) | $\frac{\text{Net income (WC01751)}}{\text{Premium earned (WC01002)}} \times 100\%$ |
| Return on assets (%) | $\frac{\text{Net income}_t \text{ (WC01751)}}{\text{Total assets}_t \text{ (WC02999)} + \text{Total assets}_{t-1} \text{ (WC02999)}} \times 2 \times 100\%$ |
| Return on equity (%) | $\frac{\text{Net income}_t \text{ (WC01751)}}{\text{Book value of equity}_t \text{ (WC03995)} + \text{Book value of equity}_{t-1} \text{ (WC03995)}} \times 2 \times 100\%$ |
| **Firm characteristics** | |
| Capital asset ratio | The ratio of capital to assets (WC15121) |
| EV dummy (1/0) | A dummy variable equal to 1 if the insurer discloses embedded value on a group basis, and 0 otherwise. |
| Firm size | Logarithm of total assets (WC02999) |
| Income growth | $\frac{\text{Net income}_t \text{ (WC01751)} - \text{Net income}_{t-1} \text{ (WC01751)}}{\lvert Net\ income_{t-1}\ (WC01751) \rvert}$ |
| Insurance penetration | The ratio of total premium written in the country to gross domestic product |
| Liquidity | $\frac{\text{Cash and equivalent (WC02005)}}{\text{Total assets (WC02999)}}$ |
| Market share | $\frac{\text{Premium earned (WC01002)}}{\text{Total premium written in the country}}$ |
| Non-insurance activities | $\frac{\text{Total liabilities (WC03351)} - \text{Insurance reserves (WC03030)}}{\text{Total liabilities (WC03351)}}$ |
| PEV ratio | $\frac{\text{Market Value of Equity (MV)}}{\text{Embedded value}}$ |
| Premium growth | $\frac{\text{Premium earned}_t \text{ (WC01002)}}{\text{Premium earned}_{t-1} \text{ (WC01002)}} - 1$ |
| Sentiment-adjusted PEV ratio | We regress PEV ratios of life insurers on the crisis sentiment index and construct the sentiment-adjusted PEV ratios as the residuals of the regression. |
| Use of reinsurance | $\frac{\text{Reinsurance premium (WC01005)}}{\text{Premium earned (WC01002)}}$ |
| **Determinants of embedded value disclosure** | |
| Earnings variability | Standard deviation of net profit scaled by premium for the last 5 years |
| Firm size | Logarithm of total assets (WC02999) |
| Hostile takeover | Five-year average of $\frac{\text{Number of life insurer hostile takeovers announced}}{\text{Number of life insurers in the country}}$ |
| Product market regulation index | The Product Market Regulation Index developed by the Organisation for Economic Cooperation and Development (OECD) |
| Inverse Mills ratio | The selection bias correction term to control for the possibility that the insurer's decision to disclose embedded value is endogenously determined. |
| **Crisis sentiment measure** | |
| Crisis sentiment index | The first principal component of the search volume for the terms "financial crisis", "credit crisis", "bank crisis", and "subprime crisis" on Google. |
| **Earnings forecast errors** | |
| 1-year earnings forecast errors | $\frac{\text{12 month forward earnings per share}_t \text{ (EPS1FD12)} - \text{12 month trailing earnings per share}_{t+1} \text{ (EPS1TR12)}}{\text{Market price}_t \text{ (P)}}$ |
| t-year earnings forecast errors for $t \geq 2$ | Accumulative 1-year earnings forecast errors in the subsequent t years |
| **Stock returns** | |
| Unadjusted return | Raw return of life insurers |
| Market-adjusted return | We regress unadjusted returns of life insurers on the returns of the MSCI Europe Index and construct the market-adjusted returns as the residuals of the regression. |
| PB-adjusted return | We regress unadjusted returns of life insurers on price-to-book value ratios and construct the PB-adjusted returns as the residuals of the regression. |
| Size-adjusted return | We regress unadjusted returns of life insurers on the logarithm of market prices and construct the size-adjusted returns as the residuals of the regression. |
| Market-, PB-, and size-adjusted return | We regress unadjusted returns of life insurers on the returns of the MSCI Europe Index, price-to-book value ratios, and logarithm of market prices, and construct the market-adjusted returns as the residuals of the regression. |

# Research on the Ways of Green Insurance's Effect on Realizing the Target of Peaking Carbon Dioxide Emissions and Carbon Neutrality

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**Keywords:** Green insurance, Carbon dioxide emissions, Carbon neutrality, New energy vehicle insurance, Insurance green investment.

**Abstract.** As the global warming problem becomes more and more serious, the issue of controlling greenhouse gas emissions has attracted more and more attention from all countries in the world. As a responsible major country, China needs to ensure high-quality economic development on the one hand, and at the same time fulfill its responsibilities as a major country. In the 14th Five-Year Plan and the Long-Range Objectives through the Year 2035, China has solemnly pledged to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060. The realization of this policy goal provides opportunities and challenges for the development of green finance, and also puts forward higher requirements for the development of green finance, which is incumbent and constitutes the fundamental work of the future financial system. As an important part of the financial system, the insurance industry should also play a role in the construction of a green financial system to help achieve the goal of carbon peak and carbon neutrality.

In 2016, the People's Bank of China, the Ministry of Finance and other seven ministries and commissions jointly issued the "Guiding Opinions on Building a Green Financial System", which clearly pointed out the need to vigorously develop green

insurance. It also puts forward specific requirements for the development of green insurance from the product and service side and the use of funds, so that green insurance has been given a broader meaning. Therefore, under the background of China's economy entering a new stage of development, it is of great significance to study how green insurance can effectively help to peak carbon dioxide emissions.

This article mainly discusses the following issues:

First, from the perspective of the product side. Focusing on the new energy vehicles and their industrial chain insurance, researching insurance product development that serves the green industry. Analyze the popularization trend of new energy vehicles and insurance participation, and study the characteristics of new energy vehicle products and industrial risk insurance. Point out the shortcomings of the current new energy vehicle insurance method. Learn from the development of new energy automobile insurance in developed countries such as Europe and the United States, solve the problem of product innovation and lack of supporting policies as soon as possible, and provide reliable supporting services for the popularization of new energy vehicles and industrial development.

Secondly, from the perspective of investment side, research the institutional arrangements for insurance funds to invest in green and low-carbon projects. The typical case method is used to sort out the investment of insurance funds in green and low-carbon projects in recent years, and combine the current policies of insurance funds to analyze the deficiencies of insurance companies in the green use of funds and the areas for improvement. Support the development of green industries while effectively controlling investment risks.

Finally, starting from the insurance company itself, it analyzes the realization of low-carbon and green operations by my country's insurance companies in their daily operations. In combination with specific cases, specific improvement measures are proposed for the realization of the insurance company's own carbon peak and carbon neutral goals.

## 1. 引言

近年来，二氧化碳排放量的快速增加导致全球范围内气候异常和极端气候灾难频发，全球气候变暖已经成为全人类共同面临的巨大挑战，推动绿色低碳转型以应对气候变化问题迫在眉睫。中国作为负责任的大国，积极响应国际号召，多次公开表明坚持可持续发展的立场，在 2020 年 9 月 22 日的联合国大会上，习近平总书记郑重承诺，“中国将力争 2030 年前达到二氧化碳排放峰值，努力争取 2060 年前实现碳中和”[1]，在 2021 年 4 月 22 日的领导人气候峰会上，更是表明

[1] 新华网. 习近平 “在第七十五届联合国大会一般性辩论上的讲话”. [2020-9-22]

要将碳达峰、碳中和纳入生态文明建设整体布局。

在大力推动绿色低碳转型以实现碳达峰、碳中和的大背景下，绿色金融体系的作用越来越受到重视，发展绿色金融更是助力可持续发展的重要举措。保险业作为金融体系的重要组成部分，也应该在经营活动的全过程秉持低碳绿色的发展理念。本文从绿色保险广义的定义出发，分别从产品服务、投资以及经营活动三个层面研究绿色保险对实现碳达峰、碳中和目标的具体作用途径，由此能够较为全面地分析绿色保险的发展现状，以及发展中存在的问题，同时针对问题提出建议，有助于绿色保险在促进节能减排中更好的发挥作用，也为全面构建绿色金融体系提供借鉴。

## 2. 文献综述

国内外学者关于绿色保险还没有形成统一定义。狭义绿色保险局限于有助于环境保护的保险产品，有学者直接将其定义为环境污染责任保险。阚小冬（2005）认为绿色保险就是环境责任保险，是为经济可持续发展以及生态环境的保护起到保驾护航作用的保险产品。安伟（2008）将绿色保险定义为以企业发生污染事故对第三者造成的损害依法应承担的赔偿责任为标的的保险，即“环境污染责任保险”，并将绿色保险纳入绿色金融体系，研究其对节能减排的作用机理。也有学者将绿色保险纳入绿色金融服务范畴进行扩展，翁智雄，葛察忠，段显明，龙凤（2015）在对国外绿色金融产品的分析基础上，将保险领域中的绿色金融产品分为汽车保险、家庭和商业保险以及碳保险三类，建议我国加快绿色保险产品创新，丰富绿色金融产品体系。王顺庆，张莺（2016）认为除了环境责任保险外，绿色保险还应该包含食品安全责任保险和生态损失责任保险。

在广义的概念中，绿色保险不仅仅是一款保险产品，更是一种需要植根保险业发展理念的战略考量。章金萍（2006）认为应该从广义角度理解绿色保险内涵，要将生态观念引入保险业，形成有利于资源节约、降低能耗、改善环境的保险增长模式。卓志（2010）指出绿色保险应该是泛指一切有利于绿色经济发展、环境保护、社会和谐等有机协调发展的保险统称。吕宙（2010）认为绿色保险不仅是与环境污染责任相关的保险制度，还应该是保险业自身可持续发展的一种发展理念，其核心内容是服务绿色经济和低碳产业。田辉（2014）指出绿色保险不能仅局限于环责险这一单一险种，更应该是一种贯穿保险经营和服务全过程的发展理念。汪国庆（2019）将绿色保险视为保险人在承保和经营环节对环保产业进行大力支持并体现环保意识的一种行为。王波，岳思佳（2020）认为绿色保险是指通过保险机制实现环境风险成本内部化，除了研究环境污染强制责任保险，还提出保险公司应该开展绿色投资以充分发挥保险在绿色金融体系中的重要作用。

由于学界尚没有对绿色保险的统一定义，因此在绿色保险如何助力节能减排问题上，研究角度也各不相同，主要包括研究绿色保险产品的开发问题以及保险资金的绿色投资问题，暂时缺少对保险公司绿色经营问题的研究。首先，对于绿色保险产品的开发，大部分文献集中于对个别有利于环境保护的保险产品的研究，不具有典型性，且产品的开发建议对于绿色保险缺乏普遍适用性。张诗青，王建伟，郑文龙（2017）指出交通运输在中国各大行业碳排放总量中占比增速排名第一，且其排放量已成为第二大二氧化碳排放部门。由此可见，通过推广新能源汽车来缓解交通运输业碳排放问题是实现碳排放碳达峰目标的关键，关于新能源汽

http://www.xinhuanet.com/politics/leaders/2020-09/22/c_1126527652.htm

车保险的研究也具有典型代表性。张权辉（2011）分析了新能源汽车产业存在的技术风险和市场风险，在此基础上研究新能源汽车在开发与推广以及产品出售后的保险产品设计。霍潞露,方海峰（2017）梳理了汽车保险政策的法规体系，从产品风险的角度建议开发新能源汽车专属保险产品，比如针对新能源汽车及重要零部件的产品责任险以及专属附加险种等。康雷闪,刘永志（2020）指出目前新能源汽车投保存在的“高保低赔”、保险诈骗等问题，从保险法的角度提出新能源汽车保险问题的解决路径。其次，对于保险资金的绿色运用，相关的文献较少，吴杰（2019）分析了保险资金绿色投资可选择的品种，同时指出了保险资金绿色投资所面临的问题，通过借鉴国际经验，从政策监管层面以及公司层面对我国保险资金的绿色运用提出建议。

梳理文献可知，学者们对绿色保险发展问题进行了深入探讨，取得了丰硕的研究成果，为本文的研究提供了思路。然而从目前的文献研究情况看，学界在绿色保险的定义上还没有统一的认识，因此对绿色保险发展问题的研究缺少较为全面的视角。本文在已有文献的基础上，根据我国目前的发展状况，赋予绿色保险更加广泛的定义，并且从定义出发以较为全面的视角研究绿色保险如何助力节能减排。在绿色保险产品的开发问题上，通过对具有典型性的新能源汽车投保问题的研究，兼顾绿色产品和产业链风险，为绿色保险产品的开发提出建议。在保险资金的绿色运用上，结合目前的投资现状，分析保险资金如何更广泛的投资于绿色环保项目。在保险公司的绿色经营上，结合具体的案例，为保险公司节能减排实现自身碳达峰碳中和提出意见建议。

## 3.绿色保险的定义及其对碳达峰碳中和目标实现的作用机理

### 3.1 绿色保险定义

在当前大力倡导节能减排的背景之下，根据 2016 年中国人民银行、财政部等七部委联合印发的《关于构建绿色金融体系的指导意见》对发展绿色保险提出的具体要求，本文将绿色保险定义为保险业在经营活动全过程秉持绿色可持续的发展理念，并全面贯彻于经营各环节。首先在产品端，保险公司开发和完善有利于生态环境保护的险种，推出绿色保险产品服务；在投资端，保险公司将保险资金更多地投资于有利于环境保护的产业和项目，注重保险资金绿色效益；在保险公司日常运营中，倡导和坚持绿色环保办公理念，实现公司自身绿色经营。

### 3.2 绿色保险对碳达峰碳中和目标实现的作用机理

要实现碳达峰碳中和的目标，就要求各行业必须坚持节能减排。绿色保险作为绿色金融体系中的重要组成部分，更应该发挥自身的作用，助力“碳达峰碳中和”目标的实现。厘清绿色保险定义，明确保险公司通过产品端、投资端以及公司绿色经营三个途径来助力碳达峰碳中和。

丰富绿色保险产品和服务，为绿色产业的发展提供风险保障。在对绿色保险进行产品设计时，既要关注绿色项目或绿色产品自身的风险，还要关注整个绿色产业链的风险。具体以新能源汽车保险为例，研究绿色产品和产业链保险的险种开发，通过保险的风险保障功能，为绿色产业的产品风险和产业链风险提供保障，鼓励有助于节能减排的绿色产业发展，推动碳达峰碳中和目标的实现。

保险资金通过投资于绿色环保低碳项目，促进环保事业的发展。投资领域涵盖水力发电、风力发电、核电等新能源项目，从能源的使用上减少碳排放。投资于环境治理等领域，改善生态环境，治理污染问题，生态环境的改善也有利于加

强植被对碳排放的吸收，从而实现碳中和的目标。

保险公司通过绿色经营，倡导绿色环保经营理念，在日常的经营活动中做到低碳环保，节约资源，保护环境。培养员工的环保意识，倡导绿色低碳出行。使行业自身率先实现碳达峰碳中和的目标。

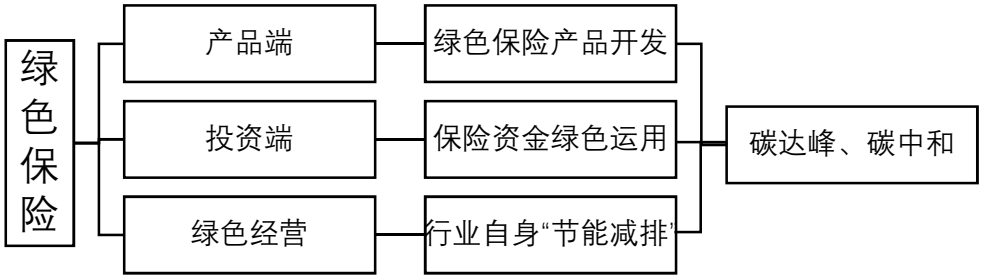


图 1　绿色保险对碳达峰碳中和目标实现的作用机理

## 4. 绿色保险发展存在的问题

### 4.1 绿色保险产品开发滞后问题：新能源汽车保险案例

新能源汽车是指“采用新型动力系统，完全或者主要依靠新型能源驱动的汽车，包括插电式混合动力（含增程式）汽车、纯电动汽车和燃料电池汽车等”[2]。

#### 4.1.1 新能源汽车产业发展现状

（1）新能源汽车产销现状

2012 年《节能与新能源汽车产业规划（2012-2020）》的颁布，确定了我国新能源汽车产业化的目标，新能源汽车也开始迅速推广和发展。根据中国工信部提供的数据（见图 2），自 2014 年以来，我国的新能源汽车产业发展迅速，2020 年我国的新能源汽车产量达 136.6 万辆，销量达 136.7 万辆。从新能源汽车产销量的总体变化趋势来看，我国的新能源汽车产销量基本匹配，新能源汽车产业基本实现了较为平稳的发展。关于我国新能源汽车未来的发展趋势，中国汽车工程学会在 2020 年编制的《节能与新能源汽车技术路线图 2.0》中指出，预计 2025 年新能源汽车市场占比能够达到 20%，至 2035 年，新能源汽车的年销量将超过总体的 50%，新能源汽车将逐渐成为汽车市场的主流产品。

[2] 中国汽车工业协会.工业和信息化部关于修改<新能源汽车生产企业及产品准入管理规定>的决定.[2020-7-24] http://www.caam.org.cn/chn/9/cate_99/con_5231280.html

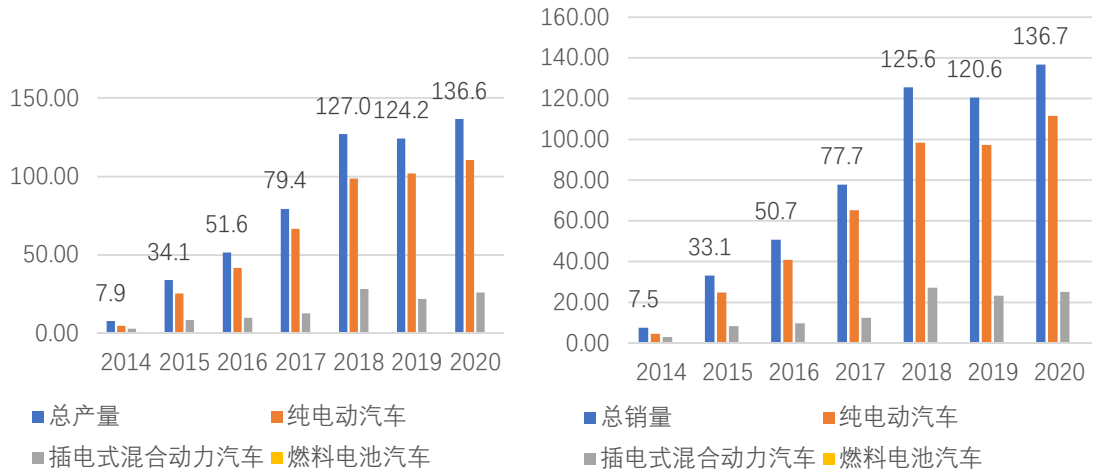


图 2 2014-2020 年我国新能源汽车产销量情况（单位：万辆）[3]

（2）新能源汽车参保情况

在当前新能源汽车市场不断发展的情况下，关于新能源汽车的投保问题也越来越受到关注。然而目前还没有新能源汽车的专属险种，新能源汽车在投保的时候仍然按照普通燃油汽车的车险险种进行投保。随着新能源汽车市场不断扩大，投保需求也不断扩大，新能源汽车的承保数量和保费规模快速增加，承保数量从2014年的14万辆增加到2020年的300多万辆，虽然仅占行业总承保车辆的1.4%，但是发展迅速，保费规模也在2017年突破100亿。从目前新能源汽车的承保情况可以看出，新能源汽车的承保还处于起步阶段，保险公司缺少对新能源汽车承保和理赔的经验，缺少对新能源汽车保费定价的数据支撑。尽管目前保费在车险份额中的占比较小，而且关于新能源汽车的承保和理赔数据积累不足，但是新能源汽车市场的投保需求较大，亟需研发和创新险种以满足市场多样化的需求。

4.1.2 新能源汽车产品和产业风险分析

（1）新能源汽车产品风险

1）自燃风险

导致新能源汽车自燃的原因有很多，其中最主要的原因是电池过热。由于受到技术的限制，电池的耐高温、防水等性能还不成熟，导致目前运用于新能源汽车的电池在安全性方面存在着不足。在新能源汽车长时间的驾驶，或者是长时间的充电之后，甚至是处在高温环境时，电池都极易出现过热的现象，这就增加了新能源汽车发生自燃的风险。同时由于电池的研发成本高，电池制造商受到资金的限制，在研发和生产阶段没有很好地解决电池耐高温等关键问题，导致一些质量较差的电池流入市场，劣质电池极易发生短路，这也会导致汽车自燃。在2020年，国内有报道的新能源汽车的自燃事故达61起，而这些事故的原因大部分都是因为电池过热短路导致的。由此可见，新能源汽车发生自燃的概率远大于传统燃油汽车，自燃风险也是新能源汽车保险应该关注的主要风险。

2）特殊零部件损坏风险

新能源汽车车主在特殊零部件损坏之后，将会面临难以负担的高额维修费用。

[3] 数据来源：中华人民共和国工业和信息化部官网
https://www.miit.gov.cn/gxsj/tjfx/zbgy/qc/art/2021/art_80a68716879e4180a0dea39183b546cf.html

首先，不同于依靠发动机的传统燃油汽车，电池、电机和电控是新能源汽车的核心。电池为汽车提供动力，电机则将动力转变为驱动力，电控根据制动踏板和油门等传递的信号将其转化为指令，向电池和电机发出指令。由于新能源汽车的特殊性，普通的汽车修理厂通常无法直接对其进行维修。其次，新能源汽车更新换代快，发展迅速。对于一些已经停产的车型，在其零部件损坏之后，难以找到同样的零部件进行替换，甚至需要制造厂商专门为其生产损坏的零部件，这就提高了维修成本，导致消费者难以负担高昂的维修费用。最后，政策只为消费者购置新能源汽车时提供财政补贴，在新能源汽车的维修费用上，全部由消费者自己承担，而新能源汽车的关键零部件，比如动力电池，其成本几乎占到了整车成本的一半，所以甚至出现了电池的维修费费用高于新车的购置价格的情况。

（2）新能源汽车产业风险

1）技术研发风险

新能源汽车的研发面临许多的技术难题，目前我国新能源汽车的核心“电池、电机与电控”技术相对落后，电池的安全性能、耐损耗性能问题还没有得到有效的解决。尽管国外的新能源汽车技术较为先进，但由于这些关键技术是新能源汽车的核心竞争力，国内的厂商难以获得国外的研发经验，这就在一定程度上增加了技术研发难度。同时在新能源汽车的研发过程中，需要巨额的资金投入，研发成本高，试错成本高，一些新能源汽车厂商没有足够的资金来攻克技术难题。这就导致了新能源汽车的技术研发发展缓慢，整个产业也面临着技术研发风险。

2）融资风险与信用风险

新能源汽车在整个研发、生产、销售以及后期维修阶段都需要大量的资金投入，一些规模较小的厂商面临着融资困难的问题。尽管国家为鼓励新能源汽车产业的发展，为新能源汽车厂商提供了绿色信贷，但是在新能源汽车的后续生产和销售中，企业的盈利周期过长，很容易出现资金周转问题，再加上企业面临房租、设备、工资等固定成本约束，企业利润情况不断恶化。在这种情况下，企业信贷违约风险将不断上升，提供贷款的银行将面临更大的信用风险，这将导致企业的后续融资更加困难，企业难以维持正常的经营。

3）基础设施风险

新能源汽车的普及和推广离不开充电桩等基础设施的建设。对于公共充电桩，由于充电桩前期建设投入成本大，后期投资回报慢，盈利周期太长，很多充电桩企业面临亏损，缺少建设公共充电桩的积极性。同时充电桩的建设还要考虑选址的科学性，结合地区新能源汽车的保有量现状，使充电桩的数量既能满足地区新能源汽车的充电需求，同时也不会产生资源浪费，这个问题仅靠充电桩企业的决策，是很难解决的。因此便出现了有些地区充电桩过剩，有些地区充电桩供不应求的情况。对于私用充电桩，车主面临着安装费用高、充电桩财产损失以及充电时线路短路发生火灾等风险，这些因素也使车主缺少安装私用充电桩的积极性，这也在很大程度上抑制了新能源汽车的普及和发展。

4.1.3 新能源汽车投保存在的问题

（1）高保费低赔付

保险公司在对新能源汽车进行承保时，综合考虑汽车的型号、用途、官方价格等因素，其中保费的确定在很大程度上会受到官方价格的影响。由于国家政策支持新能源汽车的发展，在购置新能源汽车时会给予车主一定的价格补贴，车主的实际购置价低于新能源汽车的官方价格，因此在投保时，车主将支付较高的保

险费。而当保险事故发生后，保险公司则根据车主的实际购置价进行理赔，车主获得相对于保费来说较低的赔付。因此在新能源汽车的投保中便出现了高保费低赔付的问题

（2）车险定价缺少数据支撑

由于目前还没有新能源汽车的专属保险产品，新能源汽车只能在市场上为传统燃油汽车设计的产品中进行选择。要想设计专属于新能源汽车的产品，就要解决定价问题，但是新能源汽车的各项风险数据都掌握在其制造厂商的手中，而在我国的新能源汽车市场上，还有很多国外的厂商。数据的难以获得使得保险公司在对险种进行定价时缺少数据支撑，保险公司难以对风险进行准确的衡量，这阻碍了我国新能源汽车保险的创新和推出

（3）风险没有得到充分保障

当前的承保形式并完全没有涵盖新能源汽车所面临的主要风险。以新能源汽车的关键零部件电池为例，电池发生短路风险的可能性较大，由电池过热导致的汽车自燃的事故也时有发生，且根据前文的分析，电池的维修成本很高。而目前车损险的保障责任中，并没有包括电池损坏引起的财产损失和人身伤害风险，事故一旦发生，将会面临着定损难、理赔难等问题。新能源汽车的风险没有得到充分的保险保障，这也不利于新能源汽车的普及和推广。

## 4.2 保险资金绿色投资现状和存在的问题

### 4.2.1 保险资金绿色投资现状

保险资金在投资中往往坚持安全性、流动性、收益性、偿付性等原则。早期由于受到政策和监管的限制，保险资金主要投资与安全性较高的风险较低的银行存款。随着金融市场的发展，监管制度和相关政策不断完善，保险资金的投资工具上逐渐丰富。在投资领域上也包含了环保、新能源等方面，对于节能减排工作的开展，以及“碳达峰碳中和”目标的实现起着至关重要的作用。为深入贯彻生态文明思想，中国保险资产管理业协会在 2018 年发表了《中国保险资产管理业绿色投资倡议书》，明确提出要搭建“间接投资+直接投资”的绿色投资体系。[4]

（1）直接投资

目前我国的保险资金主要通过债权投资计划、股权投资计划、资产支持计划、绿色产业基金等方式对绿色项目进行直接投资，其中债权投资计划是主要方式。根据中国保险资产管理业协会的数据，“截至 2019 年 4 月底，保险资金以债权投资计划形式进行绿色投资的产品注册规模已近 7900 亿元”。[5]通过对保险资金的产品注册信息进行检索，2020 年共获批注册 285 例，其中投资于绿色项目的产品如表 1 所示，据不完全统计，达到 17 例，占整体产品的 5.97%，尽管这个比重不高，但也可以看出保险企业正逐渐响应政策号召，并且主要通过债权投资计划直接投资于绿色项目，同时投资领域也涵盖了环保、水务、新能源等各方面。

[4] 中国保险资产管理业协会. 中国保险资产管理业绿色投资倡议书.[2018-6-21] https://www.iamac.org.cn/xhgz/201806/t20180627_5563.html

[5] 中国保险报网.保险资金积极参与绿色投资和责任投资 支持绿色金融发展.[2019-6-6] http://www.ocn.com.cn/touzi/chanye/201906/iooqw06102406.shtml

表 1 2020 年保险资金获批投资于绿色项目产品情况

| 产品名称 | 投资方式 | 投资领域 |
|---|---|---|
| 华泰-深圳能源基础设施债权投资计划（一）期 | 债权投资 | 新能源 |
| 华泰-深圳能源基础设施债权投资计划（二）期 | 债权投资 | 新能源 |
| 华泰-深圳能源基础设施债权投资计划（三）期 | 债权投资 | 新能源 |
| 人保资本-中国广核集团基础设施债权投资计划（一）期 | 债权投资 | 核电 |
| 人保资本-中国广核集团基础设施债权投资计划（二）期 | 债权投资 | 核电 |
| 太平洋-中国广核集团债权投资计划 | 债权投资 | 核电 |
| 新华-贵州水投水务基础设施债权投资计划（一）期 | 债权投资 | 水务 |
| 新华-贵州水投水务基础设施债权投资计划（二）期 | 债权投资 | 水务 |
| 平安-贵州省骨干水源工程债权投资计划(二期) | 债权投资 | 水务 |
| 平安-水发集团水电建设债权投资计划（一）期 | 债权投资 | 水电 |
| 平安-水发集团水电建设债权投资计划（二）期 | 债权投资 | 水电 |
| 光大永明-河南水利基础设施债权投资计划(一期) | 债权投资 | 水电 |
| 中保投-河南水投蔡州水生态项目基础设施债权投资计划 | 债权投资 | 环保 |
| 中意-河南水投襄城水生态项目债权投资计划 | 债权投资 | 环保 |
| 人保资本-晋煤循环经济项目债权投资计划 | 债权投资 | 环保 |
| 阳光-河南水投水生态项目基础设施债权投资计划（一）期 | 债权投资 | 环保 |
| 中国人寿-中国环保基础设施债权投资计划 | 债权投资 | 环保 |

（2）间接投资

保险资金还可以通过绿色债券、绿色股权指数的形式间接投资于绿色项目。自 2015 年由上海浦东发展银行发行第一支绿色债券以来，在绿色金融政策的号召下，我国的绿色债券市场快速发展，在 2019 年，各类绿色债券发行数量达到 295 只[6]，主要由金融债、企业债和公司债构成，并且绿色债券的信用评级以 AAA 债券为主。由此可见，低风险的绿色债券与保险公司在资金投资中遵循的安全性原则高度符合，同时绿色债券相对于传统的银行存款，具有更高的收益率，这也与保险公司追求投资收益的目的符合，因此绿色债券是保险公司间接投资于绿色项目的主要方式。绿色股权指数发展缓慢，自 2008 年发布第一支上证公司治理指数以来，截至 2018 年，我国共发布 21 只绿色股权指数。由于绿色股权指数发布数量较少，也就限制了保险公司的绿色投资选择。

4.2.2 保险资金绿色投资存在的问题

（1）没有统一的绿色投资行业标准

当前针对于保险资金绿色投资并没有统一的行业标准，保险公司在进行投资选择时，没有行业标准作为依据来判断投资项目是否符合绿色项目的标准，这也增加了保险公司前期进行投资项目选择的成本。同时缺少针对保险公司绿色投资的激励机制，这不利于提高保险公司进行绿色投资的积极性。

（2）绿色金融产品数量难以满足投资需求

在前文对保险公司绿色投资的途径分析中可以看出，当前保险公司主要通过债权投资计划和绿色债券的方式参与到绿色项目的建设中，而绿色产业基金、绿

[6] 商瑾.2019 年中国绿色债券运行报告[J].债券,2020(01):37-41.

色指数化产品等其他绿色金融产品发展缓慢、缺乏创新，这就使得保险公司的投资选择较为狭窄，难以满足绿色投资需求，也不利于发挥保险资金在支持绿色产业发展中的重要作用。

（3）保险公司防范绿色投资风险的能力较弱

保险公司在进行绿色投资的过程中，也面临着金融市场中的投资风险。由于绿色金融是近几年才得到快速发展的，对其相关的绿色金融产品的风险评估和预测机制还不完善，保险公司难以在投资时做出准确判断。由于缺少相关的投资经验，保险公司对绿色项目的风险分析能力尚且不足，一些绿色项目由于杠杆率过高，出现违约风险的可能性较大，这不利于保险公司绿色资金的安全，甚至会影响到保险公司的正常经营，影响其偿付能力。

## 4.3 保险公司绿色经营现状和存在的问题

### 4.3.1 保险公司绿色经营现状

为响应国家节能减排的号召，各保险公司纷纷在日常经营活动中贯彻绿色发展理念，并且制定具体的计划来落实绿色经营。国内保险公司低碳行动较为成功的典型案例是中国平安在2010年3月正式启动的以“绿色承诺 平安中国”为主题的低碳100行动，将100项低碳举措贯彻落实到了企业的经营管理、业务发展、以及员工的日常办公等环节中。首先在公司的运营中，平安通过采用无纸化办公，在核保核赔等环节节约了大量纸张。在节约用电方面，规定在每晚八点由系统自动关闭办公电脑，避免对电力资源的浪费。其次在业务的拓展中，更多的采用网络销售渠道，为投保人提供电子保单，减少投保过程中纸张的使用数量。最后在公司的文化中，倡导绿色低碳理念，通过组织和鼓励员工参加绿色公益活动，比如平安举办的健步跑活动、倡议员工参加“地球一小时”等活动，来培养员工的环保意识。

### 4.3.2 保险公司绿色经营存在的问题

保险业不同于其他实体行业，在经营过程中不会产生大量的能源消耗和二氧化碳排放，所以保险公司要实现“节能减排”就应该在各个经营环节体现绿色低碳理念，但是保险公司的绿色经营也面临着问题。首先，由于技术的限制，保险公司在推广电销渠道以及线上核保理赔上面临着技术和成本挑战。其次，保险公司在新能源的运用上需要技术和资金支持，比如将太阳能发电运用到办公大楼需要付出较大的成本来对原有的供电设施进行改造。最后，员工参与绿色公益活动以及坚持节能减排行动的积极性不高，将绿色低碳融入公司的发展理念需要较长时间。

# 5.绿色保险发展对策建议

## 5.1 加快绿色保险产品开发和险种创新

### 5.1.1 加强险种创新以涵盖产品及产业链风险

（1）针对绿色产品风险的保险产品设计

不同的绿色产品具备自身特有的产品风险，在对产品风险的全面分析基础上，针对不同的产品风险设计专属的保险产品。以新能源汽车专属保险产品的设计为例，可以整体参照传统车险，同时根据新能源汽车的特性，推出针对新能源汽车电池、电机等关键零部件的专属附加险种，为关键零部件的损坏风险提供保险保

障，通过附加险的方式补偿车主难以负担的高昂维修费用。同时在产品设计中还要包含有电池过热短路等导致的自燃风险，以及由自燃导致的其他财产损失和人身伤亡。

（2）针对绿色产业链风险的保险产品设计

绿色产业的发展面临着众多的产业链风险，包括影响绿色产业发展的科技研发风险，融资风险以及配套基础设施风险等。以新能源汽车产业链保险为例，可以设计产业链保险以应对前文分析的产业链风险，比如科技保险、信用保证保险以及充电桩保险等。

1）科技保险

政府为企业科技研发提供税收优惠，保费可以列入技术开发费用，在税前列支。由于新能源汽车企业在技术的研发过程中，面临着高的试错成本，同时还需要昂贵的研发设备。在研发过程中，关键研发人员也面临着人身意外伤害的风险。因此保险公司可以创新科技保险，比如新能源汽车企业产品研发责任保险、关键研发设备保险、关键研发人员团体健康保险和意外保险等险种。

2）信用保险和保证保险

为新能源汽车企业以及提供绿色信贷的银行创新信用保险和保证保险产品。为绿色信贷中的违约和信用风险提供保险保障。有效解决新能源汽车企业前期融资困难的问题，使企业能够有足够的资本加强前期技术研发以及后续的生产和销售。

3）充电桩保险

充电桩作为最重要的配套设施，对于新能源汽车的普及有很大影响。针对车主较为关心的私用充电桩的风险防范，保险公司可以研发和创新充电桩财产保险以及充电桩用电安全责任保险，在新能源汽车投保时以附加险的方式，为车主提供保险保障。

### 5.1.2 与绿色厂商合作获得可靠数据以科学定价

绿色保险产品开发受阻的一大重要原因就是保险公司在对产品进行定价时缺少可靠的数据支持，并且这些产品数据通常难以获得。保险公司可以通过和绿色厂商开展合作，与厂商成为利益相关者，获取足以支撑保险产品科学定价的数据。

以新能源汽车保险定价为例，目前由于新能源汽车的理赔经验不足，在保险产品开发的过程中，缺少准确的数据作为科学定价的支撑。要解决这个问题，可行的办法是保险公司与汽车厂商开展合作，当汽车厂商与保险公司成为了利益相关者，保险公司就能够获得大量关系到新能源汽车安全系数的关键数据。合作的方式可以是保险公司通过股权投资计划成为汽车厂商的重要股东，由此便能获得可靠准确的数据。同时还可以与汽车厂商签订合作协议，针对汽车厂商生产的汽车型号，设计专属的保险产品，提高新能源汽车的后续销售服务质量，让消费者在购车时就能获得专属车型的车险产品，通过这种合作计划，保险公司与汽车厂商有相同的利益，在产品设计时便能获得大量的可靠数据，同时也能避免保险公司因错误定价而导致的亏损。

### 5.1.3 借鉴国外成熟经验为绿色保险产品提供优惠费率

通过借鉴国外较为成熟的经验，为绿色产品提供优惠费率，以扩大绿色保险产品的需求，从而推动绿色产业的发展。比如在欧美国家，通常根据新能源汽车的风险等级为新能源汽车提供保险费率上的优惠，在日本，部分企业制定与优惠

条件相符的电动汽车目录，对于目录上的车型分别提供直接的保费优惠、依照比率给予优惠、定额优惠。为了推广新能源汽车，倡导绿色消费，节能减排，可以借鉴国外的成熟经验，建立权威的风险评级机构，在对新能源汽车的风险等级进行评定后，依据评定结果为新能源汽车提供优惠费率，避免出现“高保费低赔付”的情况，提高消费者购买新能源汽车的积极性。

## 5.2 鼓励保险资金投资绿色环保项目

### 5.2.1 制定统一的绿色投资行业标准和激励机制

要尽快制定统一的绿色投资行业标准，在结合保险公司具体的绿色投资经验基础之上，制定科学合理的绿色投资行业标准，重点在于制定绿色投资项目和绿色投资金融产品的认定标准，使保险公司能够降低选择投资项目的成本，更加明确绿色投资计划。同时还要制定激励机制，提高保险公司开展绿色投资的积极性，比如对保险公司的绿色投资项目提供所得税优惠等。

### 5.2.2 创新绿色金融产品

要加快创新绿色金融产品，在完善和发展绿色债券市场的基础上，也要兼顾绿色股票市场、绿色基金市场的发展。政府要鼓励和支持符合监管标准以及有条件的金融机构创新绿色金融产品，推动绿色指数、绿色基金等产品的创新，为保险公司的绿色投资提供更加多元化的选择。

### 5.2.3 提高绿色投资风险防范能力

保险公司要不断提升绿色投资风控能力，加强对绿色资产风险的分析，及时开展环境压力测试。建立信息共享机制，与更多的金融机构共享对于绿色资产的风险预测，提高行业对绿色资产风险的预测准确性。建立评估机制，提高对绿色资产风险评级的可靠性以及对绿色资产风险评估的科学性。完善绿色信用体系建设，及时披露绿色投资信息，有效防范绿色债务违约风险。

## 5.3 保险公司坚持绿色经营

保险公司要从自身做起，通过绿色运营、绿色办公、绿色建筑等方式，降低行业自身的能源消耗以及二氧化碳排放。[7]

在运营环节中，保险公司可以结合先进的互联网技术，与互联网公司开展技术合作，拓宽网络销售渠道，签发电子保单，减少投保环节中的资源浪费和能源消耗。同时可以将互联网技术运用到核保理赔环节中，在提高保险公司运营效率的同时，也有助于贯彻低碳节能的经营理念。

在日常办公中，保险公司可以通过推广无纸化办公，减少对资源的消耗。可以通过绿色建筑的方式，采用太阳能发电等新能源技术，保证公司日常办公产生最少的能源消耗和二氧化碳排放。还可以在公司的用电行为上做出规范，比如在规定时间由公司系统自动关闭办公区电源以减少资源的浪费。

在公司理念中，保险公司可以将绿色低碳融入公司的发展理念。通过宣传标语、组织绿色公益活动等方式，制定奖励机制鼓励员工绿色出行，培养员工的环保意识。还可以通过社会捐赠的方式，为公益环保事业的开展提供资金和其他物资支持，树立绿色低碳的企业形象，为其他行业的节能减排做示范。

[7] 中证网 保险资管业协会发布《助推实现“碳达峰、碳中和”目标倡议书》
http://www.cs.com.cn/bx/202105/t20210520_6168673.html

## 6. 结语

目前，整个绿色金融的发展都还处于起步阶段，绿色保险作为其重要组成部分，要实现更高质量发展，任重而道远。绿色保险是保险行业的一种可持续发展理念，通过绿色险种创新、保险资金的绿色运用以及保险公司自身的绿色经营，保险行业从各方发力，助力于碳达峰碳中和目标的实现。

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# 绿色保险对实现碳达峰碳中和目标作用途径研究

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**关键词：**绿色保险；碳达峰；碳中和；新能源汽车保险；保险绿色投资

**中文摘要.** 随着世界气候变暖问题日益严重，控制温室气体排放越来越受到世界各国重视。中国作为负责任大国，一方面需要保障经济高质量发展，同时需要履行大国责任，中国政府已在十四五规划和 2035 远景目标中庄严承诺 2030 年实现碳达峰、2060 年实现碳中和。实现这个政策目标为绿色金融发展提供了机遇和挑战，发展绿色金融责无旁贷，构成未来金融体系基础性工作。保险业作为金融体系中重要组成部分，也必须在绿色金融体系的构建中努力发挥作用，助力碳达峰碳中和目标的实现。

2016 年中国人民银行、财政部等七部委联合印发的《关于构建绿色金融体系的指导意见》中，明确指出要大力发展绿色保险，并从产品和服务端以及资金的运用上对绿色保险的发展提出了具体要求，绿色保险正被赋予更广泛的含义。在我国经济进入新发展阶段背景下，进一步深入研究绿色保险助力碳排放达峰具体路径意义重大。

本文主要讨论以下问题：

首先从产品端角度，以新能源汽车及其产业链保险为重点研究服务绿色产业的保险产品开发问题。分析新能源汽车普及趋势以及参保情况，研究新能源汽车产品和产业风险保险特性。指出当前新能源汽车投保方式的缺陷。借鉴欧美等发达国家新能源汽车保险的开展情况，尽快解决产品创新和配套政策，为新能源汽车普及和产业发展提供可靠配套服务。

其次从投资端角度，研究保险资金投资于绿色低碳项目的制度性安排。通过

典型案例法对近几年来保险资金投资于绿色低碳项目的情况进行梳理，并结合当前的保险资金相关政策对保险公司在资金的绿色运用上存在的不足以及需改进的地方进行具体分析。支持绿色产业发展的同时有效控制投资风险。

最后从保险公司自身出发，作为金融主体在日常经营活动过程中逐步实现低碳绿色经营。结合具体案例，讨论保险企业自身早日实现碳达峰碳中和目标。

# Research on Corporate Governance Supervision and Problem-solving Financial Institutions：Taking the Case of Dissolution and liquidation of Anbang Insurance Group as an Example

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**Keywords:** Corporate governance, Ownership structure, Internal control

**Abstract.** Since the 18th National Congress of the Communist Party of China, in order to prevent and resolve major financial risks, the China Banking and Insurance Regulatory Commission has continuously strengthened corporate governance and supervision, focusing on the construction of corporate governance structures in the

socialist banking and insurance industries with Chinese characteristics. In August 2020, the China Banking and Insurance Regulatory Commission issued the "*Three-year Action Plan for Improving Corporate Governance in the Banking and Insurance Industry (2020-2022)*." Compared with previous years, the level of corporate governance in the financial industry has improved, but problematic institutions and the risk incidents they bring are still frequent. Corporate governance deficiencies often become the main cause of risk events in financial institutions, and those in serious situations face the end of liquidation and disintegration.

"A lesson from the past, a teacher from the next." This article takes Anbang Insurance Group as an example, from the perspective of corporate governance, and uses relevant theoretical tools to analyze the reasons for the liquidation and disintegration of Anbang Insurance Group from different sides. Then analyze the main focus of the regulatory authorities in dealing with problematic financial institutions. On the premise of learning from experience and lessons, it proposes targeted measures based on improving the governance mechanism of insurance companies. This paper first systematically sorts out the relevant literature on insurance company governance research. Secondly, based on the theory of separation of two powers, analyzing from the dimensions of ownership structure and board governance, it is found that the ownership and control of Anbang Insurance Group are not separated. The group is completely controlled by Wu Xiaohui. Then, based on the stakeholder theory, from the analysis of other stakeholders' governance dimensions, It is discovered that Anbang Insurance Group has problems with the transmission of related-party transactions and the mixed operation of bancassurance, which has brought conflicts of interest to other stakeholders such as policy holders, investors, etc. Thirdly, based on the COSO internal control theory, from the perspective of risk assessment and internal control activities, it is found that Anbang Insurance Group's internal control system has defects. On the whole, the flaws in corporate governance caused the liquidation and disintegration of Anbang Insurance Group. This article sorts out the process and main measures of the supervisory authority in the disposal of Anbang Insurance Group, and summarizes the main experience of the supervisory authority in dealing with problematic financial institutions. Finally, relevant suggestions are put forward for improving the corporate governance supervision system of financial institutions.

## 1. 引言

党的十八大以来，为防范化解金融领域存在的重大风险，中国银行保险监督管理委员会不断强化公司治理监管，聚焦于中国特色社会主义银行业、保险业公司治理体系的建设，并在二零二零年八月出台了《健全银行业保险业公司治理三年行动方案（2020—2022年）》。与前些年相比，金融行业公司治理水平有所提升，但问题金融机构带来的风险事件依然频出。公司治理缺陷往往成为金融机构风险事件的主要诱因，情况严重者更是使得金融机构走向清算解体的结局。

为了适应金融业竞争格局、推进市场化改革以及防范风险，亟待严格化公司治理监管，具体而言，可通过内控体系的改良、聚力于董事会建设、加强股权的监管等方式从而进行改良，进而促进公司治理的完善，使之从“形式规范”进步

为“治理实效”（贲奔，臧明仪，2021）；对于存在问题的金融机构，其退出市场的方式总共分为以下几种：责令整改、注资援助、进行广义上的退市（徐秋菊，曹利莎，张同建，2014）。研究表明，接管、收购或兼并、破产是问题保险公司可以选择的主要退出方式(陈华，张艳，2010），另外根据相关法律规定，针对出现问题的保险企业，监管机构基于保险企业的经营状况，应采取相应的行政措施来改善经营，其中包括重点监管、责令限期整改、整顿、接管。本文以安邦保险集团解散清算案为例，该集团选择的是被监管部门接管的退出方式。

## 2．案例介绍

### 2.1 安邦保险集团基本情况

安邦保险集团于二零一一年注册成立，是由安邦财险发展而成的大型保险集团，“巅峰时期”公司总规模达到了近两万亿，包括了安邦财险等多39家子公司，经营着财产险、人寿险、健康险、资产管理等众多业务。

集团的股东包括宁波世界汽车城、嘉兴公路建设投资有限公司等39个公司，其中的每个股东持股比例均小于5%，集团的股权高度分散；另外各子公司95%以上的股份被集团所拥有，集团高度控股子公司。在董事会中，吴小晖从2013年11月起担任集团的董事长和总经理，同时还是集团的实际控制人，集团的控制权和经营权被他一人掌握。

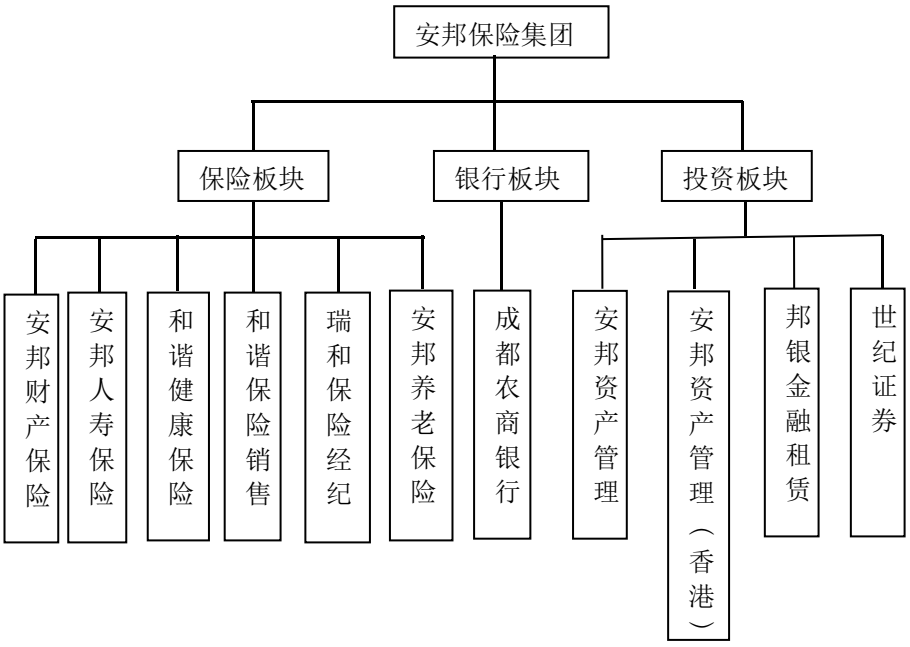


图1 安邦集团架构

表1 安邦保险集团董事会、监事会人员变动表

<table>
<tr><th>时间</th><th>董事长</th><th>副董事长</th><th colspan="2">董事</th><th>监事</th><th>总经理</th></tr>
<tr><td>2013前</td><td>胡茂元</td><td>吴小晖<br>陈萍</td><td colspan="2">陈小鲁、龙永图、姚大锋、赵虹、<br>朱云来、刘榕、刘晓光、彭颢</td><td rowspan="3">叶潇飞<br>韩怡<br>张晔</td><td>姚大峰</td></tr>
<tr><td>2013.11</td><td rowspan="6">吴小晖</td><td rowspan="6">（取消）</td><td>陈小鲁、姚大锋、赵虹、朱艺、陈萍、胡元茂、朱云来</td><td>刘晓光<br>彭颢<br>孙沛城<br>王新棣</td><td rowspan="6">吴小晖</td></tr>
<tr><td>2014.09</td><td rowspan="4">陈小鲁<br>姚大锋<br>赵虹<br>朱艺<br>陈萍</td><td>刘晓光<br>彭颢<br>顾清扬</td><td rowspan="3">水志仁<br>卞春坡<br>韩晓青<br>黄庄庄<br>李瑛</td></tr>
<tr><td>2015.02</td><td rowspan="2">刘晓光<br>彭颢<br>顾清扬<br>白士泮</td></tr>
<tr><td>2016.01</td></tr>
<tr><td>2016.03</td><td rowspan="2">姚大锋<br>朱艺<br>陈萍</td><td rowspan="2">刘晓光<br>顾清扬<br>白士泮</td></tr>
<tr><td>2016.10</td><td>水志仁<br>卞春坡<br>韩晓青<br>黄庄庄<br>袁圃</td></tr>
</table>

## 2.2 安邦保险集团发展历程

2.2.1 安邦保险集团的兴起

安邦保险集团选择的是“资产驱动负债”的经营发展模式，这一模式下企业可借助于相关投资、理财产品的运营，进而获得充足流动资金，之后在国内和海外进行资产收购，在企业规模扩大后再反哺承保业。安邦集团仅仅经历10年左右的时间就发展成资产近两万亿的保险公司，发展速度令人咋舌。集团主要依靠的保险产品是万能险，其销售收入是集团的主要营业收入来源，万能险产品是一款具有理财性质的保险产品，其主要利用的是银行渠道进行积极销售。从2014年开始，集团拓宽了万能险等众多保险产品的开发，随即众多的保户储金急剧流到企业账户，现金规模疯涨。据统计，安邦人寿的资产增长超过90倍，资产总额从二零一三年的169亿元疯涨到二零一六年的近1.5万亿元，而安邦财险的增长奇迹般地超过了154倍，安邦集团更是一跃成为当时保险业资本金最雄厚的公司。

2.2.2 安邦保险集团的扩张

与此同时，安邦保险集团利用保费资金频繁举牌、大肆进行投资收购。在国内，其大量收购招商银行、民生银行的股份，除此之外，安邦集团还收购了万科安邦、金地集团等多家公司。在国外，安邦保险集团也是进行了大规模的并购，

并购目标仍然是金融类和房地产企业，其涉及国家包括美国、加拿大、比利时、荷兰、韩国和日本，集团的商业版图进一步扩大。

2.2.3 安邦保险集团的覆灭

二零一八年二月二十三日，对于安邦保险集团是个注定不会忘怀的日子，安邦因可能严重危及到了集团偿付能力为由被保监会处以接管的惩罚，并且集团的“三会一层”中绝大部分权责由负责接管处理的任务组代为直接执行，接管期限为一年。时间到了一年之后，银保监会一致表决将安邦保险再次接管一年。接管过程中，负责接管处理的任务组于二零一九年六月二十五注册成立了大家保险，原集团的相关经营业务被其合法受让，短短几年，安邦集团被大家保险集团所取代。吴小晖因经济犯罪被法院判处有期徒刑十八年。在被接管途中，安邦集团资产“瘦身”万亿，银保监会出示了披露公告，把和主营业务关联度不高的边缘资产、不重要的金融执照进行了拍卖出售处理，而这些资产包括了集团的许多子公司，这位保险行业的庞然大物最终消失殆尽。

## 3．安邦保险集团治理结构存在的主要问题分析

### 3.1 基于两权分离理论视角的分析

该理论核心在于“所有者与控制者的分离”，一方面，由职业经理为代表的管理层对公司进行经营管理。另一方面，由股东为代表的所有者则负责对管理层采取监管和激励。而安邦保险集团的领导人吴小晖同时担任集团的董事长和总经理，掌握了公司的控制权和经营权，同时也是企业的实际控制人，这种状况给公司的发展带来了严重的弊端，不利于企业的长远发展。下文具体从股权结构、董事会治理维度开展分析安邦集团存在的缺陷。

3.1.1股权嵌套，隐匿实控关系

安邦保险的前身是安邦财险，安邦财险的最初发起股东是7家，后来才投资入股的是中石化，8家股东中有2家国企，其中包括中石化和上汽集团，另外6家均是民企，且均为吴小晖实际控制。经历了3轮增值的安邦集团，股东于二零一四年由最初的8家疯涨到39家。在这一趋势下，最初的两大股东的持股比例和被稀释至仅占1.77%，而剩下的37家民企股东关系错综复杂，经过层层穿透后，最终发现吴小晖实际控制这37家股东。吴小晖通过层层嵌套股权，隐匿真实的股权关系，最终成为安邦的实质控制人。

3.1.2董事会独立性受限

一般而言，董事会在公司治理结构中发挥着非常重要的作用，其职能的发挥可能会碰到以下阻碍：董事会被实质控制人所掌握、董事会与第三方存在关联方交易。从2013年起，吴小晖一直是企业的掌控者，集团董事会中很多的投资、经营决策更多的体现的是吴小晖个人的意志，权利的高度集中使得董事会的独立性受损，监事会的监督职能履行困难。综上所述，安邦保险集团内部的董事会的职能难以发挥。

### 3.2 基于利益相关者理论视角的分析

该理论认为各种利益相关者的间接或非间接参与一起导致了企业的快速发展，这个时候，公司追求的不单单是某一主体的利益，更是其他利益相关者的共

同利益，这里的利益相关者有股东、债权人、员工、顾客等。保险企业中的保险消费者的作用一般比较大，是保险企业重要的利益相关者，保险企业经营出现问题时，最容易影响保险消费者的利益。下文结合相关分析，最终发现安邦保险在日常营业中常常进行关联交易、银保混业经营，造成保单持有者（债权人）、投资者、子公司等相关利益主体发生利益冲突。

3.2.1 通过关联交易输送利益

对安邦保险日常经营的观察与分析发现，吴小晖利用关联方隐匿，通过关联交易进行利益输送，之后将获得的保险资金投向自己的实业企业。首先，吴小晖把安邦财险等公司作为融资平台，通过非法手段进行投资型保险产品的超募销售，接着，他指使工作人员通过划款不记账将部分超募保费转移到自己实际控制的实业公司。最终吴小晖以实业控制注资的方式，完成了安邦的循环注资，安邦资产激增近568亿。吴小晖的这一系列行为给其他股东、保险消费者等相关利益主体间带来了严重的利益威胁。

3.2.2 银保混业经营产生利益冲突

安邦集团的快速扩张与发展离不开银行这一平台的帮助，其大规模扩张银行业正是看中了银行的销售平台以及与保险业的协同效应，集团主要使用银行渠道进行保险销售。例如作为子公司的成都农商行，通过子公司的身份代销安邦保险集团的保险产品，其代销的129种保险产品中，足足有120种是自身的保险产品，并且把其银行储户改为保险客户。在银行类子公司放自身保险产品，存在着同业竞争，这一做法容易使子公司之间产生利益冲突。

### 3.3 基于COSO内部控制理论视角的分析

COSO内部控制理论认为，控制环境、风险评估、内控活动、信息与沟通、监督五要素共同构成了内部控制系统。下文将结合安邦保险的本身的经营情况，具体分析安邦集团的内部控制活动，发现该公司在风险评估和内控活动方面存在缺陷。

3.3.1 风险评估不到位

安邦集团虽然建立起了风险三道防线管理体系，但是集团投资过于激进，缺乏相应的风险评估。集团在2014年起利用银销渠道大规模出售万能险产品，快速获得大量资金，同时，集团把获得的大量保费资金进行投资活动。然而万能险的保费应归类为企业的短期资金,安邦却把这样的短期资金用于投资酒店这种长期投资的项目。这种“短债长投”的做法极易产生市场风险。安邦保险公司在风险评估方面存在问题，投资过于激进，没有定期的对控制目标情况进行评估，给企业带来了风险。

3.3.2 内部控制活动不严

对于安邦保险集团的内部控制，其存在着诸多不足，例如缺少执行力，内部控制力度较弱。保监会于2016年起限定了万能险的销售比例和中短存续期产品的销售规模，这使得万能险销售良好的安邦保险的保费收入急剧下降。为了持续性地获得保费所产生的现金流，安邦人寿上市了一款名为“安邦长寿安享5号年金保险”的产品，其通过生存金返还的途径（两年内保费大量退还给投保人）以此获得大量的短期现金，另外一款产品不经精算师的许可，开始了上市销售。以上的这些行为均违背了相关监管部门的规定，由此可见，安邦保险集团在业务层面的内部控制活动不严。

通过对安邦保险集团的公司治理情况进行了分析，综合来看，公司治理的缺陷是造成了安邦保险集团的清算解体的主要原因之一。二零一八年随着安邦集团偿付能力问题的凸显，监管机构依法对其采取了接管处理。

## 4．监管部门对安邦保险集团的处置

### 4.1 问题金融机构处置的基本思路

在问题金融机构的处置方面，之前学者提出要综合考量以下几大方面：一是处理支付端的不足，包括问题金融机构对其自身资产实现变现的处理、政府方给予的一些资金的补助等方案。二是处理存量端的不足，例如问题金融机构和其他金融机构通过市场机制或非市场行为达到收购或者兼并、以达到债务转移等目的。三是处理流量端的不足，比如完善问题机构的运营程序，裁减相关人员、以严格地预算控制实现降本增效等。

### 4.2 监管部门处置安邦保险集团的过程

#### 4.2.1 行使职责，引入资金

对安邦集团进行接管处理之后，负责接管处理的任务组马上展开了一系列措施，一方面，任务组随即撤销被接管处理企业的管理层，二零一八年三月，安险保险的法人被撤销，另外，集团的“三会一层”的大部分权责直接由接管组执行；与此同时，保险保障基金注册注资了安邦保险。半个月过后，银保监会批准承认了保险保障基金对安邦保险高达近610亿的注资，一周过后，安邦保险确认了保险保障基金对其高达近610亿元的注资，这时集团的注册资本还是维持在619亿的水平；之后，企业启动了战略投资者的相关遴选工作，五月份，银保监会批准承认集团股东的这一变更。

#### 4.2.2 资产“瘦身”万亿

接管执行后，负责接管处理的任务组推进了安邦保险资产处置这方面工作的落实，在稳定集团正常经营的同时，银保监会出示了披露公告，把和主营业务关联度不高的边缘资产、不重要的金融执照进行了拍卖出售处理，而这些资产包括了集团的许多子公司，这些处理过后，安邦集团资产减少万亿，资产规模显著性下降。而后任务组持续性对集团的各类资产进行处理，一系列措施过后，一个全新的金融主体浮现于资本市场。

#### 4.2.3 新设大家保险

二零一九年四月，负责接管处理的任务组决定，集团将减少股本近204亿元。二零一九年六月，大家保险集团有限责任公司注册产生，注册资本恰好为203.6亿，这一数额与安邦集团减少的股本数额惊人地相等，并且公司的股东结构也和安邦保险一样。二零一九年七月，银保监会批准承认大家保险集团的依法注册成立，新的公司可依法拥有安邦人寿、安邦养老的股权。在这次大重组结束之后，安邦集团将不从事新的业务。此后，之前的安邦集团已变成了大家保险。直至二零二零年二月，银保监会批准结束对安邦保险的接管处理。

### 4.3 监管部门处置安邦保险集团的主要经验

#### 4.3.1 选择合适的处理模式

安邦集团选取的是“全面托管－处理流量端的不足－处理存量端的不足—新设承接”的处理模式，对于安邦集团而言，其产业分布集中、暴露的不足较为显

著，与这一模式较为贴合。由此可见，对于存在不同问题类型的企业，我们应该选择不同的处理模式。

4.3.2 处置过程中切实维护消费者权益

对于这一问题，银保监会的处理宗旨是处理结果影响最低化、对资产价值的破坏最小化、对社会负面影响最薄弱化。安邦集团的接管处理在各方的坚持与努力下，取得了不错的效果。接管安邦后，负责接管处理的任务组对未实现的保险事项均进行了圆满地兑现，切实有力地保障了保险消费者权益。

4.3.3 听取第三方机构的专业意见

安邦集团接管工作之所以会取得成功，其所聘请的第三方机构给予的处理意见有很大见效。自企业被接管处理，负责接管处理的任务组综合清查与评估安邦保险资产，而且聘请中金等咨询机构提供了处理建议，全面协商后确认了抽离与主营业务关联性不高的、非重要的业务的举措。此后开展的一系列的工作以这一举措为指导方针，为接管工作的顺利完成奠定了基础。

## 5．健全金融机构公司治理监管体系的建议

### 5.1 优化股权结构，加强股权监管

在公司治理中，企业应不断优化股权，首先，应加强对大股东的制约机制设计，降低大股东的冒险动机，保证偿付能力；其次，中小股东要提高决策意识，增强话语权，使得企业决策更加科学、有效；另外，企业应引入多方投资，实现投资主体多元化，例如机构资本、境外资本、私人资本，充分发挥资本市场的调节作用。最后，强化股权监管，实现穿透式监管，披露各主体之间的关系和完整的股权链条，通过对内部实质进一步的追查，能够进一步识别企业的股权结构。

### 5.2 规范董事会运作，加强监事会管理

董事长兼任总经理，这一岗位设置导致决策层与经营层的权责部分重合，导致了董事会监督职能无法发挥，使企业正常经营受阻。公司治理应明确董事会与管理层的分工，董事会主要是保证公司科学决策，使得公司利益最大化，保障利益相关者权益，企业应明确董事会的具体职能定位，规范董事会的运作，董事长和总经理选取不同人员进行担任。另一方面，监事会行使企业的监督权，主要履行公司的日常经营监督和特殊事项监督，是企业的“防护伞”，但就安邦保险而言，其职能极度薄弱，未发挥其实质性监督作用，所以监事会应充分履行监督职能，投身于公司治理水平的建设。

### 5.3 加强风险管控，提高投资管理能力

“资产驱动负债”的经营模式给企业带来了诸多风险，其中包括流动风险和市场风险等，在日常营业中机构要着力于风险的评估和预测：在流动性管理制度机制方面应进一步完善加强；在资金的运用管理上应加强管控，在投资运作机制建立方面应以稳健、审慎为原则，严禁通过关联交易进行利益输送；在公司治理管理体系完善方面，应进一步加强股东管理。

### 5.4 加强事前监管，选择合适的机构退出机制

监管机构的监管存在滞后性，集团早在2014年就开始大肆利用万能险聚集资金，并大力进行金融、房地产投资，其很早就存在违规行为。安邦保险风险扩大

的一部分原因在于监管机构的不及时介入。监管机构要聚焦于事前监管，严格化金融机构资金的监管力度，改善相关法律政策，进而对金融机构的经营行为产生约束，从而降低经营风险。

对于即将退市的问题金融机构，监管机构可基于机构的营业成果，采取相应的行政措施来改善经营，其中包括重点监管、责令限期整改、整顿、接管。接管组在安邦集团出现严重偿付能力问题时及时出手对集团进行了接管，针对安邦集团的产业以及风险问题相应地选择了特有的“全面托管－处理流量端的不足－处理存量端的不足—新设承接”的接管模式，最终取得了成功，因此，面临存在问题不同的金融机构应因地制宜选取合适的处置方式。

## 致谢

本文为湖北经济学院专业学位硕士研究生教学案例建设项目《公司治理与问题金融机构处置案例分析——以安邦保险集团解散清算案为例》和湖北经济学院2020年研究生科研立项(104)的阶段性成果。

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# 公司治理监管与问题金融机构处置研究
## ——以安邦保险集团解散清算案为例

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**关键词:**公司治理；股权结构；内部控制

**中文摘要.** 党的十八大以来，为防范化解金融领域存在的重大风险，中国银行保险监督管理委员会不断强化公司治理监管，聚焦于中国特色社会主义银行业、保险业的公司治理结构的建设，并且在二零二零年八月出台了《健全银行业保险业公司治理三年行动方案（2020—2022年）》。与前些年相比，金融行业公司治理水平有所提升，但问题金融机构带来的风险事件依然频出。公司治理缺陷往往成为金融机构风险事件的主要诱因，情况严重者更是使得金融机构走向清算解体的结局。

“前车之鉴，后事之师”。本文以近年来倍受社会关注的安邦保险集团清算解散案为例，从公司治理的角度，运用相关理论工具，从不同侧面对该集团清算

解散的原因进行深度剖析，进而分析监管部门处理问题金融机构的主要着力点，在吸取经验教训的前提上，提出基于完善保险公司治理机制的针对性措施。首先，本文系统梳理了保险公司治理研究的相关文献，明确开展案例分析的理论基础。其次，基于三种主要的公司治理理论，从不同的维度对安邦保险集团公司覆灭的原因进行深入解析：基于两权分离理论，从股权结构、董事会治理维度开展分析，发现安邦保险集团的所有权和控制权并不相分离，集团完全由实际控制人一手掌控；基于利益相关者理论，从利益相关者治理维度开展分析，发现安邦保险集团存在关联交易利益输送和银保混业经营的问题，造成保单持有者、投资者等相关利益主体间严重的利益冲突；最后，基于COSO内部控制理论，从风险评估与内部控制活动维度开展分析，发现该集团在内部控制系统方面也存在严重缺陷。综合来看，公司治理的缺陷是造成了安邦保险集团的清算解体的主要原因之一。再次，本文梳理了监管部门在处置安邦保险集团的过程和主要举措，总结监管部门对问题金融机构处理的主要经验。最后，针对健全金融机构公司治理监管体系提出相关建议。

# Study on the Impact of Insurance Corporate Governance on Solvency

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**Keywords:** Insurance company, Corporate governance, Solvency.

**Abstract.** As the second of "five lines of defense" of China's insurance regulatory system, corporate governance supervision is the basis, solvency supervision is the core. In recent years, China Banking Regulatory Commission is working to build and continuously improve the second generation solvency regulatory system (hereinafter referred to as "the second generation of compensation "). In 2021, the China Banking Regulatory Commission revised and issued the *"Provisions on the Management of the Solvency of Insurance Companies "*, which, after absorbing the results of C-ROSS, further specified the need to strengthen solvency supervision, effective prevention and control of solvency risk in insurance industry. Although solvency is the key to the survival and development of insurance companies, good corporate governance is also the basis for the long-term and steady operation of financial institutions. In 2020, the CBRC issued the *"Three-Year Action Plan for Improving Corporate Governance in Banking and Insurance Industry (2020-2022)"*, which aims to further deepen the reform of corporate governance in banking and insurance industry and continuously

enhance the scientific, robust and effective corporate governance in China's banking and insurance industry. So how does the corporate governance structure affect the solvency of insurance companies? What aspects should insurance companies improve their corporate governance structure to consolidate their solvency?

The research purpose of this paper is to find answers to the above questions. Firstly, this paper reviews the relevant literature of insurance company governance and solvency relationship research, and combines theoretical analysis with previous scholars, making research assumptions that shareholder governance, board management, board management, and executive management affect solvency. Then, this paper examines the direction and level of shareholder management and board management on solvency through empirical analysis. It is found that the shareholding ratio and solvency of the majority of the shareholders can enhance the solvency of the insurance company, the supervision and the independence of the solvency of some governance elements are not shown, and the listed insurance company may fail to play the positive role of the board of directors and the board of supervisors. Finally, according to the empirical results, making suggestions for insurance companies to further improve their corporate governance and solvency.

## 1. 引言

近年，随着保险行业规模的扩大以及社会居民对保险的需求日益增加，保险行业的发展势头强劲。保险业作为重要的金融分支，国家对其风险监管也越来越严。从监管层面来看，偿付能力监管一直是保险业的监管核心。2021年，中国银保监会修订发布《保险公司偿付能力管理规定》，该项规定在吸收偿二代建设实施的成果后，进一步明确要强化偿付能力监管，有效防控保险行业偿付能力风险。

偿付能力是保险公司生存发展的关键，但良好的公司治理也是金融机构长期稳健运行的基础，因为保险公司治理水平通过影响保险公司的风险管理能力，从而影响保险公司的偿付能力。目前，中国保险公司治理已经进入到关注治理有效性的新阶段。2020年，中国银保监会发布了《健全银行业保险业公司治理三年行动方案(2020-2022年)》，旨在通过该方案进一步深化银行业保险业公司治理改革。

虽然公司治理是影响保险公司偿付能力的一个重要因素，但是学术界对保险公司治理具体如何影响其偿付能力的研究却较少。为了进一步了解保险公司治理要素如何具体影响偿付能力，本文以中国上市保险公司为研究对象，通过回归结果分析中国上市保险公司治理要素对偿付能力的具体影响以及上市保险公司治理可能存在的问题，为中国保险公司提高治理水平、提升偿付能力提出建议。

## 2. 理论分析与研究假设

## 2.1股东治理与偿付能力

关于股东治理对偿付能力的影响，较多学者认为保险公司的股权集中与保险公司的偿付能力呈正相关关系。例如，周盼盼（2015）以2009-2011年的调研数据为样本，通过回归得出保险公司股权集中和偿付能力的正向关系[1]。郝臣、白丽荷、崔光耀（2016）选取我国保险公司为样本，基于偿付能力的视角，研究保险公司股东治理与投保人利益保护的关系，实证结果显示，保险公司的股权结构越集中，保险公司的偿付能力越好[2]。本文认为，第一大股东的持股比例越大，在企业发生经营风险时承担的风险比例也会越大，为了保障自身的利益以及躲避无法承担的风险，第一大股东在进行决策时会更加谨慎，从而对公司的偿付能力产生正向作用。因此，本文提出以下假设：

**假设1：第一大股东持股比例与偿付能力呈正相关关系。**

## 2.2董事会治理与偿付能力

根据委托代理理论所描述，在高管参与企业经营决策时，股东可能更希望经理层作出有利于提高他们收益的决策，例如选择投资高回报、高风险的项目，尽管这些项目可能会损害其他利益相关者的利益（Burkar，2001）[7]。设立董事会有助于防止经营层作出只顾股东不顾其他利益相关者的决策，因为董事会对管理层的行为有监督作用，其能促使企业的经营目标不仅能够保障股东们的利益，也能保障其他利益相关者例如投保人的利益。因此，有效的董事会治理有利于协调公司内部股东、管理层、投保人等利益相关者之间的关系，从而影响公司的偿付能力。国外学者多从公司绩效的角度来研究公司治理的影响，因为公司绩效包含了企业风险管理的能力。Tornyeva、Wereko（2012）围绕保险公司治理与公司绩效的关系展开研究，发现大型的董事会规模有利于提升保险公司的财务绩效，从而提升公司的偿付能力[8]。近年，国内学者开始关注保险公司治理与偿付能力之间的关系。钱璟（2019）选取125家保险公司2015-2017年三年的公司数据作为样本，通过多元回归，研究发现保险公司董事会规模、董事会成员背景（学历背景、金融背景）与保险公司的偿付能力呈正相关关系[3]。但是，也有董事会特征对保险公司的经营产生不利影响。例如，李红坤，张笑玎（2010）研究认为保险公司的董事长和总经理为一人时，更容易产生委托代理问题，董事会两职合一的领导特征会让保险公司增加风险[4]。基于现有研究，本文认为董事会规模的扩大有利于保险公司偿付能力的提升，因为董事会成员越多，董事会所汇集的资源越丰富，董事会会议决策时所能够使用的信息越多，不同背景下的董事们有自己不同的知识储备和实战经验，针对提升企业偿付能力所提出的建议也会更加充分。但是，董事会会议越多，开会成本越高，频繁的会议还会让董事产生疲倦，影响董事会会议质量。此外，董事长和总经理的职位统一时，董事会的监督职能可能会无法实施，那么董事会和经理层的监督机制可能会失去平衡，这既不利于企业偿付能力的提升，也不利于企业的经营。因此本文提出以下假设：

**假设2：董事会规模与偿付能力呈正相关关系。**

**假设3：董事会会议与偿付能力呈负相关关系。**

**假设4：两职合一与偿付能力呈负相关关系。**

### 2.3监事会治理与偿付能力

陈晗，王霄（2015）以我国寿险公司2014年的公司数据为样本，选用多元回归的方法研究公司治理在“偿二代”的背景下对保险公司偿付能力的影响，他们发现，集团控股的寿险公司和非集团控股的寿险公司的实证结果有较大差异，对前者来说，监事会规模与偿付能力呈负相关关系，而对后者来说，监事会规模与偿付能力呈正相关关系[5]。监事会的主要作用体现在其“监”字上，即监督，监督内容是董事、管理层的日常经营决策。当监事会的规模越大时，监督董事、管理层的“眼睛”更多，更有利于保障股东的利益以及职工的权益。同时，监事会的规模越大，监事会内部人员分工详细且具体，汇集的信息越多，监事会对公司内部情况的了解更加详细，更有利于发挥监事会的监督作用。因此，本文提出以下假设：

**假设5：监事会规模与偿付能力呈正相关关系。**

### 2.4高管治理与偿付能力

高管是企业日常经营管理的主力军。白丽荷（2017）认为经理层是董事会选拔的高级管理人员，对保险公司的偿付能力有积极作用[6]。本文认为，高管的规模越大，不同知识背景下的思想碰撞越多，这有利于企业的创新发展。同时，高管规模的扩大也有利于管理层内部的协调稳定，一方面，高管规模越大，高管之间的差异性越大，高管内部互相监督的作用也更容易发挥，另一方面，在企业日常经营管理中，高管越多，能提供的管理资源也越多。因此，本文提出以下假设：

**假设6：高管规模与偿付能力呈正相关关系。**

## 3. 研究设计

### 3.1样本来源

本文选取2011年至2019年上市保险公司作为样本，共有54个有效样本。数据主要来源于国泰CSMAR经济数据库、保险行业协会官网公布的信息以及保险公司官网公布的年报。

## 3.2研究变量的选择

3.2.1因变量

本文选取综合偿付能力充足率作为因变量，该指标等于保险公司的实际资本和最低资本的比值。相较于核心偿付能力充足率主要衡量保险公司高质量资本的充足状况，综合偿付能力充足率更全面的衡量保险公司资本的总体充足状况，因而常常被当作衡量保险公司偿付能力的重要指标。

3.2.2自变量

自变量为保险公司第一大股东持股比例、董事会规模、董事会会议次数、两职合一、监事会规模、高管规模。第一大股东持股比例是上市保险公司第一大股东的持股比例，该数据能够反映保险公司股权结构的集中程度。董事会规模是上市保险公司董事会成员的数量，能够反映董事会治理的结构特征。董事会会议次数是上市保险公司董事会每年开会的次数，该数据能够反映董事会治理的行为特征。两职合一是指董事长和总经理为同一人，其能反映董事会治理的领导特征。监事会规模、高管规模是上市保险公司的监事会成员人数以及高管人数，分别反映监事会治理、高管治理的结构特征。

3.2.3控制变量

本文选取公司规模和公司资产负债率两个因素作为控制变量。

（1）公司规模

公司规模取公司当年年末总资产的自然对数值。规模越大的公司往往财务监管更加严格，所享有的资源也更加丰富。这些优势会促进公司财务绩效的提升，从而促进公司偿付能力的提升。

（2）资产负债率

当公司的资产负债率较高时，说明公司需要偿还的债务较多。这时，公司经营管理者可能为了避免自身利益受到损害，通过加倍的努力来提升公司经营效绩。因此，资本结构通过

影响治理结构影响企业财务绩效，从而影响公司偿付能力。

表1汇总了研究中所用到的变量。

表1 变量定义

| 变量类型 | 变量名称 | 符号 | 度量 |
|---|---|---|---|
| 因变量 | 综合偿付能力充足率 | zhc | 保险公司的实际资本/最低资本 |
| 自变量 | 第一大股东持股比率 | dydg | 第一大股东的持股比例 |
| | 董事会规模 | dsh | 董事会的总人数 |
| | 董事会会议次数 | dshy | 董事会一年召开的会议次数 |
| | 两职合一 | lzhy | 董事长和总经理不为同一人取时 0，董事长和总经理为同一个人取时 1 |
| | 监事人数 | jsrs | 监事会的总人数 |
| | 高管人数 | ggrs | 高管的总人数 |
| 控制变量 | 公司规模 | gsgm | 公司当年年末资产总额的自然对数值 |
| | 资产负债率 | zcfz | 负债期末总额/公司资产期末总额 |

| | | | |
|---|---|---|---|
| 虚拟变量 | 年份 | nf | 9 个年份，设置 8 个年份虚拟变量 |

### 3.3 实证模型设计

基于上文，本文构建如下模型：

$$zhc_1 = \alpha + \beta_1 dydg + \beta_2 gsgm + \beta_3 zcfz + \beta_4 nf + \varepsilon \quad (1)$$

$$zhc_2 = \alpha + \beta_1 dsh + \beta_2 gsgm + \beta_3 zcfz + \beta_4 nf + \varepsilon \quad (2)$$

$$zhc_3 = \alpha + \beta_1 dshy + \beta_2 gsgm + \beta_3 zcfz + \beta_4 nf + \varepsilon \quad (3)$$

$$zhc_4 = \alpha + \beta_1 lzhy + \beta_2 gsgm + \beta_3 zcfz + \beta_4 nf + \varepsilon \quad (4)$$

$$zhc_5 = \alpha + \beta_1 jsrs + \beta_2 gsgm + \beta_3 zcfz + \beta_4 nf + \varepsilon \quad (5)$$

$$zhc_6 = \alpha + \beta_1 ggrs + \beta_2 gsgm + \beta_3 zcfz + \beta_4 nf + \varepsilon \quad (6)$$

上述模型中，a为常数项；β 为各变量的回归参数； ε 代表回归残差。本文在实证分析中用到的数据分析工具主要是EXCEl以及Stata13.0软件。

## 4. 实证分析

### 4.1 描述性统计分析

全部样本的描述性统计结果如表 2 所示。从表 2 我们可以看到，上市保险公司的偿付能力整体水平并不差，综合偿付能力充足率平均为 227.8%。不过，综合偿付能力充足率的最小值为 52%，最大值为 602%，这说明所选取的上市保险公司的综合偿付能力充足率波动范围较大。第一大股东持股比例平均为 32.524%，说明我国上市保险公司第一大股东持股比例较均衡，但是上市保险公司也有第一大股东持股比例较高的，例如最大值 68.37%。上市保险公司的董事会规模平均为 14 人，规模最大的董事会有 24 名董事成员，规模最小的董事会有 9 名董事成员。董事会会议平均每年开 8 次，各上市保险公司之间董事会会议次数差距较大，会议次数最少的有 2 次，最多的有 23 次。两职合一在所选取样本里分布较为平均，相对来说，还是董事长和总经理为同一人的情况更多。上市保险公司监事会规模平均为 5 人，规模大的有 11 人，规模小的只有 3 人。关于高官的规模，上市保险公司高管规模平均为 27 人，高管人数最多的达到 45 人，而最少的只有 14 人，差距较大可能与企业规模有关。

表 2　描述性统计表

| 变量 | 样本量 | 均值 | 标准差 | 最小值 | 最大值 |
|---|---|---|---|---|---|
| zhc | 54 | 2.278 | 0.961 | 0.520 | 6.020 |
| dydg | 54 | 32.524 | 18.719 | 5.410 | 68.370 |
| dsh | 54 | 14.537 | 4.206 | 9.000 | 24.000 |
| dshy | 54 | 8.296 | 3.407 | 2.000 | 23.000 |
| lzhy | 54 | 0.537 | 0.503 | 0.000 | 1.000 |
| jsrs | 54 | 5.593 | 2.042 | 3.000 | 11.000 |

| | | | | | |
|---|---|---|---|---|---|
| ggrs | 54 | 27.315 | 8.827 | 14.000 | 45.000 |
| gsgm | 54 | 26.530 | 2.438 | 21.356 | 29.597 |
| zcfz | 54 | 0.811 | 0.189 | 0.249 | 0.930 |

### 4.2相关性分析

表 3 给出了回归模型中主要自变量的相关分析结果。第一大股东持股比例与综合偿付能力充足率的相关系数为 0.401，在 1%的显著水平正相关，与假设 1 相符合。董事会规模与综合偿付能力充足率的相关系数为 0.278，在 5%的显著水平正相关，与假设 2 相符合。两职合一与综合偿付能力充足率的相关系数为 -0.270，在 5%的显著水平负相关，与假设 4 相符合。监事会规模与综合偿付能力充足率的相关系数为 0.330，在 5%的显著水平正相关，与假设 5 相符合。高管人数与综合偿付能力充足率的相关系数为 0.335，在 5%的显著水平正相关，与假设 6 相符合。

表 3 相关分析表

| | zhc | dydg | dsh | dshy | lzhy | jsrs | ggrs | gsgm | zcfz |
|---|---|---|---|---|---|---|---|---|---|
| zhc | 1.000 | | | | | | | | |
| dydg | 0.401*** | 1.000 | | | | | | | |
| dsh | 0.278** | -0.052 | 1.000 | | | | | | |
| dshy | -0.138 | -0.030 | -0.019 | 1.000 | | | | | |
| lzhy | -0.270** | -0.609*** | 0.155 | 0.104 | 1.000 | | | | |
| jsrs | 0.330** | 0.248* | 0.777*** | 0.132 | 0.015 | 1.000 | | | |
| ggrs | 0.335** | 0.112 | 0.919*** | 0.055 | 0.029 | 0.893*** | 1.000 | | |
| gsgm | 0.332** | 0.370*** | 0.620*** | -0.343** | -0.216 | 0.579*** | 0.662*** | 1.000 | |
| zcfz | 0.174 | 0.224 | 0.486*** | -0.154 | -0.209 | 0.480*** | 0.0.548*** | 0.825*** | 1.000 |

注：***表示 1%的显著水平、**表示 5%的显著水平、*表示 10%的显著水平

### 4.3 实证结果及分析

基于前文，为了检验本文提出的研究假设，该部分对中国上市保险公司治理对其偿付能力的影响进行实证，具体回归分析结果如表 4 所示。从实证结果来看，模型 zhc1 的回归系数为 0.015，在 10%的水平上显著，表明第一大股东持股比例与偿付能力呈正相关关系，支持了假设 1。第一大股东持股比例与偿付能力呈正相关关系，本文分析主要是两方面原因：一方面，大股东的存在可以改善内部治理环境，利于减少股权分散环境下小股东不出力的现象；另一方面，控股越多的股东与企业经营状况联系越大，为了企业的良好发展，大股东有更多动力、更大意愿去付出监督成本，这既有利于减少代理成本，也有利于控股股东的利益与投

保人利益趋于一致。因此，股权集中有利于提升保险公司的偿付能力。模型 zhc4 的回归系数为-0.613，在 10%的水平上显著，表明两职合一与偿付能力呈负相关关系，支持了假设 4。两职合一与偿付能力呈负相关关系，主要是两职合一更容易让心怀不轨的人有机可乘。对于董事长来说，两职合一赋予董事长更多的控制权力，但弱化了董事会的监督权和独立性，这给董事长提供了谋取自身利益更大化的可操作空间，容易出现董事长为谋取个人利益而忽视企业整体利益的问题。对于管理层来说，董事会监督职能的减弱、权力制衡机制的弱化均无形之中增加了管理层决策的隐蔽性和便利性，管理层利用信息不对称来牟取私人利益的途径也在相对宽松的环境下变得多样化。因此，两职合一不利于保险公司偿付能力的提升。

此外，从实证结果表 4 也可以看到，上市保险公司许多公司治理要素的实际有效性并没有显示出来。除了第一大股东持股比例以及两职合一两项要素，其余四项要素没有对偿付能力产生显著影响，没能证明本文所提出的假设 2、假设 3、假设 5 以及假设 6。这四项要素没能在本文研究设计的模型中显现出显著影响，一方面可能是因为本文所选择的样本量较少，另一方面可能是因为在企业的实际经营中这些治理要素的作用未能得到有效发挥。

表 4　回归分析表

| | zhc1 | zhc2 | zhc3 | zhc4 | zhc5 | zhc6 |
|---|---|---|---|---|---|---|
| dydg | 0.015* | | | | | |
| | (2.26) | | | | | |
| dsh | | -0.000 | | | | |
| | | (-0.00) | | | | |
| dshy | | | 0.023 | | | |
| | | | (0.58) | | | |
| lzhy | | | | -0.613* | | |
| | | | | (-2.59) | | |
| jsrs | | | | | 0.062 | |
| | | | | | (0.72) | |
| ggrs | | | | | | 0.017 |
| | | | | | | (0.80) |
| gsgm | 0.173 | 0.242* | 0.264** | 0.227** | 0.208* | 0.195 |
| | (1.91) | (2.30) | (2.70) | (2.70) | (2.05) | (1.83) |
| zcfz | -1.264 | -1.710 | -1.884 | -1.892 | -1.734 | -1.726 |
| | (-1.13) | (-1.46) | (-1.57) | (-1.74) | (-1.49) | (-1.49) |
| _cons | -2.433 | -3.456 | -4.105 | -2.747 | -2.877 | -2.676 |
| | (-1.43) | (-1.81) | (-2.00) | (-1.68) | (-1.51) | (-1.36) |
| nf | 控制 | 控制 | 控制 | 控制 | 控制 | 控制 |
| N | 54.000 | 54.000 | 54.000 | 54.000 | 54.000 | 54.000 |
| r2_a | 0.251 | 0.160 | 0.167 | 0.275 | 0.170 | 0.173 |
| F | 2.614 | 1.917 | 1.963 | 2.831 | 1.988 | 2.005 |

注：***、**、* 分别表示 1%、5%、10%的显著性水平，括号内为 t 检验值

## 4.4 基于滞后一期回归法的稳健性检验

公司治理的发展是逐步渐进的，这一年偿付能力水平的提高可能是上一年公司治理改善的结果。基于此，本文做出滞后一期回归的稳健性检验，结果如表 5 所示。从实证结果可以看到，模型 zhc1 的回归系数为 0.019，在 5%的水平上显著，表明第一大股东持股比例与偿付能力呈正相关关系，支持了假设 1。模型 zhc4 的回归系数为-0.710，在 5%的水平上显著，表明两职合一与偿付能力呈负相关关系，支持了假设 4。这与表 4 的回归结果一致，表 4 实证结果的稳健性通过。

表 5 稳健性检验表

| | zhc1 | zhc2 | zhc3 | zhc4 | zhc5 | zhc6 |
|---|---|---|---|---|---|---|
| dydg | 0.019** | | | | | |
| | (2.80) | | | | | |
| dsh | | -0.059 | | | | |
| | | (-1.34) | | | | |
| dshy | | | 0.012 | | | |
| | | | (0.27) | | | |
| lzhy | | | | -0.710** | | |
| | | | | (-2.85) | | |
| jsrs | | | | | -0.011 | |
| | | | | | (-0.11) | |
| ggrs | | | | | | -0.001 |
| | | | | | | (-0.05) |
| gsgm | 0.170 | 0.333** | 0.269* | 0.236** | 0.263* | 0.260* |
| | (1.86) | (3.07) | (2.58) | (2.74) | (2.48) | (2.31) |
| zcfz | -1.262 | -1.935 | -1.933 | -2.006 | -1.837 | -1.842 |
| | (-1.13) | (-1.64) | (-1.55) | (-1.84) | (-1.52) | (-1.53) |
| _cons | -1.611 | -3.965* | -3.221 | -1.983 | -2.967 | -2.922 |
| | (-0.94) | (-2.03) | (-1.45) | (-1.19) | (-1.50) | (-1.41) |
| nf | 控制 | 控制 | 控制 | 控制 | 控制 | 控制 |
| N | 48.000 | 48.000 | 48.000 | 48.000 | 48.000 | 48.000 |
| r2_a | 0.265 | 0.150 | 0.111 | 0.269 | 0.109 | 0.109 |
| F | 2.691 | 1.828 | 1.584 | 2.728 | 1.576 | 1.574 |

注: ***、**、* 分别表示 1%、5%、10%的显著性水平，括号内为 t 检验值

## 5. 结论与建议

本文研究了我国上市保险公司治理与偿付能力之间的关系，根据实证结果，本文得出以下结论：第一大股东持股比例与偿付能力呈正相关关系，股权集中有利于提升保险公司的偿付能力；两职合一与偿付能力呈负相关关系，董事长和总

经理为同一人会弱化董事会的监督权和独立性，不利于保险公司偿付能力的提升；一些公司治理要素的实际有效性没有显示出来，上市保险公司可能存在未能发挥董事会治理、监事会治理等积极作用的问题。

基于以上结论，本文认为，一定的股权集中能缓解上市保险公司内部代理问题，有利于完善上市保险公司内部治理。为了更好的发挥股东治理的激励作用，保险公司需要在股权结构上保持一定的集中度水平，让大股东有动力、有意愿推动内部治理的完善。当然，保险公司也应该加强对大股东的监管，防止大股东利用自身权利做出损害小股东、投保人、企业利益的行为。其次，为了完善企业的公司治理体系，保险公司应将董事长和总经理的职位分离，避免两者之间监督机制的失衡。对于现已存在的董事长和总经理为同一人的职位，保险公司应加大对其监管，利用制度约束、奖励激励、严厉惩罚措施来规范董事或管理层的行为。最后，监事会治理作为公司治理的一部分，对企业发展的促进作用不容小觑，上市保险公司应充分发挥监事会的作用，利用其保障股东利益以及职工权益，为企业打造良好的公司治理以及较强的偿付能力添加动力。

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# 保险公司治理对偿付能力的影响研究

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**关键词**：保险公司；公司治理 ；偿付能力

**中文摘要**.作为中国保险监管体系“五道防线”之二，公司治理监管是基础，偿付能力监管是核心。近年来，中国银保监会正在着力构建和不断完善第二代偿付能力监管制度体系(下称“偿二代”)。2021年，中国银保监会修订发布《保险公司偿付能力管理规定》，该项规定在吸收偿二代建设实施的成果后，进一步明确要强化偿付能力监管，有效防控保险行业偿付能力风险。虽然偿付能力是保险公司生存发展的关键，但良好的公司治理也是金融机构长期稳健运行的基础。2020年，中国银保监会发布了《健全银行业保险业公司治理三年行动方案(2020-2022年)》，旨在通过该方案进一步深化银行业保险业公司治理改革，持续提升我国银行业保险业公司治理的科学性、稳健性和有效性。那么，公司治理结构如何影响保险公司的偿付能力呢？保险公司应该从哪些方面完善公司治理结构以巩固公司的偿付能力呢？

本文的研究目的即是为上述问题寻找答案。首先，本文梳理了现有的保险公司治理和偿付能力关系研究的相关文献，将理论层面分析和前人学者的研究结论

相结合，提出本文的研究假设，即股东治理、董事会治理、监事会治理、高管治理这些治理要素如何影响偿付能力。

然后，本文通过实证分析来检验股东治理、董事会治理等要素对偿付能力的影响方向和水平。通过研究发现，第一大股东持股比例与偿付能力呈正相关关系，股权集中有利于提升保险公司的偿付能力；两职合一与偿付能力呈负相关关系，董事长和总经理为同一人会弱化董事会的监督权和独立性，不利于保险公司偿付能力的提升；一些公司治理要素的实际有效性没有显示出来，上市保险公司可能存在未能发挥董事会治理、监事会治理等积极作用的问题。最后，本文根据实证结果，为保险公司进一步提升公司治理水平和偿付能力提出建议。

# Systemic Importance Assessment of Insurance Group Based on Complex Network

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**Keywords:** Systemic Importance, Insurance Group, Social Network Analysis, Complex Networks.

**Abstract.** This paper adopts the social network analysis method to analyze the complex network model of the insurance market, which is based on the five major industries: insurance, banking, securities, trust, and real estate, and completes the systemic importance measurement of 11 Chinese insurance groups through the node centrality model. The study found that: Firstly, the top three rankings of systemic importance are Ping An Group, PICC Group, and China Life Group. The centrality scores of these three insurance groups are much higher than those of the lower-ranked groups. Therefore, they are important to insurance industry of China, even the entire finance industry. Secondly, the top three insurance groups have always been the leading companies in insurance industry of China. Compared with other groups, they are more scale-efficient and easier to obtain advantageous resources. This also explains the existence of the Matthew effect in China's insurance industry. Thirdly, according to the

development process of the developed insurance market, it is a historical development trend to build a fully licensed comprehensive insurance group. The scale effect produced by the financial full license and the organic cooperation between various business lines maximize the overall benefits of the insurance group.

Although the group business strategy has promoted the development of many insurance companies by leaps and bounds, the disadvantages brought about by the group strategy have become increasingly prominent. This is mainly reflected in the complex business crossover and opaque transactions, which make the original “risk firewall” created by supervision gradually invalidate, and the systemic risk of the entire financial system has risen sharply. Therefore, this paper puts forward the following four suggestions: Firstly, establish and improve a penetrating supervision mechanism for insurance groups, and strictly prevent insurance groups from using complex equity structures or related transactions to conduct illegal activities. Secondly, strengthen the supervision and inspection to further enhance the internal mechanism construction and standard operation of insurance groups; thirdly, realize the supervision of systemically important insurance groups as soon as possible from the technical level. It is recommended that the supervisory authorities determine the score threshold based on the actual situation and the evaluation results of systemically important insurers, and then draw up a list of China's domestic systemically important insurance groups and take corresponding supervisory measures for these groups. Fourthly, strengthen the comprehensive supervision of the insurance group's main business and sideline business, and promptly limit the insurance group's operations that are too aggressive in investment and seriously deviate from the main business, to ensure that financial stability and consumer rights are not harmed.

From the result-oriented perspective, the empirical results can better reflect the main characteristics of Chinese insurance market, and can give reasonable explanations to the empirical results. This has a high value for the supervision of systemically important insurance groups. The work in this paper can not only provide technical support for the implementation of the supervision actions of systemically important insurers by China Banking and Insurance Regulatory Commission, but also effectively apply complex network models and social network analysis methods to the theoretical research of systemically important insurers.

## 1. Introduction

After the worldwide financial crisis in 2008, assessing and preventing systemic risks has become the top priority of insurance supervision in various countries. According to the research of Bisias et al. (2012), systemic risk assessment can be divided into macro-prudential systemic risk assessment and micro-prudential systemic risk assessment: the former focuses on the assessment of systemic risks from the overall economic performance, and the latter focuses on the degree to which entities contribute to systemic risks[1]. And this degree of contribution can be used as a measure of the importance of an entity in its own system, that is, its systemic importance. The greater the contribution of entities to systemic risk, the more systemically important it is.

Because the crisis events of certain entities can often have a significant impact on the entire industry and even the national economy, identifying these systemically important entities and measuring their systemic importance has become an academic hot spot and a regulatory focus.

In July 2013, the International Association of Insurance Supervisors (IAIS) released the Global Systemically Important Insurers (G-SIIs) Evaluation Method to evaluate the systemic importance of insurers and identify the insurers that have the greatest impact on the financial system[2]. By imposing more conservative constraints on it, the supervisory authorities will ultimately reduce the potential systemic risks brought by the `Big Mac' insurers to the global financial system. Determining systemically important insurers is a prerequisite for preventing systemic risks. According to Fan Xiaoyun et al.'s (2012) econometric research on measuring Chinese systemically important banks, compared with the asset size of financial institutions, the degree of debt correlation of financial institutions is a more important factor in determining their systemic importance[3]. Considering that the financial market is a complex system composed of multiple financial institutions that interact with each other, the complex network model can more intuitively establish the connections between financial institutions and objectively measure their impact on the market. Therefore, the use of the complex network model in this article is more helpful to study the connections and interactions between financial institutions from a comprehensive perspective, and then evaluate the systemic importance of insurers based on this.

According to the complex network theory, the association and interaction between network nodes will have an important impact on the overall stability of the network, so the association and interaction between individual financial institutions (especially systemically important entities) will also have great impacts on the entire financial network. Therefore, establishing a financial network and researching the distribution of degrees and the centrality of nodes can provide effective technical support for financial risk management. Kanno (2014) measured the marginal contribution rate of systemic risk of insurance companies in the Asia-Pacific region during the financial crisis, and used this as a reference for evaluating the systemic importance of insurance companies[4]. Kanno (2016) also evaluated the systemic importance of non-life insurance companies through the network structure[5].

At present, most of the evaluation studies of domestic systemically important insurers use the index method. For example, Zhang Lin et al. (2015) and Zhu Nanjun et al. (2018) both use the index method and principal component analysis to obtain the systemic importance ranking of insurance companies (groups)[6] [7]. Research on the use of complex network models to assess the systemic importance of financial institutions is mainly concentrated in the banking field. Ma Junlu et al. (2007) used the matrix method to analyze the contagion effect of a single bank failure and multiple bank failures under different loss levels, and measured a single bank's systemic importance according to the contagion effect caused by its failure[8]. Xiao Pu et al. (2012) used CoVaR and quantile regression model to measure the risk spillover effects of Chinese listed banks and the risk contribution rate of a single bank to the entire banking system. And then, the systemic importance ranking was obtained according to the risk contribution rate of each bank[9] .

At present, there is no published research on the construction of complex network models in the insurance market, and the complex network models of the banking industry based on the inter-bank market transaction data have been widely used in academic research. The nodes and degrees in the complex network model can visualize key institutions in the market and business data reflecting the flow of risks, and perform quantitative analysis based on mathematical models. Therefore, the complex network

model has important academic application value in the study of key institutions that may have an important influence on the entire system. Based on the unique advantages of the above-mentioned complex network model and its successful application in the research of systemically important banks, this article will study the insurance market network model to find important network nodes.

Finding important network nodes is one of the basic problems of graph theory research. Hernan (2007) pointed out that the main research methods include social network analysis, system science analysis and information search analysis[10]. Due to the lack of effective complex network models to simulate the insurance market, these methods are currently not applied in the evaluation research of systemically important insurers. From the perspective of evaluation accuracy and operational feasibility, the three methods have no absolute advantages or disadvantages. Based on the consideration of intuition, simplicity and ease of calculation, this paper chooses social network analysis method to evaluate the importance of network nodes. This method can measure the importance of nodes through the node centrality model.

The market method uses mathematical statistical models or network models to objectively measure systemic importance. This method has been relatively mature in the application of related research on Chinese financial market, and has good applicability to Chinese financial market. Based on the above-mentioned advantages of this method, this article is first committed to determining a complex network model that can capture the main internal and external characteristics of the insurance market. Analyzing and optimizing the complex network model that simulates the insurance market and its main external connections, according to the equity data and business data of head institutions of the five major financial industries (or industries closely connected with the financial industry)that includes insurance, banking, securities, trust, and real estate, which is the model basis for subsequent research work. The more complex network model simulates the real situation and the more fully reflects the main characteristics of the insurance market, the more accurate the systemic importance measurement of entities will be. Secondly, based on the complex network model, the social network analysis method is used to measure the systemic importance of each node (that is, all entities), and the centrality score of each node is calculated according to the algorithm of the degree centrality, betweenness centrality and other models. To select multiple dimensions to measure node centrality, it is necessary to synthesize multiple centrality models. The algorithms of different centrality models target different objects. For example, the degree centrality model focuses on the degree of the node while the betweenness centrality model focuses on the betweenness of the node. This makes the problem of inconsistent dimensions when synthesizing multiple centrality models. In order to eliminate the influence of dimensional inconsistency between different centrality scores, a normalization method is used to standardize multiple centrality scores, so as to further comprehensively evaluate the systemic importance of 11 insurance groups. According to the evaluation results of the systemic importance of each insurance group, the corresponding conclusions and policy recommendations are finally put forward. From the result-oriented perspective, the empirical results can better reflect the main characteristics of the insurance market, and we can give reasonable explanations to the empirical results. This has a high reference value for the supervision of systemically important insurance groups, and also illustrates the empirical method used in this article is reasonable and effective. The work of this paper can not only provide technical support for China Banking and Insurance Regulatory Commission’s supervision on systemically important insurers, but also effectively apply complex network models and social network analysis methods to the theoretical research of systemically important insurers.

The structure of this article is arranged as follows: The first part is the research background, which mainly explains the meaning of systemic importance and compares the index method with the market method, combining the research results of relevant systemically important financial institutions at home and abroad, and the intersection of finance and complex network theory, to determine the research ideas and methods of this article. The second part starts from the two dimensions of theoretical foundation and model foundation, introducing the complex network theory involved in the research process; at the same time, on the basis of existing research, optimizes and determines the complex network model through analysis and demonstration, and uses this as a follow-up model basis for research. The third part uses the social network analysis method to evaluate the systemic importance of the insurance groups based on the node centrality model, and analyzes the results in detail based on the market situation. The fourth part is the research conclusions and policy recommendations. This part summarizes and extends the empirical results and the analysis of the results, gets the research conclusions of this article, and extracts targeted policy recommendations.

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## 2. Complex network model

At present, there is no research which uses the complex network method to assess the systemic importance of insurers. The main reasons are: 1. Systemic financial risk has not occurred in China, and no insurance companies has closed down; 2. The development history of Chinese insurance industry is relatively shorter than foreign insurance market, with less accumulation of historical data, so it is difficult to construct an insurance market model that conforms to the reality. Therefore, to use the market method to evaluate the systemic importance of insurance companies, it is a prerequisite to construct a realistic insurance market model.

### 2.1 Theoretical basis

According to the existing research results, the modern financial network is neither a regular network nor a completely random network, but a complex network in between. A complex network consists of several nodes and several edges between nodes. In the financial network, a single financial institution can be regarded as a node, and the connection between the institutions can be regarded as the connecting edges between the nodes. Based on the existing research foundation of our research team, the following will combine the complex network model that has been constructed to explain the complex network theory knowledge used in the article.

Our research team analyzed the industries and companies that may have cross-infection with the insurance industry in the project work report of `Analysis of Systemic Risk Infection Paths and Early Warning Mechanisms in the Insurance Industry under the Background of Cross-Border Integration' (2019), and concluded that banks, securities, trust, real estate, and the Internet are five industries that are significantly related to systemic risks of insurance industry, and a two-tier complex network model based on equity linkages and business transactions has been constructed. Among them, the complex network of equity linkages is a complex network constructed based on three types of data of cross-shareholdings, related transactions and secured transactions[11],

which can reflect the internal linkages of the insurance industry and the main linkages with external industries, as shown in Figure 1.

`Degree' refers to the number of edges connecting a node. The degree of a node indicates the connection of the node with other nodes. The larger the contact amount, the thicker the connecting edge, and vice versa. Table 1 counts the list of company nodes in the network model. In terms of types, the node involves companies in six major industries including insurance, banking, securities, trust, asset management and real estate, which fully considers other industry entities that are closely related to the systemic risks of the insurance industry. From the perspective of scale, the selected nodes are all leading entities in the industry, which allows the nodes to have a better industry representative. From a hierarchical point of view, nodes are divided into parent companies (group companies) and subsidiaries (professional companies). The parent company includes an operating parent company and a holding parent company.

Degree distribution is the frequency corresponding to any node with degree v in the network, which is generally represented by P(v). The scale-free network model shows strong heterogeneity in the degree distribution. The pivot nodes have more edges, but other nodes that account for the majority have fewer edges. Under the assumption that `the number of edges connected to the node can better reflect the importance of node', the more connected the nodes are, the more important the network is. Then this kind of complex network model with obvious differentiation characteristics of degree distribution is more suitable for node importance Evaluation. Figure 2 is the degree distribution diagram corresponding to the clustering complex network model. As shown in Figure 2, the distribution of node degrees is significantly different, some nodes have higher degrees, and some nodes have lower degrees, and the entire network presents a scale-free feature. Therefore, combined with the aforementioned theories, this scale-free network is suitable for node importance evaluation under certain assumptions.

Assume that the network model $G(M,N)$ is composed of $M$ nodes and $N$ edges, and the connecting edge between any two nodes is called a path. The average path length (APL) is the average of the shortest path lengths of all node pairs in the network, which reflects the global characteristics of the network. The calculation formula is:

$$APL = \frac{2}{M(M-1)} \sum_{i \neq j} d_{ij} \tag{1}$$

where $M$ is the number of nodes, and $d_{ij}$ is the length of the shortest path between node $i$ and node $j$.

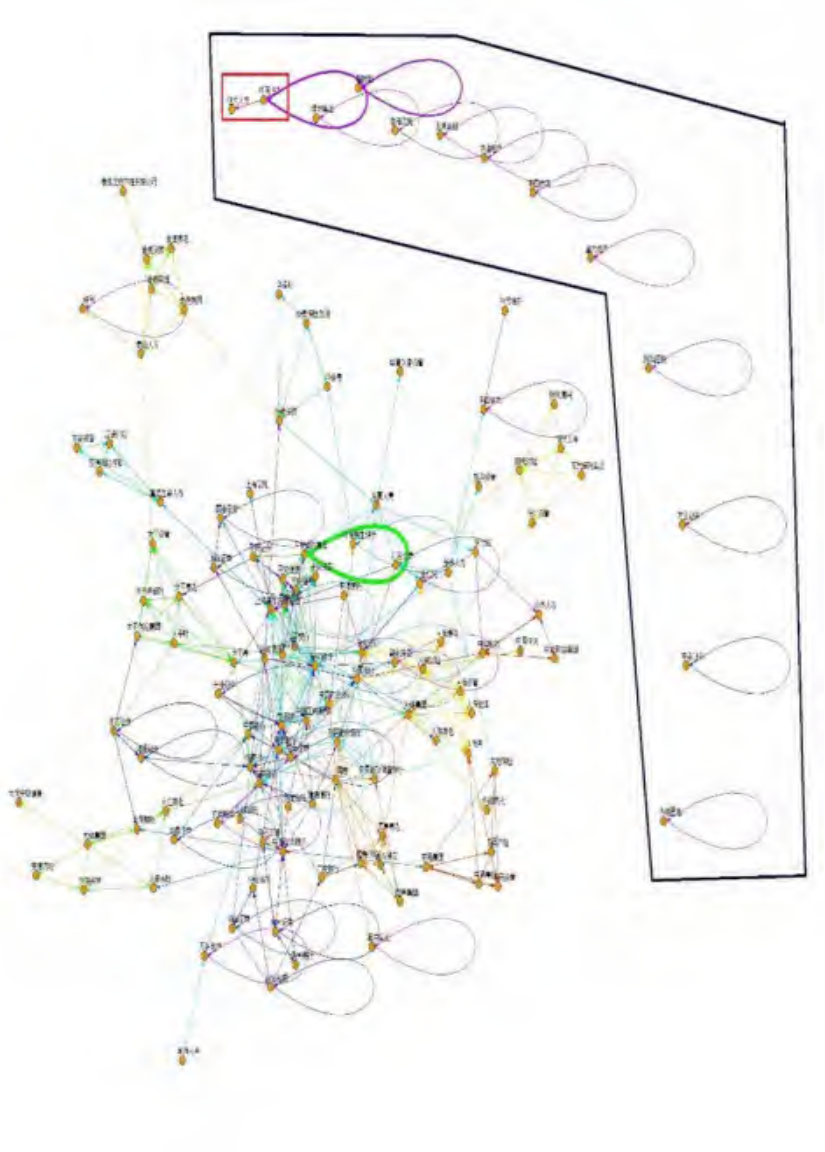

Fig. 1. This figure shows our clustering complex network model, consisting of a total of 125 major entity nodes from the selected industry of insurance, banking, securities, trust, and real estate and the relationships between these entities based on three types of data of cross-shareholdings, related transactions and secured transactions.

Suppose a node has $x(x \leq N)$ connecting edges, and there are at most $\frac{x(x-1)}{2}$ connecting edge between the node and the node corresponding to x connecting edges. Then the clustering coefficient of a node is defined as the ratio of the actual number of connected edges of the node divided by the maximum possible number of connected edges. It reflects the aggregation of nodes in the network. From the overall point of view, the aggregation of all nodes can be represented by the network aggregation coefficient, that is, the average value of the aggregation coefficients of all nodes. After calculation, some statistical characteristics of the network are obtained: the average shortest path length is 4.576731, and the aggregation coefficient is 0.3106509.

Table 1 Etity nodes

| No. | Entity | No. | Entity | No. | Entity | No. | Entity |
|---|---|---|---|---|---|---|---|
| 1 | 中华联合集团 | 33 | 太保财险 | 65 | 中国建设银行 | 97 | 交银信托 |
| 2 | 中华财险 | 34 | 安信农险 | 66 | 中国农业银行 | 98 | 上海信托 |
| 3 | 中华人寿 | 35 | 太保寿险 | 67 | 中国银行 | 99 | 兴业信托 |
| 4 | 中再集团 | 36 | 太保安联健康 | 68 | 交通银行 | 100 | 渤海信托 |
| 5 | 中再产险 | 37 | 长江养老 | 69 | 邮储银行 | 101 | 建信信托 |
| 6 | 中再寿险 | 38 | 太保资管 | 70 | 招商银行 | 102 | 华润信托 |
| 7 | 大地保险 | 39 | 太平保险集团 | 71 | 兴业银行 | 103 | 光大信托 |
| 8 | 中再资管 | 40 | 太平寿险 | 72 | 浦发银行 | 104 | 华宝信托 |
| 9 | 国寿集团 | 41 | 太平财险 | 73 | 中信银行 | 105 | 平安信托 |
| 10 | 中国人寿 | 42 | 太平养老 | 74 | 中国民生银行 | 106 | 外贸信托 |
| 11 | 国寿财险 | 43 | 太平资管 | 75 | 中国光大银行 | 107 | 中海信托 |
| 12 | 国寿养老 | 44 | 太平再保险 | 76 | 平安银行 | 108 | 华能信托 |
| 13 | 国寿资管 | 45 | 平安保险集团 | 77 | 华夏银行 | 109 | 保利 |
| 14 | 人保集团 | 46 | 平安财险 | 78 | 北京银行 | 110 | 融创中国 |
| 15 | 人保财险 | 47 | 平安寿险 | 79 | 广发银行 | 111 | 万科地产 |
| 16 | 人保寿险 | 48 | 平安养老 | 80 | 中信证券 | 112 | 远洋集团 |
| 17 | 人保健康 | 49 | 平安健康 | 81 | 国泰君安 | 113 | 中国金茂 |
| 18 | 人保再保险 | 50 | 平安资管 | 82 | 广发证券 | 114 | 招商蛇口 |
| 19 | 人保养老 | 51 | 华泰保险集团 | 83 | 海通证券 | 115 | 阳光城 |
| 20 | 人保资管 | 52 | 华泰财险 | 84 | 申万宏源 | 116 | 华润置地 |
| 21 | 阳光保险集团 | 53 | 华泰寿险 | 85 | 招商证券 | 117 | 新城控股 |
| 22 | 阳光财险 | 54 | 华泰资管 | 86 | 华泰证券 | 118 | 富力地产 |
| 23 | 阳光信用 | 55 | 富德保险控股 | 87 | 中国银河 | 119 | 中国世茂 |
| 24 | 阳光人寿 | 56 | 富德生命人寿 | 88 | 国信证券 | 120 | 中海地产 |
| 25 | 阳光资管 | 57 | 富德财险 | 89 | 东方证券 | 121 | 龙湖地产 |
| 26 | 泰康保险集团 | 58 | 生命资管 | 90 | 中信建投 | 122 | 绿地集团 |
| 27 | 泰康人寿 | 59 | 新华保险 | 91 | 光大证券 | 123 | 碧桂园 |
| 28 | 泰康在线 | 60 | 新华资管 | 92 | 兴业证券 | 124 | 中国恒大 |
| 29 | 泰康养老 | 61 | 华夏保险 | 93 | 平安证券 | 125 | 恒大人寿 |
| 30 | 泰康资管 | 62 | 华夏久盈资管 | 94 | 方正证券 | | |
| 31 | 泰康健康管理 | 63 | 前海人寿 | 95 | 中泰证券 | | |
| 32 | 太保集团 | 64 | 中国工商银行 | 96 | 中信信托 | | |

Note: This table shows the names of all nodes in the complex network model. Each node represents a company in their respective industries.

There are many types of network structures, and there is currently no unified definition of group-based network structures. Based on the existing results, this paper defines the group-based network structure as a network structure with dense connections within groups and sparse connections between groups after network nodes are grouped according to certain rules.

After observing the distribution of nodes, it is found that: 1. Node companies are clustering in the same area according to their group. For example, Ping An Group, the parent company, and its subsidiaries such as Ping An Life Insurance, Ping An P&C Insurance, Ping An Bank, and Ping An Securities are clustering in the same area; 2. Banks, Insurance companies are mostly located in the central area of the network graph, showing their relatively active internal and external connections; 3. Most real estate companies are located at the edge of the network graph, showing their low activity in the insurance market; 4. The graph shows obvious group-based network structure, reflecting

the group operation of financial institutions, including insurers. Based on the above network characteristics, it can be determined that the network diagram not only intuitively reflects the infection channels of systemic risks in the insurance industry, but also better reflects the group business model of insurance companies.

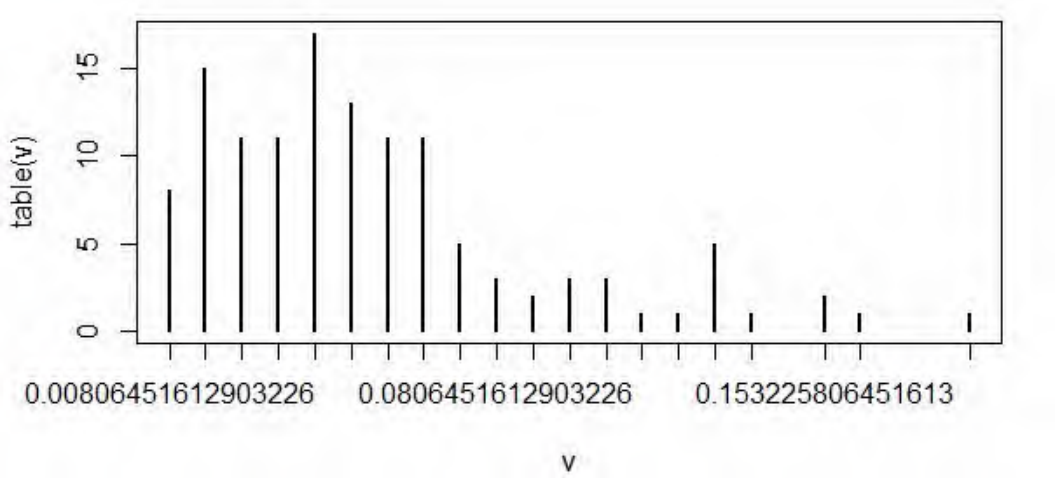


Fig. 2. Degree distribution diagram with abscissa axis standing for the degree of clustering and vertical axis standing for the number of nodes. The distribution of node degrees is significantly different, some nodes have higher degrees, and some nodes have lower degrees, and the entire network presents a scale-free feature.

In summary, the network model has the following advantages: 1. A total of 125 major companies and institutions in selected industries are selected, which is highly representative; 2. It presents the clustering characteristics and a relatively complete internal risk infection channel; 3. It considers the five major industries that are significantly related to the systemic risks of the insurance industry, more comprehensively reflecting the external risk infection channels; 4. It uses three types of data, cross-shareholding, related-party transactions, and secured transactions, to build a complex network model. The data is easy to obtain and can reflect the inter-company connections well.

## 2.2 Optimize complex network model

Based on the advantages of above clustering network model in Figure 1, this article chooses to evaluate the systemic importance of insurance groups on the basis of this network model. It should be noted that there are some isolated nodes in the network graph, that is, nodes that only point to themselves. These isolated nodes and other nodes do not affect each other, but will have an adverse impact on the systemic importance evaluation (we will illustrate in subsequent node centrality model), so these isolated nodes can be removed for subsequent work.

Compared with the main part of the network, the real estate nodes such as China Shimao and Greenland Group in Figure 1 are isolated nodes, that is, nodes that do not have any impact on other nodes in the network. In the later systemic importance assessment, only insurance groups and their subsidiaries will be considered. In Figure 1, China Evergrande and Evergrande Life Insurance are real estate companies and their holding insurance companies, not insurance groups; in addition, the two nodes of China Evergrande and Evergrande Life Insurance are only internally related, and they are isolated from the main part of the network. Based on these two considerations, the node between China Evergrande and Evergrande Life Insurance was removed. In summary, these isolated nodes in Figure 1 are removed, and the remaining nodes form a clustering

connected network model, which is Figure 3. After statistics, the network model shown in Figure 3 includes a total of 112 companies.

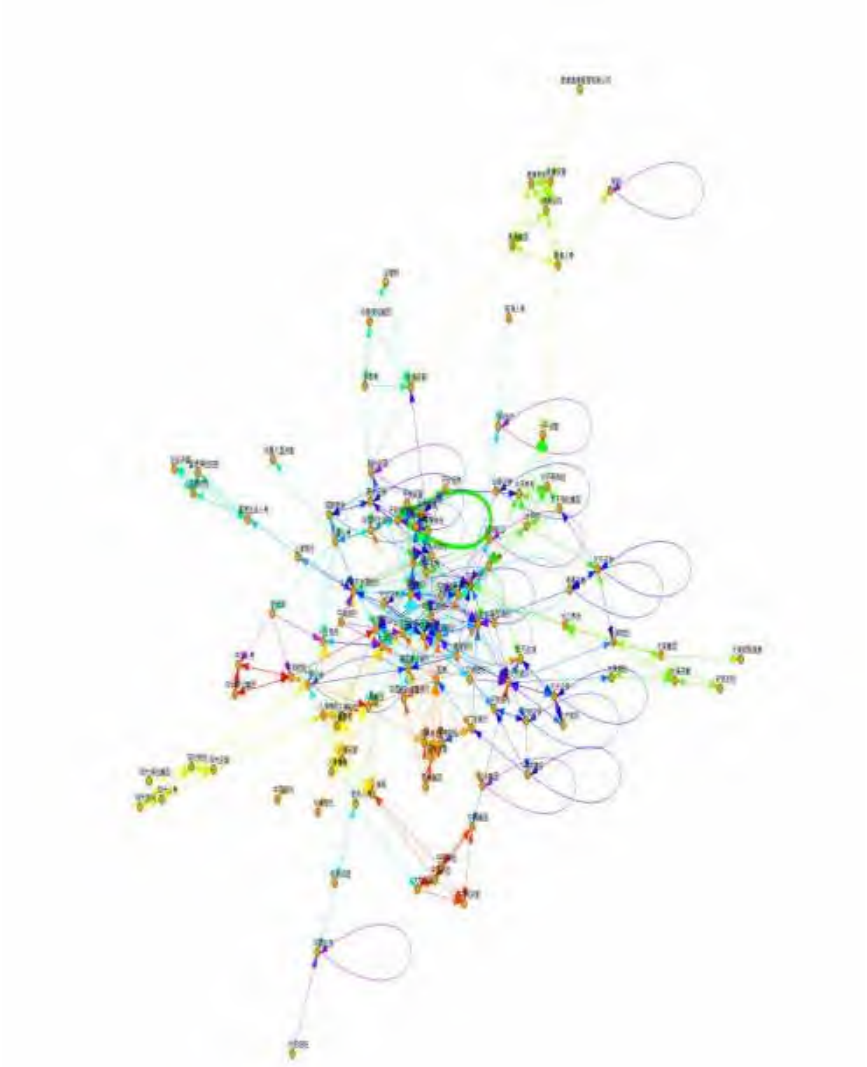

Fig. 3. Clustering connected network model, which has removed isolated nodes and corresponding edges from the original clustering complex network model in Fig. 2. After statistics, the current complex network model includes a total of 112 nodes.

Through analysis and comparison of a large number of studies using centrality theory, it is found that social network analysis research does not use a single centrality score, but comprehensively uses the above models to evaluate the importance of nodes in the network. Since the units of the centrality scores are not consistent, the centrality scores should be converted to between 0 and 1 to be normalized. When the data meets the characteristics of the benefit-type index function or the cost-type index function, that is, when the data is generally considered to be "bigger is better" or "smaller is better", the linear function normalization method can be used. Since the centrality model measures the significance of a node, the larger the value, the higher the significance of the node, that is, the more important it is. Therefore, the linear function normalization method is

used to normalize the centrality scores of different nodes to make each centrality scores comparable.

Linear function normalization regards each group of data as a feature vector, first determines the maximum and minimum values in each feature vector, and then normalizes the elements in the feature vector, as shown in the following formula

$$\|x\|_c = (x - x_{min})/(x_{max} - x_{min}) \quad (2)$$

Among them, $\|x\|_c$ refers to the normalized value of the linear function, $x_{min}$ refers to the smallest element in the feature vector, and $x_{max}$ is the largest element in the feature vector.

Based on Figure 3, this paper first calculates the three centrality scores of each parent company and subsidiary based on the node centrality model, and integrates the results from the insurance group level, that is, aggregate the same centrality scores of the parent and subsidiary companies belonging to the same insurance group. Taking into account the inconsistent units of these three centrality scores, the normalization method is used to uniformly convert them into numbers in the interval [0,1] Finally, the three types of normalized centrality scores of each insurance group are arithmetic averaged, and the final centrality scores are obtained and sorted in order to complete the systemic importance assessment of the insurance group.

## 3.1 Empirical research

The node centrality model can be divided into degree centrality, betweenness centrality, proximity centrality and feature vector centrality. Among them, the feature vector centrality believes that the higher the centrality of neighboring nodes of a node, the higher the centrality of that node. This is very likely to cause overestimate to some nodes that are close to important nodes, but not important themselves. This feature does not conform to the logic of the systemic importance evaluation of financial institutions, so this method will not be introduced in the subsequent parts. With the rapid advancement of technology, the calculation of node centrality models can be implemented in software such as R and MATLAB. Based on the clustering connected network model in Figure 3, the degree function, betweenness function, and closeness function of the node centrality model are called in the R software to calculate the degree centrality, betweenness centrality, and closeness centrality of each node with results showning in Table 2, Table 4, and Table 6, respectively.

### *3.1.1 Degree centrality*

Degree centrality focuses on the number of edges connected to the node. The more connected edges, the more important it is. Generally speaking, the larger the institution, the greater its influence, and the more frequent its internal and external contacts. Formula (3) is the calculation formula for the degree centrality of node $i$

$$c_D(i) = \sum_k x_{ik} /(M - 1) \quad (3)$$

Among them, the number of edges connected to node $v$ is $k$, $\sum_k x_{ik}$ refers to the degree value of node $i$, and $M$ is the number of nodes in the entire network. Degree centrality is convenient to calculate and can reflect the importance of nodes to a certain extent. The

results of degree centrality calculated by our optimized complex network model is shown in Table 2.

Table 2 Results of degree centrality

| Entity | Degree Centrality | Entity | Degree Centrality | Entity | Degree Centrality | Entity | Degree Centrality |
|---|---|---|---|---|---|---|---|
| 中华联合集团 | 4 | 泰康养老 | 6 | 富德财险 | 5 | 招商证券 | 10 |
| 中华财险 | 8 | 泰康资管 | 8 | 生命资管 | 3 | 华泰证券 | 3 |
| 中华人寿 | 5 | 泰康健康管理 | 1 | 新华保险 | 6 | 中国银河 | 1 |
| 中再集团 | 9 | 太保集团 | 7 | 新华资管 | 2 | 国信证券 | 6 |
| 中再产险 | 6 | 太保财险 | 7 | 华夏保险 | 9 | 东方证券 | 8 |
| 中再寿险 | 5 | 安信农险 | 2 | 华夏久盈资管 | 1 | 中信建投 | 5 |
| 大地保险 | 4 | 太保寿险 | 4 | 前海人寿 | 1 | 光大证券 | 8 |
| 中再资管 | 5 | 太保安联健康 | 1 | 中国工商银行 | 7 | 兴业证券 | 5 |
| 国寿集团 | 5 | 长江养老 | 5 | 中国建设银行 | 12 | 平安证券 | 7 |
| 中国人寿 | 19 | 太保资管 | 4 | 中国农业银行 | 8 | 中信信托 | 5 |
| 国寿财险 | 11 | 太平保险集团 | 6 | 中国银行 | 9 | 建信信托 | 6 |
| 国寿养老 | 8 | 太平寿险 | 11 | 交通银行 | 16 | 华润信托 | 10 |
| 国寿资管 | 6 | 太平财险 | 8 | 邮储银行 | 5 | 交银信托 | 3 |
| 人保集团 | 16 | 太平养老 | 7 | 招商银行 | 15 | 上海信托 | 2 |
| 人保财险 | 14 | 太平资管 | 6 | 兴业银行 | 13 | 兴业信托 | 6 |
| 人保寿险 | 9 | 太平再保险 | 5 | 浦发银行 | 20 | 光大信托 | 4 |
| 人保健康 | 7 | 平安保险集团 | 13 | 中信银行 | 17 | 华宝信托 | 3 |
| 人保再保险 | 8 | 平安财险 | 16 | 中国民生银行 | 6 | 平安信托 | 16 |
| 人保养老 | 4 | 平安寿险 | 19 | 中国光大银行 | 16 | 外贸信托 | 1 |
| 人保资管 | 8 | 平安养老 | 10 | 平安银行 | 23 | 中海信托 | 3 |
| 阳光保险集团 | 3 | 平安健康 | 12 | 华夏银行 | 13 | 华能信托 | 1 |
| 阳光财险 | 8 | 平安资管 | 7 | 北京银行 | 12 | 保利 | 3 |
| 阳光信用 | 3 | 华泰保险集团 | 4 | 广发银行 | 7 | 融创中国 | 3 |
| 阳光人寿 | 5 | 华泰财险 | 2 | 中信证券 | 6 | 万科地产 | 4 |
| 阳光资管 | 5 | 华泰寿险 | 4 | 国泰君安 | 6 | 远洋集团 | 3 |
| 泰康保险集团 | 9 | 华泰资管 | 6 | 广发证券 | 7 | 中国金茂 | 4 |
| 泰康人寿 | 7 | 富德保险控股 | 5 | 海通证券 | 5 | 招商蛇口 | 5 |
| 泰康在线 | 8 | 富德生命人寿 | 7 | 申万宏源 | 5 | 阳光城 | 4 |

Note: This table shows the results of degree centrality for 112 entity nodes, based on the complex model in Fig. 3 and degree centrality index.

According to the attribution principle of each insurance group, the above results are classified and summarized. For example, the degree centrality of China United Insurance Group, China Property Insurance and China Life is added to obtain the new degree centrality of China United Insurance Group. The sum of the degree centrality of China Life Group, China Life, China Life Property Insurance, China Life pension, China Life Asset Management and China Guangfa Bank has resulted in a new degree centrality of China Life Group. Finally, the following insurance group centrality results of Table 3 are obtained:

Table 3 Degree centrality normalized results

| Insurance Group | Degree Centrality | Normalized Value |
|---|---|---|
| Ping An Group(平安集团) | 123 | 1 |
| PICC Group(人保集团) | 66 | 0.46729 |
| China Life Group(中国人寿) | 56 | 0.373832 |
| Tai Ping Group(太平集团) | 43 | 0.252336 |
| Taikang Group(泰康集团) | 39 | 0.214953 |
| Pacific Insurance Group(太保集团) | 30 | 0.130841 |
| China Reinsurance Group(中再集团) | 29 | 0.121495 |
| Sunshine Insurance Group(阳光保险) | 24 | 0.074766 |
| Fude Insurance Group(富德保险) | 20 | 0.037383 |
| China United Group(中华联合) | 17 | 0.009346 |
| Huatai Insurance Group(华泰保险) | 16 | 0 |

Note: This table shows degree centrality normalized results for all Chinese insurance groups. Based on the linear function normalization method, the result of top 1 insurance group (Ping An Group) is 1, which means the most influential group. Conversely, 0 means the least significant group (Huatai Insurance Group) in all insurance groups.

As shown in Table 3, the top three degree-centric groups are Ping An Group, PICC Group, and China Life Group, reflecting that these three insurance groups have more internal and external connections in the insurance market. Taking Ping An Group as an example, Ping An Group includes professional subsidiaries such as Ping An Life, Ping An Property Insurance, Ping An Health, Ping An Pension, Ping An Bank, Ping An Asset Management, Ping An Securities, and Ping An Trust. These subsidiaries work together under the framework of the same group, having coordinated layout and close internal ties. This makes Ping An Group one of the largest insurance groups in China, and also confirms the view that `the larger the institution, the greater its influence, and the more frequent its internal and external contacts‘.

*3.1.2 Betweenness centrality*

Betweenness is proposed by Freeman et al. (1977) when analyzing the importance of individuals in social networks. It is divided into node betweenness and edge betweenness. The former is the ratio of the number of shortest paths passing through a specific node in all the shortest paths in the network, and the latter refers to the proportion of the number of shortest paths passing through a specific edge in the network[13]. The two respectively reflect the influence of the corresponding node or edge in the network. The formula for calculating the betweenness centrality of node $i$ is

$$C_B(i) = \sum_{s \neq t \neq i \in M} \frac{\sigma(s,t|i)}{\sigma(s,t)} \tag{4}$$

Among them, $\sigma(s,t|i)$ is the number of shortest paths through $i$ between $s$ and $t$, and $\sigma(s,t)$ is the number of shortest paths between $s$ and $t$ (whether through node $i$ or not).

Betweenness centrality reflects the ability of network nodes to master network information. The greater the betweenness centrality of a node, it means that the node has a higher information grasping ability in the network, that is, the node has a higher influence and is more important. And the results of betweenness centrality calculated by our optimized complex network model is shown in Table 4. And these results are

classified and summarized according to the attribution principle of each insurance group in Table 5.

Table 4 Results of betweenness centrality

| **Entity** | **Betweenness Centrality** | **Entity** | **Betweennes s Centrality** | **Entity** | **Betweenness Centrality** | **Entity** | **Betweenness Centrality** |
|---|---|---|---|---|---|---|---|
| 中华联合集团 | 0 | 泰康养老 | 0 | 富德财险 | 86 | 招商证券 | 169.4 |
| 中华财险 | 447.5 | 泰康资管 | 93.3 | 生命资管 | 0 | 华泰证券 | 0 |
| 中华人寿 | 7.3 | 泰康健康管理 | 0 | 新华保险 | 89 | 中国银河 | 0 |
| 中再集团 | 586.9 | 太保集团 | 193.6 | 新华资管 | 0 | 国信证券 | 326.9 |
| 中再产险 | 151.6 | 太保财险 | 666.0 | 华夏保险 | 1209.4 | 东方证券 | 411.7 |
| 中再寿险 | 69.1 | 安信农险 | 0 | 华夏久盈资管 | 0 | 中信建投 | 251.1 |
| 大地保险 | 17.8 | 太保寿险 | 95.6 | 前海人寿 | 0 | 光大证券 | 142.3 |
| 中再资管 | 16.3 | 太保安联健康 | 0 | 中国工商银行 | 28.7 | 兴业证券 | 0 |
| 国寿集团 | 2.8 | 长江养老 | 243.2 | 中国建设银行 | 562.7 | 平安证券 | 105.5 |
| 中国人寿 | 932.0 | 太保资管 | 0 | 中国农业银行 | 0 | 中信信托 | 203.2 |
| 国寿财险 | 240.2 | 太平保险集团 | 208.4 | 中国银行 | 318.4 | 建信信托 | 114.8 |
| 国寿养老 | 823.6 | 太平寿险 | 726.1 | 交通银行 | 877.9 | 华润信托 | 306.9 |
| 国寿资管 | 6.5 | 太平财险 | 324.3 | 邮储银行 | 38.9 | 交银信托 | 0 |
| 人保集团 | 1801.6 | 太平养老 | 76.5 | 招商银行 | 749.4 | 上海信托 | 0 |
| 人保财险 | 743.5 | 太平资管 | 0 | 兴业银行 | 1027.8 | 兴业信托 | 177.1 |
| 人保寿险 | 207.9 | 太平再保险 | 0 | 浦发银行 | 2106.0 | 光大信托 | 0 |
| 人保健康 | 88.5 | 平安保险集团 | 328.0 | 中信银行 | 1265.6 | 华宝信托 | 0 |
| 人保再保险 | 290.7 | 平安财险 | 563.3 | 中国民生银行 | 251.3 | 平安信托 | 231.7 |
| 人保养老 | 512.0 | 平安寿险 | 555.1 | 中国光大银行 | 1759.6 | 外贸信托 | 0 |
| 人保资管 | 213.5 | 平安养老 | 94.5 | 平安银行 | 1125.0 | 中海信托 | 0 |
| 阳光保险集团 | 0 | 平安健康 | 68.2 | 华夏银行 | 495.4 | 华能信托 | 0 |
| 阳光财险 | 207.4 | 平安资管 | 0 | 北京银行 | 301.7 | 保利 | 0 |
| 阳光信用 | 0 | 华泰保险集团 | 1 | 广发银行 | 278.2 | 融创中国 | 0 |
| 阳光人寿 | 15.7 | 华泰财险 | 0 | 中信证券 | 377.2 | 万科地产 | 0 |
| 阳光资管 | 134.3 | 华泰寿险 | 1 | 国泰君安 | 402.1 | 远洋集团 | 0 |
| 泰康保险集团 | 439.8 | 华泰资管 | 879.1 | 广发证券 | 561.8 | 中国金茂 | 0 |
| 泰康人寿 | 10 | 富德保险控股 | 0.5 | 海通证券 | 6.3 | 招商蛇口 | 0 |
| 泰康在线 | 4.8 | 富德生命人寿 | 528.5 | 申万宏源 | 84.4 | 阳光城 | 97.9 |

Note: This table shows the results of betweenness centrality for all entity nodes, based on the complex model in fig. 3 and betweenness centrality model.

Table 5 Betweenness centrality normalized results

| Insurance Group | Betweenness Centrality | Normalized Value |
|---|---|---|
| PICC Group(人保集团) | 3857.876 | 1 |
| Ping An Group(平安集团) | 3071.342 | 0.775303 |
| China Life Group(中国人寿) | 2283.364 | 0.550194 |
| Tai Ping Group(太平集团) | 1335.338 | 0.279362 |
| Pacific Insurance Group(太保集团) | 1198.293 | 0.240211 |
| Huatai Insurance Group(华泰保险) | 881.1 | 0.149595 |
| China Reinsurance Group(中再集团) | 841.6628 | 0.138329 |
| Fude Insurance Group(富德保险) | 615 | 0.073576 |
| Taikang Group(泰康集团) | 548 | 0.054435 |
| China United Group(中华联合) | 454.8667 | 0.027829 |
| Sunshine Insurance Group(阳光保险) | 357.4546 | 0 |

Note: This table shows betweenness centrality normalized results for all Chinese insurance groups. Based on the linear function normalization method, the result of top 1 group (PICC) is 1, which means the most influential group. Conversely, 0 means the least significant group (Sunshine Insurance Group) in all groups.

As shown in Table 5, the top three groups with highest betweenness centrality are PICC Group, Ping An Group, and China Life Group, reflecting that PICC has the highest network information control ability in the insurance market network model, and Sunshine Group has the weakest information control ability. According to the ranking results, institutions with the largest scale and highest strength have better information control capabilities, and thus have a first-mover advantage in opening up the market.

*3.1.3 Closeness centrality*

Closeness centrality believes that if a node is very close to many nodes in the network, then the node is in the center of the network. The higher the closeness centrality, the shorter the path that the node can connect to multiple nodes, and the stronger the influence of the node. The calculation formula for the close centrality of node $i$ is

$$C_i(i) = \frac{1}{\sum_{j=1} d_{ij}} \tag{5}$$

$d_{ij}$ is the length of the shortest path between nodes $i, j \in M$[14].

According to formula (5), the shortest path length between any two nodes is needed to calculate the closeness centrality. If there are isolated nodes in the network graph, there is no shortest path length between these isolated nodes and other nodes, which makes the calculation of closeness centrality impossible. Therefore, it is necessary to remove isolated nodes in the network before computing closeness centrality. The results of closeness centrality calculated by our optimized complex network model is shown in Table 6.

Table 6 Results of closeness centrality

| **Entity** | **Closeness Centrality** | **Entity** | **Closeness Centrality** | **Entity** | **Closeness Centrality** | **Entity** | **Closeness Centrality** |
|---|---|---|---|---|---|---|---|
| 中华联合集团 | 0.035 | 泰康养老 | 0.043 | 富德财险 | 0.035 | 招商证券 | 0.037 |
| 中华财险 | 0.036 | 泰康资管 | 0.043 | 生命资管 | 0.034 | 华泰证券 | 0.037 |
| 中华人寿 | 0.035 | 泰康健康管理 | 0.043 | 新华保险 | 0.041 | 中国银河 | 0.009 |
| 中再集团 | 0.036 | 太保集团 | 0.036 | 新华资管 | 0.040 | 国信证券 | 0.037 |
| 中再产险 | 0.036 | 太保财险 | 0.036 | 华夏保险 | 0.037 | 东方证券 | 0.036 |
| 中再寿险 | 0.036 | 安信农险 | 0.009 | 华夏久盈资管 | 0.009 | 中信建投 | 0.036 |
| 大地保险 | 0.035 | 太保寿险 | 0.035 | 前海人寿 | 0.009 | 光大证券 | 0.035 |
| 中再资管 | 0.035 | 太保安联健康 | 0.009 | 中国工商银行 | 0.035 | 兴业证券 | 0.038 |
| 国寿集团 | 0.036 | 长江养老 | 0.036 | 中国建设银行 | 0.036 | 平安证券 | 0.037 |
| 中国人寿 | 0.038 | 太保资管 | 0.009 | 中国农业银行 | 0.009 | 中信信托 | 0.036 |
| 国寿财险 | 0.037 | 太平保险集团 | 0.037 | 中国银行 | 0.037 | 建信信托 | 0.037 |
| 国寿养老 | 0.037 | 太平寿险 | 0.037 | 交通银行 | 0.037 | 华润信托 | 0.038 |
| 国寿资管 | 0.036 | 太平财险 | 0.037 | 邮储银行 | 0.036 | 交银信托 | 0.037 |
| 人保集团 | 0.037 | 太平养老 | 0.036 | 招商银行 | 0.036 | 上海信托 | 0.036 |
| 人保财险 | 0.037 | 太平资管 | 0.009 | 兴业银行 | 0.037 | 兴业信托 | 0.036 |
| 人保寿险 | 0.036 | 太平再保险 | 0.009 | 浦发银行 | 0.037 | 光大信托 | 0.035 |
| 人保健康 | 0.036 | 平安保险集团 | 0.037 | 中信银行 | 0.037 | 华宝信托 | 0.038 |
| 人保再保险 | 0.036 | 平安财险 | 0.037 | 中国民生银行 | 0.036 | 平安信托 | 0.037 |
| 人保养老 | 0.036 | 平安寿险 | 0.038 | 中国光大银行 | 0.036 | 外贸信托 | 0.009 |
| 人保资管 | 0.037 | 平安养老 | 0.037 | 平安银行 | 0.037 | 中海信托 | 0.038 |
| 阳光保险集团 | 0.043 | 平安健康 | 0.037 | 华夏银行 | 0.035 | 华能信托 | 0.009 |
| 阳光财险 | 0.042 | 平安资管 | 0.036 | 北京银行 | 0.035 | 保利 | 0.009 |
| 阳光信用 | 0.040 | 华泰保险集团 | 0.039 | 广发银行 | 0.037 | 融创中国 | 0.009 |
| 阳光人寿 | 0.041 | 华泰财险 | 0.036 | 中信证券 | 0.036 | 万科地产 | 0.009 |
| 阳光资管 | 0.042 | 华泰寿险 | 0.039 | 国泰君安 | 0.036 | 远洋集团 | 0.009 |
| 泰康保险集团 | 0.044 | 华泰资管 | 0.036 | 广发证券 | 0.036 | 中国金茂 | 0.009 |
| 泰康人寿 | 0.043 | 富德保险控股 | 0.035 | 海通证券 | 0.035 | 招商蛇口 | 0.036 |
| 泰康在线 | 0.043 | 富德生命人寿 | 0.036 | 申万宏源 | 0.034 | 阳光城 | 0.035 |

Note: This table shows the results of closeness centrality for all entity nodes, based on the complex model in fig. 3 and closeness centrality model.

The above results are classified and summarized according to the attribution principle of each insurance group, and the results of insurance groups closeness centrality are obtained in Table 7.

Table 7 Closeness centrality normalized results

| Insurance Group | Closeness Centrality | Normalized Value |
|---|---|---|
| Ping An Group(平安集团) | 0.33085211 | 1 |
| Taikang Group(泰康集团) | 0.25759815 | 0.674048 |
| PICC Group(人保集团) | 0.25558193 | 0.665077 |
| China Life Group(中国人寿) | 0.22173531 | 0.514472 |
| Sunshine Insurance Group(阳光保险) | 0.20712919 | 0.449481 |
| China Reinsurance Group(中再集团) | 0.17859233 | 0.322503 |
| Pacific Insurance Group(太保集团) | 0.16967026 | 0.282803 |
| Tai Ping Group(太平集团) | 0.16512517 | 0.262579 |
| Huatai Insurance Group(华泰保险) | 0.14985693 | 0.194641 |
| Fude Insurance Group(富德保险) | 0.14003611 | 0.150943 |
| China United Group(中华联合) | 0.10611346 | 0 |

Note: This table shows closeness centrality normalized results for all Chinese insurance groups. Based on the linear function normalization method, the result of top 1 group (Ping An Group) is 1, which means the most influential group. Conversely, 0 means the least significant group (China United Group) in all groups.

As shown in Table 7, the top three groups with highest closeness centrality are Ping An Group, Tai Kang Group, and PICC Group, reflecting that most nodes of these three insurance groups are in a relatively central position in the network, and are closer to other nodes in the network. This is also reflected in the clustering connected network model in Figure 3.

### 3.2 Assessment Result

Based on the results in Table 3, Table 5, and Table 7, the normalized scores of the above node centralities are arithmetic averaged and sorted to obtain the centrality score ranking in Table 8.

Table 8 Ranking of Insurance Groups' Systemic Importance

| Entity | Ranking | Average scores of normalized value |
|---|---|---|
| Ping An Group(平安集团) | 1 | 0.92510103 |
| PICC Group(人保集团) | 2 | 0.710788841 |
| China Life Group(中国人寿) | 3 | 0.479499267 |
| Taikang Group(泰康集团) | 4 | 0.314478825 |
| Tai Ping Group(太平集团) | 5 | 0.264759088 |
| Pacific Insurance Group(太保集团) | 6 | 0.217951605 |
| China Reinsurance Group(中再集团) | 7 | 0.194108928 |
| Sunshine Insurance Group(阳光保险) | 8 | 0.174749087 |
| Huatai Insurance Group(华泰保险) | 9 | 0.114745484 |
| Fude Insurance Group(富德保险) | 10 | 0.087300457 |
| China United Group(中华联合) | 11 | 0.012391489 |

Note: Anbang Group has not released relevant data due to the takeover of the insurance protection fund, so it is temporarily not included in the ranking. In addition, since the research object of this article is insurance group, the life insurance companies of non-insurance groups such as New China Life and Hua Xia Life are not included in the ranking of insurance groups' systemic importance for the time being. The list of insurance groups is not static and can be adjusted flexibly in future evaluations.

According to the final ranking results, Ping An Group's centrality score is the highest, indicating that Ping An Group has the most significant systemic importance. From the perspective of business scale, the original premium income of Ping An Group, PICC

Group and China Life Group in 2019 was 794.6 billion yuan, 552.199 billion yuan and 568.4 billion yuan respectively, which reflects that Ping An Group has a greater influence on the insurance market. Compared with the low-ranking insurance groups, the three head insurance groups, Ping An, PICC and China Life have stronger systemic importance, and their market voice and influence are in a leading position. After comparing the average centrality scores of Ping An, PICC and China Life, it is found that the scores of the three are quite different. This is because the three insurance groups have their own advantages and disadvantages in different centrality scores. Due to the most mature development of integrated finance and the close relationship between the parent and subsidiary companies, Ping An Group has shown obvious advantages that PICC and China Life do not have in terms of degree centrality and closeness centrality. The PICC Group, which has been operating for the longest time since the founding of New China, has shown obvious advantages in information control and has the strongest betweenness centrality. Because of the above differences, China Life Group's score among the three insurance groups is relatively low. In addition, thanks to the "insurance, asset management, medical care" strategic layout of the life insurance sector and the development of the property and casualty insurance sector based on Taikang Online, Taikang Insurance Group has continued to grow at a relatively rapid growth rate in recent years, and its degree centrality and closeness centrality rankings are relatively high, so it is second only to Ping An, PICC and China Life in the ranking of systemic importance of insurance groups.

## 3. Conclusion

### 3.1 The main conclusions and recommendations of the systemic importance assessment of insurance groups

The academia has proven that traditional insurance business will not lead to systemic risks in the insurance industry. Historical experience has shown that insurance industry crises are often accompanied by M&A, reorganization and investment radicalization. The serious crisis of leading insurance groups is difficult to solve by itself. Considering that the market and the public cannot withstand the impact of the crisis, the regulatory authorities need to take necessary preventive measures and handling measures. Currently, most regulatory agencies use indicator methods to identify systemically important financial institutions. Taking into account the unique advantages of the complex network model, this article improves the complex network model constructed based on three types of data: related party transactions, cross-shareholding and internal guarantees, so that it better reflects the insurance market and conforms to the basic system importance assessment. Finally, we use the node centrality models and the normalization method to achieve the systemic importance assessment of insurance groups.

This article draws three conclusions from the empirical results: First, the top three in the ranking of systemic importance are Ping An Group, PICC Group, and China Life Group. The centrality scores of these three insurance groups are much higher than those of the lower-ranked groups. Therefore, their importance to Chinese insurance industry and the entire financial system is self-evident. Second, these three insurance groups have always been the leading companies in Chinese insurance industry. Compared with other groups, they are more scale-efficient and easier to obtain advantageous resources. This also explains the existence of the Matthew effect in Chinese insurance industry.

Third, looking at the development process of mature insurance markets, it is a historical trend to build fully licensed comprehensive insurance groups. The scale effect produced by the financial full license and the organic cooperation between various business lines maximize the overall benefits of the insurance group.

Although the group business strategy has promoted the development of many insurance companies by leaps and bounds, the disadvantages brought about by the group strategy have become increasingly prominent. This is mainly reflected in the complex business crossover and opaque transactions, which make the original “risk firewall” created by supervision gradually invalidate, and the systemic risk of the entire financial system has risen sharply. Therefore, this paper puts forward the following four suggestions: Firstly, establish and improve a penetrating supervision mechanism for insurance groups, and strictly prevent insurance groups from using complex equity structures or related transactions to conduct illegal activities. Secondly, strengthen the supervision and inspection to further enhance the internal mechanism construction and standard operation of insurance groups; thirdly, realize the supervision of systemically important insurance groups as soon as possible from the technical level. It is recommended that the supervisory authorities determine the score threshold based on the actual situation and the evaluation results of systemically important insurers, and then draw up a list of Chinese domestic systemically important insurance groups and take corresponding supervisory measures for these groups. Fourthly, strengthen the comprehensive supervision of the insurance group's main business and sideline business, and promptly limit the insurance group's operations that are too aggressive in investment and seriously deviate from the main business, to ensure that financial stability and consumer rights are not harmed.

### 3.2 Research outlook

With the diversification of financial formats and the continuous development of information technology, relevance and complexity have become important factors in the assessment of systemic importance. In practice, scale is also an important factor in the evaluation. How to consider the scale factor in social network analysis is worth studying. In addition, considering the continuous changes in reality and different focuses of the three centrality models, there are certain errors in the weighting of the three. How to give them corresponding weights accurately becomes the direction of follow-up research.

Complex network technology can be applied to simulate the real world, and its accuracy depends on the advanced level of technical tools and the sufficiency of information. Restricted by obstacles such as information islands, it is difficult to simulate a network that is highly close to reality. Therefore, the method of importance assessments of network nodes can be used as a basis for evaluating the importance of nodes under a certain degree of confidence. With the maturity of big data and cloud computing technology, if the information of the establishment of a complex network model is infinitely close to complete information, the credibility of this model will be greatly improved. At the same time, the research of complex network will also show more powerful advantages in the systemic importance assessment research.

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# Anti Poverty Function and Spatial Spillover of Digital Inclusive Insurance

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**Keywords:** Inclusive insurance; poverty; anti return to poverty; spatial spillover.

**Abstract.** As one of the main means to alleviate rural poverty, inclusive insurance is also an important measure to prevent poverty. By reducing the transaction threshold of insurance services, improving the availability of insurance needs of all social strata and groups is one of the effective focuses to solve the problem of rural poverty and prevent the phenomenon of returning to poverty. Starting from the modernization of national governance system and governance capacity, under the background of the continuous improvement of digital governance level, the combination of inclusive insurance and digital technology is the basis of realizing the high-quality development of China's social economy, the strong support for improving the precise poverty alleviation and preventing the return to poverty, and the key to promoting the development and deepening of China's inclusive financial system. In the aspect of theoretical research, this paper combs the anti return to poverty path of digital inclusive insurance, analyzes the anti return to poverty effect of the development of digital inclusive insurance in rural areas, and reveals the anti return to poverty transmission mechanism of digital inclusive insurance from the perspective of direct effect and indirect effect. In the aspect of empirical analysis, this paper uses the provincial economic data of China from 2012 to 2018 to measure the spatial characteristics of the development of digital inclusive insurance in China by using the spatial econometric method, and constructs the classic panel model and spatial panel model to empirically test the spatial characteristics and anti poverty effect of the development of digital inclusive insurance

in China. The results show that: 1. The development of digital inclusive insurance in China can inhibit the occurrence of poverty in rural poor areas through direct and indirect effects. The direct effects are to improve the availability of insurance services in rural poor areas, reduce the cost of insurance services in rural poor areas, and enhance the risk resistance ability of rural poor groups; The income growth effect, the equalization effect of health care, the equalization effect of education and the labor transfer effect of the development of digital inclusive insurance are indirect effects. 2. Due to the different levels of economic development in different regions of China, the degree of development of digital inclusive insurance is also different. Moreover, the development of digital inclusive insurance in China has significant spatial dependence, but also spatial heterogeneity. 3. Through the construction of ordinary panel regression model and spatial panel regression model, the empirical analysis shows that the anti return to poverty effect of digital inclusive insurance lags behind. The reason may be that China's digital inclusive insurance is still in the early stage of development, and insurance, as an effective means of risk management, will temporarily reduce the disposable income of rural poor groups by paying premiums at the initial stage, But in the later stage, providing risk guarantee can effectively alleviate the occurrence of poverty. 4. Based on the spatial panel model, the spatial spillover effect of the anti poverty effect of digital inclusive insurance is further clear: there are indirect spillover effect and total spillover effect in the inhibition of poverty by the development of digital inclusive insurance in China's provinces. Based on the above conclusions, this paper suggests that: in order to comprehensively consolidate the achievements of poverty reduction in the battle of precision poverty alleviation, and improve the work of anti-poverty, China should enhance the ability of digital governance, accelerate the process of digital development of inclusive insurance, strengthen the construction of new urbanization and rural digital infrastructure, and constantly deepen the reform of the socialist market economic system, We will promote a virtuous circle between the development of digital inclusive insurance and economic growth.

## 1. Introduction

Inclusive Finance is an institutional arrangement to promote social equity and effectively reduce poverty by reducing the transaction threshold and improving the availability of financial needs of all social strata and groups. Since its concept was put forward by the United Nations in 2005, it has been focused by governments of all countries, and also received a positive response from China. At present, inclusive finance has become an important poverty alleviation mechanism in China, and it is also the focus of China's current financial development. With the promotion of inclusive financial policies, inclusive insurance has gradually attracted people's attention. On November 3, 2020, the Fifth Plenary Session of the 19th CPC Central Committee deliberated and adopted the "proposal of the CPC Central Committee on formulating the fourteenth five year plan for national economic and social development and the long-term goal for the year 2035", which proposed the new goal of building a modern socialist country in an all-round way, paying more attention to the construction of system and governance system, and requiring the construction of a multi-level social security system, And we should improve the level of financial science and technology and enhance the financial inclusiveness. In 2013, in the Third Plenary Session of the 18th CPC Central Committee, the development concept of Inclusive Finance was put

forward for the first time. In March 2015, Premier Li Keqiang made clear the concept of Inclusive Finance for the first time in the 2015 State Council government work report at the third session of the 12th National People's Congress. In November 2015, the State Council issued the development plan of promoting Inclusive Finance (2016-2020), which emphasized to improve the coverage rate of financial services and basically realize the full coverage of insurance services at the township level. In the field of insurance, inclusive insurance has also attracted more and more attention. In August 2016, China Insurance Regulatory Commission issued the 13th five year plan for the development of China's insurance industry, which pointed out that it is necessary to vigorously develop inclusive insurance and build an insurance people's livelihood security network. In the context of the Current Rural Revitalization Strategy, the role of inclusive insurance can not be ignored. In September 2018, the State Council issued the Rural Revitalization strategic plan (2018-2022), which further stressed the need to increase financial support for agriculture and encourage financial resources such as insurance to further serve the Rural Revitalization. It can be seen that as an important part of Inclusive Finance, inclusive insurance has been paid more and more attention.
With the development of information technology and the popularization of digital technology, the mode of government governance is quietly changing. In 2013, the Third Plenary Session of the 18th CPC Central Committee proposed to promote the modernization of national governance system and governance capacity as the overall goal of comprehensively deepening reform. In October 2019, the Fourth Plenary Session of the 19th CPC Central Committee proposed to strengthen and innovate the social governance system, and take data as a basic factor of production to participate in labor distribution. In November 2020, the Fifth Plenary Session of the 19th CPC Central Committee also put forward the new goal of building a socialist modern country in an all-round way, and emphasized the importance of the construction of system and governance system. Therefore, under the background of the current digital era, the digital governance system, which combines digital technology and multi-agent participation, emerges as the times require. Digital governance not only promotes the level and ability of government services, but also promotes its own governance reform, improves the efficiency of social governance, and promotes the development of the whole social economy by relying on digital technology.

Today, when socialism enters a new era, the main contradiction in China has changed into the contradiction between the people's growing needs for a better life and the unbalanced and inadequate development. Lowering the transaction threshold and improving the availability of financial needs of all social strata and groups are one of the effective focuses to solve this problem. As an important part of Inclusive Finance, inclusive insurance is an important part of Inclusive Finance, The combination of inclusive insurance and digital technology is the foundation for the realization of high-quality social and economic development in China, the strong support for winning the battle against poverty, and the key to promoting the development and deepening of inclusive financial system in China. In this context, what is the transmission mechanism of the anti poverty effect of digital inclusive insurance in China? What is the development level of digital inclusive insurance in China? Does the development of digital inclusive insurance in China have spatial characteristics? How can China win the "battle against poverty" in an all-round way and do a good job in preventing poverty return? In depth analysis of the above issues, this paper will sort out the transmission path of the anti return to poverty effect of digital inclusive insurance, and analyze the spatial characteristics of the development of digital inclusive insurance and the spatial

spillover effect of the development of digital inclusive insurance on the inhibition of poverty through spatial econometrics, To provide practical support for poverty prevention.

## 2. Literature review

Inclusive insurance is an important part of Inclusive Finance. It is of great significance to sort out the related research of Inclusive Finance. The concept of Inclusive Finance was first put forward by the United Nations in 2005, mainly to solve the problem of the widening gap between the rich and the poor in various countries. Its initial form is mainly micro credit. Many scholars at home and abroad believe that Inclusive Finance is mainly to improve the availability of financial needs of all social strata and groups by reducing the transaction threshold, eliminate the financial exclusion of rural poor groups, alleviate credit discrimination, improve the uneven allocation of banks and insurance, and alleviate the poverty situation of rural poor groups. Hanning and Jansen (2010) pointed out that the promotion of financial inclusiveness can effectively enhance financial stability, inclusive finance can effectively combat financial exclusion, improve the allocation efficiency of financial resources and enhance the stability of the financial system. Jiao Jinpu (2014) studies the development experience of Inclusive Finance in typical countries, and believes that inclusive finance mainly covers all social groups and is jointly promoted at home and abroad, and the development of Inclusive Finance mainly lies in improving the market mechanism and strengthening policy support, so that the low-income groups can continuously improve the availability of financial services. Kapoor (2015) believes that Inclusive Finance is a kind of equalizer by studying India's economic development and the implementation of financial policies, which enables all social strata to contribute to and benefit from economic growth through inclusive finance.

At present, in the new era of socialism, there are many challenges in the development of Inclusive Finance in China. Xing Yan (2015) believes that there is a huge potential demand for financial services for low-income groups and small and micro enterprises in China, but the inclusive financial services in China at this stage can not form a scale effect. The main reason is that the cost of promoting the development of inclusive financial technology in a large scale is too high, and it is difficult to contact the poor groups and small and micro enterprises with credit constraints. Du Xiaoshan (2006) proposed by studying how to establish and improve the rural financial system that microfinance has a huge potential market in developing countries and should be integrated into the inclusive financial system to broaden the financial boundary of Inclusive Finance and benefit the poor and remote groups who were excluded from financial services in the past. Du Li and pan Xiaojian (2017) made a quantitative analysis on the effect of Inclusive Finance Development and regional economic growth, and concluded that there is an unbalanced development among regions in China's inclusive finance development, and it shows a gradient decreasing trend in the East, the middle and the West.

As an important component of the financial industry, insurance industry is one of the three pillars of the financial industry, and inclusive insurance is one of the sub topics of Inclusive Finance. Many scholars have defined the concept of inclusive insurance. Maleika and Kuriakose (2008) proposed that inclusive insurance is mainly composed of micro insurance, which can effectively supplement the existing social security plan and reduce the negative impact of external shocks on poor groups to a certain extent. When

Yue Yifan (2017) studied the efficacy of inclusive insurance, he believed that inclusive insurance is an insurance service that provides all kinds of insurance services for low-income groups, and with the development of society, its extension continues to extend. Sun Rong and Wu Jian et al. (2019) from the perspective of inclusive concept, combined with Rawls' difference principle, think that inclusive insurance mainly includes Rural Micro insurance and agricultural insurance, and has the characteristics of market-oriented operation, policy attribute and the goal of maximizing the interests of vulnerable groups. Yin ye, Xu Xian and Wang Yingli (2020) defined inclusive insurance as insurance provided for the whole society under the guidance of national policies, based on the requirements of equal opportunities and the principle of commercial sustainability, and the principle of non discrimination. Referring to the definition of inclusive insurance in the existing literature, this paper defines inclusive insurance as: it is mainly composed of social security, micro insurance and agricultural insurance. Under the guidance of the national poverty alleviation policy, it aims to maximize the interests of the poor groups, and continuously provides appropriate and effective insurance services for all social strata and groups at affordable cost.

Under the background of digital development, the organic combination of digital technology and inclusive insurance promotes the development of digital inclusive insurance. Its main purpose is to effectively reduce transaction costs and insurance service threshold, and expand the scope and coverage of inclusive insurance services. Its initial development form is mainly Internet insurance and network mutual assistance. Long Weiyang and Yan Haisi (2002) analyzed the business environment of Chinese funded insurance companies after China's accession to the WTO. They believed that digital intensive is the main feature of the insurance industry. Insurance companies should use information technology to accelerate the informatization of insurance companies, so as to enhance the competitiveness of insurance companies in an all-round way. The economic research team of Allianz Insurance Group (2015) conducted a survey on its customers based on Internet technology. It is believed that digital customer service and interaction will determine the future of the insurance industry, and the customer communication structure of the future insurance service will be mainly digital. Miao Li (2019) believes that the digital transformation of insurance enterprises is driven by the external digital technology environment and the internal digital ability. Insurance enterprises should comprehensively promote the digital strategic transformation to promote the connotative high-quality development of insurance enterprises. Based on this, this paper defines digital inclusive insurance as: through the application of digital information technology in the field of inclusive insurance, it can effectively reduce the transaction cost and insurance service threshold, expand the scope and coverage of inclusive insurance service, and let the rural poor groups equally enjoy the inclusive insurance service.

The related research of spatial spillover effect mainly exists in the spatial econometrics based on financial geography, most of which are based on the financial industry, and mostly use Moran's I index to test the regional spatial correlation, and use Moran's I scatter diagram to show the spatial correlation characteristics. Zhao Yi (2014) used Moran's I scatter plot to test the degree of regional dependence. Lesageand pace (2014) decomposes spatial spillover effect into intra regional spillover effect, inter regional spillover effect and total spillover effect by derivation, which can be realized by applying partial differential method to spatial regression model. Xiang Xiuli and Liu Wanping (2020) studied the spatial dynamic convergence of Inclusive Finance

Development in China, and found that although the development level of Inclusive Finance in various regions of China is gradually increasing, there are large regional differences. Guo Feng et al. (2020) compiled the digital inclusive finance index of Peking University with the help of innovative technologies such as intelligent algorithm and cloud computing. At the same time, they also found that China's digital Inclusive Finance has the characteristics of regional convergence and strong spatial agglomeration and heterogeneity. This paper thinks that spillover effect is a form of externality, and defines spatial spillover effect as: when an activity is carried out in a certain area, it will not only produce the expected effect on the area, but also produce the influence based on the expected effect on the adjacent areas.

Through combing the past research, it is found that there are still some areas worthy of further discussion in the existing research: firstly, most of the relevant researches on inclusive insurance only show that inclusive insurance mainly serves the rural poor in the form of micro insurance and agricultural insurance, and there is no clear definition of inclusive insurance. Secondly, in the research on the anti return to poverty effect of Inclusive Finance, most of the empirical analysis is based on the construction of ordinary panel data regression model, and the spatial factors are not included in the empirical analysis, nor is it discussed from the perspective of inclusive insurance alone. Finally, most of the existing studies focus on the anti return to poverty effect of digital inclusive finance development, but there is no separate analysis of the anti return to poverty effect of inclusive insurance and related influencing factors and transmission mechanism. Based on the above factors, this paper, on the basis of the existing research, starts from the background of digital governance, combs the transmission mechanism of the anti poverty effect of the development of digital inclusive insurance, analyzes the spatial characteristics of the development of digital inclusive insurance by using spatial econometric method, and further studies whether there is spatial spillover effect in the development of digital inclusive insurance, Then through the construction of ordinary panel regression model and spatial panel regression model, this paper makes an empirical analysis on the anti return poverty effect of digital inclusive insurance. Finally, based on the spatial panel model, this paper further clarifies the spatial spillover effect of the anti return poverty effect of digital inclusive insurance.

## 3. Analysis on the transmission mechanism of the anti poverty effect of the development of digital inclusive insurance

Many studies have shown that the lack of disposable income is one of the important reasons for the rural poor to fall into poverty. From the perspective of digital governance, the combination of inclusive insurance and digital information technology is one of the important measures to reduce poverty in rural poor areas. The development of digital inclusive insurance improves the availability of insurance services in rural poor areas, reduces the use cost of insurance services in rural poor areas, and enhances the risk management ability of rural poor groups The effects of medical equalization and labor transfer have a certain role in promoting the growth of disposable income of rural poor groups, and then inhibit the occurrence of poverty in rural poor areas. Moreover, compared with traditional inclusive insurance, digital inclusive insurance expands its service function and coverage, further reduces the use cost and service cost of insurance services in rural poor areas, and improves the availability of insurance services in rural poor areas and remote areas to a greater extent.

## 3.1 The direct mechanism of anti poverty effect of digital inclusive insurance

### *3.1.1 The development of digital inclusive insurance improves the availability of insurance services*

From the perspective of digital governance, the combination of inclusive insurance and digital information technology is one of the important measures to reduce poverty in rural poor areas, but the development of digital inclusive insurance is also the difficulty of the development of digital Inclusive Finance. Based on the "two eight principle" and "long tail theory" expounded by Pareto law, it shows that for insurance institutions, 20% of the head customers can generate 80% of the profits, while the remaining 80% of the customers are faced with the problem of insufficient insurance services. And the rural poor groups are often "long tail customers". Due to the high difficulty in obtaining information, it is easy to cause serious information asymmetry. At the same time, due to the low income and weak financial awareness and risk management awareness, insurance institutions tend to set higher insurance service threshold, which makes it more difficult for rural poor groups to obtain insurance services.

Based on the above problems, in the perspective of digital governance, the combination of digital technology and inclusive insurance makes the development of digital inclusive insurance different from the traditional insurance services. It has the characteristics of mainly facing the poor and vulnerable groups in rural areas and remote areas, providing a wide coverage and highly effective insurance service at affordable cost. Therefore, the development of digital inclusive insurance can effectively improve the availability of insurance services, alleviate the insurance exclusion of rural poor groups to a certain extent, broaden the coverage of rural insurance services, and effectively expand the insurance density and depth of inclusive insurance services. Compared with the traditional insurance companies that need to set up physical service points to improve the insurance accessibility of the rural poor, digital inclusive insurance greatly improves the penetration of insurance services in rural remote areas through digital technology, and greatly reduces the marginal cost and service threshold of insurance companies, It effectively reduces the infrastructure construction and labor costs of insurance companies to provide insurance services for the poor, and then reduces the threshold for the rural poor to obtain insurance services. And according to the consumption demand of the rural poor groups, we can innovate insurance products and insurance services to meet the consumption, medical care, social security and other needs of the rural poor groups, so as to reduce the poverty level of the rural poor areas.

### *3.1.2 The development of digital inclusive insurance reduces the cost of insurance services*

Based on the theory of Financial Exclusion, the price of financial products and geographical constraints will inhibit the financial needs of the poor and vulnerable groups, which means that the vulnerable groups in the society have no ability or channel to obtain the necessary financial products and services. Insurance exclusion is an extension of the concept based on Financial Exclusion, which mainly refers to the difficulties and obstacles faced by the vulnerable groups in the society when they obtain the necessary insurance products and services. Due to the existence of information asymmetry, the low income level of rural poor groups, the unstable agricultural income, the high cost of insurance companies to obtain their information, and the weak financial awareness and risk management awareness of rural poor groups, all these factors inhibit the financial demand and insurance demand of rural poor areas, It hinders the

development of Finance and insurance in rural poverty-stricken areas, which is the main reason for the low efficiency of financial poverty alleviation and insurance poverty alleviation in rural poverty-stricken areas.

From the perspective of digital governance, the combination of inclusive insurance and digital information technology can reduce the cost of insurance services and insurance resources, effectively alleviate the insurance exclusion of rural poor groups, enhance their willingness to use insurance services, improve the risk management awareness of rural poor groups, and then solve the problem of insufficient insurance effective demand of rural poor groups. And compared with the traditional mode, the rural poor need to go to the physical network to get insurance services. Through the application of digital technology, the digital inclusive insurance greatly reduces the transportation cost, time cost and communication cost for the poor to get insurance services. And through the application of Internet technology, effectively slow down the risk of adverse selection caused by information asymmetry. Digital inclusive insurance reduces the use cost of insurance services in rural poor areas from multiple dimensions, improves the willingness of rural poor groups to use insurance services, alleviates the problems of information asymmetry and insurance exclusion, and strengthens the risk management awareness of rural poor groups, so as to improve the disposable income level of rural poor groups, It has restrained the probability of poverty in rural poor areas.

#### *3.1.3 The development of digital inclusive insurance enhances the risk resistance ability of rural poor groups*

Starting from the background of digital development, the combination of inclusive insurance and digital information technology can improve the insurance use frequency of rural poor groups, and gradually enhance the risk resistance ability of rural poor groups by playing the insurance function in rural poor areas. First of all, because most of the poor groups in rural areas live in remote areas, mainly rely on agriculture for a living, their income has the characteristics of instability. Inclusive insurance is mainly composed of micro insurance, social security and agricultural insurance. On the one hand, it can help rural poor groups to enhance their ability to resist risks when they are impacted by external risks or internal risks of their families, reduce their family vulnerability, and reduce the possibility of "poverty caused by diseases and disasters" and "returning to poverty due to diseases and disasters" in rural poor areas. On the other hand, through the effective application of the Internet and information technology, the social security level of the rural poor has been improved. Moreover, the rural poor can complement each other through mutual assistance services such as inclusive insurance and Internet crowdfunding platform to effectively alleviate the risk impact of "poverty caused by disease and disaster" and "returning to poverty due to disease and disaster". In the process of promoting the development of rural economy and rural industry, digital inclusive insurance not only enhances the risk resistance ability of poor people, but also expands the production and operation activities of rural poor groups to a certain extent, expands the income increasing channels of rural poor groups, and plays a positive role in alleviating rural poverty.

### 3.2 The indirect mechanism of anti poverty effect of digital inclusive insurance

#### *3.2.1 The development of digital inclusive insurance has the effect of income growth*

The occurrence of poverty in rural areas can be analyzed from the income and expenditure of rural poor groups. The low income and high expenditure of rural poor groups is the main cause of poverty. Therefore, the increase of disposable income of

rural poor group is one of the main ways to improve their livelihood ability, reduce their poverty level and the probability of poverty return. The improvement of the level of disposable income of the rural poor will be restricted by Financial Exclusion and insurance exclusion. The development of digital Inclusive Finance and digital inclusive insurance can effectively alleviate the phenomenon of Financial Exclusion and insurance exclusion in rural poverty-stricken areas, and greatly increase the coverage of financial services and insurance services in rural areas, especially in rural poverty-stricken areas, which is conducive to improving the savings level of rural poverty-stricken groups and enhancing the risk resistance ability of rural poverty-stricken groups, To improve the degree of capital accumulation of rural poor groups, and then promote the development of agricultural industry, promote the economic development of rural poor areas, so as to improve the level of disposable income of rural poor groups, and inhibit the occurrence of poverty in rural poor areas.

Moreover, the development of digital inclusive insurance can effectively promote the development of agriculture related enterprises, thus increasing employment in rural poor areas and improving the disposable income level of rural poor groups. The development of digital inclusive insurance can effectively reduce the threshold for rural poor groups, rural small and medium-sized enterprises and other agricultural individuals and agricultural economic organizations to obtain insurance services, enhance their ability to resist risks, promote their production level and innovation ability, and thus promote the development of industries in rural poor areas. At the same time, it can effectively expand the income increasing channels of rural poor groups, stabilize the income of rural poor groups, enhance their disposable income, and inhibit the occurrence of poverty in rural poor areas. The transmission mechanism of the income growth effect of the development of digital inclusive insurance is shown in Figure 1.

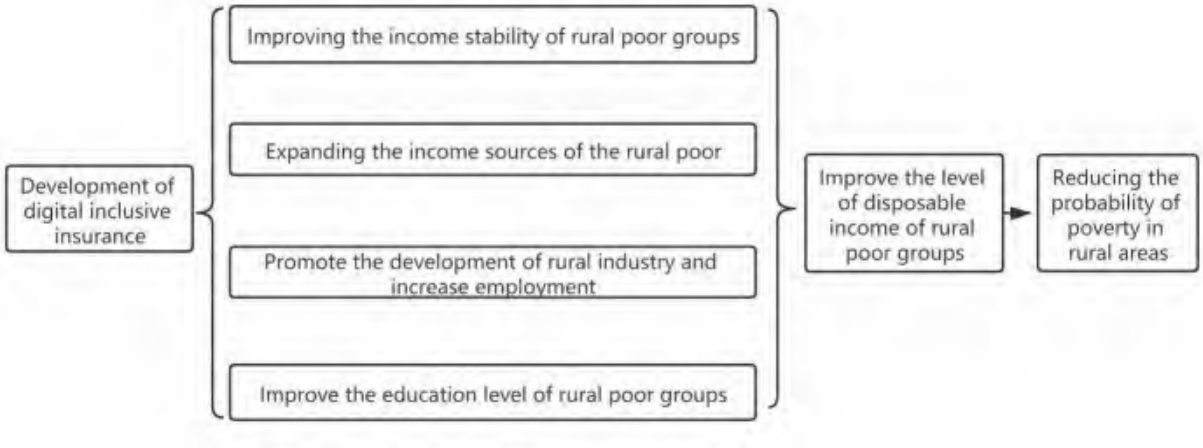


Fig. 1. The transmission mechanism of income growth effect of digital inclusive insurance.

### *3.2.2 The development of digital inclusive insurance has the effect of medical equalization and education equalization*

According to the statistics of China's National Health Commission, more than 42% of the poverty-stricken households in 2017 were caused by the phenomenon of poverty caused by illness and returning to poverty due to illness, and more than 40% of the main rural labor force were sick. It shows that the phenomenon of poverty caused by illness and returning to poverty will not only lead to a substantial increase in the medical expenses of patients, but also make their families fall into deeper poverty. From the perspective of digital governance, the combination of inclusive insurance and digital

insurance plays an important role in restraining the phenomenon of poverty caused by illness and returning to poverty due to illness, but its development still needs to be improved. The low level of medical equalization is caused by the low level of medical services, the lack of medical funds and the imperfect medical facilities in rural poor areas, which leads to the long-term existence of medical poverty in rural poor areas and deepens the poverty level of rural poor groups. Digital inclusive insurance can effectively promote the equalization of rural health care, and then alleviate medical poverty. First of all, digital inclusive insurance can promote the development of rural medical insurance, enhance the coverage of medical insurance through digital means, reduce the burden of poor families, and reduce the vulnerability of rural poor families. Moreover, the development of digital inclusive insurance can promote the equalization of rural health care, improve the health level of farmers, enhance the social capital of rural poor areas, promote the economic development of rural poor areas, increase the family disposable income of rural poor groups, and reduce the probability of poverty in rural poor areas. Finally, the development of digital inclusive insurance can promote the realization of medical equalization in rural poor areas through the following three channels: first, the development of digital inclusive insurance can effectively improve the medical insurance coverage of rural poor groups, so that rural poor groups can equally enjoy medical services; Secondly, the development of digital inclusive insurance can guide the insurance funds to flow to the medical industry, strengthen the investment in medical facilities in rural areas, and promote the development of medical equalization in rural poor areas; Third, digital inclusive insurance can innovate insurance service products, meet the financial needs of rural poor groups due to diseases, and reduce the probability of "poverty caused by diseases" and "returning to poverty due to diseases". The development of digital inclusive insurance can reduce the probability of poverty in rural poor areas by promoting medical equalization in rural poor areas. The conduction mechanism is shown in Figure 2.

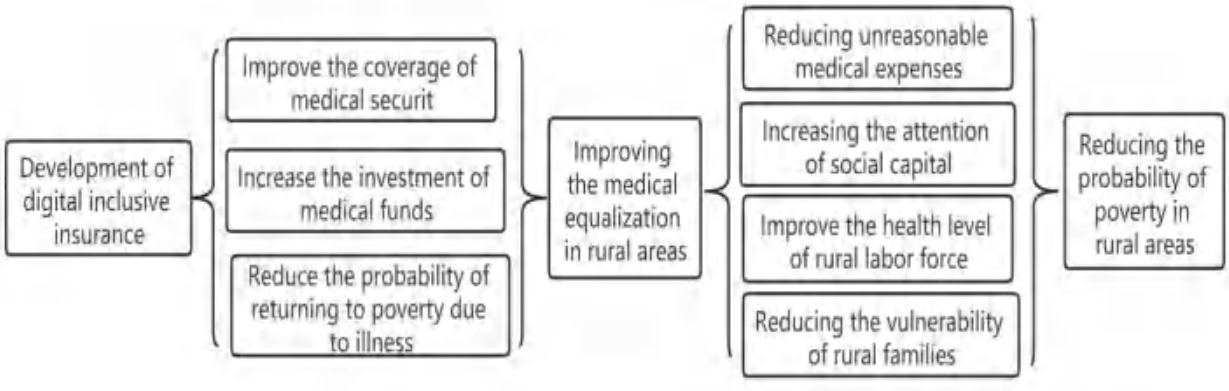


Fig. 2. The medical equalization effect of the development of digital inclusive insurance.

Digital inclusive insurance can improve the education level of rural poor, and then improve the disposable income level of rural poor groups, and reduce the probability of poverty occurrence in rural poverty-stricken areas. Digital inclusive insurance can increase insurance products for rural poor groups, provide education annuity for children of rural poor groups, on the one hand, promote education equalization, reduce the possibility of deepening poverty caused by education expenditure, on the other hand, improve the education level of children of rural poor groups, Thus, the level of human capital of rural poor groups can be improved, and the disposable income level in the

future will be improved, thus the occurrence of "poverty caused by learning" and "returning to poverty due to learning" will be restrained.

*3.2.3 The development of digital inclusive insurance has the effect of labor transfer*

Some rural poor groups are characterized by that their disposable income may be higher than the poverty line level, but because of their excessive expenditure, their income is not enough to meet the needs of poverty. This shows that the rural poor group has a certain survival capacity, and to solve this part of the rural poor group is to strengthen their "hematopoietic ability", so that the rural poor groups can achieve independent poverty alleviation. With the development of social economy and the advancement of new urbanization, the rural surplus labor force gradually transferred to non-agricultural industry, and also showed the characteristics of transferring from rural areas to urban areas. Although the transfer of rural labor force to urban areas can make the income of the rural poor group stable gradually, it also leads to the outflow of rural labor force, which makes the production efficiency of rural poor areas insufficient, and is also one of the key reasons for the poverty in rural poor areas. At present, China has entered the critical period of winning the "fight against poverty" in an all-round way. The marginal efficiency of poverty alleviation policy is declining, but its marginal cost is constantly improving, and the transfer of rural labor force has become one of the effective ways for rural poor groups to get rid of poverty.

The development of digital inclusive insurance can enhance the supply of insurance funds in rural poor areas, thus affecting the level of rural labor transfer. First, digital inclusive insurance can effectively reduce the transfer cost of rural labor. In the process of rural labor transfer, digital inclusive insurance can provide various kinds of insurance insurance, and can innovate more targeted insurance products and provide more risk protection for its labor transfer. Secondly, the digital inclusive insurance can provide more social security for their families and labor force, improve the welfare level of labor force and their families, and help the rural poor get rid of the poverty. Finally, digital inclusive insurance can provide a strong risk guarantee for small and medium-sized enterprises in rural poor areas, help to improve the level of entrepreneurship in rural poverty-stricken areas, promote the entrepreneurship of rural poor groups, thus enhancing the employment level in rural poverty-stricken areas, expanding the income channels of rural poor groups and improving their disposable income, Then, the probability of poverty in rural poor areas will be reduced. The conduction mechanism is shown in Figure 3.

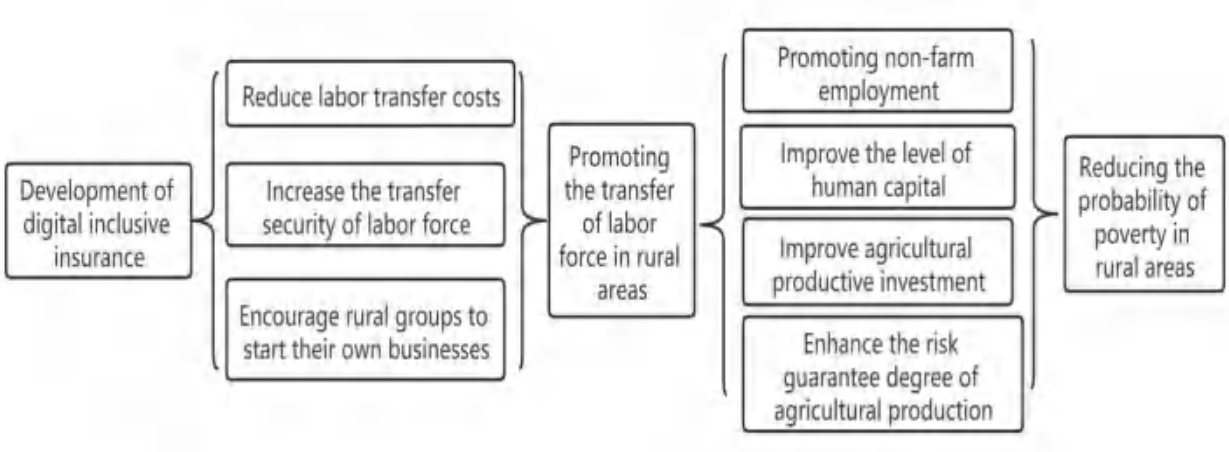


Fig. 3. Labor transfer effect of digital inclusive insurance development

Based on the above analysis, this paper analyzes the transmission mechanism of the Anti-poverty Effect of digital inclusive insurance, mainly from two aspects of direct effect and indirect effect. The direct effects include: Digital inclusive insurance can improve the availability of insurance services in rural poor areas, reduce the use cost of insurance services in rural poor areas, and enhance the risk resistance ability of rural poor groups; The indirect effect is that the development of digital inclusive insurance has the effects of income growth, health care equalization, education equalization and labor transfer. Based on this, this paper summarizes the transmission mechanism of anti poverty effect of digital inclusive insurance, as shown in Figure 4.

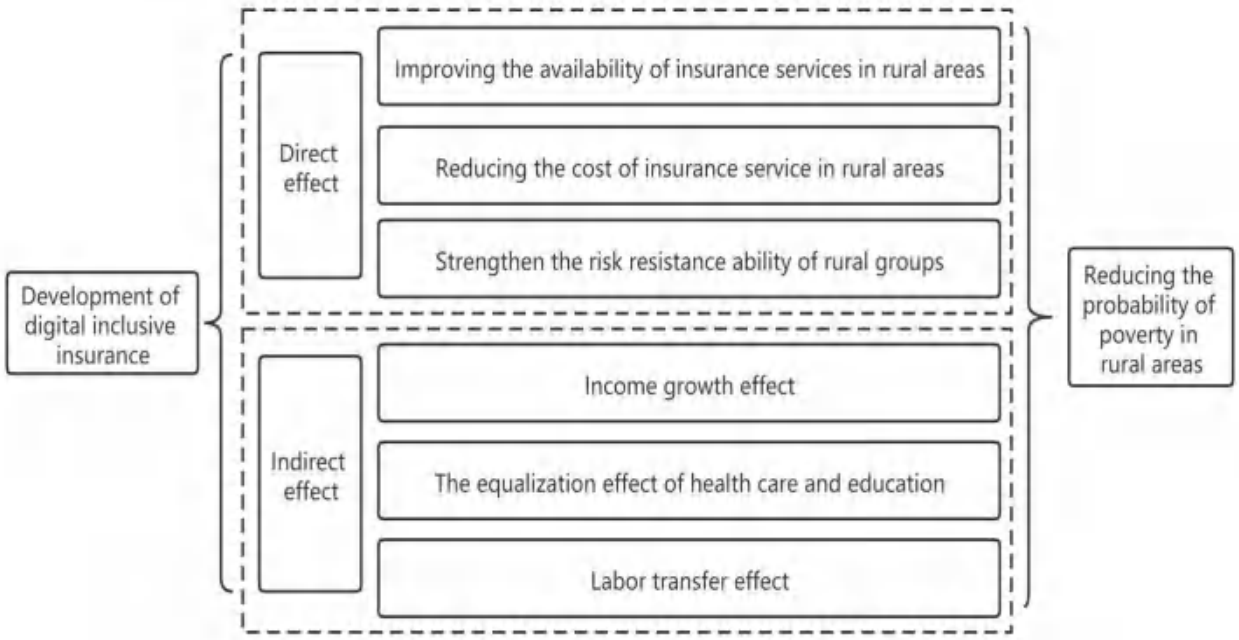


Fig. 4. Transmission mechanism of anti poverty effect of digital inclusive insurance

## 4. Variable selection and model establishment

### 4.1 Variable selection

*4.1.1 Explained variable*

According to the analysis method of most existing literatures, the incidence of poverty in provinces and regions (PI) is chosen as the explanatory variable of this study. If the incidence of poverty in a region decreases year by year, it shows that the more obvious the role of poverty prevention in this area is.

*4.1.2 Explanatory variable*

The insurance index (DII) of Peking University Digital inclusive financial index is selected as the explanatory variable to represent the development degree of digital inclusive insurance. The larger the value is, the higher the development degree of digital inclusive insurance is.

*4.1.3 Control variable*

In order to make the empirical analysis results of the anti poverty effect and spatial spillover of inclusive insurance more accurate from the perspective of digital governance, based on the existing research results, this paper selects nine representative indicators of China's provinces from 2012 to 2018 as control variables. They are: per capita GDP (PGDP), Theil index (TI), Internet penetration rate (IP), urbanization rate (UBL), government participation (gov), degree of opening to the outside world (open),

degree of industrial structure adjustment (is), per capita length of schooling (EDU) and degree of marketization (MR). The Internet penetration rate is measured by the percentage of Internet users in the total population of a region, and the urbanization rate is measured by the percentage of the urban population in a region. The degree of government participation is measured by the proportion of fiscal expenditure in GDP. The degree of opening to the outside world is measured by the degree of opening to the outside world of a region and the proportion of the actual foreign direct investment in the GDP of the region. The degree of industrial structure adjustment is measured by the proportion of the added value of the tertiary industry in the GDP of a region. The construction formula of Theil index and the measurement formula of per capita education years are as follows:

The construction formula of Theil index is as follows:

$$ti_{i,t} = \sum_{j=1}^{2} \left(\frac{Y_{ij,t}}{Y_{i,t}}\right) \times \ln\left(\frac{Y_{ij,t}/Y_{i,t}}{P_{ij,t}/p_{i,t}}\right) \quad (1)$$

Where j = 1 is town, j = 2 is rural; Y is income; P is population, I is province, t is time.

The formula for measuring the average education year is:

$$edu = \frac{PSE\times 6+JHSE\times 9+SHSE\times 12+UE\times 16}{\text{Total number of people over six years old}} \quad (2)$$

Among them, PSE is the number of primary school culture, JHS is the number of junior high school culture, SHSe is the number of senior high school culture, UE is the number of university culture. The higher the value is, the higher the per capita educational years and the higher the level of human capital are.

The degree of marketization (MR) can effectively reflect the reform process of China's socialist market economic system. The more perfect China's market economic system is, the stronger the decisive role of the market in resource allocation, and the higher the efficiency of resource allocation, thus the higher the level of economic development. This paper refers to the marketization index in the report of marketization index of China's provinces (2018) jointly released by National Economic Research Institute and social science literature press in Beijing as a proxy variable to reflect the reform process of China's socialist market economic system. The higher the value, the higher the degree of marketization.

### *4.1.4 Data sources and statistical description*

Considering the difficulty of data acquisition, this paper selects the economic development data of 30 provinces and cities except Tibet Autonomous Region from 2012 to 2018 for empirical analysis. The data comes from the National Bureau of statistics, statistical yearbooks of various provinces and cities, statistical database of China Economic and social development, statistical database of China Economic and social development, National Economic Research Institute and Social Science Literature Publishing House jointly released the report of China's provincial marketization index (2018) in Beijing and the China digital inclusive finance index compiled and released by Peking University. In the process of empirical analysis, the analysis software used are stata14.0 and geoda1.12.

The statistical descriptions of the explained variables, explanatory variables and control variables selected in this paper are shown in Table 1.

Table 1. Statistical description of variables.

| inde | pi | dii | pgdp | ti | ip | ubl | gov | open | is | edu | mr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Incidence of poverty (%) | Digital inclusive insurance development | Per capita GDP (ten thousand yuan) | Theil index | Internet penetration (%) | Urbanization rate (%) | Government participation | Degree of opening to the outside world | Industrial structure adjustment | Years of education per capita | Degree of Marketization |
| Mean | 6.19 | 4.70 | 5.64 | 0.12 | 50.47 | 57.67 | 24.94 | 1.99 | 46.50 | 9.20 | 6.75 |
| Sd | 5.91 | 1.63 | 3.89 | 0.06 | 11.48 | 12.03 | 10.20 | 1.52 | 9.23 | 0.89 | 1.93 |
| Min | 0.00 | 1.04 | 1.15 | 0.01 | 28.13 | 36.41 | 11.81 | 0.01 | 30.94 | 7.51 | 2.53 |
| Mid | 4.90 | 4.81 | 4.70 | 0.12 | 49.81 | 55.27 | 22.83 | 1.78 | 45.18 | 9.12 | 6.58 |
| Max | 28.50 | 8.50 | 48.80 | 0.26 | 78.00 | 89.60 | 62.69 | 7.96 | 80.98 | 12.68 | 10.83 |

## 4.2 Model establishment

### *4.2.1 Construction of space matrix*

The selection of spatial matrix is the basis of empirical analysis of the spatial characteristics of the development of digital inclusive insurance. The spatial matrix structure of this paper is as follows:

①Geographic distance weight matrix

The spatial relationship reflected by the weight matrix of geographical distance is mainly based on the geographical distance of the two regions. Using the geographical distance between two regions as the denominator, the spatial weight matrix of geographical distance can be constructed. The formula is as follows：

$$W1_{ij} = \begin{cases} 1/\,d_{ij}\,, & i \neq j \\ 0\quad, & i = j \end{cases} \tag{3}$$

Among them, $d_{ij}$ represents the distance between the two regions, and the closer the geographical distance between the two regions, the greater the weight.

②Economic distance weight matrix

The spatial relationship reflected by the weight matrix of economic distance is mainly based on the differences of economic development between the two regions. In this paper, the absolute value of the difference of per capita GDP between the two regions is chosen as the denominator to construct the spatial weight matrix of economic distance. The formula is as follows：

$$W2_{ij} = \begin{cases} 1/\left|Y_i - Y_j\right|, & i \neq j \\ 0\quad, & i = j \end{cases} \tag{4}$$

Among them, Y represents the average per capita GDP from 2012 to 2018, i and j are regions. The larger the economic development gap between the two regions, the smaller the weight.

③Geo economic nested spatial weight matrix

The nested spatial weight matrix of geography and economy can not only reflect the relationship of geographical location in space, but also relate it to the differences of regional economic development. This paper uses the differences of geographical location and per capita GDP between provinces to construct the spatial weight matrix of geography and economy. The formula is as follows：

$$W3_{ij} = \begin{cases} \frac{Y_{ij}}{Y}/d_{ij}, & i \neq j \\ 0 \quad , & i = j \end{cases} \tag{5}$$

Among them, Y represents the average per capita GDP of the whole country from 2012 to 2018, $Y_{ij}$ represents the difference between the average per capita GDP of the two regions from 2012 to 2018, $d_{ij}$ represents the distance between the two regions, and I and j are regions.

*4.2.2 Spatial correlation test*

Through the empirical analysis of spatial measurement to measure the spatial characteristics of the development of digital inclusive insurance, this paper mainly uses Moran's I index to test the spatial correlation of the development of digital inclusive insurance in China's provinces. The formula is as follows：

$$\text{Moran's I} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(x_i - x)((x_j - x)}{s^2 \sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}} \tag{6}$$

$$\text{Among them, } s^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - u)^2 \tag{7}$$

$W_{ij}$ represents the constructed spatial weight matrix; $S^2$ is the variance of the observation sample; $X_i$ is the observation value of unit I; U is the mean value of the selected sample. If there is a spatial negative correlation, Moran's I index is between - 1 and 0; If there is a positive spatial correlation, Moran's I index is between 0 and 1; When Moran's I index is equal to 0, there is no spatial correlation.

*4.2.3 Construction of econometric model*

①Common panel model

This paper studies the specific impact of the development of digital inclusive insurance on poverty prevention, and constructs the following panel model for empirical analysis.

$$pi_{i,t} = C + \alpha_1\, dii_{i,t} + \alpha_2\, pgdp_{i,t} + \alpha_3\, ti_{i,t} + \alpha_4\, ip_{i,t} + \alpha_5\, ubl_{i,t} + \alpha_6\, gov_{i,t} + \alpha_7\, open_{i,t} + \alpha_8\, is_{i,t} + \alpha_9\, edu_{i,t} + \alpha_{10}\, mr_{i,t} + \varepsilon_{i,t} \tag{8}$$

Among them, PI is the incidence of poverty, which measures the role of anti return to poverty; DII indicates the development degree of digital inclusive insurance; PGDP is the level of economic development; TI is the income gap between urban and rural areas; IP is the degree of Internet development; UBL indicates the level of urbanization development; GOV indicates the degree of government participation; OPEN indicates the level of opening to the outside world; IS is the degree of industrial structure adjustment; EDU indicates the education level per capita; It refers to other factors not included in the model.

②Spatial panel model

From the perspective of space, based on the weight matrix of geographical distance and economic distance, the spatial panel regression model is constructed to analyze the anti poverty effect of the development of digital inclusive insurance. The spatial dobin model is a more general form generated by the expansion of spatial lag model and spatial error model, The spatial Dobbin model based on geographic distance weight matrix and economic distance weight matrix is as follows:

$$pi_{i,t} = \alpha + \beta(Wpi_{i,t}) + \rho_1\, dii_{i,t} + \rho_2(Wdii_{i,t}) + \delta\, X_{i,t} + v_i + \mu_i + \varepsilon_{i,t} \tag{9}$$

Among them, PI is the incidence of poverty, which measures the role of anti return to poverty; DII indicates the development degree of digital inclusive insurance; X represents other control variables; W is the spatial weight matrix; V is time effect; μ is

the spatial effect; ε is the random error term; The footmark i is the province and t is the time; β、 ρ and δ is the coefficient term.

Based on the dobin model of space panel, the spatial spillover effect of the development of digital inclusive insurance in China is further decomposed by using partial differential method of space panel model. The methods are as follows:

Firstly, the model is transformed into matrix form：

$$pi_{i,t} = (I - \rho W)^{-1} X_{i,t}\beta + (I - \rho W)^{-1}\varepsilon_{i,t} \tag{10}$$

$$\text{Among them, } (I - \lambda W)^{-1} = I + \sum_{i=1}^{n} \lambda^i W^i \tag{11}$$

$$\text{Available:} pi_{i,t} = \sum_{s=1}^{n} \beta_s (I - \lambda W)^{-1} x_s + (I - \lambda W)^{-1}\ \varepsilon_{\ i,t} \tag{12}$$

Where $X_S$ is the s-th explanatory variable in X; In addition, the following are provided:

$$\begin{pmatrix} pi_1 \\ \vdots \\ pi_n \end{pmatrix} = \begin{pmatrix} S_s(W)_{11} & \cdots & S_s(W)_{1n} \\ \vdots & \ddots & \vdots \\ S_s(W)_{n1} & \cdots & S_s(W)_{nn} \end{pmatrix} \begin{pmatrix} x_{1s} \\ \vdots \\ x_{ns} \end{pmatrix} + (I - \lambda W)^{-1}\ \varepsilon_{\ i,t} \tag{13}$$

$S_S\ (W)_{\ ij}$ is the element (I, J) in $S_S$ (W). By partial differentiation, we can get the following results:

$$\frac{\partial pi_i}{\partial x_{js}} = S_s(W)_{ij} \ \ \& \ \ \frac{\partial pi_i}{\partial x_{is}} = S_s(W)_{ii} \tag{14}$$

Among them, PI is the incidence of poverty, which measures the role of anti return to poverty; X represents explanatory variables and other control variables; W is the spatial weight matrix; Is the random error term; The footmark i is the province and t is the time; Is the coefficient term. $S_S\ (W)_{\ ij}$ is the inter regional spillover effect, which indicates the indirect spillover effect of explanatory variable s in region J on adjacent region I; $S_S\ (W)_{ii}$ is intra regional spillover effect, which indicates the direct spillover effect of explanatory variable s in the region; The total effect is the sum of intra regional spillover effect and inter regional spillover effect, which is expressed by $S_S\ (W)_{\ ij}$ + SS $(W)_{\ ii.}$

## 5. Empirical process and result analysis

### 5.1 Estimation of classical panel data model

First of all, without considering the influence of spatial factors, we use the common panel regression method of classical econometric model to empirically analyze the anti poverty effect of digital inclusive insurance in China's provinces. The regression results are shown in Table 2.

Table 2. Panel regression results of classical econometric models.

| | OLS | FE | RE |
|---|---|---|---|
| dii | -0.0090601*** | 0.0018934 | -0.0058281*** |
| | (-5.12) | (1.34) | (-3.63) |
| lnpgdp | -1.434772* | -0.0957845 | -0.8884719 |
| | (-1.66) | (-0.17) | (-1.17) |
| ti | 16.89909** | -58.49776** | -19.49581* |
| | (2.05) | (-2.46) | (-1.88) |
| ip | -7.148219* | -21.81351*** | -15.29035*** |
| | (-1.65) | (-3.18) | (-2.87) |

| | | | |
|---|---|---|---|
| ubl | -9.041726 | -75.57567*** | -17.3275** |
| | (-1.34) | (-6.3) | (-2.18) |
| gov | -0.7530846 | -6.506879 | -4.939521 |
| | (-0.15) | (-0.67) | (-0.85) |
| open | 1.463819 | 3.785593 | -1.244591 |
| | (0.07) | (0.21) | (-0.06) |
| is | 4.421795 | 8.622894 | 7.67573 |
| | (0.89) | (1.16) | (1.3) |
| edu | 10.97615* | -12.789* | 6.275238 |
| | (1.95) | (-1.66) | (0.95) |
| mr | -8.356682*** | -5.833946** | -11.41374*** |
| | (-4.11) | (-2.27) | (-5.31) |
| _cons | 22.11775 | 104.801*** | 43.70561*** |
| | (1.48) | (6.33) | (2.77) |
| $R^2$ | 0.7575 | 0.8137 | 0.7519 |
| F | 62.16 | 74.24 | - |
| Prob>F | 0 | 0 | - |
| Wald | - | - | 488.44 |
| Prob>chi2 | - | - | 0 |

Note: The values in brackets are statistical values of T and Z; "*", "**", "***" The results were significant at the levels of 10%, 5% and 1%, respectively.

The results in Table 2 show that the anti return poverty effect of digital inclusive insurance in China's provinces has a high goodness of fit in the empirical analysis of different classical econometric models. In the mixed regression model and fixed effect panel regression model, F value is statistically significant. In the panel regression model of random effect, Wald value is also statistically significant, which shows that the empirical analysis of the anti poverty effect of digital inclusive insurance in China has a good fitting effect under the classical econometric model.

In the panel regression model of mixed regression and random effect, the coefficient of digital inclusive insurance is negative and statistically significant. It shows that the development of digital inclusive insurance has a restraining effect on the occurrence of poverty, and the development of digital inclusive insurance has a certain role in preventing poverty. In the control variables, the increase of per capita GDP can inhibit the occurrence of poverty, but it is only significant in the mixed regression model; The narrowing of urban-rural income gap, the improvement of Internet penetration, the improvement of urbanization rate and the improvement of market-oriented allocation all have inhibitory effects on the occurrence of poverty, which are statistically significant, indicating that economic development, the narrowing of urban-rural income gap, the promotion of urbanization, the development of urbanization, the development of rural economy, the development of rural economy, the development of rural economy, the development of rural economy, the development of rural economy, the development of rural economy, the development of rural economy The popularization of digital technology and the deepening of the reform of the socialist market economy system have played a role in reducing poverty to a certain extent.

## 5.2 Spatial correlation analysis

The spatial weight matrix of geographical distance is constructed by using the difference of geographical location of each province, the spatial weight matrix of economic distance is constructed by using the economic difference of each province, and the nested matrix of geographical economy is constructed by combining the spatial difference and economic development difference of each province. Based on the three different spatial weight matrices, Moran's I index is used to test the global spatial correlation and local spatial correlation of the development of digital inclusive insurance in China.

Table 3. The global Moran index of China's provincial digital inclusive insurance development under different spatial weight matrices.

| | Moran index of the development of digital inclusive insurance in China | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Geographic distance weight matrix | | | Economic distance spatial weight matrix | | | Geo economic nested weight matrix | | |
| year | Moran's I | z | p-value | Moran's I | z | p-value | Moran's I | z | p-value |
| 2018 | 0.195 | 6.37 | 0 | 0.327 | 3.824 | 0 | 0.32 | 2.268 | 0.012 |
| 2017 | 0.184 | 6.109 | 0 | 0.318 | 3.76 | 0 | 0.308 | 2.213 | 0.013 |
| 2016 | 0.15 | 5.111 | 0 | 0.202 | 2.502 | 0.006 | 0.15 | 1.182 | 0.119 |
| 2015 | 0.103 | 3.881 | 0 | 0.215 | 2.702 | 0.003 | 0.235 | 1.765 | 0.039 |
| 2014 | 0.125 | 4.535 | 0 | 0.347 | 4.141 | 0 | 0.419 | 2.975 | 0.001 |
| 2013 | 0.144 | 5.109 | 0 | 0.317 | 3.843 | 0 | 0.303 | 2.83 | 0.002 |
| 2012 | 0.111 | 4.322 | 0 | 0.243 | 3.167 | 0.001 | 0.222 | 1.769 | 0.038 |

The results in Table 3 show that in the selected sample period, Moran's I of the development of digital inclusive insurance in China's provinces is greater than 0 based on the spatial weight matrix of geographical distance, economic distance and nested weight matrix of geographical economy, which indicates that the development of digital inclusive insurance is spatially dependent and positively correlated. Therefore, in the process of analyzing the role of digital inclusive insurance in preventing poverty, it is very important to add spatial factors.

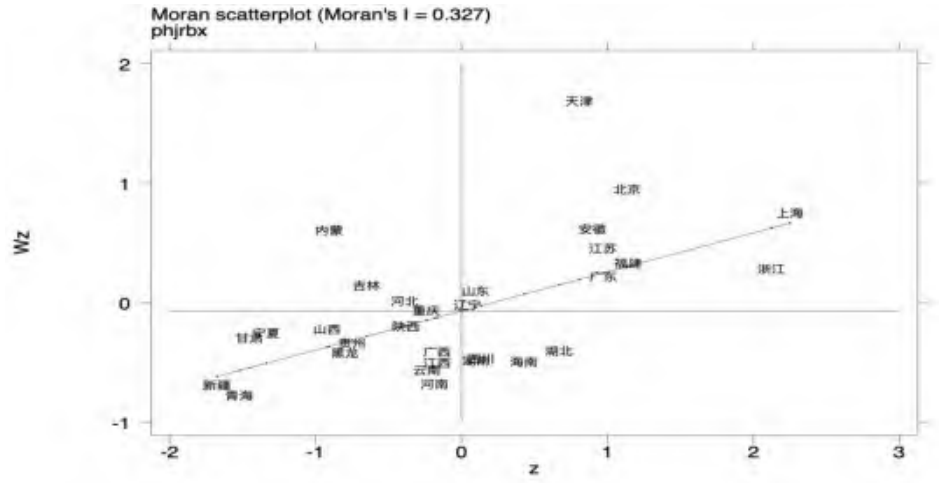


Fig. 6. Moran scatter map of digital inclusive insurance development under the weight matrix of geographic distance in 2018

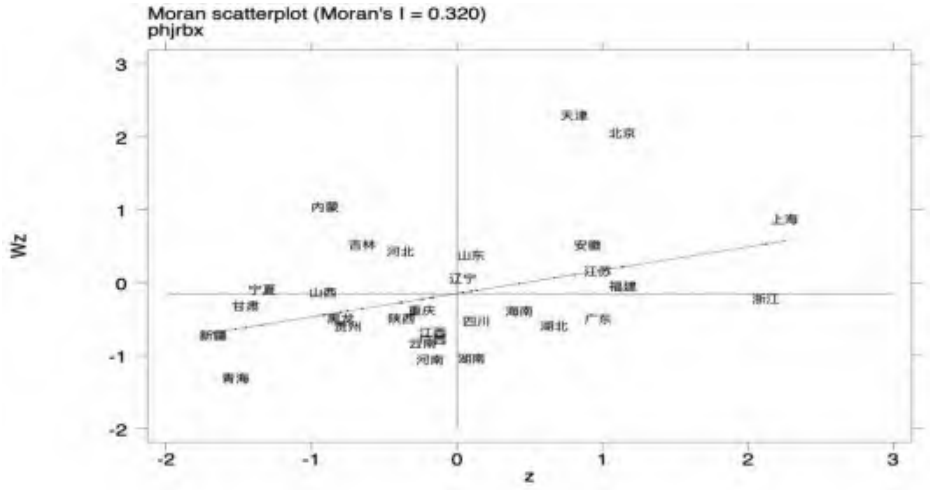


Fig. 7. Moran scatter chart of the development of digital inclusive insurance under the economic distance weight matrix in 2018

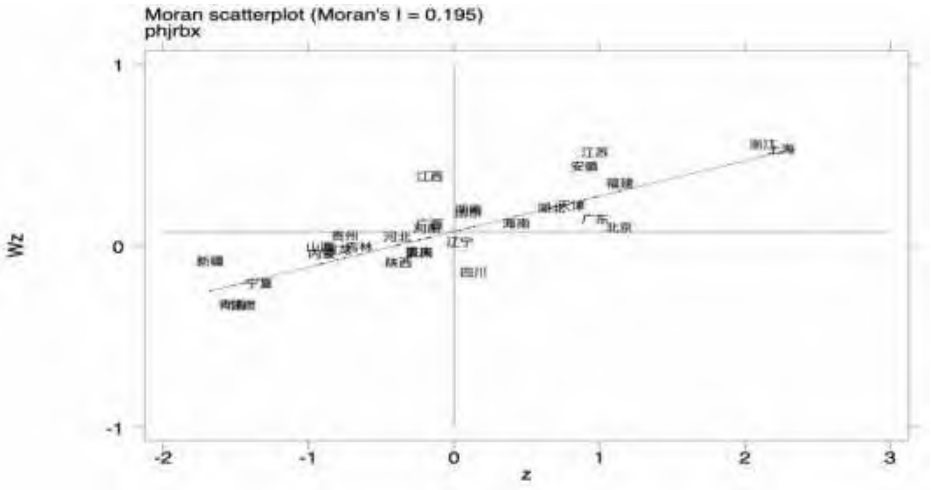


Fig.8. Moran scatter map of digital inclusive insurance development under nested weight matrix of geographic economy in 2018

In order to more intuitively see the spatial dependence of the development of digital inclusive insurance in China's provinces, based on three different spatial weight matrices, Moran's I scatter diagram of the development of digital inclusive insurance in 2018 is drawn. Figure 5, Figure 6 and Figure 7 show that the development of digital inclusive insurance in most provinces of China is spatially dependent, and is in one or three quadrants of Moran scatter diagram, that is, the development of digital inclusive insurance in most provinces has the spatial effects of "high agglomeration" and "low agglomeration". To further explore, this paper analyzes the local Moran index of China's provinces in 2018, as shown in Table 4.

Table 4. Local Moran index of China's Provincial Digital inclusive insurance development in 2018.

| | Geographic distance weight matrix | | | Economic distance spatial weight matrix | | | Geo economic nested weight matrix | | |
|---|---|---|---|---|---|---|---|---|---|
| area | Moran's I | z | p-value | Moran's I | z | p-value | Moran's I | z | p-value |
| BJ | 0.096 | 0.551 | 0.582 | 1.078 | 2.887 | 0.004 | 2.347 | 2.883 | 0.004 |
| TJ | 0.167 | 0.858 | 0.391 | 1.381 | 2.259 | 0.024 | 1.868 | 1.979 | 0.048 |
| HB | -0.012 | 0.144 | 0.886 | 0.008 | 0.068 | 0.945 | -0.151 | -0.124 | 0.902 |
| SX | 0.026 | 0.417 | 0.677 | 0.244 | 0.657 | 0.511 | 0.176 | 0.271 | 0.787 |
| NMG | 0.06 | 0.783 | 0.433 | -0.537 | -1.451 | 0.147 | -0.925 | -1.155 | 0.248 |
| LN | 0 | 0.241 | 0.809 | -0.002 | 0.258 | 0.797 | 0 | 0.14 | 0.888 |
| JL | 0.02 | 0.274 | 0.784 | -0.076 | -0.098 | 0.922 | -0.314 | -0.361 | 0.718 |
| HLJ | 0.032 | 0.338 | 0.735 | 0.376 | 1.491 | 0.136 | 0.45 | 1.17 | 0.242 |
| SH | 1.19 | 6.707 | 0 | 1.667 | 2.67 | 0.008 | 1.898 | 2.092 | 0.036 |
| JS | 0.495 | 2.941 | 0.003 | 0.42 | 2.427 | 0.015 | 0.103 | 0.406 | 0.685 |
| ZJ | 1.181 | 6.757 | 0 | 0.552 | 3.245 | 0.001 | -0.59 | -2.321 | 0.02 |
| AH | 0.388 | 2.455 | 0.014 | 0.543 | 3.177 | 0.001 | 0.425 | 1.318 | 0.187 |
| FJ | 0.383 | 3.848 | 0 | 0.349 | 0.989 | 0.323 | -0.124 | -0.147 | 0.883 |
| JX | -0.062 | -0.212 | 0.832 | 0.092 | 0.309 | 0.757 | 0.126 | 0.238 | 0.812 |
| SD | 0.016 | 0.416 | 0.678 | 0.007 | 0.241 | 0.809 | 0.033 | 0.173 | 0.863 |
| HN | -0.014 | 0.21 | 0.834 | 0.136 | 0.605 | 0.545 | 0.209 | 0.439 | 0.66 |
| HB | 0.129 | 1.333 | 0.183 | -0.301 | -0.63 | 0.529 | -0.445 | -0.443 | 0.658 |
| HN | 0.019 | 0.457 | 0.648 | -0.054 | -0.094 | 0.925 | -0.114 | -0.184 | 0.854 |
| GD | 0.127 | 1.499 | 0.134 | 0.185 | 0.554 | 0.579 | -0.552 | -0.67 | 0.503 |
| GX | -0.017 | 0.134 | 0.893 | 0.076 | 0.634 | 0.526 | 0.144 | 0.491 | 0.623 |
| HN | 0.045 | 0.577 | 0.564 | -0.235 | -0.317 | 0.751 | -0.196 | -0.175 | 0.861 |
| CQ | 0.014 | 0.388 | 0.698 | 0.025 | 0.22 | 0.826 | 0.107 | 0.197 | 0.844 |
| SC | -0.023 | 0.086 | 0.931 | -0.071 | -0.127 | 0.899 | -0.082 | -0.097 | 0.923 |
| GZ | -0.025 | 0.08 | 0.936 | 0.287 | 0.868 | 0.385 | 0.505 | 1.222 | 0.222 |
| YN | 0.015 | 0.434 | 0.665 | 0.146 | 0.476 | 0.634 | 0.216 | 0.621 | 0.535 |
| SX | 0.046 | 0.91 | 0.363 | 0.09 | 0.524 | 0.6 | 0.213 | 0.318 | 0.751 |
| GS | 0.524 | 3.309 | 0.001 | 0.493 | 2.519 | 0.012 | 0.562 | 1.292 | 0.196 |
| QH | 0.547 | 3.238 | 0.001 | 1.278 | 3.178 | 0.001 | 2.143 | 2.827 | 0.005 |
| NX | 0.315 | 3.086 | 0.002 | 0.398 | 2.386 | 0.017 | 0.206 | 0.575 | 0.565 |
| XJ | 0.182 | 3.383 | 0.001 | 1.252 | 3.142 | 0.002 | 1.346 | 2.599 | 0.009 |

The results in Table 4 show that the development of digital inclusive insurance in most provinces of eastern China presents a spatial effect of "high high agglomeration", which is statistically significant, such as Shanghai, Zhejiang and other provinces. Although there is a spatial dependence on the development of digital inclusive insurance in most provinces in Central China, it is not obvious, such as Inner Mongolia, Jilin and Jiangxi. The development of digital inclusive insurance in most provinces of Western China presents the spatial effect of "low low agglomeration", such as Sichuan, Guizhou and other provinces. It can be seen that although there is spatial dependence in

the development of digital inclusive insurance in China, it also shows a certain level of spatial heterogeneity. Therefore, we should not ignore the spatial factors in the empirical process of analyzing the anti poverty effect of Provincial Digital inclusive insurance development.

## 5.3 Spatial panel data model estimation

Under three different spatial weight matrices, the correlation spatial econometric test is carried out firstly. Through LM Test, LR test, Hausman test and joint significant effect test, it is concluded that it is most appropriate to build a spatial panel Durbin model with individual fixed effect to empirically analyze the anti return poverty effect of digital inclusive insurance in China's provinces, and the results are shown in Table 5.

Table 5. Estimation results under different spatial weight matrices.

| variable | Geographic distance weight matrix | Economic distance spatial weight matrix | Geo economic nested weight matrix |
|---|---|---|---|
| dii | 0.0152629*** | 0.0143468*** | 0.0115853*** |
| | （4.64） | （4.12） | （3.82） |
| lnpgdp | -0.6692464 | 0.5432882 | 0.1108594 |
| | （-1.5） | （1.02） | （0.21） |
| ti | -44.83904** | -39.0623* | -45.55881** |
| | （-2.47） | （-1.75） | （-2.24） |
| ip | -20.09597*** | -18.39534*** | -16.76411*** |
| | （-3.55） | （-2.87） | （-2.65） |
| ubl | -65.12386*** | -83.28693*** | -76.05047*** |
| | （-6.16） | （-5.91） | （-5.92） |
| gov | -8.248258 | -26.54275*** | -12.78203 |
| | （-1.06） | （-2.78） | （-1.43） |
| open | 13.64844 | 5.309202 | 3.985681 |
| | （0.9） | （0.33） | （0.26） |
| is | 18.69274*** | 24.79108*** | 14.11284*** |
| | （3.37） | （3.82） | （2.32） |
| edu | 2.501875 | -0.5715792 | -1.27508 |
| | （0.42） | （-0.08） | （-0.2） |
| mr | -2.106841 | -6.093432*** | -4.998452** |
| | （-1.07） | （-2.69） | （-2.3） |
| W-dii | -0.0182378*** | -0.0220001*** | -0.0130006*** |
| | （-4.11） | （-5.89） | （-4.42） |
| W-lnpgdp | 1.075987 | 0.5919427 | -0.260687 |
| | （0.37） | （0.66） | （-0.44） |
| W-ti | -324.2919*** | -52.9748 | -8.81327 |
| | （-3.48） | （-0.98） | （-0.22） |
| W-ip | 57.48785*** | 57.771*** | 13.4963** |
| | （2.97） | （4.6） | （2.09） |
| W-ubl | 33.41032 | -97.78871*** | -42.21339*** |
| | （0.61） | （-3.75） | （-2.77） |
| W-gov | -89.58162* | -85.53683*** | -19.03253 |
| | （-1.82） | （-3.42） | （-1.03） |

| | | | |
|---|---|---|---|
| W-open | 258.1875*** | -56.83686 | 32.79218 |
| | （2.92） | （-0.89） | （0.79） |
| W-is | 83.3941** | 3.410324 | -14.17766 |
| | （2.08） | （0.23） | （-1.38） |
| W-edu | -42.59924 | 32.32223** | 10.37248 |
| | （-1.59） | （2.08） | （1） |
| W-mr | -26.79285*** | -7.648792 | -2.9325 |
| | （-2.9） | （-1.46） | （-0.91） |
| R2 | 0.8596 | 0.8538 | 0.8498 |
| AIC | 722.192 | 764.5984 | 757.8749 |
| BIC | 795.8283 | 838.2347 | 831.5113 |
| Log-likelihood | -339.096 | -360.2992 | -356.9375 |

Note: The values in brackets are statistical values of Z; "*", "**", "***" The results were significant at the levels of 10%, 5% and 1%, respectively.

Table 5 shows that, from the overall perspective, the fitting degree is relatively good under three different spatial weight matrices, indicating that the model has certain robustness. According to the information criterion of red pool, the fitting effect of Dubin model of spatial panel based on geographic distance spatial weight matrix can be seen from AIC value, BIC value and log likelihood value.

From the perspective of variables, the coefficient of the explanatory variable digital inclusive insurance is greater than zero, and all pass the significance level test with the significance level of 1%, which shows that the development of digital inclusive insurance has no inhibition effect on the occurrence of poverty. However, the lag coefficient of digital inclusive insurance is less than zero, and it has passed the 1% significance level test. Moreover, the coefficient value is slightly larger, indicating that the effect of digital inclusive insurance is lagging behind. The reason may be that inclusive insurance is the means of risk management, In the early stage, the disposable income of poor residents may be reduced because of the payment of premium, but the risk guarantee provided in the later period can effectively reduce the occurrence of poverty.

In the control variables, under three different spatial weight matrices, the increase of urban-rural income gap, the improvement of Internet penetration and the continuous advancement of urbanization all have inhibitory effect on the occurrence of poverty, and all pass the 1% significance level test. However, the adjustment of industrial structure has no inhibitory effect on the occurrence of poverty, and its coefficient is statistically significant and positive. However, the inhibition effect of government participation on poverty is only significant in the economic distance spatial weight matrix, while the inhibition effect of marketization on poverty is not significant in the geographical distance spatial weight matrix, but significant in the economic distance spatial weight matrix and the geographical economy nested weight matrix.

### 5.4 Decomposition of spatial spillover effect

In order to further explore the role of digital inclusive insurance in preventing poverty and its spatial characteristics. Based on the individual fixed effect spatial panel Durbin model under three different spatial weight matrices, the partial differential method of spatial panel model is used to further clarify it. The results are shown in Table 6.

Table 6. Decomposition of direct spillover effect of anti poverty effect of digital inclusive insurance under different weight matrices.

| variable | Geographic distance weight matrix | Economic distance spatial weight matrix | Geo economic nested weight matrix |
|---|---|---|---|
| dii | 0.0146758*** | 0.0156159*** | 0.0139558*** |
| | （3.4） | （4.1） | （3.86） |
| lnpgdp | -1.220891 | 0.4994542 | 0.1206845 |
| | （-0.08） | （0.95） | （0.22） |
| ti | -184.5988 | -34.72572 | -43.94208** |
| | （-0.09） | （-1.61） | （-2.08） |
| ip | -10.05019 | -21.15284*** | -19.38702*** |
| | （-0.11） | （-3.33） | （-2.96） |
| ubl | -70.44685 | -80.83104*** | -74.57303*** |
| | （-0.94） | （-5.83） | （-5.4） |
| gov | -37.83843 | -23.19275*** | -10.8154 |
| | （-0.1） | （-2.56） | （-1.2） |
| open | 110.3686 | 7.654892 | -0.371975 |
| | （0.08） | （0.48） | （-0.02） |
| is | 62.9687 | 24.63062*** | 16.32278** |
| | （0.09） | （3.76） | （2.53） |
| edu | -13.49809 | -1.416142 | -2.101494 |
| | （-0.05） | （-0.21） | （-0.31） |

Note: The values in brackets are statistical values of Z; "*", "**", "***" The results were significant at the levels of 10%, 5% and 1%, respectively.

The results in Table 6 show that: under three different weight matrices, digital inclusive insurance has direct spillover effect on the occurrence of poverty, and all pass the significance level test with significance level of 1%, but its coefficient is positive. It shows that the development of digital inclusive insurance in a region can not inhibit the occurrence of poverty. The reason may be that the early premium payment will reduce the disposable income of poor families in a short period of time, and the digital inclusive insurance is still in the early stage of development, which may not form a good scale effect.

In the control variables, the increase of Theil index has a direct spillover effect on the suppression of poverty, and it is significant under the geographic economy nested matrix, which indicates that the increase of Theil index in a region will inhibit the occurrence of poverty. The reason may be that with the development of China's economic level, the disposable income of residents continues to increase, which makes the incidence of poverty continue to decrease. However, the disposable income of urban residents has increased more than that of rural residents, which leads to the formation of this phenomenon. The improvement of Internet penetration rate, urbanization rate and marketization degree have direct spillover effects on the inhibition of poverty, and they are significant under the economic distance weight matrix and geographical economy nested matrix. However, the improvement of government participation has a significant direct spillover effect on poverty only under the economic distance spatial weight matrix.

Table 7. Decomposition of indirect spillover effect of anti poverty effect of digital inclusive insurance under different weight matrices.

| variable | Geographic distance weight matrix | Economic distance spatial weight matrix | Geo economic nested weight matrix |
|---|---|---|---|
| dii | -0.0244391 | -0.0217339*** | -0.0150231*** |
| | （-0.3） | （-5.89） | （-4.49） |
| lnpgdp | -15.01893 | 0.4468673 | -0.2193106 |
| | （-0.03） | （0.56） | （-0.38） |
| ti | -4295.617 | -37.00538 | 3.862337 |
| | （-0.07） | （-0.87） | （0.11） |
| ip | 315.9805 | 52.8428*** | 17.08731*** |
| | （0.12） | （4.66） | （2.87） |
| ubl | -150.8107 | -63.71438*** | -14.03371 |
| | （-0.07） | （-2.76） | （-0.95） |
| gov | -913.0755 | -65.82859*** | -12.86384 |
| | （-0.08） | （-2.92） | （-0.8） |
| open | 2952.861 | -45.65 | 28.86465 |
| | （0.07） | （-0.86） | （0.79） |
| is | 1342.101 | -2.780027 | -16.70516* |
| | （0.06） | （-0.22） | （-1.83） |
| edu | -500.071 | 27.32913** | 9.38897 |
| | （-0.06） | （1.98） | （0.98） |
| mr | -297.9991 | -4.786497 | -0.934708 |
| | （-0.08） | （-1.07） | （-0.3） |

Note: The values in brackets are statistical values of Z; "*", "**", "***" The results were significant at the levels of 10%, 5% and 1%, respectively.

The results in Table 7 show that: under the spatial weight matrix of economic distance and the nested matrix of geographical economy, digital inclusive insurance has an inhibitory effect on the occurrence of poverty, and there is an indirect spillover effect in space, which indicates that the development of digital inclusive insurance in a region has an inhibitory effect on the occurrence of poverty in adjacent regions. However, the improvement of urbanization rate and government participation has a significant indirect spillover effect on poverty only under the economic distance spatial weight matrix. The restraining effect of the adjustment of industrial structure on the occurrence of poverty only has significant indirect spillover effect under the nested matrix of geographical economy.

Table 8. Decomposition of total spillover effect of anti poverty effect of digital inclusive insurance under different weight matrices.

| variable | Geographic distance weight matrix | Economic distance spatial weight matrix | Geo economic nested weight matrix |
|---|---|---|---|
| dii | -0.0097633 | -0.0061181*** | -0.0010673 |
| | （-0.12） | （-3.45） | （-0.88） |
| lnpgdp | -16.23982 | 0.9463216 | -0.0986261 |

| | | | |
|---|---|---|---|
| | （-0.03） | （1.12） | （-0.18） |
| ti | -4480.216 | -71.7311 | -40.07974 |
| | （-0.07） | （-1.59） | （-1.23） |
| ip | 305.9303 | 31.68997*** | -2.299707 |
| | （0.11） | （2.78） | （-0.36） |
| ubl | -221.2575 | -144.5454*** | -88.60674*** |
| | （-0.1） | （-6.84） | （-7.8） |
| gov | -950.9139 | -89.02134*** | -23.67923 |
| | （-0.08） | （-3.57） | （-1.45） |
| open | 3063.229 | -37.99511 | 28.49268 |
| | （0.07） | （-0.68） | （0.81） |
| is | 1405.07 | 21.8506 | -0.3823819 |
| | （0.06） | （1.61） | （-0.04） |
| edu | -513.569 | 25.91298* | 7.287476 |
| | （-0.06） | （1.88） | （0.84） |
| mr | -309.874 | -10.62033** | -5.788369** |
| | （-0.08） | （-2.55） | （-2.18） |

The results of table 8 show that: under the economic distance weight matrix, the development of digital inclusive insurance in China has an inhibitory effect on the occurrence of poverty, and there is a total spillover effect, which is significant at the 1% significance level. Moreover, the improvement of urbanization rate and marketization degree can inhibit the occurrence of poverty, and there is a total spillover effect, which is significant under the economic distance weight matrix and geographical economy nested weight matrix. Under the spatial weight matrix of economic distance, the increase of government participation has an inhibitory effect on the occurrence of poverty, and there is a total spillover effect, which is significant at the 1% significance level.

## 6. Conclusion

At present, there are few researches on the anti poverty effect of inclusive insurance and inclusive insurance, and few scholars analyze the anti poverty effect of inclusive insurance from the perspective of digital governance. This paper takes digital inclusive insurance as the starting point, uses the economic data of various provinces as samples to sort out the anti poverty function of digital inclusive insurance, and establishes an empirical model of the development of digital inclusive insurance. This paper explores the spatial relationship of the development of digital inclusive insurance in China, and further clarifies it by using the spatial measurement method. This will help policy makers better understand the role and status of HP insurance digital development in the work of poverty prevention, and improve the targeted and accurate policy. It also points out the direction for the development of inclusive insurance under the background of the modernization of the current governance system and governance capacity in China, and it is of great significance to how to help the insurance industry improve the work of anti poverty. Through theoretical analysis and empirical test, the results are as follows: First, under the background of digital development, digital inclusive insurance can inhibit the occurrence of poverty and anti return to poverty through direct and indirect effects. Second, the development of digital inclusive insurance has significant spatial

dependence, but also spatial heterogeneity. The main performance is that the development of digital inclusive insurance in most provinces of eastern China presents the spatial effect of "high high agglomeration", while the development of digital inclusive insurance in most provinces of central China has spatial dependence, but it is not obvious. The development of digital inclusive insurance in most provinces of the western region presents the spatial effect of "low low agglomeration". Thirdly, by constructing a spatial panel Durbin model with individual fixed effect, this paper makes an empirical analysis on the anti return poverty effect of digital inclusive insurance in China. It is found that, on the whole, the anti return poverty effect of digital inclusive insurance in China's provinces lags behind. The reason may be that as a means of risk management, universal insurance is the most effective way to prevent the return of poverty, In the early stage, it may reduce the disposable income of poor residents by paying premiums, but the risk guarantee provided in the later stage can reduce the occurrence of poverty to a certain extent. Fourth, from the perspective of space, the paper further decomposes the anti return poverty effect of Provincial Digital inclusive insurance in China. It is clear that there are indirect spillover effect and total spillover effect in the restraining effect of Provincial Digital inclusive insurance on poverty. Based on the above theoretical analysis and empirical analysis results, this paper gives the following three suggestions：

## 6.1 Enhance digital governance capacity and strengthen the development level of digital inclusive insurance in rural areas

In recent years, China's digital technology has been rapid development, has made many remarkable achievements. But in rural areas and remote areas, the popularity of digital technology is not high, and the awareness of Finance and risk management needs to be improved. Today, we are promoting the modernization of national governance capacity and governance system. From the perspective of digital governance, the effective combination of inclusive insurance and digital information technology can expand the coverage of inclusive insurance services, enable more rural poor groups to enjoy the convenience of insurance services, help rural poor groups reduce the pressure of medical expenses, reduce the probability of poverty caused by disease and disaster in rural areas, and alleviate the economic burden of rural families, And to a certain extent, improve the level of investment income of residents, help the rural poor effectively improve the level of disposable income and get rid of poverty. Therefore, we should give full play to the resource advantages of China's insurance institutions, strengthen the innovation ability of insurance institutions, deepen the integration of insurance industry and digital technology, make full use of the advantages of cloud computing, big data and other new technologies, and provide different insurance products and insurance services for different groups. And efforts should be made to strengthen the financial awareness and risk management awareness of the poor groups, so as to effectively alleviate financial exclusion and insurance exclusion. Make good use of the spatial spillover effect of the development of digital inclusive insurance, gradually improve the insurance service environment in various regions, enhance the availability of insurance services and insurance products, so that the rural poor can effectively obtain risk protection, and make due contributions to the insurance industry to help improve the anti-poverty work.

## 6.2 Strengthen the construction of new urbanization and promote the implementation of regional coordinated development strategy

Strengthening the construction of new urbanization and accelerating the implementation of regional development strategy is the focus of China's current social and economic development. From the perspective of digital governance, we should strengthen the construction of new urbanization. Give full play to the social security function of insurance, promote the agglomeration effect of insurance resources in space, and effectively reflect the role of digital inclusive insurance in preventing poverty. Make full use of the spatial spillover effect of urbanization on poverty alleviation, achieve a good situation of coordinated development of regional economy in all provinces and cities, effectively promote the development of poverty alleviation, and help improve the implementation of anti-poverty work. Moreover, adhering to the Rural Revitalization Strategy of giving priority to the development of agriculture and rural areas can effectively improve the income level of rural areas, guide more public resources to focus on the rural poor areas, improve the financial service facilities and public infrastructure in rural areas and remote areas, and enhance the ability of insurance service access in rural areas, So that the anti poverty role of digital inclusive insurance can be better played.

### 6.3 Deepen the reform of the socialist market economic system and promote the virtuous cycle of the development of digital inclusive insurance and economic growth

Deepening the reform of the socialist market economic system is not only a strong support for China's rapid economic growth, but also the key to China's social and economic development. In this process, it is particularly important to deal with the relationship between the government and the market for the current economic development of our country, and to fully play the decisive role of the market in the allocation of resources, and better play the role of the government in the socialist market economic system reform. The stable development of economy will ensure the development of digital inclusive insurance, and the development of digital inclusive insurance also injects new vitality into economic development. Deepening the reform of socialist market economy system can improve the allocation efficiency of social resources. Therefore, we should make full use of the spatial spillover effect of market-oriented allocation to enhance the inhibition of poverty, constantly deepen the reform of the socialist market economic system, and promote the virtuous cycle of the development of digital inclusive insurance and economic growth in China.

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# Study on the Role of Commercial Insurance in Municipal Solid Waste Treatment

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**Keywords:** Domestic waste, Classified treatment, Industrial chain, Commercial insurance company, Benefit analysis.

**Abstract.** From the needs of China's economic development and environmental protection, combined with several basic treatment modes of municipal solid waste in China, this paper puts forward the possible role of commercial insurance companies in municipal solid waste treatment. Through the discovery of possible problems in the links of waste collection and classification, transportation and processing, terminal utilization and so on, including insufficient attention to the role of grass-roots classifiers in waste classification and recycling; The waste treatment method is too single (i.e. incineration and landfill), and there is a lack of advanced technology and a sufficient number of technical and management professionals; People's awareness of waste classification is weak and the degree of waste classification is low; The degree of marketization and industrialization of waste treatment industry is low; Failed to carry out optimal economic model combination for multiple links of waste treatment. This paper analyzes the two main contents of domestic waste treatment, namely, the classification and recovery of domestic waste and the processing and treatment of domestic waste. Two values are discussed, namely, the social value and economic value of processing. Combined with the functional characteristics of commercial and insurance companies, from the perspective of improving residents' quality of life and perfecting the social security system, this paper studies its possible role in urban domestic waste treatment, that is, risk transfer and improving system comprehensive services. By analyzing the factors affecting the industrial chain of municipal solid waste treatment, it is considered that the main problems are as follows: (1) the degree of specialization is not enough; (2) Service efficiency is not high enough; (3) The

function of comprehensive treatment is insufficient; (4) Resource calls are passive; (5) Insufficient system services. From the perspective of economic structure and social development, with reference to the relevant theories and models of waste treatment and utilization in some developed countries, the resource value calculation model of recycled waste, including the prediction model of urban domestic waste production, the theoretical model of recyclable resources and the theoretical model of the total economic value of recyclable resources, The quantitative analysis model of the causality of the total economic value of recyclable resources, combined with China's national conditions, points out the functional advantages of commercial insurance companies (including the diversification of service forms, the specialization of service content, the service function combined with residents, communities and government institutions, and the coordination with relevant waste treatment enterprises and other social organizations, which has the characteristics of high efficiency and It puts forward the angles and ways that commercial insurance can intervene (for residents, classifiers, enterprises and Society). This paper puts forward feasible suggestions for the development of urban domestic waste treatment industrial chain in China.

## 1．引言

城市生态环境安全是指城市生态系统健康与稳定，包括与城市居民活动有密切关系的一切自然条件和社会条件免受不可逆破坏和威胁的状态。一个城市的自然资源和环境净化能力是有限的，超过负荷则生态平衡遭受破坏。城市环境安全的实质就是实现人口、资源、环境的协调发展。

随着中国经济、社会的发展，现代化和城市化的进程不断加快，由经济发展而产生的各种工业垃圾、生活垃圾和建筑垃圾的数量越来越多。中国政府非常重视垃圾处理问题，于 2012 年，提出《“十二五”全国城镇生活垃圾无害化处理设施建设规划》；于 2017 年下发了《生活垃圾分类制度实施方案》。虽然中国现在垃圾处理与利用的项目较之以前取得了较大的增加，形成了以拾荒者为代表、城市废旧资源分解者为源头的废旧物资处理与利用产业链，但与一些发达国家相比，中国的垃圾处理产业链尚不完善，从垃圾产生源头分类到回收利用，还未形成完整的闭环系统。

### 1.1 发达国家垃圾处理模式

（1）德国的垃圾产业链模式。在循环经济的指导思想下，将传统的“资源—产品—废物排放与末端”的单向流动的线性经济模式，逐步转型、改造升级，成为“资源—产品—再生资源与回用”的闭合回路经济模式。把垃圾定义为资源，重视资源的循环再利用，保证产业链的良性循环。在德国，每个公民必须对垃圾严格分类。垃圾在分拣中心经过分拣，不同类别的垃圾将送往不同的加工厂。最后无法再利用的垃圾就送到焚烧厂焚烧发电，焚烧后的余灰则用于铺路等工程。

德国的循环垃圾处理模式源于先进的技术、国民的高素质、完善的环保制度、充分的环保教育、环保引资发展等。而这种完整的产业系统，前端的分类和清运与后端的处理相辅相成。

（2）日本的垃圾产业链模式。日本是世界上人均垃圾生产量最少的国家，每年人均垃圾只有 410 公斤。同时，日本也是世界上垃圾分类回收做得很好的国家。日本有三大类环境产业，分别是：保全型环境产业、服务型环境产业和循环利用

型环境产业（即静脉产业）。静脉产业这个专业术语是日本首先提出。静脉产业的推动主题由政府（宏观层面）逐渐下放到企业、国民（微观层面），全社会的共同参与。

### 1.2 中国目前的垃圾处理模式

中国目前主要以拾荒者为代表的城市分解者对源头的废旧物资进行收集、分类，然后通过对垃圾的集中填埋、堆肥和焚烧三种形式进行处理。对于垃圾的分类回收，基层拾荒者一般都是选择性回收垃圾（即一般只会回收一些高价值物品）。由于居民们的垃圾分类意识较弱，导致垃圾分类程度低。对于垃圾的加工处理，受技术的影响，较多的还是采用传统的处理方法，即焚烧和填埋，处理方式过于单一，缺乏成套的新型垃圾处理处置技术以及足够数量的技术和管理专业人员；垃圾处理产业市场化、产业化程度较低，低价值物品的利用效益低（即回收利用的成本比制作新产品的成本还要高）；未能对垃圾处理的多个环节，进行最优的经济模式组合等。

一方面，废弃物无害化处理率的上升远远不足以满足需求，而垃圾排出量日益庞大、种类繁多，其污染性不仅仅是环境保护、更是社会经济可持续发展的一大难题；另一方面，环保行业的年产值正逐年提高，成为国民经济的重要产业之一。严峻的环境现状和行业发展趋势，为我国的环保产业中垃圾处理行业的发展提供了巨大的市场空间。

## 2．面临的主要问题

随着城市化的发展，城市经济实力的不断增强，吸引了大量外来人员，大大增加了生活垃圾的产生量。由家庭产生的生活垃圾主要包括厨余垃圾、可回收垃圾、有害垃圾和其它垃圾等，种类非常多。就垃圾的化学成分而言，大多是可回收利用或处理难度较低的。如果回收利用得当，将减少大量生态资源的消耗。若同时加强对有害废品的分类回收，将有效地控制土地污染、水污染等问题。因此，如何优化生活垃圾的分类、回收、加工、盈利的产业链，已成为优化城市生态环境的关键。

我国垃圾回收的产业链大致包括回收—加工—处理三个环节 。其主要的过程及问题分述如下：

### 2.1垃圾分类回收

垃圾分类回收过程最重要的是垃圾分类，目前主要由拾荒者完成。我国垃圾处理一直重视下游的填埋、焚烧，忽视了上游的分类、收运，缺乏全产业链的系统设计。个人和家庭对垃圾分类的贡献微乎其微。其主要原因是：第一，政府目前对垃圾分类主要是提倡而非强制实施，而垃圾分类意识还并未深入广大人民群众的心中；第二，尚未建立推进垃圾分类的激励和机制。由此导致生活垃圾处理压力大、收益低。

对于垃圾回收，目前的垃圾回收运输仍主要由政府环卫相关部门负责。垃圾收集方面，城市生活垃圾的收集方式主要有混合收集、分类收集、专门收集。混合收集由于操作简单，运行费用低，是目前城市生活垃圾最主要的收集方式。

### 2.2 垃圾加工处理

中国在垃圾处理方面采取的主要方式有：垃圾填埋、垃圾堆肥和垃圾焚烧三种形式。

（1）垃圾填埋。优点是费用低，处理方便。缺点是要占用较大的空间，对周围环境有严重的危害。垃圾填埋实质上是一种“污染物转移”的方式，并没有从根本上处理垃圾。虽然成本较低，但未合理利用垃圾资源，且会延续对环境的污染。
（2）垃圾焚烧。目前垃圾焚烧主要是靠焚烧发电来产生经济效益。垃圾焚烧法是一种高温热处理技术，让有机废物在焚烧炉里进行燃烧反应，产生的热量可以用于发电等其它用途。主要优点是厂址选取灵活，占地面积较小（相对于填埋处理），处理量大，处理速度快，经济效益好等。需要解决的主要难题是对焚烧产生的有害气体的处理成本较高，并且当地的居民不太容易接受。

（3）垃圾堆肥。利用自然界的细菌、真菌和放线菌等微生物的新陈代谢，将垃圾降解为肥料的过程。其主要优点是工艺简洁、投资小和操作简单。主要难点是垃圾堆肥需要较高的垃圾分类体系，生产出来的肥料肥效低，还可能含有有毒物质，可能对环境有潜在污染。并且垃圾降解为肥料的时间周期较长，经济效益差，不适宜处理持续、大量的生活垃圾。

### 2.3 垃圾处理后期资源利用

由于低价值可回收物的再利用成本可能比销售利润还高，因此，企业不愿意回收这些资源。虽然政府采取了一些措施对再生资源回收的扶持，制定了低值可回收物回收利用优惠和补贴政策，引导社会企业进入低值可回收物回收处理市场。但由于企业受技术和环境的约束，参与的积极性和投入的力度都不够，且受到垃圾收集、分类效果的限制，以及可再生回收利用信息的掌握不够全面、及时，导致垃圾处理的后期资源利用率远远不能应对垃圾的产生。未能形成较完备的垃圾产业链的盈利体系。

## 3．回收垃圾的资源价值测算模型

构建城市垃圾可回收资源的重量及其经济链理论模型，结合相关资源，例如再生收购中心的调研所获取的资料，估算某市垃圾拾荒者所拾捡资源的经济价值。此模型主要利用数据得出垃圾清运量、建立模型预估垃圾产生量，得出两个数据的差值来衡量拾荒者的经济贡献价值

3.1 城市生活垃圾产生量预测模型：

（以时间序列预测） $z_i = z_0 \times (1+s)^n$

（$z_i$表示第 $i$ 年某市生活垃圾产生量，$z_0$表示基期的垃圾产生量，$s$ 表示垃圾的平均增长速度，$n$ 表示相隔年数）

（以人均量来预测） $z_i = 365 \times P_i \times W_i$

（$P_i$为第 $i$ 年某市人口数，$W_i$为人均每天产生的垃圾量，二者乘积则为某市所有人口排放的生活垃圾量/天）

3.2 拾捡可回收资源量总经济价值理论模型：

垃圾拾荒者所拾捡的可回收资源量近似的认为是垃圾产生量与垃圾清运量之间的差距：

$$Q_i = Z_i - C_i$$

（$C_i$为第 $i$ 年垃圾清运，$Q_i$为第 $i$ 年垃圾拾荒者所拾捡的可回收资源量）

拾捡可回收资源总经济价值理论模型：

$$V_i = \sum_{j=1}^{m} Q_i \times r_j \times p_j$$

（$m$ 为所回收资源类别的总数，$r_j$为回收资源中第 $j$ 种资源所占的比例，$j$=1，…，$m$； $p_j$为回收资源中第 $j$ 种资源的收购价格，$j$=1，…，$m$。）。

3.3 可回收资源经济、社会价值的关联量化模型

通过调查，利用收集的数据，测算我国在生活垃圾产业链方面人、财、物的投入对可回收资源总经济价值的影响程度（投入产出关系）。描述垃圾回收、分类、可回收资源总经济价值的数量关系。

建立可回收资源总经济价值指标与全体影响要素指标之间的关系模型。从要素出发，系统地、动态地评价各要素指标的影响效果，在定量评价模型中，测算并考察与垃圾产业链有关的要素指标的作用、影响程度，分析作用的效果及可持续性。

关注的指标变量（因变量）----生活垃圾分类的准确率，生活垃圾加工处理投入产出率。对于生活垃圾分类准确率，影响的要素变量主要有：居民（分类意识，分类行为）；拾捡者（工作条件，生活环境，基本保障，激励机制）；回收企业（价格波动，国家宏观政策，激励机制）；环境（社会环境，经济环境，人文环境）。对于生活垃圾加工处理投入产出率，影响的要素变量主要有：垃圾加工处理企业（设备，规模，技术，人员）；政府支持力度（组织、管理，资金、政策）；其它（运输、储存、排放）。

记可回收资源总经济价值指标为 $Y_i$, $i$=1,…,$k$，影响要素指标为 $X_j$, $j$=1,…,$n$，则可建立如下关系模型：

$$Y_i=b_{i0}+b_{i1}X_1+\ldots+b_{in}X_n+u_i \qquad i=1,\ldots,k$$

借助相关的截面数据和时间序列数据，采用回归分析的方法，拟合可回收资源总经济价值指标与全体影响要素指标间的因果关系模型，通过分析反映要素指

标的变量在模型中的表征，定量评价要素指标的变量在可回收资源总经济价值变化过程中的作用。

若要测算垃圾产业链投入对可回收资源总经济价值的贡献度（或弹性），则可采用相应的对数模型如下：

$$\ln Y_i=\ln b_i0+b_{i1}\ln X_1+...+ b_{in}\ln X_n+u_i \qquad i=1,...,k$$

通过数据，采用回归分析的方法，拟合可回收资源总经济价值指标与全体影响要素指标间的因果关系模型。此模型中，反映要素指标变量前的系数就是该要素变量对可回收资源总经济价值的贡献弹性。

## 4. 商业保险公司的作用

通过上述分析可以看到，随着我国经济、社会发展，人们生活的不断提升和丰富，一方面，垃圾特别是生活垃圾在大量增加，垃圾分类问题迫切需要解决，单靠个人或企业难以解决这一问题；另一方面，垃圾作为一种可再生资源，其经济价值也在不断增加，而技术的投入门槛较高使很多企业望而却步。在这种情况下，商业保险公司作为社会保障的重要补充，可以依托政府，利用自己的特点，参与此类工作，并发挥积极的作用。

第一，商业保险公司作为一种金融服务机构，由于商业保险公司在自身的运营和服务体系的结构中，已经掌握有较全面的信息资源。并能建立获取新资源的的途径。对居民，能够大致了解人们的结构特征、居住分布、出行规律、生活习惯、消费方式等，可初步获得人们的生活垃圾的结构和产生量；对企业，了解他们的生产内容、技术特征、资本规模，可初步掌握企业具有的能力和技术；对社会，了解各个社区、各个行业、各种社会组织的分布结构，大致掌握他们对垃圾处理的关注度、能力和可能的投入。

第二，商业保险公司作为一个社会服务机构，拥有专业的分析队伍和研究人员，在自身的运营和服务体系的结构中，已经涉及到对投保人的多项服务，具有较全面和较系统的服务功能。兼顾有三大责任即服务居民、服务企业和服务社会。在服务居民方面，借助大数据分析系统， 商业保险公司可以较全面地采集居民生活的数据信息，深入研究居民们对改善环境的意愿，可能付出的能力和方式，特别是在有一定的激励机制下的行为改进。借助互联网信息平台，及时、准确地获得居民们的服务需求。在服务企业方面，商业保险公司在其投保客户的群体中，涉及到社会的各个行业，拥有众多的企业信息资源，了解企业的产品、技术、规模等，可以对相关企业在生活垃圾处理的过程中进行引导、支持和提供专业化的服务。在服务社会方面，由于保险公司自身的业务可以涵盖经济、社会的各个方面。因此，保险公司可以在政府的引导下，积极配合社区居委会，通过对构建信息平台的高效使用，与社会的各种组织和团体建立联系，协调开展工作。可以与社会的各种公益性组织、各种福利机构合作开展工作，可以与学校、协会、社会团体和民间组织有机协调，全方位、深层次地开展城市环境的建设和服务。

第三，商业保险公司作为提供风险转移的服务机构，具有三大技术特征：即风险的测算、风险的预警和风险的转移。面对生活垃圾分类、处理产业链的各个环节，商业保险公司可以发挥专业技术人员和研究机构的特征，利用大数据，从宏观和微观层面，分析生活垃圾的回收、分类、处理的社会效益和经济效益。借

助信息平台，对产业链的各个环节进行风险测算。利用信息技术，研究增强收益评价方式的合理化。以垃圾发电为例，一旦掌握了发电的资源来源，以及建立了与用电用户的联系，就可以建立一定的生产模拟模型，从供给侧和需求侧两方面系统了解电价水平、电价结构和电力消费的关系并做出评价，制定合理电价，增加项目收益。研究产业链整体互动，减少资源消耗。生活废弃物品的回收率通过个人回收经营者得以提高,有利于加强回收—加工的产业链模式，减轻了后期处理负荷，提高回收后的处理效率。利用市场机制，通过价格杠杆，对相关费用和标准进行调节。废旧物品按其排出量收费、原生材料征税、预收处理费用和押金—返还制度等均有一定的激励作用。通过收费管理改善个人与企业的观念和行为，可以为新技术、新设备、新投资提供较强的经济支持。

借助各类资源和大数据分析系统，研究产业、技术的发展趋势，通过分析宏、微观环境，了解经济发展、政策导向、人口规模、文化环境等相关要素的变化，利用相关的量化模型，对各类风险进行系统模拟和预警。

发挥商业保险的专业服务特征，对生活垃圾分类、处理产业链的各个环节，研究金融工具所能开展的相关服务，结合激励机制和保险计划，设计相关环节的风险转移安排。为居民、为拾荒者、为企业减少后顾之忧，为社会的环境安全和经济安全提供较好的安全保障。

## 5. 结论

论文针对垃圾特别是生活垃圾产业链的相关问题开展研究参照发达国家的相关模式，结合我国目前的现状和发展要求，分析了生活垃圾产业链的结构和要素，构建了垃圾产业链的资源价值测算模型。虽然影响垃圾产业链的因素有很多，但大体包括四类：即个人、企业、社会、政府。

为改善城市环境，减轻生活垃圾带来的问题，我们急需要做的工作是：

（1）从垃圾分类，需要建立“源头三分、节点细分”的垃圾分类基本模式，推进公共机构及企业生活垃圾的强制分类，扩大居民小区生活垃圾分类试点范围，尝试使用智能垃圾分类投放等。商业保险公司可以提供信息和相关的保障服务。

（2）从垃圾回收，原有的垃圾收集系统需要重构，垃圾转运系统需要优化，需要增设一些有毒有害垃圾的清运系统。针对已分类的生活垃圾，现有的大型垃圾转运车无法满足分类运送的需求，需要转型为分类运送的小型转运车，在转运中的精分类，需要增设多个分拣站来实现。垃圾收集系统的重构不只是设备的重构，还需要对回收人员进行重构，增设分拣人员等。商业保险公司可以设计相应的产品，提供金融服务。

（3）在“垃圾运输和处理”环节中，政府可以制定相关政策，规范回收和运输方式、废弃物处理的技术指标和运营标准，建立垃圾处理厂，补贴技术研发企业，委托专门的企业进行不同类别的垃圾处理工作，并向社会开放垃圾处理产业，引入竞争机制，打造垃圾的收集、分拣、回收、储运、处理、再生利用、产品经营一体化的产业链。企业则进行垃圾处理技术研发、设备管理与运营、环保

意识普及、废弃物运输和处理。对分类收集的垃圾由专业机构和企业进行分类处理，例如焚烧发电、重新制成类似产品、物理化学处理后制成新产品等。商业保险公司可以提供专业技术服务，对技术和企业的生产运营，进行风险测算、预警和转移。

目前我国垃圾处理产业链上各环节的工作及其相互之间的互联作用，急需形成完善的机制，垃圾处理仍然是政府和全社会急需解决的问题。如何更大的发挥垃圾的经济效益，改变传统的垃圾处理模式，从根本上缓解全社会的环境和资源问题。本文开展的工作是尝试通过要素分析，找出城市生活垃圾处理产业链的主要症结所在，进行综合治理。通过科学地测算，确定垃圾总量的变化，发现垃圾处理的经济价值和社会价值。

当人们对环境保护意识逐渐增强，人们保护环境的行为更加规范，人们会更积极主动地关心和参与垃圾分类处理的过程。随着科学技术的进步，先进的垃圾处理技术应用可以更好地解决垃圾处理的问题。在政府的引导和鼓励下，更多的企业会投入到这一行业，提供资金、技术、管理和市场。这给商业保险公司带来更多的机遇和发展空间。解决人们生活中的问题，转移企业运行的风险，缓解社会发展中的矛盾，这本身就可以是商业保险公司的义务和责任。在中国共产党和政府的高度关注下，在国家政策的引导下，通过政府相关职能部门的认真工作和全社会的努力工作，尽可能充分地利用垃圾，保护和改善环境，让垃圾作为一种资源更好地服务于社会和经济的持续发展。

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# The Introspection of Network Mutual Assistance ---Taking the Water Drop Mutual Assistance as an Example

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**Keywords:** Network mutual assistance, Risk sharing, Critical illness, internet platform, Insurance, Regulator.

**Abstract.** The mode of Network mutual assistance firstly emerged in 2011 and gradually sank around 2021. At the beginning, network mutual assistance, as a complement to critical illness hospital costs, was expected to improve the Chinese multi-level medical security system given the deficiency of social basic Medicare and costly commercial insurance. However, with the development of new mode, some uncertain problems and challenges followed behind, which may be the main reason of the failure of network mutual assistance. This article tries to introspect the main problems of mutual assistance and proposed related solutions and suggestions. Starting from the concept of mutual assistance and the case of water drop mutual aid, this article initially identified the potential problems from the view of three participants namely mutual assistance platforms, mutual assistance members and supervision department. Accordingly, those problems such as the absence of regulation, misleading advertising from platform, unreasonable fee pricing,

inadequate events disclosure, untransparent fund pool management, unqualified audit institutions, adverse selection and moral hazard will be analysed in the second part. Finally, based on those problems, the related solutions will be put forward from the view of three participants, including defining regulators, improving the accuracy of pricing, establishing sound audit process, improving information disclosure and so on.

## 1. Introduction

### 1.1 Research background

In recent years, with the continuous development of Internet technology, network mutual aid platforms have been able to develop relatively quickly. Since 2011, when the Cancer Society was launched, the number of members of "XiangHubao", a network mutual assistance platform, has exceeded 100 million, and the number of members of online mutual aid platforms such as "Easy mutual assistance" and "WaterDrop mutual assistance" has exceeded 10 million, which shows that the future development of the online mutual aid model still has great potential. The network mutual aid scheme is expected to be a new type of protection system outside of China's social medical security system and commercial insurance system, to a certain extent, to make up for the gap in medical protection for the majority of low- and middle-income groups, effectively reducing the problem of "poverty due to illness".

However, with the rise of this new model of online mutual aid, a series of problems arising from its development are gradually coming to light. In October 2015, the CBIRC (China Banking and Insurance Regulatory Commission) issued a "Risk Alert on Mutual Aid Schemes"[1]; in December 2016, the CBIRC issued a "Notice on Illegal Engagement in Insurance Business in the Form of Mutual Aid Schemes"[2]; in November 2018, a mutual insurance company "Trustlife" withdrew from "XiangHuBao" and received penalties from the CBIRC;A mutual aid platform changed the "health requirements" in the mutual aid covenant, leading to a large number of withdrawals and causing mutual aid to be triggered.

The original intentions of online mutual aid platforms were good, bringing a timely and warm protection to many families. But as the platforms continue to expand and develop, the hidden problems behind them are becoming apparent, and online mutual schemes are at a crossroads and urgently need to be regulated and reorganised to avoid being trapped in a crisis.

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## 1.2 Research purpose

This paper will try to explore the potential problems behind the various mutual assistance schemes. After identifying the potential problems, recommendations are made for their development. In addition, risk warnings are given to the participating public, existing problems are revealed to the platform operators to urge them to rectify them, and countermeasures are proposed to address potential problems, providing a feasible regulatory idea for future regulators to facilitate a shift towards sustainability and rationalisation of online mutual aid platform operations.

## 1.3 Research methodology

*1.3.1 Comparative analysis.*

Try to compare online mutual aid with other similar products such as online charity crowdfunding and internet insurance to properly understand the special characteristics of online mutual aid. By comparing the covenants, terms, and operating methods of different mutual aid schemes, this essay will uncover the existing problems of online mutual aid, and further summarise and categorise them.

*1.3.2 Data analysis.*

By joining the Waterdrop network mutual aid plan, acquiring the public disclosure information including financial information, compensation, mutual members and so on, which were published over the years. Then, summarising those figures in a table and charted based on that information. The resulting charts are used to discover the problems behind the data.

## 1.4 Literature review

*1.4.1 Studies on regulatory issues*

From a legal perspective, Ma Wen (2019) finds that the current online mutual aid industry faces legal dilemmas and lacks legal regulation[3]. Then, she explored the regulatory logic of online mutual aid plans through the contractual perspective, organizational perspective and functional dimension. Wu Ting (2019) finds it difficult for the existing legal system to define the nature of online mutual assistance, and proposes that three types of subjects, namely the government, platform parties and consumers, should all play a regulatory role based on the unclear nature of existing regulatory bodies[4]. Lai Yeming and Xu Xinya (2018) recognise that there is a lack of regulation of online mutual aid platforms under the perspective of market failure, and propose the establishment of a system of fund supervision and information regulation[5]. Song Zhanjun and Song Mengmeng (2016) point out that the regulatory

[3] Ma Wen. The regulatory logic of online mutual aid schemes [D]. Harbin Institute of Technology, 2019.
[4] Wu Ting. On the regulation and supervision of online mutual aid platforms [J]. Shanghai Insurance, 2019(07): 22-24.
[5] Lai Yeming, Xu Xinya. The construction of a regulatory system for online mutual assistance platforms from the perspective of market failure [J]. Journal of Guangzhou Radio and Television University, 2018, 18(02): 102-106+112.

attribution of online mutual assistance is yet to be resolved, and that the regulatory issues involve many aspects such as whether the online mutual assistance platform is operating legally, protecting the legal rights of consumers, and safeguarding the safety of funds[6]. It is suggested that online mutual schemes should be included in the insurance regulatory system.

*1.4.2 Studies on existing problems with mutual aid platforms*

Shao, Zhiquan and Wu, Qiongqiong (2019) suggest that online mutual aid platforms themselves are more problematic, mainly in terms of adverse selection and moral hazard[7]. They argued that online mutual platforms are the same in nature as insurance in terms of preventing "insurance with illness", but that the description of illnesses in the exclusion clause mixes hundreds of diseases or symptoms together, with a large number, and mostly uses general descriptions, leaving more room for the platform's own interpretation, which undermines the fairness of the contract and makes it difficult for a single user to obtain Mutual benefits. Chen, Ling. (2018) points out that online mutual aid platforms have policy risks, internal operational problems, and integrity problems, and analyses the reasons for their occurrence, arguing that the platforms' ability to control their own risks is weak, members' awareness of their rights is not strong, and mutual aid platforms have not yet been characterised[8]. He Xiaowei and Xiao Yucheng (2017) compared mutual assistance programs launched by online mutual assistance platforms with commercial critical illness insurance and found problems and pitfalls in the areas of liability coverage, access thresholds, cost sharing, and verification of insurance events[9]. They also put forward policy recommendations to enhance the sustainable operation of the platform in this regard. By comparing online mutual schemes with mutual insurance, Wang Mengying (2017) recognises that online mutual platforms are guilty of illegal operation of insurance business and other behaviours, and gives corresponding regulatory rectification measures[10].

*1.4.3 Studies on the existing problems of mutual membership rights*

Nie Xinmiao and Ding Shaoqun (2020) point out that mutual members are prone to losing their mutual rights and benefits due to insufficient account balances and failure to meet contribution obligations, and lose their eligibility for corresponding protection, making it difficult to protect the rights of members[11]. They also suggest transforming

[6] Song Zhanjun, Song Mengmeng. Analysis of the characterization and regulatory attribution of online mutual assistance platforms[J]. Insurance theory and practice, 2016(11):78-93.
[7] Shao, Zhiquan, Wu, Qiongqiong. Research on legal risks and regulation of online mutual platforms - based on the perspective of member protection[J]. Shanghai Insurance, 2019(12): 53-57.
[8] Chen Ling. Research on the risk and prevention and control countermeasures of online mutual platform [D]. Beijing University of Posts and Telecommunications, 2018.
[9] He Xiaowei, Xiao Yucheng. Research on the cost of participation and risk matching in online mutual aid platforms: an analysis of adverse selection, moral hazard and sustainability of online mutual aid platform operation[J]. Price Theory and Practice, 2017(10): 158-161.
[10] Wang Mengying. Risks and regulation of online mutual aid practices [J]. Financial market research, 2017(05):124-134.
[11] Nie Xinmiao, Ding Shaoqun. Exploring the inherent pitfalls and transformation directions of online mutual platform operation mechanism[J]. Shanghai Insurance, 2020(02):49-53.

online mutual aids into mutual insurance or charitable organisations and thus subjecting them to the supervision of the CBIRC or civil authorities. Cao Zhichao (2019) notes that it is difficult to protect the right to information of online mutual members, defend the rights of mutual members and protect the information of users' information[12]. Then, he proposes to establish a perfect dispute resolution mechanism and rights protection system based on the above problems.

### 1.5 Contribution

The academic research on the existing risks of online mutual aid platforms generally stays at the macro level and does not deeply explore the online mutual aid schemes lacking the grasp and exploration of micro data. This paper attempts to fill the gap in microscopic research by carefully studying the public information, financial data, capital pools, specific conventions and health requirements of water-drop mutual schemes to draw relevant conclusions and identify the potential problems that exist in online mutual platforms. Based on those problems identified, solutions are proposed to accompany them and help the online mutual aid industry clarify its ideas for rectification.

## 2. Overview of Network Mutual Aid

### 2.1 Definition of network mutual aid

The definition of online mutual aid mostly originates from its industry. According to Martin Zhang, founder of China's first mutual aid platform, Kangai Commune, the essence of online mutual aid is "mutual funding help" based on an online platform. The Waterdrop mutual aid plan defines online mutual aid as a group of mutual aid members based on the principle and terms of a mutual aid scheme, where members enjoy the right to receive assistance and share obligations with each other. According to Zhang Zongliang, network mutual aid is the use of the Internet to gather groups of people at homogeneous risk, who become a mutual aid group based on trust mechanisms and the spirit of contract, and when members trigger the conditions agreed upon, the group members are obliged to give financial assistance by sharing a certain amount of mutual aid, thus gaining the right to receive assistance when they are in the same situation.

In general, online mutual aid refers to a sharing economy in which a mutual aid platform relies on internet technology and blockchain technology to bring people with the same kind of protection needs together to form a mutual aid group and develop a mutual aid plan based on the group's characteristics. When a member of the plan suffers from an agreed disease, the other members of the group share the compensation fund for him. The network is often divided according to age, type of

[12] Cao Zichao. Legal risks and regulation of online mutual public welfare platforms [D]. Heilongjiang University, 2019.

protection and other factors. Common mutual aid plans include: mutual aid for serious illness, mutual aid for accidents, mutual aid for chronic illnesses, etc.

## 2.2 Key features of network mutual aid

### *2.2.1 Rapid growth in membership*

Network mutual schemes generally rely on internet platforms for their operation and promotion. As the internet platforms themselves have a large number of using customers, network mutual schemes can rapidly expand their membership by absorbing these potential target customers, thus creating a clustering effect.

### *2.2.2 Welfare and Inclusiveness*

Network mutual aid plans are low cost and high protection. The entry and exit mechanisms are lenient and any member of the community who meets the health requirements can join the scheme. Members pay a monthly contribution of just a few dollars to enjoy the right to receive up to RMB 200,000 or 300,000 in benefits. Although the network does not promise mandatory payments, it does give members a significant amount of money to cover their medical expenses in the event of illness.

### *2.2.3 Strong homogenization*

The mainstream online mutual plans in the market are focused only on two types of protection: sickness and accidental injury, with insufficient product variety. Different platforms offer similar plans, with the same health requirements and agreed illnesses, and a lack of innovation in the range of products available.

### *2.2.4 Low management fees charged by the platform*

Online mutual platforms generally charge management fees based on a certain percentage of the total amount apportioned funds every times. Compared with insurance companies, the level of management fee rates for online mutual aid plan is relatively low. The management fee rates of mainstream online mutual plans in the market are mostly between 1% and 8% (as shown in Table 2.1).

Table 2.1 Management expense rate of main network mutual aid platforms

| Mutual platform | Management rate |
|---|---|
| Xianghu mutual assistance plan | 8% |
| Water-drop mutual assistance plan | 8% |
| Easy mutual assistance plan | 6% |
| MeiTuan mutual assistance plan | 8% |
| KangAi mutual assistance plan | 1% |

Source: gathered from the disclosure of each mutual assistance plans

In order to more visually compare the difference between the rates of network mutual plans and those of traditional insurance companies, this paper collected relevant financial data of three property insurance companies in 2019, and calculated the

expense rates of the three insurance companies separately by imitating with the components of network mutual management expenses (underwriting expenses, platform operating expenses, etc.) (as shown in Table 2.2).

Table 2.2 The expense ratios of three Chinese property insurers in 2019

| Item | PingAn | PICC | CPIC |
|---|---|---|---|
| Operating and management fee | 5474.58 | 7740.97 | 2687.55 |
| Commission fee | 3937.9 | 5614.63 | 1806.37 |
| Amortized reinsurance expense | 654.65 | 1011.49 | 574.83 |
| Claims | 13977.78 | 26354.72 | 6943.23 |
| Expense ratio | 62.66% | 46.84% | 56.44% |

Data source: obtained by collating and calculating the public information disclosure of insurance companies

Unit: Thousand Yuan

As the management expense ratio for network mutual aid plan is charged as a percentage of the total apportioned amount, the formula for calculating the insurance companies' expense ratio was adjusted to:

(Operating and management fees + commission - amortisation of reinsurance expenses) / claims = Expense ratio

After calculating, the expense ratio for three property insurance company is all above 45%, which is much higher than the management fee rates charged by online mutual platforms.

### 2.3 The comparison of network mutual aid with internet charity crowdfunding

Online charity crowdfunding in the context of this thesis mainly refers to major illness online fundraising, which is different from general entrepreneurial crowdfunding and equity crowdfunding. Online charity crowdfunding for serious illnesses refers to the practice of patients who are already suffering from serious illnesses and cannot afford to pay for their medical treatment, using online platforms to raise money from relatives, friends and the general public. Online crowdfunding and online mutual aid are similar in that they both operate on online platforms and both have certain public interest attributes. In essence, however, they differ in a number of ways.

(1) The physical condition of the target audience is different. The prerequisite for joining a network mutual aid plan is to meet the health requirements and be in good health. In contrast, most applicants for online crowdfunding are already suffering from illnesses.

(2) Different sources of funding. The funds for network mutual aid come from the sharing of all mutual aid members within the scheme. In online charity crowdfunding, the funds come from the applicant's close friends, family, social groups and well-wishers in the community.

(3) The cost of access is different. Internet mutual aid requires mutual aid members to fulfill their mutual aid contribution obligations before they can enjoy the right to be mutualized. Online crowdfunding does not require the applicant to pay any fees in advance.

(4) The strength and amount of protection are different. The amount of money raised through online mutual aid is based on the plan, which has a strong guarantee and a fixed amount. The amount of money raised through online crowdfunding is more volatile and subjective, and is often influenced by the applicant's illness, the event description, the surrounding community, exposure and social attention, making it difficult for the applicant to obtain certain protection.

(5) The review mechanism of events is different. The online mutual fundraising platform will commission a third-party review agency to verify the event, and the event will be publicised for a certain period of time so that it can be monitored by all mutual fundraising members. Online crowdfunding, on the other hand, relies heavily on the crowdfunding platform, which has its own limitations, and as a result, fraudulent donations are common and social credibility has declined.

Table 2.3 The main differences between online mutual aid and online charity crowdfunding

| Mode | Online mutual aid | Online charity crowdfunding |
|---|---|---|
| Applicants | Healthy groups | Disease groups |
| Funding source | Share between mutual aid plan members | Donations from society |
| Acquisition costs | Prior apportionment for others | No prior payment required |
| Coverage amount | Fixed amount | Uncertain amount |
| Investigation mechanism | Multi-party investigation | Mainly dependent on platform control |

## 2.4 The comparison of network mutual aid with internet insurance

The former CIRC has repeatedly issued a reminder to the public that insurance-like "mutual assistance plans" are not insurance products. Following the original CIRC's issuance, the major online mutual platforms have rectified the slogan and clearly marked their product pages with the words "mutual aid plans are not insurance". Although online mutual aid is similar in form to internet insurance, they are fundamentally different in terms of operating principles, legal forms and institutional entities.

(1) The nature of business is different. Internet mutual assistance has the characteristics of public welfare while Internet insurance has stronger commercial attributes.

(2) The strength of protection is different. Internet mutual aids do not guarantee compensation, and the protection agreed in the mutual plan may lose its effectiveness at any time due to policy implications or insufficient membership. Insurance products have rigid benefits, and according to the insurance law, even if the insurance company goes bankrupt, there will be other insurance companies to take over its business, so the protection is stronger.

(3) The basis for calculating fees is different. The apportion amount, Prepaid fees, coverage amount and platform subsidies for online mutual aids lack actuarial basis. The premiums for insurance products are calculated based on the law of large numbers and actuarial models, while reasonable liability reserves are taken to protect the adequacy of the pay-out.

(4) The cost of acquisition is different. Network members are only required to participate in each mutual event to obtain the agreed coverage, which is less costly. Insurance products with the same level of cover have higher premiums.

(5) Different sources of funding. Mutual funds from the network are shared by all mutual members. Insurance is paid out by the insurance company.

(6) Different operating platforms. Most internet mutual platforms are operated and managed by technology companies to provide technical support and capital support; most internet insurance products are sold by traditional insurance companies or insurance agents.

Table 2.4 The main differences between online mutual aid and internet insurance

| Mode | Online mutual aid | Internet insurance |
|---|---|---|
| Nature of business | Public welfare | For-profit purposes |
| Strength of protection | No commitment to mandatory payouts | Mandatory payout |
| Premium calculation | Lack of scientific calculation | Law of large numbers and actuarial models |
| Acquisition costs | Smaller apportion fee | High premiums |
| Compensation fund source | Members apportion | Insurance company claim |
| Operation platform | Technology company | Insurance company |

## 2.5 The operating mode of online mutual aid platforms

### *2.5.1 No pre-deposit fees mode*

No pre-deposited fees mode means that mutual members participating in a mutual plan are not required to prepay the mutual fund in advance. The mutual aid platform often adopts a fixed apportion date to publicise the mutual aid events that need to be apportioned, and then collects the amount from the participating members of the same plan on the apportioned date after the third party verificating the truth of mutual aid

event. The amount of compensation charged includes the illness compensation and the management fee charged by the platform.

Advantages: No large pool of funds, reducing the risk of managing funds. The operation is more transparent, reducing to a greater extent the ability of the platform to intervene as an intermediary, with a strong service and objectivity.

Disadvantages: slow pooling of mutual funds, poor liquidity of the platform.

*2.5.2 Pre-deposit fees mode*

The pre-deposit mode means that members who participate in the plan pay a portion of the deposit to the platform and the deposit is held in their personal account within the online mutual platform. When a mutual member of the aid plan makes an application for mutual assistance and meets the conditions for mutual assistance, the network mutual platform will deduct the amount directly from the individual account of the mutual member on behalf of the general public for mutual assistance. The amount deducted includes the amount required for the mutual contribution and the administration fee. The fees deposited by members are in effect pooled into the network's pool of funds. A closer look at the covenants of the mutual aid plan under this model reveals that the platform has the right to manage the pre-deposited mutual funds of its members. Participating mutual members should ensure that the amount of pre-deposited mutual funds under their personal accounts is sufficient, often with a requirement of no less than a certain amount. If the pre-deposited balance is not sufficient to cover the amount, the member will lose their eligibility and protection.

Advantages: The network mutual platform has a strong initiative to manage the pool of funds and can quickly allocate funds to maintain the daily operations of the platform in the event of mutual matters.

Disadvantages: Risk of misappropriation of funds, illegal fund raising etc. Transparency of fund movements and related financial data is low.

Table 2.5 Features of major mutual plans

| Mutual Aid Platform | Operating Companies | Entry requirements | Disclosure date and frequency | Management fee |
|---|---|---|---|---|
| XiangHu Bao | Ant Gold | No pre-deposit | 7th and 21st of each month | 8% |
| KangAi community | Shanghai Zhongbao Network Technology Co. | No pre-deposit | 1st and 17th of each month | 1% |
| Waterdr | Beijing | Deposit ￥9 in advance, | 4 times a month on | 8% |

| | | | | |
|---|---|---|---|---|
| op | ZhongQingXiangqian Technology Co. | balance greater than ￥1 | Thursdays | |
| ZhongTuo aid | Shanghai Zhongtuo Network Technology Co. | Pre-deposit ￥10,account balance above ￥0 | 2 times per month | 0.01 ￥/Day |
| Easy aid | Beijing Easy Fundraising Network Technology Co. | Deposit ￥3, Monthly renewal ￥2 | 4 times a month on Tuesdays | 6% |
| E aid | Shenzhen DianLiang Information Technology Co. | Deposit ￥30 in advance Account balance greater than ￥1 | Twice a month on Wednesdays | 1 ￥/month/person |
| KuaKe union | Shanghai Zhuo Bao Network Technology Co. | Deposit ￥30 in advance Account balance greater than ￥0 | Once a month | 1 ￥/month/person |
| MeiTuan aid | Chongqing LiangXin Jincheng Technology Co. | No pre-deposit | 3 times a month on the 9th, 18th and 27th of each month | 8% |

Data source: Acquired from the launch plans of various mutual aid platforms

## 3. Analysis of the problems of online mutual aid

In order to better identify the existing problems in online mutual aid, this section will look at the multiple parties involved in the online mutual aid model down to the mutual aid plans, specific contract terms, public information and mutual aid cases. By analysing the above objective data, the existing problems in the online mutual aid industry will be revealed.

### 3.1 Regulatory authorities

#### *3.1.1 No regulator has been defined*

As the online mutual mode has not yet been characterised, there is a lack of regulatory authority to oversee the mutual aid platforms. The former CIRC has issued a number of articles to the community (Table 3.1) suggesting that there are risks associated with insurance-like online mutual aid and stating that online mutual schemes are not insurance products, drawing a clear line between them and insurance products. However, the regulatory advice given by the former CIRC was from the perspective of the insurance industry and did not clearly define the market position of online mutual products themselves. The Ministry of Civil Affairs has also issued a reminder that online mutual aid is not charity and does not fall within the scope of the charity regulator's supervision. As a result, there is a regulatory gap in online mutual aid.

Table 3.1 Relevant documents of the former CIRC on online mutual aid

| Time | CBIRC documents | Main content |
|---|---|---|
| October 2015 | "Risk Alert on Mutual Aid plans and Other Types of Insurance-like Activities" | Online mutual aids are not insurance. There are risks in the online mutual mode |
| June 2016 | "Q&A on the Quark aid plans and other mutual aid plans" | Re-emphasise that online mutual aids are not insurance and suggest that insurance terminology should not be used in mutual aid plans |
| November 2016 | "Q&A with journalists on issues related to online mutual aid platforms" | Inadequate risk control of online mutual aid can lead to financial risks |
| December 2016 | "Notice on the special rectification work on illegal insurance business in the form of online mutual aid plans" | Tackling illegal disguised insurance business of online mutual aids |
| September 2020 | "Analysis of illegal commercial insurance activities and study of countermeasure suggestions" | Online mutual aids have a large risk potential and need urgent rectification |

### *3.1.2 Lack of relevant laws and regulations*

China has not yet introduced a legal term for online mutual aid platform, and only the regulatory documents issued by the CBIRC make it clear that there is a fundamental difference between them and insurance products. There is no programmatic document such as the Insurance Law, and there is a lack of restrictions on the establishment of online mutual platforms, capital allocation, pricing methods, platform operation, and many other aspects. When disputes arise between participating groups and online mutual platforms, there is a lack of legal wording to support consumers' rights. The lack of guidance at the national level on online mutual aid has led to a trend of differentiated development in the mutual industry due to the lack of uniform industry standards. As online mutual aid has financial attributes such as pooling of funds and transferring large amounts of money, there is an urgent need for the government to introduce regulatory rules to maintain market order in the online mutual industry.

## 3.2 Mutual aid platforms

### *3.2.1 Study case illustration*

Waterdrop Mutual is a network mutual aid platform launched by Beijing Zongqiang Forward Limited Technology Company, which was established in May 2016 and has become a leader in the network mutual aid industry. The platform has received capital injections from IDG Capital, GaoRong Capital, Tencent Investment, etc. In June 2019, Waterdrop Mutual completed a Series C round of financing about RMB 1 billion, with a total of RMB 1.7 billion in financing. The platform offers six types of mutual aid plans and has a total of over 80 million users registered as members. Waterdrop

Mutual adopts a pre-deposit fee mode, and as of September 30, 2019, the balance of the pool reached RMB 447,697,617.83.

### *3.2.2 Hidden dangers in product advertising*

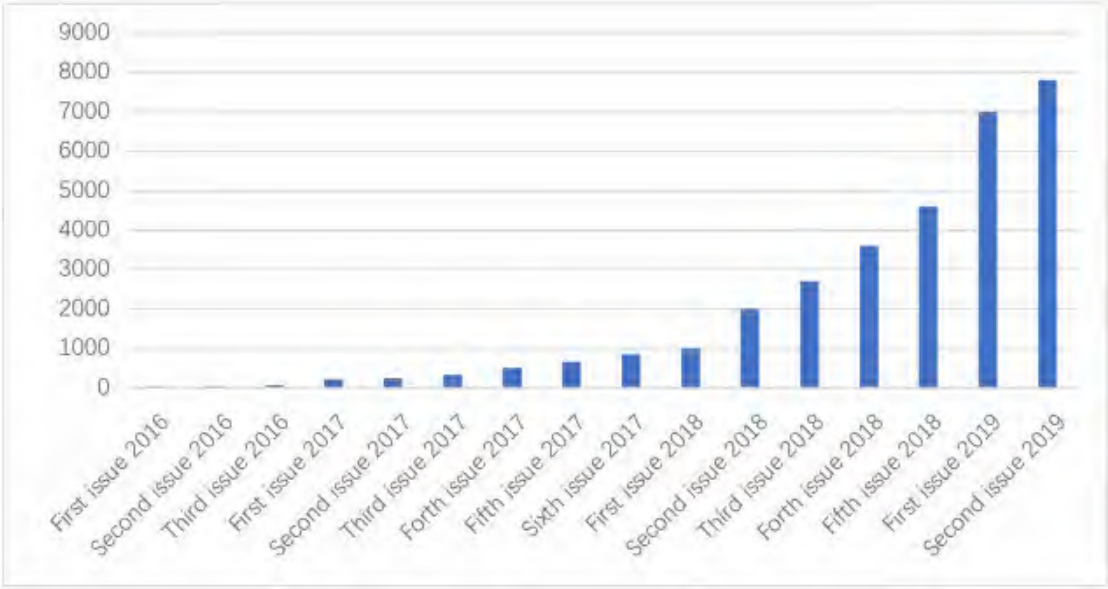
#### *3.2.2.1 Misleading advertising*

The total number of Waterdrop members is prominently displayed on the home page of the app. As of March 10th, 104,475,205 people have joined the program, and the number is rising in real time. It's easy for first-time-use customers to think that 100 million people have joined the Waterdrop mutual aid scheme, but in fact not all of those 100 million people have joined the various schemes.

Actually, all the customers need to do is to fill their mobile phone number or authorise their WeChat or other internet account to log in and then, they can become part of the 100 million members, without having to join any plan or make a pre-deposit.

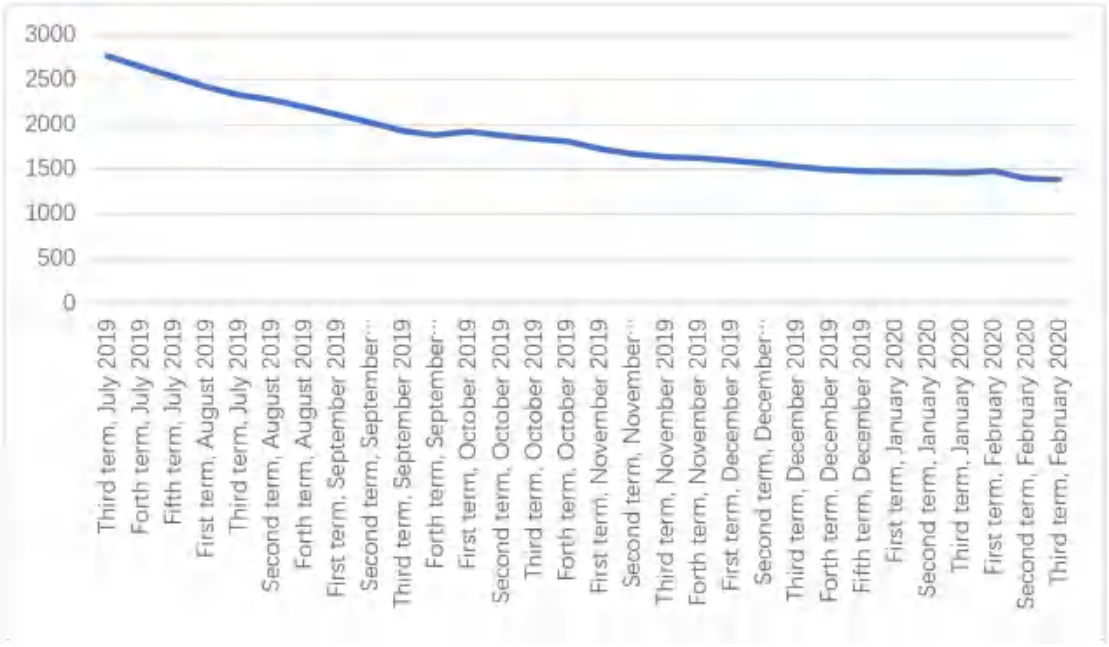
The Waterdrop Mutual platform has consistently highlighted the cumulative growth in the number of Waterdrop members. As shown in Figure 3.2, Period 2 2019 is the most recent public disclosure of the number of people enrolled in Waterdrop Mutual, and as of February 20 the figure has exceeded 100 million. However, the total number of people actually fulfilling their apportionment obligations and actually participating in the mutual apportionment is decreasing period by period, as shown in Figure 3.3, with only 13.81 million people participating in the apportionment as of February 2020, the number of registered members and the number of valid apportioned members are significantly different. Under this circumstance, it appears that Waterdrop Mutual has been misleadingly advertised, deliberately creating the phenomenon of a large and gradually increasing number of Waterdrop members to attract consumers to sign up, while in reality the number of genuine and effective Waterdrop Mutual members is decreasing period by period, and shows an expected continuous decline.

Figure 3.2 The cumulative number of registered members of Waterdrop




Data source: Waterdrop platform mutual aid incident public data Unit: 10,000 people

Figure 3.3 Actual number of mutual members participating in apportion




Data source: Waterdrop platform mutual aid incident public data Unit: 10,000 people

The problem of misleading advertisements by Waterdrop Mutual is a microcosm of the entire online mutual aid industry and is more representative. The original online mutual aid platforms all had enlarged markings on their product promotion pages to indicate the number of people registered on the platform, however, the true and effective number of contributors was not visually marked on the product promotion pages and could only be found in the public information after the participating groups had become mutual members and actually joined the plan.

*3.2.2.2 Lack of product descriptions*

The Waterdrop Mutual platform uses a standard form contract, where the covenants and terms are entirely drawn up and amended by the platform, and the member community can only choose to accept or reject them. Insurance products similar to mutual schemes also adopt form contracts, and Article 17 of the Insurance Law requires insurance companies to fulfil their obligation to state the terms of the form. In practice, insurance companies will clearly indicate the exclusions in the contract and make return visits to the policyholder to clearly inform them of the relevant terms and conditions by telephone. The policyholder can also ask questions about what they do not understand. In contrast, the platform lacks a description of the terms and conditions of the contract and has no telephone call-back or written confirmation. The platform also lacks a channel for answering questions about the terms and conditions, making it difficult for mutual members to find the platform to ask questions about the terms and conditions, other than reading the terms and conditions themselves.

*3.2.3 Lack of actuarial basis for pre-deposited costs*

There are six plans available on the Waterdrop mutual aid platform, as shown in Table 3.4. The Million Lifetime Cancer Plan is an upgraded version of the Teenager

Plan and the Young Adult Plan, which includes multiple compensation up to a cumulative amount of $1.5 million. As can be seen from Table 3.4, the three plans are categorised according to age and should be differentiated by a certain amount according to the probability of illness at different ages (Figure 3.5). In practice, however, the same amount of pre-deposit is charged for both young and old, and the maximum amount available for both the teenager and young adult groups is the same at 300,000 RMB, suggesting that the pre-deposit amount is not reasonable.

Table 3.4 Plans available on waterdrop mutual aid platform

| Plan name | Pre-deposit amount | Highest compensation |
|---|---|---|
| The Million Lifetime Cancer Plan | RMB 59 | RMB 1,500,000 |
| Young adult plan | RMB 9 | RMB 300,000 |
| Teenager plan | RMB 9 | RMB 300,000 |
| Old adult plan | RMB 9 | RMB 100,000 |
| Patients mutual aid plan | RMB 10 | RMB 100,000 |
| Accident mutual aid plan | RMB 9 | RMB 100,000 |

Date source: Based on the Waterdrop mutual aid platform

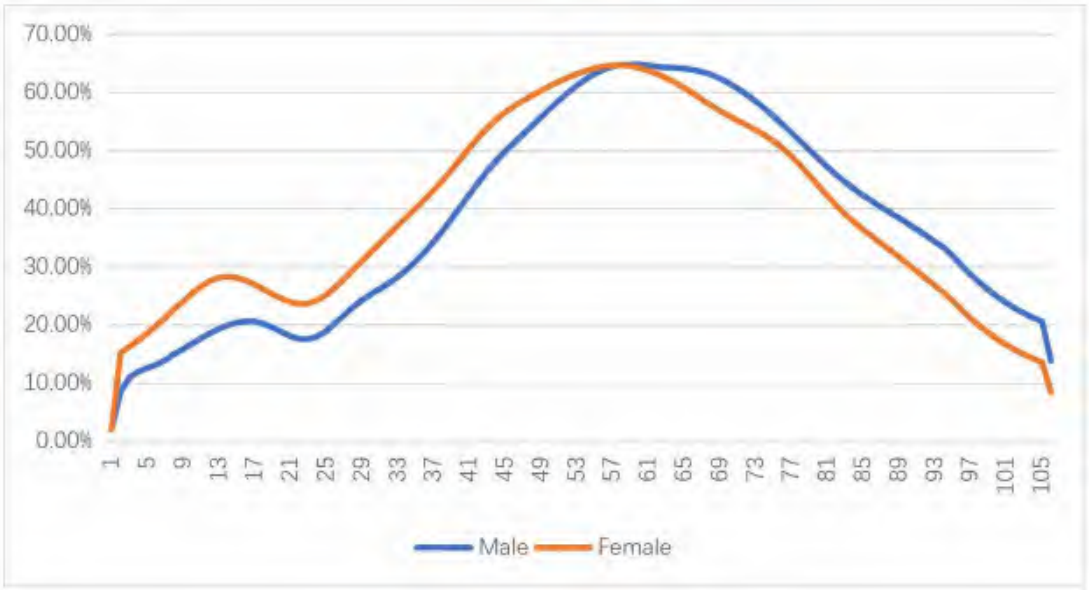



Figure 3.5 Incidence of critical illness in China

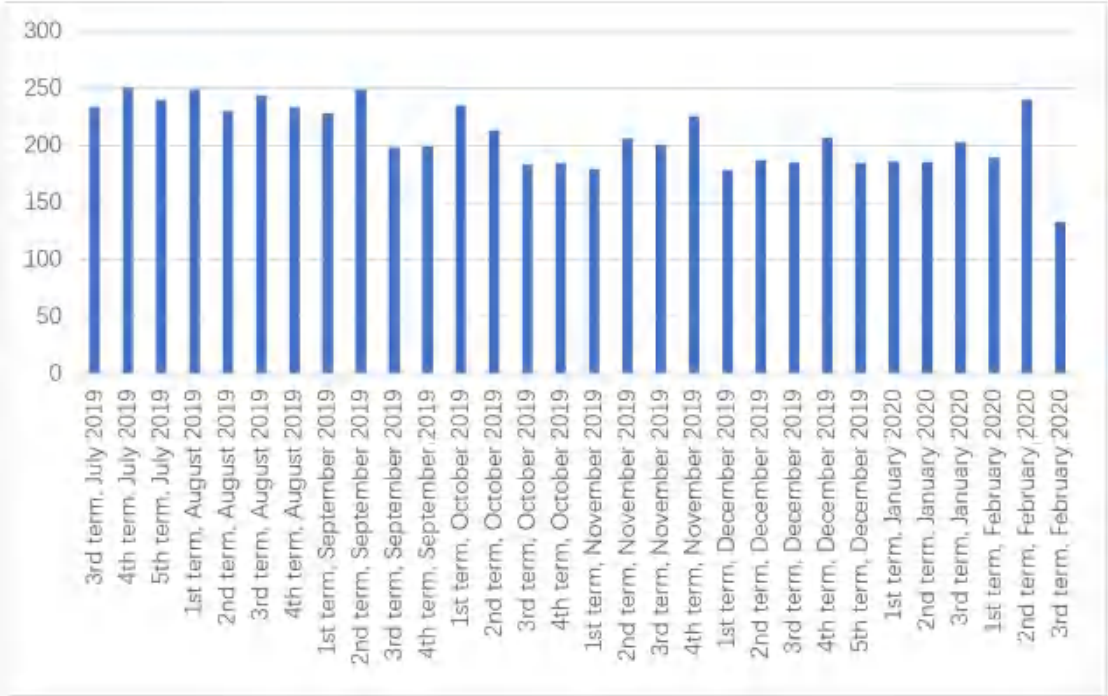
Data source: Collected according to the serious disease incidence table disclosed by CBIRC

Although this is not a major problem at the beginning of the plan, as the number of mutual aid events rises, the pool of money pooled by the pre-deposit fee will be significantly consumed when the large number of members reaches a peak of illness. Then the online mutual aid platform may face the risk of not having enough fund pool to pay out. If the platform then charges the high amount of apportioned money to all mutual members, the members may withdraw in large numbers due to the high cost, which would make the mutual plan unsustainable.

### *3.2.4 The charging basis for management fees needs to be improved*

The platform charges an 8% management fee to ensure the stable operation of the plan. The terms of the plan state that the management fee will be used to pay for case verification, litigation and arbitration, information collection, online publication of information, depository of mutual funds, member monitoring, support for the sustainable operation and development of the platform. The management fee is levied at 8% of the total amount of the mutual fund for each period to all members participating in the assessment (Figure 3.6). As of March 15, 2020, the Waterdrop mutual aid platform has paid a total of RMB1,380,708,400 for mutual aid. According to the public announcement of the calculation of management fees, the Waterdrop mutual aid platform has collected a total of RMB110,456,672 in management fees.

Figure 3.6 Management fees every term from 2019 to 2020




Data source: Calculated based on the aid compensation amount apportioned every term

Unit: 10,000 RMB

As the plan described, members suffering from a minor illness such as thyroid cancer can receive 50,000 RMB and a member suffering from lung cancer can receive 200,000 RMB, with the amount of the compensation adjusted according to the medical costs of the illness.

However, according to the plan rules, the management fee is proportional to the amount of compensation for a mutual event, which is unreasonable. The cost of investigation, labour capital and time spent on cases such as verification should be relatively certain for each incident. Therefore, the administration costs incurred by the platform are less relevant to the severity of the member's illness and should not be assessed on the basis of the amount of the apportion amount.

In addition, there is a lack of disclosure on the use of management fees. The mutual aid member community does not know what proportion of the 8% management fee is spent in reviewing mutual events or operating the platform. The platform also does not disclose the cost of a third-party auditor to conduct the verification. There is no basis for pricing the percentage of management fees charged, and the platform does not have a public disclosure section similar to that of insurance companies. There is no information available to mutual members regarding the annual financial reports of Waterdrop.

### *3.2.5 Inadequate information disclosure system*

The platform's public announcement channel is relatively single. The platform only relies on the mobile app or WeChat public platform to publish information, and the official website only serves to advertise the product. Mutual aid members must regularly check their mobile phones to learn about mutual aid cases and top up their mutual funds into their balance account, otherwise it may lead to the suspension of their mutual aid right and recalculation of waiting periods, etc.

Waterdrop mutual funds public announcement lacks uniform standards, long update cycle and slow timeframe. The movement of the mutual fund pool is of vital concern to all mutual members. However, as of 10 March 2020, the latest announcement of the fund pool on the Waterdrop Mutual platform is dated 30 September 2019, a break of up to six months. This paper collects information from each announcement released by Waterdrop Mutual since its foundation (as shown in Table 3.7 and Table 3.8), and finds that the interval between each issue of fund announcements is inconsistent, the entries in each issue are inconsistent, and the timing is ambiguous.

Table 3.7 Collation of public information on the management of Waterdrop mutual aid funds

| Fund depository | Disclosure term | Disclosure period | Interval |
|---|---|---|---|
| China Social Welfare Fund | 1st term 2016 | 2016.5.1-6.30 | 2 months |
| China Social Welfare Fund | 2nd term 2016 | 2016.7.1-7.31 | 1 months |
| China Social Welfare Fund | 3rd term 2016 | 2016.8.1-8.31 | 1 months |
| China Guangfa Bank | 1st term 2017 | 2016.9.1-2017.2.28 | 7 months |
| China Guangfa Bank | 2nd term 2017 | 2017.3.1-3.31 | 1 month |
| Waterdrop Convergence welfare Fund | 3rd term 2017 | 2017.4.1-6.31 | 3 months |
| Waterdrop Convergence welfare Fund | 4th term 2017 | 2017.7.1-8.31 | 2 months |
| Waterdrop Convergence welfare Fund | 5th term 2017 | 2017.9.1-10.31 | 2 months |
| Waterdrop Convergence welfare Fund | 6th term 2017 | 2017.11.1-11.30 | 1 month |
| Waterdrop Convergence welfare Fund | 1st term 2018 | 2017.12.1-12.31 | 1 month |
| Waterdrop Convergence welfare Fund | 2nd term 2018 | 2018.1.1-2.28 | 2 moths |
| Waterdrop Convergence welfare Fund | 3rd term 2018 | 2018.3.1-3.31 | 1 month |

| | | | |
|---|---|---|---|
| Waterdrop Convergence welfare Fund | 4th term 2018 | 2018.4.1-5.31 | 2 months |
| PingAn Bank | 5th term 2018 | 2018.6.1-10.14 | 4 months |
| PingAn Bank | 1st term 2019 | 2018.10.16-2019.1.31 | 4 months |
| PingAn Bank | 2nd term 2019 | 2019.2.1-3.31 | 2 months |
| PingAn Bank | 3rd term 2019 | 2019.4.1-6.30 | 3 months |
| PingAn Bank | 4th term 2019 | 2019.7.1-9.30 | 3 months |

Table 3.8 Changes to the public information of Waterdrop Mutual aid

| Disclosure term | Main content and changes |
|---|---|
| 1st term 2016-4th term 2017 | a. Accumulated number of members<br>b. Accumulated apportion fund amount<br>c. Accumulated number of families helped<br>d. Bank account information including (previous balance, new pre-deposit, current fund transfer, account balance, pool balance)<br>e. The number of mutual aid events and details of the amount of mutual aid for the four types of plans: young, middle, old and accident |
| 5th term 2017 | Add visiting mutual aid member activity |
| 6th term 2017-1st term 2018 | Delete visiting mutual aid member activity |
| 2nd term 2018-4th term 2018 | Delete accumulated apportion fund amount term.<br>Delete accumulated number of members |
| 5th term 2018-2nd term 2019 | Add aid members Q&A |
| 3rd term 2019-4th term 2019 | a. Accumulated number of aid cases.<br>b. accumulated mutual funds<br>c. Bank account information including (previous balance, new pre-deposit amount, transfer amount, account balance, pool balance) |

Data Source: Compiled from information published on the Waterdrop mutual aid platform

### *3.2.6 Non-transparent management of the fund pool*

From the table 3.7, it can be found that the depositary of the mutual fund pool has changed four times in three years. At the beginning of foundation, Waterdrop Mutual entrusted its mutual fund pool to the China Social Welfare Foundation (CSWF), stating that it was the first and only company in the industry to entrust its mutual fund pool to a third-party public welfare fund. However, in the first quarter of 2017, Waterdrop Mutual ended its relationship with China Social Welfare Foundation (CSWF) and transferred the pool depositary to the commercial bank, Guangfa Bank.

In April 2017, the Waterdrop Mutual platform changed its pool depository to the Waterdrop Convergence Public Welfare Foundation. It is still worth exploring whether this change is in accordance with the regulations, whether there is any

underhanded operation of the left hand pouring the right hand, and whether Waterdrop is using the pool for investment activities.

In May 2018, the depository of the pool was changed again, from the original Waterdrop Convergence Foundation to PingAn Bank, which in turn is owned by Ping An Insurance Group of China. This raises the question of whether there is some kind of partnership between Waterdrop and PingAn Insurance Company. The frequent switching of large sums of money is inherently risky, but the fees, interest costs, management costs and partnership agreements for the multiple switches are not disclosed to the members of Waterdrop, which leads to the conclusion that there are management risks in the mutual fund pool.

### *3.2.7 Inadequate qualification of third-party auditors*

The occurrence of a mutual aid case is similar to the occurrence of a critical illness in insurance, in that the person covered by the risk suffers from the relevant disease and applies for the corresponding Compensation. Therefore, the whole process maintains for a long period, which can last for years or even decades before the client becomes ill. Therefore, the underwriting department should be able to collect information such as the patient's medical report and condition in order to identify whether the patient is at risk of being insured with a disease or fraudulent.

However, there are concerns as to whether the third-party verification agencies working with the Waterdrop Mutual aid platform have the appropriate underwriting capabilities. The third-party organisations listed in Table 3.9 are the main partners that Waterdrop works with. In addition, it can be seen that the following companies operate in most parts of the country, with three information consulting companies, two insurance valuation companies and three insurance consulting companies. The scope of operation of these institutions is broad and the nature of the companies is not uniform. Only two insurance valuation companies have been recorded through the CBIRC. Compared to the underwriting mechanisms of insurance companies, the third-party organisations that work with the Waterdrop Mutual platform suffer from a lack of specialisation, uniform standards and audit qualifications in verifying mutual aid cases.

The underwriting process for insurance companies is overseen by the CBIRC and the underwriting department must verify the insurance incident in an impartial and objective manner. However, the third-party auditors cooperated with Waterdrop Mutual aid have absolute authority over the verification of mutual cases. Therefore, in the absence of reasonable and effective supervision, there may lead to unfair decisions towards the platform or the applicant and concealment of the truth of the case.

Table 3.9 Third party auditors cooperated with Waterdrop Mutual aid

| Third-party auditor | Main business |
|---|---|
| Zhongyi Tiancheng Insurance Advisory Services Limited company | *Insurance consulting;* business information consulting; market research; legal documentation |

| | |
|---|---|
| | agency services;<br>Used car appraisal consultancy; brand promotion; design, production, agency and publication of advertisements; marketing planning |
| Zongbao Health Technology Services Limited company | *Nutritional health consulting* (not including diagnosis and treatment); computer network technology development, technology consulting, technology transfer, technology services; *insurance consulting*; business information consulting;<br>Market research; data processing and storage services; domestic advertising business; business management consulting and other items that are not prohibited and do not require a license according to the laws, regulations, decisions of the State Council and other provisions. |
| Beijing Chengguang Information Consulting Co. | Economic and trade consulting; business management consulting; technology promotion services; business planning; sales of electronic products, computers, software and auxiliary equipment; conference services; product design;<br>Computer graphics design and production; software development; computer systems services; basic software services; application software services (not including medical software);<br>Data processing; market research; *health management* (except for medical treatment activities subject to approval); *health consulting* (except for medical treatment activities subject to approval); Internet information services. |
| Shaanxi Yiye Zhiqiu Business Information Consulting Co. | Business information consulting; legal information consulting (excluding intermediary); automotive information consulting; market research; business management consulting; business management services; construction engineering technical services, technical outsourcing;<br>*Health management* (except for treatment activities subject to approval); *health consulting* (except for treatment activities subject to approval); forensic consulting services (excluding training, medical treatment);<br>Forensic identification technology research, promotion, application, prognosis, evaluation and |

| | |
|---|---|
| | consultation; forensic identification consulting services. |
| Shenzhen Yizheng Insurance Appraisal Co. | *Pre- and post-underwriting inspection, valuation and risk assessment of insurance subjects in the whole country* (except Hong Kong, Macau and Taiwan); investigation, inspection, damage assessment and residual value treatment of insurance subjects after the occurrence of an accident;<br>Risk management consultancy; other business approved by CIRC. |
| Hunan Qingyixuan Business Information Consulting Co. | Business information consulting; business management consulting services; corporate image planning services; marketing planning services; public participation in the planning of cultural performances, competitions and other cultural activities;<br>Real estate information consulting; real estate brokerage services; market research services. (Projects subject to approval according to the law, approved by the relevant departments before business activities can be carried out) |
| Guangzhou Gaolan Insurance & Valuation Co. | *Operating insurance adjusting business;* other business as approved by CBIRC |
| Shenyang Zhixin Insurance Claims Consulting Co. | Business information consulting; business management consulting; investment consulting; *insurance information consulting;* market research; traffic accident insurance claims consulting services;<br>Legal information consulting (not including litigation agency). |

Data source: Third-party worked with Waterdrop Mutual aid, based on information published by Waterdrop Mutual. Business information selected from the China Bureau of Industry and Commerce.

### *3.2.8 Adverse selection and moral hazard issues*

The lack of an underwriting process makes online mutual aid more vulnerable to adverse selection and moral hazard than insurance products. Participating groups can simply register as members of major platforms through mobile apps or WeChat channels. In turn, mutual aid platforms are unable to effectively audit and investigate registered members, which makes it easier for a large number of high-risk groups to join. There are two main groups of people who are at higher risk of adverse selection.

The first group, mainly low- and middle-income groups and mostly floating people, come from less economically developed areas. This group lacks commercial insurance cover and is generally in the fourth category of employment or even higher.

They rarely attend medical examinations and are unaware of their health status. They may already be suffering from illnesses that have not yet been detected.

The second group is the sick group, which is no longer able to take out commercial insurance through the normal underwriting process. As the network is simple to join and has no underwriting process, it is up to people to decide whether they meet the health requirements.

As online mutual plans operate on an internet-based platform, membership and withdrawal mechanisms are flexible. In addition, the cost of withdrawal is low and not restricted by the platform. With the influx of high-risk groups, the incidence of future mutual events is bound to increase, thus increasing the cost of apportioning. As a result, price-sensitive low-risk groups will opt out of the plan due to the increasing cost of apportion. When the low-risk groups drop out and the high-risk groups stay, it will be difficult to maintain the effectiveness of the mutual platform and the fundraising crisis will result.

### 3.3 Mutual aid members

#### *3.3.1 Difficulty in securing privacy*

When a mutual aid member suffers from an illness or accidental injury as agreed in the mutual aid scheme, he or she is required to submit an application for mutual aid to the platform. Upon receipt of a mutual aid member's application, the mutual aid platform generally requires the mutual aid applicant to submit supporting documents of the incident including medical records issued by a doctor, pathological examination reports, blood test reports and documents proving the diagnosis of the relevant disease, original medical receipts and lists of expenses. Upon receipt of the above documents the mutual aid platform will commission a third-party review body to verify them. As the patient's information changes hands with multiple parties, it is easy to cause leakage of the patient's privacy.

After verification by the third party, the patient's discharge diagnosis, confirmation report and other information will be placed on the mutual platform for public display, during which all members will be able to read the above-mentioned materials. On clicking on the materials, it was found that all reports and diagnoses were not treated for privacy, and the patient's name and age, as well as his or her medical history, were on display, making it difficult to protect the patient's privacy.

## 4. The response to the problems of online mutual aid

### 4.1 Clarify regulatory authority

#### *4.1.1 Discussion of regulatory attribution*

When explored at a regulatory level, three possibilities exist for regulators of online mutual aids.

##### *4.1.1.1 Regulation by the Ministry of Industry and Information Technology*

Existing online mutual assistance platforms basically rely on technology companies to register or provide technical support. As online mutual assistance is registered with technology companies, it should be subject to the supervision and management of the Ministry of Industry and Information Technology. However, due to the financial and

public welfare attributes of online mutual aid businesses, the supervision by the Ministry of Industry and Information Technology alone may lead to problems such as lack of regulatory experience.

#### *4.1.1.2 Financial sector regulation*

As the business of online mutual aids involves the pooling and redistribution of large amounts of capital, it has certain financial attributes and falls within the scope of the financial regulatory system. In practice, the former CIRC has also issued a number of risk warnings about online mutual aids and has had some experience in regulating them, as it has rectified irregularities and out-of-bounds publicity. In the short term, the CBIRC could temporarily regulate the online mutual aid industry to help clean up the messy situation.

#### *4.1.1.3 Civil affairs department regulation*

There are certain public welfare attributes of online mutual aid. Some mutual aid platforms have set up public welfare foundations, such as the "Shanghai Together Community Public Welfare Foundation" launched by Quark Alliance, and the "Waterdrop Convergence Public Welfare Foundation" set up by Waterdrop Mutual, etc. For mutual aid industry derived public welfare foundations, the civil affairs department should manage them. Although network mutual aid has certain public welfare properties, it is still commercial in nature. The maintenance and redevelopment of the mutual aid model requires the injection of a large amount of capital, and investors' needs are more about whether network mutual aid can bring capital returns.

### *4.1.2 Establishment of a new regulatory authority*

As discussed in the previous chapter, online mutual aid has its own unique advantages in improving people's livelihoods, combating "poverty due to illness" and providing basic protection. Because it is fundamentally different from insurance, there are certain limitations to having the CBIRC take over the online mutual aid industry. This may reduce the unique advantages of online mutual aids and fail to fully activate their function and potential to provide livelihood protection and improve the social security system. Therefore, a new supervisory department should be set up within the existing financial regulatory system, which would be dedicated to the professional regulation of the online mutual aid industry, so as to ensure that it operates in a standardised mode. In addition, it is also help to combat the chaos in the industry, and guide the healthy development of the online mutual industry. Eventually, it may help online mutual aid become an indispensable part of the construction of China's multi-level social security system.

### *4.1.3 Establishing a multi-dimensional joint monitoring system*

As online mutual aid involves multiple entities and institutions, a multi-dimensional supervision system is needed to further regulate the long-term development of the online mutual aid industry in order for it to continue to operate well. This paper proposes the establishment of a four-dimensional joint supervision system.

**Member oversight:** Mutual aid platforms should establish a platform oversight department, composed of representatives of mutual aid member groups, who become

supervisors through voting and other means, and participate in platform audits to play a supervisory role.

**Industry self-regulation:** set up a network mutual industry association. Members of the association should be made up of major mutual aid platforms and work together to develop an association convention and rules to strengthen communication between platforms, break down industry barriers and avoid vicious competition and other situations.

**Society governance:** increase the number of social reporting channels and use the power of the public to monitor whether mutual aid platforms are operating reasonably and to monitor the authenticity of mutual aid events. Add third-party evaluation agencies or media reviews to assess the platforms from a third-party perspective and give the public options and advice.

**Government regulation:** Add a new online mutual fund regulator to the existing financial regulatory system to properly lead the development of the online mutual fund industry. It also strengthens cooperation and communication with the Ministry of Industry and Information Technology, the Ministry of Civil Affairs and the Banking and Insurance Regulatory Commission to play an all-round supervisory role.

## 4.2 Regulating platform operations

### *4.2.1 Adjustment of advertising pages*

Standardise the data information on product promotion pages. Weakly advertise the number of registered members and highlight the number of genuine and valid mutual members within the mutual aid scheme. A valid mutual member here is someone who actually participates in each assessment period, has a sufficient account balance and enjoys mutual rights. Strengthen the clarification of standard form terms. During the registration process, the exclusion clause of the plan should be clearly indicated and special notes. Explanations should be provided for obscure terms and clauses.

Add a call-back session to further clarify mutual aid liability and plan terms. Online mutual aid platforms can follow the example of insurance companies in appointing special customer service staff to visit mutual aid members to ensure that they are aware of the meaning of the terms, conditions of the contracts, the rights and obligations they should fulfil. This can reduce legal disputes arising from contractual issues.

### *4.2.2 Scientific determination of pre-deposit fees*

Network mutual schemes should make reference to the pricing model of insurance products and use elements such as the law of large numbers, actuarial models and disease incidence to reasonably measure pre-deposit costs. In addition, it is reasonable to change the previous pricing method of sharing costs equally among network mutual aid and take into account the impact of factors such as gender and age on the amount to be shared. Low-risk groups should bear a low cost of contribution, while higher-risk groups should bear a high cost of contribution. At the same time, adjustments to the amount of the mutual aid compensation should be made to take into account the actual losses incurred by the applicant, rather than the traditional "one-size-fits-all" method of calculating the amount of the mutual aid claim.

### *4.2.3 Management fees are reasonably priced and transparently disclosed*

Changing the previous method of extracting management fees based on a certain percentage of the total amount apportioned to one based on the frequency of mutual aid occurring in the current period. Disclosure to mutual members of the auditing costs incurred in each mutual case to pay third-party organisations and the details of the platform's operating costs. The management costs are broken down and quantified so that the mutual member groups can clearly understand the composition of the management costs. Mutual aid platforms, as a medium for online mutual aid, may charge intermediary fees to the mutual aid member community. In addition, they should also follow the example of insurance companies in regularly disclosing financial annual reports and other information for monitoring by mutual member groups and the general public.

### *4.2.4 Improving the information disclosure system*

#### *4.2.4.1 Improving the integrity of mutual aid case disclosure*

Online mutual aid platforms should publish all applications for mutual aid cases and the results of their verification. Mutual aid platforms are a medium for the wider mutual aid community and should avoid dominating the outcome of mutual aid events and interfering with the review of events as much as possible. The platform should disclose failed applications to the members. This will increase the awareness of the mutual aid members by announcing the success rate and convince the members by informing them of the reasons for the failed applications, as well as warning those unscrupulous individuals who wish to defraud the mutual funds.

#### *4.2.4.2 Improving the standardization of major information disclosure*

Enriching information disclosure channels. Reasonable use of official websites, SMS alerts and voice calls to broaden the channels for disclosure, reminding mutual members to keep their fund account balances adequate and to pay attention to disclosure information every period to participate in supervision.
Standardising the mutual fund disclosure system. It is wise to standardise the format of the existing mutual fund disclosure system.

#### *4.2.4.3 Establish a comprehensive pool management system*

It is necessary for platform to identify the depositary of the pool and disclose the relevant deposit agreement to ensure that there is no underhanded operation or kickbacks of interest. When a change of depositary occurs, all members of the pool should be consulted and disclosed in a timely manner through a public notice system. In addition, clearly stating the rights and obligations of the mutual fund platform in relation to the management of the pool, and disclose relevant information including, but not limited to, the movement of the pool, the use of the balance interest, the standard of audit fees by third party institutions, a description of the costs of visits by Waterdrop members, details of the platform's operating costs and other significant matters such as expenditure and income

#### *4.2.5 Regulating third party auditors*

Platform should choose a qualified third-party auditor. The verification of mutual events is one of the most important aspects of online mutual aids, as it is directly related to the cost-sharing of mutual funds for all members and is also a litmus test for the fairness of the mutual platform. As the audit of mutual events is similar to the underwriting of life insurance, the mutual platform should commission an insurance adjusting company or insurance consulting company with relevant professional experience and a record with the CBIRC.

Moreover, Mutual aid platforms should standardise the criteria for reviewing mutual aid events and make the review of mutual aid events procedural. For example, by clearly specifying the provision of relevant supporting documents and centralising the reporting to third party organisations for review, so as to avoid bias in the review results due to subjective factors of third-party investigators.

#### *4.2.6 Reduce adverse selection and moral hazard by increasing the screening process*

##### *4.2.6.1 Social Information Survey*

Social information checks are added to screen suitable groups for membership. It is worth to mention that the social information includes the member's occupation, family, income and existing risk coverage. The survey takes the form of an online questionnaire, which prompts registrants to fill in real information at the questionnaire window and emphasises privacy protection. In addition, the information collected can be summarised using big data technology to reduce the systemic risk of the mutual aid group by differential pricing or refusal to join for high-risk groups.

##### *4.2.6.2 Health survey*

A health enquiry session will be introduced to reduce the incidence of sickness. The health inquiry should be initiated by the mutual aid platform to the registered members of the mutual, rather than relying on members to read the health requirements themselves. The inquiry could be based on the smart underwriting mechanism of internet insurance, where registrants are prominently warned to be truthful about their health and the consequences of withholding material facts. Under this circumstance, a dedicated health advisor could be set up to explain and explain online where registrants do not understand the health requirements.

### 4.3 Maintaining member privacy

Mutual aid platforms should pay attention to the protection of patients' privacy when disclosing applicants' information, by coding photos of sensitive body parts and sensitive personal information. The disclosure should also be limited to the valid member groups who actually participate in the apportionment, and prevent the public and strangers from viewing the patient's disclosure information to protect the patient's privacy. Third-party auditors should also take care to protect patients' privacy when visiting to collect patient information and not to disclose it to others.

## 5. Conclusion

The paper firstly identifies a number of conceptual differences between online mutual aid and online charity crowdfunding and traditional insurance, and finds that its rapid membership growth, large volume, universality and low management costs are well suited to the needs of low- and middle-income groups for risk protection. However, the development of the online mutual model has not yet matured. By discussing and analysing the three parties involved in the online mutual model from different perspectives, it is found that in terms of regulation, there are unclear regulatory authorities and a lack of corresponding laws and regulations; in terms of platforms, there are misleading advertisements, lack of actuarial basis for pre-deposit fees, imperfect information systems, non-transparent management of capital pools, insufficient qualification of third-party auditors, and unreasonable basis for charging management fees. On the member side, privacy and security are difficult to be guaranteed.

Then, in response to the problems identified, this paper further proposes that from the perspective of the three main parties, there is a need to clarify the regulatory authority and improve the supervision system; on the part of the platform, there is a need to standardise its operation, adjust the publicity page, scientifically determine the fees, improve the information disclosure system and regulate the third-party auditor qualification; on the part of the members, there is a need to maintain the privacy and security of the members.

Looking back on the whole research process, there are still some shortcomings. Firstly, the data used in this paper is somewhat limited and does not represent the level of development of the industry as a whole. As this paper takes Waterdrop Mutual aid plan as a specific research object, some of the problems it reveals may not be reflected in other mutual platforms, and other online mutual platforms may have other problems that have not been explored. It is believed that with the introduction of regulatory policies and the continuous improvement of mutual aid models, the potential of online mutual aid will be further stimulated, ultimately promoting the development of the social security system.

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# Research on the High-Quality Development Model and Path of Shaanxi's Insurance Industry under the Background of "Strong Supervision"

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**Keywords:** "Strong supervision" background, high-quality insurance industry, model and path.

**Abstract.**Based on the background of "strong supervision" in the insurance market, this paper constructs an index system based on the five development concepts, and evaluates the high-quality development of Shaanxi's insurance industry by using the gray correlation analysis method and the coupling coordination degree model. The results show that the high-quality development of the insurance industry in Shaanxi is gradually moving towards a good development direction. In the development process, the innovation aspect is relatively immature, and the open concept and the sharing concept need to be improved; the five development concepts influence each other in the process of promoting the high-quality development of insurance. promote. On this basis, countermeasures and suggestions for the high-quality development model and path of Shaanxi's insurance industry are put forward.

## 1. 序言

十九大以来，我国进入了新时期，经济发展处在转变发展方式、转换新动能的关键时期，创新驱动逐渐成为新的增长引擎，传统产业向新兴产业全面转型升级。经济进入高质量发展，金融监管发生重大变革，由此催生了新的保险需求，为保险业高质量发展提供了新的机遇，也带来了新的挑战[1]。2018 年，陕西省保险业全省累计实现保费收入 969.39 亿元，同比增长 11.59%，保费规模排名全国第 14 位，增速排名全国第 7 位。陕西保险业总体呈现出保费收入实现较快增长，回归本源成效明显；增长新动能逐渐显现，险种功能更加多元，服务经济社会能力显著增强。保险业的迅速发展，不可避免的会出现险企内部治理混乱的问题，由此陷入“激进产品、激进投资、虚增资本”的高杠杆高风险的恶性循环。2018 年银保监会合并，保险行业全面防范风险，“强监管”孕育而生。新形势下的改革，是以规范、去芜存菁和强化保险业可持续发展为目的而进行的必要调整，体现了很浓的“补短板”色彩，并且监管的加强并不必然带来创新的削弱。随着互联网技术的发展，对保险科技创新与应用带了新的变革，保险治理等各种风险也随之暴露，加强对保险行业的市场监管、防御风险、推动创新仍需纵深推进。

目前，关于强监管下保险业高质量发展的研究主要分三个方面。第一是关于

强监管方面的研究。2018 年，国家多次召开中央经济工作会议提出把防控金融风险放在更加重要的位置，保险业拉开了“强监管”的序幕，国家多次召开中央经济工作会议提出防控金融风险放在更加重要的位置，保险监管是保险业务发展空间的决定因素之一。田辉（2017）提出在保险业强监管背景下，应该将关注点放在监管转变背后的内涵上，而不是过度担心强监管带来的业务收缩效应[2]。阳爱姣（2018）提出市场通过保险中介有助于挖掘潜在的保险需求，而监管部门对保险中介机构的要求，正在逐步向保险公司看齐[3]。第二是关于保险业高质量发展方面的研究。党的十九大后，保险业迎来高质量发展的春天，关于保险业高质量发展的研究也如雨后春笋般涌现。黄万鹏（2018）借助科技创新推动保险行业高质量发展，重视推动保险行业大数据基础建设和数据共享以及保险科技发展方面监管体系的建设[4]。第三是关于高质量发展评价方法及模型方面的研究。学者们主要采用自回归分布滞后误差校正模型、因子分析、灰色关联分析和 Logit 模型对高质量发展进行评价。钟芳等（2020）运用自回归分布滞后误差校正模型，研究了金融规模高质量发展刺激中国经济发展的同时也带来了碳排放量金融规模，是短期和长期的正相关关系[5]。Sihem（2019）运用 Logit 模型分析得出影响农民购买农业保险的因素包括保险费用、耕地面积、农民受教育程度等多重因素[6]，所以要想发展好绿色保险就需要受多方因素来协调。

国外虽然没有高质量发展这一说法，更没有保险业高质量发展的相关理论和评价指标体系，但是关于经济可持续发展的文献值得借鉴。国外关于经济发展的研究成果集中于物质、制度和人力资本等要素对经济增长的贡献，但缺乏系统的分析研究，在借鉴这些研究成果时，要认清中国和国外存在的差异，探索合适本国国情的模式。

综上所述，将“强监管”与“高质量”发展结合起来的研究很少，大都是实现高质量发展以强监管为前提，建立指标体系进行定量研究的几乎没有。因此，在强监管背景下，加快对保险业高质量发展的研究，对于增强保险业的核心竞争力，促进保险业市场繁荣具有重要意义。本课题结合经济高质量发展研究和陕西保险业发展现状，贯彻五大发展理念，建立“强监管”背景下，陕西保险业高质量发展指标体系，通过实证分析，提出陕西保险业高质量发展的模式和路径。

## 2. 陕西保险业高质量发展的现状与必要性、可行性研究

### 2.1 陕西保险业高质量发展的现状

#### 2.1.1 发展优势

保险市场不断稳定。随着新技术的出现和渗透，保险业集中度不断提高。随着保险市场的不断发展，其经营模式和业务内容也有了改变，保险从业队伍不断壮大，保险公司岗位不断细分。保险业增长迅速。随着保险业的飞速发展，保险投资渠道也逐步拓宽，有效分散了投资风险。从现有发展情况来看，人口基数较大以及风险管理需求不断增加，这些都给保险业的发展带来长期利好。保险业监管不断完善。从最初的人行监管发展到成立保监会，再到银、保监会的合并，保险业监管制度不断完善。

#### 2.1.2 存在的问题

没有维护好保险的声誉和形象。目前，由于保险营销人员众多、行业准入门槛较低，保险销售行为不规范，使新客户对保险业务产生抗拒心理，导致保险行

业的声誉和形象受损。

保险业核心功能的发挥存在弊端。保险业的核心功能是风险保障，但由于大部分保险公司更看中保险金融属性忽略了风险保障功能，而且其扩张的速度远远高于质量方面的提升，因此保险业不得不走向转型的道路。

### 2.2 陕西保险业高质量发展的必要性与可行性

#### 2.2.1 必要性

从理论上来看，保险业的发展必须与金融业的发展高度贴合。金融业本身属性特殊，风险较高，一旦出现金融危机，将会对整个国家甚至国际经济产生影响，所以金融业的发展必须以保险业的风险保障为前提。

从国家层面来看，坚持创新是实现保险高质量的必要条件。目前大多数保险产品出现严重的同质化，所以互联网保险的出现颠覆了传统保险[7]。除了保险产品创新外，保险业还应该探索营销模式和保险监管的创新，改善传统保险的弊端，实现保险业的高质量发展。虽然我国保险业发展较慢，仍然存在诸多不足，但是随着监管结构调整、监管力度加大，我国保险业一定会向着高质量的方向发展。

#### 2.2.2 可行性

从理论上来看，保险业高质量发展的核心就是要加快优化保险业的风险保障功能。保险作为市场化的风险管理机制，在交易的同时，也承担了分散风险的功能，使得各个部分相互激励和配合，从而提高自身效率、控制风险。从这个意义上讲，保险业在取得客户信赖的同时，还需降低社会风险，推动经济高质量发展。

从国家层面来看，我国是人口大国，其背后蕴藏巨大的保险市场需求。随着人们生活水平的提高，对物质精神方面有了更高的要求，人身财产安全，健康保障等需求增加，这些需求是保险业得以发展的源泉[8]。此外，我国人口老龄化程度增强，个性化医疗和专业的养老服务等需求日益增加，这些需求推动保险业高质量发展。

## 3. “强监管”背景下，陕西保险业高质量发展概念界定

### 3.1 强监管

当前，我国正在进一步推进金融业对外开放，保险业要应对外部环境的各种变化和挑战，必须加强监管。监管的指导思想是开正门，不走旁门。强监管加大对行业违法违规行为的处罚力度，规范金融业的经营行为，建立良好的市场秩序。强监管不但可以引导保险业转变经营理念，强化合规意识，健全风险治理；而且有助于推动金融回归本源，防范和消除风险隐患，促进保险业的健康可持续发展。强监管是金融业实现高质量发展的基本保障，有助于增强金融服务实体经济能力，守住不发生系统性金融风险的底线，推动深化改革、加快转型发展，为我国经济持续健康发展提供坚强的金融保障[9]。

### 3.2 保险高质量发展

保险高质量发展是顺应国家经济和行业自身发展的必然趋势，不仅是行业规模的增加，更是效益、产品和服务质量的提高，表现为质量第一、效益优先。

保险高质量发展包括以下几个方面。第一，保险要立足保障本源。保险公司在服务实体经济的同时，需要有效发挥其经济补偿、风险管理和资金融通等功能，切实体现“保险姓保”。第二，保险覆盖面的扩大。第三，保险业结构持续优化。

第四，行业效益合理、稳定，大部分市场主体能够实现整体盈利。第五，保险产品供给充足且结构完善，充分满足人民群众不同层次需求。第六，发展动能转换。第七，从业队伍具有较高素质和口碑。第八，市场环境良好，竞争充分且规范有序。

### 3.3 五大发展理念

中共十八届五中全会确立了创新、协调、绿色、开放、共享这五大发展理念，五大发展理念的确立是关系中国发展全局的一场深刻变革。十八大以来，“大众创业、万众创新”“京津冀协同发展”“绿色化”“一带一路”“亚投行”“精准扶贫”等一系列战略、举措，正在践行着五大发展理念中的一个或多个。未来，五大理念将结合得更为紧密，成为具有内在联系的集合体。

创新发展，体现的是更高质量、更高效益的发展。协调发展，体现的是更加均衡、更加全面的发展。绿色发展，体现的是更加环保、更加和谐的发展。要想实现绿色发展，需要不断地进行技术创新和理念创新。同时，绿色发展有利于提高人们的生活质量，使共享发展成为有质量的发展。开放发展，体现的是更加优化、更加融入的发展。坚持开放发展，将增强我国经济的开放性和竞争性，更加有利于实现共享发展。共享发展，体现的是更加公平、公正的发展。一切发展都是为了人民。坚持共享发展，是坚持其他四种发展的出发点和落脚点[10]。

### 3.4 从五大发展理念出发构建指标体系的构思

党的十八大以来，我国经济转向了高质量发展阶段，这是遵循经济发展客观规律的必然要求。随着经济转向高质量发展，金融监管的构架也发生相应的变革，保险业的转型力度也必将加大，这一趋势让保险业迈向高质量发展的道路。保险业的转型也给自身带来了许多不确定性，所以保险业应加快形成从五大理念出发实现保险业高质量发展的指标体系。

本文以“五大发展理念”为出发点，紧紧围绕强监管背景下保险业高质量发展概念，结合“十三五”发展规划要求和实际情况，在供给侧结构性改革、发展战略、创新驱动、新兴产品方面突出保险业的高质量特点，从结构调整、产业升级、科技进步、质量效益提升、民生福利改善、生态环境改善等方面构建保险业高质量发展的指标体系，体现科学发展、实现有质量的稳定增长的思路和模式。

## 4. “强监管”背景下，陕西保险业高质量发展实证分析

### 4.1 指标体系的构建

本论文严格按照建立指标体系的原则，考虑主要影响因素。评价过程基本包括选取、构建评价指标（或指标体系）、获取指标量值、选取适当的评价方法、给出评价方案和程序设计方案，然后在电子计算机上进行计算，最后给出评价结果、定级、分类[11]。

“强监管”背景下，陕西保险业高质量发展指标体系构建遵循科学性与系统性原则、动态性与稳定性原则、可比性原则、整体性与层次性原则、可操作性原则。紧扣陕西省保险业高质量发展的概念，结合陕西保险业高质量发展的关键特征，构建了指标体系。具体指标体系如表 1 所示。

表 1 “强监管”背景下，陕西保险业高质量发展评价指标体系

| 目标层 | 准则层 | 指标层 | 变量代号 | 指标属性 |
|---|---|---|---|---|
| “强监管”背景下，陕西保险业高质量发展 | 创新 | 中高等院校保险专业在校生（人） | $X_1$ | 正指标 |
| | | 中高等院校保险专业师资力量（人） | $X_2$ | 正指标 |
| | | 互联网普及率（%） | $X_3$ | 正指标 |
| | 绿色 | 农业保险赔付率（%） | $X_4$ | 负指标 |
| | | 农业险规模占比（%） | $X_5$ | 正指标 |
| | 协调 | 保险密度（元） | $X_6$ | 正指标 |
| | | 保险深度（%） | $X_7$ | 正指标 |
| | | 人均 GDP（元） | $X_8$ | 正指标 |
| | | 金融机构贷款余额（亿元） | $X_9$ | 正指标 |
| | | 金融机构存款余额（亿元） | $X_{10}$ | 负指标 |
| | | 社会消费品零售总额（亿元） | $X_{11}$ | 正指标 |
| | 开放 | 外资保险公司保费占比（%） | $X_{12}$ | 正指标 |
| | | 外资保险公司数量占比（%） | $X_{13}$ | 正指标 |
| | 共享 | 短期健康险保费占比（%） | $X_{14}$ | 正指标 |
| | | 人均养老缴纳费用（元） | $X_{15}$ | 正指标 |

## 4.2 数据来源

研究陕西省保险业高质量发展，选取了 2010-2018 年 9 年陕西省的数据，查阅了《陕西省统计年鉴》（2010-2018 年）、中国西部地区的统计年鉴，中国西部各省市及自治区的保险学会、国泰安数据库等。

## 4.3 模型理论

### 4.3.1 灰色关联

灰色关联[12]源于灰色系统理论，由我国著名学者邓聚龙教授提出。主要是研究系统内部各因素的关联程度，使各种因素之间“灰色”关系清晰化。灰色关联的优点是对样本大小没有要求，并且有无规律都能适用，结果与规律之间相符[13]。使用方法是用参考序列与比较序列之间数据计算得出关联度大小，当数值大的时候关联度越大，说明参考序列与比较序列的关系是密切的，反之数值结果越小就越不密切。

### 4.3.2 耦合协调度模型

耦合协调度[14]就是指标体系中，指标之间相互依赖于对方的一个量度，可以计算出指标体系中准则层指标的紧密配合与相互耦合度。根据准则层指标的重要性对指标进行加权处理。这里采用熵值赋权法计算权数。熵权法可以避免人的主观性赋权，使结果更科学、更准确。

耦合度$C$取值范围为[0,1]，$C$越接近1，表示各系统间的耦合度越大；反之越小，借鉴相关学者研究，将耦合度的变化阶段具体分类见表2。

耦合度$C$只说明了各个子系统之间的相互作用程度，为了更好地评价各子系统之间的协调发展程度，进一步计算耦合协调度 $D=\sqrt{C\times T}$ 。

借鉴国内相关研究对耦合协调度评价标准进行区间划分，以对陕西省保险业高质量发展指标体系耦合协调度的发展程度进行判定。具体划分见下表3。

表2 耦合度的变化分类

| 耦合度值 | 耦合程度 | 系统耦合所处阶段 |
|---|---|---|
| $C=0$ | 极小 | 无关状态且向无序发展 |
| $0\le C<0.3$ | 低等 | 低水平耦合 |
| $0.3\le C<0.5$ | 中等 | 颉颃时期 |
| $0.5\le C<0.8$ | 良性 | 磨合阶段 |
| $0.8\le C<1.0$ | 优良 | 高水平耦合 |
| $C=1.0$ | 最大 | 良性共振耦合且趋向新的有序结构 |

表3 耦合协调度参照表

| 耦合协调度 | 协调度等级划分 | 耦合协调度 | 协调度等级划分 |
|---|---|---|---|
| 0.90~1.00 | 优质耦合协调 | 0.40~0.49 | 濒临失调 |
| 0.80~0.89 | 良好耦合协调 | 0.30~0.39 | 轻度失调 |
| 0.70~0.79 | 中级耦合协调 | 0.20~0.29 | 中度失调 |
| 0.60~0.69 | 初级耦合协调 | 0.10~0.19 | 严重失调 |
| 0.50~0.59 | 勉强耦合协调 | 0.00~0.09 | 极度失调 |

## 4.4 实证分析

### 4.4.1 灰色关联分析

为了充分说明陕西省保险业高质量发展与陕西省保险业保费收入增长之间的关系，根据代表性、可获得性和可比性原则，本文选取2010-2018年陕西省保险业高质量发展的数据，进行灰色关联度分析并对其大小进行排序。2010-2018年陕西省保险业保费收入用来作为陕西省保险业高质量发展灰色关联的参考序列，陕西省保险业高质量发展评价指标按五大发展理念为准则，15个指标作为比较序列。为了方便计算，给各个指标赋变量代号，标注指标属性，详情回见表1。

### 4.4.2 耦合协调度分析

对陕西省保险业高质量发展指标体系的五大发展理念准则层指标与陕西省保险业保费收入发展程度之间的动态对比分析之后，进一步评价陕西省保险业高质发展指标体系中五大发展理念体系内部的协调发展程度，由此评价陕西省保险业高质量发展程度，为此，选取耦合协调度模型进行评价。

## 4.5 实证分析结果

（1）陕西省保险业保费收入与保险业高质量发展指标体系灰色关联计算结果

参数序列$Y$与比较序列$X_i$的关联程度计算得出，通过9个关联系数反映得

到的，将其 9 个年份分成 3 段得出陕西省保险业保费收入与保险业高质量发展指标体系动态关联矩阵，求平均值得到 $X_i$ 和 $Y$ 的关联度，如表 4 所示。

表 4 陕西省保险业保费收入与保险业高质量发展指标体系动态关联矩阵

| 发展理念 | 指标层 | 2010-2012 年 | 2013-2015 年 | 2016-2018 年 |
|---|---|---|---|---|
| 创新 | 中高等院校保险专业在校 $X_1$ | 0.7777 | 0.5148 | 0.6840 |
| | 中高等院校保险专业师资力 $X_2$ | 0.6040 | 0.4552 | 0.9387 |
| | 互联网普及率 $X_3$ | 0.9417 | 0.8918 | 0.9186 |
| 绿色 | 农业保险赔付率 $X_4$ | 0.5104 | 0.8657 | 0.8047 |
| | 农业险规模占比 $X_5$ | 0.4322 | 0.7119 | 0.4848 |
| 协调 | 保险密度 $X_6$ | 0.9947 | 0.9934 | 0.9965 |
| | 保险深度 $X_7$ | 0.6097 | 0.9516 | 0.8612 |
| | 人均 GDP$X_8$ | 0.7706 | 0.8749 | 0.9548 |
| | 金融机构贷款余额 $X_9$ | 0.7686 | 0.9827 | 0.9510 |
| | 金融机构存款余额 $X_{10}$ | 0.7755 | 0.9614 | 0.9069 |
| | 社会消费品零售总额 $X_{11}$ | 0.7647 | 0.9456 | 0.9428 |
| 开放 | 外资保险公司保费占比 $X_{12}$ | 0.7426 | 0.7185 | 0.5658 |
| | 外资保险公司数量占比 $X_{13}$ | 0.7811 | 0.8751 | 0.8102 |
| 共享 | 短期健康险保费占比 $X_{14}$ | 0.7684 | 0.5565 | 0.4909 |
| | 人均养老缴纳费用 $X_{15}$ | 0.8792 | 0.9119 | 0.9398 |

一般情况下，$\gamma_{ik} > 0.6$ 时，认为所选取的子序列对母序列有着重要的影响，所以由表 4 可以看出陕西保险业保费收入与保险业高质量发展指标体系的动态关联度基本上是较高的。

（2）陕西省保险业高质量发展指标体系准则层五大发展理念灰色关联结果

根据五大发展理念为划分基础，将代表各理念指标的灰色关联度分别求取平均值，对比五大发展理念对陕西省保险业高质量发展的动态变化过程。由表 4 可以计算出 2010-2012 年、2013-2015 年、2016-2018 年三段年份中创新、绿色、协调、开放、共享五个准则指标的关联度，即：

$$R_{创新}=(r_1+r_2+r_3)/3 \quad (4\text{-}1)$$

$$R_{绿色}=(r_4+r_5)/2 \quad (4\text{-}2)$$

$$R_{协调}=(r_6+r_7+r_8+r_9+r_{10}+r_{11})/6 \quad (4\text{-}3)$$

$$R_{开放}=(r_{12}+r_{13})/2 \quad (4\text{-}4)$$

$$R_{共享}=(r_{14}+r_{15})/2 \quad (4\text{-}5)$$

可以得陕西省保险业保费收入与陕西省保险业高质量发展准则层五大发展理念的动态关联矩阵，如表 5。

表 5 陕西省保险业保费收入与陕西省保险业高质量发展五大发展理念的动态关联矩阵

| | 2010-2012 | 2013-2015 | 2016-2018 |
|---|---|---|---|
| 创新 | 0.7745 | 0.6206 | 0.8471 |
| 绿色 | 0.4713 | 0.7888 | 0.6447 |
| 协调 | 0.7806 | 0.9516 | 0.9355 |
| 开放 | 0.7618 | 0.7968 | 0.6880 |
| 共享 | 0.8238 | 0.7342 | 0.7153 |

由表 5 可以得出 2010-2018 年陕西省保险业高质量发展五大发展理念的关联排序。

2010-2012 年：共享>协调>创新>开放>绿色。2013-2015 年：协调>开放>绿色>共享>创新。2016-2018 年：协调>创新>共享>开放>绿色。2010 年至 2012 年期间，陕西省保险业高质量发展准则层的五大发展理念对陕西省保险业发展的关联程度中，共享与陕西省保险业保费收入的关联度最大，绿色最小。2013 年至 2015 年期间，协调与陕西省保险业保费收入的关联程度最大，绿色发展至第三位，共享由首位变化至第四位，开放由第四位变化到了第二位。2016 年至 2018 年期间，协调理念的发展稳居首位，创新由上一阶段的末尾跳跃至第二位。优化陕西省保险业高质量发展评价体系，促使陕西省保险业之间均衡协调发展，也是推动金融经济发展和增长方式的重要动力。进一步证明指标体系的建立也是较为合理的。

（3）陕西省保险业高质量发展耦合协调度模型结果

从表 6 和图 1 可以看出，绿色理念的综合发展值由 2010 年的 0.1025 发展至 2018 年的 0.8647，在 2014 年至 2017 年都处于五大理念里的最低值，在 2017 年到 2018 年出现了大幅度跳跃，增长了 0.75。陕西绿色保险的发展虽然 2018 年达到了五大理念综合发展排名的相对中等水平，但总体来说发展很不稳定也不持续，在未来发展中，绿色险种的挖掘还有待开发，以响应高质量发展的绿色发展理念。

表 6 陕西省保险业高质量发展耦合协调度五大发展理念综合评价值表

| $f(x)$ | 创新 | 绿色 | 协调 | 开放 | 共享 | $T$ |
|---|---|---|---|---|---|---|
| 2010 | 0.5386 | 0.1025 | 0.1693 | 0.0124 | 0.0016 | 0.1649 |
| 2011 | 0.4991 | 0.1758 | 0.2027 | 0.0218 | 0.0376 | 0.1874 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2012 | 0.5717 | 0.3093 | 0.2233 | 0.1650 | 0.0854 | 0.2709 |
| 2013 | 0.6905 | 0.3287 | 0.2942 | 0.3146 | 0.2112 | 0.3678 |
| 2014 | 0.3824 | 0.3530 | 0.3698 | 0.6142 | 0.4459 | 0.4331 |
| 2015 | 0.2262 | 0.0976 | 0.4926 | 0.9523 | 0.2019 | 0.3941 |
| 2016 | 0.2285 | 0.1868 | 0.6505 | 0.8534 | 0.3492 | 0.4537 |
| 2017 | 0.4089 | 0.1154 | 0.7880 | 0.9731 | 0.2851 | 0.5141 |
| 2018 | 0.4693 | 0.8647 | 0.8877 | 0.4846 | 1.0000 | 0.7412 |

协调理念的综合发展评价值在 2010 年 2018 年间一直稳步上升，从最开始的 0.1693 增长至 0.8877，其中 2015 年至 2016 年的增长幅度最大，从 0.4926 发展到了 0.6505。协调理念包含了保险业发展的一些基础性指标，比如保险密度、保险深度、人均 GDP 等，呈现出陕西经济和保险业发展稳定向好的良好趋势。

开放的综合发展值 2010 年至 2017 年间增长迅速，一跃成为五大发展理念综合水平的首位，从 2017 年后出现转折，大幅度下降至 2018 年的 0.4846。陕西保险业开放程度的发展在后期有所停滞，在大数据时代，保险业更加需要增加开放性，增加数据开放共享，利用数据挖掘提供个性化服务，最终增强行业竞争。目前，陕西保险业的开放性对推动陕西保险高质量发展的作用还处于不成熟阶段，保险业的开放平台发展也需提上日程。

图 1 陕西省保险业高质量发展五大发展理念综合发展趋势图

共享理念的综合发展值在 2010 年至 2017 年间一直处在偏低水平位置波动，最高值为 0.4459，其中 2014 年后开始向下发展。2018 年值迅速增大成为最高值，增长了 0.72。随着经济社会的发展，人们逐渐提升了共享风险的意识，比如注重养老、医疗、健康方面的共享经济。经济高质量发展需要社会综合发展齐头并进，因此，共享理念对于保险高质量发展是不可或缺的。

从总体的综合评价值 $T$ 来看，总体呈向上发展趋势，从 2010 年的 0.1649 发展至 2018 年的 0.7512，且局部波动变化不大。陕西保险业高质量发展呈现从左下角项右上角发展的良好态势，五大理念在推动保险高质量发展过程中相互影响，相互推动。

根据表 2 耦合度和表 3 耦合协调度参照表，将计算出来的耦合度和耦合协调

度一一对应，得到表 7。

表 7 陕西省保险业 2010-2018 年高质量发展耦合协调度实证分析表

| 年份 | $C$ | $D$ | 发展程度 |
|---|---|---|---|
| 2010 | 0.2727 | 0.212 | 严重失调 |
| 2011 | 0.5756 | 0.3284 | 中度失调 |
| 2012 | 0.8245 | 0.4726 | 濒临失调 |
| 2013 | 0.9199 | 0.5817 | 勉强耦合协调 |
| 2014 | 0.9786 | 0.651 | 初级耦合协调 |
| 2015 | 0.7386 | 0.5396 | 勉强耦合协调 |
| 2016 | 0.8449 | 0.6191 | 初级耦合协调 |
| 2017 | 0.7791 | 0.6329 | 初级耦合协调 |
| 2018 | 0.9515 | 0.8398 | 良好耦合协调 |

表 6 和表 7 中，$T$ 代表的是耦合协调发展水平的综合评价指数，$C$ 代表的是耦合度，$D$ 代表的是耦合协调度。通过上述耦合协调度实证结果得出陕西省保险业高质量发展的五大理念的耦合协调度在逐步上升，从 2010 年的 0.2120 逐渐平稳上升到 2018 年的 0.8938，中间 2015 年稍有回落但是在 2016 年继续又稳步上升。

## 4.6 结论

### 4.6.1 灰色关联分析相关结论

由表 4 的结果可得结论，保费密度对陕西省保费业高质量发展的关联度最大，社会消费品零售总额和保险深度的排名由低发展至较高位置。因此，陕西省保险业的高质量发展对实现陕西省经济高质量发展具有明显的推动作用；互联网普及率的排名处于下降趋势，在互联网科技瞬息万变的现今，侧面反应出陕西省保险业对于互联网科技的应用和发展仍不充分；中高等院校保险专业在校人数的波动位置很大，人才储备对于一个行业的创新发展战略是至关重要的，说明陕西省保险业的发展在过去的时间段里创新发展相较不成熟；农业险规模占比一直处于靠后位置波动，农业保险赔付率有排名有所上升；绿色保险理念对陕西保险业高质量发展还不深入，规模不大；人均养老缴费、金融机构存款余额、金融机构贷款余额、人均 GDP 等一直处于中间位置小幅波动；短期健康险保费占比一直在靠后位置且呈下降趋势，同样处于下降趋势的是外资保险公司保费占比和外资保险公司数量占比；陕西省保险业高质量发展，在保险业开放理念和共享理念方面的有待提高。

从表 5 整体可以看出，开放理念在推动陕西保险业高质量发展的过程中一直处于较为平稳的位置。相比之下，绿色理念和创新理念的发展并不是很稳定，绿色理念起始的关联度也不是很大，说明陕西保险业的绿色保险理念发展速度较慢，保险创新和绿色保险也将是推动陕西保险业高质量发展的主要抓手。绿色类指标对保费增长的关联度在逐年降低，而协调对保费增长的关联度逐年提升，说明陕西省保险业高质量发展协调方面成果显著，主要需要加强创新、绿色、开放、

共享类指标的量化数据统计量，也需要在这些方面继续加强。

#### 4.6.2 耦合协调度分析相关结论

五大发展理念的耦合水平由低耦合水平逐步提升至高水平耦合阶段只用了三年的时间，从 2010 年的 0.2727 发展到 2013 年的 0.8245，五大理念之间存在着客观事物高质量发展的本质联系，体现了五大理念的正确性。从 2014 年至 2018 年，起初耦合度持续了三年的高水平耦合，后期不是很稳定，耦合度一直在高水平耦合和磨合阶段之间来回波动。耦合协调程度 D 值由 0.2120 发展至 0.8398，从 2010 年至 2014 年间的耦合协调水平依次是严重失调、重度失调、濒临失调、勉强耦合协调、初级耦合协调，2013 至 2017 年间偶和协调程度相对稳定，在勉强和初级耦合协调两者间波动，2018 年最终发展至良好协调。在发展初期，五大理念发展的不稳定、不平衡导致陕西保险业整体发展水平偏低。随着时间的推移，五大理念体系的不断磨合前进，五大发展理念的协调发展程度逐渐转好，说明在创新、绿色、协调、开放和共享这五个理念下，陕西保险业高质量发展正在开始进入良好发展态势。

## 5. “强监管”背景下，陕西保险业高质量发展模式和路径

### 5.1 发展模式

#### 5.1.1 强监管下，实现开放合作

保险业高质量发展的关键在于给保险注入新型活力、增强保险的创新力和提升保险行业竞争力，这也是从供给侧改变现有保险结构模式的根本途径。陕西省保险业高质量发展需要银保监会在强监管的同时，还需放开政策，大力引入外资保险公司的进入，开放中外资保险公司相互合作共赢的局面。

#### 5.1.2 建立共享互助机制，实现多样化服务

陕西保险业构建保险行业大数据平台，共享平台建设可以创新保险产品提供高质量服务，进一步带动经济高质量发展。在“强监管”的背景下，陕西保险业更应当将“合作+共享+互助”联合行动发挥极致，使得各保险公司在保险业里百花齐放，保证保险业可以高质量发展。

### 5.2 路径建议

#### 5.2.1 注重保险科技创新能力

陕西保险公司以“风险管理+财富管理”为核心，构建“保险+科技+服务”的新业务模式，发展综合竞争实力。尤其是在“强监管”背景下，保险创新科技可以赋予保险业新的发展模式和路径，帮助提高保险业市场占有率，优化保险业市场竞争环境，在碎片化、场景化、生活化的生活信息中利用科学技术的方式产生保险需求，实现保险行业整体的高质量发展。

#### 5.2.2 加大绿色保险宣传力度

政府应建立明确的制度，加大绿色保险宣传力度，进而宣传绿色保险政策，推动绿色保险的实施，不管是对于数据平台的更新还是保险精算等方面都是十分迫切和必要的。探索绿色保险对节能减排的实际效应，加强绿色保险的险种试点，提出更全面的保险业高质量发展模式和路径。

5.2.3 把服务当做保险公司的核心竞争力

在“强监管”背景下，每一个保险公司或是每一个保险从业人员都应该遵守行业行为准则，如此保险业才能得到更好的规范来服务社会，整个保险行业的风气才能得到改善。现如今人们对保险有了更多的需求感，陕西保险业首先要做好自己服务方面影响的源头，使上层建筑诸因素得到良好发展从而将保险业高质量发展得到提升。

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# “强监管”背景下，陕西保险业高质量发展模式和路径研究

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**关键词:** “强监管”背景;保险业高质量;模式和路径

**中文摘要.** 本文立足于保险市场“强监管”的背景，以五大发展理念为准侧层构建了指标体系，利用灰色关联分析方法与耦合协调度模型评价了陕西保险业高质量发展程度。结果显示，陕西保险业高质量发展逐渐朝向好的发展方向，发展过程中创新方面相较不成熟，开放理念和共享理念方面有待提高；五大发展理念在推动保险高质量发展过程中相互影响，相互推动。在此基础上，提出了陕西保险业高质量发展模式和路径的对策建议。

# The Spatial Measurement Analysis of Insurance Agglomeration to the Innovation Efficiency of High-tech Industry
## --Based on Panel Data of 31 Provinces and Cities in China

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**Keywords:** Insurance agglomeration, Innovation efficiency, Spillover effect, DEA-Malmquist, Spatial Dubin model

**Abstract.** With the development of the global economy, enhancing the innovation capacity of various industries, improving innovation efficiency and occupying a strong market position are important initiatives to increase the regional economic and technological competitiveness. As a financial instrument, insurance agglomeration determines toa certain extent the level of risk management in the region, and the ability to handle risk reflects the strength to explore new markets. Based on the data of 31 provinces and cities in China from 2009 to 2018, this paper firstly constructs the index systems and then analyzes the insurance agglomeration index and the innovation efficiency of high-tech industries by using the entropy method and the data envelopment analysis (DEA) model. Moreover, we explore the spatial spillover effect of insurance agglomeration on innovation efficiency, which has important theoretical and practical significance to develop the rational insurance industry and enhance the innovation efficiency of regional high-tech industry.

The main results indicate that the level of insurance agglomeration and high-tech agglomeration in China gradually decreases from the eastern region to the central region and then to the western region. The innovation efficiency level shows an overall year by year increased trend during the research period due to the promotion

of technical efficiency and technological changes. Moreover, insurance agglomeration has a significant positive impact on the innovation efficiency of high-tech industries in the province, whereas it has a negative spillover effect on the innovation efficiency of neighboring provinces. Finally, economic level, industrial structure and environmental utilization have significant positive direct impact on innovation efficiency. Economic level, urbanization rate and wage level have positive innovation spillover effects, while environmental utilization and government participation have negative spillover effects.

## 1. Introduction

With the continuous development of the global economy, improving the efficiency of industrial innovation conducive to occupy a strong market position and increase regional economic and technological competitiveness. The better the economic development of the region, the more financial institutions and insurance companies will be introduced, as well as the gathering of more insurance industry personnel and the capital investment. The development of insurance can effectively protect the rights and interests of local citizens. Insurance can maintain social stability and has an increasingly important position in social and economic development. Economic development can effectively support local technological innovation and provide more production factors, such as capital. The introducing new industries can enhance knowledge exchange with surrounding regions. On the other hand, due to the characteristic of the R&D and investment of innovative products, time lag and the uncertainty of market demand changes, there is the failure risk of R&D. The risk protection function of insurance can effectively mitigate the capital loss caused by the failure of R&D in the high-tech industry. The ability of an enterprise to bear failure can continue the innovation enthusiasm of R&D personnel and put ideas into practice more boldly.

Marshall (1920) proposed the concept of economic agglomeration. Agglomeration promotes both competition and cooperation, and attracts economic activities close to the areas with high concentration, thus forming agglomeration regions or urban clusters. With the promotion of regional development strategies such as new urbanization and urban agglomeration construction in China, agglomeration will drive the continuous development of the economy, bringing a relative concentration of capital, technology, and professional talents, which is conducive to the exchange and improvement of technology. At the same time, it can also improve resource utilization by sharing, matching and learning that work on production efficiency (Duranton and Puga, 2003; Takeda et al., 2008). On this basis, it cultivates the innovation ability of enterprises or individuals, enhances the core competitiveness within the region, achieves the improvement of innovation efficiency, and further promotes regional development.

Insurance agglomeration provides more reasonable insurance products and services. It not only provides more innovation opportunities for insurance, but also provides companies with the ability to act and respond quickly (Carlino et al., 2014). High-tech industries are characterized by high risks and high returns. China's traditional financial intermediaries tend to invest in industries with low-risk and stable-return. Therefore, insurance products provide investment entities with an instrument to diversify investment risks (Gary, 1997). Insurance agglomeration can enhance the risk

prevention awareness of high-tech industries and have a positive impact on the efficiency of innovative technology transformation (Luo, 2010). However, due to the uneven development of China's insurance industry, insurance is still in the development stage, and it has not shown its due agglomeration effect on the innovation efficiency of high-tech industries (Liu, 2017). There are big differences in the development of economy, education, science and technology in various regions of China, and the innovation ability among regions is also uneven. A large number of studies have introduced spatial models for testing, and the results show that the impact of industrial agglomeration on the innovation efficiency of high-tech industries differs within regions at different stages of development, indicating that spatial agglomeration has driving force on technological innovation in the short term (Yang et al.,2020; Zhang et al., 2019).

Much attention has been paid to the development and impact of economic agglomeration or financial agglomeration, and the unilateral effect of insurance on the economy. The feasible policy recommendations put forward in these literatures have important reference significance. However, existing studies mostly use a single index to measure the degree of insurance agglomeration. As a complete industry, insurance has more complicated influencing factors. Therefore, the single factor measurement of insurance agglomeration is not suitable. Moreover, there is rarely studied in depth to explore the impact of insurance agglomeration on innovation efficiency. It is even rarer to study the spillover effect of insurance agglomeration on innovation efficiency from a spatial perspective. Therefore, this study firstly constructs an insurance density measurement system through multiple indicators including insurance density and insurance depth and uses the entropy method to measure the index of insurance agglomeration. Then the data envelopment analysis (DEA) model has been used to measure the innovation efficiency of high-tech industries in each province of China. Finally, this study uses the Spatial Dubin Model (SDM) to study the spillover effect of insurance agglomeration on innovation efficiency to provide empirical evidence support for policy makers.

The remainder of this study is organized as follows. Section 2 presents a brief review of the literature. Section 3 presents the model and introduces the empirical approach. Section 4 presents the empirical results and discussions. Section 5 provides the conclusion and policy recommendation.

## 2. Literature review

The level of economic development is one of the main factors affecting the degree of insurance agglomeration. Adnan and Evrim(2009) find that the scale effect of insurance is particularly important for the development of insurance. Tian and Jin (2016) analyze the spatial agglomeration characteristics of China's provincial insurance development and believe that the development of the insurance industry in each province shows significant spatial agglomeration. Insurance relies on the input of production factors such as talents. The improvement of the information infrastructure will help both parties to the insurance contract avoid the emergence of information asymmetry. Speeding up the dissemination of information will improve the effectiveness of communication and reduce additional costs in the transaction process (Zhang, 2016). As an important savings tool, the savings function of insurance is an important source of revenue for insurance companies. Based on the high level of

residents' savings, insurance companies make reasonable investments and turn them into assets that can be used. In addition, the degree of foreign exchanges, the level of urbanization, the total value of imports and exports, industrial structure and government policies all have a positive impact on the agglomeration of financial-related industries (Liang, 2009).

There are many methods to measure the degree of agglomeration, the most common is the measurement of overall economic activity. Yu et al. (2019) used location entropy to measure the degree of agglomeration of high-tech industries, the study found that the agglomeration of high-tech industries and R&D efficiency can promote each other. Eleonora (2005) uses location entropy index and Theil dissimilarity index to analyze the development of European manufacturing agglomeration from 1985 to 2001. Wang (2013) uses the DO index to study the agglomeration of input and output factors in China's real estate industry. In addition, the standard deviation ellipse method can be used to explore the agglomeration characteristics of spatial elements. Uchida and Nelson (2009) used the agglomeration coefficient to measure the degree of urban concentration.

Taking into account the relevance of industry and financial agglomeration, the single index method in the method of measuring agglomeration generally chooses location entropy, Herfindahl-Hirschman index and spatial Gini coefficient, which can be used to analyze the degree of specialization of production departments in various industries, concentration and dispersion of a certain industry and spatial distribution of the industry (Kies et al., 2009; Thembalethu et al., 2020; Crespo, 2020). Among the existing comprehensive evaluation methods, Ye et al. (2018) uses financial industry related variables and the added value of the tertiary industry to measure the level of financial agglomeration. Ru et al. (2014) constructed an indicator system of financial agglomeration from four aspects: financial background, financial scale, financial density and financial depth, and analyzed the level of financial agglomeration in central cities. Few studies have used comprehensive evaluation methods to measure the level of insurance agglomeration.

In today's economic globalization, more and more scholars are beginning to explore the innovation efficiency of high-tech industries. Guan et al. (2012) proposed the DEA model of relational network data envelopment analysis, which used the network of knowledge production process to measure the innovation efficiency of the national innovation system. Cruz-Cázares et al. (2013) also estimated the innovation efficiency of high-tech through the DEA model, and observed the annual innovation efficiency changes according to the global Malmquist index. Ivanova et al. (2015) used the SFA model to analyze the impact of government funding on the innovation efficiency of high-tech industries. There are also studies using single indicators such as the ratio of new product sales revenue to new product development investment and knowledge efficiency to measure the innovation efficiency of the industry (Cagno et al., 2015; Hong et al., 2016)

The eastern part of China has more high-tech industries with strong innovation capabilities, and good knowledge spillovers can be formed between enterprises. With the acceleration of the opening-up process, inter-regional knowledge spillovers and technological advancements have brought a broader positive impact (Zhang, 2011). High-quality workers can show greater value in the production process. Workers with

different skills can bring innovative capabilities from different perspectives to the high-tech industry, which is conducive to improving the innovation efficiency of regional industries. (Xi, 2019; Banwo et al., 2017). The optimization and upgrading of the industrial structure will improve the quality of the elements, promote the continuous innovation and upgrading of products (Yi et al.,2020). Li et al. (2018) found that government actions such as government subsidies have an important impact on the technological innovation efficiency of the regional manufacturing industry, and the more R&D investment, the more it will stimulate the enthusiasm of R&D personnel for innovation. Academic exchanges and research institutions are also factors that affect the efficiency of scientific research in the high-tech industry (Cheng, 2011).

## 3. Methodology

### 3.1 Measurement of insurance agglomeration

Entropy method can be used to measure the spatial distribution of production factors in a certain area. In information theory, entropy is used to measure the uncertainty of random variables. The smaller the information entropy is, the larger the amount of information and the higher the corresponding weight will be.

The basic steps of the entropy weight method are as follows.

Construct the decision matrix of n indexes and m evaluated objects.

$$\mathrm{P}_{nm}=\begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1m} \\ X_{21} & X_{22} & \cdots & X_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ X_{n1} & X_{n2} & \cdots & X_{nm} \end{bmatrix}_{n\times m} \tag{1}$$

Among the above metric, $X_{ij}$ is variable *i* of the insurance agglomeration measure in province *j*.

Due to the difference in the dimension and magnitude of the variables of the insurance agglomeration, if the values are not standardized, it may cause the observation variables with larger dimensions to have a greater impact on the results and weaken the weight. After standardizing the values, different observed variables have the same scale, which can eliminate the differences among different observed variables, accelerate the convergence of weight parameters, and make the evaluation index more reasonable. Normalize the data according to following equation:

$$M_{ij}=\begin{cases} \dfrac{X_{ij}-\min\{X_{ij},\ldots,X_{nj}\}}{\max\{X_{ij},\ldots,X_{nj}\}-\min\{X_{ij},\ldots,X_{nj}\}},(X>0) \\ \dfrac{\max\{X_{ij},\ldots,X_{nj}\}-X_{ij}}{\max\{X_{ij},\ldots,X_{nj}\}-\min\{X_{ij},\ldots,X_{nj}\}},(X<0) \end{cases} \tag{2}$$

According to the definition of information entropy,

$$E_{ij}=-\ln(n)^{-1}\sum_{j=1}^{n}P_{ij}\ln P_{ij}\ , \tag{3}$$

where If $P_{ij}=0$, then define $\lim_{p_{ij}\to 0}P_{ij}\ln P_{ij}=0$

The weight of index *i* in province *j* is calculated by,

$$W_{ij} = \frac{1 - E_{ij}}{m - \sum_{i=1}^{m} E_{ij}}, 0 \le W_{ij} \le 1, \sum_{i=1}^{m} W_{ij} = 1 \quad (4)$$

Then, the measure of the insurance agglomeration level of province *j* is defined as follows:

$$IA_j = \sum_{i=1}^{n} W_{ij} X_{ij} (i = 1,2,\ldots,n), \quad (5)$$

where $X_{ij}$ is variable *i* of the insurance agglomeration measure in province *j*, and $W_{ij}$ is the weight of variable *i* in city *j*.

### 3.2 Measurement of innovation efficiency

Data Envelopment Analysis Method (DEA) uses linear programming methods to evaluate units of the same type and comparable. The Malmquist index was used to calculate the spatial difference in the carbon sequestration efficiency. The Malmquist index is a linear function that uses distance functions to represent the multiple output and input variables (Caves et al., 1982):

$$M^{t,t+1} = [\frac{D^t(x^{t+1}, y^{t+1}) D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t) D^{t+1}(x^t, y^t)}]^{1/2}, \quad (6)$$

where the input and output variables and $t+1$ are represented by $x^t$, $y^t$ and $x^{t+1}, y^{t+1}$, respectively. and represent the distance function estimated using the technical reference sets of and $t+1$, respectively.

According to Fare et al. (1994), Eq. (7) can be decomposed into

$$M_0(x_t, y_t, x_{t+1}, y_{t+1}) = \frac{D_0^t(x_{t+1}, y_{t+1})}{D_0^t(x_t, y_t)} \times [\frac{D_0^t(x_{t+1}, y_{t+1})}{D_0^{t+1}(x_{t+1}, y_{t+1})} \times \frac{D_0^t(x_t, y_t)}{D_0^{t+1}(x_t, y_t)}]^{1/2}, \quad (8)$$

where $M^{t,t+1} > 1$ indicates the efficiency increases; $M^{t,t+1} < 1$ indicates the efficiency decreases; $M^{t,t+1} = 1$ indicates the efficiency is invaraint. Eq. (8) can be decomposed into：

$$M_0(x_t, y_t, x_{t+1}, y_{t+1}) = tfpch = techch \times effch = techch \times (\sec h \times pech), \quad (9)$$

Where, total factor productivity (*tfpch*) is the product of the technological progress index (*techch*) and the technological efficiency change index (*effch*). The technical efficiency index can be further decomposed into the pure technical efficiency ( $Pech$) index and the scale efficiency index (*Sech*). Variables *tfpch, techch,* sech, *pech* and *effch* all take 1 as the boundary between growth and decline of the efficiency.

### 3.3 Spatial autocorrelation model

The Moran Index (Moran's I) was proposed by Moran (1950). The index value belongs to the interval [-1,1], which can be used to determine whether the relevant index has a spatial correlation in a certain range. Moran's I> 0 indicates positive spatial correlation. Global Moran's I can determine whether there is agglomeration in

the space, and local Moran's I can determine the specific location of the agglomeration.

The global Moran index is defined as:

$$GI = \frac{\sum_{i=1}^{n}\sum_{j=i}^{n} W_{ij}(X_i - \bar{X})(X_j - \bar{X})}{\sum_{i=1}^{n}\sum_{j=i}^{n} W_{ij} \times \sum_{i=1}^{n}(X_i - \bar{X})^2}, \tag{10}$$

where and are the i-th and j-th observations in the whole region, respectively, i.e., the gross regional product in this study. $\bar{X}$ is the sample mean. is the element of the i-th row and the j-th column in the spatial matrix. GI>0 indicates that there is an overall positive spatial correlation, if GI<0, it indicates that there is a negative spatial correlation. The larger the absolute value of GI, the stronger the spatial correlation.

The local Moran index is defined as:

$$LI = \frac{n(X_i - \bar{X})\sum_{j=i}^{n} W_{ij}(X_j - \bar{X})}{\sum_{i=1}^{n}(X_i - \bar{X})^2} \tag{11}$$

The global Moran index and the local Moran index are used to measure the spatial autocorrelation of insurance development in this study.

### 3.4 Model specification

There are several econometric models that are currently used to study the spatial effects, the Spatial Lag Model (SLM), the Spatial Error Model (SEM), and the Spatial Dubin Model (SDM). The SLM considers that the influence of the explanatory variables can act on other spatial regions by spatial transmission mechanisms. . The SEM assumes that the spatial dependence is reflected by the random error terms and the existence of spatial correlation for unobservable random shocks. The SDM on the other hand, combines the characteristics of the SLM and SEM by introducing the spatial lag terms of the independent and dependent variables, which can better estimate the spatial effects measured based on panel data. Therefore, the SDM is used in this study.

The expression of SDM is:

$$y = \rho Wy + \alpha \iota_n + X\beta + WX\gamma + \mu + \lambda + \varepsilon, \tag{13}$$

where $Wy$ is the spatial lag of the dependent variable, $WX$ is the spatial lag of the independent variables; $\mu$ is a spatial fixed effect; $\lambda$ is a time fixed effect; and $\varepsilon$ is random error term with normal distribution; W is the spatial weight matrix. The spatial weight matrix can reflect the interaction between regions (Richard et al., 2011). In this study, three spatial weight matrices are used to describe spatial spillover effects.

The economic distance matrix is based on the level of economic development between provinces.

$$W^{E}{}_{ij} = \begin{cases} \dfrac{1}{|\overline{Y}_i - \overline{Y}_j|}, i \neq j \\ 0, i = j \end{cases} \tag{14}$$

The geographic distance matrix uses the inverse of the linear distance between the geographic centers of two province as the matrix elements.

$$W^{0\text{-}1}{}_{ij} = \begin{cases} \dfrac{1}{d_{ij}}, i \neq j \\ 0, i = j \end{cases} \tag{15}$$

The 0-1 weight matrix is based on the judgement of whether the provinces are geographically adjacent to each other.

$$W^{G}{}_{ij} = \begin{cases} 1, \text{i and j are adjacent in space} \\ 0, \text{i and j are not adjacent in space} \end{cases} (i \neq j) \tag{16}$$

Considering the spatial correlation of insurance agglomeration and spillover effects, the SDM equation in this paper is finally expressed as follows:

$$\begin{aligned} \ln IE_{it} &= c + a_1 \ln IA_{it} + a_2 \ln Env_{it} + a_3 \ln Urb_{it} + a_4 \ln Fdi_{it} + a_5 \ln Invest_{it} \\ &+ a_6 \ln Wage_{it} + a_7 \ln Industry_{it} + a_8 \ln Gov_{it} + a_9 \ln Gdppc_{it} + a_{10} \ln WIA_{it} \\ &+ a_{11} \ln WEnv_{it} + a_{12} \ln WUrb_{it} + a_{13} \ln WFdi_{it} + a_{14} \ln WInvest_{it} + a_{15} \ln WWage_{it} \\ &+ a_{16} \ln WIndustry_{it} + a_{17} \ln WGov_{it} + a_{18} \ln WGdppc_{it} + \rho \ln WIA_{it} + \mu_i + \lambda_t + \varepsilon_{it}, \end{aligned} \tag{17}$$

where IE is the innovation efficiency of high-tech industries, IA is the level of insurance agglomeration, Env is the degree of environmental utilization, Urb is the urbanization rate, Fdi is the degree of opening to the outside world, Invest is fixed asset investment, Wage is the wage level, Industry is the industrial structure, Gov is the degree of government participation, and Gdppc is the level of economic development. $\rho$ measures the spatial spillover effect of innovation efficiency. $a_i (i = 1,...,9)$ measure the effects of the related variables on innovation efficiency. $a_i (i = 10,...,18)$ measures the spatial spillover effects.

## 4. Empirical analysis

This paper selects the panel data of 31 Chinese provinces from 2009 to 2018 to analyze the spatial role of insurance agglomeration on innovation efficiency and the spillover effect of innovation efficiency of high-tech industries in each surrounding region. Data are from the 2010-2019 China High-Tech Statistical Yearbook, the financial and fiscal section of the China Statistical Yearbook, and the statistical yearbooks of 31 provinces. Insurance density refers to per capita premium income, and insurance depth refers to proportion of the premium income of the insurance industry in a certain region to the regional GDP. The data comes from the "China Insurance Yearbook". Data processing is performed using DEAP2.1, Stata16.0, ArcGIS software.

## 4.1 Insurance agglomeration and innovation efficiency

### 4.1.1 Insurance agglomeration

This study constructs a measurement system of insurance agglomeration from various aspects such as insurance depth, insurance density, the number of employees in the insurance industry, the number of insurance institutions and the amount of insurance. The depth and the density of Insurance can measure the maturity of the regional insurance market, reflecting the status of the local insurance in the national economy and people's insurance awareness. The number of employees in the insurance industry, the number of insurance institutions, and the amount of insurance are the most intuitive demonstration of insurance development and agglomeration. All the above indicators can reflect the development of regional insurance and are also important indicators for measuring insurance agglomeration.

Table 1 Insurance agglomeration index

| Variables | Description | Unit |
|---|---|---|
| Insurance Agglomeration (IA) | insurance depth | % |
| | insurance density | yuan/person |
| | the number of insurance employees | person |
| | the number of insurance institutions | pieces |
| | insurance amount | 100 million yuan |

Figure 1 shows the average insurance agglomeration level by provinces and cities from 2009 to 2018.There has been an overall upward trend in insurance concentration over the past decade. However, the development of China's insurance industry is uneven. The degree of insurance agglomeration gradually decreased from the eastern region to the central region and then to the western region.

The average insurance agglomeration level can be roughly divided into four groups according to the level of agglomeration. Beijing, Shanghai, and Guangdong have the highest degree of insurance agglomeration and are the first echelon. They have strong economic foundation and political resources. Insurance company headquarters are more concentrated, and have strong radiating ability to surrounding areas. With the gathering of senior talents, high salary level, and people's overall insurance awareness, the insurance market demand is broad. Chongqing, Zhejiang, Shanxi, and Henan belong to the second echelon of China's insurance agglomeration level with certain economic strength. In recent years, due to the active layout of technology-based financial and insurance products, the insurance industry to achieve greater development. Tibet, Qinghai, Guizhou, and Guangxi have the lowest degree of agglomeration in the fourth echelon. Ten years after the western development policy, the strategic layout has been adjusted, the scale of insurance has expanded compared with before. However, the number of insurance companies is still relatively small and the introducing and training of insurance talents is still in progress. The other provinces are in the third echelon.

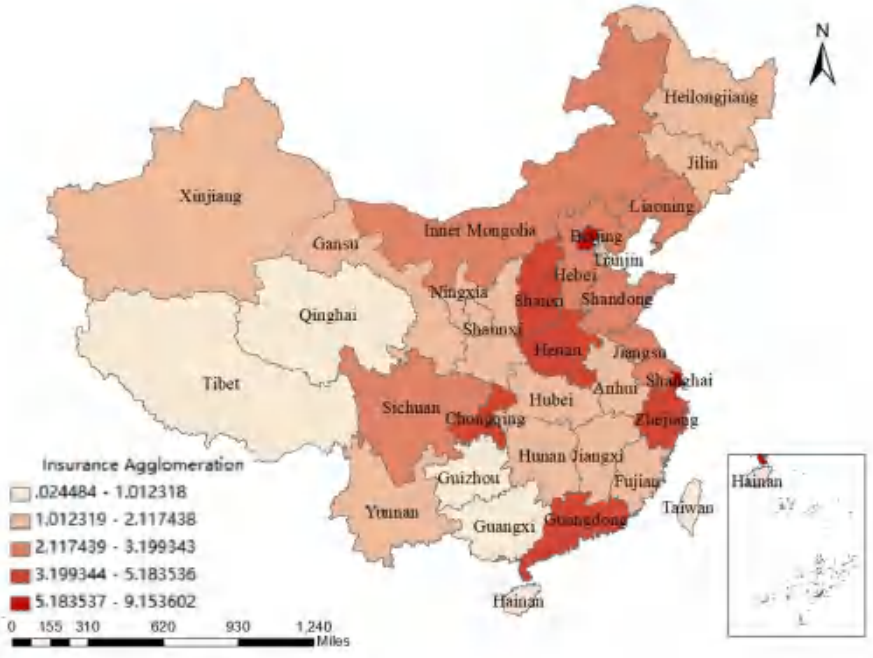


Figure 1 Annual average insurance agglomeration in various provinces and cities

4.1.2 Innovation efficiency of high-tech industry

R&D personnel profile and research funding are two important indicators of measuring innovation efficiency input (Cruz-Cázares et al., 2013). In this study, R&D expenditures and R&D employment are used as input indicators of innovation efficiency in high-tech industries, and the number of patent applications and new product sales revenue are used as output indicators (Xie, 2011; Ya et al., 2020; Liu and Chen, 2020). More details are reported in Table 2.

Table 2 Input-output indicators of high-tech industry innovation efficiency

| Variables | | Description | Unit |
|---|---|---|---|
| innovation efficiency (IE) | input | R&D expenditures | Ten thousand yuan |
| | | R&D employment | persom |
| | output | Patent applications number | Pieces |
| | | sales of new products | Trillion yuan |

Based on the selected innovation efficiency indicators, the innovation efficiency of the whole country and each province and city was measured by applying the DEA model. Table 3 shows the DEA-Malmquist index and its decomposition results. Overall, the national total factor productivity in innovation was 1.006 with a growth rate of 0.6% during the period 2009-2018, an overall upward trend in innovation efficiency over the study period. The technical efficiency index increased by 24.8% and the technical progress index increased by 11.7%, both contributing to the improvement of the efficiency of technology innovation. The pure technical efficiency and scale efficiency indices increased by 2.7% and 17.8%, respectively, indicating that both scale efficiency and pure technical efficiency contribute to the improvement of innovation efficiency.

In the terms of time scale, the innovation efficiency of high-tech industry increased in 2010-2011, 2012-2013, 2013-2014, 2015-2016, 2016-2017, 2017-2018. Among them,

in 2010-2011 and 2015-2016, the technical efficiency index was less than 1, but the technical progress index was greater than 1, indicating that in these two periods, the growth due to technical efficiency is not significant, while the technological progress drives the total factor productivity. Whereas technical efficiency increased in 2012-2013, 2013-2014 and 2016-2017, the technical change index decreased, indicating that the main indicator contributing to the productivity of innovation factors was technical efficiency in these years. The increase in technical efficiency from 2012-2013 and the technical change from 2011-2012 is particularly evident. The technical efficiency increased by 7.6% and the technical change index increased by 4.5% in 2017-2018, indicating that scientific and technological inventions are valued and the efficiency of resource allocation is developing in synergy for the better, which together contribute to productivity growth.

Table 3 The national DEA-Malmquist index and the decomposition of high-tech industry innovation efficiency

| | Technical efficiency | Technological progress | Pure technical efficiency | Scale efficiency | TFP |
|---|---|---|---|---|---|
| 2008-2009 | 0.936 | 0.974 | 1.014 | 0.923 | 0.911 |
| 2009-2010 | 1.144 | 0.732 | 0.985 | 1.161 | 0.838 |
| 2010-2011 | 0.688 | 1.600 | 1.016 | 0.677 | 1.101 |
| 2011-2012 | 0.350 | 2.521 | 0.864 | 0.404 | 0.881 |
| 2012-2013 | 4.114 | 0.273 | 1.183 | 3.478 | 1.125 |
| 2013-2014 | 1.199 | 0.854 | 1.122 | 1.166 | 1.020 |
| 2014-2015 | 0.889 | 1.034 | 0.959 | 0.927 | 0.919 |
| 2015-2016 | 0.830 | 1.302 | 1.071 | 0.775 | 1.081 |
| 2016-2017 | 1.253 | 0.837 | 1.066 | 1.175 | 1.049 |
| 2017-2018 | 1.076 | 1.045 | 0.987 | 1.089 | 1.138 |
| Average | 1.248 | 1.117 | 1.027 | 1.178 | 1.006 |

Then we analyze the innovation efficiency of each province for 2010, 2012, 2014, 2016 and 2018 (Figures 2, 3, 4, 5, and 6). Overall, there is a clear trend of improving the efficiency of innovation in China. However, high-tech efficiency is concentrated in the eastern coastal regions, and the efficiency gradually declined from the east to the west with large differences in efficiency. There is a certain trend of clustering of innovation efficiency, and the direction of efficiency development in the same region tends to be consistent and more concentrated. In 2010, Shanxi, Beijing, Eastern and Southern China had relatively higher innovation efficiency. In 2012, eastern China achieved substantial innovation and development. Inner Mongolia and Hebei saw a leap forward in innovation efficiency. At the same time, the western region was also gradually developing. Due to the small data base of each indicator in Qinghai and Tibet, the improvement or change of factors had a greater impact on the growth rate, which in turn affected the innovation efficiency. Inner Mongolia, Henan, Hunan and Jiangsu are the provinces with consistently high innovation efficiency in high-tech industries h, while the innovation efficiency in the western region is not stable. It can be seen that the innovation and development of high-tech industries in neighboring provinces also varies, and knowledge spillover and technological exchange have not reached expectations.

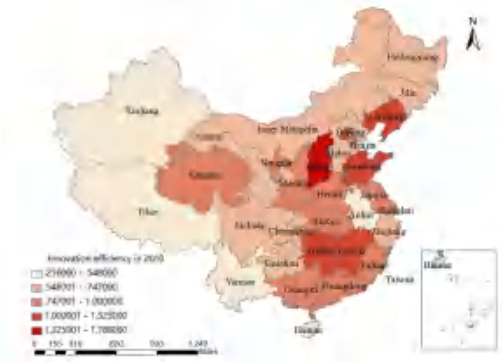

Figure 2 Innovation efficiency in 2010

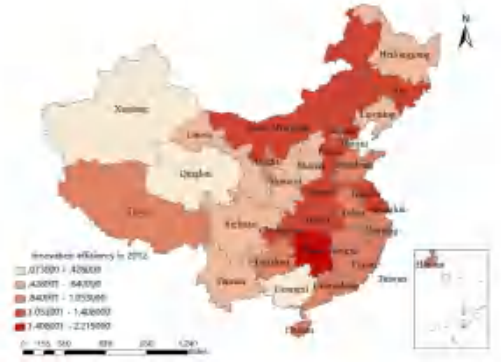

Figure 3 Innovation efficiency in 2012

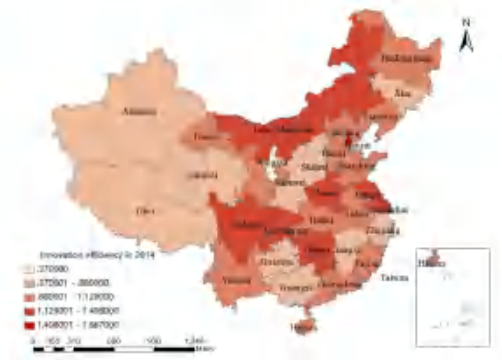

Figure 4 Innovation efficiency in 2014

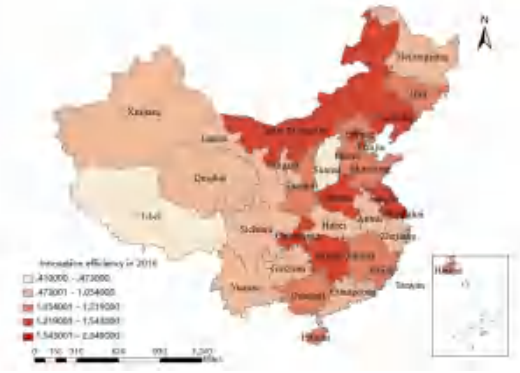

Figure 5 Innovation efficiency in 2016

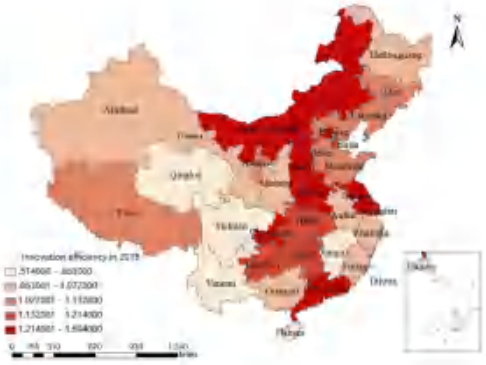

Figure 6 Innovation efficiency in 2018

## 4.2 Empirical analysis of insurance agglomeration on innovation efficiency

4.2.1 Spatial correlation

The spatial correlation between innovation efficiency and insurance agglomeration was first tested using Moran's I based on the geographical distance matrix, and the results are shown in Table 4. The Moran's I value of innovation efficiency from 2009 to 2018 ranged from 0.132 to 0.213 with the corresponding p-value all less than 0.05. The Moran's I value of insurance agglomeration is in the interval of 0.239-0.273 with the corresponding p-value all less than 0.01. This is the evidence that there is a significant spatial correlation between the innovation efficiency and insurance agglomeration in all Chinese provinces. The Moran's I value of innovation efficiency dropped from 0.168 in 2009 to 0.140 in 2012, after which Moran's I exhibited a dynamic trend of increasing and decreasing intermittently. And the positive spatial

correlation of insurance agglomeration emerged in each province showed a decreasing and then increasing trend, and the spatial correlation phenomenon is obvious.

Table 4 Moran'I of innovation efficiency and insurance agglomeration

| innovation efficiency | | | | | | | | insurance agglomeration | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Moran'I | z | p | Year | Moran'I | z | p | Year | Moran'I | z | p | Year | Moran'I | z | p |
| 2009 | 0.168 | 1.788 | 0.037 | 2014 | 0.150 | 1.834 | 0.033 | 2009 | 0.255 | 2.495 | 0.006 | 2014 | 0.239 | 2.364 | 0.009 |
| 2010 | 0.132 | 1.646 | 0.050 | 2015 | 0.146 | 1.868 | 0.031 | 2010 | 0.253 | 2.485 | 0.006 | 2015 | 0.251 | 2.467 | 0.007 |
| 2011 | 0.147 | 1.795 | 0.036 | 2016 | 0.169 | 1.935 | 0.026 | 2011 | 0.250 | 2.463 | 0.007 | 2016 | 0.267 | 2.594 | 0.005 |
| 2012 | 0.140 | 1.786 | 0.037 | 2017 | 0.159 | 1.988 | 0.023 | 2012 | 0.243 | 2.407 | 0.008 | 2017 | 0.273 | 2.645 | 0.004 |
| 2013 | 0.163 | 1.777 | 0.038 | 2018 | 0.213 | 2.136 | 0.016 | 2013 | 0.239 | 2.369 | 0.009 | 2018 | 0.267 | 2.585 | 0.005 |

To further analyze the agglomeration characteristics of China's innovation efficiency, a national vector map for 2018 was drawn using Stata16.0 software for correlation analysis (Figure 7). The first and third quadrants indicate that there is a positive spatial correlation between regions with high innovation efficiency surrounded by high value regions and regions with low efficiency surrounded by low values, respectively. The second and fourth quadrants the existence of negative spatial correlation between regions with low innovation efficiency surrounded by high-value regions and high-efficiency regions surrounded by low-value regions, respectively. It can be seen from Figure 7 that most of Chinese provinces fall in the first and third quadrants, indicating that innovation efficiency of each province has a positive spatial correlation trend.

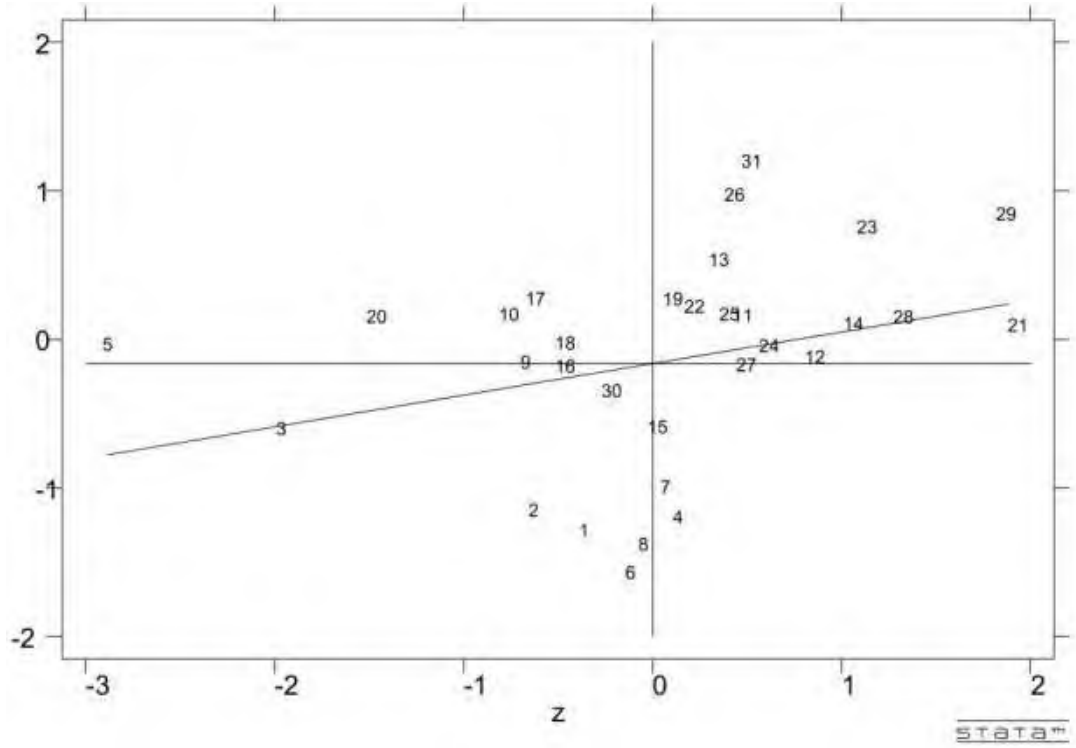


Figure 7 Moran' I scatter plot of innovation efficiency in 2018

4.2.2 Variable selection spatial measurement

Table 5 reports the variables involved in SDM model. Innovation efficiency is affected by the extent to which the innovation environment is utilized, and the

construction and investment of facilities represent the importance given to the innovative industries. In this study, we chose the area of construction land as a percentage of the total area of the region to measure the degree of environment use.. The population tends to favor cities with more job opportunities, high wages, and relatively good infrastructure such as healthcare. The regions with the above elements generally have a stronger overall capacity and will be more efficient in innovation. However, too high a urbanization rate may produce population overload and congestion of production factors External exchange can introduce cutting-edge foreign technological knowledge and for the exchange and discussion of innovative technologies (Liu et al., 2020). On the other hand, it can attract high-level talents from all over the world through opening to the outside world forming a concentration of talent elements enhancing innovation capacity and innovation level. Therefore, the degree of external openness can reflect the regional innovation. The input of innovation efficiency includes capital, manpower and other factors. Investment in fixed assets, including equipment and tools purchase costs and construction project costs, can control the investment of scale in innovation factors and affect the investment intensity of innovation R&D, which is in turn affects the innovation efficiency of high-tech industries.

In this study, we use average urban employee wages to measure wage levels. High wages can attract high-tech talents on the one hand, but on the other hand, innovators will be less enthusiastic in R&D with high and stable wages. With China's economic development, the industrial technology structure is gradually optimized, and financial and other industries are developing rapidly. The proportion of emerging service industries in the tertiary industry has increased, and the labor force is also gradually shifting to the secondary and tertiary industries. Thus, the industrial structure and the innovation efficiency development can reflect each other. The government’s contribution to innovation, such as financial support in R&D, helps high-tech enterprises in high-quality project selection and investment management. To a certain extent, it will help to improve the efficiency of innovation, but the effect of government support will also be bounded by the scale effect. We use the government's share of GDP in high-tech industries to represent government support. The economic development of each province can attract the innovation resources from the surrounding regions, and it is also the basis for enhancing innovation ability and efficiency.

Table 5 Spatial measurement variables

| Category | Variables | Description | Unit |
|---|---|---|---|
| Explained variable | IE | See 3.1 for details | |
| Core variable | IA | See 3.2 for details | |
| Control variables | Env | Construction land area/total area | % |
| | Urb | Urban population/total population | % |
| | Fdi | Total Import and Export/Gdp | % |
| | Invest | Fixed Asset Investment/Gdp | % |
| | Wage | Average urban employee salary | yuan/person |
| | Industry | Gross value of tertiary industry/Gdp | % |
| | Gov | Government spending/GDP | % |
| | Gdppc | Gdp/person | $10^4$yuan/person |

### 4.2.3 Analysis of innovation efficiency

First, the SDM is measured using the Wald test and LR test to determine whether it can be reduced to a spatial lag model (SLM) or a spatial error model (SEM)[1]. The Wald test statistic is 50.56 with the p-value is 0.000 and the LR statistic is 32.22 with the p-value is 0.000, both of which reject the null hypothesis, and indicating that the SDM model is appropriate. The Hausman test statistic is 15.42with p-value is 0.0515, and the Hausman test results favored use of a random effects model. In addition, combining the value of each model and the regression standard error, the random effects model of SDM has the highest degree of goodness of fit. The estimation results of the random effects of the SDM under three weight matrices are shown in Table 6.

Table 6 Regression results of SDM

| | Economic distance weight | Geographic distance weight | 0-1 adjacency weight |
|---|---|---|---|
| IA | 0.076***(3.78) | 0.085***(3.74) | 0.037**(1.96) |
| Env | 0.019***(4.75) | 0.010**(2.17) | 0.009**(2.24) |
| Fdi | -0.006***(-3.54) | -0.005**(-2.45) | -0.002(-1.43) |
| Wage | -0.001*(-1.65) | -0.001*(-0.94) | 0.001(-0.61) |
| Industry | 0.006**(2.37) | 0.008***(2.84) | 0.008***(3.00) |
| Gov | 0.001(0.27) | -0.001(-0.27) | -0.001(-0.35) |
| Gdppc | 0.078***(3.21) | 0.080***(3.16) | 0.067**(2.02) |
| Urb | -0.006(-1.48) | -0.008*(-1.94) | -0.004(-0.89) |
| Invest | -0.001(-0.76) | -0.001(-0.79) | -0.002*(-1.77) |
| W×IA | -0.155***(-3.71) | -0.091*(-1.89) | -0.179**(-2.44) |
| W×Env | -0.016**(-2.44) | -0.029***(-3.07) | -0.033*(-1.67) |
| W×Fdi | 0.001(0.14) | 0.005(1.10) | 0.011**(2.10) |
| W×Wage | 0.001***(3.68) | 0.001**(2.43) | 0.001**(2.30) |
| W×Industry | -0.003(-0.43) | 0.001(0.18) | -0.009(-1.03) |
| W×Gov | -0.007***(-2.67) | -0.009*(-1.71) | -0.121*(-1.69) |
| W×Gdppc | 0.150***(3.54) | 0.130**(2.20) | 0.073(1.10) |
| W×Urb | 0.018**(2.30) | 0.018*(1.92) | -0.009(-0.69) |
| W×Invest | -0.005**(-2.32) | -0.002(-0.66) | -0.002(-0.81) |
| Sigma$^2$ | 0.080***(12.44) | 0.080***(11.54) | 0.079***(11.72) |
| $R^2$ | 0.8768 | 0.7673 | 0.7026 |
| cons | 0.930**(2.03) | 0.234(0.38) | 2.01**(2.51) |

Note: *, ** and *** indicate that the coefficients are significant at 10%, 5%, and 1%, respectively.

[1] The tests of the original hypotheses ( $H_0:\gamma=0$ and $H_0:\gamma+\rho\beta=0$ ) can determine whether the SDM can be simplified to the SLM and SEM. If the null hypothesis $H_0:\gamma=0$ and $H_0:\gamma+\rho\beta=0$ are rejected, the SDM is the most suitable model for the observed data. These two tests obey the $\chi^2$ test with K degrees of freedom, and the corresponding tests are the Likelihood Ratio (LR) and Wald tests. The Hausman test was used to determine whether the model had fixed or random effects; and $R^2$ and sigma$^2$ were used to determine the goodness of fit of the model.

Insurance agglomeration has a significant positive impact on innovation efficiency under all three weight matrices:1% effect under the economic distance weight matrix and geographic distance weight matrix, and 5% effect under the 0-1 adjacency weight matrix. It indicates that the higher the degree of insurance agglomeration in each province, the more beneficial to the development of local innovation efficiency. However, the spatial variables of insurance agglomeration have significant negative impacts on the innovation efficiency of high-tech industries with the values of -0.155, -0.091, and -0.179 under all three weight matrices, respectively. It reveals that the spatial variables of insurance agglomeration have inhibitory effects on innovation efficiency of high-tech industries. That is, a rise in insurance agglomeration in neighboring provinces can inhibit the local innovation efficiency level. The plausible reason is that the insurance agglomeration in neighboring provinces may have attracted too much financial and economic resources, which have a trade-off effect on the efficiency of local innovation.

The degree of environmental utilization, industrial structure and economic development level all have a positive and significant impact in the three matrices. It indicates that the positive economic development, the emphasis on the use of the innovation environment and the realization of the optimization of the industrial structure contribute to improve the local innovation efficiency. The degree of opening to the outside world and wage level have a significantly negative effect in the economic distance weight and geographic distance weight matrices, respectively. With a high degree of openness, the local area may pay more attention to economic development and foreign capital exchanges, and ignore innovation. If the salary level is too high, the comfortable state of R&D personnel will make R&D enthusiasm lower. In the three weighting matrices, government participation is not significant effect on the innovation efficiency of high-tech industries. The urbanization rate has a significant negative impact in the geographical distance weight matrix. The population agglomeration brought by the increase in the population size will to some extent weaken the knowledge spillover from the concentration of professionals. As a result, population overload can burden innovation. Fixed asset investment has a negative effect on innovation efficiency at the 0-1 adjacency matrix at the 10% significant level.

For spatial variables, government participation and environmental utilization have significant negative spillover effects on innovation efficiency under the three weight matrices. The higher the environmental utilization, the stronger the attraction to regional factors. Driven by the siphon effect, it will have a negative impact on the innovation efficiency of surrounding regions to a certain extent. The wage levels in the surrounding regions have a positive impact on the local innovation efficiency of high-tech industries. In the process of catching up with the high wages in the surrounding regions, it will promote the motivation of R&D personnel in the high-tech industries in the region. The degree of opening to the outside world has a significantly positive spatial spillover effect in the 0-1 adjacent weight matrix. The opening up of surrounding areas will introduce external resources, and the knowledge spillovers from technological exchanges will bring advantages to the local innovation efficiency. The level of fixed asset investment in the surrounding areas only has a significantly negative impact in the economic distance weight matrix There is a significant positive spillover effect of both economic development level and urbanization rate in the economic distance and geographical distance weight matrices,

indicating that the economic development and urbanization rate of the surrounding region increase the economic strength and the number of talents in the region, which increase the efficiency of local innovation.

The decomposition of the direct and indirect effects of each factor is reported in Table 7. The direct impact is the direct effect of each variable on the innovation efficiency of the region's high-tech industry. Insurance agglomeration, economic level and industrial structure all have positive and significant effects on innovation efficiency. The level of environmental utilization showed a positive and significant effect. Improving environmental utilization can provide a broader platform for innovative research and development, and efficiency will also be improved. The degree of opening to the outside world has a negative impact on innovation efficiency in the economic distance and geographical distance weight matrices The indirect influence reflects the influence of the innovation efficiency influencing factors in the region on the innovation efficiency of neighboring regions. Insurance agglomeration shows a significant negative indirect spillover effect. The wage level has a significant and positive innovation spillover effect. And the spillover effectfrom the high local economic level and high urbanization rate will help the surrounding regions to improve the innovation efficiency. The degree of environmental utilization and government participation are negative spillover effects. In the 0-1 adjacency matrix, the degree of opening to the outside world has a positive spillover effect with significance level of 10%. The more frequent the local external communication, the more it contributes to the innovation efficiency of the surrounding regions.

Table 7 Decomposition of direct and indirect effects of SDM

| Variables | Economic distance weight | | | Geographic distance weight | | | 0-1 adjacency weight | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direct | Indirect | Total | Direct | Indirect | Total | Direct | Indirect | Total |
| IA | 0.074*** | -0.157*** | -0.083 | 0.083*** | 0.089 | -0.006 | 0.033* | -0.211** | -0.177* |
| Env | 0.019 | -0.016** | 0.003 | 0.008* | -0.033*** | -0025 | 0.008** | -0.356 | -0.028 |
| Fdi | -0.006*** | -0.001 | -0.006*** | -0.004** | 0.005 | 0.001 | -0.002 | 0.012* | 0.010 |
| Wage | -0.001 | 0.002*** | 0.001*** | -0.001 | 0.002** | 0.001* | -0.001 | 0.002** | 0.001* |
| Industry | 0.006** | -0.002 | 0.004 | 0.008*** | 0.003 | 0.011 | 0.008*** | -0.010 | -0.002 |
| Gov | 0.001 | -0.008*** | -0.007** | -0.001 | -0.012* | -0.013* | -0.001 | -0.014 | -0.015 |
| Gdppc | 0.075*** | 0.013*** | 0.088*** | 0.076*** | 0.022* | 0.098** | 0.066* | 0.035 | 0.101 |
| Urb | -0.006 | 0.018** | 0.012 | -0.007* | 0.020* | 0.013 | 0.005 | -0.011 | -0.006 |
| Invest | -0.001 | -0.006** | -0.007** | -0.001 | -0.002 | -0.003 | -0.002* | -0.004 | -0.006 |

Note: *, ** and *** indicate that the coefficients are significant at 10%, 5%, and 1%, respectively.

## 4.3 Discussions

The innovation efficiency in high-tech industries in most regions of China has improved in recent years, with particularly significant growth in technological efficiency in 2012-2013 and the technological progress in 2011-2012 h. With good policy support in 2011 and 2014, the Chinese enterprises expanded. However, due to the long cycle of innovation and insignificant economic benefits , the innovation dynamics of enterprises are insufficient, and the efficiency of innovative technology is not high. Many enterprises do not rely on their innovation ability to occupy market positions. Although the role of technological innovation is not yet obvious in the short term, companies are gradually accumulating high-quality technologies and using technological progress to drive innovation efficiency. As for the insurance industry, the life insurance premium income in the Chinese insurance market slowed down in

2011, and traditional insurance, universal insurance and investment-linked insurance all shrank, making the business development of the insurance industry hindered and the demand declined. Since 2015, companies began to develop innovation, with increased financial investment and fruitful output, and the upward trend of the innovation index is obvious.

The higher the insurance agglomeration in each province, the more beneficial to the development of local innovation efficiency. The insurance agglomeration brings diversified insurance products and derivative financial instruments. The risk management functions can improve the innovation system of high-tech industry. A high degree of agglomeration indicates that the number of local insurance companies and the level of premium income are all at a relatively high level, that the quality of workforce is high and the knowledge of insurance is more advanced. Therefore, their innovation consciousness and innovation ability are relatively strong, which contributes to improving the innovation efficiency (Tan, 2019). On the other hand, insurance agglomeration provides protection for venture capital companies, and also provides protection for R&D companies against the risks that R&D may entail, which contributes to the innovative development of high-tech industries. However, due to the late start of China's insurance industry, which is still in the development stage. The research and development speed of insurance products is still catching up with the people's increasing demand for risk control. Moreover, because of the obvious regional differences in insurance industry and the insurance legislation is not yet well managed, the scale effect of insurance cannot be manifested. The size of the company also limits the insurance industry’s ability to take risks, and the investment and protection of high-tech industries remains to be improved. Therefore, insurance agglomeration creates constraints on the spatial spillover of innovation efficiency (Liu, 2017; Zhu, 2020)。

Regions with a high economic level, optimized industrial structure and more attention to environmental utilization are more inclined to the development of innovative R&D of enterprises. Their innovative facilities and knowledge introduction have comparative advantages. Excessive wage levels create a stable working atmosphere, which will reduce the enthusiasm and creativity of employees in R&D (Xiao and Lin, 2014; Chen and Wang, 2017). The effect of government participation on the innovation efficiency of high-tech industries is not significant, but it has a positive impact under the economic distance weight matrix. that the plausible reason is that the government's support for enterprise innovation has not yet reached the level of precise policy-making and accurate support, and has not achieved the optimal level of support and precise support time. The negative spillover effect of government participation is due to the fact that government has different preferences to participate in companies with different technologies. And the government tends to support the innovation strategies of the preferred companies in the allocation of funds and resources, which to a certain extent causes the market to be inequitable and non-optimal allocation of resources. The capital-intensive conditions brought by increased investment in fixed assets can focus more on the development of large projects, which to a certain extent inhibits the benefits of enterprises that rely on innovation and reduces the enthusiasm for innovation in high-tech industries.

## 5. Conclusion and policy recommendation

This study uses the panel data of 31 provinces in China from 2009 to 2018 to construct a multivariate insurance density measurement system, and uses the entropy method to measure the insurance agglomeration index of each province. Then, we construct the input-output indicators of innovation efficiency, use the DEA-Malmquist model to measure the innovation efficiency to explore the factors affecting the innovation efficiency of each region. Based on the above research, SDM is applied to investigate the direct and indirect spatial spillover effects of insurance agglomeration on the innovation efficiency of high-tech industries.

The level of insurance agglomeration in China gradually decreases from the eastern region to the central region and then to the western region. Beijing and Shanghai lead the way in the insurance agglomeration, while Tianjin and Henan have the highest innovation efficiency. High-tech efficiency is concentrated in the eastern coastal areas, and the efficiency gradually decreases from the east to the west with a large extreme difference. The level of insurance agglomeration and innovation efficiency show an overall upward trend during the research period. North and Central South China are the two regions with more stable innovation growth trends. There is a significant spatial correlation between the innovation efficiency and insurance agglomeration of various provinces. Insurance agglomeration has a significant impact on the innovation efficiency of local high-tech industries, but it shows a significant negative spillover effect. Economic level, industrial structure and environmental utilization level all have significant positive direct effects on innovation efficiency, and the effect of government participation on the innovation efficiency is not significant. The wage level has a significant and positive innovation spillover effect, the economic level and urbanization rate have a significant positive spillover effect, while the environmental utilization and government participation have a negative spillover effect, and the degree of openness has a positive effect.

The theoretical and empirical analysis of the intensity and direction of the impact of insurance agglomeration on the innovation efficiency of high-tech industries has been described above. This article puts forward several policy suggestions based on the above research conclusions.

(1) Insurance elements will gradually gather in the core provinces and cities, and the core provinces and cities can play the role of radiation and spillover effects of insurance development. Cities can exert industrial linkage effects and economic driving effects. The eastern and western regions should strengthen business contacts with the insurance and financial industries, and conduct more knowledge exchanges and information sharing. High-quality high-tech industry clusters can attract more companies to settle in, reduce innovation costs through scale effects, and narrow the difference in innovation efficiency levels among regions.

(2) All regions should improve insurance legislation, introduce insurance innovation and sales talents, and increase the quality of industry services. Companies should produce more innovative insurance products to protect risks, encourage technological innovation of high-tech industries, and provide them with a funding platform. But Insurance agglomeration has negative spillover effects. The government should pay attention to the coordinated development of insurance and innovation, and

provide diversified financing methods to small primary innovative enterprises in order to prevent insurance clusters from squeezing out innovation efficiency.

(3) In order to provide a favorable environment for innovation, the region should focus on the improvement of the economic level and continuously optimize the industrial structure and spatial layout, so as to make high-tech enterprises more capable of investing in technology and human capital in innovation. Local governments can attract more foreign companies and talents by raising wages. Areas with a high urbanization rate can attract innovative elements from surrounding areas. The government should provide different levels of support and funding levels to enterprises at different levels, and ensure market fairness.

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# 保险集聚对高新技术产业创新效率的空间计量分析
## ——基于中国31个省市的面板数据

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**关键词：**保险集聚；创新效率；溢出效应；DEA-Malmquist；空间杜宾模型

**中文摘要.** 随着全球经济的不断发展，提升各行业的创新能力、提高创新效率、占据强有力的市场地位，是增加区域经济与科技竞争能力的重要举措。保险作为一种金融工具，保险集聚一定程度上决定了区域内的风险管理水平，对风险的处理能力反映了对新型市场的探索实力。本文运用我国31个省市2009-2018年数据，在构建指标体系基础上，分别运用熵权法和数据包络分析（DEA）模型测算出保险集聚指数和高新技术产业创新效率，并进一步研究保险集聚对创新效率的空间溢出作用，对更合理地发展保险产业，提升区域产业的创新效率具有重要的理论与现实意义。

本文实证分析结果表明，我国保险集聚和高新技术集聚水平由东部地区向中部再向西部地区逐级递减；创新效率水平在研究时段内整体呈逐年提升的趋势，技术效率和技术变化都促进了效率的提升；保险集聚对本省市的高新技术产业创新效率有显著的正向影响，而保险集聚对周边省市创新效率有负向的溢出效应；经济水平、产业结构和环境利用对创新效率都有显著正向的直接影响，经济水平、城镇化率和工资水平有正向的创新溢出效应，而环境利用程度和政府参与度是有负向外溢作用的。

# Chapter 2. Risk Management

# Temporary Advantage or Insurtech？– Research on Efficiency and Fairness of Online Mutual Aid

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**Keywords:** Mutual-aid platform, Insurtech, Commercial insurance.

**Abstract.** Online mutual-aid platform is an emerging internet finance phenomenon in China and has provided low-cost insurance cover for more than 200 million people. Mutual-aid platform aggregates groups requiring the same risk coverage online, within which the individuals share the ex-post losses. The coverage cost of mutual-aid platforms turns out to be far less than that of insurance companies. Does such low-cost advantage of the mutual-aid platform stem from the temporary rapid user-growth or from the Insurtech business model? Also, is the mutual-aid platform sustainable? We establish a theoretical model to compare the mutual-aid platform with commercial insurance. We find that the low-cost advantage of mutual-aid platform comes from inherent business model. In addition, we find there exists significant adverse selection risk.

## 1. 引言

网络互助平台是我国互联网金融领域中正如火如荼发展的新兴事物，是基于互联网进行风险共担的保障模式创新，近年来已经累计吸引了超过 2 亿人次的互联网用户。我国最早的网络互助平台可以追溯至 2011 年成立的康爱公社（原名“抗癌公社”），随后迅速出现了众托帮、水滴互助、轻松互助等一系列千万用户级别的平台，近期更是吸引了包括蚂蚁金服、滴滴、苏宁、美团等一大批互联网巨头的相继加入。其中，最令人瞩目的是蚂蚁金服旗下的“相互宝”，其会员数已经超过了 8600 万并在不断增长，相当于整个德国的人口，成为了全球最大网络互助平台。可以说，迅速发展的网络互助平台是我国互联网金融领域特有的现象，也是金融科技领域的一大亮点。

互助概念最早源于古罗马的丧葬互助会等组织中，是面临共同特定风险的团体中的每个成员共同享有保障的权利和承担分担风险的义务的一种模式。在今天的互联网时代，网络互助平台实现了通过互联网的信息撮合功能集中相同风险的人群并进行同担风险。在网络互助模式中，会员通过签署协议并承诺共同分担风险，通常需要预先缴纳一定的互助金作为给付保证，任何会员的风险损失在所有会员中进行分摊。网络互助平台承担了互助规则设计、用户推广、风险审核、风险管理等功能，并通常收取一定的管理费用。

网络互助模式最鲜明的两大特征为：“事后均摊原则”和“保障成本低”。首先，网络互助平台的绝大多数“互助计划”只是预先收取小额费用作为该会员后期进行均摊支付的保证[1]，这与保险产品商业保险产品定价极度依赖精算技术进行风险定价和费率厘定存在本质差异。其次，“先保障后分摊”的模式使得会员分摊费用主要用于赔付风险事件，节约了商业保险的销售成本、日常运营等费用，基于互联网的效率有效降低了保障成本。与相同保障程度的商业保险相比，网络互助的保障成本不足二分之一，这也是网络互助平台迅速吸引大量用户的重要原因。

随之而来的第一个问题是：网络互助保障的高效率保障的原因是什么？质疑

[1] 由于网络互助并非保险且未受监管，绝大多数平台将其具体的互助产品成为“互助计划”。

的声音认为，网络互助平台的保障成本低是阶段性的“接盘游戏”，主要是由于平台处于增长期，许多后期加入的新增会员需要参与均摊。那么，在剔除增长因素之后，网络互助模式是否也更具有效率呢？仍未有相关的理论或实证文献研究网络互助模式的低成本保障的原因。网络互助平台的发展也引起了一些国内学者的关注，但缺乏理论或实证层面的相关研究（魏迎宁，2018）。一些可以参考的文献是关于国外更早出现的 P2P 保险模式的研究，有观点认为基于保险科技的保障机制是降低保障成本的重要原因（杨超和陈秉正，2018）。

此外，另一个问题是网络互助模式是否具有公平性呢？也即，网络互助的机制设计是否考虑了逆向选择风险和可持续性？逆向选择风险广泛地存在于保险市场中，是保险机制设计中需要重视的重要问题（如 Cutler & Reber, 1998; Finkelstein & James, 2004; Cohen & Siegelman, 2010; 朱信凯和彭廷军, 2009）。根据 Rothschild & Stigliz（1976），建立在平均概率基础上的保费将使风险概率低于平均的个体退出市场，导致“劣币驱逐良币”。因此，商业保险针对不同风险水平个体分别制定合约，采用分离均衡克服逆向选择问题。从现实观察来看，网络互助模式的当前规则设计可能存在着公平性的缺陷。重要的原因在于，当前网络互助平台的规则和机制更多地从用户和市场推广角度出发，而非依据于精算意义上的公平性。如果网络互助平台的规则缺乏公平性，即一部分群体对另一部分群体进行风险补贴，将使得平台面临着逆选择风险，将不利于平台的可持续性。

简答总结，网络互助这一新兴的互联网保障模式缺乏相关学术研究分析其保障的效率性以及规则的公平性。因此，本文从效率与公平视角对网络互助模式进行理论分析。效率是指会员为了实现保障所需要付出的成本，也即，成本越低则效率越高；公平是指保障规则对于不同风险水平个体的财务公平。首先，本文基于理论框架探讨和比较不同的保障模式的成本，包括商业保险和网络互助模式。进一步地，本文研究了不同保障模式为实现机制公平所需要满足的条件。最后，我们基于实际数据验证我国网络互助平台规则的公平性，以期为互助平台未来规则的迭代和完善提供依据。

本文的主要贡献在于从理论角度对理解网络互助模式提供研究支持。保险科技(Insurtech)已经成为了金融科技的一个重要分支，并在全球范围内处于迅速增长的态势（Thakor，2019）。Kaffash et al.(2019)指出当前学界缺乏对于保险科技如何提升保险行业效率的研究；加以网络互助是我国互联网金融的独有模式与新现象，与国外新兴的保险科技模式也存在差异，关于网络互助模式的研究就更加匮乏。本文希望能为网络互助模式的机制设计提供研究支持。

## 2. 网络互助的背景

### 2.1 网络互助的发展

2011 年，我国第一家网络互助平台“抗癌公社”（现已更名为“康爱公社”）成立，网络互助开始进入公众视野。随着政策对于相互组织的承认，我国在 2016 年迎来了网络互助的元年，多个网络互助平台会员数量超过百万级，吸引了千万级的资本投入。截至 2019 年 9 月初，各网络互助平台会员总量已经突破 2 亿人，累计互助人数超 2 万人，累计发放互助赔付超过 27 亿元。目前，我国规模最大

的两家平台是相互宝和水滴互助，相互宝会员人数超过 8600 万，水滴互助平台规模居于其后，会员人数超过 8000 万。自成立至今，网络互助平台作为我国互联网金融独特的现象，非但没有出现任何平台“跑路”，更是体现出了普惠性，对我国现有的保障体系形成了有益的补充。

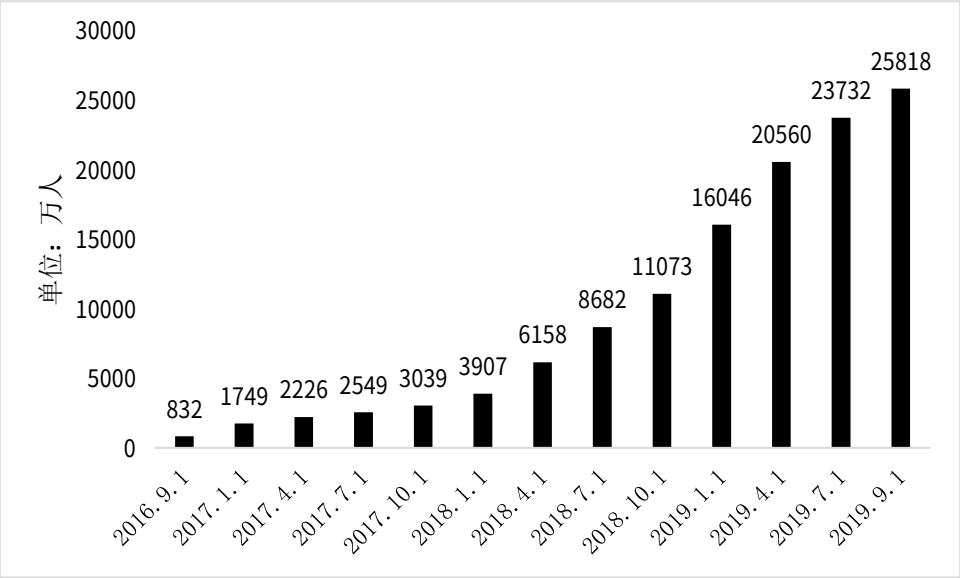


图 1 我国网络互助平台会员总数

目前，我国的网络互助平台在责任范围、均摊规则、会员准入与风险控制等方面已经初步建立起了相对清晰的行业规则与模式。网络互助平台会员通过签署协议并承诺共同分担风险，通常需要预先缴纳一定的互助金作为给付保证，任何会员的风险损失在所有会员中进行分摊。在分摊模式上，大多数平台采用的均摊模式，在同一个风险池中的会员对损失进行平均分摊，各家网络互助平台通常会规定每人单次分摊金额的上限。出于公平性考虑，各平台往往会对风险池中成员年龄段做出细分，越高年龄组内成员得到的互助金额越低。网络互助平台通常会按互助金的一定比例收取一定金额的管理费。

## 2.2 网络互助的效率与公平

网络互助平台迅速发展的一个重要原因在于用较低成本满足了我国民众当前的健康保障缺口：社会保险在重大疾病领域的保障还有进一步提升的空间，同时商业重疾保险对于中低收入群体来说又难以负担。在保障范围来看，我国网络互助平台主要针对的是以恶性肿瘤为代表的重大疾病互助计划[2]。多数网络互助平台所保障的重大疾病，均囊括了中国保险行业协会颁布的重大疾病有关定义所规定的全部 25 种重大疾病，并在此基础上新增了数十种重疾。与商业保险相比，网络互助平台表现出了较低的保障成本优势。

表1 2018年主要网络互助平台均摊成本

| 互助平台 | 互助范围 | 少青 | 中青 | 老年 |
|---|---|---|---|---|

[2] 部分平台也推出了综合意外互助计划和家财互助计划，但规模远不如重疾互助。

| | | | | | |
|---|---|---|---|---|---|
| 众托帮 | 111 种重疾 | 77 种特定 | 6.42 | 12.84 | 25.68 |
| 夸克联盟 | 60 种重疾 | 0 | 43.96 | 80.40 | 86.49 |
| 康爱公社 | 115 种重疾 | 低度癌症 | 32.96 | 98.86 | 108.70 |
| e 互助 | 癌症 | 低度癌症 | 21.84 | 119.04 | 148.08 |
| 17 互助 | 25 种重疾 | 低度癌症 | 124.52 | 124.52 | 124.52 |
| 壁虎互助 | 65 种重疾 | 18 种特定 | 63.00 | 126.00 | 252.00 |

表2 商业重疾保险成本举例

| 商业保险产品 | 保障范围 | | 25 岁 | 35 岁 | 45 岁 | 备注 |
|---|---|---|---|---|---|---|
| 安享一生防癌险 | 癌症 | 0 | 99 | 165 | 244 | 一年期保险 |
| 京彩一生百万医疗保险 | 100 种重疾 | 0 | 155 | 312 | 548 | 一年期保险，基础版（有社保） |
| 昆仑健康保重大疾病保险 | 110 种重疾 | 25 种中症+50 种轻症 | 2097.5 | 2865.75 | 3852.61 | 以男性为例，保至 70 岁，缴费期限 20 年，基本保额 30 万 |
| 百年康惠保重大疾病保险 | 100 种重疾 | 30 种轻症 | 1740 | 2370 | 3120 | 以男性为例，保至 70 岁，缴费期限 20 年，基本保额 30 万 |
| 瑞泰瑞盈重大疾病保险 | 100 种重疾 | 50 种轻症 | 2022 | 2748 | 3630 | 以男性为例，保至 70 岁，缴费期限 20 年，基本保额 30 万 |
| 复星联合康乐一生（2019 版）重大疾病保险 | 108 种重疾 | 25 种中症+40 种轻症 | 3195 | 4305 | 5763 | 以男性为例，保至 70 岁，缴费期限 20 年，基本保额 30 万 |

根据表 1 和表 2 的对比可知，以相互宝和水滴互助为代表的网络互助平台的均摊成本远低于类似保障的商业重疾险，约为一年期给付型商业保险的二分之一。值得注意的是，由于平台的快速增长会导致人均分摊较低，不同增长阶段的平台的均摊成本也不同。

从公平机制上来看，网络互助平台规则普遍缺乏“事前精算”，只是较为粗糙地考虑了不同年龄组的公平性。大多数平台粗略地将会员根据年龄进行区间划分为少儿、中青年与老年计划，所有会员进行平均均摊对应的计划内互助赔付。在计划内，平台规则粗略地根据年龄增大阶梯性地降低保障额度，但是保障额度显然不是基于精算而是采用整数保额。也有少数平台在阶梯保额的基础上，同时设置不同年龄群体的分摊系数，发病率的群体对应越高的分摊系数，但是划分机制同样较为粗糙。在当前的互助均摊模式下，很容易出现低风险者补贴高风险者的现象，分摊机制并未体现出公平性。可以说，当前网络互助平台的规则主要从市场推广角度出发，采用简单化的规则，但是忽视了精算意义的公平性。

## 3. 理论框架

在本节，我们理论考察不同的保障机制或保障模式实现保障的逻辑。本节首

先建立一般化模型，并阐述保障规则的效率和公平的概念。然后，本节分别介绍了两种现实中存在的保障机制模式。

## 3.1 一般化模型、效率与公平

考虑共有 $n$ 位不同的个体需要转移某个特定的风险(如重疾、意外身故等)，不同个体的风险发生概率既可以是相同的(同质风险群体情形)，也可以是不同的(不同质风险群体情形)。为了实现风险转移和风险共担，我们将现实中的保障机制(包括商业保险、网络互助等形式)的逻辑抽象化表示为如下一般化模型，具体参数设定如下：

- 我们考虑单期模型，所有的个体在初始时刻参与该保障计划；在期末时刻，出险的个体将获得预先约定的保额的赔付，其余的个体将获得或支出保障计划规则规定的现金流。
- 模型用二元变量 $I_j$ 来表示编号为 $j$ 的个体在期末的出险状态：如果其没有遭受损失，则记 $I_j=1$；如果其遭受损失，则记 $I_j=0$。我们始终假设，任何不同个体的风险事件是独立的。
- 我们将该模型在期末时刻所有的可能状态的集合记为 $\Omega$，每一个期末状态都涉及所有个体的出险状态 $w=(I_1,I_2,...,I_n)$。因此，模型的状态集合 $\Omega$ 共有 $2^n$ 个不同的期末状态。
- 对于任意的期末状态 $w\in\Omega$，我们将编号为 $i$ 的个体的净回报(回报现金流减去支出现金流)记为 $R_i(w)$，将组织者(对应如保险公司、网络互助平台)的净回报记为 $R_0(w)$。

事实上，如果我们将每个个体的期末损失记为随机变量：$X_1,X_2,\mathrm{L}$，由于风险同质并且个体是独立的，这些随机变量具有共同的期望值 $\mu$。根据大数法则，当被保险人的数量足够大的时候，每个个体的平均损失期将是可预测的：

$$\bar{X}_n := \frac{1}{n}(X_1+\mathrm{L}+X_n)\to\mu, \qquad n\to\infty.$$

由于网络互助平台的互助计划基本上给付型，也即一旦发生损失就赔付约定额度，本文考虑编号为 $i$ 个体的损失等于 $X_i=(1-I_i)b_i$，其中 $b_i$ 是编号为 $i$ 个体的保障额度。

在该一般化的模型中，在约定的机制下，在不同的期末状态下，所有的现金流在 $n$ 各个体和组织者中进行重新分配。由于该保障组织系统中的现金流是封闭的，因此为“零和游戏”。也即，所有个体与组织者的净回报总和为零。

$$R_0(w)+\sum_{i=1}^{n}R_i(w)=0, \text{对于任意的 } w\in\Omega. \qquad (1)$$

我们首先阐述公平性的概念：公平性要求任何个人和组织者的期望净回报为零。用模型参数表示，我们称该保障机制对于组织者是公平的，如果其满足 $E[R_0(w)\,|\,w\in\Omega]=0.$ 同样地，该保障机制对于会员个体是公平的，如果其满足 $E[R_i(w)\,|\,w\in\Omega]=0,$ 对于任意的 $i$。

基于条件（1）和公平性条件，我们可以得到如下引理：

**引理 1** 在同质风险群体情形中，保障机制对于组织者是公平的当且仅当其对所有个体是公平的。

引理 1 表明，在保障机制中公平性是系统的性质，如果保障机制对于所有的

参与个体(同质风险)是公平的，那么其对组织者也是公平的；反之亦然。

该引理的结果可以推广到非同质风险的情形。值得注意的是，引理 2 说明了，如果保障机制的规则能做到对于任何参与个体，无论高风险还是低风险，都是公平的，那么该规则对于组织者也是公平的。但是反之不然。

**引理 2** 对于非同质风险群体，如果保障机制对于对所有个体是公平的，那么其对组织者也是公平的。

在实际情形中，互助计划基本都是针对非同质风险群体，例如。常见的互助计划一般面向某一年龄段区间的风险个体，如 20-50 岁等。引理 2 对于网络互助平台的启示是，其作为保障机制的组织者和规则制定者，其出发点如果仅仅要求在互助规则下平台自身不以营利为目标是不够的，因为无法保证该互助规则对于每个个体都是公平的。反之， 如果互助规则在制定时能够保证对于每一细分群体的公平性，那么该规则自然也能保证平台的公平性。

其次，我们阐述效率的概念。在现实中，由于存在各种实现成本，任何的保障机制几乎不可能实现完全的公平性。为了方便后文的分析，我们定义期望收获(expectation gain)和期望损失(expectation loss)分别作为不公平的机制中的“获利”和“损失”的衡量。我们将 $E[R_0(w)]$ 和 $E[R_i(w)]$ 称为期望收获，如果 $E[R_0(w)]>0$ 或 $E[R_i(w)]>0$；将 $E[R_0(w)]$ 和 $E[R_i(w)]$ 称为期望损失，如果 $E[R_0(w)]<0$ 或 $E[R_i(w)]<0$。

我们明确定义：一个保障机制的效率高低指的是，所有参与个体在该机制下为了获得保障所需要付出的期望损失的总和。明显地，根据零和游戏条件可知，所有参与个体的期望损失的绝对值等于组织者的期望收获。也即，一个保障机制下的组织者的期望收获越高，则该机制的效率越低，成本越高。在本文中，我们定义一个保障机制的效率损失为 $E[R_0(w)]$。

## 3.2 商业保险模式

我们基于一般模型对商业保险保费定价进行数学描述。商业保险是基于精算的事前定价机制，主张对于不同个体的公平性。因此，我们考虑商业保险对共有 $n$ 个同质风险的被保险人群体的精算定价过程。

在期初，被保险人通过向保险公司支付保费进行风险转移；在期末，保险公司需对被保险人的损失进行赔付。编号为 $i$ 的被保险人在期末的净回报则表达为

$$R_i=(1-I_i)b-\pi.$$

在实务中，保险公司对于被保险人的理赔申请还需要付出一定比例的核验成本。此外，为了保护公众利益，保险公司还受到偿付能力的监管。保险公司的监管成本(偿付能力准备金的机会成本)也将被计算入保费中。

因此，保险公司的净回报可以表示为

$$R_0=n\pi-(1+\theta)\sum_{i=1}^{n}(1-I_i)b-r\rho\left(\sum_{i=1}^{n}(1+\theta)(1-I_i)b_i\right),$$

其中 $\pi$ 为每份保单的保费，$\theta$ 为核验成本比例系数，$r$ 为准备金的资本成本；保险公司对于该负债的准备金记为 $\rho\left(\sum_{i=1}^{n}(1+\theta)(1-I_i)b_i\right)$，其中 $\rho$ 为用于计算准备金的风险测度。出于简化符号，我们标记 $N$ 为期末所有幸存人的总数，$N\sim \mathrm{Bin}(n,p)$，则

$$R_0=n\pi-(1+\theta)(n-N)b-r\rho\big((1+\theta)(n-N)b\big),$$

公平保费是使得保险公司期望净收益为零的保费水平 $\mathrm{E}[R_0]=0$，即

$$\pi=\frac{1}{n}\Big[(1+\theta)\mathrm{E}\big[(n-N)b\big]+r\rho\big((1+\theta)(n-N)b\big)\Big].$$

事实上，保险公司收取的保费需要在公平保费上附加一定的利润率水平，记为 $\alpha^I$，则保险公司实际收取的保费为

$$\pi^I=\frac{1+\alpha^I}{n}\Big[(1+\theta)\mathrm{E}\big[(n-N)b\big]+r\rho\big((1+\theta)(n-N)b\big)\Big].$$

## 3.3 网络互助模式

网络互助模式是一种原始保险形态与互联网结合的互联网金融模式，利用互联网的信息撮合功能聚集起具有相同风险的群体。互助平台会员之间通过协议承诺承担彼此的风险损失。由于网络互助模式主张“事后分摊”，不预缴或少额预缴是该模式的一个重要特征。为了保证参与平台的会员都能在有成员申请赔付时进行均摊，现实中，我们可以观察到网络互助平台的两类做法：一类平台是以水滴互助为代表的，会员为获得保障需要预先缴纳最低金额的互助金(如 10 元)，在平台发生赔付时，需要均摊的金额将从每个均摊会员账户中扣减；另一类平台是以相互宝为代表的，平台具有第三方支付牌照和预扣款功能，当发生均摊时候，平台将直接从会员账户中进行扣款。可以看出，第一类网络互助平台具有一定规模的资金池，资金池的金额是会员预存的互助金，会员可以申请赎回；第二类网络互助平台不预设资金池，所有的赔付都是在事后从会员账户中扣费。

通常，网络互助平台为了防止“黑天鹅”事件或大额赔付，通常还对会员的单次分摊或全年均摊总额设定上限。例如，水滴互助的互助计划规定会员单期分摊金额不能超过 3 元；相互宝平台在宣传中称会员一年均摊总额上限是 188 元，平台将承担超额部分赔付[3]。由于网络互助平台规则使得所有会员的单期均摊或年度均摊存在上限，互助平台并不承诺刚性赔付。也即，对于申请赔付的会员，平台将依据实际情形组织均摊，赔付总额未必能达到互助计划保障金额。因此，网络互助平台的保障逻辑如下：

- 在期初，互助平台通过机制设计(预存或支付渠道)保证所有会员都能在“事后均摊”时进行均摊；
- 在期末，平台根据规则组织所有幸存人对索赔人的赔付进行均摊，每个幸存人的均摊总额不超过预先设定的上限 $d$。

由于许多互助平台会员基数量大，规模在百万以上，在实际情形中基本未发生超额赔付事件。也由于此，一些平台实际上提供了一种隐性刚性赔付承诺，超额部分由平台承担。根据是平台是否对会员承诺刚性赔付，我们将互助平台分为两类分别进行分析： 非刚性赔付模式和平台隐性担保模式。

### 3.3.1 非刚性赔付模式

网络互助平台的非刚性赔付模式的重要特征是：在期末，索赔人将获得的实际赔付金额不确定，取决于会员群体的实际出险状态(由于存在分摊上限)，最高可获得互助计划约定的保障金额 $b$。在该模式下，所有索赔人的赔付由存活人进行均摊，平台不承担赔付。也即，互助平台主要承担了信息撮合、规则执行的功

[3]2019 年 4 月份，相互宝在宣布将“相互保”升级“相互宝”时，公布用户在 2019 年 1 月 1 日-12 月 31 日的分摊金额不超过 188 元，有多出部分由蚂蚁金服承担。

能，并不承担给付责任。

从会员的角度来看，如果编号为 $j$ 的会员存活，则其需要承担的均摊额度为

$$c_j = \frac{b(n-1-M)}{M+1} \wedge d,$$

其中 $M$ 是其余会员中的幸存人总数，$M \sim \mathrm{Bin}(n-1, p)$。如果编号为 $j$ 的会员发生了损失，其将获得的给付为

$$b_j = \frac{dM}{n-1-M} \wedge b.$$

因此，编号为 $j$ 会员的净回报可以表示为

$$R_j = b_j(1-I_j) - c_j I_j.$$

由此可知，对于参与会员公平的互助规则需要满足

$$p\mathrm{E}\left[c_j\right] - q\mathrm{E}\left[b_j\right] = 0.$$

如果我们记 $d = \alpha b$，则公平条件可以写成

$$p\mathrm{E}\left[\frac{n-1-M}{M+1} \wedge \alpha\right] - q\mathrm{E}\left[\frac{M\alpha}{n-1-M} \wedge 1\right] = 0.$$

在互助平台不收取费用的情形下，由于该模式不提供刚性赔付，合理的 $\alpha \in (0, q)$。由于非刚性赔付模式无法提供给会员承诺的保额，既不同于现实的互助平台情形中，也与商业保险存在巨大差异，所以本文就不具体讨论.

3.3.2 平台隐性担保模式

网络互助平台隐性担保模式的特征是：一是，无论在任何情况下索赔人都将获得互助计划约定的保障金额 $b$，互助平台将隐性地承担超额部分赔付；二是，由于互助平台承担了隐性担保，其将通过收取管理费的形式覆盖担保成本。我们仍然先考虑该模式承担了 $n$ 个同质风险会员的情形，并且显然有 $b > d$。

首先，我们考虑会员的净回报。对于任意的编号为 $j$ 的会员，当他/她存活时需要承担如下不超过 $d$ 的分摊

$$c_j = \frac{b(n-1-M)}{M+1} \wedge d,$$

其中 $M$ 是除了编号为 $j$ 的会员之外的 $n-1$ 个会员中的幸存人个数，$M \sim \mathrm{Bin}(n-1, p)$。除了分摊金额之外，幸存人还将支付给平台 $\pi_0$ 的管理费用。在实际情形中，网络互助收取的管理费用通常是赔付总额的一定比例。因此，幸存人的净回报可以表示为

$$R_j = b(1-I_j) - \left(c_j + \pi_0\right) I_j.$$

互助计划规则对于会员是公平的，如果其满足

$$qb - p(\mathrm{E}\left[c_j\right] + \pi_0) = 0.$$

第二，我们从互助平台的角度来看，其净回报为

$$R_0 = \sum_{j=1}^{n} I_j \pi_0 - \left( \sum_{j=1}^{n} (1-I_j) b - \sum_{j=1}^{n} I_j \left( \frac{b(n-1-M)}{M+1} \wedge d \right) \right)_+,$$

将所有会员的幸存人数变量用 $N$ 表示， $N=\sum_{j=1}^{n} I_j \sim \mathrm{Bin}(n,p)$ ，可得

$$R_0(N)=N\cdot\pi_0-\left(b(n-N)-N\cdot(\frac{b(n-N)}{N}\wedge d)\right)_+$$

$$=\begin{cases} N\cdot\pi_0, & N>\dfrac{bn}{b+d} \\ N\cdot\pi_0-\left(b(n-N)-Nd\right)_+, & N\le\dfrac{bn}{b+d} \end{cases}.$$

如果互助规则对于互助平台是公平的，即 $E[R_0]=0$ ,则有

$$np\pi_0-\mathrm{E}\left[\left(b(n-N)-N\cdot(\frac{b(n-N)}{N}\wedge d)\right)_+\right]=0.$$

可得，

$$\pi_0=\frac{1}{np}\mathrm{E}\left[bn-(b+d)N\cdot I_{N\le\frac{bn}{b+d}}\right].$$

## 4. 保障模式的效率分析：基于同质风险情形

在介绍了保障规则的一般化模式以及具体的模式之后，我们对不同模式进行效率性分析和讨论。对于网络互助平台针对的给付型赔付（发生损失即赔付保障金额）的风险，我们可以得到如下结论。

**命题 1** 考虑同质风险群体，对于商业保险模式以及网络互助平台隐性担保模式，公平机制下的个体获得保障的期望成本相等，均为 $qb$ 。

该命题的证明可以基于一般化模型容易得到，由个体的期望净回报为零可知：个体的期望付出（期望保障成本）等于其期望收益（保障期望值）。接下来，我们分别基于三个特定模式验证。

- 第一，商业保险模式下，公平保费等于赔付的期望值 $qb$ 。
- 第二，在网络互助平台隐性担保模式中，由公平条件可得

$$p(\mathrm{E}[c_j]+\pi_0)=qb,$$

即期望均摊为 $qb$ 。

总结来说，网络互助平台隐性担保模式是基于互联网的商业保险与团体互助相结合的复合模式。在商业保险公司没有任何成本和利润要求的前提下，商业保险模式、网络互助平台隐性担保模式在效率上是等价的。

但是，由于事实上商业保险具有必要的成本和利润要求，以及互助平台也有核赔成本等，所有的模式都必然具有效率损失。也即，在不同的模式下，参保群体需要付出额外的成本。根据前文的分析可知，相比于商业保险模式，网络互助平台隐性担保模式具有更低的效率损失的原因在于“风险分割”：利用效率较高的团体互助承担小额风险，用效率较低的方式承担尾部风险。这样的组合方式提高了总体保障机制的效率，也是网络互助平台在国内外迅速获得大量关注和用户的重要原因。

### 4.1 商业保险模式

显然，无论是在公平保费还是实际保费情形下，被保险人净回报的期望值为

负，即遭受期望损失 $E[R_i(w)]<0$。但是，由于被保险人的风险厌恶使得其效用函数是凹函数，其购买保险的效用值仍高于或等于无保险情形。这也是真实世界中即使净回报的期望为负，却仍然有商业保险的原因。基于效率性的视角，商业保险模式的保障机制会让所有被保险人损失期望，其效率损失为

$$\alpha^I\left[(1+\theta)\mathrm{E}\left[(n-N)b\right]+r\rho\left((1+\theta)(n-N)b\right)\right].$$

## 4.2 网络互助模式

我们考虑网络互助平台具有核赔成本以及利润边际的情形，个体的管理费为

$$\pi_0^M=\frac{1+\alpha^M}{np}\mathrm{E}\left[\left((1+\theta)b(n-N)-N\cdot(\frac{(1+\theta)b(n-N)}{N}\wedge d)\right)_+\right]$$

则平台收取的管理费总和为

$$\pi^M=(1+\alpha^M)\mathrm{E}\left[\left((1+\theta)b(n-N)-N\cdot(\frac{(1+\theta)b(n-N)}{N}\wedge d)\right)_+\right]$$

其中 $\alpha^M$ 是网络互助平台收取的利润率水平。与商业保险不同的是，网络互助平台还未受到监管，没有监管成本。因此，平台隐性担保模式的效率损失为

$$\alpha^M\cdot\mathrm{E}\left[\left((1+\theta)b(n-N)-N\cdot(\frac{(1+\theta)b(n-N)}{N}\wedge d)\right)_+\right],$$

易知其为 $d$ 的减函数。因此，我们可以得到如下命题。

**命题 2** 在与商业保险公司相同的核赔和利润率水平下，网络互助平台隐性担保模式的效率损失低于商业保险模式。

## 5. 结论与政策建议

国内方兴未艾的网络互助模式已经成为了我国保险科技领域的亮点，创新地为 2 亿以上用户提供了基于互联网的低成本的保障形式。目前，国内外文献中关于网络互助的理论和实证研究十分匮乏，本文从理论角度对相关文献进行了重要补充。

本文从理论角度对新兴保障模式的效率性和公平性进行了分析。我们的主要发现有三点。第一，在保障机制效率方面，网络互助模式通过不同的方式均实现了比传统商业保险更低成本的保障方式。这一发现从理论上解释了网络互助在国内外迅速获得大量用户的现象。同时，理论分析还发现这一成本和效率优势来源于两个方面：1.互联网平台更低的利润要求和更高的运营效率；2.更低的监管成本。网络互助形式通过互联网实现的群体之间的互助实现了部分风险的分担机制，剩余的超额风险由保险公司和商业保险公司实现。

第二，在保障机制的公平性方面，虽然网络互助模式是依据“事后分摊”原则，但是公平的互助机制设计仍然离不开“事前精算”。本文基于模型给出了公平的网络互助模式所需要满足的公平性条件，为网络互助规则的公平性校验提供了方法。

我们建议，为了避免逆向选择风险以及保证平台的可持续性，网络互助平台需要在规则制定上更加注重精算公平性。网络互助模式需要意识到精算的作用在于保证不同风险水平群体的公平性，避免互助平台积聚逆向选择风险，长期将对

网络互助平台的可持续性带来挑战。

另外，本文的研究还发现了，监管成本只是网络互助模式成本优势的一个原因；即使在未来考虑了监管成本后，网络互助模式与商业保险相比仍然具有效率优势。目前，网络互助已经为 2 亿人次的用户提供了保障，但是由于网络互助平台属于我国独特的创新模式，还处于无部门监管、无法规可依的尴尬处境。鉴于目前大部分的互助平台已经开始收取管理费，并已有部分平台在营销时承诺了刚性赔付，我们建议有关监管机构应该在条件成熟时采取适当的监管措施，出台一定的措施保证平台的偿付能力和保护公众利益。最后，本文基于效率和公平视角的理论分析希望为理解互联网保障的保险科技，以及未来开展监管和促进互助行业的平稳发展做出贡献。

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# 阶段红利还是保险科技？

# ——网络互助模式的效率与公平研究

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**关键词：**网络互助；保险科技；商业保险

**中文摘要**．网络互助平台是近年来我国互联网金融新兴的保障模式，已经为累计2亿人次提供了低成本的普惠保障。网络互助模式依托互联网聚集具有相同保障需求的群体，以“事后均摊”形式对出险的个体进行赔付，保障成本远不及类似商业保险。那么，网络互助模式的低成本优势究竟是源于平台用户迅速增长和无监管的阶段性红利，还是源于保险科技的创新模式？以及模式是否具有可持续性？本文建立了理论模型，将网络互助模式与传统商业保险模式进行对比，发现网络互助模式的低成本优势源于模式结合了互助机制。另外，本文发现互助规则缺乏精算，存在明显的不公平性和逆向选择风险。

# Study of the Stability of Different Interbank Networks

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**Keywords:** Interbank system, Network structure, The degree of difference, Monte Carlo simulation..

**Abstract.** The connection between financial institutions plays a key role in the spread of financial crisis, and bank crisis is an important manifestation of systemic financial crisis. It is of great practical significance for financial risk management to establish interbank system network to identify the contagion law of banking system risk, which is conducive to controlling systemic financial risk. This paper builds the interbank system network model, and uses the Monte Carlo simulation method to study the stability of different network structures under different situations. We find that: when the interbank debt connection in the system are homogeneous, if the number of connections increase, the stability of the network will become better or remain unchanged; the increase in the degree of bank difference in the system will not improve the stability; when the system debt ratio is large enough and the degree of interbank connection difference is sufficiently large, the stability of the ring network will be significantly improved, and even become the most stable network structure.

## 1. 引言

2008年全球金融危机以及随后的欧债危机，凸显了金融机构的脆弱性，同时也说明了金融机构间的关联性在金融危机传播中的关键作用，而银行危机是系统性金融危机的重要表现形式，受到了很多学者以及监管部门的重视。由于实际生活中银行间借贷数据的不可得性，无法得到实际银行间系统网络的结构以及个体银行和银行间债务联系的特点，想要判断当前银行间系统网络结构是否最优无法实现，因此本文尝试根据系统负债率、银行的差异程度以及银行间债务的差异程度对多种情形进行模拟，通过改变银行的债务联系数量来改变网络结构，试图寻找不同情形下的最优网络结构。

对于最优的金融网络结构，目前的研究还没有一个统一的说法。总体上而言，主要存在三种观点。

第一种观点认为系统中金融机构之间的联系是一种分散风险的方式，Allen and Gale（2000）最早研究最优金融网络结构问题并持有第一种观点：连接更加充分的网络对外部冲击更加富有弹性，因为一家银行对于外部冲击的损失可以通过网络连接分散并转移到其他银行，有助于风险的分散，因此连接更加充分的网络能够更好地抵抗外部冲击。相反，在一个环状网络中，当外部冲击足够大时，如果一家银行破产，那么这一冲击会沿着环状路径一直传导下去，最终可能导致所有银行破产。Krause and Giansante（2012）也持有相同的观点。

第二种观点与第一种观点相反，认为连接更加充分的网络更加容易导致系统性风险。Brusco and Castiglionesi（2007）通过构建只有四个节点的环状网络和完全网络研究银行间存款市场，发现当一个银行区域遭受冲击时，完全网络结构会使更多银行区域受到冲击但是每个银行区域遭受的损失会更低。Degryse and Nguyen（2007）使用关于单个银行的银行间风险敞口、大额双边银行间风险敞口和跨境银行间风险敞口的详细信息，研究发现，比利时银行系统从1993年的完全网络结构到2002年“多重货币中心”结构，这一过程实际上降低了传染的风险和影响。ViverLirimont（2006）的研究也得出了类似的结论，连接越充分的网络被传染的银行数量越多，且传染发生速度也越快。Mario Eboli(2019) 将金融系统表示为一个流动网络，研究了三种网络，即完全网络、星状网络和环状网络。研究发现，完全网络和星状网络对冲击都表现出稳健但脆弱的反应。这些网络对小于给定传染阈值的冲击具有抵抗力，而当冲击大于阈值时，这些网络中的所有代理都会一起违约；同时还发现，星状网络比完整网络更能抵抗大的冲击，也就是说，前者比后者更少暴露在全面系统性危机的风险下。相反，环状网络似乎是脆弱而有弹性的，与完全和星状网络相比，它们对大冲击的弹性更强。

第三种观点认为，网络结构与风险传染之间并不是简单的单调线性关系，而是非单调线性关系。Nier et al.（2007）用随机生成网络的模拟实验研究发现，网络的连接程度与网络稳定性并不是单调线性关系，初始连接程度的小幅增加会增加网络的传染效应，但是超过一定的阈值之后，连接程度的增加会使得整个系统吸收冲击的能力增强。Gai and Kapadia（2010）、Haldane and May（2011）也持有类似的观点。Acemoglu et al.（2015）通过建立银行间网络的数学模型，提出了金融系统“稳健但脆弱”的理论：银行间网络的更高互联性可以降低违约的可能性，因为最初冲击的传播可以由许多交易对手共享，它会更快地被分散。另一方面，当冲击的幅度超过一个临界阈值时，由于互联性的增加，冲击将蔓延到整个系统，这可能会导致违约的大规模连锁反应。Georg（2013）把Nier et al.（2007）的静态网络拓展到动态网络，发现有外界冲击时，网络结构对网络稳定性的影响

才会比较显著，且以央行为核心的网络结构会比随机网络结构稳定性更强，在稳定时期，不同的网络结构对金融系统的稳定性并没有太大的影响。Elliott et al.（2014）从一体化（Integration）和多样化（Diversification）两个方面研究了金融网络，研究发现，这两个方面对于传染程度和范围的影响是不同且非线性的。John Leventides et al.（2019）使用蒙特卡洛模拟的方法也得出了相同的结论，同时也考虑到银行间联系的异质性存在时，初始冲击比银行间联系同质情况下更容易消散。

笔者认为对于最优网络结构观点的不同主要是由于模型的假设以及网络中元素（在银行间系统网络中主要是银行以及银行间的联系）的设置不同。在不同的情形下，网络结构的稳定性可能会发生显著变化，最优的网络结构也会不同，所以对于最优网络结构一概而论是不合理的，需要具体情况具体分析。

目前国内对于金融网络的研究主要集中在风险传染上，并且只是关注特定的网络结构，而不同网络结构对银行间系统稳定性影响研究非常少。马君潞等（2007）使用矩阵法估算了我国银行系统双边传染风险，分析了不同损失水平下单个银行倒闭及多个银行同时倒闭引起的传染性；巴曙松等（2013）阐述了利用金融网络解决金融传染问题的相关研究；方意和郑子文（2016）结合了系统重要性银行、系统脆弱性银行以及传染风险等指标，提出并度量了系统重要性传染路径指标。由于本文的重点在于不同情形下银行间系统网络结构的稳定性，关于风险传染的文献不再赘述。

本文主要基于Acemoglu et al.（2015）的模型假设以及John Leventides et al.（2019）的风险传导模型来搭建了银行间系统网络，并根据系统负债率、银行间系统网络节点的差异程度、银行间系统网络中联系的差异程度将情形分为多种，分别研究具体情形下更为稳定的网络结构，并在这个过程中得到了网络中节点异质性和联系异质性对于网络结构稳定性的影响。

正文部分主要分为四个部分：第一部分是数学模型部分，第二部分是蒙特卡洛模拟实验过程，第三部分是实验结果和分析，第四部分是结论及政策建议。

## 2. 模型

### 2.1 数学模型

考虑一个具有$N$家风险中性银行的银行间系统，系统中的银行构成银行间系统网络的节点，节点集合记为$\{1,2,3，\ldots，N\}$。第$i$家银行拥有$k_i$单位的资本，能够以现金、贷款给其他银行或者投资项目的形式存在。在每一时间点，第$i$家银行可以收到项目现金流$z_i$,有现金$c_i$,第$i$家银行对第$j$家银行的负债记为$y_{ji}$,可以从$j$银行收回贷款$x_{ij}$，则在当下银行$i$可以收回的贷款总额为$\sum_{j=1}^{N} x_{ij}$,当$z_i + c_i + \sum_{j=1}^{N} x_{ij}$无法偿还债务时，银行需要将投资项目折现，但是只能拿到项目总价值$Ai$的一部分，该比例记为$\zeta$，$\zeta \in [0,1)$。

第$i$家银行的债务分为优先级债务$v$和普通债务$yi$，$y_i = \sum_{j=1}^{N} y_{ji}$，所以第$i$家银行的债务总和为$v + y_i$。

因此，在每一个时间点，第$i$家银行可以用于偿还银行间负债的资金为：

$$b_i = z_i + c_i + \sum_{j=1}^{N} x_{ij} + \zeta A_i - v \tag{1}$$

当$bi \le yi$时，第$i$家银行破产。

由于我们假设所有普通债权人——也就是其他银行具有同等的优先等级。因此，如果第$j$家银行能够偿付优先级债务$v$，但对普通债权人违约，普通债权人将按照负债的比例得到偿还，即

$$x_{ij} = \frac{y_{ij}}{\sum_{i=1}^{N} y_{ij}} b_j, \qquad b_j > 0 \tag{2}$$

另一方面，如果第$j$家银行不能偿还其优先级负债，那么它的普通债权人将不能得到债务偿还,即

$$x_{ij} = 0, \qquad b_j \le 0 \tag{3}$$

设初始可偿还普通债务资金向量为$B_0$，则

$$B_0 = (b_1, b_2, b_3, \dots, b_N)' \tag{4}$$

银行间系统网络的联系矩阵记为$Y$，即银行间债务矩阵，矩阵当中的元素$y_{ij}$表示第$j$家银行对第$i$家银行的负债，由于银行自己与自己不会发生借贷关系，所以联系矩阵$Y$对角线上的元素为$0$，即

$$Y = \begin{pmatrix} 0 & \cdots & y_{1N} \\ \vdots & \ddots & \vdots \\ y_{N1} & \cdots & 0 \end{pmatrix}$$

显然，在矩阵$Y$中，第$i$行的元素之和$\sum_{j=1}^{N} y_{ij}$表示第$i$家银行借出资金之和，第$i$列元素之和$\sum_{j=1}^{N} y_{ji}$表示第$i$家银行的银行间负债总和。

我们用破产矩阵$R_t$来表示银行是否破产,$t$表示迭代次数。$R_t$中的元素$r_{it}$定义如下：当$b_{it-1} \le 0$时，$r_{it} = 1$,当$b_{it-1} > 0$时，$r_{it} = 0$。$b_{it-1}$为经过$t-1$次迭代之后第$i$家银行可用于偿还银行间负债的资金。

设经过$t$次迭代之后可偿还普通债务资金向量为$B_t$，

$$B_t = (b_{1t}, b_{2t}, b_{3t}, \dots, b_{Nt})' \tag{5}$$

$B_t$的递推公式为

$$B_t = B_0 - YR_{t-1} \tag{6}$$

其中，$t \ge 1$。

我们假设银行间系统破产触发机制为系统N家银行中1家银行在冲击之下先破产，因此初始破产矩阵$R_0$为只有一个元素为1其余$N-1$个元素均为0的$N$维列向量。在没有特殊要求下，由于在实验模拟中银行间系统网络中所有的节点——银行都是随机产生的，所以在我们的模型中一般假设第一家银行破产，即$R_0 = (1,0,0,0,\dots,0)'$，来研究不同网络结构的稳定性。

本文的模型主要用于研究不同情形下不同网络结构的稳定性，首先要对本文所研究的网络结构进行说明。本文的研究从最简单的环状网络过渡到完全网络，即从每一家银行只向其余银行中的一家银行负债过渡到向其余$N-1$家银行负债，本文的债务联系数$n$是指第$i$家银行负债的银行数量。在本文的模型中，各个银行的债务联系数是相同的。

本文用于衡量网络稳定性的指标有两个，一是迭代至破产银行数量不再变化时简称最终状态的破产银行数量$n$，二是系统资产损失率$r$，显然$r \in [0,1]$。资产损失率在本文定义为系统可用于偿还普通债务资金的损失率，即系统初始可用于偿还普通债务资金与最终状态时系统可用于偿还普通债务资金之差与系统初始可用于偿还普通债务资金的比例，假设迭代$T$次后系统达到最终状态，由于银行申请破产后，可用于偿还普通债务的资金不会为负值，所以在计算时，最终状态可

用于偿还普通债务资金向量$B_T$中的负值元素全部取0，则资产损失率的数学表达式为：

$$r = \frac{\sum_{i=1}^{N} b_i - \sum_{i=1}^{N} b_{iT}}{\sum_{i=1}^{N} b_i} \tag{7}$$

在模型中，我们研究的主要问题为银行间系统中银行和债务联系差异程度对不同网络结构稳定性的影响，所以需要对其他影响系统网络稳定性的因素进行控制。

首先，系统负债率对于网络稳定性一定会有影响。系统负债率$r_s$在本文中定义为系统银行间负债总和与系统初始可用于偿付普通债务资金总和之比，即

$$r_s = \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} y_{ij}}{\sum_{i=1}^{N} b_i} \tag{8}$$

直观上来说，系统负债率越高，不管是什么网络结构，系统网络的稳定性都会越差，考虑极端情况，如果系统中不存在银行间借贷，那么一家银行的破产对于系统中其他银行便没有影响。随着系统负债率的上升，当一家银行破产时，意味着整个系统中与这家银行直接联系的银行遭受到的冲击比较大，进一步对间接联系的银行产生较大的冲击，一个大的冲击需要更多的银行来分散，以防止有更多的银行破产，但同时，网络结构越复杂，即联系数越大，意味着更多的银行将直接受到冲击，当系统负债率超过某一个特定值，一家银行倒闭会导致所有银行倒闭。这一直观猜想我们通过在模拟实验中设置不同的系统负债率进行研究。

系统中的节点与联系的差异性也是影响系统网络稳定性的重要因素。系统初始可用于偿还普通债务资金以及银行间负债在网络中的分布情况不同时，系统网络的稳定性也会存在差异。为了探究不同情形下不同网络结构的稳定性，我们根据系统中银行是否同质以及银行间债务联系是否同质将银行间系统网络分为四大类进行研究，通过控制随机产生银行初始可用于偿还普通债务资金以及银行间债务联系的分布方差来控制差异程度，方差越大，代表系统中的银行差异程度越大。在不同的银行差异程度下，不同网络拓扑结构的稳定性可能也会发生变化，所以在模拟实验中，需要对这些因素进行控制，研究不同情形下的不同网络结构的稳定性。

## 2.2 一个简单情形的例子

当系统中银行同质且每一家银行的债务均匀分布在其对手银行时，即系统中每家银行都有相同的初始可用于偿还普通债务资金、联系银行数量以及银行间债务均相同时，我们可以通过矩阵计算得出网络结构对于网络稳定性的影响。这个简单情形的例子有助于我们更加深入地理解冲击在银行间系统网络中的传导机制。

假设系统中有$N$ 家银行，系统中银行初始可用于偿还普通债务资金均为100，矩阵为$B_0 = (100,100,\dots,100)'$,假设第一家银行由于外界冲击申请破产，则$B_0$变为$(0,100,\dots,100)'$。设系负债率为$r_s$，当网络结构为环状网络时，联系矩阵：

$$Y = \begin{pmatrix} 0 & 100r_s & 0 & \cdots & 0 \\ 0 & 0 & 100r_s & \cdots & 0 \\ 0 & 0 & 0 & \cdots & \vdots \\ \vdots & \vdots & \vdots & \ddots & 100r_s \\ 100r_s & 0 & 0 & \cdots & 0 \end{pmatrix}$$

初始破产矩阵$R_0 = (1,0,0,0,\dots,0)'$。我们将这些矩阵代入递推公式中进行迭代，第一次迭代后可以得到新的可用于偿还普通债务资金向量$B_1 = (0,100,\dots,100(1-r_s))'$。显然，当$0 \le r_s < 1$时，第一家银行的破产不会导致其余银行破产，这一冲击仅仅由第1家银行传导至第$N$家银行就结束了，其他银行不会受到影响。当$r_s \ge 1$时，第1家银行的破产会导致第$N$家银行破产，第$N$家银行的破产又会导致第$N-1$家银行破产，依次传导下去，达到最终状态时，所有银行均会破产。

当网络结构为完全网络时，即每一家银行与其余$N-1$家银行均有债务联系时，联系矩阵：

$$Y = \begin{pmatrix} 0 & \frac{100r_s}{N-1} & \frac{100r_s}{N-1} & \cdots & \frac{100r_s}{N-1} \\ \frac{100r_s}{N-1} & 0 & \frac{100r_s}{N-1} & \cdots & \frac{100r_s}{N-1} \\ \frac{100r_s}{N-1} & \frac{100r_s}{N-1} & 0 & \cdots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \frac{100r_s}{N-1} \\ \frac{100r_s}{N-1} & \frac{100r_s}{N-1} & \frac{100r_s}{N-1} & \cdots & 0 \end{pmatrix}$$

，初始破产矩阵为$R_0 = (1,0,0,0,\dots,0)'$。我们再次将这些矩阵代入

递推公式进行迭代，第一次迭代后得到可用于偿还普通债务资金向量$B_1 = (0,100(1-\frac{r_s}{N-1}),\dots,100(1-\frac{r_s}{N-1}))'$，显然，只要$r_s < N-1$，除了最初破产的第一家银行，其余的银行均不会破产，但是随着$r_s$的增加，其余银行遭受的损失会随之增大，即虽然银行破产数量不会增加，但是系统资产损失率会随着$r_s$的增大而增大。由此也可以看出，只考虑银行破产数量作为网络稳定性的评判指标是不严谨的，所以在我们的模型中，加入资产损失率这一标准，使得结果分析更加全面。当$r_s \ge N-1$时，当第一家银行破产后，所有的银行均会受到牵连破产。

在银行同质的简单情形下，通过对比两种极端的网络结构，我们很容易发现，当系统负债率$r_s < 1$，环状网络和完全网络的银行破产数量均为1，系统资产损失率均为$\frac{1}{N}$，当系统负债率$r_s \ge N-1$，环状网络和完全网络的银行破产数量均为$N$，系统资产损失率均为100%,即在本文的稳定性评判标准下，系统负债率$r_s < 1$或$r_s \ge N-1$时，环状网络与完全网络具有相同的稳定性；但是当$1 \le r_s < N-1$时，在环状网络的情况下，银行破产数量为$N$，资产损失率为100%，而在完全网络的情况下，银行破产数量为1，资产损失率仅为$\frac{1}{N}$，显然在这种情况下完全网络具有更强的稳定性。

通过上述简单情形的例子，我们容易发现，在实际监管中，相关部门可以通过控制系统负债率来提高系统网络的稳定性，在不同的情形下，某一网络结构的稳定性也会随之改变。

## 3．蒙特卡洛模拟实验过程

本文使用蒙特卡洛模拟的方法放宽银行同质的条件，对于上述简单情形以及更加一般的情形进行模拟实验，研究不同网络结构的稳定性。

在模拟实验中，由于银行信息和债务联系是完全相同的或者是随机产生的，银行的序号与银行节点所包含的信息无关，所以在做模拟实验时，本文设置的冲击总是让第一家银行破产，观察冲击传导导致的系统银行破产数量以及资产损失率。

此外，为了保证系统中所有银行都能够直接或者间接存在债务联系，避免出现有银行被系统中其他银行孤立的情况，我们在设计联系矩阵时，遵循“有序借贷”的原则，即当联系数为$n$且$1 \le i \le N-n$时，第$i$家银行对第$i+1,\dots,i+n$家银行负债，当联系数为$n$且$N-n<i\le N$时，第$i$家银行对第$i+1,\dots,\mathrm{N},1,\dots,\mathrm{i}+\mathrm{n}-\mathrm{N}$家银行负债。因此，在本文模拟实验过程中形成的银行间系统网络中，每一家银行作为借方的对手银行数量与作为贷方的对手银行数量相同，但是对手银行序号不一定相同，且当债务联系服从均匀分布随机产生时，银行借入资金总和与借出资金总和不一定相同。

### 3.1 情形分类

本文根据银行间系统中银行初始可用于偿还普通负债资金是否相同以及债务联系是否存在差异分为如下的四大类情形：

情形一：系统中所有银行同质，初始可用于偿还普通债务资金均为100000，且每一家银行的债务均匀分布在其对手银行，即每个债务联系资金为$\frac{100000r_s}{n}$，其中$n\in\{1,2,\dots,N-1\}$为对手银行数量；

情形二：系统中所有银行同质，初始可用于偿还普通债务资金均为100000，但是每一家银行的债务随机分布在其对手银行，每一个债务联系服从$[0+\delta,\frac{200000r_s}{n}-\delta]$上的均匀分布，该分布方差为$\frac{(\frac{200000r_s}{n}-2\delta)^2}{12}$，其中$n\in\{1,2,\dots,N-1\}$为对手银行数量，$\delta\in[0,\frac{100000r_s}{n})$，$\delta$在本文中称为债务联系差异程度控制参数。这一设定保证了每一个债务联系的均值为$\frac{100000r_s}{n}$，即系统负债率均值为$r_s$，$\delta$越小，方差越大，银行间债务联系的差异程度也就越大，因此我们可以通过调整$\delta$的大小来控制银行间债务差异程度；

情形三：系统中银行异质，每家银行初始可用于偿还普通债务资金服从$[0+\varepsilon,200000-\varepsilon]$上的均匀分布，其中$\varepsilon\in[0,100000)$，在本文中称为银行差异程度控制参数。同样的，这一假设使得系统中银行初始可用于偿还普通债务的资金均值为100000，方差为$\frac{(200000-2\varepsilon)^2}{12}$，$\varepsilon$越小，方差越大，银行的差异程度也就越大，因此我们可以通过控制$\varepsilon$的大小来控制银行的差异程度。债务联系情况同情形一。

情形四：系统中银行异质，同情形三，每家银行初始可用于偿还普通债务资金服从$[0+\varepsilon,200000-\varepsilon]$上的均匀分布，债务联系分布也存在差异同情形二，每一家银行的债务随机分布在其对手银行，每一个债务联系服从$[0+\delta,\frac{200000r_s}{n}-\delta]$上的均匀分布。

上述四种情形是按照银行间系统中银行初始可用于偿还普通负债资金是否相同以及债务联系是否存在差异进行划分的，在实验中，为了研究不同情形下网络结构对网络稳定性的影响，本文对系统负债率$r_s$、债务联系差异程度控制参数$\delta$、银行差异程度控制参数$\varepsilon$等变量进行控制，得出不同情形下的实验结果。同时，通过改变$r_s$、$\delta$、$\varepsilon$，我们又可以将四大类情形细分为更多一般情形，使得研究更加全面细致。

### 3.2 实验参数设置

在模拟实验时，为了避免程序在计算时精度对实验结果的影响，我们将银行初始可用于偿还普通债务资金均值设置为100000。

情形一：由于所有银行完全相同，所以银行初始可用于偿还普通债务资金为100000，将$r_s$设置为0.9、10、30和50分别进行模拟实验，每种情况做10000次实验，取最终状态破产银行数量以及资产损失率的平均值作为每种情况下银行间系统网络稳定性的评判指标，并作图；

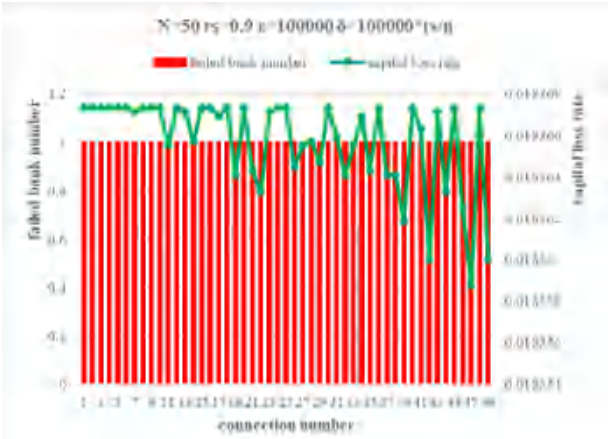
情形二：银行初始可用于偿还普通债务资金均为100000，$\delta$取值$\frac{100000*0.75r_s}{n}$、$\frac{100000*0.50r_s}{n}$、$\frac{100000*0.25r_s}{n}$以及0，分别在$r_s$为0.9、10、30、50的情况下进行模拟实验，每一组参数即每一种情形下实验10000次取最终状态时破产银行数量以及资产损失率的平均值，作图；

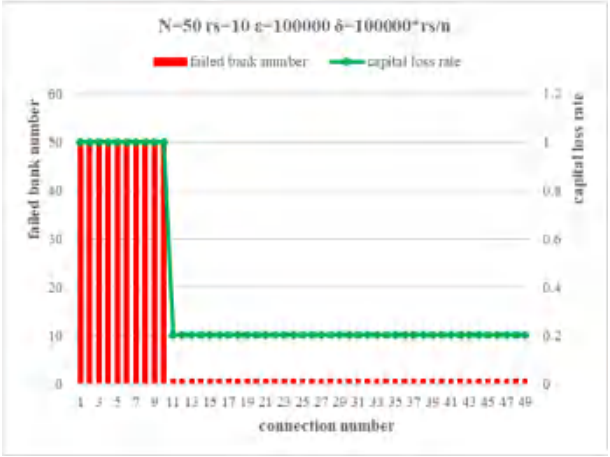
情形三：银行初始可用于偿还普通债务资金均值为100000，$\varepsilon$设置为75000、50000、25000和0，$\delta$一直取为$\frac{100000r_s}{n}$，分别在$r_s$为0.9、10、30、50的情况下进行模拟实验，每一组参数即每一种情形下实验10000次取最终状态时破产银行数量以及资产损失率的平均值，作图；

情形四：银行初始可用于偿还普通债务资金均值为100000，$\varepsilon$分别设置为75000、50000、25000和0，$\delta$分别取为$\frac{100000*0.75r_s}{n}$、$\frac{100000*0.50r_s}{n}$、$\frac{100000*0.25r_s}{n}$以及0，分别在$r_s$为0.9、10、30、50的情况下进行模拟实验，每一组参数即每一种情形下实验10000次取最终状态时破产银行数量以及资产损失率的平均值，作图。

### 3.3 模拟实验结果及分析

3.3.1 情形一实验结果及分析





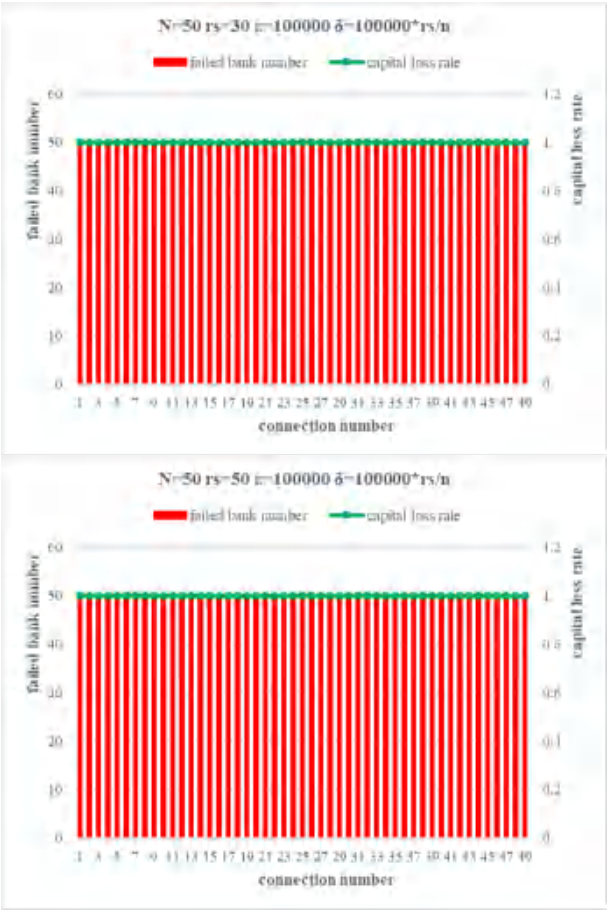



图1 情形一实验结果

从实验结果可以看到，当系统中所有的银行完全相同且负债平均分布在对手银行时，我们可以得出以下结论：（1）当$r_s = 0.9 < 1$时，不管联系数为多少，均只有最初的一家银行在最终状态时破产，且资产损失率均为1.8%左右，更一般的表达式为$\frac{100000r_s}{100000\times49} = \frac{r_s}{49}$,在这种情形以及本文的稳定性评判标准下，所有的网络结构具有相同的稳定性。值得一提的是，虽然最终状态时破产银行数量以及资产损失率均相同，但是最初一家银行的破产影响到的银行数量随着联系数的变化而变化，为联系数$n$；（2）当$1 \le r_s < 49$时，很容易发现，联系数存在一个临界点（也可以叫做断点）$r_s$，这一断点两边是两种极端情况，没有过渡阶段，具体来说，当$n < r_s$时，最终状态时所有银行均破产，资产损失率为100%，但是当$n > r_s$时，则完全相反，最终状态时只有最初的一家银行破产，资产损失率也仅为$\frac{r_s}{49}$；（3）当$r_s \ge 49$时，不管联系数是多少，最终状态时所有的银行均会破产，资产损失率均为100%。

3.3.2 情形二实验结果及分析

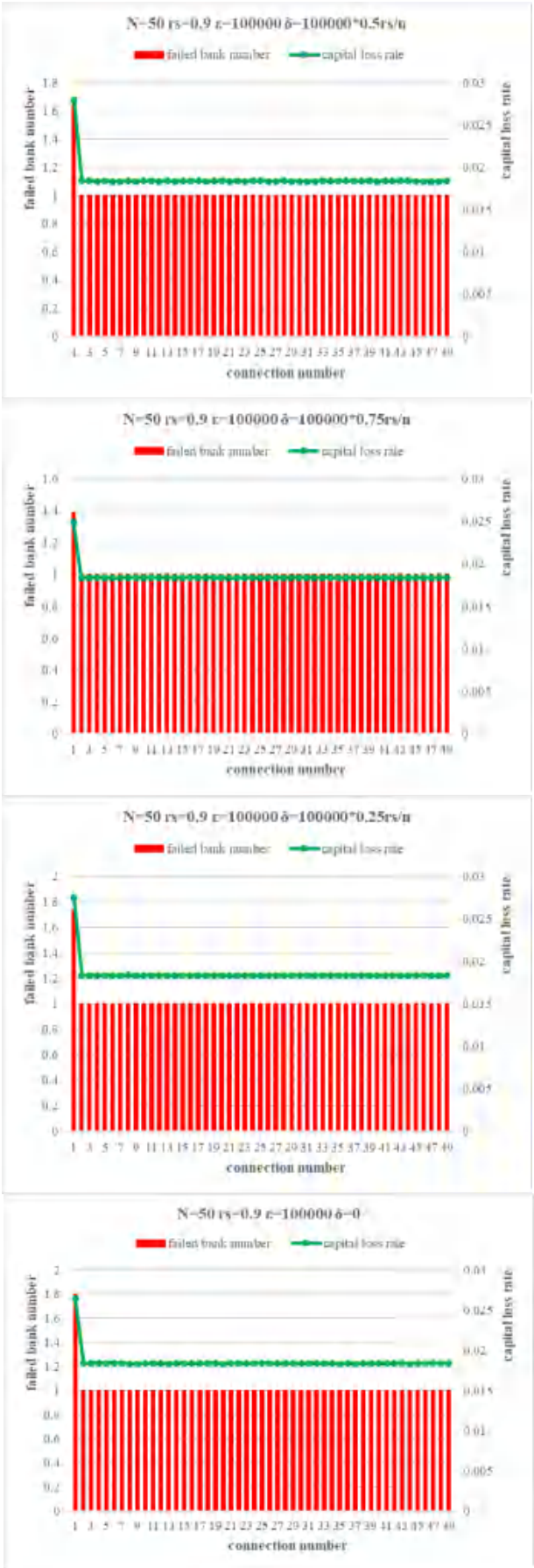



图2　情形二$r_s = 0.9$时实验结果

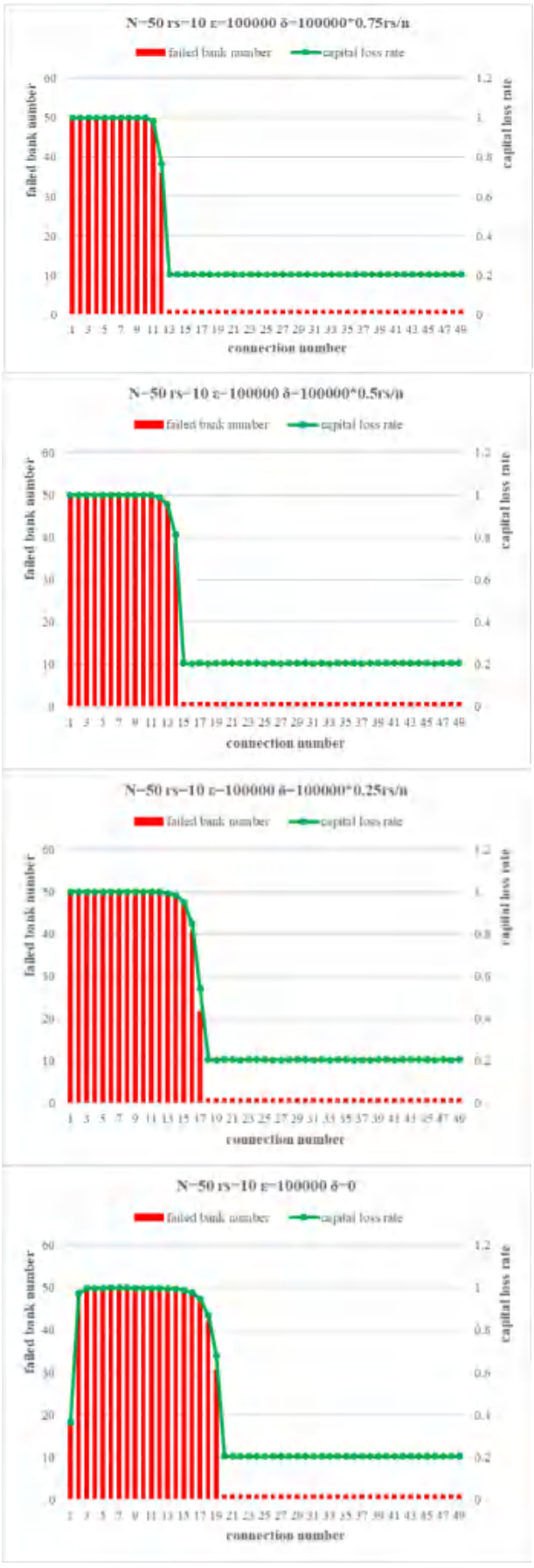



图3 情形二$r_s = 10$时实验结果

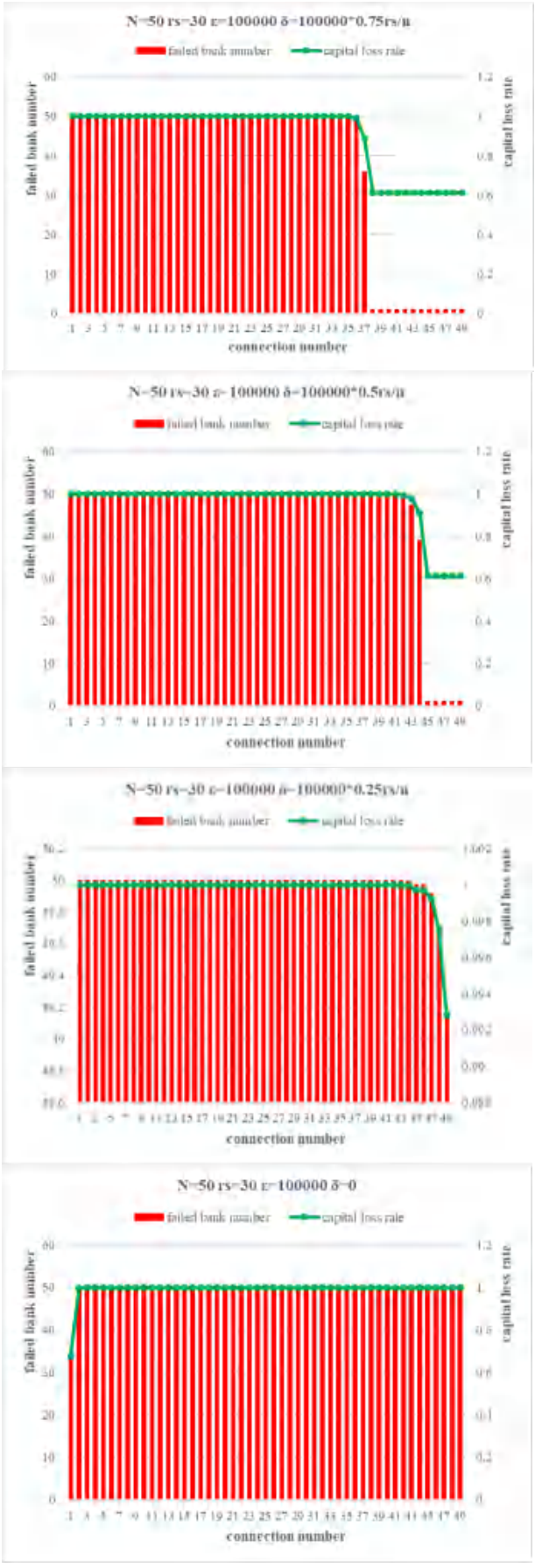



图4　情形二$r_s = 30$时实验结果

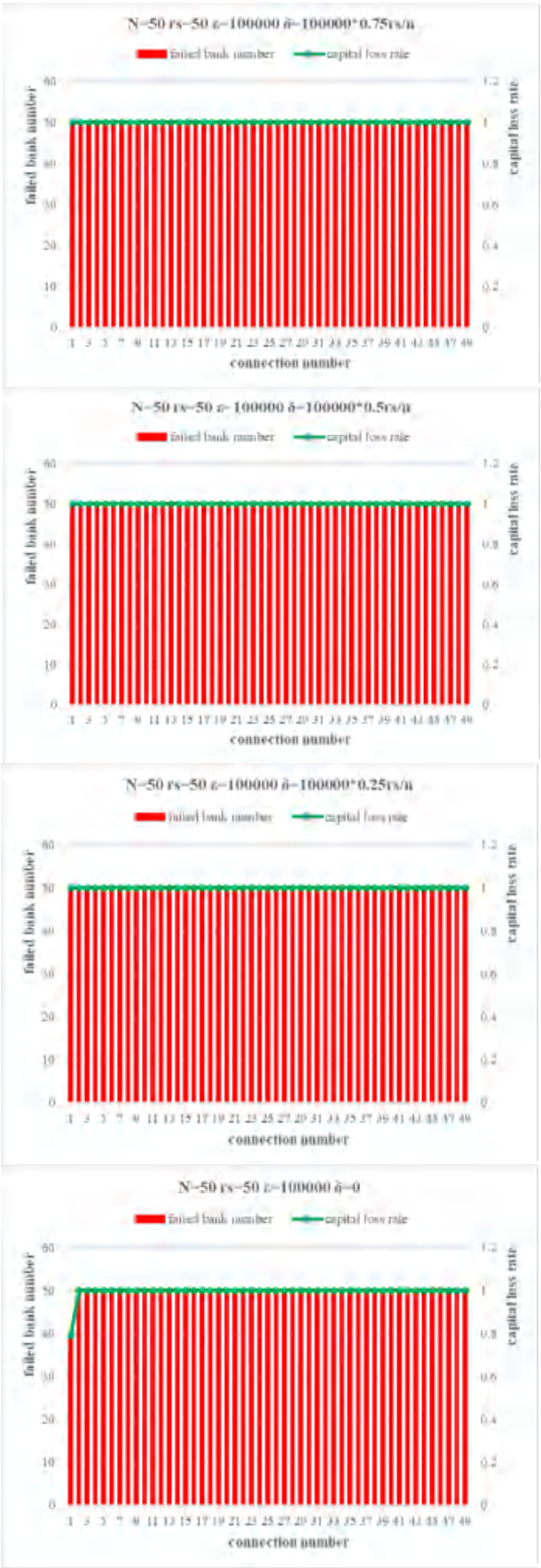
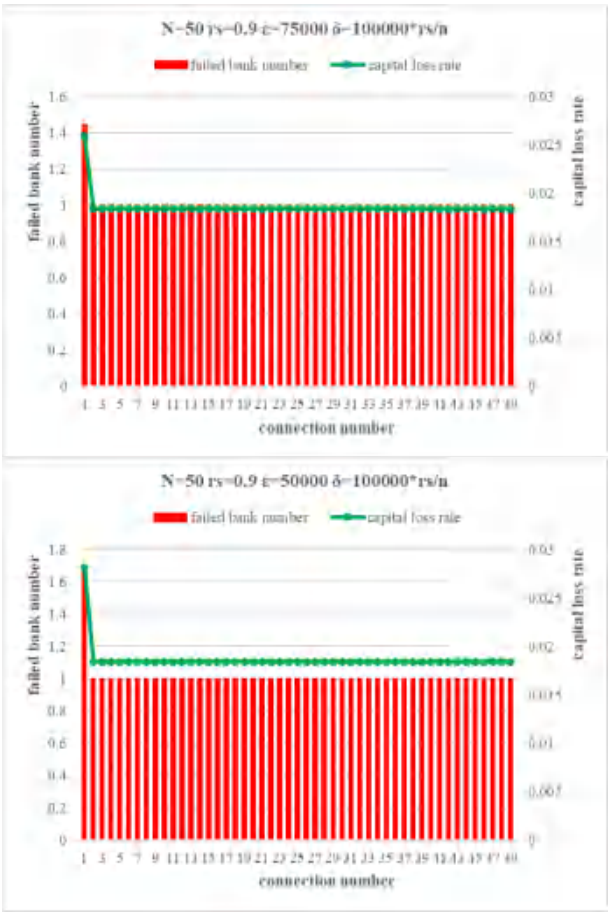



图5 情形二$r_s = 50$时实验结果

通过观察情形二实验结果并与情形一的结果对比可以得出以下结论：（1）当$r_s = 0.9$时，相比于银行债务联系无差异的情况，当银行债务联系具有差异时，环状网络的稳定性略微变差，随着差异程度的增加，环状网络的稳定性变化并不显著，其余联系数大于1的网络结构稳定性并未发生变化；（2）当$r_s$增加到10或者30且$\delta \neq 0$时（债务联系差异程度不是非常大），$n \leq r_s$的网络结构稳定性并未发生变化，在最终状态时，所有银行依然均会破产且资产损失率为100%，但是$n > r_s$且在$r_s$附近的网络结构稳定性会显著变差，当联系数充分大时，网络结构稳定性不会发生变化，但是当$\delta = 0$，也就是债务联系差异程度充分大时，环状网络的稳定性会显著变好，且优于其他网络结构；（3）当$r_s = 50$且$\delta \neq 0$（债务联系差异程度不是非常大）时，可以看到，债务联系的差异程度对于网络结构的稳定性无影响，最终状态时所有银行依然均会破产且资产损失率达到100%，但是当$\delta = 0$，也就是债务联系差异程度充分大时，环状网络的稳定性会显著变好，而且显著好于其他网络结构，其余联系数大于1的网络结构稳定性保持不变。所以我们可以看到，并不是所有的情况下完全网络都是最稳定的。

3.3.3 情形三实验结果及分析



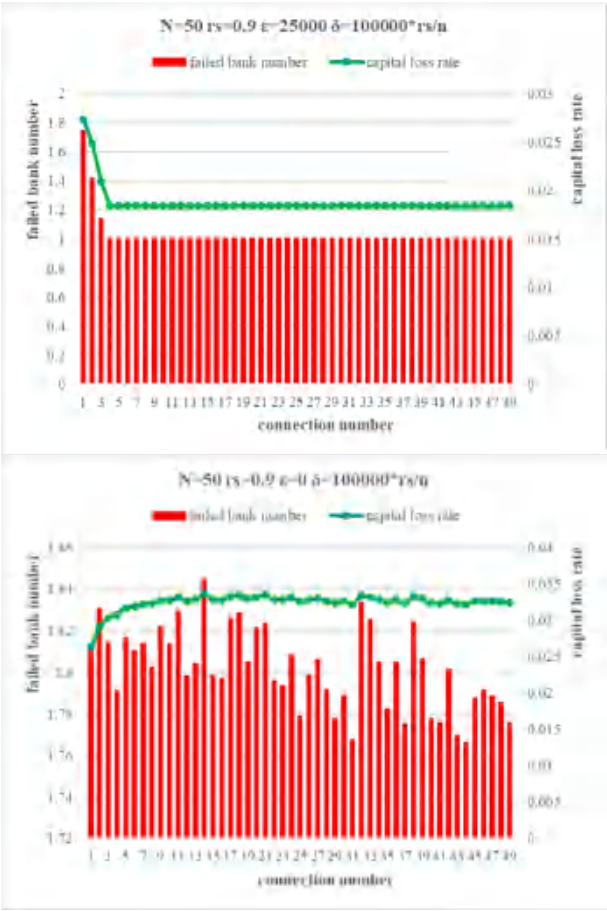



图6 情形三$r_s = 0.9$时实验结果

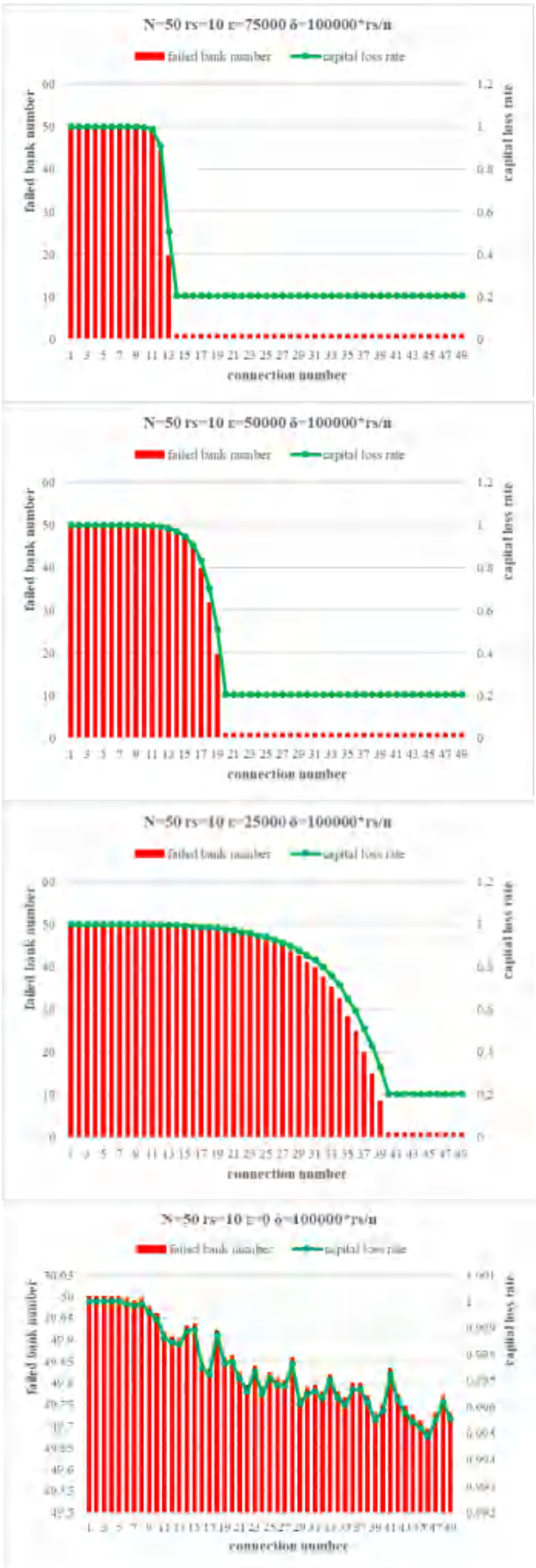



图7　情形三$r_s = 10$时实验结果

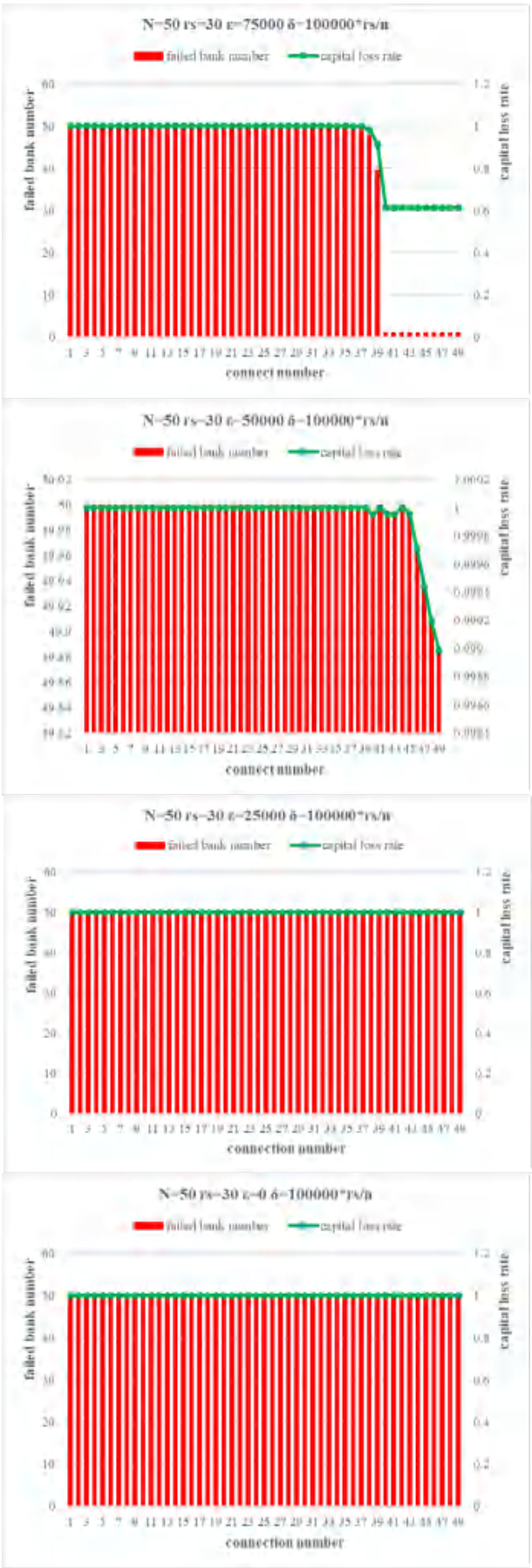



图8 情形三$r_s = 30$时实验结果

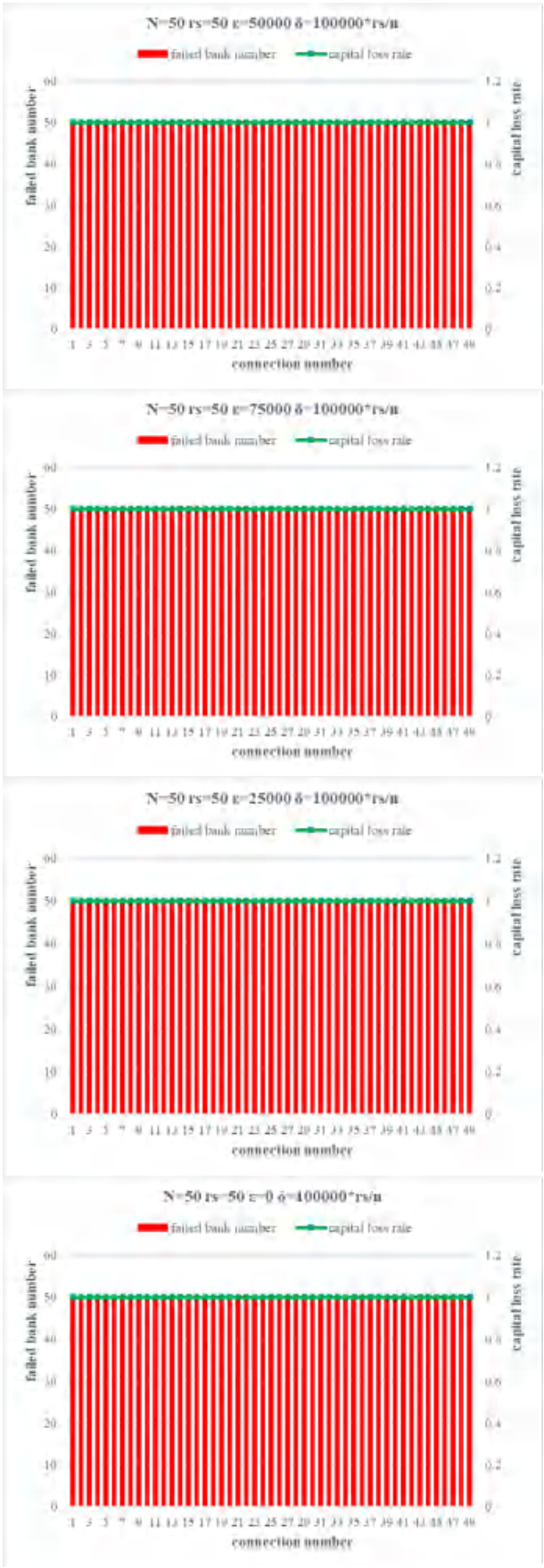



图9　情形三$r_s = 50$时实验结果

通过情形三实验结果并与情形一的结果对比可以得出以下结论：（1）随着系统中银行差异程度的提高，不管联系数是多少的网络结构，银行间系统网络的稳定性只会变差或保持不变，而不会变好；（2）不管系统负债率和银行差异程度为多少，联系数大的网络结构稳定性不会弱于联系数小的网络结构。

### 3.3.4 情形四实验结果及分析

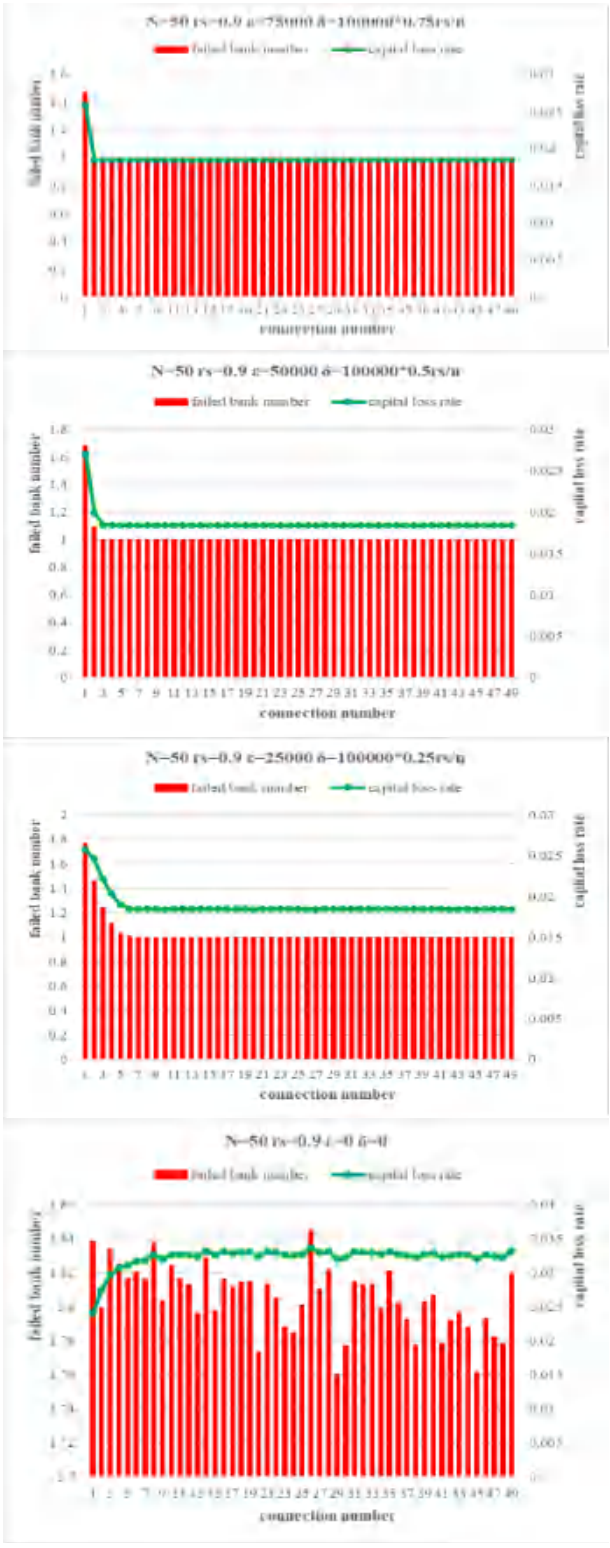



图10 情形四$r_s = 0.9$时实验结果

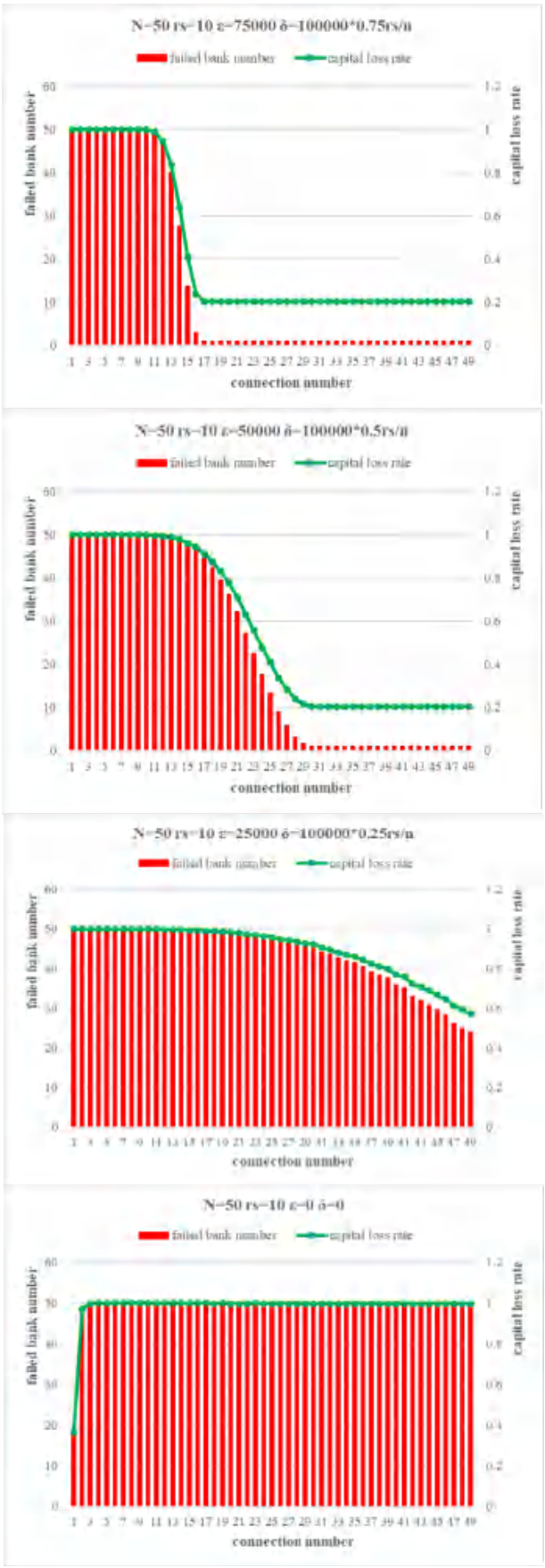



图11　情形四$r_s = 10$时实验结果

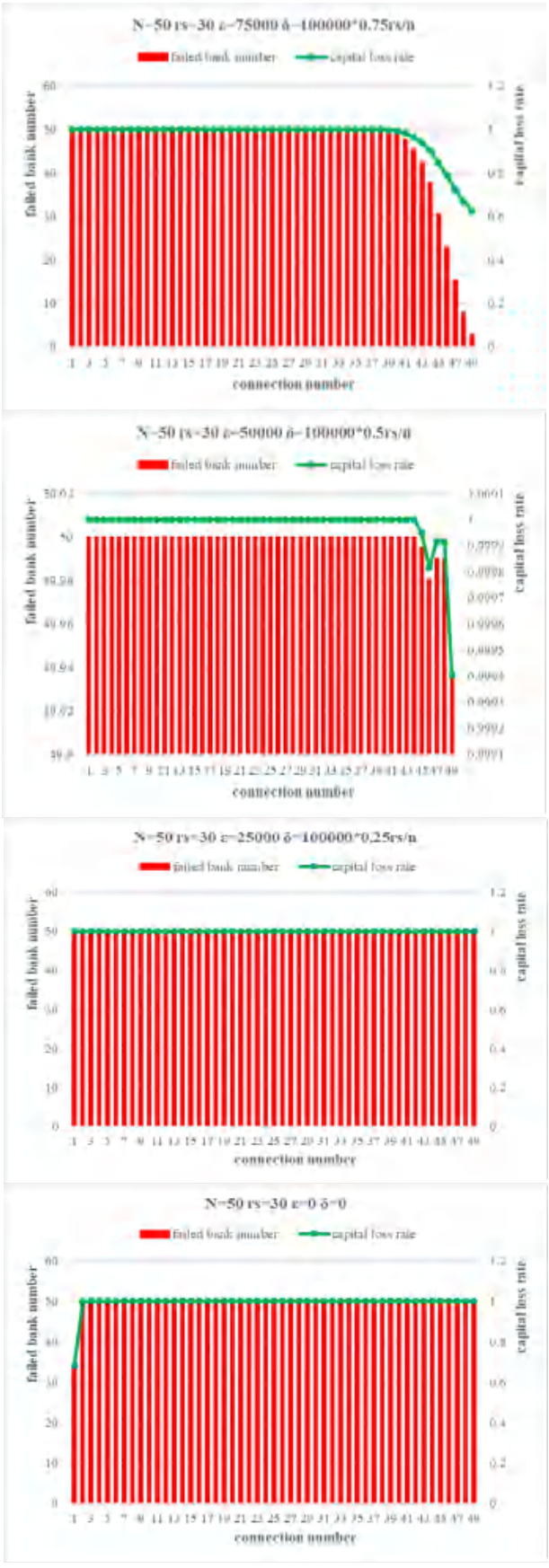



图12 情形四$r_s = 30$时实验结果

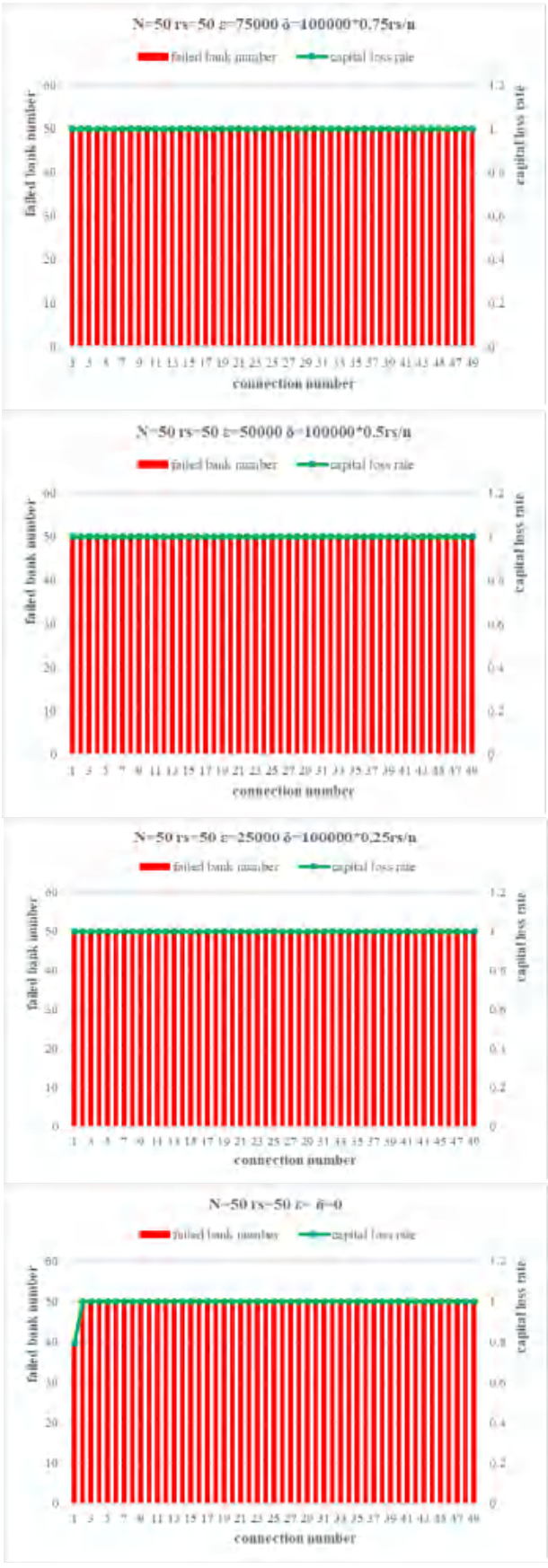



图13　情形四$r_s = 50$时实验结果

分别对比情形四与情形二和情形三的实验结果，可以发现：（1）当银行间债务联系具有差异性时，加入相同程度的银行差异性后，不管是联系数为多少的网络结构，网络稳定性只会变差或者保持不变，不会变好；（2）当系统中的银行具有差异性时，如果再加入相同程度的银行间债务联系差异性，当$r_s = 0.9$时，不管联系数为多少的网络结构，网络稳定性只会变差或者保持不变，而不会变好，而当$r_s = 10$、30或50时，除了联系数为1的环状网络外，其余网络结构的稳定性也是只会变差或者保持不变，而在银行间债务差异程度最大时，再加入最大程度的银行间债务联系差异性，环状网络的稳定性会发生显著变好，可以看到，这是银行间债务联系差异性导致的结果。

## 4．结论

由于实际生活中银行间借贷数据的不可得性，无法得到实际银行间系统网络的结构以及个体银行和银行间债务联系的特点，本文通过构建银行间系统网络，使用蒙特卡洛模拟的方法，根据系统负债率、银行的差异程度以及银行间债务的差异程度对多种情形进行模拟，通过改变银行的债务联系数量来改变网络结构，研究不同情形下的最优网络结构，并且在此过程中发现了银行的差异程度以及银行间债务的差异程度对于银行间系统网络结构稳定性的影响。研究发现：（1）当银行间系统中的银行同质且银行间债务联系同质时，不管系统负债率为多少，联系数大的网络结构稳定性不会比联系数小的网络结构稳定性差，也就是说，银行系统中的银行规模很接近时，如果银行间债务更加均匀地分布在尽可能多的银行，当遇到外界冲击时，银行系统抵抗外界冲击的能力越强，最终的资产损失也就越小；（2）当银行间系统中的银行具有差异性但银行间债务联系同质时，银行异质性会使联系数大于且接近系统负债率的网络结构稳定性变差，且随着银行差异程度的提高，网络结构稳定性变差的趋势以及范围会变大，也就是说，在此情形下，银行异质性不仅不会提高整个银行系统稳定性，相反，还会有可能降低整个银行系统的稳定性；（3）当系统负债率较大且银行间债务联系差异程度非常大时，会出现一个非常有趣的现象：相比于银行间债务联系差异程度较低时，环状网络的稳定性会显著变好，而且会成为稳定性最好的网络结构，明显优于其他联系数的网络结构，由此可见，在系统负债率较大（至少要大于1）的情况下，银行间债务联系差异程度的提高可能会提高环状网络的稳定性。

我们可以对（3）中这一有趣的现象进行进一步的解释。

首先，为什么会出现这样的现象？我们知道，当系统中的银行债务联系完全同质时，只要系统负债率大于等于1，在环状网络中所有的银行在最终状态时均会破产。但是当银行间债务联系差异性较大，也就是在均值附近波动较大时，会存在银行间债务非常小的银行，这家银行可用于偿还普通债务资金完全可以抵消掉银行间债务，那么冲击的传导就会到此为止，后面的银行就不会受到牵连。

其次，银行间债务较大的差异程度为什么很难对联系数较大的网络结构产生类似于环状网络的影响？这也很好理解，相比于环状网络，其他的网络银行联系数$n$会更大，也就是说，只有随机产生的$n$个银行间债务联系均小于银行可用于偿还普通债务资金时，冲击的传导才会停止，只要有一个银行间债务联系不满足条件，冲击就会继续在系统中传导，很显然，联系数越大，冲击传导中止这一事件发生的概率会越低。

最后，为什么银行异质性不会像银行间债务联系异质性一样，对环状网络产生同样的影响？当银行间债务联系同质时，在系统负债率很高的情况下，相比于

银行间债务联系，银行可用于偿还普通债务资金会小得多，所以出现银行间债务联系小于银行可用于偿还普通债务资金这一事件的概率也会很小。

## 5．政策建议

通过前面的分析，我们可以发现，作为监管者，面对着联系越来越错综复杂的银行间系统，仅仅停留在资产负债表的层面进行监管已经远远不够。

监管部门首先应当控制银行系统的负债率，如果系统负债率过高，不管是什么样的网络结构，面对外界冲击时，整个银行系统都会崩溃。

监管部门不仅要关注银行个体，也应该要对整个银行系统进行充分的了解从而把控全局。具体来说，监管部门要深入了解当前银行系统中银行数量及其规模分布，监测银行规模的差异程度并将其控制在较低的水平，避免出现大型银行与小型银行的两极分化，这样更有利于银行系统的稳定。

同时，监管部门还要关注银行系统中银行之间的业务往来，平衡大型银行与小型银行的业务往来关系，控制银行间借贷发生在规模相近的银行之间，而应该减少银行规模差异较大的银行之间的债务联系。这些债务联系不仅会通过网络结构影响银行系统的稳定性，同时也会通过银行间联系的异质性这一途径影响银行系统的稳定性，因此对这些业务往来的控制对于维护银行系统的稳定是非常关键的。

当整个银行系统的负债率非常高且银行之间业务往来差异程度非常大时，监管部门应该设法减少银行之间的债务联系以维护银行系统的稳定性。

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# 银行间系统网络结构稳定性研究

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**关键词:**银行间系统；网络结构；差异程度；蒙特卡洛模拟

**中文摘要.**金融机构间的关联性在金融危机传导中起着关键作用，而银行危机是系统性金融危机的重要表现形式。搭建银行间系统网络，以识别银行系统风险的传染规律，有利于把控系统性金融风险，这对于金融风险管理具有重要的实践意义。本文建立了银行间系统网络模型，并使用蒙特卡洛模拟方法对于不同情形下不同网络结构的稳定性进行了研究，研究发现：当系统中银行间债务联系完全相同时，联系数越大，网络结构稳定性会更好或者保持不变；在其他条件相同的情况下，系统中银行的差异程度增大会导致网络稳定性变差或保持不变；当系统负债率较大且银行间债务联系差异程度充分大时，相比于银行间债务联系同质的情况，环状网络的稳定性会显著变好，甚至成为所有网络结构中稳定性最好的网络结构。

# The Impact of Climate Change on the Credit Risk of Chinese Listed Companies in the Mining Industry

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**Keywords:** Climate change, Mining industry, Credit risk.

**Abstract.** The impact of the "green swan" event caused by climate change on the real economy cannot be ignored. The mining industry is a highly sensitive industry to climate change. The environmental risk and financial risk are not isolated and independent of each other, thus the credit risk triggered by climate change cannot be ignored. This article firstly analyzes the impact mechanism of climate change on the credit risk of listed companies in the mining industry: abnormal climate changes may cause negative impacts on the cash flow of the mining companies, reducing the company's repayment ability and increasing its credit risk; on the other hand, mining industrial enterprises increase their investment in pollution control to meet environmental protection standards, weakening their solvency and increasing the possibility of default, which undoubtedly increases their credit risk. Secondly, it describes the current situation of climate-related credit risk of listed companies in mining industry in China and analyzes the reasons for its formation. Finally, it presents risk prevention and control recommendations for the mining industry actively responds to credit risk under the impact of climate change, which mainly include: establishing a corporate climate change risk disclosure and assessment system,

grasping the overall rhythm of the climate transformation strategy, encouraging companies to incorporate climate change factors into credit risk stress test.

## 1. 引言

《巴黎协定》签署之后，国际上对于气候变化达成各方最广泛共识，自此，气候变化成为了世界各国无法规避的公共问题，与气候变化相关的话题一直备受关注和热议。世界经济论坛于 2021 年 1 月 9 日发布的《2021 年全球风险报告》(Global Risks Report 2021)中指出了未来十年最可能发生的风险，其中就包括了极端天气和气候行动失败。尽管在疫情的影响下，全球范围内大规模停工停产减少了 2020 年度全球碳排放量，降低了二氧化碳浓度，在一定程度上能够延缓气候变化加剧的速度，但伴随着疫情形势逐渐可控并得到好转，经济活动出现报复性反弹，随之而来的很可能会是碳排放量的增加。全球深度减排力度欠缺表明，气候变化仍在加剧，由此引发的风险不容忽视，气候问题仍然迫在眉睫。特别是我国关于“30”碳达峰、“60”碳中和的“双碳目标”的提出，向经济社会发展发出全面绿色转型的信号，对减缓和积极应对气候变化提出了迫切要求。

由气候变化引发的极端天气事件增加容易对实体经济形成冲击，造成企业的经济损失。对于由气候变化所引发的“黑天鹅事件”，国际清算银行 BIS 提出了“绿天鹅”的概念加以描述，将其定义为气候领域出现极具破坏力的现象，可能给社会生活和经济增长造成巨大财产损失，引发金融领域动荡及风险。气候变化相关问题的复杂程度远在普通黑天鹅事件的量级之上，虽然气候变化具体会产生何种影响存在很大的不确定性，但未来发生气候变化事件进而造成实体性、变革性影响的概率极大，且这种气候事件造成的破坏性影响极强。

矿产资源的开采关系到能源动力的供给，在国民经济中占据着至关重要的地位。作为一种特殊的工业行业，采矿业与气候变化之间存在着双向交互影响的关系：一方面，在开采和燃烧矿产能源的过程中，产生的以二氧化碳为代表的温室气体会重新进入大气层中，对气候异常变化起到“推波助澜”的作用，同时，原先储存在地层中的气体在矿体开采过程中极易泄露，而这些气体也存在对气候变化产生加剧作用的可能性；另一方面，由于采矿业对气候变化敏感度较高，在恶劣气候条件下进行采掘作业无疑增加了矿业项目运作的物理难度，高难度作业很可能导致产出的减少，因而影响企业的财务能力、改变企业的财务业绩，从而引发与之相关的金融风险。

国内外不少学者的研究中都认识到了气候变化对企业的影响：随着全球气温预计会继续上升，了解并预估气候变化风险对经济活动的影响越来越重要（Dell et al，2014）。气候变化风险已经成为企业必须要面对的问题，应对气候变化风险已经成为企业承担社会责任的重要指标（General Electric Company，2018）。在气候变化条件下，投资管理业应采取积极的应对和发展战略，尤其是要改进对公司的估值评估方法，充分考虑气候变化对公司价值的潜在影响（段兵，2010）。然而，目前中国的企业管理者应对气候变化风险还缺乏主动性，即因为政策法规和行业标准的强制性要求而被动地进行气候变化风险应对（潘家华等，2009）。现有相关领域文献大多在研究气候变化对企业经营绩效或者财务绩效的影响，研究气候变化对某行业具体某种金融风险影响的文献还比较少。

应对气候变化既是一种挑战，也是实现可持续发展的一种机遇。本文以采矿企业金融风险受气候变化的影响为切入点，探究气候变化对采矿业上市公司信用风险的影响机制，在明确气候问题如何延伸成企业信用风险以及这种影响的传播

路径之后，对采矿业如何积极应对气候变化影响下的信用风险提出了防控建议。

## 2．气候变化对采矿业上市公司信用风险的影响机制

随着气候变化相关问题的研究越来越广泛和深入，对于气候变化引发风险的认识不再拘泥于环境风险方面，气候变化影响之深度和广度涉及了经济、社会等多方面问题，综合性越来越强。经济与金融不是气候变化的“孤岛”，企业的经营活动和金融活动也与气候变化的联系也日趋紧密。气候相关金融风险不是一种新的风险，而是通过现有的风险类型表现出来，是固有风险的外化表现形式。气候变化对采矿业上市公司信用风险的影响机制可以分为两类，一是从物理风险层面产生影响：气候异常变化可能导致采矿业企业现金流和资产负债遭受负面冲击，降低企业还款能力，增大其信用风险；二是从转型风险层面产生影响：采矿业企业为环保达标而加大投入治污，削弱了其偿债能力并增加其违约可能性，这无疑也加大了其信用风险。

### 2.1 气候物理风险层面

气候物理风险对企业的影响主要体现在实物资产价值缩水和企业正常经营活动受阻两个方面，无论是实物资产价值受到侵蚀而造成的直接经济损失，还是因为恶劣气候事件而停工减产导致的间接经济损失，都会给企业价值及现金流量带来不可逆转的负面影响，恶化企业作为债务人的偿债能力，使得其违约率大幅增加，从而增大其信用风险。

#### 2.1.1 对企业实物资产价值的影响

突发性气候事件会影响企业已有资产的价值、降低资产的估值，给企业造成损失。在极端气候事件发生时，由采矿企业所有的生产资料和基础设备发生毁损的概率大幅提升，企业资产极有可能发生减值损失，当简单的修缮无法满足继续投入使用的条件时，就需要付出额外费用来进行设备的更新改造甚至是重置。如此一来，就造成了企业实物财产的价值损失并增加了企业的额外支付成本，为企业带来财务负担，冲减了企业的现金流量。当受灾者是身负债务的借款企业时，在极端天气事件的影响下，企业还款能力将会下降，随之而来的是违约概率的上升。如果企业以房屋等实物资产进行了抵押，由于抵押物在极端天气事件中受到的损失是无法逆转的而且无法进行弥补，因而抵押品物价值会发生减值的变化，债权人手中的资产价值会减损。

除了受到特定不确定性突发事件的影响外，一些慢性的气候变化会以“温水煮青蛙”的方式，逐渐侵蚀资产价值，最终加速企业资产的贬值。采矿企业生产经营用房屋、建筑物等暴露在天气中的大型固定资产在长时期经受酸雨冲刷的侵蚀影响下，腐蚀速度会加快，资产价值贬值的速度也会加快。特别是一些露天建筑、杂项建筑中的站台、天桥、围墙等相对“脆弱”的固定资产，在慢性气候变化的影响下资产耐受力也逐渐下降，当极端气候事件这“最后一根稻草”降临时，可能造成毁灭性的损失，给企业资产负债造成沉重打击。

#### 2.1.2 对企业营运活动的影响

对于采矿业来说，恶劣的气候环境并不是一个陌生的话题，许多矿业项目在恶劣的条件中进行运作，而自然条件的变化对于采矿企业项目运作环境及生产效率的影响无法忽视。强降雨、干旱、高温等自然灾害频发会大大增加采矿作业的物理难度，也会加速设备的折旧和毁损，从而降低采矿工人的生产效率以及生产

资本的运作效率。在对近海石油与天然气资源进行开发利用的过程中，暴风雨等自然灾害的来袭给采矿项目活动的正常运转带来压力，开采设备的毁损不仅会给企业带来额外成本费用的负担，还会使得正常的开采活动被迫中止或中断，企业正常运营受阻。由极端降雨而引发的洪水也可能导开采致项目活动中断，使企业面临矿井关闭、道路被冲断甚至是尾矿坝中的水位升高所导致的溃坝风险。企业营业收入减少、营运成本增加，造成企业的经济损失。

采矿活动对气候和地理环境要求一般都较高，一旦气候条件恶化，企业需要支付较高的应对成本来分散和消除风险的影响。由于未来的气候条件难以预测，企业在进行规划时常常基于当时的气候状况，当气候变化加剧时，如果不支付额外的费用进行改善，现行的安全标准和生产设备可能无法满足运营需要。而当气候变化对企业生产活动的影响涉及到地理位置改变与搬迁时，企业就要以付出迁移费为代价来满足新的生产经营活动的需要。这些成本及损失的发生都会给企业核心运营带来不利影响，恶化企业的财务业绩。

## 2.2 气候转型风险层面

气候转型风险对企业的影响主要体现在以下两个方面：一是在向低碳转型过程中气候政策的转变要求企业对于自己的经济行为及时作出调整，对不符合要求的企业造成财务上的成本负担；二是公众对于绿色企业的青睐和投资时的选择偏好也会给予企业转型压力，在这一过程中，企业资产的市场价值会受到重估调整，转型不成功或者不达标的企业价值极易受到损失。

### 2.2.1 转型政策对企业的影响

在低碳经济转型过程中，由于气候变化政策实施、低碳技术发展等因素，实体经济将受到冲击。当政府对企业碳排放实行强监管，大力推行低碳政策时，会在一定程度上给采矿业企业带来较大的经济压力。如果通过行政命令强制要求企业达到减排标准，会使得高碳企业产量大幅下降、收入大幅缩水，因主要经济来源受阻而增加了其违约的概率。碳税和碳交易约束政策的推行会增加企业的污染成本和治污成本，排放和环保标准提高会要求企业为了环保达标而付出额外成本或者损失经济利益，影响企业现金流和资产负债，导致企业利润、偿债能力下降，增加企业违约风险。特别是对于减排空间较大的企业，严苛的环保政策会成为其营业利润增加的一大重要阻碍，减损企业经济利益。

随着我国经济进入新常态，经济结构和增长方式有所转变，经济向低碳转型的过程中，由于对化石燃料的需求大幅缩减，部分不满足环保要求的化石燃料开采受到影响，不得不在其经济寿命结束之前退出生产性运营，沦为搁浅资产。煤炭、石油和天然气都有可能成为搁浅资产，这对企业来说是一大笔资产价值的损失。化石燃料等资源的搁浅意味着这些资产本身和以其为标的的投资品价值都会下降，当市场中充满环保严监管的信号时，所有人都会预期搁浅资产未来价值下跌。在“预期的自我实现”效应的作用下，当前资产价值会加速下跌，致使资产所有者资本和收入遭受双重受损的打击，违约风险上升。

### 2.2.2 投资者“绿色”偏好对企业的影响

随着绿色环保概念深入人心，投资者的投资偏好可能会发生改变，更加青睐符合绿色标准的企业发行的债券和股票，高污染企业发行的证券因此失去竞争力、流动性大幅下降，甚至可能退出投资者的资产组合，企业市场价值受到减损。企业为了重新在证券市场上占有“一席之地”，势必需要进行技术革新，利用清洁资源重新吸引投资者，这也意味着原有资产的价值下降以及依靠原有经营活动获取收入的能力下降。此外，技术的革新需要投入大量的时间成本和资金成本，

在转型成功之前，依然存在受到市场“排挤”的可能性。如果企业转型失败，前期投入资金的损失不可逆转，变为沉没成本；转型失败的负面新闻也可能使企业声誉受损，对企业的融资困境来说无疑是雪上加霜。

一方面，企业低碳转型前竞争力下降，在信贷市场融资的困难程度大幅提升，拉升了企业融资成本；另一方面，企业转型不能一蹴而就，新技术研发需要投入大量资金，转型过程中也可能带来经营性损失，导致企业的现金流量受损。资金供给的短缺和资金需求的旺盛使得企业陷入两难困境，没有足够的资金维持正常的经营运作，违约率大幅提升。

## 3．采矿业上市公司气候相关信用风险现状及成因分析

按照证监会的行业分类标准，在我国上海、深圳两家证券交易所上市交易的81 家采矿业上市公司股票可以继续细分为：煤炭开采和洗选业（25 家）、石油和天然气开采业（7 家）、黑色金属矿采选业（7 家）、有色金属矿采选业（23 家）、非金属矿采选业（2 家）、开采辅助活动（17 家）以及其他采矿业（0 家），具体分类如图 1 所示。

图 1 沪深股票证监会行业分类

### 3.1 采矿业上市公司气候相关信用风险现状

表 1 中展示了在证监会分类标准下采矿业各细分行业的部分经济指标，主要统计了截止 2020 年底，采矿业下的各个细分行业累计企业单位数、累计亏损企

业单位数以及累计亏损企业亏损总额。其中，煤炭开采和洗选业数量最多，亏损企业数也最多，占到了累计企业单位数的近三分之一；石油和天然气开采业虽然企业数量较少，但亏损企业数接近半数，且累计亏损总额是七个细分行业中的最大值。

表1　采矿业经济效益指标

| 序号 | 公布行业名称 | 累计企业单位数 | 累计亏损企业单位数 | 累计亏损企业亏损总额(万元) |
|---|---|---|---|---|
| 1 | 煤炭开采和洗选业 | 4,245.00 | 1,400.00 | 6,171,000.00 |
| 2 | 石油和天然气开采业 | 125.00 | 52.00 | 7,675,000.00 |
| 3 | 黑色金属矿采选业 | 1,211.00 | 265.00 | 529,000.00 |
| 4 | 有色金属矿采选业 | 1,218.00 | 320.00 | 569,000.00 |
| 5 | 非金属矿采选业 | 3,263.00 | 423.00 | 253,000.00 |
| 6 | 开采辅助活动 | 259.00 | 60.00 | 263,000.00 |
| 7 | 其他采矿业 | 9.00 | 3.00 | 1,000.00 |

表 2 中展示了在证监会分类标准下，2020 年度采矿业上市公司处于亏损的部分财务信息。作为企业开展经营管理决策的基础，净利润可以用来评价公司盈利能力、管理绩效以至偿债能力是一个体现和分析公司各个方面状况的综合性指标。这些净利润为负数的企业经营效益差，同时也存在较高的债务违约风险。

表2　2020年度亏损采矿业上市公司

| 证券代码 | 名称 | 净利润(含少数股东损益)(万元) | 归属母公司股东的净利润(万元) |
|---|---|---|---|
| 600777.SH | 新潮能源 | -265,625.66 | -265,625.66 |
| 300157.SZ | 恒泰艾普 | -120,795.23 | -120,910.36 |
| 600403.SH | ST大有 | -113,710.34 | -103,565.06 |
| 300164.SZ | 通源石油 | -113,251.97 | -105,284.34 |
| 600121.SH | 郑州煤电 | -86,318.46 | -94,408.50 |
| 000780.SZ | *ST平能 | -76,063.35 | -76,063.35 |
| 300084.SZ | 海默科技 | -60,079.58 | -59,750.33 |
| 900948.SH | 伊泰B股 | -54,589.98 | -65,705.53 |
| 603619.SH | 中曼石油 | -48,716.45 | -48,609.12 |
| 000506.SZ | 中润资源 | -48,576.10 | -49,284.88 |
| 600758.SH | 辽宁能源 | -46,754.07 | -46,707.62 |
| 600311.SH | ST荣华 | -42,020.61 | -42,020.61 |
| 600397.SH | 安源煤业 | -22,193.56 | -22,269.52 |
| 000426.SZ | 兴业矿业 | -18,386.74 | -18,385.93 |
| 002554.SZ | 惠博普 | -17,624.89 | -17,842.08 |
| 000762.SZ | 西藏矿业 | -5,590.16 | -4,851.67 |
| 600766.SH | *ST园城 | -1,542.57 | -1,542.57 |
| 002629.SZ | ST仁智 | -1,529.20 | -1,529.14 |

| | | | |
|---|---|---|---|
| 002207.SZ | 准油股份 | -829.94 | -829.94 |

下面将从银行贷款违约状况、债券违约状况以及 ESG 评分情况三个方面对采矿业上市公司的气候相关信用风险的现状进行描述和分析。

3.1.1 银行贷款违约状况

根据 wind 金融终端提供的商业银行不良贷款结构数据，整理得出近 10 年来采矿业上市公司银行贷款违约情况。通过观察图 2 可以发现，2015 年之前采矿业上市公司银行贷款违约金额还比较低，2015 年之后违约金额开始攀升，2016 年该金额达到近 10 年来的峰值，贷款违约金额超过 360 亿，此后违约金额一直维持在较高水平。《巴黎协定》于 2015 年 12 月 12 日在第 21 届联合国气候大会（巴黎气候大会）上通过，于 2016 年 4 月 22 日在美国纽约联合国大厦签署，并于同年 11 月 4 日起正式实施。作为继 1992 年《联合国气候变化框架公约》和 1997 年《京都议定书》之后，人类历史上应对气候变化的第三个里程碑是的国际法律文件，《巴黎协定》的重要程度不言而喻，昭示着各国对气候变化采取行动刻不容缓。《巴黎协定》发出绿色转型的强烈信号，在这一过程中，转型政策和市场情绪都会波及到采矿业的利益，影响采矿业的财务业绩，可以合理地推测，2015 年之后采矿业上市公司银行贷款违约金额的大幅攀升与气候转型的迫切要求有一定的联系。

图 2 2011-2020 年采矿业上市公司银行贷款违约金额

3.1.2 债券违约状况

在证监会行业分类的统计标准下，采矿业上市公司并未发生债券实质性违约，发生违约的主要是煤炭开采和洗选业的非上市公司，且这些违约都发生在了 2016 年及以后。结合表 1 中提供的数据，煤炭开采和洗选业累计亏损企业数及是细分行业内的最大值，累计亏损总额已逾 600 亿元，再联系上文提到的《巴黎协定》的签署和实施，也就不难理解为何该细分行业会有如此多的违约发生。主体信用评级分为三等九个级别（AAA、AA、A、BBB、BB、B、CCC、CC、C），AA 级代表企业偿还债务能力较强，受不利经济环境的影响不大，债券违约风险很低。通过观察表 3 可以发现，即使是 AA 级及其以上的债券也发生了实质的违

约，这表明违约风险低也并不意味着没有违约的可能。虽然上市公司相对于非上市公司来说资质更好，违约风险更低，但在气候变化的大背景下，采矿业上市公司在物理风险层面和转型风险层面遭受双重打击，资产负债及现金流发生恶化的概率大幅提升，违约概率也随之上升。

表3　违约债券明细

| 序号 | 债券信息 | | | |
|---|---|---|---|---|
| | 债券简称 | 违约发生日 | 代码 | 违约前主体评级 |
| 1 | 16宁远高 | 2021-04-12 | 136356.SH | C |
| 2 | 20永煤SCP008 | 2021-04-09 | 012002557.IB | B |
| 3 | 18永煤PPN002 | 2021-03-29 | 031800190.IB | B |
| 4 | 20永煤CP001 | 2021-03-01 | 042000080.IB | B |
| 5 | 18永煤MTN001 | 2021-02-02 | 101800091.IB | B |
| 6 | 18永煤PPN001 | 2021-01-26 | 031800049.IB | B |
| 7 | 20永煤SCP006 | 2020-12-25 | 012001102.IB | B |
| 8 | 19永煤CP003 | 2020-12-21 | 041900475.IB | B |
| 9 | 20永煤SCP005 | 2020-12-15 | 012000962.IB | B |
| 10 | 20永煤SCP004 | 2020-12-08 | 012000539.IB | BB |
| 11 | 20永煤SCP007 | 2020-12-08 | 012001559.IB | BB |
| 12 | 20永煤SCP003 | 2020-11-26 | 012000356.IB | BB |
| 13 | 18远高01 | 2020-11-23 | 155041.SH | AA |
| 14 | 18永泰集团SCP001 | 2018-12-10 | 011800431.IB | AA+ |
| 15 | 15川煤炭PPN002 | 2018-09-25 | 031572019.IB | C |
| 16 | 15川煤炭PPN001 | 2018-01-09 | 031560001.IB | C |
| 17 | 14川煤炭PPN002 | 2017-09-28 | 031490870.IB | C |
| 18 | 14川煤炭PPN001 | 2017-05-19 | 031490367.IB | C |
| 19 | 12川煤炭MTN1 | 2017-05-15 | 1282153.IB | C |
| 20 | 13川煤炭PPN001 | 2016-12-26 | 031390443.IB | C |

3.1.3 ESG 评分与信用风险

ESG 分析是一种把环境 E（Environment）、社会责任 S（Social Responsibility）及公司治理 G（Corporate Governance）三项指标纳入评价范围的评分模式，对于 ESG 三项指标的评价结果可以为责任投资者的投资决定提供投资参考依据。越来越多的信用评级机构、资产管理公司开始重视并强化对 ESG 相关研究的实践，认为 ESG 与公司信用风险存在一定的的关联度。2016 年 8 月 31 日，标志着开启中国绿色金融新纪元的《关于构建绿色金融体系的指导意见》发布，自此之后，市场对于 ESG 的关注度不断提升。

采矿业上市公司的 ESG 评分对信用风险的影响主要体现在三个方面：第一，公司经营和运转与所处的环境状况密不可分，气候变化等带来的自然环境恶化会影响公司的正常经营，恶化企业的资产负债；第二，承担更多社会责任、或者在运营管理时把更多社会因素（如：绿色、低碳转型等）纳入经营理念的企业，相较于一般的企业具有更强的竞争优势；第三，

在监管当局对于环境、社会责任等因素提出较为严苛的监管要求的背景下，ESG 风险因素敞口较大的企业很可能需要付出额外的成本和代价来满足监管要求，从而弱化企业的盈利能力、恶化企业的现金流，进而对其信用造成负面影响。

根据华证指数和 Wind 金融终端提供的资料显示，选取沪深 300 和中证 500 为比较基准，2021 年 1 月 31 日三只指数的 ESG 评级结果如下：沪深 300 的 ESG 评分为 90.23 分，中证 500 的 ESG 评分为 87.83 分，而证监会采矿业的 ESG 评分为 85.11 分，在三者中评分最低。具体的评分结果对比如图 3 所示。

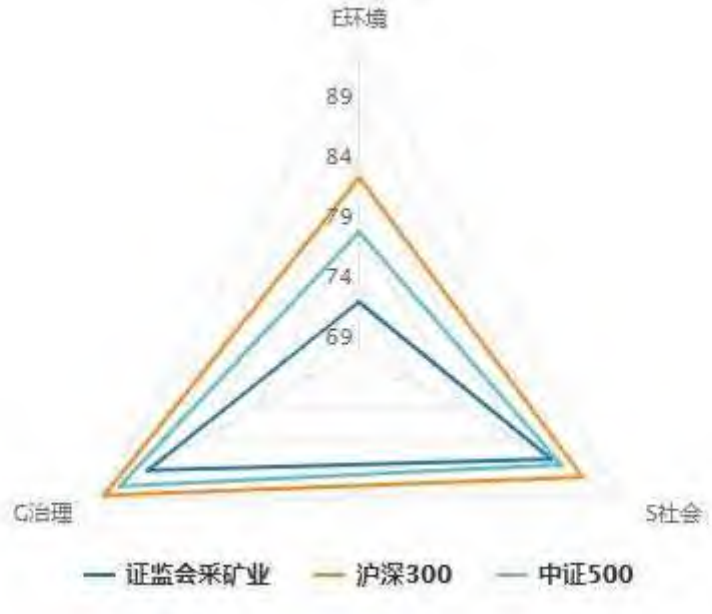


图 3 ESG 评分总览

观察图 4 中展示的 E/S/G 分项得分可以发现，证监会采矿业分项得分均低于沪深 300 和中证 500 相应指标的得分。其中，证监会采矿业环境评分与比较基准差距最大。气候变化是环境评分的一个重要考量项目主题，气候物理风险和气候转型风险都可能通过其传导机制，对采矿业上市公司产生不利影响，这可能会成为采矿业环境评分较低的一个重要原因。而社会评分和治理评分中也可能会存在气候变化影响公司的“影子”，例如：企业有没有承担保护环境的社会责任、积极响应绿色低碳转型的号召，有没有采取合理的措施管理气候风险等。

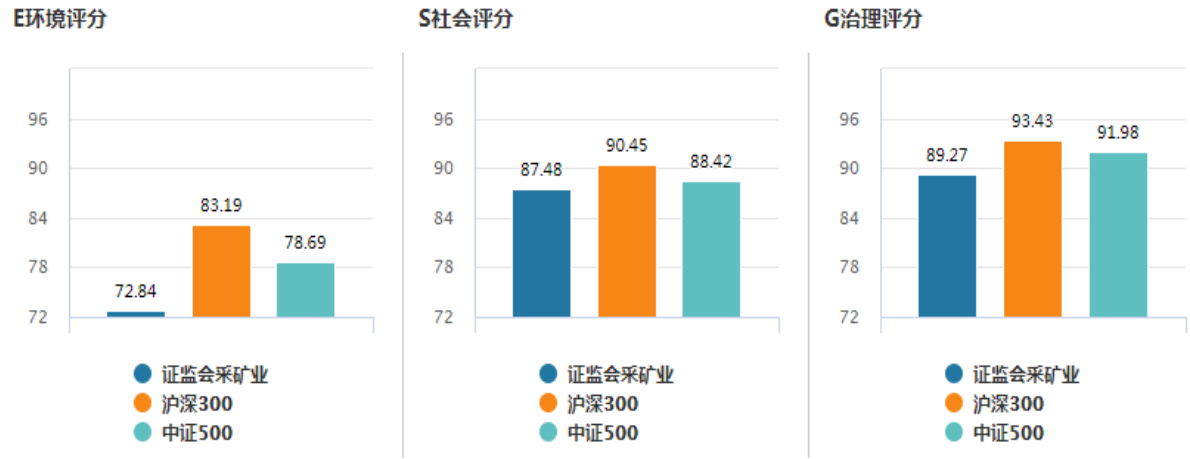


图 4 E/S/G 分项得分

对比证监会采矿业、沪深 300 及中证 500 的 ESG 综合评级可以发现，证监会采矿业有超过 45%成分股 ESG 评级在 A 级以下，这一比例远高于其他两只指数。ESG 评分低在一定程度上反映了企业存在较大的信用风险，图 5 展示了 ESG

综合评级的分布情况。

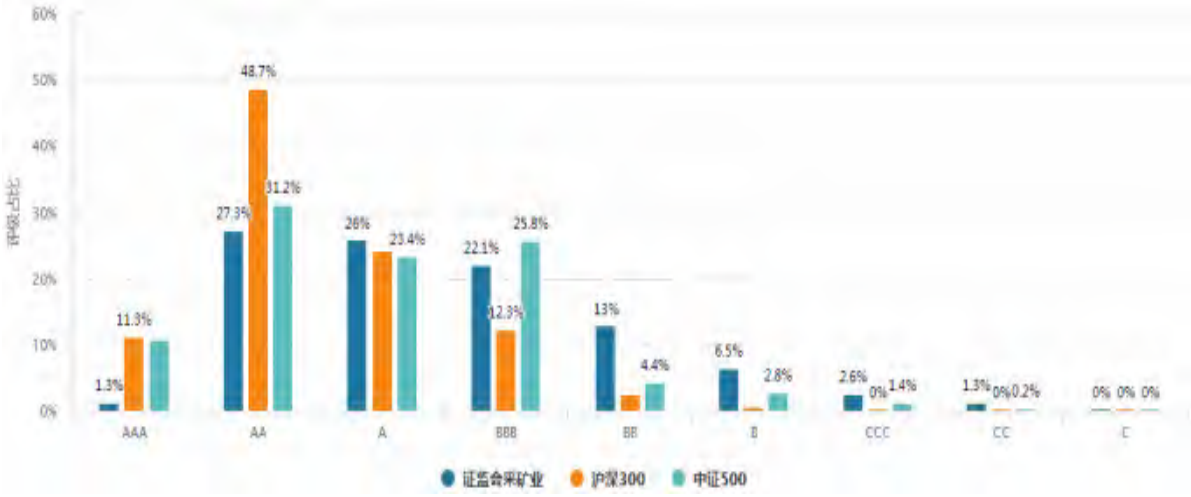


图 5 ESG 综合评级对比

## 3.2 信用风险成因分析

气候变化通过物理风险和转型风险两条传播路径影响采矿企业的信用风险，最终可能损害其债权人的利益。关于气候相关金融风险的成因，可以从通过下角度进行分析：

### 3.2.1 企业气候变化相关风险披露不足

企业作为债务人，与其债权人之间存在着相当程度的信息不对称，相对于企业来说，债权人能够掌握的与企业有关的信息以及获取相关信息的渠道都十分有限。尽管企业会定期披露财务报告，债权人可以通过企业披露的三大财务报表及报表附注中的内容来了解企业的经营状况及财务状况，但是这并不意味着债权人掌握的信息足以充分反映或预测企业的历史沿革、运营现状及未来发展，这种信息不对称的存在意味着债务人被企业愚弄的情况依然可能会发生。由于采矿企业与气候变化之间有着极强的相关性，企业许多业务活动的开展都要依赖天气条件而进行，特别是在恶劣气候条件下，企业的运转甚至可能瘫痪，经营效益大大受损，造成现金流运转困难，违约风险大幅提升。

对于采矿业企业来说，气候变化是不可忽视的影响因素，甚至有可能是影响其经营绩效和财务绩效的决定性因素。然而，很少会有企业主动去披露与气候风险相关的数据，这就导致债权人无法得知企业所面临的气候相关风险的状况，从而容易忽视气候变化对采矿企业的影响，对企业信用等级的估计失真。若债权人低估了企业的信用风险，带来的结果很可能是债权人的资产损失。

### 3.2.2 企业气候转型节奏过快

进入新发展阶段，“绿色”概念得到广泛接纳和认可，经济向低碳化转型成为大势所趋。部分企业可能已经意识到了低碳转型的重要性，但是如果仅仅依靠道德约束、期望企业主动承担社会责任来应对气候变化、达到碳减排的要求，要达成这一目标还是具有一定难度的。所以，与应对气候变化相关的政策的出台是必要的、给予企业适度的转型压力也是可行的。有了相关政策作为指引，企业可以“化压力为动力”，找准转型的方向，少走弯路。

但是，如果采用过于严苛的政策向企业施加压力，强制要求企业在“猝不及防”中完成转型，最终的结果可能会事与愿违。随着低碳和减排政策的颁布和实施，采矿行业的发展受到约束，企业增长速度显著放缓，融资难度及融资成本大

幅提升，企业现金流及资产负债管理面临严峻挑战。转型对于企业来说本就是一项冲击和挑战，如果没有把控好速度和节奏，没有留给企业适应和探索新路径的时间，对于所有企业都采取“一刀切”的政策，企业在巨大的转型压力下可能会有较差的财务表现，现金流发生困难，还有可能因为不能成功转型而负面新闻缠身，更加不被市场看好，从而利润大幅缩水，企业违约概率因偿付能力下降而大幅上升。

3.2.3 未将气候因素纳入企业信用风险评估

虽然气候变化是一种外部风险冲击，但气候相关金融风险会通过已有的风险类型外化表现出来，从信用维度来看，气候风险加剧会导致采矿企业信用风险增大，企业信用风险的改变要求银行调整贷款定价来表示对贷款人的风险补偿，与此同时，投资人要求的回报也可能会发生改变，特别是当投资者的投资偏好发生改变时，企业需要付出更高昂的成本（即更高的投资回报率）来吸引投资者。

然而，传统的信用风险评估框架中并没有将气候变化因素纳入考量，由于气候变化引发的相关风险是企业无法规避的问题，抛开气候因素的信用评估极有可能并没有真实反映企业的信用状况。除受气候因素影响之外其他评估结果相同或相似的企业实际的信用风险可能有很大差别，如果忽视了气候因素，认为气候敏感和非敏感的两类企业信用等级相同，给予二者相同的贷款定价及证券定价，无疑会加大银行等金融机构及个人投资者的投资风险，增加其投资资产受损失的可能性。由此可见，陈旧的评估框架对于气候敏感性企业适用效果欠佳，如果银行体系和监管机构不能认识到气候变化对企业信用风险的影响，沿用对企业风险的错误定价，就很可能造成银行体系及投资人的经济损失。

## 4．采矿业上市公司气候相关信用风险防控建议

对于采矿业上市公司来说，气候变化无疑是一项挑战，但是也可以变成一种机遇。这就要求企业及相关对于与气候变化相关的信用风险问题不能只停留在认识的层面,而要采取防控措施进行积极应对，转“危”为“机”。

### 4.1 建立企业气候变化风险披露制度

尽管气候变化并不能作为一项财务指标，不能直接反应在企业的财务报告中，但是气候变化的确可以从物理风险和转型风险两个层面影响采矿业企业的净利润和资产负债，从而降低企业还款能力并增加其违约可能性，增大其信用风险。一方面，企业的管理者需要认识到企业现在或者将来可能面临哪些与气候变化相关的风险，以采取相应措施积极进行风险管理与风险应对；另一方面，企业的利益相关者（如：股东、债券投资人、贷款银行等）也需要了解企业受气候变化的影响，获取财务信息以外的其他信息来更为全面地了解企业状况，以便做出合理的投资决策。因此，有必要建立企业气候变化风险披露制度，来满足企业及其相关利益人的需要。

气候变化风险披露的内容包括但不限于企业所处的风险等级，还可以包括企业应对气候变化作出的努力等。企业进行气候变化风险披露，至少有以下好处：对于企业经营和风险管理来说，由于采矿业对气候变化高度敏感，其经营活动与气候条件休戚相关。因此，气候变化的未来趋势及其可能引发的风险事件是企业进行未来生产规划时不可忽略的考虑因素。充分考虑气候变化相关风险，可以帮助企业做到“未雨绸缪”，激励企业把气候变化纳入风险管理框架，避免因未考

虑气候风险因素而导致的后期高额成本追加。同时，由于信息披露制度的约束性，企业气候风险的相关信息变得公开透明，无形之中展开了企业间关于“气候风险应对”的竞争。企业为了树立良好的企业形象，会积极开展气候风险评估并进行信息披露以获得市场青睐；积极响应号召进行绿色低碳转型来满足市场情绪和市场偏好。随着消费者和投资者对气候变化的重视，企业对待气候变化风险的态度将会成为衡量企业未来发展的重要因素，主动进行气候风险信息披露并采取相应措施积极应对风险能帮助企业创造良好声誉、提升品牌价值。

## 4.2 把握气候转型战略整体节奏

在低碳经济的思想下，企业绿色低碳转型已成为大势所趋。然而，成功转型的实现不能一蹴而就，忽略企业自身状况、盲目推进转型往往适得其反，对于采矿业企业的过度施压极有可能给企业带来较大的经济压力，最终导致企业因偿付能力大幅下降而增加其违约概率。因此，既要积极推行气候转型战略的实施，更要把握好整体节奏，助力企业平稳转型。

一方面，政策制定者在谋划企业转型战略的规定与要求时要充分考虑到其合理性、可实施性、有效性等因素，形成新时期综合性的,支持企业境内外低碳绿色发展的新愿景、新范畴、新表述,并选择适当时机公开气候治理目标,发布低碳发展战略,向公众展示应对气候变化的决心且为企业落实具体减排行动提供内驱力。气候转型节奏要由近中期“碳达峰”向未来中长期“碳中和”逐渐推进，在不同的阶段提出适当的目标及要求，在达成“双碳”目标的进程中引导企业成功实现平稳转型。另一方面，企业也要结合自己的业务优势，在气候转型战略的引导下为自己量身定制独具特色的转型策略，探索切实可行的转型路径。由于企业对于自身经营状况、财务状况、风险状况等拥有更加详细和全面的了解，天然的信息优势使得企业更加明白自身的亮点和痛点，针对企业面临的气候相关风险问题可以“对症下药”，在同我国“十四五”低碳发展战略目标保持一致的前提下，重点明确企业为应对气候变化、实现平稳转型的具体举措。企业在推行气候转型时，也要注意把握节奏、量力而行、逐步推进，切忌忽略企业现有条件而盲目效仿其他企业的转型路径。企业可以建立应对气候变化的职能部门，综合评估企业气候相关风险并为企业定制转型方案，实时监督企业转型措施落实情况并定期要求企业汇报气候转型进度与阶段性成果，根据企业转型的反馈效果进度适时调整转型方案。

## 4.3 将气候变化因素纳入企业信用风险压力测试

气候变化会影响采矿业企业的现金流和资产负债,导致企业利润和偿债能力下降,增加企业的信用风险，造成债权人损失概率上升。2021 年 4 月 14 日，巴塞尔银行监管委员会（Basel Committee on Banking Supervision）发布了两份分析报告，分别是《气候相关风险驱动因素与传导途径》（ Climate-related risk drivers and their transmission channels）和《气候相关金融风险——测量方法》（Climate-related financial risks – measurement methodologies）。这表明了气候相关金融风险不容忽视及国际社会对其重视程度，也说明了银行体系和监管机构将气候风险因素纳入考量将成为大势所趋。

银行体系及监管机构要将气候相关风险纳入其监管框架，在对企业进行信用风险压力测试时，要考虑借款人的碳足迹等与气候变化相关的因素，以便有效地为他们所承担的风险定价。为量化与气候相关的金融风险，银行和监管机构需要找到各种合理的场景，以评估物理风险和转型风险驱动因素对气候风险敞口的潜

在影响。这些情景需要与足够的粒度数据结合起来，并采用适当的方法来获取风险敞口露的气候敏感性。考虑到气候风险相关数据获取困难、搜集成本较高、数据呈现的规范性也有待提升，可以建立数据共享平台，鼓励企业积极进行相关信息披露，也为企业提供应对风险的共享交流平台，同时，也可以为银行及相关金融机构量化气候风险提供数据支持。另外，信用评级机构在其对发行人信誉的评估中也应该将气候风险敞口纳入考量。研究表明，信用评级并没有反映出与气候风险相关的所有信息。对于采矿业企业来说，气候变化与其经营活动密切相关，忽视这一因素下的信用评级很有可能不能真实反映企业的信用状况。因此，信用评级机构应制定较为合理的气候风险敞口衡量标准，并在其运营中充分考虑这些因素。

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# 气候变化对采矿业上市公司信用风险的影响

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**关键词：**气候变化；信用风险；采矿业上市公司

**中文摘要.** 气候变化导致的“绿天鹅”事件对实体经济的影响不容忽视，采矿业是对气候变化高度敏感的行业，气候变化引发的环境风险与金融风险并非相互隔绝、彼此独立，由气候变化引发的信用风险不容忽视。本文首先分析了气候变化对采矿业上市公司信用风险的影响机制：一方面，气候异常变化可能导致采矿业企业现金流和资产负债遭受负面冲击，降低企业还款能力，增大其信用风险；另一方面，采矿业企业为环保达标而加大投入治污，削弱了其偿债能力并增加其违约可能性，这无疑也加大了其信用风险；其次，对我国采矿业上市公司气候相关信用风险现状进行描述并对其成因进行分析；最后，对采矿业积极应对气候变化影响下的信用风险提出了防控建议，主要包括：建立企业气候变化风险披露机制、把握气候转型战略整体节奏、鼓励将气候变化因素纳入企业信用风险压力测试等。

# Fintech, Popularity Index and the Vulnerability of Life Insurance Companies

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**Keywords:** Financial technology, the Vulnerability of Life Insurance Companies, Profit, Popularity Index

**Abstract.** Fintech is getting more attention. As one of the three carriages of the financial industry, the insurance industry plays a vital role in ensuring the stability of the national economic life. Insurance companies use scientific and technological means to improve operating efficiency and at the same time subtly change consumers' attitude towards the service industry. Using the panel data of 71 domestic life insurance companies from 2010 to 2019 as the research sample, this paper defines the vulnerability of life insurance companies according to the competitive vulnerability hypothesis, explores the impact of the application of financial technology on the operating stability of life insurance companies, and whether it is transmitted through the mechanism of being preferred by consumers. The process is to make regression by synthesizing the degree index of financial technology used by life insurance companies as the core explanatory variable. It is found that the application of financial technology significantly reduces the operational vulnerability of individual life insurance companies. The reason lies in that the use of scientific and technological means helps life insurance companies to reduce the possibility of information asymmetry and moral hazard in the industry to a certain extent, thus increasing the company's own competitiveness, improving profits, reducing the degree of corrosion, and thus reducing the business vulnerability of life insurance companies. Based on the above conclusions, this paper suggested that life insurance companies take advantage of financial technology, financial technology and regulators should pay attention to "double effect", both to encourage insurance companies to use financial technology innovation, but also should make full consideration to the life insurance companies using cutting-edge technologies as a competitive weapon of the impact of this behavior. In addition, in the context of how fintech

will affect banks and the market structure, it is of great significance to analyze whether the impact of life insurance companies' application of fintech on the industry will affect the stability of the social security system, which also provides new regulatory ideas for regulators.

## 1. 研究背景

18 世纪 60 年代开始的世界第一次工业革命使人类迈入了机器生产的时代，而现如今 21 世纪的人们正处于以高级智能机器人为代表的新时代。随着科技的飞速进步， 5G 信息技术领跑全球、大数据精准画像目标客户、人工智能仿生技术、移动无障碍支付功能等等给人们的生活带来了极大的便利。金融（Finance）与科技（Technology）合成为一个新词语即“金融科技（Fintech）”。

金融科技以大数据、区块链、云计算、人工智能等为代表的新兴前沿技术不断打破金融服务业的边界从而进行重构，创新了行业的技术应用、以及新产品的推广与服务。保险行业作为金融的一个分支领域在保障国民经济生活稳定中扮演着重要的角色。通过集中社会的财富转移个体的风险使保险在社会生活中发挥“精巧稳定器”的功能，商业保险作为社会保险的补充极大的弥补了社会保险保障不足的部分。而金融科技的发展也对保险行业产生了重大影响，体现在方方面面，从公司经营里保险产品的开发定价、产品宣传营销、核保理赔、售后服务等。保险公司均开始运用金融科技辅助公司经营管理。

根据《中国保险科技发展白皮书（2019）》报告显示，金融科技赋能于保险领域成为保险科技，并在应用云计算、大数据、人工智能、区块链等前沿技术的基础上深度与保险公司的特性相结合，推出与实际生活场景联系更加紧密的车联网、无人驾驶技术、基因诊疗技术等等，不断推进行业往数字化转型。这意味着我国金融科技赋能保险行业有广阔的发展空间。

相比较于财险公司，寿险公司由于经营产品周期较长、资金流动较大的特点，决定了其偿付能力一旦低于监管值，就有可能造成市场甚至于社会的动荡。因此关注寿险公司经营稳定性有实际的意义。

目前，已有的文献大致可归为公司间的“竞争稳定性”假说与“竞争脆弱性”假说。其中，“竞争稳定性”假说认为保险公司间的竞争程度较低，此时拥有很大市场份额的保险公司深信自己会“大而不倒”，因此其为了获得更多的利润就会提高保单价格，收取更高的保费，而这一行为将会造成一系列的道德风险和逆向选择的问题，最终导致公司经营不稳定。而“竞争脆弱性”假说则认为激烈的行业竞争将会腐蚀保险公司的利润，从而减少保险公司对市场的控制力，最终造成公司的经营不稳定性。

根据此背景，本文将重点研究个体寿险公司的经营稳定性状况是否会受到其金融科技运用程度的影响，即金融科技的运用能否显著影响公司的盈利状况，在此，我们将寿险公司脆弱性定义为公司的利润被腐蚀。

本文文章脉络如下安排，第一部分为引言，第二部分是文章文献综述与研究假设，主要归纳总结现有的研究成果以及提出本文的研究内容。第三部分是研究设计，主要从数据的收集到实证模型的构建，以及进行回归实现。第四部分是执政结果分析，对回归结果进行解读。以及最后第五部分总结。

## 2. 文献综述与研究假设

Pressman 等人(2003)认为，技术可以成为行业增长的一个重要因素，并预测使用技术可以改善数据分析，提供更好的保险解决方案。在早期阶段，网络信息技术仅用于数据分析，但随着近年来科技的飞速发展，其越来越广泛的被用于各个领域。Jiajia Liu 等人（2020）认为金融科技的出现满足了消费者对于金融市场的多样化需求，从业务流程，风险控制到业务模型都发生了改变。他们通过分析数据库中关于金融科技对商业模式产生影响的论文最终发现未来的区块链技术会对商业模式造成颠覆性的影响。Kaleemullah Abbasi 等人（2021）发现中小企业作为经济生活中的重要角色，研究它的生存途径有着重大意义。因此，以 OECD 国家中小企业数据为样板，在分析金融科技对中小企业经营效率后发现，金融科技与中小企业有正相关效率关系。因此，本文提出以下假设：

研究假设 1：不同寿险公司金融科技的运用程度会影响该公司的经营稳定性，且金融科技运用程度越高，越会降低寿险公司的脆弱性。

Bharal 和 Shapiro(2016)研究了人工智能在保险行业的应用，分析了消费者和技术变革之间的关系，并预测人工智能会影响行业价格变化，冲击行业的其他领域，如产品供给和服务形式，从而影响保险公司之间的竞争。周雷等（2020）认为保险科技其实是从金融科技演变而来，而金融科技的核心技术则推动了保险产品与服务的创新以及行业的转型升级，且显著提升了保险业的发展质量。而 Lapavitsas 和 Dos Santos（2008）发现金融科技最为核心的关键技术能够降低行业内信息不对称问题。谢婷婷和赵雪莉（2021）在取样了 58 家财险公司的面板数据和中国数字金融发展指数后，分析到科技运用于保险行业与财险公司经营效率之间会产生 U 形关系。前期会对财险公司产生消极影响，后期科技与公司深度结合的时候，则会对公司的经营产生正向影响关系。

而关于金融科技在商业银行上的应用对其经营产生影响的文献研究较多。王应贵和梁惠雅（2018）在观察到全球金融科技浪潮对传统商业银行产生冲击后，分析了金融科技是一把双刃剑，尽管它能提升银行员工的生产效率但更在逐步侵蚀商业银行的价值链。李瑞晶等（2017）认为我国中小企业是科技创新的“主力军”，而金融科技的发展会对中小企业的经营以及创新动力产生正向影响，最后结果表明国家财政科技支出会对中小企业的创新产生正向影响，且金融科技发展程度不同的地区，中小企业创新表现力也不同，但与金融科技发展程度呈正比。Yang Wang（2021）等人评估了金融科技对银行业的潜在影响。结果表明，对于商业银行来说，金融科技的发展提高了银行的盈利能力、产品创新周期以及改善了风险控制能力。总体而言，商业银行可以通过金融技术改进传统业务模式，降低银行运营成本，提高服务效率，加强风险控制能力。为客户创造增强型客户导向的业务模式，从而提高综合竞争力。Anjan V. 和 Thakor（2020）则把目光放在了金融科技与银行之间的互动影响关系上，定义金融科技核心是利用技术提供新的和改进的金融服务。然后研究了包括其在支付系统（包括加密货币）、信贷市场（包括 P2P 借贷）和保险方面的创新，同时借助区块链辅助的智能合约发挥作用。王仁祥和刘伊江（2020）认为目前我国科技和金融耦合系统脆弱性整体上不断下降，区域之间的科技与金融系统耦合性发展不平衡，且区域科技与金融耦合系统脆弱性集聚态势增强。关注、调控科技与金融耦合系统脆弱性是科技与金融耦合系统未来健康发展的关键所在。而李易懋（2020）在通过调查国内 13 家商业银行年报数据后，得出了金融科技对我国商业银行盈利能力产生显著影响的结论，其中互联网、移动支付、云计算等市场规模对银行净资产收益率产生正向

影响的关系，但大数据、人工智能等市场规模却会对其产生负向影响。这表明金融科技对商业银行的影响是双向的。

金融科技创新了寿险公司的产品定价开发、营销核保、理赔售后模式，这些改变最终影响的是消费者的感受。因此，文本推测消费者对于不同寿险公司金融科技运用程度的个人体验会影响该公司对于市场的控制力即寿险公司受消费者青睐指数会降低公司的脆弱性。鉴于此，本文提出第二个假设：

研究假设 2：受消费者青睐指数作为中介变量会降低寿险公司经营脆弱性。

## 3. 研究设计

### 3.1 实证模型

本文研究的是金融科技对寿险公司经营脆弱性的影响，为了验证假设 1，构建如下实证模型：

$$Vulnerability = \beta_0 + \beta_1 Fintech + \beta_i Controls + \varepsilon \quad (1)$$

验证假设 2，我们在进行逐步回归验证受青睐指数这个中介效应的影响：

$$PopIndex = \beta_0 + \beta_1 Fintech + \varepsilon \quad (2)$$

$$Vulnerability = \beta_0 + \beta_1 Fintech + \beta_2 PopIndex + \beta_i Controls + \varepsilon \quad (3)$$

其中，$Vulnerability$是寿险公司脆弱性，$Fintech$是各寿险公司运用金融科技程度，$PopIndex$为受青睐指数，$Controls$为控制变量。

### 3.2 样本与数据

本文样本期选取 2010-2019 年共 71 家寿险公司作为研究样本。为确保数据的全面性与有效性，所选寿险公司包括了中资、外资、中外合资、已上市及未上市的公司。且本文剔除了成立时间不满 3 年的寿险公司，以防止由于公司刚成立时前期投入较高，所披露的财报数据无实际意义从而对实证结果造成影响。寿险公司的数据主要来自于各家公司每年度披露的财务报表、中国保险行业协会公开的财务数据以及中国银行保险信息技术管理有限公司公开发布的评级数据。

### 3.3 变量

3.3.1 被解释变量。（1）寿险公司的净利润。本文研究的是金融科技对寿险公司经营脆弱性的影响，即是否会影响寿险公司的利润，因此，寿险公司的净利润是主要的被解释变量。（2）寿险公司偿付能力充足率，偿付能力充足率是衡量寿险公司经营稳定性的一个关键变量，其大小决定了寿险公司是否能够有足够的资金用以给付赔偿，因此，本文选取偿付能力充足率也作为被解释变量。

3.3.2 核心解释变量。核心解释变量是各家寿险公司运用金融科技（fintech）的程度。本文参照金洪飞等（2020）的做法度量金融科技发展程度，利用文本发掘法构建各家寿险公司自主运用金融科技的程度。

第一步，根据金融科技对保险行业的赋能领域，确定关键词库。通过《中国保险科技发展白皮书（2019）》，本文提炼总结了金融科技赋能保险行业的四环节（表 1）以及各环节运用的核心技术（表 2），金融科技的核心关键词确定为五个，

分别为大数据、区块链、人工智能、物联网以及云计算。

表 1　金融科技在保险行业中的运用

| 前端销售 | 中端核保核赔 | 后端定价 | 运营管理 |
|---|---|---|---|
| 智能客服 | 人脸识别 | 定价因子完善重塑 | 智能合约 |
| 用户画像 | 反欺诈模型 | 大数据分析 | 数据处理挖掘 |
| 产品创新 | 环节分析 | 精准定位目标群体 | 量化模型 |
| 场景构建 | 数据解构 | 行为建模 | 策略配置 |

表 2　金融科技应用环节的主要技术

| 前端销售 | 中端核保核赔 | 后端定价 | 运营管理 |
|---|---|---|---|
| 大数据 | 云计算 | 人工智能 | 区块链 |
| 云计算 | 人工智能 | 云计算 | 大数据 |
| 物联网 | 区块链 | 区块链 | 云计算 |
| 人工智能 | 大数据 | 物联网 | 移动计算 |
| 增强现实 | 移动计算 | 大数据 | 人工智能 |

第二步，计算各年度各样本公司的金融科技关键词词频。主要是借助主成份因子分析法构建各寿险公司运用金融科技的程度。借助金洪飞等（2020）做法，以各家寿险公司与关键词（例如：中国人寿保险有限公司+大数据）进行搭配在百度新闻上进行搜索，选择百度新闻是因为百度新闻是全球最大的中文新闻搜索平台，涵盖了 500 多家权威的新闻发布官方，因此能够获得有效的数据量。根据搜索出来的结果，选取 2010-2019 年间的新闻，并分年度分公司进行整理。为确保搜索的精确程度，在数据处理的时候筛掉了与样本公司和关键词毫无关联的其他新闻，只留下涵盖其中一个及两个关键词的新闻作为有效新闻数目。基于搜索到的 4662 条数据，利用主成因子分析法合成各年度各样本寿险公司的金融科技运用程度。

3.3.3 其他解释变量。中介效应变量即受消费者青睐指数（PopIndex），该指标选取中国银行保险信息技术管理有限公司公布 2017 年至 2019 年的 71 家寿险公司的服务评级，自 2015 年 7 月 21 日，中国保监会（现更名为中国银保监会）印发新的《保险公司服务评价管理办法（试行）》，将寿险公司的服务评级以 A、B、C、D 等级为基础划分 10 个级别，最后的综合评级范围覆盖包涵销售、承保、保全、理赔、咨询、回访、投诉等在内的所有服务环节和渠道，因此，本文选取该评级指标作为中介效应变量，由于从 DDD 级以上各等级之间的差距在 5 分，因此，本文将等级转化为平均分数（例 AAA 级=97.5，AA 级=92.5）进行衡量。其他控制变量包括退保率（SurRate）、投资收益率（ROA）、资本结构（CapStruc）、总资产（Asset）、资产负债率（ALR）。变量定义见表 3。

表 3　变量定义

| 变量类型 | 变量名称 | 变量符号 | 变量解释 |
|---|---|---|---|
| 被解释变量 | 净利润 | Profit | 寿险公司每年经营的净利润进行标准化处理 |

| | | | | |
|---|---|---|---|---|
| | | 偿付能力充足率 | Solvency | 寿险公司偿付能力充足率<br>实际资本/最低资本 |
| 核心解释变量 | | 金融科技运用程度 | Fintech | 各家寿险公司运用金融科技的程度 |
| 其他解释变量 | 中介效应变量 | 受青睐指数 | PopIndex | 受消费者喜爱程度进行标准化处理 |
| | 控制变量 | 总资产规模 | Asset | 公司每年经营的总资本金额取对数 |
| | | 资产结构 | CapStruc | 权益性资本/总资本 |
| | | 退保率 | SurRate | 退保费/总保费 |
| | | 资产负债率 | ALR | 资产负债比率 |
| | | 投资收益率 | ROA | 寿险公司的投资收益率 |

对主要变量做描述性统计见表 4，防止极端值给回归结果带来影响，本文对所有的变量进行 1%缩尾处理。从表 4 来看，金融科技的最小值是-0.0372，最大值为 2.832，均值为 0.0422。从受青睐指数来看，其波动在-3 至 2 之间，相比较其他的变量，受青睐指数的波动较大。其他的变量数值也都在正常范围内，没有明显的极端值。

表 4　描述性统计

| 变量 | 样本量 | 平均值 | 标准差 | 最小值 | 最大值 |
|---|---|---|---|---|---|
| Fin | 613 | 0.0422 | 0.709 | -0.372 | 2.832 |
| PopIndex | 165 | 0.0210 | 0.909 | -2.336 | 1.715 |
| SurRate | 609 | 0.143 | 0.305 | -1.089 | 1.540 |
| ROA | 114 | 0.0759 | 0.0694 | 0.00808 | 0.398 |
| CapStruc | 239 | 0.114 | 0.0979 | 0.000131 | 0.524 |
| Asset | 613 | 4.356 | 0.845 | 2.703 | 6.387 |
| ALR | 612 | 0.833 | 0.191 | 0.0514 | 1.333 |
| Profit | 612 | -0.0225 | 0.742 | -0.442 | 4.853 |
| Solvency | 610 | -0.0410 | 0.0053 | -0.04218 | -0.0011 |

## 4. 实证分析

从表 5 第（1）列来看，金融科技运用程度在 0.1%的置信水平上显著拒绝零假设，即各寿险公司在经营发展过程中运用金融科技程度会影响公司的净利润，且影响方向为正，当金融科技运用程度每提高一单位，寿险公司的净利润会提高 0.842 个单位。结果验证了我们的假设 1，当寿险公司积极运用金融科技为其经营管理服务时，金融科技赋能于公司的各个运营环节程度越深，会提高寿险公司的净利润，降低利润腐蚀程度，即降低寿险公司的脆弱性。深究其原因，更大可能是因为寿险公司利用核心科技技术降低了行业内原本可能发生的道德风险及

逆向选择的问题，从而增加了自身的竞争力。以中国平安保险公司为例，其公司与全国绝大多数公立医院建立了数据共享库，因此客户在投保的时候，公司在承保时能轻而易举的调查投保人是否存在欺瞒、诈骗的行为。这一定程度上减少了寿险公司面临的潜在风险。而退保率、公司的总资产规模、资产负债率等对公司的净利润都有显著的影响。

而本文选取的第二个被解释变量结果即第(3)列显示不能显著拒绝原假设，金融科技的运用并不能显著的影响寿险公司偿付能力充足率，其最大的原因很可能是偿付能力充足率与公司的最低资本和实际资本相挂钩，所以公司的资产负债比率以及公司的总资产规模可以非常显著的影响偿付能力。而相比下，金融科技对其的影响反而微乎其微。

第（2）列加入了中介效应变量，加入受青睐指数后，我们发现金融科技运用程度与受消费者青睐指数分别在 1%、0.1%的置信水平上显著拒绝零假设，接着我们探寻受青睐指数是否发挥了其作为中介效应变量的作用。见第（5）列，金融科技对受青睐指数的回归并不显著，总的来看，实证模型（1）中金融科技对寿险公司经营脆弱性的总效应显著，模型(3)中的直接效应也显著，但式(2)中受青睐指数对金融科技的反应不显著，为了进一步探寻中介效应我们紧接着使用 Bootstrap 法进行检验。

Bootstrap 检验结果发现式（2）的结果仍然不显著，间接效应不显著。

表 5　回归结果

| Variables | Profit | | Solvency | | PopIndex |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | （5） |
| FinTech | 0.842*** | 0.269*** | 7.51e-06 | -0.000633 | 0.0469 |
| | (3.39) | (3.13) | (0.95) | (-1.30) | (0.59) |
| PopIndex | | 0.835*** | | 1.03e-05 | |
| | | (3.30) | | (1.39) | |
| SurRate | -2.864** | 0.161 | -1.64e-05 | 0.00123 | |
| | (-2.89) | (0.39) | (-0.53) | (0.60) | |
| ROA | -2.155 | -0.0613 | -6.69e-05 | -0.00750 | |
| | (-0.59) | (-0.05) | (-0.43) | (-1.06) | |
| CapStruc | -3.250 | 0.120 | -4.58e-05 | -0.00680 | |
| | (-1.23) | (0.14) | (-0.49) | (-1.47) | |
| Asset | 1.596*** | 0.787*** | 0.0000402* | 0.000894 | |

| | | | | | |
|---|---|---|---|---|---|
| | (3.94) | (4.81) | (2.33) | (1.36) | |
| ALR | -24.01*** | -1.232 | -0.000765*** | -0.0140*** | |
| | (-3.79) | (-1.95) | (-4.06) | (-4.01) | |
| cons | 13.77*** | -2.555*** | -0.0414*** | -0.0323*** | -0.0370 |
| | (3.30) | (-4.28) | (-254.77) | (-13.69) | (-0.34) |
| N | 27 | 107 | 27 | 107 | 165 |

注：括号内为 t 统计量（*p<0.05,**p<0.01,***p<0.001）

表 6 Bootstrap 检验

| Indirect effect(s) of X of Y: | | | | |
|---|---|---|---|---|
| | Effect | BootSE | BootLLCI | BootULCI |
| PopIndex | -0.1093 | 0.2884 | -0.8094 | 0.3666 |

注：BootLLCI 至 BootULCI 之间不跨过 0 视为显著，否则，不显著。

考虑到利用中国保信发布的评级数据，只有 2017 年至 2019 年共三年的，所以本文猜测是否是由于样本量不够大导致中介效应不显著的。因此，本文利用各家寿险公司年度保费收入替换服务评级做中介变量。表 7 是回归结果，在用各年度各寿险公司保费收入替换服务评级后，样本量提升，在模型（3）中金融科技运用程度对寿险公司的经营脆弱性影响仍然是显著的，但受青睐指数不能显著拒绝原假设。而模型（2）在经过样本量的调整后，金融科技对受青睐指数的影响非常显著，在 0.1%的置信水平上拒绝零假设。因此，我们仍然需要进一步做 Bootstrap 检验。

Bootstrap 检验结果见表 8，结果显示间接效应依然不显著。至此，本文先前的假设 2 即受消费者青睐指数作为中介变量会降低寿险公司经营脆弱性并不成立。受青睐指数的传导路径并不是通过金融科技影响的。但受青睐指数本身会降低寿险公司的脆弱性，某寿险公司越受消费者的喜爱，其经营净利润会上升，被腐蚀的利润减少，从而使得脆弱性降低。

表 7 替换中介变量回归结果

| Variables | Profit | | Solvency | | PopIndex' |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Fin | 0.842*** | 0.271** | 7.51e-06 | -0.000632 | 0.309*** |
| | (3.39) | (2.74) | (0.95) | (-1.32) | (7.85) |
| PopIndex' | | 0.216 | | -0.00363 | |
| | | (0.55) | | (-1.89) | |

| | | | | | |
|---|---|---|---|---|---|
| SurRate | -2.864*** | -0.719 | -1.64e-05 | 0.00183 | |
| | (-2.89) | (-1.70) | (-0.53) | (0.89) | |
| ROA | -2.155 | -0.436 | -6.69e-05 | -0.00564 | |
| | (-0.59) | (-0.30) | (-0.43) | (-0.80) | |
| CapStruc | -3.250 | -0.569 | -4.58e-05 | -0.0101* | |
| | (-1.23) | (-0.57) | (-0.49) | (-2.07) | |
| Asset | 1.596*** | 0.735* | 0.0000402* | 0.00403* | |
| | (3.94) | (2.01) | (2.33) | (2.26) | |
| ALR | -24.01*** | -1.810** | -0.000765*** | -0.0108** | |
| | (-3.79) | (-2.29) | (-4.06) | (-2.82) | |
| cons | 13.77*** | -2.493*** | -0.0414*** | -0.0348*** | 3.465*** |
| | (3.30) | (-4.54) | (-254.77) | (-13.02) | (32.89) |
| N | 27 | 107 | 27 | 107 | 611 |

注：括号内为 t 统计量（*p<0.05,**p<0.01,***p<0.001）

表 8　Bootstrap 检验

| Indirect effect(s) of X of Y: | | | | |
|---|---|---|---|---|
| | Effect | BootSE | BootLLCI | BootULCI |
| PopIndex' | 0.005 | 0.0149 | -0.0337 | 0.0304 |

注：BootLLCI 至 BootULCI 之间不跨过 0 视为显著，否则，不显著。

结果显示我们的假设 1 是成立的，金融科技赋能保险公司程度越深，公司的经营净利润越高。但受青睐指数与我们预计的有差，受青睐指数本身会对公司的脆弱性带来影响，但其并未发挥作为中介变量的作用。

## 5. 结论

金融科技赋能于保险公司的经营管理各环节的程度随时间变化越来越深，传统的保险公司也抛弃过去原有的公司经营管理办法，结合新兴科技从产品的创新定价、宣发销售、核保核赔以及公司资产配置等出发对公司的经营管理方式进行重新塑形，而这也确实给寿险公司带来更多的利润收入，鉴于金融科技对寿险公司净利润的影响，本文提出以下建议：

保险公司应当抓住第四次科技浪潮，利用数字科技推动公司经营管理升级转型，将发展目标更多的聚焦于打造保险生态圈、价值链创新，利用核心技术降低公司运营管理成本、调高效率，创新销售模式，利用大数据防止更多的道德风险以及逆向选择问题的发生。而“互联网+”的模式更会有助于公司的服务模式的创新，摒弃原先效率低下、耗费人力的传统售后理赔服务模式，转向线上智能客服以及时解决问题。未来，保险业务自动化、智能化等创新方式必将成为保险行业竞争焦点。

同时，对于保险公司利用金融科技进行资产配置的行为，中国银保监会也要加强这方面的监督管理，金融科技是一把双刃剑，理性的保险公司寻求的是长期健康经营，但并不排除有部分保险公司本身经营已经是强弩之末，但因为保险公司的经营特殊性，即便经营濒临破产也会被银保监会兜底，所以便无下限的利用一些新兴技术在金融市场上进行投机行为。因此，银保监会的监管措施也要及时跟上时代的步伐。设立行业自检会，实施“项目创新”及“监管沙沙盒”制度，鼓励支持人才流入的同时防范行业潜在的风险。

金融科技与保险行业融合的趋势是保险科技的发展，保险科技的存在势必会给保险行业带来新的突破。

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# 金融科技、受青睐指数与寿险公司脆弱性

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**关键词:** 金融科技；寿险公司脆弱性；利润；受青睐指数

**中文摘要.** 金融科技（Fintech）的关注度日益增高。作为金融业的三驾马车之一，保险业在保障国民经济生活的稳定方面起到至关重要的作用。保险公司利用科技手段在提升经营效率的同时也潜移默化的改变着消费者对于服务业的态度。本文利用2010-2019年国内71家寿险公司的面板数据为研究样本，根据竞争脆弱性假说定义寿险公司脆弱性，探究金融科技的应用对寿险公司经营稳定性的影响，以及是否通过受消费者青睐这一机制进行传导，其过程是通过合成各寿险公司运用金融科技的程度指标作为核心解释变量进行回归。研究发现，金融科技的运用显著降低了个体寿险公司经营脆弱性。究其原因，在于科技手段的利用帮助寿险公司在一定程度上减少了行业信息不对称及道德风险发生的可能，从而增加了公司的自身竞争力，提升利润，减少被腐蚀的程度，进而降低寿险公司的经营脆弱性。基于以上结论，本文建议寿险公司好好利用金融科技，而监管机构则要注意金融科技带来的“双面影响”，既要鼓励寿险公司利用金融科技进行创新，但也要充分考虑寿险公司利用前沿科技手段作为竞争武器这一行为带来的影响。此外，在当前人们普遍关注金融科技会如何对银行、以及市场格局产生影响的背景下，分析寿险公司运用金融科技对行业造成的影响是否会波及社会保障系统的稳定性具有重要意义，这也给监管机构提供了新的监管思路。

# The Construction and Improvement of Risk Sharing Mode of Sci-Tech Finance: Based on Comparative Analysis of the Modes between "Government-Bank-Insurance" Model and "Government-Bank-Assurance" Model[1]

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**Keywords**: Sci-Tech Finance; Financing Mode; Risk-Sharing System

**Abstract:** With the rapidly economic development, the scale and quantity of Small-and-Medium-Sized Enterprises are increasing sharply， they have become the most dynamic and important part of China's economic lifeline. The high-tech SMEs (Small-and-Medium-Sized Enterprises) play a significant role in SMEs. The

[1] This article is the soft science project of the Hubei Provincial Department of Science and Technology "Research on the Construction of the Science and Technology Financial Risk Prevention and Control System of Wuhan City Circle" (2018ADC155) and the research project of the Hubei Insurance Institute "Analysis of the Financing Model of "Political Banking and Insurance" for Small and Medium-sized Technology-based Small and Medium-sized Enterprises-Taking Wuhan City One of the phased achievements of "East Lake High-tech Zone as an Example" (HX20010).

combination of technology and finance can effectively promote the R & D( Research and Development) and transformation of scientific and technological achievements, which is an effective means to promote the transformation and upgrading of regional industrial structure and the transformation of regional economic growth mode. However, the characteristics of "light assets, high growth and high risk" of high-tech enterprises make it harder for them to finance from banks. In order to alleviate the financing difficulties of SMEs. In order to solve this problem, local governments have promulgated a series of policy to encourage the development of Sci-Tech Finance, and established a system share risk, which composed of government, banks and insurance companies or guarantee firm.

This paper takes the risk sharing model of Sci-Tech Finance in Wuhan and Suzhou as the main research object. On the basis of on-the-spot investigation, this paper uses the method of comparative analysis to analyze the two typical models of “Government-Bank-Insurance” and “Government-Bank-Assurance”. Providing policy recommendations for perfecting the model after the comparative analysis. The survey found that the two models of “Government-Bank-Insurance” and “Government-Bank-Insurance” have been used in Wuhan. Under the Government-Bank-Insurance mode, insurance companies together with the government and banks, share the financing risk of high-tech SMEs by providing credit-guarantee insurance for them. In the Government-Bank-Assurance mode, the guarantee firm takes the place of the insurance company to undertake the main liability of overdue compensation. On the basis of Government-Bank-Insurance in Suzhou, the guarantee firms and venture capital institutions are included in the risk sharing system, meanwhile, further resisting the financing risk of high-tech SMEs, and improving the participation enthusiasm of each body. At the same time, it established a credit platform for the financing of high-tech SMEs, provides credit-enhancement function, makes the credit of enterprises promote openness and transparency, and solves the problem of insufficient information to certain extent.

On the one hand, comparing the two modes of “Government-Bank-Insurance” and “Government-Bank-Assurance”, this paper presents that there are differences in the participants and operation patterns, which makes them quite different in the applicable objects, scope and the enthusiasm of participating in the risk sharing systems. On the other hand, comparing the risk sharing systems of high-tech SMEs between Wuhan and Suzhou, this paper shows that the risk sharing systems of Wuhan has some problems, such as single participants, unbalanced development and so on. Wuhan should learn from the experience of Suzhou in sharing risk with multiple institutions and establishing a credit platform and give full play to the policy guide for attracting all kinds of financial institutions to join in system of sharing risk. Thus, the risk of individual participants could be dispersed and encourage high-tech SMEs to develop further innovate.

## 1.引言

当今的信息技术飞速前进，经济水平猛烈增长，科技与金融逐渐成为螺旋并进上升，二者相互促进推动科技的创新与进步，继而科技金融成为了经济增长的主要推动力。中小企业在此环境下蓬勃生长，成为我国经济发展命脉中的主要能源，特别是科技型中小企业作为高新技术生产的核心，在近些年来取得了很大的发展，但与此同时科技型中小企业在现在仍然面临着一些困难和坎坷，融资的情况不容乐观。在这种情况下，为了帮助科技型中小企业度过融资困境，便出现了由政府引导，保险公司、担保机构与银行参与的科技金融风险共担模式。

武汉市的科技金融风险共担分为两种模式：一种是政府、银行与保险公司合作，由保险公司提供保证保险服务，三者按 3：2：5 的风险比例进行分摊（以下简称“政银保模式”）；另一种是政府性融资担保机构、湖北省再担保集团、银行业金融机构和地方政府分别按 4：3：2：1 的比例承担风险责任（以下简称“政银担模式”）。这两种模式中提供的信用担保的机构不同，在实际应用中也都显现出了差异性。

本文对武汉市科技金融风险共担模式下的政银保模式和政银担模式进行分析和对比，为了完善武汉市科技金融风险共担模式，继而分析苏州市风险共担模式，通过研究分析充实该领域的研究，从而对科技金融风险共担模式提出科学的建议，完善科技金融风险共担模式的构建，为科技型中小企业提供更好的金融支持。

## 2.武汉市科技金融风险共担模式对比分析

### 2.1 武汉市科技金融风险共担的现行模式

2013 年，在湖北省市政府的大力支持下，人保财险在东湖高新技术开发区（以下简称“东湖高新区”）专门设立了人保财险东湖开发区科技保险支公司，同时在湖北保监局、人民银行武汉分行、管委会金融局共同支持领导下，率先开展科技贷款保证保险，简称为“科技贷”，是政银保模式下的主力军。自 2013 年开展以来，东湖科技保险支公司累计受理辖区内有超过 2500 家企业融资申请，累计支持 401 家中小企业从合作银行成功融资超过 9 亿元。该产品已成为众多中小微科技型企业解决贷款难问题的便捷通道，成为东湖高新区科技金融重点项目，为东湖高新区注入了创新发展的新动能。在东湖高新区的政银保模式得到有效的成果后，2017 年，科技保险推广至武汉全市，为武汉市科技型中小企业提供信用保证保险——“科保贷”，截止 2020 年 8 月一共认定科技型中小企业 1040 家，政府对其提供的科技金融政策补贴的企业数量达到 267 家，提供的财政支持额度达到 3.78 万元。政银保模式下的主要合作银行积极开展，以光大银行为例，目前为止中国光大银行在“科保贷”业务上，共计投放 3.13 亿元，当前贷款余额 1.19 亿元。

2019 年武汉市政府与省再担保集团签订“政银担合作框架协议”， 担保公司在风险共担中的任务与保险公司相同，均是为科技型中小企业提供信用保证，帮助企业获得融资构建新型政银担合作机制，扶持科技型中小企业发展，助力民营经济发展壮大。在政银担模式中，武汉市东湖高新区管委会与湖北省再担保集

团以“4321”风险共担模式的进行合作。截止 2020 年 2 月，政银担模式的规模超过 240 亿元，2020 年底湖北省在保融资达到了 2 万户，目前在保的余额有 182.36 亿元。

## 2.2 武汉市政银保模式的架构

武汉市政银保模式下，政府、银行与保险公司分别以 3:2:5 的比例共同承担科技型中小企业的贷款违约风险。保险公司为科技型中小企业提供信用保证保险，承担企业违约后的赔偿责任，政府设置专项补贴的资金池，为申请信用保证保险的科技型中小企业提供信用评级和保费补贴。

政银保模式的运行流程为：首先，保险公司、银行和当地的政府共同协商，明确三方各自的责任、权力和义务，签订合作协议；申请“科保贷”的企业既可由武汉市企业科技创新服务中心（以下简称“科技创新服务中心”）组织推荐，也可由经办银行或保险公司推荐并经市科技创新服务中心认定，申请贷款的企业通过“科创汇”平台进行信用评价，由市科技金融中心出具《武汉市科技型企业认定表》盖章确认通过信用评价的企业；其次保险公司和银行再次要申请贷款的公司进行资信调查，调查结束后，贷款申请人向保险公司提供人民银行征信系统查询的结果；征信审核通过以后，符合条件的科技型中小企业与银行签订贷款合同，同时与为其提供保证保险的保险公司签订贷款保证保险和借款人意外伤害保险合同，保险费率不高于贷款本息的 2.6%；最后一步便是在所有相关的流程手续完毕后，银行向借款人发放贷款，最高限额为 500 万元，根据贷款企业的风险，适当浮动，贷款利率上限为最近一次公布的 1 年期 LPR 加 120 个基点，贷款最长期限为 36 个月。政银模式的基本运行模式见如下图 1。

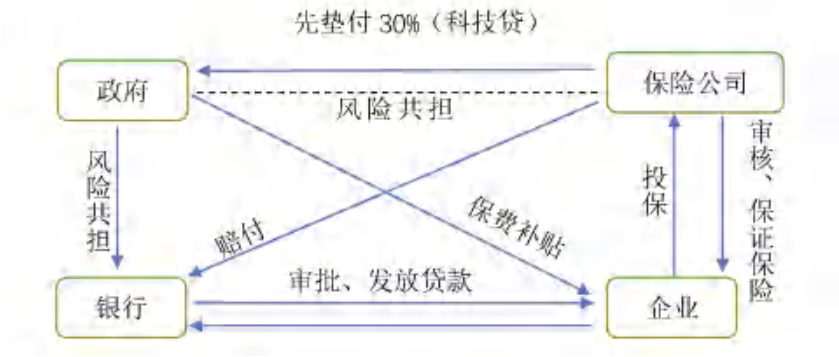


图 1　政银保模式基本流程

在政银保模式中，科技型中小企业即使没有可抵押实务，也能通过保险公司得到信用保证保险服务，在有可靠的保险公司担保下获得银行贷款，解决企业的困境。但是该模式也有不足之处，政府、银行与保险公司的风险共担比例虽然明晰，可在违约发生时的追偿机制上存在一定的疏漏。由于政府在后期没有建立追偿环节的措施，所以当企业发生违约情况时，追偿的重担便落在了银行的身上，银行在追偿环节不仅要追偿自己 20%的债务，还需要帮助政府追偿 30%的债务资金，这对于银行而言无疑是加大了追偿的难度，因此很可能打击银行参与政银保模式的积极性。

## 2.3 武汉市政银担模式的架构

在湖北省政府引导的政银担模式下，湖北省再担保集团作为融资担保体系的主要战力，建立了政银担模式的合作窗口，响应结合了国家的扶持政策。在《进一步改进和完善东湖国家自主创新示范区科技型企业贷款保证保险业务运行机制的意见》中，东湖高新区在"政银保"的基础上增加了担保公司，保险公司与担保公司可以选择共同合作分担 50%的风险或者是单独承保承担风险。

中小企业可以自行向融资机构提出申请，也可以通过武汉市金融服务中心或金融机构向融资机构推荐。企业通过光谷金融服务平台申请，提供企业征信信息相关的资料，在平台的审核通过后，担保公司与银行还需要再次对企业的进行信用审核和评价，在审核均通过够，最后由担保公司为企业提供信用担保，银行为中小企业发放贷款。政银担模式的基本运行模式见如下图 2。

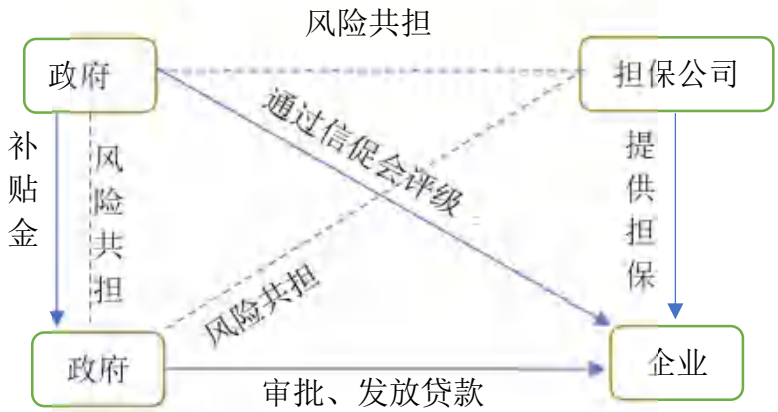


图 2 政银担模式的运营流程

风险管理上，对于纳入再担保体系中小企业无力偿还到期的担保贷款时，政府性融资担保机构、湖北省再担保集团、银行业金融机构和地方政府分别按 4：3：2：1 的比例承担风险责任。随之补偿业务发生风险后，融资机构可以向"信促会"提出补偿审核的请求，在审核通过后，"信促会"向融资机构划转补偿资金。

## 2.4 政银保模式与政银担模式对比分析

### 2.1.1 保险公司与担保机构的属性差异

保险公司的建立与发展经过了长时间的历史进步和变革，在目前的经济市场上的属于准金融机构，受到银保监会的监管和社会大众的监督，而担保机构并非金融机构，也不受银保监会的监管。从保险公司的成立到营运的过程中，都被严格管理要求，保证金制度和保险保障基金制度都是对风险防范措施，让保险公司在市场上提供的保险职能更加稳定可靠。对比在近些年中，担保公司在市场上的发展并不顺利，同时由于对担保机构的监管和市场约束力不够，公司的相关管理制度只要是以信息报告为主，对企业的保证金要求也没有严格规定，所以管理部门掌握其真实情况难度较大，担保机构在市场上容易出现由于担保方资质差异出现担而不保的情况。因此在科技金融的风险共担模式下，保险公司自身的金融机

构属性比非金融机构的担保公司更具有可信赖性。

2.1.2 保险公司与担保机构的运行机制差异

保险公司的运行机制与担保公司相比更加的完善和成熟，担保公司的规模普遍较小、资本实力较弱，在发展的过程中容易出现经营管理不够规范的问题，因此很大程度地影响了担保公司的运行机制。保险公司无论在规模还是发展的过程，都比担保公司更深远，保险公司提供的保证保险服务，具有大数法则等理论支撑，使保险公司自身的风险也能够合理的分摊，以此为后期的服务提供保障，不会因为资金的断裂而导致保证保险的服务终止。湖北省再担保集团成立时间较短，因此科技型中小企业为了自身的信用以及资金的保证，保险公司与担保公司相比将更具有可信赖性。

2.1.3 保险公司与担保机构的业务开展区别

武汉市开展的政银保模式下的保险公司是在湖北省建立的省级保险公司，在开展信用保证保险业务的时，对科技型中小企业的申请和审核都需要经过总公司审核，所以在政银保模式下，初期的业务申请流程的时间和过程都会比担保机构更加复杂和繁琐。湖北省再担保集团则是一个独立的企业，在为科技型中小企业提供的担保服务中，能够自主担保服务的流程和进度，相比保险公司在业务开张上更加灵活，能够根据科技型中小企业需要的保证进行调整。湖北人保财险的业务在规定范围内，虽然可以略微的调整，但是为了整体的稳定性，保险在提供信用保证保险时，还是难以达到担保机构的灵活度。

2.1.4 保险公司与担保机构的业务比重差异

湖北省再担保集团以融资担保体系为核心，是政银担模式的合作窗口，主营业务便是为企业提供融资担保。在科技金融风险共担下，人保财险只是为企业提供保证保险的一个主体，保证保险对于其而言只是所有保险业务中的小部分，投入在政银保模式下的保证保险人力物力都较少，因此也会使得开展业务时的周期长，工作效率无法提高。政银担模式下的湖北省再担保集团的优势便凸显了出来，政银担模式作为该企业的主营业务，在担保过程中的人力物力投放都会高于保险公司，极大的提高了担保机构在为科技型中小企业提供担保服务的工作效率。

## 3.武汉市与苏州市的科技金融风险共担模式对比分析

### 3.1 苏州市科技金融风险共担模式现状

苏州市作为全国第一批的科技与金融结合试点地区，对区域经济发展状况持续探索研究，重点关注科技型企业资产少、专业性强和高风险等特征，通过政府部门加以引导，充分利用财政资金吸引更多的金融服务参与到风险共担体系中，为科技型企业提供金融服务，在此情况下，苏州市构建了多方联合共同承担风险的科技金融风险共担新型模式，这种模式中，不仅有政府、银行和保险公司的参与，还增加了担保机构、创投机构和券商共同参与到苏州市科技金融风险共担体系中。多个金融主体加入科技金融服务后，既降低了科技企业的融资风险，又完善了科技金融服务机制，独具特色的苏州科技发展模式取得了一定的成效。

苏州市政府认识到发展期的科技型中小企业的信用信息不够明晰且评估困难，对其提供贷款的风险较大等问题，苏州市政府便采取了加强对前端科技型企业的金融服务支持的力度，为科技型企业设立了信用保证基金。有了信用保证基

金后，银行、保险公司（担保公司）与该保证基金分别以 20：15：65 的比例承担起企业的贷款风险。

苏州市目前为具有成长性且轻资产的科技型企业提供的资金支持规模已经达到了 10 亿，在这种多方金融单位联合共担风险的模式下，有效的解决了苏州市前端科技型中小企业因信用信息无法申请的贷款的难题。

苏州市政府成立了苏州地方企业征信机构，构建了信息采集长效机制。符合“瞪羚计划”企业、“雏鹰计划”企业，以及经过苏州市科技局认定的重点支持企业均有机会向苏州市科技金融服务平台提交申请，继而由科技局进行审核。在银行方面，苏州市为了更好促进科技金融的融合，成立了交通银行首家为了科技金融服务的科技分行。在保险层面上苏州市成立了全国首家科技保险专营机构，专门为了苏州地区的科技型企业的信用保证保险业务服务，致力于帮助科技与金融的结合，创新科技保险新产品和新业务。苏州市风险共担基本运行模式可见下图 3。

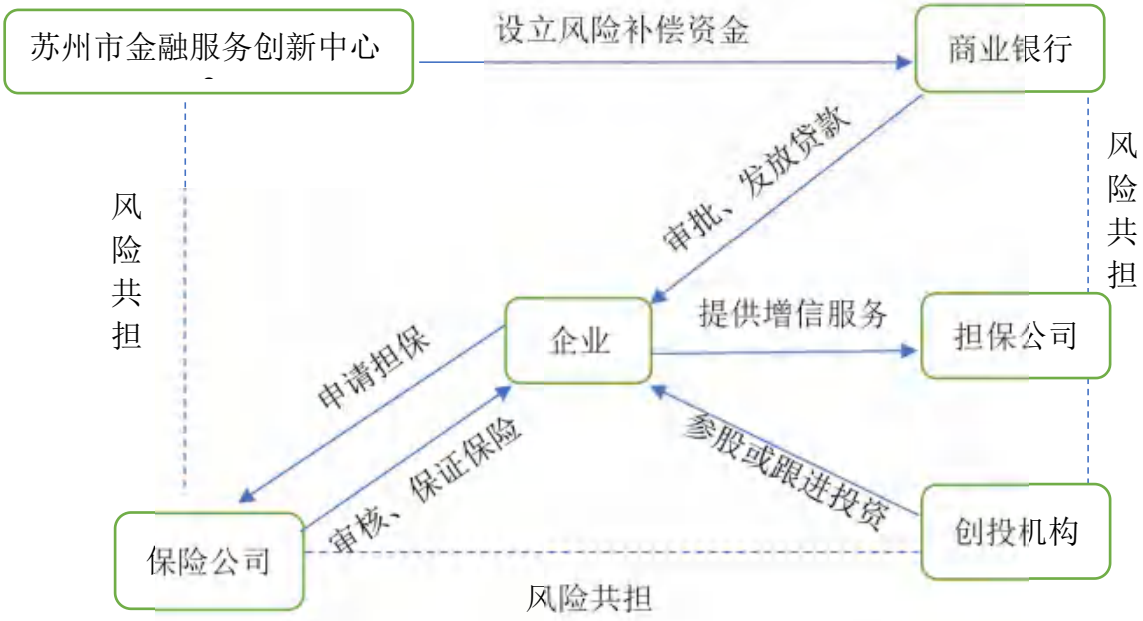


图 3 苏州市风险共担运营流程

苏州市在后期企业违约风险上，信用保证基金、银行与保险公司（担保机构）分别承担 65%、20%和 15%的风险，省级财政对项目 70%的损失进行承担，市级和县（区）级共同承担剩下的 30%左右，而申请信用保证贷款的企业则需要承担起贷款相应的法律责任。银行在违约风险发生后，按照合同和法律流程对相关企业进行追偿并且承担相应的利息损失风险，追偿的费用亦是由合作银行进行承担。由此可见，苏州市科技金融风险共担模式下在后期追偿中，主要力量还是依靠合作银行。

## 3.2 武汉市与苏州市的风险共担模式对比

3.2.1 苏州市与武汉市风险共担系统参与主体差异

苏州市风险共担系统中，不仅有政府、银行、保险公司和担保公司，还加入创投机构，能够以直接参股和跟进投资的方式分担科技型企业的贷款风险。苏州市不仅参与风险共担体系的单位多于武汉市，并且术业有专攻，在提供信用保证保险上成立了全国第一家科技型保险专营机构，开拓了全国首个科技型中小企业贷款保证保险共保体，更直接对口的为轻资产的科技型企业提供信用保证。在贷款方面，苏州市专门成立了为科技型企业提供金融服务的专营科技支行。政策上为了激励科技支行和鼓励吸引科技型企业的申请，特地设置了审批信贷机制、专项考核激励办法等专项政策。武汉市目前实际上只有人保财险主要负责“政银保”模式的保险，并且人保财险认为与其他保险公司合作会增加未知的风险，不愿意与其他保险公司共同合作，以至于大部分的风险都由单家保险公司独自承担，从而导致承担的风险相对比较集中。

3.2.2 武汉市与苏州市的征信平台差异

金融机构所从事的信贷业务中存在着各种各样的风险，因此在风险防控上金融机构会更为重视，建立统一的信贷平台则可以有效地集中信息。苏州市政府成立了苏州地方企业征信机构，利用信息采集，能够方便有效的获取企业的信用信息，苏州市的信用体系建设全方位合作，信息和资源进一步整合与共享武汉市针对科技新中小企业的征信平台，在政银保模式和政银担模式中各自使用了两个不同的平台，分别是“科创汇”和“光谷金融服务平台”，并未统一平台，针对中小企业贷款征信审核时，在信息调查上便会导致偏差和不便，同时中小企业的数量庞大，挨个对其进行调查审批也会耗费大量的成本和时间，不利于业务的拓展，对于为企业提供融资的金融机构也会增大前期审核调查的工作量，降低融资效率。武汉市的科技金融风险共担中由于平台不同，合作方对风险的评判标准不一，各方接收到的信息也将会不同，便会对业务的进展造成阻碍。

3.2.3 武汉市与苏州市后期的追偿机制

武汉市在后期的追偿机制问题上跟苏州市面临着同样的窘境，均是因为政府在后期追偿上尚未制定有力的措施去追偿科技型中小企业的责任，而仅是在前期提供资金的补贴和资助。同时由于政府服务和监督的职能不够全面政府对于科技型企业主体了解的不够充分全面，便导致科技型企业在后期出现逾期违约等情况发生时，政府没有合适的应对措施，只能依靠银行在后期的追偿上付出主要的力量，加重了银行在后期所需要承担的风险压力。

# 4.结论与建议

## 4.1 结论

武汉市目前的科技金融风险共担模式中，保险公司和担保机构的优缺点鲜明，保险公司提供的信用保证保险具有较强的稳定性和可靠性，但是在在初期的申请流程上由于步骤繁杂和人力的不充足，所以会大大降低业务的处理效率，提高工

作效率是保险公司需要进行衡量和调整的。湖北省再担保集团的的创立时间和运营机制不胜保险公司，但在对业务处理上更有效率和灵活。武汉市科技金融风险共担的构建应该参考苏州市的风险共担模式，将保险公司和担保机构放在同一个体系中，更大程度的将风险分摊至各个单位，但是在追偿机制上不够完善全面，以及缺少统一的征信平台。

## 4.2 建议

### 4.2.1 完善武汉市科技金融风险共担下的补偿机制

一是明确风险补偿资金中支持科技型中小企业的标准，对科技局财政资金池地放款更加明晰，以此为企业提供及时的资金支持。二是补充完善融资机构面临企业违约时，政府应该采取的追偿措施，目前模式中政府并未由任何追偿措施，使得银行、保险公司在追偿上的难度较高。完善政府一方追偿机制，减少融资机构的追偿压力，以此提高融资机构参与的积极性。在后期的追偿中政府参与进来，协同银行共同追偿，减轻银行追偿责任的压力，以此激励增加银行参与风险共担体系中的意愿度。追偿机制的完善也能够促使保险公司和担保机构在为科技型中小企业提供信用保证时愿意受理更多的企业，因为有政府在背后的支持，金融机构能够更为放心的提供金融服务。

### 4.2.2 鼓励多方参与的风险分担机制

目前武汉市的两种风险共担模式中都只有一个信用担保机构，过于单一，无法再继续减少各个参与单位承担的风险。因此鼓励向苏州市风险共担模式学习，增加多单位参与进一个风险共担体系中，甚至也可以学习苏州市的风险共担模式将创投机构吸引参与进来，将风险更分散地分摊至各个单位。参与风险共担的主体越多，风险分散至各个单位的部分就越少，这样对于参与其中的单位而言也是一种降压的方法，减少风险的同时考虑盈利，在此基础上，便可能吸引更多的银行和保险公司加入。于此同时，政府需要加大力度宣传和鼓励银行以及各种类型的金融机构参与进来，采用激励政策，鼓励更多的金融机构加入，从而更好的为科技型中小企业提供帮助，促进科技金融的融合发展。

### 4.2.3 建立统一的科技金融平台

武汉市缺少统一的对科技型中小企业的征信平台，同时中小企业的数量庞大，建立统一的科技金融平台能够让各个金融机构能够更加便利和清晰地得到申请贷款的企业状况信息，也能让企业能选择更适合得融资渠道。统一的征信平台能够使政府、银行、保险公司与担保机构等更好的获取企业信息，在审核阶段便能够大大减少工作流程，提高整个业务进展的效率。搭建科技金融、科技信息、金融机构所提供的业务等科技金融服务的在线对接平台，实现科技金融信息服务平台的完善，并通过组建适应各类产业发展的多种形式的贷款担保公司，实行市场化运作，更好地为科技型中小企业提供融资担保服务，提升其担保获得能力，扩大科技贷款覆盖面。

4.2.4 建立属于武汉市的科技专营金融机构

参考苏州市的专营科技银行和保险公司，武汉市已经建立属于自己的科技保险公司，还可以建立武汉市的科技银行，为科技型中小企业提供更对口的服务，同时也能够有效的防止企业在申请环节被其他金融服务“截胡”导致业务流失。武汉市建立专营的科技保险公司，能够极大地增加保险公司参与科技金融风险共担业务的投入，以此促进吸引更多科技型中小企业的加入，帮助企业改善解决融资困难的局面，能够继续发展，自己成长的同时也能促进武汉市的经济提升。

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# 科技金融风险共担模式的构建与完善

## ——基于“政银保”模式与“政银担”模式的对比分析

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**关键词：**科技金融；融资模式；风险共担机制

**中文摘要:**在经济发展的巨潮中，中小企业的规模和数量猛烈增长，已经成为我国经济命脉中最具活力的重要组成部分，其中科技型中小企业更是重中之重。科技和金融的结合能够有效促进科技成果的研发和转化，是推动区域产业结构的转型升级和转变地区经济增长方式的有效手段。但科技型企业“轻资产、高成长、高风险”的特征，决定了其从银行获取融资的难度更高。为缓解科技型中小企业融资难问题，各地政府出台了一系列鼓励科技金融发展的举措，建立由政府、银行、保险机构或担保机构共担风险融资，即是其中一种模式。

本文以武汉市和苏州市的科技金融风险共担模式为主要研究对象，在实地走访调研的基础上，运用对比分析的方法，对“政银保”和“政银担”两种典型模式进行深入解析，为完善该模式提供政策建议。调研发现，“政银保”和“政银担”两种模式在武汉市都得到了运用。在“政银保”模式下，保险公司通过为中小企业提供信用保证保险，与政府、银行一起按一定比例共同承担科技型中小企业的融资风险；而在“政银担”模式下，则由担保公司代替保险公司，承担主要的逾期代偿责任。苏州市则在“政银保”的基础上，将担保机构、创投机构同时纳入风险共担机制，进一步分散了科技型企业的融资风险，提高各个主体的参与积极性；同时建

立了信贷投放平台，为科技型中小企业融资提供了增信功能，使得企业的信用更加公开透明，在一定程度上解决了信息不充分问题。

通过对比“政银保”和“政银担”两种模式，本文发现两者在参与主体和运营模式上存在的差异，使得两者在适用对象和范围、参与风险共担机制的积极性等方面存在较大差别。通过对比武汉市和苏州市的科技金融风险共担模式，本文发现武汉市的风险共担模式存在参与主体单一、发展不均衡等问题，武汉市应借鉴苏州的多方机构共担和建立信贷平台的经验，充分发挥政府政策的引导作用，吸引各类金融机构加入到风险共担体系中来，分散减低单个参与主体的风险，以此支持鼓励科技型中小企业进一步创新发展。

# Does Grass-roots Government Make Residents Accept Catastrophe Insurance?

## -- A Case Study of Rural Areas in Lincang, Yunnan

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**Keywords:** Catastrophe Insurance, WTP, Risk Perception, Government Behaviors.

**Abstract.** This article considers the relationship between the behaviors of grass-roots government and the local residents' willingness to pay (WTP) for earthquake insurance in rural area. The study used household surveys from 640 sampled households in Lincang, and key informant interviews to collect the data, which included residents' perception of risk, perception of the effect of government work, whether they have insured earthquake insurance and social information of families surveyed. Descriptive statistics, inferential tests, and binary logit model were used to analyze the collected data. The results of the study evidenced that the grass-roots government's disaster prevention reduces residents' risk perception, but its negative impact on earthquake insurance WTP is weaker than the positive effect of government participation in the promotion of catastrophe insurance. After passive housing

reinforcement, the residents showed lower WTP and higher dependence on government assistance, which proves the existence of adverse selection.

## 1. Introduction

It is readily acknowledged that China is one of the most vulnerable countries to earthquakes, which are mainly distributed along 23 seismic zones[1]. In 2020, a total of 28 earthquakes of magnitude 5 or above occurred in China, including 20 in mainland areas. It is recognized as an earthquake disaster event by the Ministry of Emergency Management of China when the negative impact of an earthquake exceeds a certain level. In 2020, 5 earthquake disaster events on the Chinese mainland caused five deaths and 30 injuries, with a direct economic loss of about 1.847 billion yuan. In particular, due to China's unique disaster-aid system, the negative economic impact of a catastrophic earthquake may not be confined to the affected areas[2], and concerns about the risk of systemic economic stagnation caused by the earthquake are becoming more serious[3].

In 2008, the occurrence of Wenchuan Earthquake was one of the obvious reasons that led to the start of the pilot earthquake catastrophe insurance in various regions of China[4,5]. There is a growing recognition that a single earthquake prevention project and rescue plan will not solve all problems. After 2008, Sichuan Province, Yunnan Province, Ningbo City, Shenzhen City and other regions in China successively launched pilot earthquake catastrophe insurance programs with their own characteristics[6].

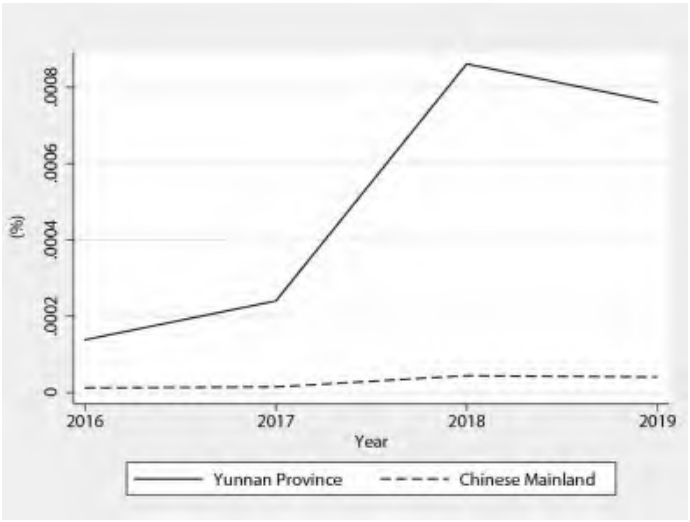


Fig 1. Trends in the insurance density of REI over years in Yunnan Province & Chinese Mainland.
Source: CREIP.

China Residential Earthquake Insurance Pool (CREIP), which currently runs China's largest catastrophe insurance pilot project, was established in 2015. Despite some positive success to the CREIP and governments' efforts, the coverage for its

Residential Earthquake Insurance (REI) has been limited in most provinces in China[7]. REI has been introduced in Yunnan province since 2016 as a financial instrument to help protect policy holders against the damage to houses caused by the earthquake. The effective demand growth in Yunnan Province is fast (Fig 1), which differs significantly from other earthquake-prone areas, although the diversity of REI is still relatively incomplete. The research on the residents' WTP for earthquake insurance in Yunnan Province may depict the important influencing factors of behavioral decision making, and the research results may provide a reference for future policy formulation.

In 2018, in Lincang, a prefecture-level city in Yunnan Province, CREIP launched the Rural Housing Earthquake Insurance (RHEI) in cooperation with the local government. Adding protection for rural housings and residents from common insurable natural disasters, including floods, mudflows, lightning strikes and so on, it can be seen as an extension of insurance liability under the REI framework. In addition, a striking feature of RHEI is the high level of government intervention in its operation. Not only do county-level finance bureaus subsidies the insurance, but civil servants at the grass-roots level are directly involved in the promotion and claim settlement of the insurance. Intuitively, this may partly explain the increase in earthquake insurance coverage in the region.

The low demand for catastrophe insurance is common in developing countries, and Several factors contributes to it. Many studies have identified affordability of catastrophe insurance services to be one of the main reasons for the low demand, especially earthquake insurance[8]. This can be interpreted as a market failure in catastrophe risk management and indicates a flaw in the mechanism design[7,9]. In addition, moral hazard, adverse selection and asymmetric information are often cited as significant causes of low demand. In addition to researching the effects of defects in catastrophe insurance products on demand, another line of research has looked at whether or not risk perception will affect the decision to buy catastrophe insurance[10]. Although debate is ongoing about whether and how risk perceptions cause individuals to make decisions to buy earthquake insurance, a preponderance of social scientific evidence supports a positive relationship between risk perception and people's Insurance behavior.

A direct question comes into view: what factors alter high/low risk perception enough to influence insurance decision making? A large number of studies have provided a wealth of referential conclusions, which summarized the influencing factors including the individual's gender, age, income, education level, disaster experience, social relations, property insurance purchasing experience, etc[11,12]. In recent discussions of risk perception and the need for catastrophe insurance, the influence of the external environment has also been taken into account, leading to some interesting conclusions. For example, the cultural atmosphere to deal with disasters, the government's urban development planning, the distribution of disaster monitoring stations, and so on[5-7,13]. These external so-called external factors can be summarized as the impact of society,

public management, and science and technology on risk perception and catastrophe insurance demand.

We found an interesting question, that is, with the rise and continuation of China's "poverty alleviation" program, the housing conditions in rural areas have been significantly improved. It needs to be considered that when Grass-roots governments help residents with necessary earthquake prevention measures, will they generally reduce the perception of earthquake risk and thus the demand for catastrophe insurance?

Taking the above information into account, this study sought to understand whether the actions of the grass-root government would change residents' awareness of major earthquakes and the demand for earthquake insurance (i.e., the willingness to pay for insurance). This is a study to use the sampling data in rural areas of Lincang city to answer the following research questions:

*(1) Will higher seismic risk perception lead to more willingness to pay for seismic catastrophe insurance?*

*(2) What is the role of grassroots governments in earthquake risk mitigation? In other words, does it have a positive/negative effect on the willingness to pay for earthquake catastrophe insurance?*

## 2. Material and methods

### 2.1 Research areas

Yunnan Province is located in the collision zone between the Eurasian plate and the Indian Ocean plate, with high frequency and intensity of seismic activity. It is one of the most serious earthquake disaster areas in China. According to the Suggestions for the Government of Yunnan Province on Further Using Insurance to Promote Economic & Social Development, it is considered that the earthquake insurance pilot should be the breakthrough point in the construction of local catastrophe insurance system. Lincang city, located in the southwest of Yunnan Province, covers an area of 24,000 square kilometers and has a population of 2,538,200 people in 2019, with rural population accounting for more than 41%. This study was conducted in rural areas of Lincang city, covering 7 county-level areas (Fig 2).

Fig 2. Location of the case study area.

## 2.2 Research framework

This survey was planned to be carried out in July 2020, and key informant interviews and questionnaires were used. The key informant interviews were to have a discussion with the local emergency management department officials, finance department officials, poverty alleviation cadres, insurance regional sales executives, etc. It had two purposes:

*(1) Understand the local grassroots government's practical actions in RHEI promotion work and poverty alleviation work (including work projects, labor and capital investment to improve housing safety, etc.);*

*(2) Through these discussions, the details of the questionnaire were improved to make the questions more targeted and more practical. As a comprehensive research project, 7 sets of questionnaires were designed for different subjects, which were used to survey the information of rural residents, urban residents, grass-roots government officials, insurance company salesmen, etc.*

Therefore, the questionnaire sample data used in this paper is a sub-research project. The content of the question includes the risk perception of rural residents, the influence of local government on their insurance purchasing decisions, the willingness to pay for earthquake catastrophe insurance, and some necessary personal social characteristics information (Table 1).

Table 1. Summary of questionnaire.

| Variable | Questions | Options & Points |
|---|---|---|
| WTP | Has your family purchased the REI? | 0=no ; 1=yes. |

| | | |
|---|---|---|
| RiskPerception1 | Did you take earthquake resistance into consideration when you built a family house in the past? | 1=not at all ; 2=not really ; 3=neutral ;4=somewhat ; 5=very much. |
| RiskPerception2 | Do you pay attention to disaster risk after government guidance? | 1=not at all ; 2=not really ; 3=neutral ;4=somewhat ; 5=very much. |
| Gov_trust | Do you agree or disagree with the statement that government assistance after an earthquake can solve all problems? | 1=strongly disagree ; 2=disagree ; 3=neutral ; 4=agree ; 5=strongly agree. |
| Insurance | Does your family have any other non-life insurance? | 0=no ; 1=yes. |
| Gender | What is the gender of the main decision-maker in the family? | 0=male; 1=female. |
| Education | Does the main decision-maker in your family have a high school degree or higher? | 0=no ; 1=yes. |
| Eth_culture | What ethnic group is your family? | 0=ethnic minorities ; 1= Han. |
| Fam_size | How many members are there in your family? | numbers. |
| Fam_income | What is your family's main source of income? | 0=agricultural income ; 1=non-agricultural income. |
| Fam_incomelevel | What is the per capita annual income of your family? | 1=under ￥10000; 2=￥10000 ~29999；3=￥30000 ~49999；4=￥50000 ~99999； 5=￥100000 ~200000. |
| Region | What is the location of your family house? | 1=Yunxian ; 2=Zhenkang ; 3=Cangyuan ;4=Fengqing ; 5=Gengma ; 6=Yongde ; 7=Shuangjiang. |
| Bu_structure | What kind of construction is your family's house? | 1=reinforced concrete structure ; 2=brick structure ; 3=brick & wood structure ; 4=soil & wood structure ; 5=others. |
| Gov_assistance | Has your family received any government housing construction/reinforcement assistance? | 0=no ; 1=yes. |

## 2.3 Methods of data collection

The primary data was gathered from randomly selected respondents during fieldwork in the rural areas. The research used structured interview schedule and interviewees were asked to answer questions related socio-economic and environmental factors. During the survey, interviewees were also asked questions about their risk perception (at an earlier time/at present) and evaluations of the efforts of local governments. In addition to RHEI's WTP, this study also reveals an intuitive evaluation of RHEI and potential constraints to participation in such insurance.

The questionnaire was pre-tested prior to conducting The formal survey by administering it to 127 selected respondents. On the basis of the results obtained from the pre-test and the advice of professionals, the necessary modification was made On the questionnaire. A questionnaire survey was conducted among 640 sampled households in 7 surveyed counties/autonomous counties.

### 2.4 Methods of empirical analysis

To analyze the data collected, descriptive statistics, inferential tests, and econometrics model were used. Sample quantity, mean and standard deviation were used to describe the general characteristics of sampled respondents. Inferential statistics (Independent sample T-test) was used to see the differences in the risk-perceptive and other variable between insureds and non-insureds. A binary logit model was also used to examine the determinants of the household's decision to purchase RHEI.

Logit model is usually used to establish a relationship to express the response of WTP to individual characteristics and restriction constraints. The model converts the WTP of the survey sample to the probabilities are bound between 0 and 1, and relates the probability and the restriction conditions functionally[14].

A binary logit model is expressed as follows:

$$P_i = \mathbb{E}\left(y = \frac{1}{X_i}\right) = \frac{1}{1 + e^{-(\beta_0 + \beta_i X_i)}} \quad (1)$$

Eq.1 is transformed mathematically to obtain the following form:

$$L_i = Ln\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \boldsymbol{\beta_i X_i} \quad (2)$$

where $P_i$ is the probability of being insured ranging from 0 to 1, $\boldsymbol{X_i}$ is a vector of sample characteristic.

## 3. Results

### 3.1 Descriptive statistics

The descriptive statistics results are presented in Table 2. It shows that approximately 59% of the sample purchased RHEI, which is consistent with the level of coverage in the survey area. Variables *RiskPerception1* and *RiskPerception2* were used to represent the past and present risk perception of the samples, respectively. When they focused on disaster risk, the scores were higher. Therefore, the results of the second and third rows in Table 2 show that the average risk perception level of the samples has decreased. Of course, the specific reasons and characteristics need further analysis.

Table 2. Descriptive statistics of variables and Independent sample T-test.

| Variable | N | mean | sd | Independent sample T-test (Mean) | | | |
|---|---|---|---|---|---|---|---|
| | | | | WTP=0 | WTP=1 | MeanDiff | t-Value |
| WTP | 640 | 0.591 | 0.492 | | | | |
| RiskPerception1 | 640 | 2.569 | 1.084 | 2.389 | 2.693 | -0.304 | -3.517*** |
| RiskPerception2 | 640 | 2.180 | 0.936 | 1.950 | 2.339 | -0.388 | -5.264*** |
| Gov_trust | 640 | 2.722 | 1.033 | 2.840 | 2.640 | 0.1990 | 2.410** |
| Insurance | 640 | 0.284 | 0.451 | 0.225 | 0.325 | -0.100 | -2.775*** |
| Gender | 640 | 0.203 | 0.403 | 0.160 | 0.233 | -0.072 | -2.247** |
| Education | 640 | 0.289 | 0.454 | 0.267 | 0.304 | -0.037 | -1.016 |
| Eth_culture | 640 | 0.533 | 0.499 | 0.511 | 0.548 | -0.036 | -0.901 |
| Fam_size | 640 | 4.103 | 1.097 | 4.103 | 4.103 | 0.000 | -0.001 |
| Fam_income | 640 | 0.458 | 0.499 | 0.439 | 0.471 | -0.032 | -0.797 |
| Fam_incomelevel | 640 | 2.448 | 0.941 | 2.481 | 2.426 | 0.055 | 0.726 |
| Region | 640 | 3.889 | 1.959 | 3.897 | 3.884 | 0.013 | 0.085 |
| Bu_structure | 640 | 1.408 | 0.762 | 1.397 | 1.415 | -0.018 | -0.300 |
| Gov_assistance | 640 | 0.525 | 0.500 | 0.645 | 0.442 | 0.203 | 5.159*** |

*, **, and *** are significant at the statistical levels of 10%, 5%, and 1%, respectively

In addition, the independent sample T-test results are shown in Table 2. It can be seen that there is no significant difference between insured and non-insured in most sociodemographic characteristics. The insured are significantly larger in terms of risk perception and insurance consumption experience. However, the evaluation of the government's disaster aid capacity and the experience of receiving government support show opposite characteristics. The analysis results preliminarily answer the question in the introduction of this paper, that is, risk perception has a positive impact on the WTP of RHEI, and grass-roots government behavior has a negative impact on the WTP of RHEI. The correlation analysis reflects the same result (and is significant), but it does not appear in the paper due to space limitation. The following regression analysis will further demonstrate it.

### 3.2 Regression analysis

A regression was performed on allover sample, controlling for regional differences and differences in housing structure. The regression results are shown in the first column of Table 3 (Model 1). Similar to the results of the previous analysis, higher risk perception and insurance consumption experience increased the WTP of RHEI.

Table 3. Logistic regression estimations.

| | Model 1 | Model 2 | |
|---|---|---|---|
| | | Gov_assistance = 0 | Gov_assistance = 1 |
| RiskPerception1 | 0.174** | 0.426*** | -0.0400 |
| | (0.083) | (0.141) | (0.114) |
| RiskPerception2 | 0.433*** | 0.433*** | 0.289** |
| | (0.100) | (0.168) | (0.132) |
| Gov_trust | -0.196** | -0.122 | -0.208* |
| | (0.089) | (0.158) | (0.111) |
| Insurance | 0.451** | 0.523 | 0.265 |
| | (0.196) | (0.327) | (0.267) |
| Gender | 0.427** | 0.533 | 0.343 |
| | (0.214) | (0.329) | (0.308) |
| Education | 0.0770 | 0.103 | -0.127 |
| | (0.191) | (0.306) | (0.277) |
| Eth_culture | 0.112 | -0.00600 | 0.0930 |
| | (0.172) | (0.285) | (0.226) |
| Fam_size | 0.0280 | 0.0700 | -0.00800 |
| | (0.081) | (0.140) | (0.101) |
| Fam_income | 0.102 | -0.0370 | 0.101 |
| | (0.178) | (0.304) | (0.238) |
| Fam_incomelevel | -0.0910 | 0.0210 | -0.161 |
| | (0.093) | (0.149) | (0.122) |
| cons | -1.221** | -2.649*** | 0.107 |
| | (0.598) | (0.975) | (0.808) |
| Region | control | control | control |
| Bu_structure | control | control | control |
| N | 640 | 304 | 336 |
| pseudo $R^2$ | 0.0746 | 0.1534 | 0.0373 |

Standard errors in parentheses.

*, **, and *** are significant at the statistical levels of 10%, 5%, and 1%, respectively

Although the level of regression coefficient of Logit model does not have precise practical connotation, it is worth noting that the influence of the variable *Riskperception2* on WTP is greater than that of the variable *Riskperception1*. It can be understood that the original risk perception directly transforms into the demand for catastrophe insurance with relatively low efficiency. However, after the introduction of basic knowledge of earthquake risk and insurance by the government, people's perception of risk naturally correlates with the motivation of buying earthquake insurance.

Then, among all the potential influencing factors involved in the investigation, the purchase experience of property insurance has the largest and statistically significant

influence on the WTP of RHEI. Although this is not the focus of this paper, it provides a way to explain the path of risk perception and grass-roots government behavior on WTP. That is, trying to improve people's understanding of earthquake catastrophe insurance and similar financial instruments is an important way to increase the demand for RHEI.

The questionnaire took the question *Do you agree or disagree with the statement that government assistance after an earthquake can solve all problems?* as an indicator to measure the respondent's ability to compensate the government for disasters. It reflects people's confidence in the government's ability and efficiency of rescue and reconstruction after the earthquake, which is similar to the measure of social trust. Obviously, the regression coefficient of the variable Gov_trust is negative, which is in line with the current actual situation. The government is often seen as omnipotent in China, and the trust in governance has a crowding-out effect on the purchase of earthquake catastrophe insurance.

Except for the gender of the family decision-maker, the effects of other demographic characteristics were not statistically significant. Earthquake insurance is complex, and its demand may not have absolute causal relationship with general demographic characteristics, which is certainly not consistent with the views of many existing studies. This needs to be validated by more specific studies.

In Model 2. (the second and third columns in Table 3), we divided the samples into two groups for Logit regression according to whether they have received housing security assistance from local governments. The results of grouping regression showed significant reduction of variables, but the direction of influence of each variable on WTP was basically the same as that of the overall regression.

For the group receiving assistance, the coefficient of Riskperception1 became negative (not significant), and the coefficient of Riskperception2 also decreased. At the same time, the effect of Gov_trust is relatively negative. According to the mathematical explanation, in the sample that received assistance, the impact of risk perception on the improvement of WTP was small, while the high trust in governance weakened the demand for REHI. Combining the two influences, the positive effect of risk perception after risk education is still greater than that of other undesired factors.

## 4. Discussion

This study preliminarily analyzes the impact of the behavior of the grassroots government on the earthquake insurance demand of residents. Unlike agricultural insurance, the supply of earthquake insurance has not been regarded as a policy plan in China. When the attribute of earthquake insurance is not clear, the effect of grass-roots government's behavior on people's insurance decision is uncertain. There are two paths

of influence involved in the study: (1) civil servants of grass-roots government publicize earthquake risk in rural areas and assist insurance companies to sell REHI, (2) the plan to improve the safety of rural housing was implemented, including assistance in strengthening and building new houses. Intuitively, the former can directly improve people's risk perception and promote the coverage of RHEI at the same time. And the latter may weaken the enthusiasm to buy housing insurance. These hypotheses have been tested in empirical studies, and the results are consistent with expectations.

The results are further discussed to optimize catastrophe insurance products and improve WTP for residents.First, linking housing security with the promotion of earthquake insurance can reduce the negative impact of the unintended output of grass-roots government work. By reaching some kind of insurance contract or carrying out catastrophe risk education when the government provides housing reinforcement assistance, the demand for catastrophe insurance can be directly or indirectly raised and adverse selection can be reduced. A single project disaster reduction plan is difficult to adapt to the deepening of economic development and risk exposure[15]. The work of integrating catastrophe insurance mechanism into the national emergency management system has been under way. Its significance is not limited to increasing the disaster financing tools, but the ideological transformation from reducing disaster loss to reducing disaster risk. Conversely, a separate push for earthquake insurance may be ineffective. A more appropriate approach is to establish an integrated earthquake risk prevention plan, which integrates earthquake insurance, disaster prevention engineering, emergency plan and rescue plan to reduce the exclusion between different policies.

Second, under the current REI framework, CREIP's approach in Lincang is to combine seismic risks with other risks, which is an effective way to increase residents' demand for insurance. But it still needs to be considered that pricing issues and the sustainability of the insurance program. Of course, these two contradictory goals are also important obstacles to the development of catastrophe insurance all over the world. The public-private partnership model of catastrophe insurance may be a relatively optimal solution, which requires the use of bond market tools in addition to insurance[16,17].

Third, currently, REI is still microinsurance, which is far from the goal of catastrophe risk prevention. The national earthquake insurance system has not really been established, which leads to various and inappropriate operation modes of earthquake insurance. Although the earthquake insurance is struggling to generate sufficient demand , its effect is poor. Unlike Western countries, China's system also determines that the government is ultimately responsible for the damage caused by earthquakes. Therefore, it may be more useful to consider diversifying the government's financial risk caused by the earthquake.

There are limitations in this study and further study is needed. First, the research model does not reflect the path that the grass-roots government acts on the residents to buy earthquake insurance. Mediating effect and moderating effect should be demonstrated in subsequent studies. Second, the generalizability of the research is questionable. Comparative studies need to be conducted in a wider area. Third, this study expands the perspective to study the relationship between government behavior and earthquake insurance purchase decisions, but does not answer the question of how the government can effectively promote the demand for earthquake insurance within the existing framework. In addition, how to integrate earthquake insurance into the emergency management system is a difficult problem that needs long-term consideration in the future.

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# Risk Management Analysis of COVID-19 in America Based on EEMD Model

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**Keywords:** COVID-19, Ensemble Empirical Mode Decomposition, Risk management, Public health emergencies

**Abstract.** In 2020, COVID-19 wreaked havoc around the world, sounding the alarm for public health emergencies. As the most powerful country in the world, the epidemic situation in the United States has attracted attention of the whole world. Based on the reality, this paper uses the Ensemble Empirical Mode Decomposition model which is good at dealing with nonlinearity to deal with the new confirmed data of the day in the United States, and decomposes it into trend term, low-frequency component and high-frequency component. The trend item shows that the epidemic situation in the United States is still likely to continue to worsen, and new risk management measures need to be put forward urgently. We still maintain a cautious attitude towards the risk expectations of the United States and even the world. In addition, we use the Iterative Cumulative Sum of Squares algorithm to test the change point of low-frequency components. The results show that some policies and events can inhibit or accelerate the spread of the epidemic in a

certain period of time, especially the positive effect of the implementation of vaccines. The innovation of this paper is that the Ensemble Empirical Mode Decomposition method is introduced to analyze the epidemic data in the United States quantitatively, so as to find some clues for risk management.

## 1. 引言

2020 年 1 月以来，新型冠状病毒肺炎（Corona Virus Disease 2019，以下简称为 COVID-19）在全世界引起了广泛关注。它传染速度快、传播范围广、破坏力大、治疗不简单，已在全世界造成损失两百多万生命的严重后果，成为各国政府治理的重中之重。

自然而然，突发公共卫生事件这一大风险也愈来愈受人重视，网络舆情热度居高不下，成为风险管理研究中的热点问题。与此相关的政府工作人员、专家学者等，希望通过研究突发卫生公共事件的特征来达到维持人员生存、抢救经济损失、保持企业生产、预防潜在危害等风险管理的目标。其中，美国由于国家体量大、世界地位重要、影响力强，其疫情治理也受到全世界的广泛关注。

2020 年 2 月，中国处在水深火热之时，美国本土未有任何病例出现，他们持有隔岸观火、事不关己的态度，认为 COVID-19 只会在黄种人之中流传，采取的措施为封锁航班、下达禁令。2020 年 3 月中旬，美国本土疫情爆发，感染病例和讨论热度几乎呈指数上涨，其持有的态度仍可称为轻视，认为 COVID-19 类似重感冒，不会给生命财产带来重大威胁，却不想疫情益发严重。而后，美国各州和联邦政府开始逐步进行疫情防控工作，例如纽约州从 3 月下旬起取消大型集会、时任总统特朗普在 5 月宣布“曲线行动”计划以加速 COVID-19 疫苗的研制、食品和药物管理局在 8 月紧急批准使用恢复期病人的血浆治疗患者等等。

但即便如此，美国各类媒体和各界人士仍然对疫情防控发出质疑。就在 2020 年 10 月，美国知名导演吉布尼等人共同执导了名为《完全可控》的疫情纪录片，反映了政府在处理疫情问题上的连连失误和混乱无序；《商业内幕》网站撰文讽刺了政治算计大于救治生命的实情，并呼吁将疫情防控放到高位；传染病专家福奇评论认为疫情数据一直在良好基准线以上，并且不断波段上升，十分危险；大选之时，民主党总统候选人拜登与共和党总统候选人特朗普就 COVID-19 展开激烈辩论，将疫情防控又一次推向高潮。可见，COVID-19 这一突发公共卫生事件是时事热点和难点，研究这一风险问题具有现实上的意义。

现有文献中，对新冠肺炎疫情下各类风险的管理研究较多，例如杨子晖等（2020）基于风险溢出网络方法研究了疫情冲击之下我国金融市场部门之间的风险传导演变过程，并结合极端风险事件研究了国际间金融风险的传导源头与途径；甄珍等（2020）也分析了新冠疫情对中国制造企业全球价值链嵌入的负面影响，并进行了风险研判，分析了各类干预政策对疫情冲击的缓解作用。但是，基于疫情本身数据的实证研究十分稀少，这可能是数据量不足够、可选模型较少导致的。然而，Huang 等人曾于 1998 年提出过经验模态分解模型（Empirical Mode Decomposition，以下简称 EMD），而后改进为经验模态分解模型（Ensemble Empirical Mode Decomposition，以下简称 EEMD），并将其应用到了泰国登革热疾病传播的研究，为流行病学数据分析找到了道路。利用这个方法，徐阳等（2020）分析了谷歌趋势中的 COVID-19 舆情热度，也为疫情

舆论风险的控制做出了尝试。而 Chuwei Liu（2020）等则结合了 EEMD 与自回归滑动平均模型，对各国每日新增新冠肺炎发病人数做出预测。少有的这几篇文献从不同方面对新冠疫情本身的风险管理提供了研究思路，但未对其传播情况以及现有管控政策进行详细的分析。本文试图采用 EEMD 方法来分析美国疫情数据，为风险管理找到一些脉络。

## 2. 模型介绍

EEMD 方法将原始时间序列分解成多个波动简单、有趋势可寻的时间序列，如此便将一个复杂问题拆解成了多个简单问题。这些分解出的时间序列代表着原始序列在某个时间长度上的特征，被称为本征模函数（Intrinsic Mode Function，以下简称 IMF）。是故，EEMD 方法非常适用于研究波动复杂、非线性数据，具有自适应的特点。

这个方法初始被用于工程类诸如故障识别、降低噪音等的研究。例如陈可等（2010）在同步电机三相短路故障仿真下使用 EEMD 方法进行识别，实验证明该方法清楚高效地显明了电力系统的暂态故障信号特征，并可以准确定位这个故障暂态和它扰动的时刻，为真实情况下故障可能存在的时点提供分析基础。后来也逐步进入到社会科学领域。例如许锐（2016）使用 EEMD 研究了我国股市和汇市，并在此分解基础上建立了跨期套利策略模型，为规避投资风险提供了可行道路；Bangzhu Zhu 等（2018）将 EEMD 方法结合在了欧洲碳市场 VaR 的测算里，由此获得了更加准确的市场总体风险度量；张政伟等（2018）用 EEMD 分解了生猪价格序列并分析了每一个子序列的含义，区分长短期以针对性地提出风险管理的建议。总之，EEMD 的精髓就在于分解不易研究的原始数据，判断每一个简单子波的走势特征，以了解原始信号未来可能存在的风险。它的具体步骤如下所述：

① 在原始时间序列$x_t$中加入和该序列长度一样、一定幅值的白噪声序列$\varepsilon_t$，处理后的序列为$X_t$；

② 求得$X_t$的每一个局部极大值和极小值以形成上包络线和下包络线，并求出上下包络线的平均值序列，定义这个平均值序列为$m_t$；

③ 将$X_t$减去$m_t$，定义得到的序列为$d_t$；

④ 判断$d_t$是否满足 IMF 的条件。

若$d_t$满足条件，则该$d_t$是一个 IMF，得到剩余项$r_t = X_t - d_t$并重复以上步骤；若不满足，则将$d_t$直接重复以上步骤。这些步骤的终止条件为剩余项$r_t$已经是一个单调函数，或者振幅低于预先设定的阈值（通常为 0.2）而无法进一步提取 IMF。其中，IMF 的条件为：在整个数据集上，极值点数与过零点数相等或相差为 1；或在任一点，上下包络的平均值为零。

这样一来，我们可以认为$x_t = r_t + \sum IMF_i$。

## 3. 数据总览

本文采用当日新增病例数据来刻画美国疫情。所用数据来自于 WIND 数据库，自 2020 年 1 月 21 日有此数据起，至 2020 年 4 月 15 日开始分析止，共计 451 条。其图像如图 1 所示，波动十分复杂、总体呈上升趋势。这样非线性、有趋势、有周期的时间序列采用 EEMD 方法来研究是最为恰当的。

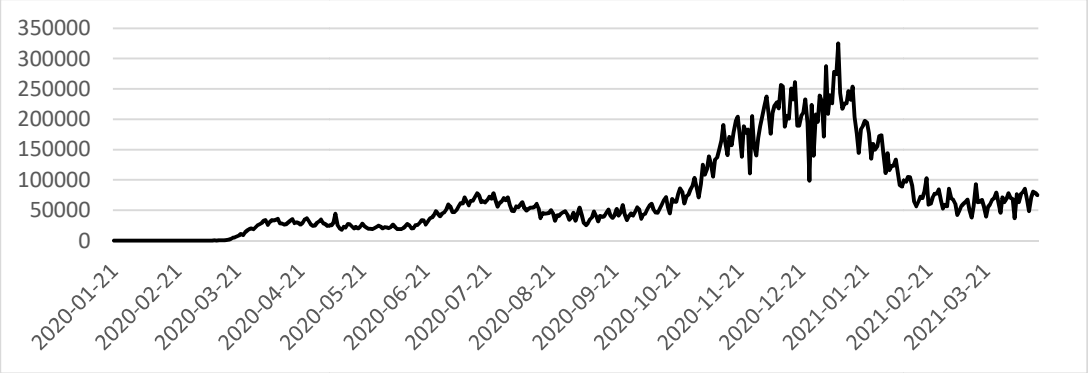


图 1 美国当日新增确诊

## 4. 分解和重构

本文使用 matlab 完成所有模型的建立。采用 EEMD 方法分解之后，美国当日新增数据共得出 7 个 IMF 和 1 个剩余项，其图像如图 2 所示。

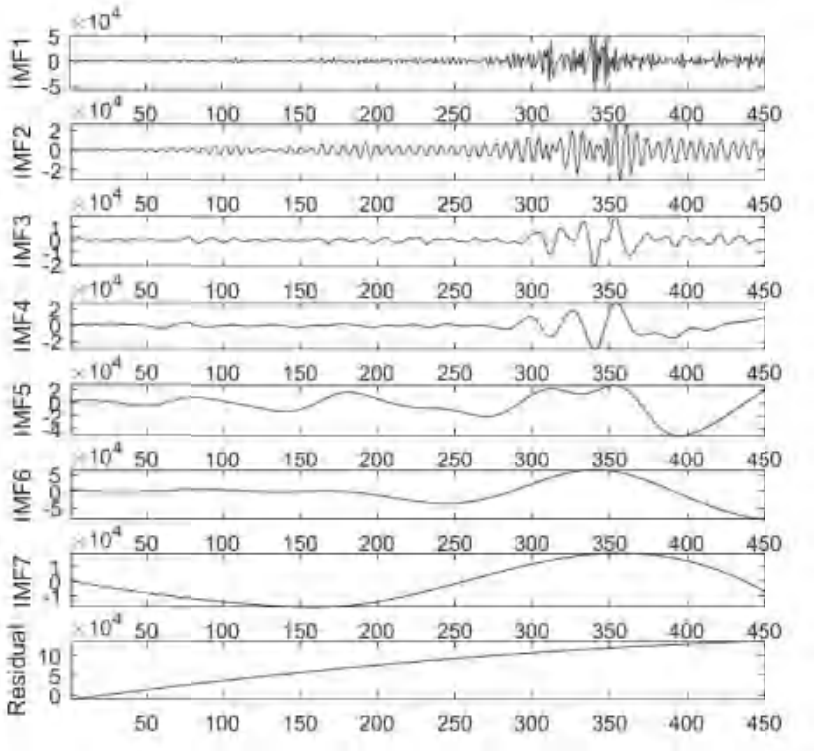


图 2 EEMD 结果

各子序列的性质如表 1 所示。其中，周期指使用快速傅里叶变换所得出的波段平均变化周期，代表该序列走势的周期性；方差占比是指每个子列的方差占所有子列方差之和的比例，方差占比越高，对原序列信息的贡献越大，子列越重要。

表 1 各子序列性质

| | IMF1 | IMF2 | IMF3 | IMF4 | IMF5 | IMF6 | IMF7 | 剩余项 |
|---|---|---|---|---|---|---|---|---|

| 周期 | 3.50 | 6.94 | 25.06 | 28.19 | 150.33 | 225.50 | 451.00 | - |
|---|---|---|---|---|---|---|---|---|
| 均值 | 49.96 | -10.97 | 50.21 | -419.89 | -1917.53 | -3798.08 | -1559.66 | - |
| 方差占比 | 2.72% | 1.35% | 0.35% | 1.55% | 8.44% | 26.55% | 3.86% | 55.18% |

本文分解出的 IMF 项数目较多，按照前人经验，可以将多个 IMF 按照一定方法归为高频分量和低频分量两类。具体方法为使用 t 检验判断每一个 IMF 的均值是否显著异于零，从第一个显著异于零的 IMF 起，至最后一个 IMF 止，归为低频类，其他的 IMF 归为高频类。本文在 95%的置信区间里的 t 检验结果如表 2 所示。

表 2　t 检验结果

| | IMF1 | IMF2 | IMF3 | IMF4 | IMF5 | IMF6 | IMF7 |
|---|---|---|---|---|---|---|---|
| p 值 | 0.914 | 0.973 | 0.763 | 0.231 | 0.019 | 0.009 | 0.005 |

t 检验的原假设为：序列均值是 0。当 p 值小于 0.05 时，可以拒绝原假设。由表 2 可知，IMF1 到 IMF4 的均值不能说是显著异于零的，故可将此四者相加作为高频分量，而 IMF5 到 IMF7 相加可作为低频分量。并且由表 1 的周期性质可知，本文得到的高低频恰好是以月度变化为分界线，具有较为明显的现实含义。高频分量、低频分量、剩余项和原序列的走势如图 3 所示，性质如表 3 所示。

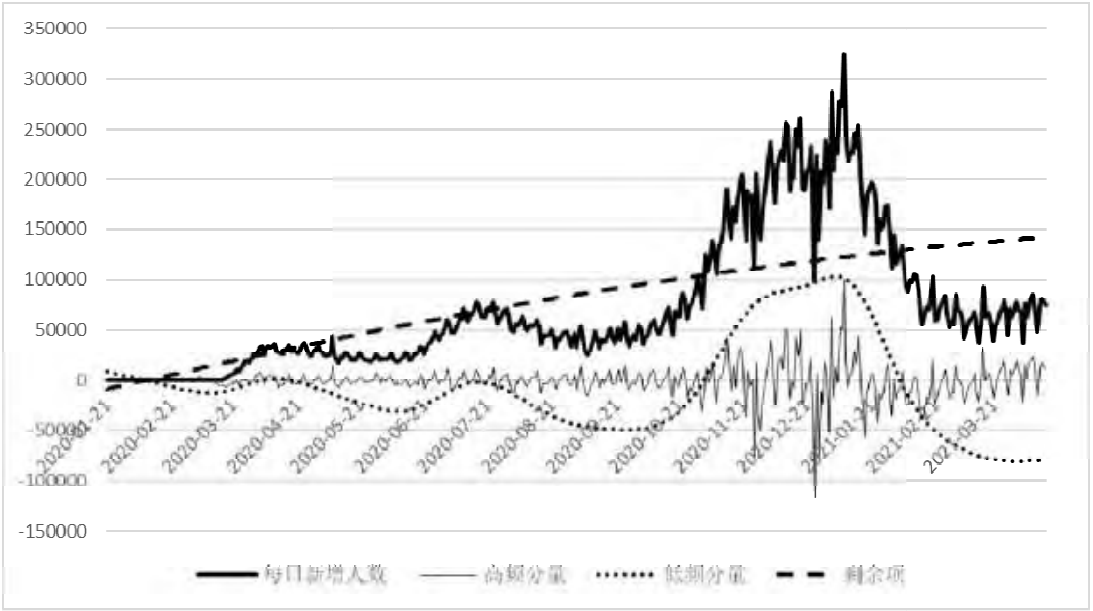


图 3　各分量图像

表 3　各分量性质

| | 高频分量 | 低频分量 | 剩余项 |
|---|---|---|---|
| 均值 | -330.697 | -7275.267 | 79001.120 |
| 方差占比 | 5.77% | 50.41% | 43.82% |

从表 3 可以看出，剩余项是贡献最大的，低频分量次之，高频分量可忽略不计。故而在进行分析时，剩余项和低频分量是重点。

## 5. 分析

重构后的高频分量、低频分量和剩余项各有其现实意义。

### 5.1 剩余项

剩余项通常被视作原序列的内在趋势，原序列虽会在某些时期出现大小不一的波动，但在影响结束后仍然会回到内在趋势上，故而又被称为趋势项。由表 3 可知，剩余项为每日新确诊的 COVID-19 患者人数变动做了 40%以上的贡献，这意味着从长远来看，研究和控制剩余项的走势对疫情风险管理有重要意义。

图 3 中，剩余项几乎呈直线斜向上升，说明美国疫情尚处于与日俱烈的阶段，但还不至于完全爆发至做不到任何缓解（若完全不在控制之下，剩余项将表现为时间的高阶无穷大函数）。从图像上来看，自 2020 年 3 月以来，美国的 COVID-19 疫情形势每况愈下，每每间隔不长就会有令人感到恐慌的新纪录产生。且由剩余项的走势看来，没有任何迹象表明这种主升浪趋势将放缓，仍然看不到被刹住回头的希望。这意味着政府所做出的的每一项举措都未能在根本上解决新冠肺炎难题，新的政策有待提出。

### 5.2 低频分量

低频分量一般被理解成重大事件冲击，例如政策改变、技术革新等等。这些冲击持续的时间长、造成的影响大，原序列较难消化。由表 3 可知，低频分量为每日新增确诊人数的变动贡献了 50.41%，是影响原序列波动最重要的因素。通过将低频分量从原数据中提取出来，我们可以直观地衡量重大事件冲击的影响，并将其作为预测类似事件影响程度的参考。

考察外部事件是否对序列造成冲击可用的方法很多，其中由 Inclán 和 Tiao 在 1994 年提出迭代累积平方和方法（Iterated Cumulative Sums of Squares，以下简称 ICSS）是较为成熟的一类。这个方法认为方差代表着信息，方差突变就代表着信息集改变。所以 ICSS 同时考虑波动和时间，假定时间序列在开始一段时间内呈现出平稳性方差，直到方差发生突变才会改变其波动水平，随后又保持一个方差直到下一个突变。反复重复上述过程，就能得到未知数目的方差突变时间，即信息的改变时间。前人使用该方法做过很多研究，例如鲁万波和李竹渝（2005）使用这个方法检验了我国沪深股市，发现股民对利好消息的反应比利空消息更强烈；何燕等（2014）将 ICSS 和 AR-AIC 方法进行比较，发现 ICSS 在检测地壳运动波段中更快更精确，更利于预测地震时间。

运用此方法时需要注意的是，突变点并不代表信息到来的时间，而是代表信息发挥出显著作用的时间，中间具有时间差。

对低频分量进行 95%置信水平下的 ICSS 检验，共出现 5 个结构变点，时间分别为 2020 年 5 月 11 日、7 月 1 日、8 月 14 日、10 月 26 日和 2021 年 1 月 23 日，其图像如图 4 所示。

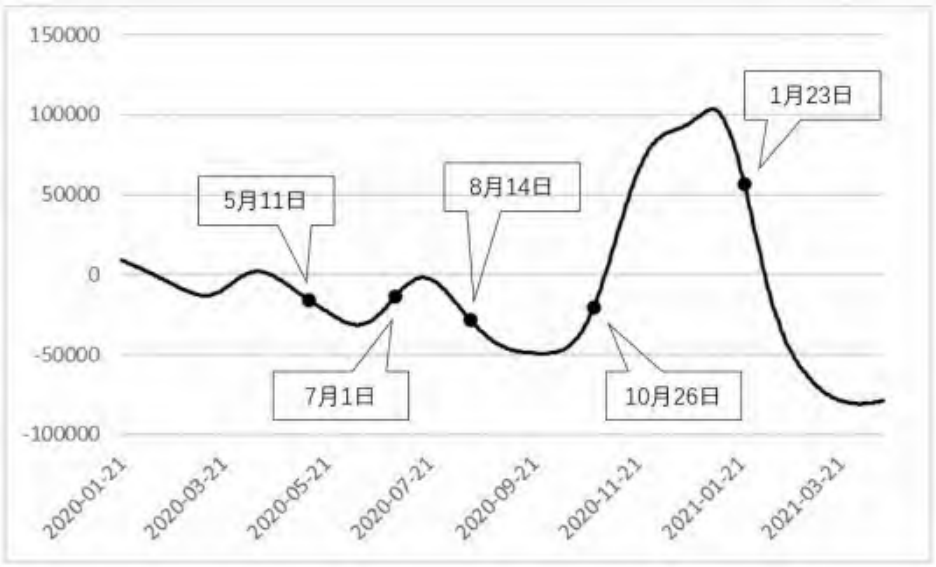


图 4　ICSS 结果

5 月 11 日的变点是两大政策实施的效果。一是全面检测的冲击，二是控制社交距离的冲击。全面检测能够迅速识别已感染人群，并立刻将其转入医院隔离治疗，切断了传染源。另外，各州政府都陆续宣布进入紧急状态，居民被劝导呆在家中进行自我防范和隔离，城市里严格执行社交距离禁令。这两大政策的冲击使得每日新增人数的低频分量在 4 月和 5 月逐步下行。根据图 4，这两大政策使每日新增确诊下降 3 万左右。

7 月 1 日的变点信息体现在美国重启经济和弗洛伊德之死的冲击充分释放。自 COVID-19 在美国出现以来，美国经济下滑，政府出台《重新开放美国经济》等指南引领各州逐步重启经济而将疫情防控的地位降低。5 月底，非裔美国人弗洛伊德遭到白人警察暴力执法而死亡，引发全美骚动，和平抗议和暴力冲突不断上演。无论哪一种均是大型集会，促进了疫情传播，使得两大政策的缓解效果消耗殆尽。

8 月 14 日的变点信息主要体现在新一轮封锁措施的实行。许多州在 7 月中旬的时候明确将复工暂停或采取预防疫情的针对性措施，例如华盛顿州叫停放宽限制措施、加利福尼亚州禁止所有餐厅室内用餐及其它室内商业娱乐活动并在疫情十分严重的县停工停产，这些州的人口占到美国人口的五分之四以上。从低频分量上来看，这些措施使每日新增确诊下降约 5 万人，在短期内对病毒的传播起到了抑制作用，且效果比之前的政策更好。

10 月 26 日的变点是冷空气来临的冲击。冷空气的到来会给疫情带来两方面的不利因素，一是低温利于病毒存活和传播，二是低温促使人们待在室内的时间加长。有专家指出，温度越高 COVID-19 越难保持活性，56 摄氏度下，这个病毒不用 30 分钟就会全部死亡；在室温下存活的时间相对久一些，可达一天左右；而 20℃、40%湿度的环境下可以存活 5 天；更低的温度就可以存活更久。且天气变冷迫使一些人长时间搬到室内，人群聚集，加速疫情的传播。从图中可以看出，冷空气的来袭使得美国新冠疫情形势急剧恶化，促使每日新增确诊在短短三个半月内大幅上升了约 15 万人，其影响程度远超之前所有重大事件和政策。

1 月 23 日的变点信息主要体现在疫苗的大范围接种。自 2020 年 12 月起，

美国开始向医护人员之外的普通人民推广疫苗。截至 2021 年 1 月，疫苗主要对 75 岁以上的老年人和一线工作者开放，成年人和儿童还未得到大范围的普及，但是此两类人群感染病毒的风险高，因此此阶段的疫苗接种仍旧对疫情传播起到了强有力的抑制效果。由于疫苗发挥作用需要一定的时间，进入 2021 年 1 月以来，接种疫苗的效果开始显现，使得美国每日新增人数大幅下降了近 20 万人。对比所有政策和重大事件的冲击带来的影响，可以发现疫苗接种是抑制病毒传播最有效的措施。

### 5.3 高频分量

在现实中，美国每日新增的 COVID-19 感染人数不仅受重大冲击和自身趋势的影响，还会受到许多其他因素的扰动，例如天气变化、计数遗漏、统计延迟等等。这些扰动的持续时间通常很短，所以才称之为高频分量。这一点也可以从表 2 中得到验证——高频分量是由 IMF1 到 IMF4 相加重构而来的。不仅如此，扰动的数值也远小于同时期的低频分量和剩余项。

高频分量体现在数据上是围绕 0 水平线作高速小幅摆动，现实意义即持续时间短且扰动影响小，不构成推动每日新增病例上升或下降的动力。是故在进行短时间内的定量避险规划时，高频分量是重要的参考因素；但在做中长期定性的风险管理时，高频分量可忽略不计。即，可以将高频分量其作为时间序列中的白噪声处理。

## 6. 结语

本文从实际角度出发，研究了美国疫情情况，在突发卫生公共事件的风险防控上有一定意义。本文首先使用 EEMD 方法来分解美国每日新增确诊人数数据。之所以选用这个方法，有以下两点考虑：一是 EEMD 方法具有自适应性，可以基于数据本身分解出不同时间尺度上的具有经济含义的分量；二是美国每日新增确诊人数数据具有趋势性、波动性和非线性性，适合从不同时间尺度上分析其特征。该模型在数据中提取出了 7 个 IMF 和剩余项，并基于 t 检验将各 IMF 重构成了高频和低频两个分量。其中，高频分量代表数据的随机波动；低频分量代表重大事件冲击；剩余项体现了该数据的长期趋势，是一个不断上升的过程。

本文使用 ICSS 方法来检测低频分量的结构变点，以找寻影响美国每日新增确诊人数的重大事件。检测表明，该数据共有 5 个结构变点，对应着全面检测与控制社交距离、经济重启与抗议示威活动爆发、新一轮封锁措施实施、气候转变、疫苗覆盖。结合低频分量的振幅，本文对每一个冲击所带来的影响进行了数量上的衡量，未来相似管理政策或风险事件的效果可以由此进行预估。

本文得出的结论如下：

① 部分政策对抑制疫情传播有良好效果，例如全面检测和停工停学，其中推行疫苗的效果尤其显著；但也有部分冲击会带来负面效应，例如游行示威和气温降低。

② 美国疫情仍有继续严重化的可能，新的风险管理举措还亟待提出，我们对于美国乃至于世界经济的预期仍需保持谨慎的态度。

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# 基于EEMD模型的美国新冠肺炎疫情风险管理分析

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**关键词：**新型冠状病毒肺炎；集合经验模态分解；风险管理；突发公共卫生事件

**中文摘要.** 2020 年，新型冠状病毒肺炎在全世界肆虐，给世人敲响了突发公共卫生事件风险防控的警钟。而作为世界第一强国，美国的疫情状况受到了全世界的关注。本文从此现实情况出发，使用善于处理非线性的集合经验模态分解模型来处理美国当日新增确诊数据，将其拆解为趋势项、低频分量和高频分量。趋势项表明美国疫情仍有继续严重化的可能，新的风险管理举措还亟待提出，本文对于美国乃至于世界的风险预期仍保持谨慎的态度。另外，本文使用迭代累计平方和算法对低频分量进行了变点检验，结果表明某些政策和事件可在一定时间内抑制或加速疫情传播，其中推行疫苗的正面效果尤其显著。本文的创新点在于，本文引入了集合经验模态分解方法对美国疫情数据进行了定量的分析，为风险管理找到一些脉络。

# Factors Associated with Chinese Residents Engaging in Environmental Protection Activities: based on the 2013 CGSS Data

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**Keywords:** perception of environmental risks； evaluation of environmental protection activities； environment protection activities；CGSS；China

**Abstract.** This study aims to discuss the effects of perception of environmental risks and evaluation of government environment protection behaviors on individual environment protection behaviors. The data used in this study was from the 2013 China General Social Survey (the 2013 CGSS) data. The valid sample associated with the environment module was 8,122. The findings show individual perception of environmental risk in terms of the number and the severity as well as individual

evaluation of government environmental protection behaviors affect individual environmental protection behavior significantly. This study also indicates the difference between urban and rural residents in environment protection behavior, which should be attracted attention.

## 1. Introduction

The 18th National Congress of the Communist Party of China （CPC） made a strategic decision to "strengthen the construction of ecological civilization". In October 2015, at the Fifth Plenary Session of the 18th CPC Central Committee, strengthening the construction of ecological civilization for the first time has been written into the national five-year plan, showing the importance of environmental issues has been highlighted at the national level. However, the solution of environmental problems requires not only the contributions from the government and enterprises but more importantly, it is necessary to mobilize citizens' enthusiasm, because to some extent environmental problems are caused by individual behaviors. Thus, it is of theoretical and practical significance to pay attention to and study the environmental-related behaviors of citizens and the influencing factors behind individual behaviors.

This study contributes to understanding two questions: First, how do residents' perceptions of environmental risks affect their participation in solving environmental problems? Second, how do the residents' evaluations of the government's environmental behaviors affect their environment behaviors?

## 2. Literature review

The existing studies have discussed different factors affecting individual environmental protection behaviors. The factors could be divided into two categories: internal individual factors and external social aspects (Jiang et al., 2018). Stern et al. (1999) proposed a value-belief-norm (VBN) theory of movement support to understand individual environmental behaviors. VBN theory attributed environmental protection behaviors to four types of factors, including situational elements (such as institutional arrangements, cost and benefit, and convenience), individual capacities (such as education, income, and social class); habit elements, and personal norms (such as value and beliefs). Davis et al. (2011) pointed out the causal relationship exists between the awareness of environmental risks and environmental behaviors. Concretely, when people recognize environment risks, they will become more committed to environmental behaviors; in turn, they become more concerned about environmental risks.

Chinese literature about the topic concerns the specific environmental behavior, such as water conservation behavior （Lu, 2015）, the reduction of carbon emissions behavior (Cui, et al., 2015), willingness to pay for green building (Tian and Li, 2018), willingness to pay for green packing (Hao et al., 2019), and green consumption behavior(Sun et al., 2019). Using the 2010 CGSS dataset, Lu (2015) found that perception of water environment problems and the level of environmental concerns were negatively associated with environmental protection behaviors. Concretely, when the respondent perceived the water environmental problems more serious and was more concerned about the environmental issues, she or he was less likely to take actions. Also, Lu (2015) claimed the demographic and socio-economic factors in terms of gender, age, education, and income all contributed to conserving water.

Female, older adults, people with higher education and more income were more likely to conserve water. Cui et al. (2015) found perception of the degree of hazard of climate change affected the mitigation action significantly through analyzing the 2010 CGSS data. Female and highly educated were more inclined to take actions in reducing pollutant emissions. Tian and Li (2018) surveyed *Shanxi* Province of China to understand people's willingness to pay for green buildings. Findings showed environment protection awareness had a significant effect on people's willingness to pay for green buildings. Hao et al. (2019) used a survey data with 781 valid samples to explore the factors influencing consumers' willingness to pay for green packaging, finding the status quo of environmental pollution had a salient impact on green packaging consumption. Sun et al. (2019) confirmed the significant relationship between the environment concern (including the perception of environment risk) and green consumption through analyzing the 2010 CGSS data.

Yan (2017) used the 2013 CGSS data to identify the perception of environment pollution and the evaluation of government environment behaviors did influence individual environment behaviors but ignored the distinction of the perception of the number of environmental risks and the perception of the severity of environmental risks.

To summarize, the effects of the perception of environmental risks and the evaluation of government environment behavior on individual environmental protection behaviors have not been fully examined in the Chinese context. The previous research has recognized the effects of the perception of environmental risks, but on the one hand, they did not distinguish effects of the perception of the number of environmental risks and the perception of the severity of environmental risks. On the other hand, most studies were conducted in local areas, which had the problem of generalizability. Moreover, the existing studies did not test the impact of the evaluation of government environment behavior on individual environment protection behaviors. Thus, this study makes a contribution to fill in the research gap. Last but not least, most extant studies neglected the difference between urban and rural residents in environment behavior, though a study had identified the urban-rural differences in environment attitudes (Yu, 2014).

## 3. Method

The data used in this study was from the 2013 China General Social Survey (the 2013 CGSS) data. The CGSS survey was conducted by the National Survey Research Center at *Renmin* University of China (http://www.chinagss.org/index.php?r=index/index).The CGSS adopted a multi-level stratified sampling method. The survey covered all administrative units in mainland China. The total sample of the 2013 CGSS was 11,438. The valid sample associated with the environment module was 8,122. The secondary analysis of data from CGSS did not require ethics approval.

### 3.1 Dependent variables

Individual behavior when encountering environmental problems is the focus of this study. In the 2013 CGSS, the individual environmental protection behaviors were measured by the question: "Have you engaged in the following activities in the last year?" The activities included waste sorting; discussing environmental behavior with their relatives and friends; bringing shopping baskets or shopping bags when purchasing daily necessities; plastic recycling of packaging bags; donation for

environmental protection; voluntarily paying attention to environmental issues and environmental protection information reported in radio, television and newspapers; actively participating in environmental publicity and education activities organized by the government and organizations; actively participating in the public environmental protection activities organized by environmental groups; self-funded maintenance of forests or green spaces; positive participation in complaints appealing to solve environmental problems. Each activity was measured by a 3-point scale ranging from 1=never to 3=often, in which a higher score indicates more active participation. This study calculated the total scores of individual participating in these ten types of environmental protection activities. The summed index of ten environmental protection activities had a Cronbach's alpha of 0.740.

### 3.2 Independent variables

The independent variables in this study included the perception of environmental risks and the evaluation of government environmental behaviors. The perception of risk is a personal subjective judgment about the characteristics and severity of a risk (Xu et al., 2017:36). The question related to the perception of environmental risks in this study is: "The following are various types of environmental problems. Do you know them? If so, how serious are they in the area you are living?" The types of environmental risks consisted of air pollution, water pollution, noise pollution, industrial garbage pollution, domestic garbage pollution, lack of green space, destruction of forest vegetation, deterioration of cultivated land quality, shortage of freshwater resources, food pollution, desertification and reduction of wild animals and plants. The answers to the first question were measured by no=0 and yes=1. If the respondent replied "yes", she or he should answer the second question: "How serious are they in the area you are living?" The perception of the severity of each environmental risk was measured by 6-point scale ranging from "very serious" to "no such problem", in which a higher score indicates less severity of such environmental risk. The author added up the responses of the perception of each environmental risk to create a composite index for the perception of the number of environmental risks, which had a high-reliability value with Cronbach's alpha of 0.902. Also, a composite index for the perception of the severity of environment risks had a Cronbach's alpha of 0.902.

Regarding the evaluation of government environmental behavior, the relevant question is: "How do you think the environmental protection work of the central government has been done in the past five years?" and "How do you think the environmental protection work of your local government?" The answers to these two questions were measured by 5-point scale ranging from "neglecting environmental protection work" to "great achievements have been made", in which the higher score indicates the more satisfactory of the respondent toward the governments' behavior in solving environmental problems. The summed index of these two items had a Cronbach's alpha of 0.783.

The other independent variables used in this study included gender（male=0, female=1）, age (calculated based on the reported birth date of each respondent), area type (rural=0, urban=1), individual yearly income, as well as health status, on the basis of a self-reported 5-point scale, in which a higher score indicates a better health status.

Descriptive statistics were provided to illustrate both the dependent and independent variables of the respondents. And then, two regression models were used to examine the effects of the perception of environmental risk and the evaluation of government environmental behaviors in predicting individual environmental

protection behaviors. The statistical software package SPSS 24.0 was used for all data analysis.

## 4.Result

Table 1 summarizes the statistics of the whole valid sample in this study. Among the 8,122 respondents, 53.0% were males. The mean age of the sample was 48.11(SD=15.81). 36.1% of respondents came from rural areas. The mean of individual yearly income was 25597.56 RMB (SD=38019.52). The mean for self-reported health status was 3.78 (SD=1.04). Regarding the individual environmental protection behavior, with a total score of 30, the average score of the sample was 15.50 (SD=3.32). Among the 12 types of environmental risks, on average, 9.36 (SD=3.31) types of environmental risks were recognized by the respondents. And the average score of the severity of environmental risks was 46.50 (SD=14.45) within the 72 scores. Regarding the evaluation of government environmental behaviors, the average score was 6.27 (SD=2.09) in a total score of 10.

Table 1 Characteristics of respondents (n=8122)

| | **Mean or percent** | **Standard deviation** | **Minimum** | **Maximum** |
|---|---|---|---|---|
| **Dependent variable** | | | | |
| Environmental protection behavior | 15.50 | 3.32 | 10 | 30 |
| **Independent variables** | | | | |
| Gender(male) | 53.0% | - | | |
| Age | 48.11 | 15.81 | 17 | 96 |
| Area type (rural) | 36.1% | - | | |
| Individual yearly income | 25597.56 | 38019.52 | 0 | More than 100000 |
| Health status | 3.78 | 1.04 | 1 | 5 |
| Perception of environment risk (number) | 9.36 | 3.31 | 0 | 12 |
| Perception of environment risk (severity)* | 46.50 | 14.45 | 12 | 72 |
| Evaluation of government environmental behaviors | 6.27 | 2.09 | 2 | 10 |

*Note:* * The number of respondents is 2735.

Table 2 reports the effects of the perception of the number of environmental risks and the evaluation of government environmental protection behavior on individual environmental protection behaviors. Both of them had a significant and positive relationship with individual environmental protection behaviors ($p<0.001$). Concretely, when the respondent recognized more environmental risks around her or him, she or he would engage in more environmental protection activities (B=0.164).

Table 2 Factors associated with individual environment protection behaviors (n=8122)

When the respondent recognized that government agencies had made more efforts to resolve the environmental problems, she or he would take more actions in protecting the environment (B=0.062).

Table 2 Factors associated with individual environment protection behaviors (n=8122)

| | **Beta** | **St. Beta** | **t** | **p-value** |
|---|---|---|---|---|
| Constant | 9.155 | | 31.088 | <0.001 |
| Gender[a] | 0.540 | 0.081 | 7.889 | <0.001 |
| Age | 0.012 | 0.058 | 4.887 | <0.001 |
| Education | 0.192 | 0.254 | 19.284 | <0.001 |
| Individual yearly income | 6.432E-06 | 0.074 | 6.822 | 0.001 |
| Health status | 0.099 | 0.031 | 2.864 | 0.004 |
| Perception of the number of environment risks | 0.164 | 0.163 | 15.476 | <0.001 |
| Evaluation of government environmental behaviors | 0.062 | 0.039 | 3.818 | <0.001 |
| Residence status[b] | 1.123 | 0.162 | 14.467 | <0.001 |
| $R^2$ | 0.194 | | | |
| F-statistic | 244.010 | | | |
| P-value | <0.001 | | | |

*Note:* [a] Referent is female. [b] Referent is urban sample.

Table 3 reports the effect of the perception of the severity of environmental risks on individual environmental protection behaviors. Similarly, after controlling for other variables, the perception of the severity of environmental risks was significantly associated with individual environmental protection behaviors ($p<0.001$). Specifically, if the respondent thought the environmental problems were more serious, she or he would participate in environmental protection activities more actively (B=-0.031).

Table 3 the relationship between perception of the severity of environment risks and individual environment protection behaviors (n=2735)

| | **Beta** | **St. Beta** | **t** | **p-value** |
|---|---|---|---|---|
| Constant | 11.288 | | 19.734 | <0.001 |
| Gender[a] | 0.489 | 0.069 | 3.819 | <0.001 |
| Age | 0.022 | 0.096 | 4.658 | <0.001 |
| Education | 0.251 | 0.294 | 13.298 | <0.001 |
| Individual yearly income | 6.036E-06 | 0.064 | 3.319 | 0.001 |
| Health status | 0.171 | 0.049 | 2.579 | 0.010 |
| Perception of the severity environment risk * | -0.031 | -0.130 | -6.508 | <0.001 |
| Evaluation of government environmental behaviors | 0.148 | 0.087 | 4.638 | <0.001 |
| Residence status[b] | 0.631 | 0.085 | 4.033 | <0.001 |
| $R^2$ | 0.160 | | | |
| F-statistic | 65.046 | | | |
| P-value | <0.001 | | | |

*Note:* [a] Referent is female. [b] Referent is urban sample.

This study has a limitation in explaining the causal relationship between environmental risks and environment behaviors, as Davis et al. (2011) claimed earlier. Since the data of this study is cross-sectional data, the causal relationship cannot be examined in this study, but further studies can make a contribution in this direction.

## 5. Discussion and conclusion

The findings show individual perception of environmental risk in terms of the number and the severity as well as individual evaluation of government environmental protection behaviors affect individual environmental protection behaviors significantly. This study also indicates the difference between urban and rural residents in environment protection behavior ($p<0.001$ in Table 2 and Table 3), which should be attracted attention.

There are two important implications for improving individual environmental protection behaviors. First, government agencies and social non-profit organizations should endeavor more efforts into the promotion of environment risk situations and the improvement of citizens' environmental awareness. Second, government agencies' policies and programs related to environmental protection are effective to enhance citizens' environmental protection behavior. Government agencies usually have two ways to influence individual environment protection behavior. The first way is using policy tools such as issuing mandatory decrees and regulations to standardize citizens' environmental behaviors. Recently, some local governments, such as

Shanghai, Shenzhen, and Guangzhou launched a strict waste classification policy. It is expected that this policy can improve citizens' environmental protection behaviors. The second way is investing in financial and human resources to protect the environment. No matter which way, governments' efforts in improving infrastructure construction, strengthening environmental protection legislation and law enforcement, and strengthening the awareness of environmental protection rules should be known to more and more citizens, thus, can improve individual environmental behaviors, and then realize the goal of sustainable development.

## Conflict of interest statement

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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# Analysis on the Spatial and Temporal Pattern Evolution and Driving Factors of Urban Informal Employment in China
## --an Empirical Study Based on Provincial Panel Data from 2011 to 2018

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**Keywords:** urban informal employment; spatial distribution characteristics; Moran index; spatial error model

**Abstract.** Under the background of the new era, urban informal employment is an important fulcrum to stabilize employment, protect people's livelihood, enhance employment elasticity and activate the labor market. Based on the interpretation of the new connotation of urban informal employment, this paper describes the provincial scale level of 30 provinces in China from 2011 to 2018, and uses spatial correlation analysis technology, global principal component analysis and spatial econometric model to deeply explore the evolution characteristics and driving factors of the spatial-temporal pattern of urban informal employment in China. The results show that the scale of urban informal employment will first decline and then rise in 2013, and the scale of urban informal employment will continue to maintain a steady growth in the future; the scale distribution has strong economic orientation and spatial agglomeration. The overall trend of "axial" expansion is from southeast coastal areas to inland provinces, and the overall degree of spatial agglomeration is increasing. The Matthew effect is obvious. Within the region, there is a "core edge" ladder like spatial differentiation pattern of "high-high" agglomeration - "high-low" agglomeration- "low- low" agglomeration - "low-high" agglomeration. When further analyzing the driving factors, the spatial error model is introduced. The results show that the

economic environment, human capital level, market environment and Local quality all have positive effects on the aggregation of urban informal employment. Besides, other comprehensive factors will have a positive spillover effect on the scale of informal employment in the adjacent cities and towns, and promote the scale of the central region, and its positive promotion is more significant. Therefore, the development law of urban informal employment should be revisit from the perspective of spatial interaction and corresponding policies should be formulated based on this. When promoting the sustainable development of urban informal employment, the regional spatial linkage effect should be fully considered, and the market tools and policy hands should be used to solve the imbalance of urban informal employment development.

## 1. 引言

就业乃民生之本，一直都是民生领域的热点话题。自改革开放以来，我国经济体制由高度集中的计划经济向相对灵活的中国特色社会主义市场经济转型，劳动力资源配置也随之向市场调节过渡。一方面，随着我国经济发展水平的提升和城镇化发展进程的稳步推进，我国劳动力市场格局产生显著变化，传统正规部门就业规模出现萎缩，以个体工商户、进城务工人员和自由职业者为代表的非正规就业规模逐渐扩张，加之互联网科技的发展及疫情的影响，城镇非正规就业内涵逐渐多样化，以网约车司机、网络平台主播和外卖配送员等为代表的新业态从业人员成为非正规就业新群体，且城镇非正规就业已经成为社会普遍现象。其在解决城镇劳动力冗余、增强就业弹性、提升劳动力资源配置效率、缓解城镇贫困问题和稳定社会等方面发挥了重要作用。另一方面，中国经济发展进入新常态，经济增速回落、结构调整阵痛和新旧动能转换相互交织，加剧了区域经济分化趋势，非正规就业作为经济活动的重要载体，其地理格局和区域图景也随之转变，激活区域劳动力市场和协调区域经济发展的作用日益突出。在此背景下，非正规就业成为学术界持续关注的焦点问题，大多数学者从规模特征、区域经济、微观差异和贸易开放等视角进行了分析。而对于目前中国城镇非正规就业规模水平究竟如何？地理位置相邻的省份，其规模是否存在相似性？城镇非正规就业水平是否存在空间聚集现象？其背后的影响因素为何等问题探讨较少。基于此，本研究在厘清城镇非正规就业概念的基础上测算其规模，运用空间计量方法和模型探究其空间演化特征及 驱动因素，以期为科学预测我国就业新形态、高效开发劳动力资源和缩小区域就业差异提供有益参考。

## 2．文献回顾与评价

自2002年国际劳工组织基于Keith Hart的非正规部门思想提出非正规就业概念框架以来，国内外学者就非正规就业的相关问题进行了一系列探讨，形成了丰富的研究成果，主要集中在城镇非正规就业概念研究、规模测度研究及影响因素实证研究三个方面。

对于城镇非正规就业的概念研究表现出与时俱进特征，这一概念自提出以来就随着社会环境变化和研究视角的切换而不断发展。具体而言，西方学者在市场经济高度发达和相关理论内涵日渐丰富的背景下，对“非正规就业”的概念界定实现了从最初基于生产单位定义（ILO，2002a）向基于生产活动（Thomas,1992;Williams等,1998）及基于法律或社会保护定义(OECD，2002)的转变过程（Perry等，2007），总体逐渐向“精准化”和以“职位分类”为标准的方向演进。我国学者则是在西方学者的研究基础上致力于将非正规就业概念本土化，使其更适宜中国国情，主要观点形成两个重要分支。一类是依托部门进行概念界定，在Hart关于“非正规部门”定义的基础上通过描述我国非正规部门特征提出本土化概念，即以具体就业部门为标准，在与传统就业形式相区分的基础上界定非正规就业，认为非正规就业是普遍存在于正规部门和非正规部门中的非传统就业形态（胡鞍钢和杨韵新，2001；姚裕群，2005；陈翊和冯云廷,2016）。另一分支的产生则是由于灵活雇佣关系逐渐向正规部门扩散，学界认为仅凭借非正规部门和正规部门来界定非正规就业不能兼顾日渐多元化的就业形式，因此主张从劳动关系视角审视中国非正规就业概念，认为那些与雇主间不存在正式雇佣关系（万向东，2008）或未签订劳动合同（吴要武等，2006），且不受政府相关规章制度约束，仍处于低层次和边缘地位的就业形式（闫海波等，2013）即为非正规就业。虽然目前我国学界对于非正规就业概念仍然存在争议，但界定角度已经初步形成，界定内容也表现出由形式界定向多维界定的转变趋势。

近年来，随着高新技术产业的发展和增长动能的转换，就业方式与工作模式发生了变化，雇佣关系逐渐走向灵活与多元，非正规就业也逐渐成为解决中国就业压力和增加城镇就业岗位的重要渠道（彭希哲等，2004；何文炯，2020）。在此背景下，我国非正规就业规模测算成为了继概念界定之后的又一研究问题。但是学界对于规模测算的研究由于其内生的“不可测度性”、“行为者-观测者-政府”信息扭曲以及特有的“统计幻觉”和“政策幻觉”等问题尚未形成统一定论（姚宇，2006）。目前国内外学界以数据类型为区分标准，形成了两类经典测算方法。一种是在问卷调查或税务审计的基础上，通过界定劳动者岗位特征而衍生出的以劳动力调查法（Williams,2004b）、住户调查法（Gorisov,2005）和产业活动单位调查法（曹俊文，2003）为代表的直接测量法。21世纪初期，我国学者通过直接调查法测算城镇非正规就业规模确实产生了丰富的研究成果（吴要武等，2006；薛进军等，2012），但是该方法测算结果的准确性完全取决于调查资料的可信度，时间维度也不具有连续性和代表性，且综合成本过高，近年来逐渐被淡化。另一种则是西方学者在发达的劳务市场和金融市场背景下提出的，以交易量统计法（Feige，1996）和现金需求量计算法（Tanzi，1983）为代表的间接测量法（Williams，2014）。该方法在引入我国进程中，国内学者根据本土情景对其进行了优化，衍生出适宜我国国情的间接测算方法，即以宏观数据和统计资料为依据，在概念界定的基础上推算规模。具体而言，一种是从部门区分视角将城镇就业人数与正规部门就业人数之差作为我国城镇非正规就业规模（胡鞍钢和赵黎2006）。该方法虽兼顾了正规部门、非正规部门以及未纳入统计的就业群体，但未能考虑周全非正规就业部门的正规就业群体，因此最终测算结果存在偏大问

题。另一种则是从社会保险角度入手，运用统计资料对地方非正规就业规模进行估算，将城镇就业人员与城镇在职职工基本养老保险参保人数之差加上个体户数即为当地非正规就业规模（张彦，2009；曲燕，2019）。该方法在进行全国范围的宏观探索时，各省份和直辖市社会保险具体实施情况存在差异可能导致计算基础不同，进而存在较大误差。总体来说，间接测量方法更具备统计操作性和国际对比性，只是细节处理仍需进一步商榷和优化。

非正规就业最初被视为生产和消费模式的残余(Geertz，1963；Gilbert, 1998)，由于进入壁垒、最低工资以及工会的制约，非正规就业劳动力是非自愿地被挤出正规就业市场，因此，非正规就业被视为经济发展水平低下和劳动力市场分割的产物（Butler，1990）。但事实证明，非正规就业并未随着经济发展水平的提高而逐渐消失。自理论界对非正规就业只是临时存在的认识发生转变后，研究深度持续推进，非正规就业的影响因素成为学界研究的重点。只是相关研究仍处于碎片化阶段，研究视角局限于微观个体差异和宏观经济环境。具体而言，微观个体差异层面的研究主要聚焦于性别差异、户籍制度和人力资本水平等，强调劳动者内在特征对非正规就业倾向的驱动（谭琳等，2003；杨凡，2015；胡风霞，2011）；宏观经济环境层面的研究则主要集中于探讨区域经济增长、贸易自由度、城镇化发展以及就业保护制度等与城镇非正规就业之间的相关关系，强调局部环境因素对非正规就业的影响（黄苏萍等，2009；胡翠等，2019；黄耿志等，2019；王海成等，2017）。总之，现有研究偏向于挖掘独立因素的驱动力，未对城镇非正规就业的影响因素进行系统归纳，且在因素探究时未考虑其相互作用及地理空间溢出效应，研究仍需深入。

纵观已有文献，学界关于城镇非正规就业的研究形成了丰富的研究成果，研究方法丰富，在扎实理论研究的基础上逐渐开拓实证分析领域；研究内容也呈现出以非正规就业为焦点的向外扩张趋势，但是也存在两个方面的不足。一是研究内容并未推陈出新。现有研究始终聚焦于概念界定、规模测度和非正规就业因果探索方面，对其空间格局鲜少讨论，仅有的成果也只是碎片化的静态研究或个案研究，且研究深度仍停留在总体规模的简单图示层面，宏观尺度的空间格局研究未曾涉及。二是相关研究忽略了非正规就业问题的空间关联性，研究方法多采用传统的面板数据回归模型。随着互联网的快速发展和全球价值链分工的变化，各地区基本成为相互交融的共同体，因此某一地区的城镇非正规就业规模聚集不仅依赖于本区域的要素禀赋和经济政策，也与周边区域的发展密不可分，因此，只使用传统的面板数据模型可能会导致估计结果存在偏误，使用空间计量模型分析更加适宜。

本研究在借鉴已有成果的基础上做出如下探索：第一，在对城镇非正规就业概念界定的基础上，运用综合测算法对其省际规模进行测算，揭示2011-2018年省域层面城镇非正规就业实际规模及其地域分布状态。第二，基于全局莫兰指数和局部莫兰指数的测算展示2011-2018年来我国城镇非正规就业规模的冷热点区域分布变化，分析其空间聚集特征。第三，利用全局主成分分析对基础指标进行降维处理，并基于空间计量模型从经济环境、人力资本水平、市场环境和地方品质四个维度分析我国城镇非正规就业影响因素的空间相关性，甄别影响城镇非正

规就业规模的关键驱动因素，以期为正确认识城镇非正规就业空间分布，推动区域劳动力市场平衡发展和区域经济协调发展有所裨益。

## 3．研究设计

### 3.1 研究方法

#### 3.1.1 中国城镇非正规就业规模测度

非正规就业的概念最早源于国际劳工组织对“非正规部门”的阐述，因此，非正规就业最初被简单定义为存在于非正规部门的就业形式。20世纪90年代，我国学者对非正规就业概念进行了本土移植，经过多年深入研究，非正规就业概念突破了计划经济遗留的“单位限制”观念，向以“岗位特征”界定转变。此外，在经济转型、国企改革及以“互联网+”为依托的新时代就业模式兴起的背景下，非正规就业趋于复杂化和多元化，其性质已不再是传统意义上的边缘型就业，而是实现我国未来就业形势保持稳中有优、稳中存变基本态势的重要支点。本文认为非正规就业是指从事城镇非农业活动的不固定就业形式，其广泛的存在于正规部门和非正规部门之中，且随着时代的发展其内涵逐渐丰富为传统城镇非正规就业和新时代城镇非正规就业。其中传统城镇非正规就业具体包括以临时用工、劳务派遣用工和非全日制用工为代表的正规部门中非正规就业群体以及以个体工商户及其从业人员、进城务工人员为代表的非正规部门中就业群体；新时代城镇非正规就业则是由平台经济、共享经济和零工经济衍生出的、依托互联网和大数据等现代信息科技手段，实现就业形式多元化、组织方式平台化、工作方式灵活化的新型就业形态，是经济新常态、市场竞争与科技进步交互作用的产物。

对非正规就业规模的估算模型要依托于定义进行精准构建，但是由于统计资料的缺失和数据的不可得性，本文仍沿用了姚宇（2006）提出的综合测算方法，从差值和汇总两个途径构建我国城镇非正规就业统计模型，尽可能降低估算误差。

首先使用差值法对非正规就业人数进行计算，以城镇总就业人数和统计的正规就业人数之差作为非正规就业的最大规模，但我国基于劳动综合统计报表制度和工商登记制度获得的城镇单位就业人数存在漏统和低估现象，因此分企业类型统计的就业人口更接近于正规部门中正规就业的概念，而未被统计在内的就业人员可被近似视为城镇非正规就业人员。具体而言，统计的正规就业人数以纳入统计年鉴的国有单位、集体单位、股份合作单位、联营单位、有限责任公司、股份有限公司、港澳台商投资单位和外商投资单位中就业人数表示。由于非正规就业同时存在于正规部门和非正规部门之中，因此，为了简化现实情况，本文在估算过程中默认将正规部门存在的非正规就业人群与私营企业中存在的正规就业人群进行抵消。

$$IE_{max} = E - E_{fe} \tag{1}$$

其中，$IE_{max}$表示城镇非正规就业人数上限，$E$代表城镇总体就业人数，$E_{fe}$表示正规就业人数。

其次使用汇总法对非正规就业人数进行二次估算，由于汇总法主要依据从业人员的来源和劳动岗位特征进行推算，分类复杂且无法面面俱到，存在一部分城市人口因在正规部门内从事非正规就业工作或因在难以分类的部门中工作而无法纳入统计，其估算数值相对小于我国实际非正规就业人数，因此将汇总法估算值作为非正规就业人数下限。本文根据数据可获得性和对现实情况的简化处理，认为非正规就业具体包括城镇私营企业中部分从业人员（$E_p$）、城镇个体从业人员（$E_i$）两类群体。由于城镇私营企业中的非正规就业人数缺乏准确的统计数据，本文根据学界常规做法，假设私营企业的就业人员一半为非正规就业。（吴伟，2008；姚宇，2005）。

$$IE_{min} = E_p \times 50\% + E_i \tag{2}$$

最后根据估算出的人数上限与下限对我国城镇非正规就业数据进行修正，采用中间值法得出最终估算结果。综上所述，可得出以下测算模型：

$$IE = \frac{1}{2}(IE_{max} + IE_{min}) = \frac{1}{2}(E - E_{ps} + E_p \times 50\% + E_i) \tag{3}$$

3.1.2 中国城镇非正规就业空间相关性分析

（1）全局空间自相关检验

全局空间自相关（Global Spatial Autocorrelation）是一种基于全域视角探究区域内某种现象整体分布情况，同时判断此现象是否存在空间聚集特征的研究方法。本文采用全局*Moran's I*指数来量化中国城镇非正规就业的总体空间关联程度。计算公式如下：

$$Moran's I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\sum_{i=1}^{n}(x_i - \bar{x})^2} \tag{4}$$

设$S^2 = \frac{1}{n}\sum_i (x_i - \bar{x})^2$, 即 *S* 代表$x_i$或$x_j$的标准差，则式（4）可以转化为:

$$Moran's I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{S^2\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \tag{5}$$

式中：n 为研究区的数量；$w_{ij}$表示空间权重矩阵，本文选择较为常见的邻接矩阵（相邻取值为 1，反之取 0）；$x_i$和$x_j$分别表示省份 i 和 j 的城镇非正规就业观测值；$\bar{x}$为中国城镇非正规就业规模的平均值；$S^2$代表城镇非正规就业观测值方差。*Moran's I* 的取值范围为［－1，1］，当 *Moran's I*＞0 时，城镇非正规就业存在空间正相关关系，且取值越大，空间相关性越强；当 *Moran's I*＜0 时，城镇非正规就业表现为空间负相关。

为了更加直观的反映 *Moran's I* 指数的计算结果，可以使用标准化统计量 Z 来反映研究区域的空间相关关系。Z 值计算关系如下：

$$Z = \frac{I - E(I)}{\sqrt{Var(I)}} \tag{6}$$

其中，$E(I)$和$Var(I)$代表 *Moran's I* 指数的期望值和方差，$E(I) = -1/(n-1)$。当 Z 值显著为正时，表明相似区域存在空间聚集现象;当 Z 值显著为负时，则相似区域趋于分散，若 Z 值为 0 时，观测值则呈现随机分布状态。

（2）空间聚类分析

局部*Moran's I* 指数测算是通过计算各个省份*Moran's I*指数及其Z得分，确定城镇非正规就业现象聚集的高(热点)、低(冷点)值空间位置。局部*Moran's I*计算公式如下：

$$I_i = \frac{Z_i}{S^2}\sum_{j\neq i}^{n} w_{ij} Z_j \tag{7}$$

其中，$Z_i = x_i - \bar{x}$ $Z_j = x_j - \bar{x}$ $S^2 = \frac{1}{n}\sum_i (x_i - \bar{x})^2$

式中：$I_i$表示第*i*个地区的局部莫兰指数；$w_{ij}$表示邻接权重矩阵；*n*为研究区域数量；$x_i$和$x_j$表示第*i(j)*地区的城镇非正规就业规模，$\bar{x}$为中国城镇非正规就业规模的平均值；$S^2$代表城镇非正规就业观测值的方差。最终根据各个研究单元的I指数及其*Z*值得分的正负将其进行区域划分，具体分为高-高、高-低、低-低和低-高四种聚集类型，以莫兰散点图等可视化的方式直观展现其空间聚集形态。

3.1.3 中国城镇非正规就业分布的驱动因素分析

（1）时序全局主成分分析

主成分分析（principal component analysis PCA）是通过线性变换减少变量个数的一种多元统计分析方法，包括经典主成分分析和时序全局主成分分析。经典主成分分析只能用于分析截面数据，因此在处理面板数据时需要运用时序全局主成分分析方法，即在经典主成分分析的基础上，将截面数据矩阵转化为立体的全局数据表，通过变换计算将原始的全局变量拟合为几个综合变量，以此描绘整个系统随时间变化的行动轨迹。

（2）空间计量模型

空间计量经济学是计量经济学的一个重要分支，其优势在于将空间交互作用和空间结构的基本思想纳入了传统回归模型，不仅解决了传统模型在处理空间数据时存在误差的问题，更为量化空间影响和空间联系提供了理论基础与技术支撑。以空间计量经济学为基础构建的空间计量模型类型众多，具体包括以空间相关性为分析点的空间常系数回归模型（空间滞后模型和空间误差模型）以及以空间异质性为切入点的空间变系数回归模型（地理加权回归模型）。本文根据城镇非正规就业现象的空间相关特征引用空间滞后模型和空间误差模型对传统面板数据模型进行修正，并采用极大似然估计法进行估计。

①空间滞后模型（spatial lag model, SLM）。该模型主要探究的是各变量在某一地区发挥作用时是否存在空间溢出效应，也被称为空间自回归模型。SLM模型表达式如下：

$$\boldsymbol{y} = \rho \boldsymbol{W}\boldsymbol{y} + \boldsymbol{X}\beta + \boldsymbol{\varepsilon} \tag{8}$$

式中：$\varepsilon \sim N(0, \sigma^2 I_n)$，$\boldsymbol{y}$为被解释变量矩阵，$\boldsymbol{X}$为解释变量矩阵，$\boldsymbol{W}$表示邻接权重矩阵，$\rho$为空间效应系数，参数$\beta$反映了自变量对因变量的影响程度，$\boldsymbol{Wy}$是空间滞后因变量，属于内生变量，反映了空间距离对区域行为的作用。

②空间误差模型（spatial error model, SEM）。该模型主要解决的是随机误差之间的空间自相关问题，尽可能减小测量周边区域时产生的不确定性因素对本地相关活动产生的影响，也被称为空间自相关模型。SEM模型表达式如下：

$$\boldsymbol{y} = \boldsymbol{X}\beta + \boldsymbol{\varepsilon}, \quad \boldsymbol{\varepsilon} = \lambda \boldsymbol{W}\boldsymbol{\varepsilon} + \boldsymbol{\mu} \tag{9}$$

式中：$\varepsilon$代表随机干扰向量;$\boldsymbol{\lambda}$表示空间误差相关系数，度量了样本中观测值相互的空间依赖作用; $W\varepsilon$是空间滞后误差项;$\mu$是服从正态分布的随机误差项向量，其他同式（8）。

### 3.2 数据来源

基于数据的可获得性、权威性和连贯性，本研究选取2011-2018年全国除西藏外30个省、直辖市和自治区的相关统计数据作为样本数据，由于西藏存在严重数据缺失现象，故本文不予考虑。其中规模测算及影响因素测度指标的基础数据均来自于2012-2019年历年《中国统计年鉴》和地方统计年鉴，部分专题指标数据来自历年《中国分省份市场化指数报告》、《北京大学数字普惠金融指数报告》、《中国劳动力市场化指数编制》以及《中国区域创新能力评价报告》等学界权威调查报告。

## 4. 中国城镇非正规就业时空格局演变分析

### 4.1 中国城镇非正规就业规模的时间演进特征

根据上述估算公式（1）（2）（3）和相关统计数据可以计算出2011-2018年我国整体城镇非正规就业规模水平。测算结果见表1和图1。

表 1 2011-2018 年我国城镇非正规就业规模估算

| 年份 | 城镇非正规就业规模估算指标 | | | | |
|---|---|---|---|---|---|
| | 城镇就业总人口/万人 | 城镇非正规就业规模上限/万人 | 城镇非正规就业规模下限/万人 | 城镇非正规就业人数/万人 | 城镇非正规就业比例/% |
| 2011 | 35914 | 21820 | 6174 | 13997 | 38.97% |
| 2012 | 37102 | 22241 | 6764.5 | 14502.75 | 39.09% |
| 2013 | 38240 | 20423 | 7314 | 13868.5 | 36.27% |
| 2014 | 39310 | 21315 | 11937.5 | 16626.35 | 42.30% |
| 2015 | 40410 | 22632 | 13390 | 18011 | 44.57% |
| 2016 | 41428 | 23830 | 14668.5 | 19249.25 | 46.46% |
| 2017 | 42462 | 25108 | 16011.5 | 20559.75 | 48.42% |
| 2018 | 43419 | 26477 | 17416 | 21946.5 | 50.55% |

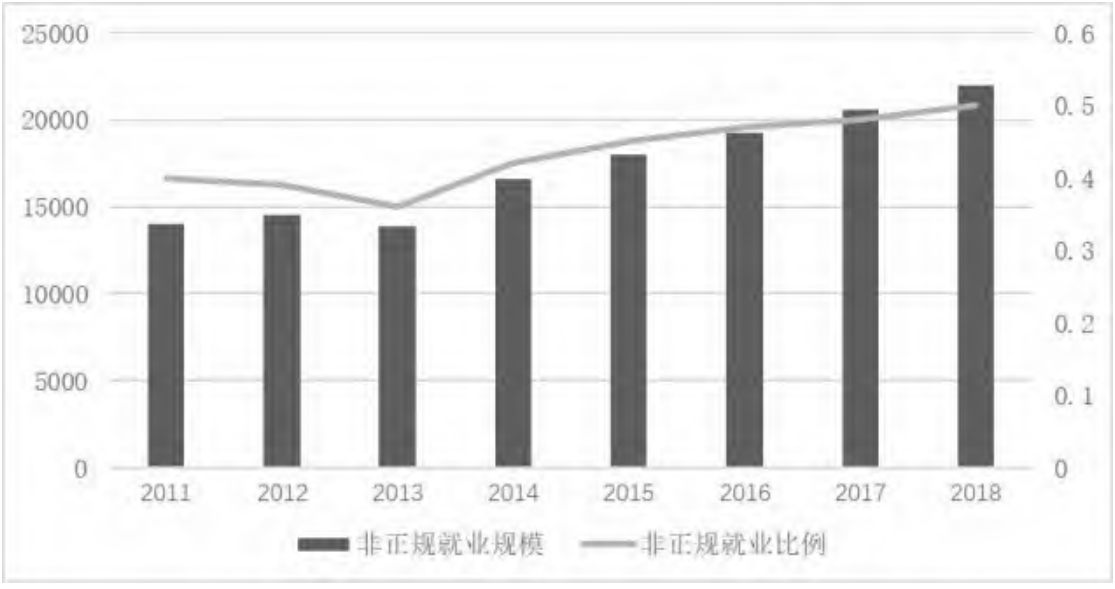


图1 2011-2018年我国城镇非正规就业演化趋势

总体来看，近八年来，我国城镇非正规就业比例呈现先下降后上升的发展态势，2011、2012年城镇非正规就业比例稳定在39%左右，到了2013年我国城镇非正规就业比例跌至36%，非正规就业人数为13868.5万人，此后便呈现出稳步上升趋势，至2018年底，我国城镇非正规就业规模达到21946.5万人，非正规就业占比超过50%。从数据的变化来看，以2013年作为分界点，我国城镇非正规就业规模发展经历了两个阶段。

第一阶段为2011-2013年，我国城镇非正规就业规模呈现先上升后下降趋势，非正规就业比例则呈现缓慢下降趋势，在2012-2013年之间出现明显波动。一方面，度过2008年全球金融危机后，我国宏观经济形势总体好转，经济秩序恢复平稳，加之政策的引导与扶持，私营企业、小微企业和个体经济发展氛围良好，就业吸纳能力增强，非正规就业规模总体保持上升趋势，非正规就业比例维持在平稳状态。另一方面，自2012年开始，重工业化和城市化带来的经济高速增长红利逐渐减弱，中国经济增速换挡，我国劳动年龄人口数量持续下降，就业压力从增量向存量转变。具体表现为劳动力供给增速趋缓，劳动者人力资本投资增加，就业观念趋向多元化，就业预期随之提升，但是工业化积累方式对低人力资本的路径依赖使得现有非正规就业岗位无法适应劳动者就业预期，就业结构性矛盾促使我国城镇非正规就业比例出现回落现象，非正规就业规模也几乎与开始测算年份持平。总体来说，我国城镇非正规就业比例在2011-2013年基本稳定在38%左右，张延吉和陈祺超等人（2015）的估算结果显示，当我国城镇非正规就业比重保持在38%左右时，非正规就业对我国经济增长的正向促进作用最大 。根据本文测算结果，2011-2013年我国城镇非正规就业对我国经济产出的正向带动作用较大，当时我国GDP保持较高增长率也间接印证了这一研究成果。

第二阶段为2013-2018年，我国城镇非正规就业规模总体呈现上升趋势，非正规就业比例也保持稳步增长局面。一方面，党的十八大明确了“劳动者自主就业、市场调节就业、政府促进就业和鼓励创业”的大政方针，以“创业带动就业”建立主动就业模式，推动就业资源配置方式由“以物为中心”向“以人为中心”转变，以此解决就业结构性矛盾，基于此，政府在大力发展小微企业和创新型科技企业的同时鼓励高校毕业生自主创业。随着政策的引导和扶持，小微企业和个体工商户数量急剧增长，非正规就业规模也相应上升。另一方面，2013年后，在“中国制造2025”“大众创业、万众创新”“互联网+”等政策的推动下，“分享经济”“平台经济”等在经济社会生活实践中爆发，为经济发展注入新动能的同时创造出新的就业增长空间，催生了以开放共享、随机协同为特征的新型就业形态。网店店主、平台主播、外卖配送员等依托新兴科技而实现工作自由化的新型非正规就业群体应运而生，非正规就业岗位初步实现与劳动者就业预期的良性互动，非正规就业规模迅速扩张，非正规就业规模增速也保持在7%左右的相对稳定状态，非正规就业比例在2018年突破50%。

Castells（2006）提出了非正规就业发展的三阶段理论，认为非正规就业规模会随着各国经济发展水平的提升而呈现出先扩大后缩小，最后趋于稳定。从我国城镇非正规就业历史演化趋势来看，我国目前处于一二阶段之间的过渡时期，未来在不发生剧烈经济波动的情况下，我国城镇非正规就业规模将趋于峰值，在经济结构调整和数字化转型完成后，非正规就业比例将持续保持稳定。

### 4.2 中国城镇非正规就业规模的空间分布格局

对中国30个省、直辖市及自治区（除西藏、港澳台地区）的城镇非正规就业规模进行测算并使用ArcGIS软件直观展示测算结果（如图2）。从空间演变趋势来看，我国城镇非正规就业区域分布在八年间发生了变化，非正规就业现象整体呈现出以东南沿海地区为核心向内陆省份“轴向”拓展的趋势，其中长三角、珠三角和环渤海三大经济圈辐射作用明显，长江经济带中游城市群和成渝城市群对于中西部的带动作用较为突出。从空间分布格局看，我国城镇非正规就业整体呈现出条块分布状态，区域聚集现象显著，具体而言，2011年，以上海、江苏、山东和广东等为代表的东南沿海地区城镇非正规就业规模明显高于内陆省份，且在区域尺度上形成“孤岛”格局。2013年以后，非正规就业的空间效应开始显现，重心开始向西北方向移动，我国城镇非正规就业规模以“孤岛”为核心向周边地区辐射，初步形成了“集群式”分布格局。至2018年，传统区域板块之间的“横向”分化格局逐渐弱化，以秦岭-淮河为界的南北“纵向”分化格局日渐清晰。在南方区域形成了以珠三角和长三角经济带为核心向周边拓展的“中心-外围”环状分布格局，而北方仍然呈现出条块分布状态，没有形成明显的核心区域，但是非正规就业整体规模明显上升。

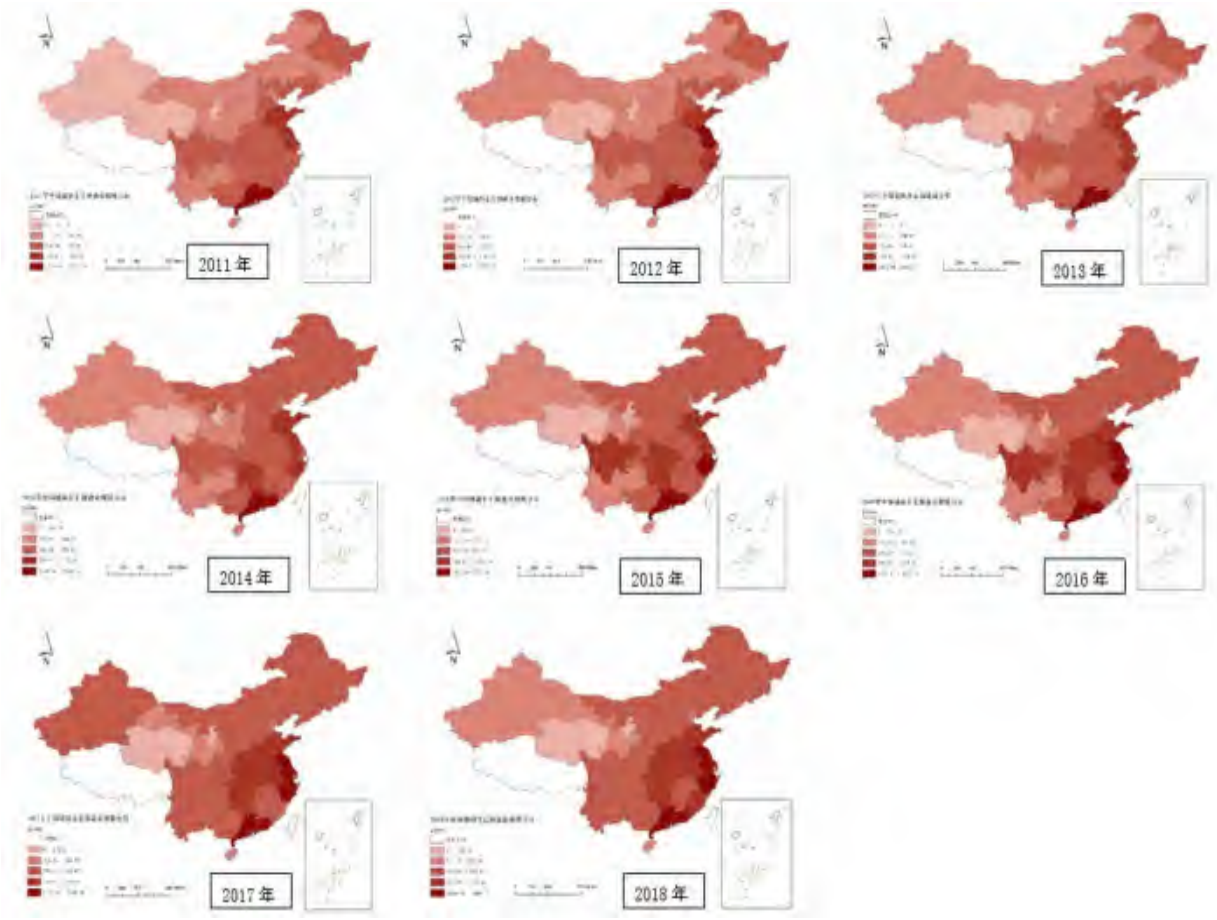


图2 2011-2018年中国城镇非正规就业规模水平空间分布演变

总体来看，中国城镇非正规就业规模分布具有较强的空间聚集性和经济指向性，具体表现为规模水平由东南沿海区域向内陆区域递减，其与我国经济发展的地理格局高度吻合。

## 4.3 中国城镇非正规就业规模的空间聚集特征

### 4.3.1 全局空间自相关分析

为了进一步探讨中国城镇非正规就业规模的空间聚集特征，利用上述公式（4）（5）（6）借助stata15.0对我国城镇非正规就业进行全局自相关检验，结果见表2。表中各项指标均显著为正，表明其存在显著的空间正相关关系，即规模水平较高的省份在空间上呈现明显的聚集状态。同时，以2011年为基期的测算结果显示，中国城镇非正规就业规模的空间关联度呈现波动的上升趋势，我国城镇非正规就业规模的空间聚集特征越来越明显。

表 2 中国城镇非正规就业规模水平空间分布的 Moran's I 指数

| 年份 | Moran's I 指数 | Z 值 | 显著性水平 |
|---|---|---|---|
| 2011 年 | 0.266 | 2.508 | 0.01 |
| 2012 年 | 0.252 | 2.390 | 0.01 |
| 2013 年 | 0.268 | 2.532 | 0.01 |
| 2014 年 | 0.267 | 2.518 | 0.01 |
| 2015 年 | 0.246 | 2.328 | 0.01 |
| 2016 年 | 0.250 | 2.362 | 0.01 |
| 2017 年 | 0.220 | 2.129 | 0.05 |
| 2018 年 | 0.301 | 2.782 | 0.01 |

4.3.2 局部空间自相关聚类

在全局自相关检验的基础上，利用stata15.0软件对我国30个省份的局部Moran's I指数及其Z得分进行计算，根据计算结果生成局部莫兰散点图（见图3），并通过ArcGIS将结果进行直观展现（见图4），进一步探索其高低值集聚分布情况。考虑到发展态势及时间间隔一致性的原则，选取2012、2014、2016和2018年四个时间断面进行展示与分析。

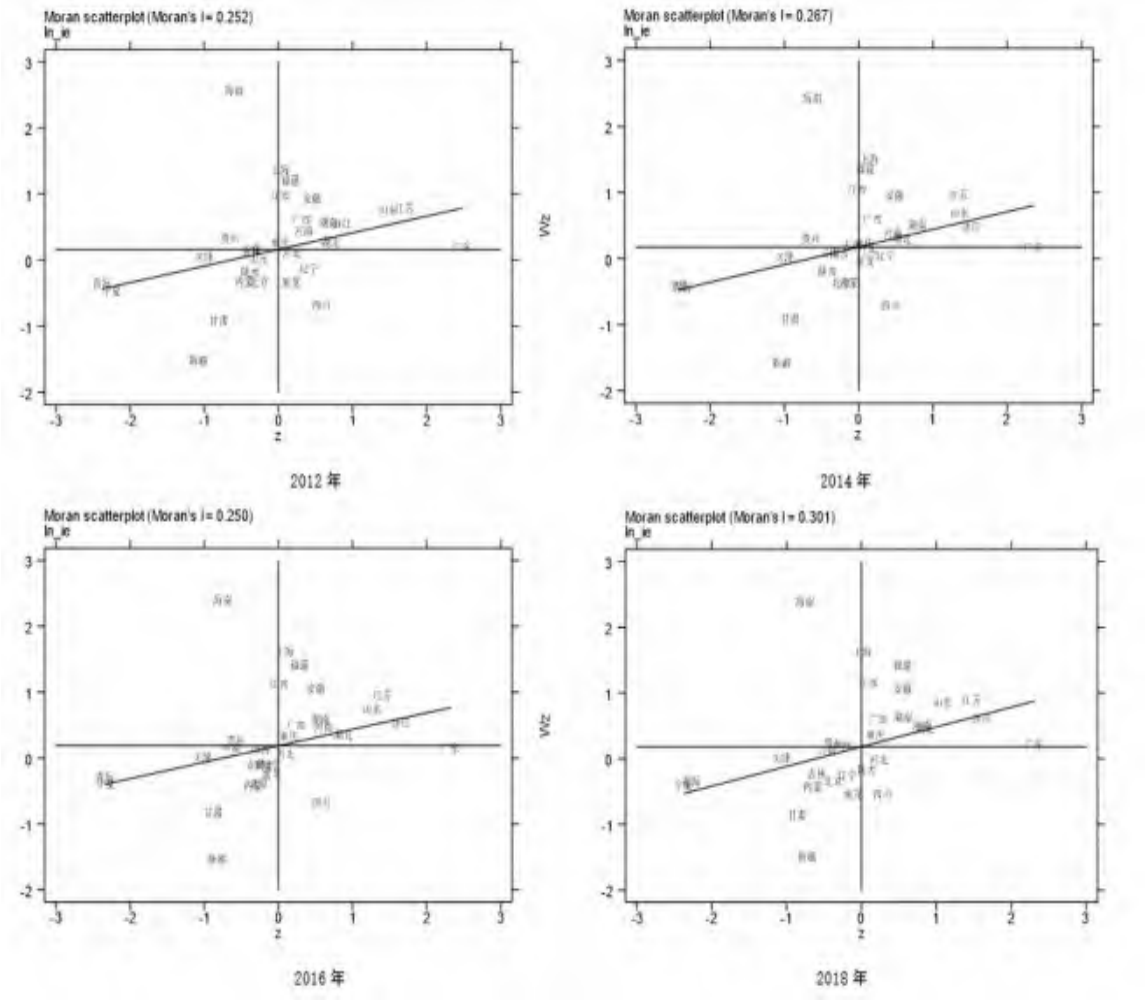


图3 中国城镇非正规就业规模局部Moran散点图

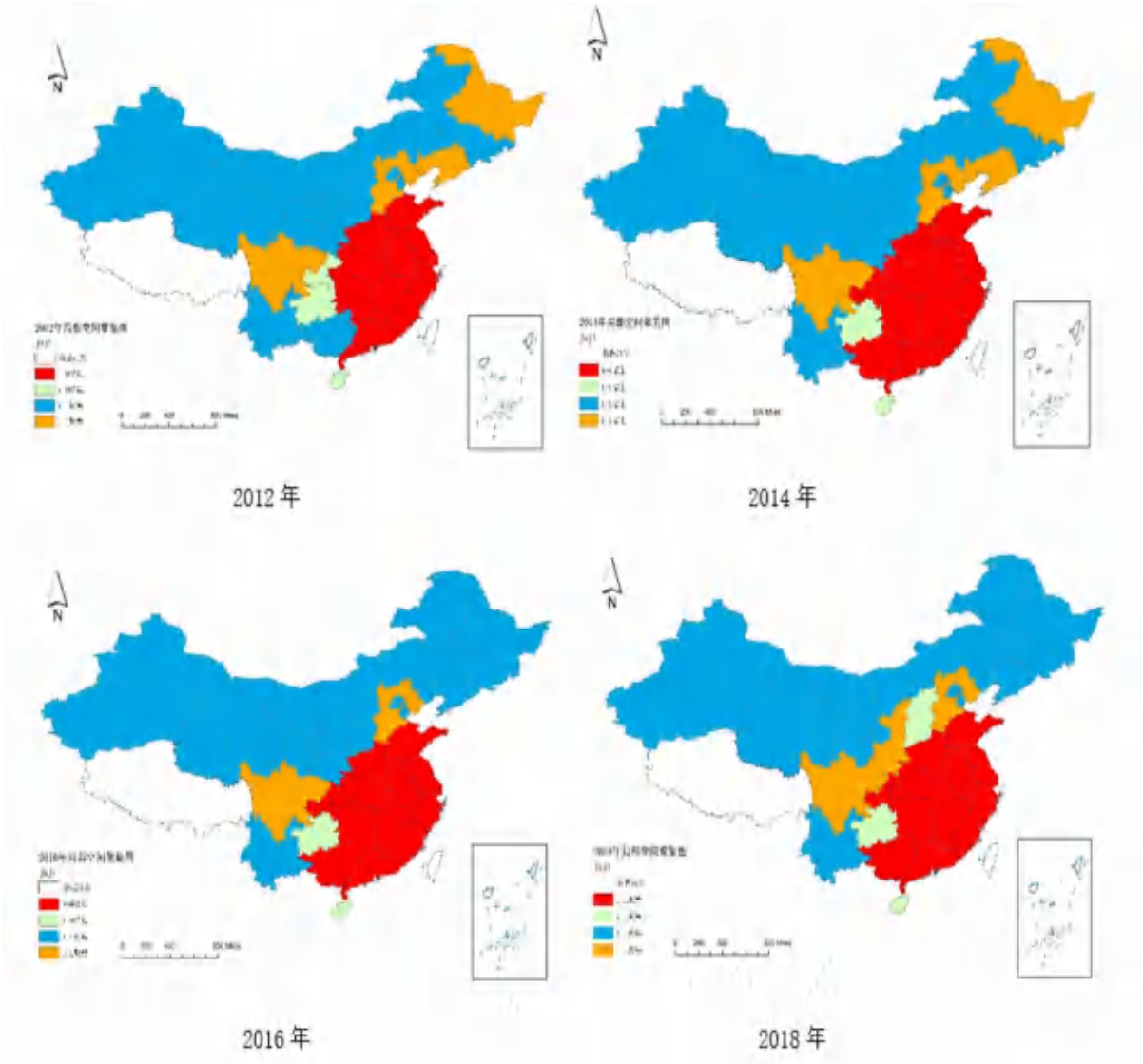


图4 中国城镇非正规就业局部空间聚集图

由图3可以看出，在空间直角坐标系中，我国30个省份主要集中在第一象限和第三象限，呈现出明显的“高-高”集聚（H-H）和“低-低”集聚（L-L）特征。结合图4地理位置具体分析空间聚集格局，不难发现中国城镇非正规就业规模水平已经形成高高集聚-高低集聚-低低集聚-低高集聚相互交织的“核心-边缘”梯状空间分异格局。

（1）高-高（H-H）集聚区，即城镇非正规就业规模观测值高的区域被同样属于高值的区域所包围，是城镇非正规就业聚集的热点区域，稳定分布于东南沿海地区及其周边省份，空间关联呈现出产业扩散效应和辐射带动作用。首先，东南沿海地区作为改革开放的先行者与贸易全球化的最先受益者，其凭借优越的区位条件、开放的经济环境以及繁荣的对外贸易，在工业化初期吸引了资本与劳动力的聚集，较早成为非正规就业聚集的热点区域。其次，位于东南沿海地区周边的省份，如安徽、江西、河南、湖北和湖南等内陆省份受到其辐射作用，也逐渐呈现出高-高集聚形态。一方面由于金融危机后我国经济面临着周期性调整和结构性优化的双重压力，东部沿海地区率先推进经济结构改革，由劳动密集型产业为主的产业结构向以创新型技术产业为主的产业结构过渡，加之技术优化推动了以由低廉劳动力组成的中小企业为主的产业集群进行升级，淘汰技术落后和产能

过剩的中小企业，迫使其向周边省份转移。另一方面，中部振兴战略的实施促使中部地区进入工业化加速期，以政府投资为牵引力，获取了东部地区经济高速增长的“接力棒”，释放出大量非正规就业岗位，加之对人才引入政策的学习使得其逐渐成为非正规就业的聚集区域。

（2）高-低（H-L）集聚区，即城镇非正规就业规模观测值高的区域被低值区域所包围，是城镇非正规就业聚集的次热点区域，主要分布于热点区域周边，以此为核心纵深延伸，空间关联呈现出极化效应。2011-2018年，四川和河北一直处于该集聚区，表明四川和河北的非正规就业发展相较于其他高值区域而言，并未产生明显的辐射作用，反而表现出较强的极化作用。近年来，四川在多点多极支撑、创新驱动发展和城乡统筹发展的战略驱动下，夯实基础建设、强化区域分工协作、优化资源配置方式和培育特色产业支柱，以宜居的自然环境条件与包容悠闲的历史文化气质吸纳了众多新时代人才，紧抓时代机遇促进了新时代城镇非正规就业的发展，但其周边省份大多为非正规就业的低值区域，表明四川并未与周边省份产生良好的互动，位于环渤海经济圈的河北以及新进入该聚集区的陕西也表现出了相似的特征。总体而言，高-低集聚区域对于周边省份非正规就业的虹吸效应要大于扩散效应。

（3）低-低（L-L）集聚区，即城镇非正规就业规模观测值低的区域被同为低值的区域所包围，是城镇非正规就业聚集的冷点区域，覆盖西北、华北和东北地区的部分省份，空间关联呈现区域联动效应弱的特点。一方面，该区域先天区位条件处于劣势，难以享受到热点区域的正向辐射作用，同时又由于靠近高-低聚集区，受到其虹吸效应和极化效应的影响，非正规就业观测值一直处于较低水平；另一方面，大部分省份在资源配置优化、产业结构调整和经济结构转型等方面未能跟上国家整体步伐，加之缺乏特色产业支撑，经济发展内生性动力不足，城镇非正规就业吸纳能力和吸引力无法提升，同时部分地区在就业扶贫政策的引导下开展转移就业与劳务输出，非正规就业水平持续处于低位状态。此外，从整体空间分布格局看（图2），西北地区和华北地区在2011-2018年始终呈现高值孤岛分布格局，处于省份单极化发展状态，未能形成高值簇，进而导致区域联动效应始终无法发挥作用，大部分省份一直处于低-低聚集形态，而位于东北老工业基地的辽宁和黑龙江则由于历史遗留问题、资源禀赋限制以及人口外流等种种因素在2015年之后由高-低聚集状态转变为低-低聚集状态。

（4）低-高（L-H）集聚区，即城镇非正规就业观测值低的区域被高值区域所包围，是城镇非正规就业聚集的次冷点区域，主要包括贵州和海南两省份，空间关联呈现出区域过渡特征。贵州处于热点区域、次热点区域和冷点区域的交互地带，虹吸效应和扩散效应共同发挥作用，加之自身经济发展水平以及以投资拉动外生性增长的发展模式限制了非正规就业的聚集，导致其始终处于低值状态，成为了连接冷热点区域的过渡地带，与之情况相似的省份还有山西，在2018年进入低-高聚集区行列。而海南则是由于其独特的区位条件和气候环境等始终无法承接由东南沿海地区转移的劳动密集型产业，受到的辐射作用有限，从而始终未能进入高-高聚集地区。

## 5. 中国城镇非正规就业时空格局演变分析

### 5.1 变量选取与数据处理

#### 5.1.1 变量选取

鉴于本文研究问题为中国城镇非正规就业时空格局及驱动因素，选择城镇非正规就业规模作为被解释变量，为了消除异方差对模型结果的影响，对被解释变量进行对数化处理，记为ln_IE。本文在借鉴已有研究成果的基础上，从经济、制度和社会三个方面构建了基础指标体系（见表3），具体基础指标选取如下：

（1）经济层面。奥肯定律、新经济增长理论、配第·克拉克定理和库兹涅茨法则等理论均表明，经济增长、知识经济兴起与产业结构变动等经济因素均对就业结构具有重要影响。本文选择从经济发展水平、贸易自由度、数字经济和产业结构发展水平四个方面构建解释变量，以人均GDP（pgdp）、人均GDP增长率（ipgdp）；进出口总额占国内生产总值比重（Open）和外商直接投资（invest）；数字普惠金融指数（dei）；第二、三产业产值占总产值比重（str）六个具体指标考虑经济因素对城镇非正规就业规模集聚的影响。

（2）制度层面。凯恩斯主义就业理论、非正规经济理论和发展经济学中的劳动力市场分割理论等都从政府活动和政治制度视角分析了城镇非正规就业产生的原因，强调制度因素对劳动力市场和就业结构的影响。因此，根据相关理论和现有研究成果，从政府干预程度、税收环境、教育水平和贫困程度四个层面构建解释变量，具体以社保和就业支出占一般公共预算收入比重（job）、政府一般公共预算支出占GDP比重（gov）；企业所得税占一般公共预算收入比重（tax）；人均受教育年限（pey）、中高等院校在校学生占地区人口比重（Edu）；城乡低保人数比重（poor）六个指标量化制度因素对我国城镇非正规就业规模集聚的作用。

（3）社会层面。二元经济模型、“人口乡一城迁移”模型和社会分层理论都阐释了人口流动、经济地位和社会环境等社会性因素对发展中国家城镇非正规就业的影响，为研究非正规就业的影响因素提供了社会分析视角。此处选择各地区人才人口密度（talent）、人才人口密度相对增长速度（italent）；工资性收入占人均可支配收入比重（wage）；区域创新能力指数（innovate）；劳动力市场化指数（labor）及市场化进程指数（market）六个具体指标衡量社会因素对我国城镇非正规就业规模水平的影响力。

表 3 城镇非正规就业影响因素的基础指标体系

| 选取角度 | 理论依据 | 基础维度 | 具体指标 |
|---|---|---|---|
| 经济层面 | 奥肯定律 | 经济发展 | 人均 GDP（pgdp） |
| | | | 人均 GDP 增长率（ipgdp） |
| | | 贸易自由度 | 进出口总额占国内生产总值比重（Open） |
| | | | 外商直接投资（invest） |
| | 新经济增长理论 | 数字经济 | 数字普惠金融指数（dei） |
| | 配第·克拉克定理<br>库兹涅茨法则 | 产业结构 | 第二、三产业产值占总产值比重（str） |
| 制度层面 | 凯恩斯主义就业理论<br>非正规经济理论 | 政府干预 | 社保和就业支出占一般公共预算收入比重（job） |
| | | | 政府一般公共预算支出占 GDP 比重（gov） |
| | | 税收环境 | 企业所得税占一般公共预算收入比重（tax） |
| | 劳动力市场分割理论 | 教育水平 | 人均受教育年限（pey） |
| | | | 中高等院校在校学生占地区人口比重（Edu） |
| | 贫困就业理论 | 贫困程度 | 城乡低保人数比重（poor） |
| 社会层面 | 二元经济模型<br>“人口乡-城迁移”模型<br>社会分层理论 | 人口流动 | 各地区人才人口密度（talent） |
| | | | 人才人口密度相对增长速度（italent） |
| | | 经济地位 | 工资性收入占人均可支配收入比重（wage） |
| | | 社会环境 | 区域创新能力指数（innovate） |

| | | | |
|---|---|---|---|
| | | | 劳动力市场化指数（labor） |
| | | | 市场化进程指数（market） |

为了增强指标选取的科学性以及消除解释变量之间的多重共线性，本文运用全局主成分分析方法对18个基础指标进行降维处理，根据降维结果进行空间计量分析。

5.1.2 数据处理

以2011-2018年30个省域相关数据为样本，构建全局数据表，在进行KMO检验和Bartlett检验的基础上，通过SPSS20.0数据分析软件对基础指标进行降维处理，得出载荷矩阵并提取其主成分系数，结果见表4至表6。

表 4 KMO 和 Bartlett 的检验结果表

| 检验 | 检验结果 |
|---|---|
| KMO 统计量 | 0.845 |
| Bartlett 检验卡方值 | 3823.981 |
| 显著度 | 0.000 |

由表4可知，KMO的统计量＞0.8，表明18个基础数据之间具有较强的相关性，适合做主成分分析。同时，由Bartlett检验结果可知，各个基础指标之间不存在独立性且通过了显著性检验。表5中有四个成分特征值超过1，累积贡献率达到74.015%，可以使用主成分分析法进行降维。为了更加科学和直观的提取主成分，本文利用最大方差旋转对初始成分矩阵进行处理，使成分矩阵系数向0-1分化，最终得到旋转成分矩阵（见表6）。

表 5 全局特征值及贡献率

| 主成分 | 特征值 | 贡献率 | 累积贡献率 |
|---|---|---|---|
| 1 | 7.816 | 43.423 | 43.423 |
| 2 | 2.790 | 15.502 | 58.925 |
| 3 | 1.407 | 7.816 | 66.741 |
| 4 | 1.309 | 7.274 | 74.015 |

表 6 全局主成分旋转载荷矩阵

| 基础指标 | 主成分 1 | 主成分 2 | 主成分 3 | 主成分 4 |
|---|---|---|---|---|
| Pgdp | 0.614 | 0.389 | 0.369 | 0.443 |
| Ipgdp | 0.726 | -0.246 | -0.067 | -0.030 |
| Str | 0.566 | 0.295 | 0.188 | 0.427 |
| Open | 0.620 | 0.160 | 0.010 | 0.673 |
| Pey | 0.386 | 0.684 | 0.156 | 0.474 |
| Invest | 0.883 | 0.038 | 0.107 | -0.025 |
| Dei | 0.202 | 0.228 | 0.871 | -0.029 |
| Innovate | 0.842 | 0.064 | -0.013 | 0.388 |
| Poor | -0.774 | -0.371 | -0.204 | -0.066 |
| Edu | 0.348 | 0.805 | 0.048 | 0.060 |
| Tax | 0.531 | 0.254 | 0.035 | 0.655 |
| Job | -0.434 | 0.516 | 0.240 | -0.384 |
| Gov | -0.792 | -0.291 | 0.183 | 0.271 |
| Talent | 0.438 | 0.744 | 0.159 | 0.131 |
| Italent | 0.054 | -0.029 | 0.050 | 0.319 |
| Wage | -0.052 | -0.281 | -0.519 | 0.562 |
| Labor | 0.129 | -0.230 | 0.790 | -0.107 |

| | | | | |
|---|---|---|---|---|
| Market | 0.232 | 0.303 | 0.878 | 0.099 |

如表6所示，全局主成分1对人均GDP、人均GDP增长率、产业结构、外商直接投资、区域创新能力、城乡低保所占比重和政府一般公共预算支出占GDP比重这7个基础指标具有较强的解释力，反映了各省份整体经济环境状况，因此将其命名为经济环境主成分。全局主成分2对人均受教育年限、中高等院校在校学生占地区人口比重、社保和就业支出占一般公共预算收入比重和人才人口密度4个基础指标具有较强的解释力，从教育和就业两个方面反映了各省份的综合人力资本水平，将其命名为人力资本水平主成分。全局主成分3包含了数字普惠金融指数、劳动力市场化指数和市场化进程指数三个基础指标，从市场调节角度解释了社会环境变化，将其命名为市场环境主成分。全局主成分4则包含了贸易自由度、税收环境、人才人口密度增长率和工资性收入占人均可支配收入比重4个基础指标，刻画了各个省份特有的基础实力，将其命名为地方品质主成分。

综上，经过对18个基础指标进行降维处理，将原有指标体系进行简化，重新组合为4个新解释变量，即经济环境（economics）、人力资本水平（human capital）、市场环境（market environment）和地方品质（local），根据其特征值、贡献率和得分系数分别计算4个新变量的得分，并将其纳入空间计量模型进行回归分析。

## 5.2 空间计量模型的确定

空间计量分析的前提是进行空间相关性检验，本文已使用Moran's I指数对城镇非正规就业规模进行了空间自相关检验，验证了城镇非正规就业分布的空间相关性，且通过局部Moran’sI指数分析了其在地理空间格局中的聚集特征。基于此，本文以2011-2018年中国30个省份的面板数据为数据基础，引入空间计量模型对中国城镇非正规就业空间分布的驱动因素进行实证分析。为确定合适的空间计量模型，基于邻接矩阵对数据依次进行Hausman检验、LM检验、Wald检验以及LR检验，结果见表7。

表 7 空间计量检验结果

| 检验 | 检验结果 |
|---|---|
| Hausman 检验 | 35.461*** （p=0.000） |
| LMLAG | 1.032 （p=0.310） |
| R-LMLAG | 0.099 （p=0.753） |
| LMERR | 141.245*** （p=0.000） |
| R-LMERR | 140.312*** （p=0.000） |
| Wald 检验—SEM | 6.97 （p=0.1027） |
| LR 检验 | 26.57*** （p=0.003） |

Hausman检验结果显示，固定效应模型优于随机效应模型，且通常情况下，当对特定个体进行回归分析时，固定效应模型比随机效应模型更具有解释力。LM检验结果显示，当被解释变量为ln_IE时，SLM模型未能通过显著性检验，而

LMERR和R-LMERR均在1%的水平下显著，因此，空间误差模型更适宜。此外，Wald统计量未能通过显著性检验，表明空间杜宾模型无法退化为空间误差模型，空间误差模型仍为最优，加之LR检验结果表明模型存在空间固定效应，最终选择空间固定效应的空间误差模型对城镇非正规就业空间分布的驱动因素进行空间计量分析。

## 5.3 模型估计与结果分析

根据空间计量检验结果，采用空间固定效应下的空间误差模型进行实证分析（见表8），同时，出于增强模型稳健性的考虑，表8同时报告了传统面板OLS混合模型结果以及基于地理距离矩阵和经济地理嵌套矩阵的空间误差模型回归结果。

表 8 模型回归结果

| 被解释变量 | 传统面板 OLS 模型 | 空间面板 SEM 模型 | | |
|---|---|---|---|---|
| | | 邻接矩阵 | 地理距离矩阵 | 经济地理嵌套矩阵 |
| economics | 0.617*** (6.45) | 0.343*** (6.51) | 0.337*** (6.31) | 0.335*** (6.23) |
| human capital | -0.0454 (-0.51) | 0.117*** (3.55) | 0.109*** (3.22) | 0.101*** (2.93) |
| market | 0.105*** (3.30) | 0.166*** (15.81) | 0.168*** (15.04) | 0.173*** (15.04) |
| local | -0.244 (-3.99) | 0.0683** (2.01) | 0.0718** (2.06) | 0.0700** (1.99) |
| _cons | 6.100*** (83.46) | | | |
| λ | | 0.221*** (2.62) | 0.295*** (2.42) | 0.343** (2.57) |
| ρ | | 0.0115*** (10.90) | 0.0116*** (10.90) | 0.0116*** (10.93) |
| N | 240 | 240 | 240 | 240 |
| $R^2$ | 0.702 | 0.7676 | 0.7655 | 0.7696 |
| Log-likelihood | -142.131 | 193.542 | 192.971 | 193.162 |
| AIC | 294.262 | -375.084 | -373.941 | -374.324 |
| BIC | 311.665 | -354.200 | -353.057 | -353.440 |

注：*、**、***分别表示估计结果在 10%、5%和 1%的水平下显著，括号内的数值表示 t 统计量

表8的回归结果表明，基于三种空间权重矩阵构建的空间误差模型，其估计结果在系数大小、符号方向和显著性水平方面基本保持一致，表明最终结果具有稳健性。从模型回归结果中，可以得出以下结论：

第一，区域经济环境是城镇非正规就业聚集的重要推力。模型结果显示，地区经济环境对城镇非正规就业规模的影响力度较大，在三种空间权重矩阵下系数分别为0.343、0.337和0.335，且都通过了1%的显著性检验，说明地区经济环境每提升1%，该地区城镇非正规就业规模增加0.3%左右。经济环境良好的地区资本实力雄厚、产业结构合理，加之外商投资吸引力强以及政策环境宽松等，对城镇非正规就业雇主和雇员形成了隐形“拉力”，反观经济环境较差的地区则由于经

济发展水平落后和区域科技创新能力欠缺等种种因素，对城镇非正规就业人口产生天然“推力”，两种作用在空间中交互，使得城镇非正规就业人口向经济环境良好的地区聚集。这一结果也充分解释了我国城镇非正规就业的高-高集聚区为何稳定分布于东南沿海地区及其周边省份，而低-低集聚区则稳定集中于西北、华北和东北地区的部分省份。

第二，区域市场环境是驱动城镇非正规就业聚集的主要因素之一。根据模型结果，地区市场环境对中国城镇非正规就业规模的影响力度次之，系数分别为0.166、0.168和0.173，且都在1%的水平下显著，即地区市场环境每优化1%，该地区的城镇非正规就业规模会增加0.17%左右。具体而言，地区市场环境包括地区数字普惠金融、劳动力市场化和市场化进程三个方面的发展程度，其中，市场环境良好的地区，数字普惠金融较为发达，其通过引导资本、带动生产要素流入新兴产业和个体经济等，促进地区新兴产业和个体经济的聚集，从而吸引了以网络平台主播和个体工商户为代表的城镇非正规就业人口的聚集。另一方面，市场环境良好的地区，劳动力市场化以及经济市场化程度较高，市场在供给和流通领域发挥着重要的调节作用，促进了中小型企业、微型企业和民营企业的发展，为城镇非正规就业人口的聚集提供了坚实的就业基础。

第三，区域人力资本水平是影响城镇非正规就业聚集的另一个主要因素之一。由表7可知，区域人力资本水平与区域市场环境对城镇非正规就业规模的影响力度相近，其系数分别为0.117、0.109和0.101，且都通过了1%的显著性检验，表明区域人力资本水平每提升1%，该地区城镇非正规就业规模增加0.11%左右。人力资本水平综合反映了地区人力资本以及就业支持力度，其中以知识和技术为构成要素的高级人力资本是推动新时代经济发展的有效途径，人力资本水平较高的地区，高等教育资源相对丰富、知识水平较高、拥有较为充足的人才储备，加之政府对就业工作的支持和就业者择业观念的灵活多元，推动了以“互联网+”就业模式为样态的新时代城镇非正规就业的快速发展。

第四，各省份特有的地方品质对城镇非正规就业的聚集也产生了一定的影响。如表7所示，地方吸引力的系数分别为0.0683、0.0718和0.0700，且都在5%的水平下显著，即各省份的地方吸引力每增加1%，该省份城镇非正规就业规模相应增加0.07%左右。地方品质从微观层面反映了该省份的企业发展环境、人才吸引能力和工资待遇水平，地方品质优的地区拥有良好的外贸环境和税收环境，利于中小型企业、微型企业和民营企业的发展，对于就业人口的吸引能力较强，加之工资待遇水平较高，自然而然成为滋养城镇非正规就业的肥沃土壤。

此外，空间误差项系数λ均在5%的水平下显著为正，表明邻近区域的城镇非正规就业规模确实会对中心区域产生影响，使得相邻省份的城镇非正规就业规模具有一定的相似性，但这种影响不是直接通过自变量表现，而是通过空间误差项传递。即除经济环境、人力资本水平、市场环境和地方吸引力之外的其他综合因素对邻近区域城镇非正规就业规模产生影响的同时也会对中心区域表现出正向溢出效应，促进中心区域城镇非正规就业规模的提升，当其他综合因素造成邻近区域城镇非正规就业规模增加1%时，中心区域城镇非正规就业规模相应提升0.3%左右，影响程度大于人力资本水平、市场环境和地方吸引力的影响程度。

## 6．研究结论与政策启示

本文在诠释城镇非正规就业新内涵的基础上，根据2011-2018年相关统计数据测算了中国30个省份的城镇非正规就业规模，通过GIS空间技术分析了其时空

格局演化特征与趋势，并基于全局主成分分析法和空间计量模型深入剖析了其驱动因素，最终得出以下结论：（1）从时间维度来看，我国城镇非正规就业规模水平以2013年为分界点呈现先下降后上升的发展态势，未来城镇非正规就业规模仍会处于增长状态。（2）从空间维度来看，中国城镇非正规就业规模分布具有较强的空间聚集性和经济指向性，整体呈现出以东南沿海地区为核心向内陆省份“轴向”拓展的趋势。此外，随着时间的变化，我国城镇非正规就业规模的空间聚集程度有所增强，马太效应特征明显，在区域内呈“高-高”集聚-“高-低”集聚-“低-低”集聚-“低-高”集聚相互交织的“核心-边缘”梯状空间分异格局。（3）经济环境、人力资本水平、市场环境和地方品质均对城镇非正规就业的聚集有正向促进作用，其中区域经济环境是城镇非正规就业聚集的重要推力，人力资本水平和市场环境的影响力度次之，地方品质的影响程度最小。此外，其他综合因素对邻近区域城镇非正规就业规模产生影响的同时也会对中心区域表现出正向溢出效应，促进中心区域城镇非正规就业规模的提升，且其正向促进作用更为显著。

基于上述结论，本文得出以下政策启示：

第一，积极推动城镇非正规就业实现可持续发展。随着时代的发展和技术的进步，非正规就业已经被赋予了新内涵，“互联网＋”就业模式成为其全新发展样态，城镇非正规就业不再是低级就业形态，而是新时代稳就业、保民生，激活劳动力市场和调节市场经济的有力工具。未来由于数字化社会的到来和疫情防控常态化的影响，城镇非正规就业规模必将处于持续增长状态，因此，政府要积极引导城镇非正规就业实现可持续性发展，在“大众创业，万众创新”战略指导下，将非正规就业发展纳入就业工作总体规划，消除就业壁垒，在鼓励多元就业形态发展的同时完善城镇非正规就业服务体系，从社会保障、劳动用工、行业监管和劳动者权益保护等方面进行配套规划，以此带动城镇非正规就业的良性发展。

第二，政策制定应充分考虑区域空间联动效应。城镇非正规就业作为地区经济活力的“晴雨表”，对协调区域经济发展和缩小区域差异具有重要的现实意义，研究表明，中国城镇非正规就业存在显著的空间正相关关系，且随着时间的推移而逐渐增强。因此，在制定相关政策时要统筹区域发展战略，鼓励区域协同发展，充分利用非正规就业高水平地区的辐射带动效应，以东南沿海部分省份带动周边地区的规模发展，最终以城镇非正规就业为杠杆实现区域协调发展。

第三，注重使用市场工具和政策手段因势利导，化解城镇非正规就业发展不平衡现象。对于城镇非正规就业规模水平高的地区，应继续稳定良好的经济环境和市场环境，持续提升人力资本水平和加强地方特色建设，实现城镇非正规就业与经济高质量发展的良性互动。对于城镇非正规就业发展落后的地区，应充分运用政策手段和市场工具营造良好的非正规就业发展环境，同时加强定向和针对性就业扶持政策的实施，以教育投入和就业扶持带动人力资本水平的提升，从环境和人才两个方面逐步推动城镇非正规就业的高质量发展。

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# 中国城镇非正规就业时空格局演化及驱动因素分析
# ——基于2011-2018年省域面板数据的实证研究

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**关键词：**城镇非正规就业；空间分布特征；莫兰指数；空间误差模型

**中文摘要.** 新时代背景下，城镇非正规就业是实现稳就业、保民生、增强就业弹性和激活劳动力市场的重要支点。文章在诠释城镇非正规就业新内涵的基础上，以2011-2018年我国30个省份的相关统计数据刻画了其省域规模水平，并采用空间相关性分析技术、全局主成分分析和空间计量模型对我国城镇非正规就业时空格局演化特征及驱动因素进行了深入剖析。研究结果表明，我国城镇非正规就业规模水平以2013年为分界点呈现先下降后上升的发展态势，未来城镇非正规就业规模将持续保持匀速增长状态；规模分布具有较强的空间聚集性和经济指向性，整体呈现出以东南沿海地区为核心向内陆省份“轴向”拓展趋势，且整体空间聚集程度不断增强，马太效应特征明显，在区域内呈“高-高”集聚-“高-低”集聚-“低-低”集聚-“低-高”集聚相互交织的“核心-边缘”梯状空间分异格局。在进一步分析其驱动因素时，引入空间误差模型，结果显示：经济环境、人力资本水平、市场环境和地方品质均对城镇非正规就业的聚集有正向促进作用。除此之外，其他综合因素对邻近区域城镇非正规就业规模产生影响的同时也会对中心

区域表现出正向溢出效应，促进中心区域规模的提升，且其正向促进作用更为显著。因此，今后应从空间互动角度重新审视城镇非正规就业的发展规律并基于此制定相应政策，在积极推动城镇非正规就业的可持续发展时要充分考虑区域空间联动效应，注重使用市场工具和政策手段因势利导，化解城镇非正规就业发展不平衡现象。

# Model Risk of Anti- COVID-19 Policy Making in the Early Stage in Wuhan: an Analysis Based on the Logistic Growth Model

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**Abstract.** Based on the data of cumulative confirmed cases in the early stage of the epidemic in Wuhan provided by related articles published in Lancet and NEJM, the development trend of the cumulative diagnosed cases of COVID-19 in Wuhan in the early stage was fitted with a logistic growth model. One of the main reasons is that if decisions are made based on the Logistic growth model, it is difficult for the governments of Wuhan and Hubei Province to avoid the slow response in the early stage. In the future, before confirming the contagiousness of unknown diseases, in addition to investigating its development trend based on Logistic models, gray prediction, polynomial and SEIR models should also be employed to reveal the disease development trends earlier and more accurately. The CDC of China should make most of the national electronic medical record system, and rely mainly on big data analyses rather than doctors' reports to actively capture the initial information of latent epidemics.

**Key words:** COVID-19 epidemic; Logistic growth model; Model risk; Trend prediction; Correct decision-making

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## 1. Introduction

The outbreak of the Corona Virus Disease 2019 (COVID-19) in Wuhan Hubei Province with the SARS epidemic having only gone for 17 years has caused huge losses to the country. With the epidemic tending to end, people begin to reflect

human beings' initial response to COVID-19 with a view to learn from the past so as to avoid falling into the same mistakes.

Needless to say, the lessons of combatting COVID-19 are extremely profound. The most important one is the unresponsiveness and improper response of Wuhan Municipal Government of Hubei Province in the early stage of the epidemic, but the concealment of the epidemic is obviously not included. Concealing reports is not politically logical and violates political rationality. The local government will not bear too much responsibility if it reports the epidemic to its superior government in time for an epidemic is a natural disaster not a man-made mistake.it is not cost beneficial and disproportionately risky for local government to report with concealment for the gains and losses are seriously asymmetric. The earliest confirmation date for the COVID-19 is December 27, 2019. The samples used in this article may have late or missed cumulative diagnoses as of January 1, 2020, but the possibility of concealment is extremely low (high Yu, Peng Yanfeng, Yang Rui, etc. 2020).

The reasons for the out-of-control of the epidemic of COVID-19 initially can be mainly attributed to the ignorance of the high infectivity of the new coronavirus and the mistakes in prevention and control decisions of Wuhan city. Tracing back to the source, ignorance and mistakes are all related to model risk. Wrong cognition and decision-making originate either from incorrectly use the correct model or the model employed is incorrect itself. In the confusion, the logistic growth model that studies the law of species development has entered people's vision. Before the high infectivity of new coronavirus was recognized, the logistic growth model was the first choice to capture its developmental pattern. After the outbreak of COVID-19, people will learn, adapt and explore combating methods, and strive to suppress its spread, which will inevitably make its development more characteristic of logistic growth model.

Model application is often accompanied by model risk, including model defects and model misuse. Model defects refer to errors that may occur in the design, development, and implementation of the model itself. Model misuse means that the correct model may be used improperly, such as continuing to use the model without the conditions for application or when the environment has undergone major changes. Administrative decisions of government institutions are not immune of model risk. In the early stage of the COVID-19 epidemic, the Wuhan Municipal Government of Hubei Province most likely mistakenly used the Logistic growth model. Summing up this error and drawing lessons from it will have a positive significance for the correct response to the future epidemic.

## 2. Literature review

The development trend curve of the cumulative number of confirmed cases in the early stage of the COVID-19 outbreak shows a trend that the growth rate initially increased and then decreased rather than continuously increasing, and finally reached a seemingly peak. The trend curve demonstrates an S shape instead of a J shape shows that it is suitable for fitting with Logistic growth model instead of exponential

model. In view of the applicability of the Logistic growth model, Zhou Yu, Tian Chunhua, and Zhang Guoquan (2010) examined the dynamic models of population stability such as stable balance, periodic oscillation, and chaos in the Logistic growth model. Without requiring strict explanation and reasoning, as an empirical approach, the Logistic model has practical value in many fields (Xu Ronghui, 2011).

Additionally, the Logistic growth model is used with other infectious disease models. Zhu Ling and Yang Junxian (2019) established a stochastic SIVR infectious disease model with Logistic growth; Yuan Shanshan and Zhang Guohong (2020) discussed a SIR infectious disease model in which information variables grow naturally according to Logistic. The combination of the logistic growth model and other infectious disease models helps to traverse the global positive solution of the model and find sufficient conditions for the existence and stability of the disease-free balance point and the endemic disease balance point. Establish an HIV infection model with treatment, complete logistic growth and delayed immune response, so that the researchers found that if the effects of reverse transcriptase inhibitors and protease inhibitors meet certain conditions, no infection balance point is the only stable within the feasible range. Status (Hao Jianling, Wang Hui, Hu Zhixing and Liao Fucheng, 2019). Shi Yuelian and Li Can (2019) studied a class of infectious disease dynamic models with logistic growth, latency delay, saturation incidence and disease recurrence, and discussed the local stability of the feasible equilibrium point. Zhang Juping, Li Kelu and Yang Junyuan (2020) extended the research to a two-strain infectious disease model with Logistic growth and superinfection, and discussed the existence and local stability of the equilibrium point.

Scholars out of China also use the Logistic growth model together with other infectious disease models. By constructing a suitable Lyapunov function, SI model, SEI model, and SIRS model with logistic growth characteristics, the existence and uniqueness of the positive solution traversal stable distribution of the model is proved (Jiamin Liu, Lijuan Chen, Fengying Wei, 2018; ZhongweiCao, WeiFeng, XiangdanWen, LiZu, 2019; SP Rajasekar, M. Pitchaimani, 2020; QunLiu, DaqingJiang, TasawarHayat, AhmedAlsaedi, Bashir Ahmad, 2020). By incorporating the non-linear incidence rate, saturated Holling type II cure rate, and logistic growth into the SIR infectious disease model, the researchers calculated the basic reproductive number of infectious diseases and revealed the regional stability conditions for their disappearance (Eric Avila-Vales, Ángel GC Pérez, 2019; Ángel GC Pérez, Eric Avila-Vales, Gerardo Emilio Garcí a-Almeida, 2019). Due to the threat of HIV to humans, the study of a random HIV-1 infection model with Logistic growth characteristics found that the sufficient conditions for the extinction of infected cells are the survival of uninfected cells, the death of infected cells, and the greatest reduction in CD4+T cell infection A good way is to improve the efficacy of antiretroviral therapy (Rachadawan Darlai, Elvin J Moore, 2017; Qun Liu, Daqing Jiang, Tasawar Hayat, Ahmed Alsaedi, 2020).

Combining the existing literature, due to its good mathematical characteristics, the Logistic growth model has high practical value in the researches of ecology, biology, infectious diseases, etc. Using it in combination with other infectious disease models

is one of the mainstream research methods in epidemiology recently. Because of its self-inhibition, the Logistic growth model will effectively capture the development trend of COVID-19 before the high infectivity of the new coronavirus is recognized.

## 3. Model and data

### 3.1 Model

Logistic growth model is often used to describe the continuous growth of the population of species in a limited environment with a S-shaped growth curve. The mathematical model is,

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right) = rN(1-\frac{N}{K}) \quad (1)$$

Here, $\frac{dN}{dt}$ is the population growth rate, N is the population size, t is the time, r is the instantaneous growth rate, K is the environmental capacity, $(1-\frac{N}{K})$ is the "remaining space" of the population development. Planck (1963) referred to r as the apparent infection rate. The main difference between this model and the exponential model is that the "remaining space" $(1-\frac{N}{K})$ as a correction factor is added to the right hand side of the equation, so that the model includes the environment's inhibitory effect on population growth.

Transform eq.(1), we can get

$$N = \frac{KN_0e^{rt}}{K+N_0(e^{rt}-1)} \quad (2)$$

Here, $N_0$ is the initial number of infections.

To divide the numerator and denominator on the right side of Eq.(2) by $N_0e^{rt}$, and let $\left(\frac{K}{N_0}-1\right)=e^{\alpha}$, we have,

$$N = \frac{K}{1+e^{\alpha-rt}} \quad (3)$$

In Eq. (3), α is a constant and e is a natural index.

Eq. (3) shows that the key to apply the Logistic growth model is to determine the parameters K, a, and r. Traditional fitting methods include three-point method (Pearl & Reed, 1920), average method (Andrewartha & Brich, 1954), four-point average method (Wang Zhenzhong, 1987), numerical method (Wu Xinyuan, 1990), and cubic design method (Pan Hui, 1992) ), genetic algorithm (Cai Yudong et al., 1993), improved simplex method (Wu Chengzhen, 1997), Levenberg-Marquardt method (Madsen, Nielsen & Tingleff, 2004), etc. In this paper, based on the data provided by Huang Chaolin et al (2020) and Gao Fu et al (2020), Gauss-Newton, Golub-Pereyra, and nl2sol algorithms are used for fitting to obtain the estimated values of parameters K, a, and r.

### 3.2 Data

The improper response to the epidemic of Wuhan City Hubei Province mainly occurred in the early stage of the epidemic. After the outbreak, relevant researchers published articles in Lancet (Huang Chaolin et al., 2020) and New England Journal of Medicine (NEJM) (Gao Fu et al., 2020), which provide detailed and reliable data for revealing the true situation at the beginning of the outbreak of COVID-19.

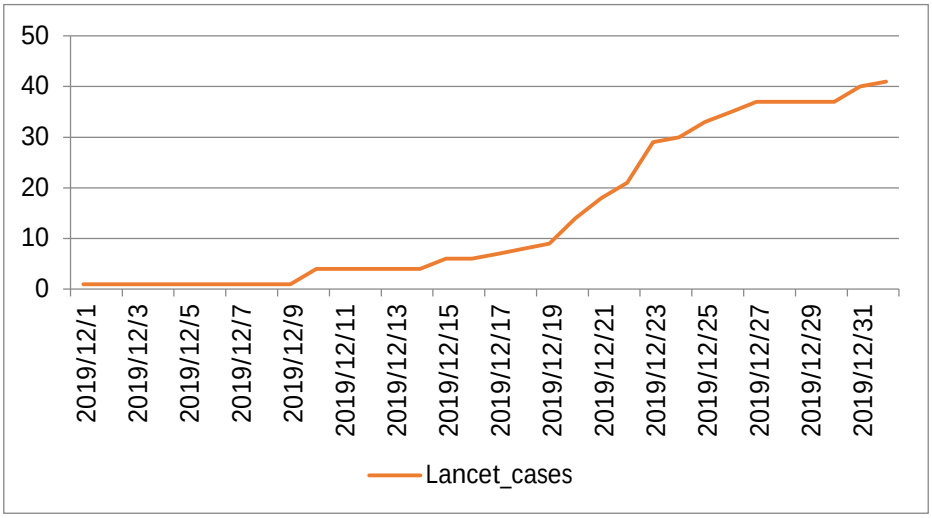


Fig. 1 the cumulative number of confirmed cases based on Lancet data

Although the cumulative time of the number of confirmed cases reported in the Lancet paper is relatively short and the smoothness of the initial development trend line of the COVID-19 outbreak is poor, Fig. 1 still clearly shows that up to January 1, 2020, the cumulative confirmed cases is approaching its logistic peak about 41 cases. As mentioned earlier, before the high infectivity of the new coronavirus is recognized, the logistic growth model is most likely the model researchers and decision makers used to predict COVID-19's future development trend. Once the logistic growth model is selected, it is difficult for decision makers to escape its trap in the face of the development trend line shown in Fig. 1, and decision errors may not be deliberate (Hua Sheng, 2020). A follow-up report from Caixin.com shows that the earliest confirmed date of the new coronavirus in Wuhan City, Hubei Province was December 27, 2019. The testing equipment and technology of the trustee instiurion are most likely from the West or even directly from the United States. Therefore, it is difficult for the Trump administration of the US to shift blame to China.

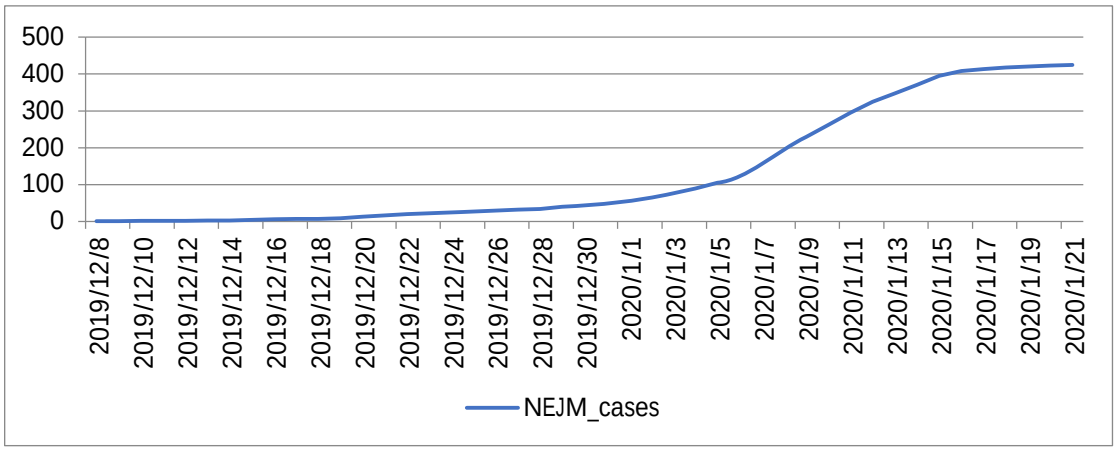


Fig. 2 the cumulative number of confirmed cases based on NEJM data

Compared with Fig. 1, Fig. 2 has a longer sample period and more cumulative confirmed cases. Its development trend line is smoother and more suitable for the Logistic growth model. It shows that the cumulative number of confirmed cases in Wuhan during the sample period Will soon stabilize in about 450 cases. However, the original data provided by NEJM shows that the daily number of newly additional cases received by the Chinese CDC has entered a double-digit growth since January 1, 2020, but between January 17 and January 21 It suddenly dropped to less than 5 cases per day, indicating that due to the tight schedule of publication of the paper, the sample reported by Gao Fu et al (2020) did not have incomplete data during the sample period. Similarly, for the cumulative number of confirmed cases on January 1, 2020, Huang Chaolin et al. (2020) reported 41 cases, while Gao Fu et al. (2020) reported 57 cases, indicating that due to the publication time of the paper, there also exists the problem of incomplete data in the sample period, which is purely a statistical problem with limited observation period rather than the problem of concealment of epidemic situation. But it is undeniable that compared with the sample of Huang Chaolin et al., the cumulative number of confirmed cases reported by Gao Fu et al. has more S-shaped development characteristics of the logistic growth model.

## 4. Empirical results and analysis

### 4.1 Estimation results of Logistic growth model

Although Huang Chaolin et al (2020) only provided 41 cumulative confirmed cases between December 1, 2019 and January 1, 2020, the Wuhan Jinyintan Hospital served by Huang Chaolin is a designated anti transmitting disease hospital in Hubei Province and Wuhan City. At the beginning of the epidemic, the hospital was the main designated hospital for centralized treatment of COVID-19 patients. It is reported that on December 29, 2019, Huang Chaolin and other doctors took a total of 7 patients from Gaohua Hospital and Tongji Hospital (Gao Yu, Peng Yanfeng , Yang Rui, etc., 2020) back to Jinyintan Hospital. On January 3, 2020, the Wuhan Municipal Health Commission reported that all cases are currently being treated in isolation in Wuhan medical institutions (Wuhan Municipal

Health Commission, 2020). Therefore, it can be considered that Huang Chaolin et al reported all known cases of COVID-19 up to January 1, 2020 in Wuhan. Of course, as of January 1, 2020, Huang Chaolin et al reported only 41 cases, while Gao Fu et al reported 57 cases. But as Gao Fu (2020) said, his paper is a retrospective analysis. With the deepening of understanding, many suspected cases may turn into confirmed cases, which is also consistent with the core idea of the Logistic growth model. Moreover, the submission date of Gao Fu et al's paper is January 27, 2020, which is later than the paper retrieval deadline of Huang Chaolin et al's paper subscribed on January 11, 2020. Based on this, it can be considered that the main basis for decision-making in Wuhan City, Hubei Province at the early stage of the epidemic was the data and related models used in the paper by Huang Chaolin et al. In order to strengthen the comparative analysis and highlight the applicability of the Logistic growth model to the initial data of the epidemic, this article simultaneously gives the estimation results based on NEJM data during the same period.

Table 1 Estimation results of the cumulative confirmed cases in Wuhan at the early stage

| Parameter | （Model_Lancet） | （Model_NEJM_fullset） | （Model_NEJM_subset） |
|---|---|---|---|
| K | 41.50944*** | 458.04488*** | 84.96489*** |
| | (35.030) | (54.214) | (6.456) |
| $N_0$ | 0.02754* | 0.7780** | 1.27813*** |
| | (1.979) | (3.025) | (4.726) |
| α | 7.31753*** | 8.68038*** | 4.181683*** |
| | (15.03) | (26.40) | (30.076) |
| r | 0.33968*** | 0.26340*** | 0.18759*** |
| | (13.551) | (23.759) | (11.058) |
| se | 1.662 | 11.12 | 1.954 |
| DF | 29 | 42 | 22 |
| RMSE | 2.888664 | 28.40709 | 0.952963 |
| MAE | 1.31989 | 8.785914 | 1.475162 |
| MAPE | 36.022% | 40.752% | 19.516% |
| period | 01/12/19-01/01/20 | 08/12/19-21/01/20 | 08/12/19-01/01/20 |

Table 1 shows that the estimation result of the Logistic model based on Lancet data is significantly better than the estimation based on NEJM full sample data. Although Lancet's sample is smaller, the judgment indicators of estimation based on its data are better than those based on NEJM full sample data. The Lancet-based model has a larger r and a smaller K, indicating that the initial development rate of COVID-19 is very fast, but the faster development speed and the smaller development space mean that the epidemic will soon reach the climax suggesting that there is no need to take more prevention and control measures that easily cause public panic. Therefore, when discussing the reasons for the erroneous decision-making in the early stage of the epidemic in Wuhan City, Hubei Province, lack of professional knowledge coupled with misleading models are to blame.

The third column of Table 1 shows the estimated results of the Logistic growth model based on NEJM sub-sample data (from December 8, 2019 to January 1, 2020). Although its sample period is only 25 days, which is 7 days shorter than Lancet's sample period, the model estimation results based on the criteria of RMSE, MAE and MAPE are better than the Lancet model. The estimation result based on the NEJM subsample has a smaller r and a larger K, indicating that the epidemic is far from peaking and will continue to last longer.

## 5. Robustness test

### 5.1 Logistic growth curve under multiple algorithms

Since a variety of algorithms can be used to fit the Logistic growth model, the robustness test should be carried out among these algorithms firstly. Table 2 shows the model fitting results under various algorithms based on Lancet data.

Table 2 Logistic growth model fitting results based on multiple algorithms

| parameters | Lancet_data （Gauss-Newton） | Lancet_data （Golub-Pereyra） | Lancet_data （nl2sol） |
|---|---|---|---|
| K | 41.50944*** | 41.50943*** | 4.151e+01 |
| | (t=35.030) | (t=35.030) | （t=0.000） |
| $N_0$ | 0.03866* | 0.03866* | 3.866e-02 |
| | (t=2.082) | (t=2.082) | (t=0.000) |
| α | 6.977939 | 6.977939 | 6.977938 |
| r | 0.33968*** | 0.33968*** | 3.397e-01*** |
| | (t=13.551) | (t=13.551) | (t=12.21) |
| se | 1.662 | 1.662 | 1.691 |
| DF | 29 | 29 | 29 |
| RMSE | 1.582096 | 1.582096 | 1.582096 |
| MAE | 1.31988 | 1.31954 | 1.31998 |
| MAPE | 36% | 36% | 36% |

Table 2 shows that the fitting results based on the three algorithms are almost the same, and the judgment indexes of the model are also almost the same. It can be seen from the perspective of algorithm, the Logistic growth model of the cumulative number of confirmed cases in the early stage in Wuhan City in this paper is very stable.

### 5.2 Comparative analysis of multiple fitting methods

For the fitting of population growth, in addition to the logistic growth model, there are also OLS models, exponential models and polynomial models.

Table 3 Identification of multi-model fitting results of Lancet data

| indexes | OLS model | Multinomial | Exponential | Logistic growth model |
|---|---|---|---|---|

| | | model | model | |
|---|---|---|---|---|
| RSME | 1.668223e-15 | 3.72897e-16 | 1.304534 | 2.888664 |
| MAE | 4.837782 | 1.520177 | 2.578786 | 1.31989 |
| MAPE | 1.599167 | 0.3570329 | 0.3988192 | 0.3602174 |

Table 3 shows that the judgment indicators of the linear model and the exponential model are both poor, indicating that the reliability of the estimation results is low. The decision index of the Logistic model or the polynomial model is ideal, but if the decision is based on the Logistic model or the polynomial model, the Wuhan Municipal Government of Hubei Province will inevitably make a mistake and make a slow response.

## 6. Conclusion and Enlightenment

Based on the data of cumulative confirmed cases of Wuhan City, Hubei Province at the early stage of the outbreak of COVID-19 provided by related articles of Lancet, the logistic growth model was used to fit the development trend of the cumulative number of confirmed cases of new coronary pneumonia in Wuhan City at the beginning of the outbreak. The cumulative number of confirmed cases will soon reach the top, without taking too many prevention and control measures. The model risk of decision-making based on the fitting result of the logistic growth model is one of the reasons for the decision-making mistakes and slow response of decision-makers in Wuhan City, Hubei Province in the early stage of the outbreak.

The Wuhan Municipal Government of Hubei Province may have known the high infectivity of the new coronavirus as early as December 27, 2019. As reported by Chaoling Huang et al. (2020), the estimated results of the Logistic Model as a sample of the cumulative number of confirmed cases as of January 1, 2020 show that if the decision is based on this model only, the model risk will make the decision maker It is difficult to avoid the trap of decision-making mistakes and slow response. According to the report by Gao Fu et al. (2020), the cumulative results of the Logistic growth model as of January 1, 2020, the sample shows that the new coronavirus is extremely infectious, and the epidemic will tend to Yu serious. It can be seen that accurate, timely and complete data in the early stage of the outbreak will help correct decision-making, but it is impossible for policy makers in the Wuhan Municipal Government of Hubei Province in the early stage of the outbreak to master the data, based on the earlier data, reported by Chaoling Huang et al. (2020) Data fits the Logistic growth model and makes decisions, and mistakes will be difficult to avoid.

Before the high infectivity of the new coronavirus was recognized, among the existing prediction models, the Logistic growth model had the best prediction effect, and decision makers were also most likely to make decisions based on it. Model risk may be the main reason for the decision-making mistakes and slow action of the Wuhan Municipal Government in Hubei Province. In the future, for diseases with unknown infectivity, multiple models should be used for initial prediction, and

multiple models should be weighted to build a compound disease prediction model to grasp the disease development trend earlier and more accurately.

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# Research on the Systemic Risk Spillover Effect of the Insurance Industry under the Impact of Asset-driven Business Model --Based on GARCH-Copula-CoVaR Model

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**Keywords:** asset-driven business model, risk spillover effects, GARCH-Copula-CoVaR model

**Abstract.** In the context of the marketization of insurance rates, asset-driven business

model emerges, and investment insurance products with strong substitutability are sought after, which has laid new hidden dangers for systemic risk infection in the insurance industry. In view of this, this paper studies the differences of systemic risk spillover effects between asset-driven and debt-driven business models, and makes an empirical analysis based on the GARCH-Copula-CoVaR model, which can better capture the risk characteristics of insurance institutions. The results show that: 1. Generally, asset-driven insurance companies have greater risk losses than debt-driven insurance companies. 2. Asset-driven insurance companies are more infectious to the risks of the insurance industry than debt-driven insurance companies, and are more susceptible to the risks of the insurance industry. 3. The risk contagion among insurance companies with the same business model is stronger, and the risk contagion among asset-driven insurance companies is greater than that among debt-driven insurance companies. The conclusion of this paper provides an empirical basis for preventing the systemic risk contagion of the insurance industry and improving the anti-risk ability of China's insurance industry, and is also conducive to further enriching the theoretical system of systemic risk of China's insurance industry.

## 1.引言

在保险业费率市场化的背景下，资产驱动型的商业模式涌现：一些新兴保险公司为了抢占市场，利用负债端理财型保险产品资金滞留期短、结算利率高的特点获得巨额现金流来支持资产端投资业务，又通过资产端激进的投资行为获得的高额投资回报来反哺负债端的给付需求。这种新型保险商业模式虽有利于短期内抢占市场份额、获得较大现金流，但也面临着较大潜在风险。一旦资本市场大环境持续下行，资产端难以获得高额投资回报甚至出现亏损，必将导致负债端高结算利率的承诺无法兑现，引发市场出现大量退保行为。而保险公司面临较大的流动性风险又将进一步影响资产端投资规模及投资回报，为保险业新的风险的爆发埋下了隐患。

关于保险业系统性风险溢出效应已有众多学者展开研究，但在这种新型保险商业模式下保险业系统性风险溢出效应鲜有学者探讨。鉴于此，本文主要研究资产驱动型和负债驱动型经营模式下保险业系统性风险溢出效应的不同之处。

在方法的选择上，由于传统测度金融变量风险损失的方法 VaR 模型仅限于衡量自身风险，难以衡量保险业系统性风险传染的强度。而 Adrian 和 Brunnermeier（2011）提出的条件在险价值（CoVaR）方法虽可以解决这一不足，但也存在难以捕捉到金融时间序列尖峰厚尾特征的问题。因此本文基于能更好捕捉保险机构风险特性的 GARCH-Copula-CoVaR 模型展开实证分析。

本文接下来的结构如下：第二部分为文献回顾；第三部分为研究假说；第四部分为 GARCH-Copula-CoVaR 理论模型；第五部分为实证过程及结果分析；最后总结并提出建议。

## 2.文献回顾

从近年来保险业发生的类似于“安邦接管”、“险资举牌”、“宝万之争”的热点事件中可以看到，保险业中涌现出了以“创新”为名、背离分散风险本质、实现滚雪球般资产迅速上涨的资产驱动型商业模式。众多学者以这一新型商业模式为出发点展开研究，一部分学者认为这是一种激进的经营模式，一方面，在负债端使得保险产品投资性增强；另一方面，在资产端可以短期获益，但容易产生连锁反应，风险可控性降低（李超，2014；田辉，2015；蔡静，2015 等）。而另一部分学者主张该种模式具有一定的积极意义，因其具有稳定的利差空间，可以大幅度提高投资收益，有利保险公司在市场竞争中迅速抢占市场份额，新兴保险公司可以通过这一模式将漫长的盈利周期缩短至 2-3 年，投资端的高收益也可以用于反哺负债端（梁薇薇，2015；曾于瑾，2016 等）。而苏泽瑞（2018）通过分析资产驱动商业模式代表安邦保险发现，该模式有利于新成立的小公司迅速抢占所剩不多的市场份额，形成较为稳定的资金支持，从而更好的扩展国际保险业务，保证保险公司在控制成本的同时实现利润最大化的目标。同时该模式也为自身及整个行业的长期稳健经营带来诸多不利影响：不仅可能遭遇较大的流动性风险影响自身偿付能力，还可能因背离“保险姓保”提供保障的基本职能整个保险业带来巨大的冲击。

而关于系统性风险的测度，学界早已广泛展开研究。由于简式模型法所需要的数据较易获得，同时具有一定的前瞻性，所以该方法得到学者们广泛的关注。尤具代表性的 CoVaR 方法是 Adrian 和 Brunnermeier(2011)基于美国金融机构间的传染机制首次提出的，该方法利用金融市场公开数据来研究金融机构间系统性风险溢出效应。随后，众多学者在 CoVaR 模型的基础上进行了完善与扩展，并运用到对各国金融机构或金融部门系统性风险溢出的测度上。我国学者林鸿灿等（2012）将 Adrian 研究中的 CoVaR 模型扩展为 AR-GARCH-CoVaR 模型并分析三家上市保险机构的风险溢出情况。沈悦等（2014）通过处理金融股票市场数据运用 GARCH-Copula-CoVaR 模型测度保险业对整体金融业的风险溢出效应。随后，徐华等（2016）结合分位数回归的 CoVaR 方法发现保险业系统性风险不仅表现出周期性特征，还与保险集团是否混业经营有关。王培辉（2017）运用时变 Copula-CoVaR 模型研究保险业系统性风险溢出效应，发现保险业内部及行业间存在明显的双向非对称的风险传染情况。韩浩等（2020）在 CoVaR 模型和分位数回归方法的基础上，通过对保险系上市公司、房地产等行业的股票数据通过进行实证分析，发现 2015 年股灾前后保险业系统性风险及对其他金融部门的影响。

综上所述，对于保险业资产驱动型商业模式的研究，学者大多集中于对该模式的内涵解读、案例分析、利弊分析以及其发展趋势预测上，对该模式冲击下保险业系统性风险变化情况的研究相当缺乏。而现有的系统性风险测度文献大多从整体上考虑保险业系统性风险溢出效应及其对金融相关行业的风险贡献度，并未以不同经营类型为出发点来研究选择不同经营方式的保险公司所带来的系统性风险及其传染强度。鉴于此，本文基于能更好捕捉保险机构风险特性的 GARCH-Copula-CoVaR 模型来探究资产驱动经营模式冲击下的视角保险业系统性风险溢出效应，本文以 2016—2020 年我国上市保险股为样本，通过实证拟分析如下问题：(1)不同经营模式保险公司对保险业系统性风险造成的影响是否不同？何者影响程度更大(2) 不同经营模式保险公司受全行业风险影响的程度是否不同？何者脆弱性更强？（3）保险公司之间的风险溢出效应有何区别？

## 3.研究假说

在传统的“负债驱动资产”模式下，保险公司以承保端业务为主要盈利点，并按照实际承保给付要求来合理配置相关资产。虽然这种模式很难实现公司的快速发展，但它能保证公司业务稳定与资金安全。而“资产驱动负债”模式恰恰相反，由于一些险企的投资行为受到单一股东利益及短期利益最大化目标的干扰，倒逼负债端保险业务的开展必须配合资产端投资的决策，导致一些险企隐藏了巨大的保单兑付压力。这一经营模式的实施是以现金流高增长和投资高回报为支撑的，当监管部门意识到相关风险并开始采取一系列限制风险聚集的措施后，可能导致保险公司流动性风险的产生。与此同时，如果资本市场不景气，保险公司资产负债匹配程度差，投资收益难以满足预定给付需求还可能引发退保潮。而此类商业模式在行业中被大量效仿，将会带来“示范效应”。如果规模较大的保险公司或者大批保险公司出现因资产驱动模式带来的重大的退保或投资亏损负面事件，可能导致整个保险业的流动性危机，不仅给行业监管和行业保障基金带来巨大压力，也使社会产生对保险业不信任与恐慌情绪，引发保险业系统性风险。基于以上分析，本文提出如下假说：

假说 1：资产驱动型保险公司比负债驱动型保险公司对保险业风险传染性更强。

假说 2：资产驱动型保险公司比负债驱动型保险公司更容易受保险业风险与变动的影响。

## 4.GARCH-Copula-CoVaR 理论模型

传统测度金融变量风险损失的 VaR 模型主要关注的是金融变量自身的风险损失，而 Adrian 和 Brunnermeier(2011)提出的 CoVaR 模型在此基础上扩展至测度金融变量系统性风险的传染性，即系统性风险溢出效应。

首先我们来看一下 VaR 模型：对于某种经营模式保险公司 i，它的 VaR 定义为在 1-q 的置信水平下面临的最大损失价值，具体表示为：

$$\Pr(X^i \le \mathrm{VaR}_q^i) = q \tag{1}$$

在此基础上，我们可以通过 CoVaR 模型来计算当某种经营模式保险公司 i 在 1-q 的置信水平下达到最大损失$\mathrm{VaR}_q^i$时，其他保险公司 j 面临的条件损失价值，具体表示为

$$\Pr\left(X^j \le \mathrm{CoVaR}_q^{j|i} \middle| X^i = \mathrm{VaR}_q^i\right) = q \tag{2}$$

由于 CoVaR 仅考虑了保险公司 i 损失分布的 q 分位数，难以充分捕捉到金融时间序列尖峰厚尾特征（王培辉，2017）。因此，本文优化 CoVaR 的含义，将其定义为：

$$\Pr\left(X^j \le \mathrm{CoVaR}_q^{j|i} \middle| X^i \le \mathrm{VaR}_q^i\right) = q \tag{3}$$

$$\frac{\Pr(X^j \le \mathrm{CoVaR}_q^{j|i}, X^i \le \mathrm{VaR}_q^i)}{\Pr(X^i \le \mathrm{VaR}_q^i)} = q \tag{4}$$

$$\Pr(X^j \le \mathrm{CoVaR}_q^{j|i}, X^i \le \mathrm{VaR}_q^i) = q^2 \tag{5}$$

根据 Sklar 定理，任何 n 维联合分布函数可分解为其边际分布函数和 Copula 函数（Sklar，1959）。即$C(u,v)=q^2$，其中$u=\Pr(X^i\le CoVaR_q^{j|i}),v=\Pr(X^i\le VaR_q^i)=$ q，C( , )为连接函数。若已知 q 和连接函数 C，可求 u，进而可得到$CoVaR_q^{j|i}$。具体模型选择如下：

1.选用 GARCH(1,1)-t 模型作为边际分布函数

本文选用 GARCH(1,1)-t 模型作为边际分布模型，拟合收益率的动态波动特征。GARCH 模型对误差的方差进行了进一步的建模，能够很好的反应金融时间序列普遍存在的波动从聚和尖峰厚尾的特征，具体形式为：

$$y_t=bx_t+e_t$$

$$e_t\sim t(k)$$

$$Var(e_t)=h_t=c+c_1e_{t-1}^2+c_2h_{t-1} \tag{7}$$

2.选用二元 t-Copula 函数作为连接函数

本文选取椭圆族 Copula 中较能表现金融数据厚尾性的二元 t-Copula 函数作为连接函数，拟合各保险公司间的相依结构，其定义如下：

$$C_{\rho,v}^t(u,v)=t_{\rho,v}\{t_v^{-1}(u),t_v^{-1}(v)\}=\int_{-\infty}^{t_v^{-1}(u)}\int_{-\infty}^{t_v^{-1}(v)}\frac{1}{2\pi\sqrt{1-\rho^2}}\left(1+\frac{s^2+t^2-2\rho\,st}{v(1-\rho^2)}\right)^{-\frac{v+2}{2}}dsdt \tag{8}$$

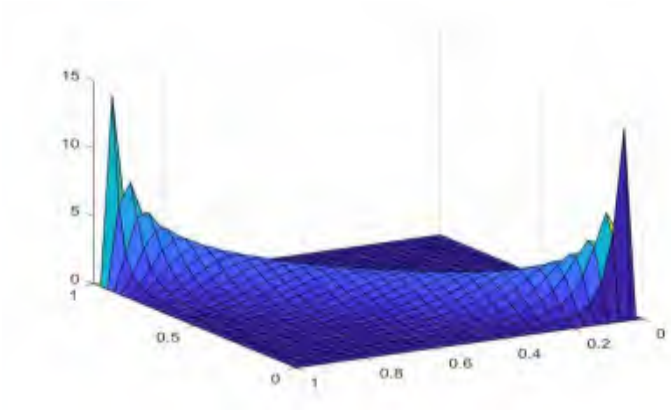



图 1 二元 t-Copula 密度函数模型图

又因为$CoVaR_q^{j|i}$同时包括了保险公司 j 自身风险损失和保险公司 j 在保险公司 i 发生最大风险损失时的溢出风险，所以我们可以通过以下公式来得到保险公司 j 的系统性风险溢出效应：

$$\Delta CoVaR_q^{j|i}=CoVaR_q^{j|i}\text{-}VaR_q^i \tag{9}$$

同时由于不同保险公司的 VaR 也存在较大差异，所以我们可以将$\Delta CoVaR_q^{j|i}$进一步标准化，更准确的反映保险公司 i 发生最大损失时对保险公司 j 的系统性风险溢出强度，计算公式为：

$$\%CoVaR_q^{j|i}=\Delta CoVaR_q^{j|i}/VaR_q^i\times 100\% \tag{10}$$

通过以上计算，我们可以得到不同经营模式保险公司的$VaR_q^i$、$CoVaR_q^{j|i}$、$\Delta CoVaR_q^{j|i}$以及$\%CoVaR_q^{j|i}$，其中$\Delta CoVaR_q^{j|i}$和$\%CoVaR_q^{j|i}$分别代表了保险公司风险的真实贡献度及相对贡献度，可以借此来做一个全面的分析，保证风险溢出效应测量的有效性和准确性。

## 5.实证过程及结果分析

### 5.1 样本选择与模式判别

由于实证分析需要用到金融市场股价数据，所以必须在已上市公司中进行选择。本文根据保险业所公认的六大保险概念股确定中国人寿、中国平安、中国太保、新华保险、控股国华人寿的天茂集团和控股天安财险的西水股份为本研究样本。其中选择天茂集团的原因有二：一是天茂集团对国华人寿持股比例高达51%，二是天茂集团将旗下产业转让出清。结合以上两点信息，我们可以确定天茂集团主营业务为国华人寿的保险业务。选择西水股份作为保险公司代表的原因与天茂集团类似：西水股份在2015年底实现天安财险50.87%的股权控制，并且已将其原有的业务全部剥离。因此可以说，天茂集团和西水股份的股价变动情况可以代表国华人寿和天安财险的经营情况。

由于本研究是基于资产驱动与负债驱动两种不同经营模式展开的系统性风险溢出效应分析，因此，首先需要判别以上六家保险公司所属经营模式。

在上述所涉及到的六家保险公司中，只有天安财险仅属于财险公司。本文选择从财险公司业务结构方面进行考量，即不同经营模式保险公司投资型保险产品的占比不同，选用投资账户占比来表示：保户储金及投资款/规模保费，其中规模保费=原保费收入+保户储金及投资款。

表1 天安财险投资账户占比情况

| 年份 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|
| 保护储金及投资款 | 2.30 | 25925.93 | 126699.37 | 247481.69 | 170249.67 | 56635.18 | 1876.73 |
| 保险业务收入 | 9957.35 | 11162.63 | 12905.91 | 13898.20 | 14224.47 | 15146.79 | 15632.05 |
| 投资账户占比 | 0.02% | 69.90% | 90.76% | 94.68% | 92.29% | 78.90% | 10.72% |

由表1可知，天安财险自2014年以来，就选择资产驱动负债的模式进行发展，投资账户占比最高达到94.68%，通过历年年报披露的数据了解到，天安财险除了2014年排名仅次于安邦（95.90%），2015-2018年投资账户占比皆位居第一，是业内公认的资产驱动型保险公司代表。

而由于其余五家保险公司均皆属于或拥有寿险公司，本文从两方面进行考量：第一，与财险公司考量方向相同的业务结构方面，即投资账户占比；第二，利润来源结构方面：不同经营模式保险公司投资获益占比不同，选用投资收益占比来表示，即投资收益/营业收入。本文选取的是投资账户占比和投资收益占比两项指标，采用熵权法进行信息综合。

熵权法是一种客观赋值方法，一般步骤如下：

（1）构建评估矩阵R，并分别计算两项指标的比重$p_{ij}$（i为寿险公司个数，j为

指标个数），计算公式为$p_{ij}=\frac{R_{ij}}{\sum_{i=1}^{m}R_{ij}}$；（2）分别计算两项指标的熵值$E_j$，计算公式为$E_j=-\frac{1}{\ln m}\sum_{i=1}^{m}P_{ij}\times\ln p_{ij}$（m为寿险公司总个数）；（3）计算变异系数$V_j$，计算公式为$V_j=1-E_j$；（4）计算第j个指标在综合评价指标中的权重$W_j$，计算公式为$W_j=\frac{V_j}{\sum_{j=1}^{n}V_j}$（n为指标总个数）；第五步，计算第i家寿险公司综合评价指数$Ent_i$，计算公式为$Ent_i=\sum_{j=1}^{n}W_j\times P_{ij}$。$Ent_i$越大，表示第i家公司资产驱动程度越大。

按照此种方法，本文综合 2013-2019 年 55 家寿险公司数据分析，列出了熵权值大于 30%的前 19 家寿险公司经营模式熵权值和排名情况，如表 2 所示。基本涵盖了业界所公认的被列为资产驱动型经营模式的寿险公司，例如东吴、前海、华夏、恒大等（由于安邦 2018 年被接管后数据暂停披露，因此未纳入统计范畴）。其他 36 家则视为负债驱动型寿险公司。由此可知，国华人寿属于资产驱动型保险公司，中国人寿、中国平安、中国太保、新华保险皆属于负债驱动型保险公司。

表 2 2013-2019 前 19 家寿险公司经营模式熵权值平均值及排名

| 公司 | 珠江人寿 | 瑞泰人寿 | 华夏人寿 | 复星保德信 | 君康人寿 | 前海人寿 | 东吴人寿 | 中融人寿 | 英大人寿 | 光大永明 |
|---|---|---|---|---|---|---|---|---|---|---|
| 熵权值 | 0.69 | 0.62 | 0.54 | 0.51 | 0.5 | 0.49 | 0.48 | 0.47 | 0.45 | 0.44 |
| 公司 | 吉祥人寿 | 国华人寿 | 恒大人寿 | 信泰人寿 | 富德生命 | 天安人寿 | 长城人寿 | 中银三星 | 幸福人寿 | 行业均值 |
| 熵权值 | 0.41 | 0.4 | 0.4 | 0.39 | 0.38 | 0.35 | 0.31 | 0.31 | 0.3 | 0.28 |

## 5.2 数据选取与处理

基于上文分析，本研究选择上述 6 家保险机构（或控股险企的非保险机构）作为保险公司样本，并以保险指数作为保险行业样本，数据来源于 WIND 数据库，数据处理使用 Stata 与 Matlab 来完成。考虑到天茂集团直到 2016 年 4 月才实现国华人寿 51%的控股，而天安财险于 2020 年 7 月中旬被银保监会实施接管，西水股份都股价变动情况不再能代表天安财险的经营情况。故本文选取 2016 年 4 月 1 日至 2020 年 6 月 31 日间各指标的日收盘数据作为样本数据，通过取对数一阶差分并乘以 100 来计算每日百分比收益率$R_t$，即$R_t=100\times\ln\left(\frac{p_t}{p_{t-1}}\right)$，其中$p_t$表示第 t 日的收盘价。

## 5.3 描述性统计

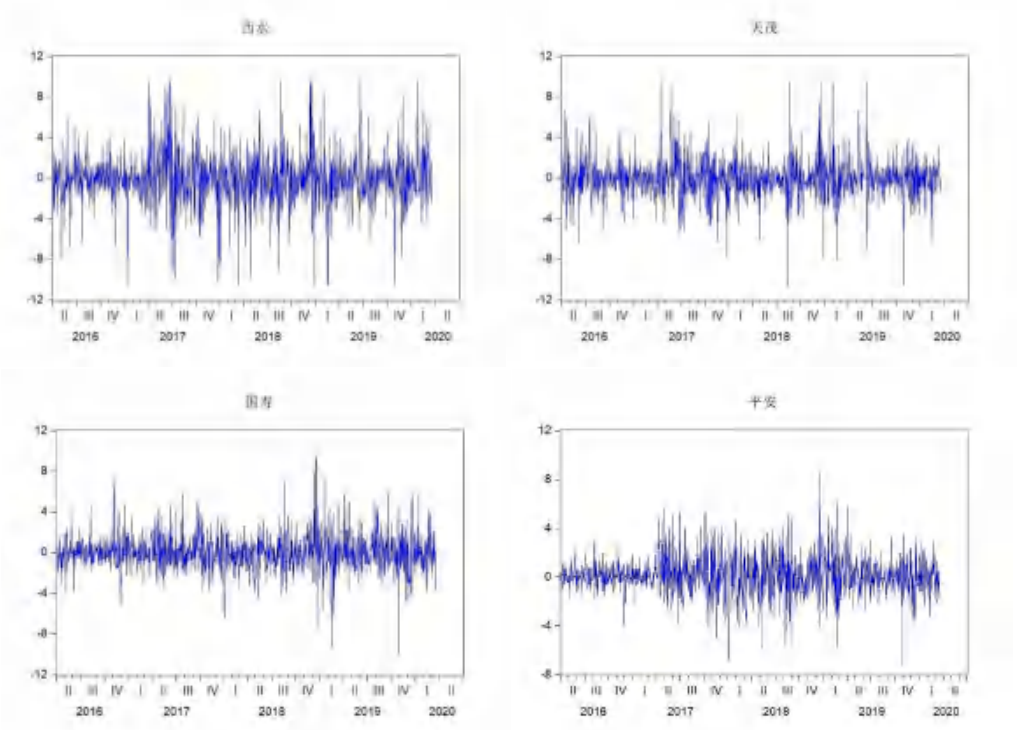
表 3 各股票日百分比收益率序列描述性统计

| | 均值 | 最大值 | 最小值 | 标准差 | 偏度 | 峰度 | J-B 统计量 | P 值 |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 西水 | -0.099 | 9.590 | -10.560 | 2.766 | -0.089 | 5.651 | 303.898 | 0.000 |
| 天茂 | -0.038 | 9.600 | -10.610 | 2.090 | 0.202 | 7.040 | 709.387 | 0.000 |
| 国寿 | 0.018 | 9.540 | -10.010 | 1.880 | 0.240 | 6.423 | 514.326 | 0.000 |
| 平安 | 0.089 | 8.550 | -7.180 | 1.641 | 0.132 | 5.370 | 244.809 | 0.000 |
| 太保 | 0.018 | 9.560 | -9.170 | 1.909 | 0.072 | 5.096 | 189.897 | 0.000 |
| 新华 | 0.012 | 9.540 | -9.640 | 2.107 | 0.204 | 5.667 | 313.408 | 0.000 |
| 保险业 | 0.070 | 8.770 | -7.660 | 1.612 | 0.087 | 5.563 | 284.023 | 0.000 |

各股票日百分比收益率序列描述性统计见表 3。由表 3 可以看出各收益率序列的均值都在 0 附近，偏差不超过 0.1；相对而言，资产驱动型代表的西水股份与天茂集团的收益率序列最大值与最小值都表现为全样本的最大与最小值，浮动范围更大；且所有的保险公司样本收益率序列都呈现出一定的左边或右偏，其中绝大多数收益率序列表现出一定的右偏，只有西水股份的收益率序列表现为左偏；而全部样本的峰度值都远远超过 5，符合大部分金融时间序列的“尖峰厚尾”的特征；在 JB 检验中可以看到，p=0.01 显著性水平下，JB 的统计值都超过了一百多，有的高达 700 多，且 p 值均显著。这说明各保险公司收益率序列不服从正态分布，下文将继续展开探讨。

与此同时，本文描绘各保险收益率序列时间变化图如下，以便更为清晰的观察各自收益率序列的特征。



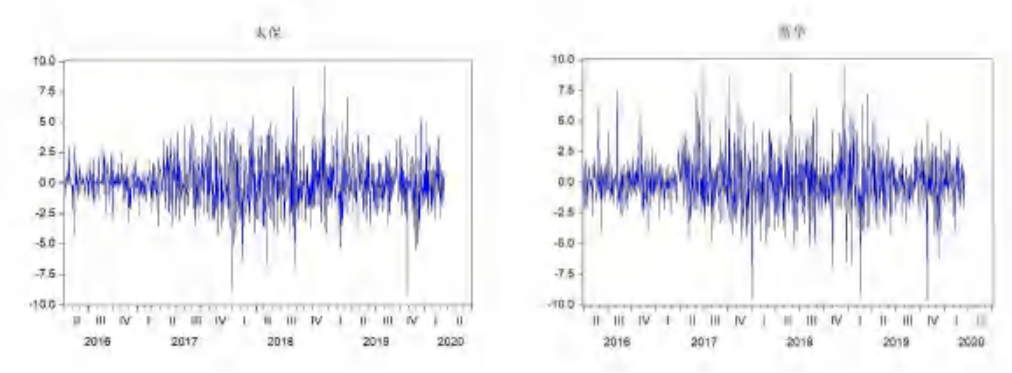


图 2 各保险股票收益率时序图

由图 2 可以看出各保险股票收益率在不同时间段有明显的波动集聚和协动趋势，其中西水股份与天茂集团间的协动性较其他四家负债驱动型保险公司的协同性更为明显，这可能意味着资产驱动型保险公司间的风险传染力更强，较其他公司更相互依赖。另外，资产驱动型保险公司波动幅度明显大于负债驱动型保险公司，这可能意味着资产驱动型保险公司更易受外在风险的影响，这一现象也与前文所提出的假说相符。

## 5.4 溢出风险价值的计算

本文基于沈悦等（2014）所引入的基于 GARCH-Copula 的 CoVaR 测算方法来度量六家保险公司之间、保险公司与保险业之间的风险溢出效应。

（1）VaR 的测算

根据对表 3 的分析，保险公司间存在明显的波动从聚现象，且与保险公司经营模式存在一定关联，并且各保险公司收益率序列均不服从正态分布，所以不能选择适用于拟合正态分布的传统 GARCH 模型。为此，本文选择能够很好的反应保险公司收益率时间序列特征的 GARCH(1,1)-t 模型进行拟合，进而计算保险公司系统性风险溢出情况。

具体做法是：首先，通过时序图粗略判断，各股票收益率序列均随时间在 0 值上下变化，且平均值都在(-0.2,0.1)，满足平稳时间序列的基本要求。在此基础上，对各保险股票、保险指数收益率序列进行 ADF 检验，结果如表 4 所示。

表 4 收益率序列 ADF 检验结果

| | 西水 | 天茂 | 国寿 | 平安 | 太保 | 新华 | 保险业 |
|---|---|---|---|---|---|---|---|
| t 统计量 | -30.174 | -32.725 | -32.413 | -31.952 | -30.676 | -31.393 | -31.846 |
| P 值 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

从表 4 可以看出，t 统计量都在-30 以下，远低于 1%显著水平下临界值-3.430，各股票收益率序列是平稳的，因此可以直接建立 GARCH(1,1)-t 模型描述各保险公司股票、保险业指数收益率的边际分布。

基于以上分析，利用 GARCH(1,1)-t 对各保险公司和保险业收益率进行建模，得到模型自由度和残差序列，已知自由度和置信水平，按照公式(1)可求得 VaR。表 5 展示的是在 95%置信水平下各保险公司及保险业 VaR 计算结果。

表 5 各保险公司及保险业 VaR 计算结果

| | 西水 | 天茂 | 国寿 | 平安 | 太保 | 新华 | 保险业 |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| VaR | -2.151 | -2.208 | -2.067 | -2.200 | -2.017 | -2.068 | -2.137 |

由表 5 可知，各保险公司自身可能面临的最大风险损失排名：天茂>平安>西水>新华>国寿>太保。由于西水、天茂为资产驱动型代表，国寿、平安、太保、新华为负债驱动型代表，所以综合来看，一般情况下，资产驱动型保险公司比负债驱动型保险公司的自身风险损失更大。具体分析如下：

根据 2019 年 11 月国际保险监督官协会(IAIS)发布《保险业系统性风险整体框架》了解到，流动性风险、关联风险以及替代性风险是保险业系统性风险的主要来源。1、流动性风险。流动性风险存在于每一家保险公司中，而保险公司经营业务的好坏直接决定了其流动性风险的大小。负债驱动型保险公司由于其利润更多是依靠承保端稳定的收入，并且会根据承保端的实际情况合理安排资产端的投资选择与投资水平，更好的做到资产负债相匹配，因此负债驱动型保险公司拥有更为稳定的现金流保证其拥有足够的偿付能力。而资产驱动型保险公司主要通过销售高结算利率的理财型保险产品来获得大量现金流，并将这部分资金通过期限错配方式用于投资回报率较高但流动性较差且周期长的相关投资产品，这种通过流动性负债匹配非流动性资产方式使其面临较高的流动性风险。2、关联风险。即保险公司与实体经济或其他金融子行业之间的相关程度，类似于资本市场不景气、交易对手违约等情况都会给保险公司带来这种风险。关联程度主要表现在保险资金运用的深度与广度上，资产驱动型经营模式的突出特点之一便在于其保险资金运用上，债权投资、信托计划、不动产投资、股权投资等都有涉及，与实体经济和其他金融部门之间关联性较强，因此当外界环境波动时，资产驱动型保险公司更易面临较大的风险损失。其中天安财险被银保监会安排接管的主要原因也是因其所持有的资产到期后交易对手违约引发巨额亏损造成的。3、替代性风险。一般而言，一家新兴保险公司按照传统的负债驱动模式经营，从开业到盈利则至少需要八年之久，所以很多保险公司为了缩短成本回收期，选择通过资产驱动经营模式来迅速抢占市场份额、扩大投资承保规模，虽有一定积极影响但由于利益最大化的驱逐其业务的替代性也更强。而坚持走负债驱动型的公司大多为根基深厚、久经考验、规模较大的保险公司，比如以上四家上市保险公司，其市场份额久居前列，难以轻易替代。

在以上三点分析的基础上，再来探究一下中国平安自身可能面临的最大风险损失大于西水股份的原因，主要表现在两个方面：一是中国平安由于较早将业务拓展至金融、银行、投资等领域，经营业务范围广泛使其风险范围更大，同时导致其与实体经济或其他金融部门之间的依赖程度更高，即面临的关联风险更强。二是中国平安国内第一的市场规模和全球活跃性也起到了放大风险的作用。

（2）CoVaR 的测算

在进行 Copula 函数拟合各保险公司间的相依结构之前，我们先通过相关系数矩阵直观了解保险公司之间、保险公司与保险业间的关系，见下表。

表 6 各保险公司及保险业收益率序列相关系数矩阵

| 相关系数 | 西水 | 天茂 | 国寿 | 平安 | 太保 | 新华 | 保险业 |
|---|---|---|---|---|---|---|---|
| 西水 | 1.000 | | | | | | |
| 天茂 | 0.682 | 1.000 | | | | | |
| 国寿 | 0.481 | 0.508 | 1.000 | | | | |
| 平安 | 0.487 | 0.484 | 0.727 | 1.000 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 太保 | 0.442 | 0.424 | 0.737 | 0.790 | 1.000 | | |
| 新华 | 0.524 | 0.501 | 0.764 | 0.760 | 0.781 | 1.000 | |
| 保险业 | 0.526 | 0.518 | 0.787 | 0.988 | 0.860 | 0.820 | 1.000 |

从表 6 可以看出，负债驱动型保险公司之间的相关系数介于 0.7-0.8 之间，资产驱动型保险公司之间的相关系数介于 0.6-0.7 之间，明显大于资产驱动型保险公司与负债驱动型保险公司之间 0.4-0.6 的相关系数。这说明，同一经营模式的保险公司之间相关性更强，且负债驱动型保险公司之间的相关性要强于资产驱动型保险公司之间的相关性。主要原因在于：同一经营模式的保险公司资金运用的方向、主要利润来源、产品种类及占比更为相似，且资产驱动型保险公司经营模式更为创新，各自公司资金运用选择面更广，所以同类相关性不如负债驱动模式。另外，从表中可以观察到，负债驱动型保险公司与保险业的相关性较资产驱动型保险公司更强，这是因为负债驱动型保险公司在保险市场上占有绝对的市场份额，而资产驱动型保险公司数量较少且大多为中小型保险公司。

接下来利用 GARCH(1,1)-t 模型拟合得到的残差序列，通过椭圆族 Copula 中较能表现金融数据厚尾性的二元 t-Copula 函数作为连接函数，拟合各保险公司间的相依结构，并按照第四节理论模型中的算法求出 95%置信水平下各保险公司间、保险公司与保险业间的 CoVaR。结果如下：

表 7 各保险公司、保险业的 CoVaR 结果

| CoVaR | 西水 | 天茂 | 国寿 | 平安 | 太保 | 新华 | 保险业 |
|---|---|---|---|---|---|---|---|
| 西水 | —— | -3.783 | -3.158 | -3.581 | -2.998 | -3.213 | -3.445 |
| 天茂 | -3.608 | —— | -3.216 | -3.617 | -3.003 | -3.236 | -3.445 |
| 国寿 | -3.378 | -3.604 | —— | -3.791 | -3.253 | -3.317 | -3.536 |
| 平安 | -3.445 | -3.641 | -3.384 | —— | -3.331 | -3.363 | -2.511 |
| 太保 | -3.336 | -3.492 | -3.402 | -3.924 | —— | -3.293 | -3.612 |
| 新华 | -3.436 | -3.624 | -3.313 | -3.760 | -3.151 | —— | -3.473 |
| 保险业 | -3.484 | -3.648 | -3.331 | -2.600 | -3.249 | -3.279 | —— |

CoVaR 衡量的是在某家保险公司发生最大可能风险损失时，另一家保险公司所面临的风险损失，不仅考虑了单个保险公司的风险损失，还包含了其他保险公司带来的风险溢出效应。从表 7 可以看出，每家公司的 CoVaR 值都十分接近，但相对于各自的 VaR 来说彼此间差距明显增大。为了进一步衡量保险公司的风险溢出效应，我们按照上文所提到的公式$\Delta CoVaR_q^{j|i} = CoVaR_q^{j|i} - VaR_q^i$扣除保险公司面临的无条件风险损失进行计算。结果如下：

表 8 各保险公司、保险业的△CoVaR 结果

| △CoVaR | 西水 | 天茂 | 国寿 | 平安 | 太保 | 新华 | 保险业 |
|---|---|---|---|---|---|---|---|
| 西水→ | —— | -1.575 | -1.092 | -1.381 | -0.981 | -1.145 | -1.308 |
| 天茂→ | -1.457 | —— | -1.149 | -1.417 | -0.987 | -1.167 | -1.308 |
| 国寿→ | -1.227 | -1.396 | —— | -1.592 | -1.236 | -1.249 | -1.399 |
| 平安→ | -1.294 | -1.433 | -1.317 | —— | -1.314 | -1.295 | -0.374 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 太保→ | -1.185 | -1.284 | -1.335 | -1.724 | —— | -1.225 | -1.475 |
| 新华→ | -1.285 | -1.416 | -1.246 | -1.561 | -1.134 | —— | -1.336 |
| 保险业→ | -1.333 | -1.440 | -1.264 | -0.401 | -1.232 | -1.211 | —— |

从表 8 可以看出，当资产驱动型保险公司发生最大可能损失时，其他资产驱动型保险公司的风险溢出效应平均大于其他负债驱动型保险公司的风险溢出效应；当负债驱动型保险公司发生最大可能损失时，其他负债驱动型保险公司的风险溢出效应平均大于其他资产驱动型保险公司的风险溢出效应。这说明同类经营模式的保险公司间风险传染性更强。与此同时，我们发现保险业发生最大可能损失时，资产驱动型保险公司更容易受其风险影响，抵抗能力更低。为了更科学的观察结果，本文对△CoVaR 标准化进行无量纲化处理，计算过程为$\%CoVaR_q^{j|i} = \Delta CoVaR_q^{j|i}/VaR_q^i \times 100\%$同时按照不同保险经营类型求取均值展开分析。如表 9、表 10 所示。

表 9 各保险公司、保险业的%CoVaR 结果

| %CoVaR | 西水 | 天茂 | 国寿 | 平安 | 太保 | 新华 | 保险业 |
|---|---|---|---|---|---|---|---|
| 西水→ | —— | 0.714 | 0.528 | 0.628 | 0.486 | 0.553 | 0.612 |
| 天茂→ | 0.677 | —— | 0.556 | 0.644 | 0.489 | 0.564 | 0.612 |
| 国寿→ | 0.570 | 0.632 | —— | 0.724 | 0.613 | 0.604 | 0.655 |
| 平安→ | 0.602 | 0.649 | 0.637 | —— | 0.652 | 0.626 | 0.175 |
| 太保→ | 0.551 | 0.582 | 0.646 | 0.784 | —— | 0.592 | 0.690 |
| 新华→ | 0.598 | 0.641 | 0.603 | 0.710 | 0.562 | —— | 0.625 |
| 保险业→ | 0.620 | 0.652 | 0.611 | 0.182 | 0.611 | 0.586 | —— |

表 10 不同经营模式保险公司%CoVaR 结果

| %CoVaR | 资产驱动型 | 负债驱动型 | 保险业 |
|---|---|---|---|
| 资产驱动型→ | 0.695 | 0.556 | 0.612 |
| 负债驱动型→ | 0.603 | 0.646 | 0.536 |
| 保险业→ | 0.636 | 0.498 | —— |

由上表可以看出研究结论与前文假说一致：1、资产驱动型保险公司比负债驱动型保险公司对保险行业的风险传染性更强，且更容易受保险行业风险影响。2、同种经营模式保险公司间风险传染性更强，且资产驱动型保险公司间的风险传染性大于负债驱动型保险公司间的风险传染性。具体表现如图 3 所示，保险公司间风险溢出效应：资产驱动型→资产驱动型>负债驱动型→负债驱动型>负债驱动型→资产驱动型>资产驱动型→负债驱动型。分析如下：

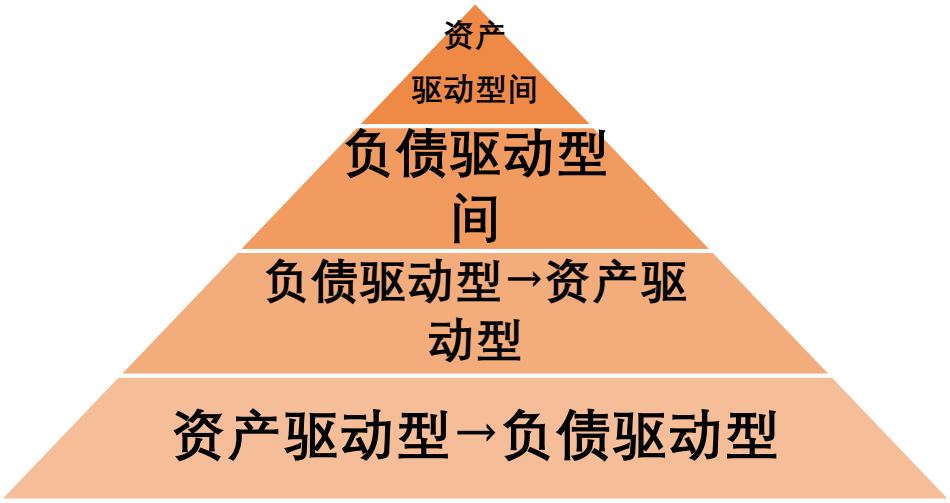



图 3 保险公司间风险溢出效应（从下往上风险溢出效应依次增大）

在前文分析的基础上我们了解到传统的“负债驱动资产”模式通常根据承保情况来合理配置资产，能较好的保证公司业务稳定与资金安全。而资产驱动型保险公司主要通过销售高结算利率的理财型保险产品来获得大量现金流，并将这部分资金通过期限错配方式用于投资回报率较高但流动性较差且周期长的产品。如果规模较大的保险公司或者大批保险公司出现因资产驱动模式带来的重大的退保或投资亏损负面事件，可能导致整个保险业的流动性危机。保险公司一旦投资失败偿付能力不足引发破产、接管，又不仅给行业监管和行业保障基金带来巨大压力，还使社会对保险行业信心不足，从而可能引发退保潮或抛售手中的保险股，进而对保险行业的系统性风险产生影响。因此，资产驱动型保险公司比负债驱动型保险公司对保险行业的风险传染性更强。

当全行业面临较大风险时（如市场下行、政策影响、金融危机），保险监管部门为了维持行业正常有序经营，开始采取相应的管制措施，这些管制措施可能导致保险公司在产品端限定最高结算利率、在成本端减少佣金比例或者在资产端控制投资激进行为，使得保险公司承保业务减少、从业人员积极性下降以及市场份额扩大受限。相对于负债驱动型保险公司而言，资产驱动型保险公司受业务失速影响更大。主要原因在于其高成本负债战略的实施，主要靠承保端高增长维持的，而业务失速将直接引发其流动性风险，当面临较大的流动性风险又将进一步影响其资产端投资规模及投资回报。因此，资产驱动型保险公司比负债驱动型保险公司更容易受保险行业风险影响。

一般而言，一旦某保险公司因破产需要进行资产清算并大规模出售资产时，资产价格就会下降，而其他同样持有该类资产的保险公司将面临经济损失；与之相似的情况，一旦某保险公司企图走薄利多销的道路，其他销售相关产品的保险公司为了争夺市场份额也随之降低产品价格，这将导致其他保险公司因承保亏损面临偿付能力不足的风险。又由于同种经营模式的保险公司资金运用的方向、主要利润来源、产品种类及占比更为相似，因此，同种经营模式保险公司间风险传染性更强。在此基础上，相对于负债驱动型保险公司而言，由于资产驱动型保险公司选择的投资产品大多为高风险高收益类别且公司销售的保险产品主要以高结算利率的理财型产品为主，一旦资产价格下降或进一步压低产品价格将带来更大的投资亏损与承保亏损。所以资产驱动型保险公司间的风险传染性大于负债驱

动型保险公司间的风险传染性。

## 6.结论与启示

在保险业费率市场化的背景下，资产驱动型的商业模式涌现，替代性较强的投资型保险产品受到追捧，为保险业系统性风险传染埋下了新的隐患。本研究选用我国四家保险上市公司与两家保险控股公司作为样本，判别其经营模式，应用2016年4月1日至2020年6月31日六家保险公司（或控股公司）的每日收盘股价及保险指数数据，基于能更好捕捉保险机构风险特性的GARCH-Copula-CoVaR模型，探究资产驱动经营模式冲击下保险业系统性风险溢出效应。研究结果表明：1.一般情况下，资产驱动型保险公司比负债驱动型保险公司的自身风险损失更大。2.资产驱动型保险公司比负债驱动型保险公司对保险行业的风险传染性更强，且更容易受保险行业风险影响。3.同种经营模式保险公司间风险传染性更强，且资产驱动型保险公司间的风险传染性大于负债驱动型保险公司间的风险传染性。

以上结论的启示是：在当前保险业的竞争格局下，类似于安邦、天安这类资产驱动型保险公司的脆弱性相对更高，对保险业风险损失影响更强。一方面其自身应该在合理把握实体经济环境的条件下做出较为稳健投资计划，时刻关注自身流动性风险与关联风险，根据实际规模及时调整自身投资布局，进而完善自己的风险管理评估体系。另一方面监管当局对其进行事后管控固然重要，但事前预警更是必不可少。需严密关注其业务的稳健性，尽快建立一套完备的风险预警体系，及时有效的进行风险评估并提出相应的改进措施，防范资产负债不匹配风险继续扩大，防止保险公司因经营不善导致重大财务损失甚至破产清算，进而遏制对保险行业的系统性风险产生影响的可能性。

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# 资产驱动型经营模式冲击下保险业系统性风险溢出效应研究——基于GARCH-Copula-CoVaR模型

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**关键词:**资产驱动型经营模式，风险溢出效应，GARCH-Copula-CoVaR模型

**中文摘要.**在保险业费率市场化的背景下，资产驱动型的商业模式涌现，替代性较强的投资型保险产品受到追捧，为保险业系统性风险传染埋下了新的隐患。鉴于此，本文着手研究资产驱动型和负债驱动型两种经营模式下保险业系统性风险溢出效应的不同之处，基于能更好捕捉保险机构风险特性的GARCH-Copula-CoVaR模型进行实证分析，研究结果表明：1.一般情况下，资产驱动型保险公司比负债驱动型保险公司的自身风险损失更大。2.资产驱动型保险公司比负债驱动型保险公司对保险行业的风险传染性更强，且更容易受保险行业风险影响。3.同种经营模式保险公司间风险传染性更强，且资产驱动型保险公司间的风险传染性大于负债驱动型保险公司间的风险传染性。本文结论为防范保险业系统性风险传染，提高中国保险业的抗风险能力提供实证依据，也有利于进一步丰富我国保险业系统性风险的理论体系。

# Analysis of the Impact of Monetary Policy on Stock Market Volatility

## —Based on the GARCH-MIDAS Model

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**Keywords:** Monetary policy; Stock market volatility; GARCH-MIDAS model; DM test

**Abstract:** Although the research on the relationship between monetary policy and stock market has been sufficient, most of the research is based on the traditional low-frequency VAR model, and does not make full use of the rich information in financial high-frequency data. On this basis, this paper fuses high-frequency stock data with low-frequency monetary policy data, constructs GARCH-MIDAS model to study the impact of China's monetary policy on stock market volatility, Using the monthly data of monetary policy from January 2001 to December 2020 and the daily rate of return of stock market as research data, this paper examines the long-term and short-term effects of monetary policy on stock market from two dimensions: level value and volatility. On the basis of establishing a single-factor GARCH-MIDAS

model based on various monetary policy variables, a two-factor GARCH-MIDAS model is further constructed, and the loss function and DM test are used to measure the out-of-sample prediction efficiency of the model. In-sample estimation results indicate that the monetary policy variables have a significant short-term impact on stock market volatility, the monthly realized volatility has a long-term negative impact on stock market volatility, while the money supply level and volatility have a long-term positive impact on stock market volatility, and the impact of monetary policy volatility is significantly greater than the level value. Interest rate factors have some impact on the long-term part of the stock market fluctuations, but they are not significant.The estimation results of the two-factor GARCH-MIDAS model constructed by adding monetary policy variables to the GARCH-MIDAS model based on realized volatility show that the two-factor GARCH-MIDAS model can describe the long-term volatility components of stock market more effectively. The results of out-of-sample prediction show that adding monetary policy variables to GARCH-MIDAS model can not only analyze the long-term impact of different monetary policies on stock market volatility, but also improve the accuracy of volatility prediction. Especially, GARCH-MIDAS model, which considers both realized volatility and money supply volatility, not only has the smallest loss function value, but also passes DM test, and has the best estimation ability and prediction effect.

## 1．引言

2014 年 6 月 12 日至 2015 年 6 月 12 日期间，中国股票市场出现了“杠杆牛”现象，A 股从最初的 2013 点上涨到了 5178 点的顶峰，足足上升了 2.57 倍。到了 2015 年 7 月 8 日，又从 5178 点跌到了 2850 点，在此期间还出现千股跌停的现象。据专家表示，此次股市的异常波动与政府实施的宽松货币政策密切相关，宽松的货币政策导致流通中的货币供给过多，资金大量流入股票市场，从而致使股票价格不断上升，这与当时的实体经济走势相违背，最终导致股灾发生。由此看来，货币政策作为国家宏观调控的重要手段之一，其制定与运作都极大影响着股票市场。因此，研究货币政策对股票市场的影响，不仅是投资者在投资过程中悉心关注的问题，还有助于了解国家宏观调控对股票市场运作产生的影响。

货币政策对股票市场的影响问题也一直备受国内外学者们的关注，他们基于此问题进行了大量的研究，如国外学者 Chatziantoniou 等(2013)[1]使用结构 VAR 模型研究多个国家的货币和财政政策冲击对股市的影响。研究发现，两种政策都能直接或间接影响到股票市场。Bekaer(2013)[2]等研究发现宽松的货币政策降低了风险规避和不确定性。Lawal 等(2018)[3]考察了财政和货币政策之间的相互作用对尼日利亚股票市场的影响，发现它们之间的相互作用会显著影响股

票市场的行为，因此应同时考虑这两种政策。国内学者刘金全等(2017)[8]使用TVP-FAVAR 模型来分析货币共给对股价的影响，发现货币供给对股价只存在短期影响。方燕和安兴琪(2019)[9]使用 VAR 与 BEKK-GARCH 模型进行研究，也得出类似结论。丁述军等(2018)[10]通过 VAR 模型研究发现货币政策能在一定程度上影响股票市场的波动。邹昆仑(2020)[11]采用 SVAR 模型进行研究，发现货币政策对股市有影响，但不显著。杨培涛等(2020)[12]研究指出，采用不同的货币政策工具也会对股票市场产生不同的影响。

综上可知，货币政策确实能对股票市场产生影响，但因选取的时间段、模型等不同，得出的结论也有所差异。同时，在计算机技术趋于成熟的今天，高频数据的获取已十分便利，高频数据中包含许多宝贵信息能提高模型估计的效果，但已有的研究大多基于传统 VAR 类低频模型进行研究，信息的损失可能导致模型估计产生偏误造成预测结果不准确。由此，本文将综合两种频率数据进行建模，参考 Engel 等(2013)[4]提出的混频 GARCH-MIDAS 模型方法，在模型中同时纳入股票高频数据与货币政策低频数据信息，希望获得更好的模型估计效果，能为央行制定货币政策和进行宏观调控提供指导，或者为投资者进行资产分配提供帮助。

## 2．模型方法

混频 GARCH-MIDAS 模型是 Engel(2013)[4]在 MIDAS(混频数据抽样)的基础上提出来的，该模型能同时纳入低频与高频数据信息，同时可以将股票市场的波动率分解为短期与长期两个部分，短期部分用来研究股票自身快速波动的影响，长期部分可以用来研究货币政策与股市波动之间的关系。模型基本形式如下：

$$r_{i,t}=\mu+\sqrt{\tau_t g_{i,t}}\varepsilon_{i,t},\sigma_{i,t}^2=\tau_t g_{i,t} \tag{1}$$

其中，$g_{i,t}$ 代表的是短期部分，表示第 $t$ 月第 $i$ 天的高频波动；$\tau_t$ 代表长期部分表示第 $t$ 月的低频波动；$\sigma_{i,t}^2$ 表示股票收益率的总条件方差。

在(1)式中，短期部分 $g_{i,t}$ 服从 GARCH(1,1)过程，长期部分 $\tau_t$ 是一个用已实现波动 $RV_t$ 来衡量的 MIDAS 滤波方程。具体形式分别如下：

$$g_{i,t}=(1-\alpha-\beta)+\frac{\alpha(r_{i-1,t}-\mu)^2}{\tau_t}+\beta g_{i-1,t} \tag{2}$$

$$\tau_t=m+\theta\sum_{j=1}^{K}\phi_j(\omega_1,\omega_2)RV_{t-j},\ RV_t=\frac{1}{N}\sum_{i=1}^{N}(r_{i,t})^2 \tag{3}$$

其中，$\theta$ 为参数，$RV_t$ 为日收益率($r_{i,t}$)的已实现波动，N 为第 t 个月的交易天数，$\phi_j(\omega_1,\omega_2)$ 为权重函数，根据 Ghyels 等(2006)[5]提出的 $\beta$ 权重函数将其定义为：

$$\phi_j(\omega_1,\omega_2)=\frac{(j/K)^{\omega_1-1}(1-j/K)^{\omega_2-1}}{\sum_{i=1}^{K}(i/k)^{\omega_1-1}(1-i/K)^{\omega_2-1}} \tag{4}$$

以上是只考虑了已实现波动的单因子 GARCH-MIDAS 模型的整体形式，而本文不仅考虑了收益率的已实现波动对股票市场波动的影响，还考虑货币政策对股市波动的影响，分别从货币政策的水平值和波动率两个角度探讨其对股市波动率长期的影响情况，因此，长期部分$\tau_t$不在局限于度量已实现波动$RV_t$，还纳入货币政策的水平值及波动率，故(3)可以修正为下式：

$$\tau_t^{\ L}=m+\theta_1\sum_{j=1}^{K}\phi_j(\omega_1,\omega_2)RV_{t-j}+\theta_2^L\sum_{j=1}^{K}\phi_j^L(\omega_1,\omega_2)X_{L,t-j} \tag{5}$$

$$\tau_t^V=m+\theta_1\sum_{j-1}^{K}\phi_j(\omega_1,\omega_2)RV_{t-j}+\theta_2^V\sum_{j-1}^{K}\phi_j^V(\omega_1,\omega_2)X_{V,t-j} \tag{6}$$

其中，$X_{L,t-j}$代表货币政策变量的水平值，$X_{V,t-j}$代表货币政策变量的波动率。

## 3．变量的选取及描述性统计

借鉴大多数学者的做法[9,10,12]，选取货币供应量(M2)与银行间 7 天同业拆借率(INR)作为货币政策的代理变量，上证综合指数作为股票市场的代理变量。样本数据为 2001 年 1 月至 2020 年 12 月的货币政策月度数据与股票市场日度收益率数据。获得货币政策各变量样本共计 240，股票收益率数据共计 4849，数据来源于中国人民银行官网与同花顺炒股软件。

根据上文叙述，股市的短期波动成分是运用 GARCH(1,1)模型来测度的，这里使用的数据为日收益率。而长期部分则是通过 GARCH-MIDAS 模型进行衡量，通过在模型中加入单个或多个变量，如货币政策的水平值(INR_L，M2_L)、货币政策的波动率(INR_V，M2_V)等来进行估计，考察货币政策对股票市场的长期影响情况。对于货币政策波动率的提取,本文借鉴了石强等(2020)[13]的做法：分别对货币政策的各个变量建立 ARMA 模型（这里，模型的最优滞后阶数则是根据 AIC 与 BIC 信息准则最小来确定），将模型估计得到的残差作为货币政策各个变量的波动率。下图是两个货币政策变量波动率的时序图:

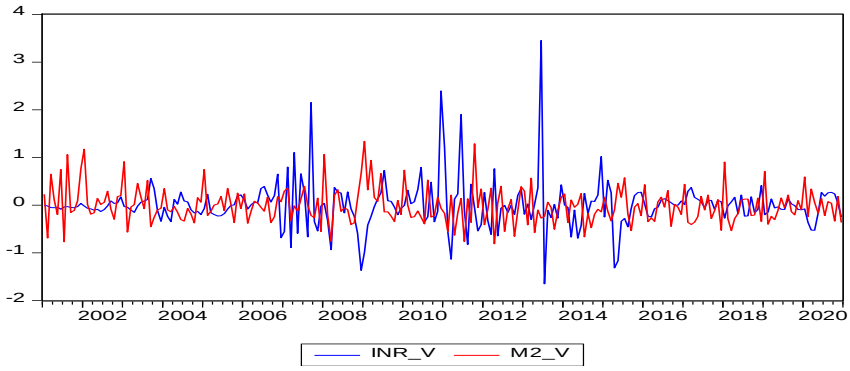


图 1 货币政策变量波动率趋势图

由上图可以看出，在 2001 年至 2020 年这段时间间隔内，货币供应量 M2 和利率 INR 均有波动产生，在 2006 年至 2014 年期间，利率波动相较大。两个变量的波动是否会对股市产生影响还需进行进一步的分析。

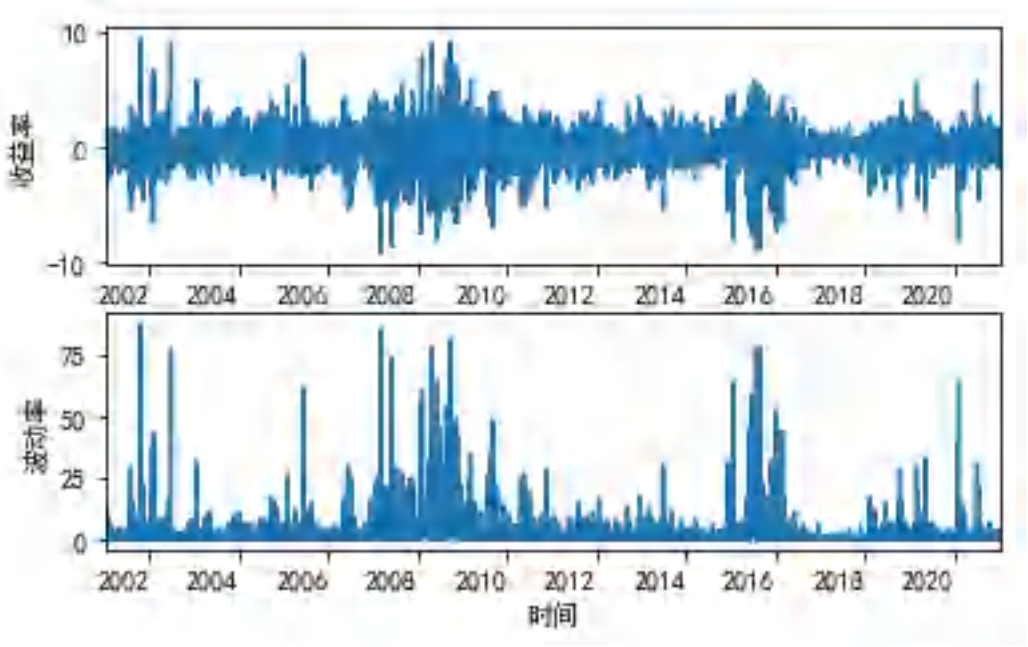


图 2 上证指数收益率及波动率时序图

由图 1 可以看出，无论是收益率还是波动率的时序图，都展现出“尖峰厚尾”现象，小的波动后往往有连续的小波动，大的波动后也有连续的大波动。

表 1 变量的描述统计

| 变量 | 均值 | 标准差 | 偏度 | 峰度 | J-B 统计量 | ADF 统计量 |
|---|---|---|---|---|---|---|
| $r_{i,t}$ | 0.000103 | 0.015569 | -0.398327 | 7.921523 | 5021.956*** | -68.28375*** |
| M2_L | 0.018104 | 0.029355 | 0.494095 | 14.55330 | 1804.742*** | -18.55563*** |
| M2_V | -0.000629 | 0.013654 | -2.641464 | 24.00973 | 4693.181*** | -12.50256*** |
| INR_L | 0.027947 | 0.009006 | 0.831541 | 4.817950 | 60.70788*** | -4.812962*** |
| INR_V | 0.000023 | 0.494095 | 2.091154 | 16.81228 | 2082.708*** | -15.55856*** |

为了进一步了解数据的具体情况，对 5 个变量进行描述统计得上表。由表 1 可知，5 个变量的均值都较小，均接近于 0；但从偏度来看，5 个变量的值都不为 0，上证指数收益率及货币供应量的波动率出现了左偏，而货币供应量的水平值、7 天同业拆借率的水平值及波动率都是右偏的；同时 5 个变量的峰度值较高，都远大于 3，且 J-B 统计量的值都在 1%的显著性水平下显著，说明这 5 个变量都不服从正态分布，证实了图 1 中“尖峰厚尾”的结论。同时，GARCH 模型可以很好的处理尖峰厚尾性，因此用 GARCH 模型描述股票数据的短期波动是可行的。由表 1 还可知，在 1%的显著性水平下 5 个变量的 ADF 值都是显

著的，说明这 5 个观测序列都是平稳的。

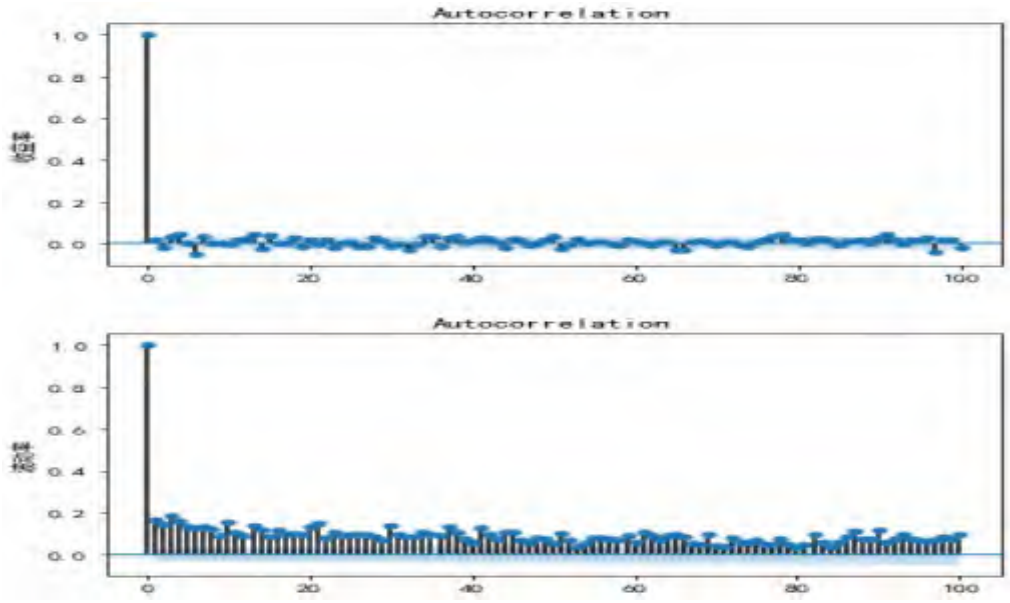


图 3 上证指数收益率与波动率自相关图

从图 3 可以看出，与收益率的自相关图相比，波动率的相关性更高，且相关系数之间表现出持续性，在短时间内无明显的平滑衰减趋势。Ding 和 Granger[6] 研究表明，当波动率的相关系数表现出持续性且平滑衰减趋势时，可能是受到长短期不同成分的影响，此时只用传统 GARCH 模型进行波动率建模预测是无效的，这为考虑从不同成分建立混频数据模型提供了理论依据。

## 4．样本内模型估计

本文将研究区间划分为样本内估计区间和样本外预测区间两部分，其中第一部分包含 2001 年 1 月至 2014 年 12 月，共计 3387 天，第二部分包含 2015 年 1 月至 2020 年 12 月，共计 1462 天。在对模型进行估计时，权重ω以及滞后期 K 的选择至关重要，本文的权重ω是根据式(4)求得的，滞后期 K 则是根据 AIC 与 BIC 最小准则，最终确定 K=12。GARCH-MIDAS 模型的估计方法本文采用的是极大似然估计法，其基本形式如下：

$$LLF=\frac{1}{2}\left[(2\pi)^{TN}+\sum_{t=1}^{T}\sum_{i=1}^{N}\ln(\tau_t g_{i,t})+\sum_{t=1}^{T}\sum_{i=1}^{N}\frac{(r_{i,t}-\mu)^2}{\tau_t g_{i,t}}\right] \tag{7}$$

这里，T 为总月数，N 为每个月的交易天数。

### 4.1 单因子 GARCH-MIDAS 模型估计

表 2 单因子 GARCH-MIDDAS 模型

| 参数及模型 | RV | M2_L | M2_V | INR_L | INR_V |
|---|---|---|---|---|---|
| μ | 0.02045 | 0.02117 | 0.02318 | 0.02068307 | 0.02045 |
| | (0.02375) | (0.02321) | (0.02313) | (0.02311) | 0.02313 |
| α | 0.06543*** | 0.05986*** | 0.05867*** | 0.06203*** | 0.06204*** |

| | | | | | |
|---|---|---|---|---|---|
| | (0.00166) | (0.00225) | (0.00062) | (0.00094) | 0.00076 |
| β | 0.93179*** | 0.93192*** | 0.93488*** | 0.93024*** | 0.93063*** |
| | (0.00003) | (0.00055) | (0.00008) | (0.00025) | 0.00018 |
| m | 1.94067*** | 0.89485*** | 1.06656*** | 1.49320*** | 1.05941*** |
| | (0.54124) | (0.15567) | (0.09538) | (0.35109) | 0.09301 |
| θ | -0.23561*** | 0.04752** | 16.51534*** | -16.5483 | 0.18345 |
| | (0.08754) | (0.02109) | (5.00582) | (13.0005) | 0.34293 |
| AIC | 13077.95 | 13095.89 | 13079.67 | 13097.87 | 13100.67 |
| BIC | 13130.44 | 13139.29 | 13123.06 | 13141.26 | 13144.06 |
| LL | -6531.526 | -6540.947 | -6532.835 | -6541.933 | -6543.335 |

注： RV 表示纳入月度已实现波动的 GARC-MIDAS 模型，M2_L、M2_V、INR_L、INR_V 分别代表纳入货币供应量水平值及波动值、利率水平值及波动值的单因子 GARCH-MIDAS 模型。*、**、***分别表示在 10%、5%、1%的显著性下显著，括号内的值表示稳健标准误差。另外，受篇幅限制，在不影响分析的情况下，未列出权重函数的参数$\omega_1$与$\omega_2$的估计结果。

表 2 中的结果告诉了我们几点信息:（1）从短期部分来看，股票收益率的长期均值μ均不显著，GARCH(α, β)模型估计结果均具有统计意义上的显著性，且满足约束条件$\alpha + \beta < 1$,表明上证综指的收益率在短期波动上具有波动聚集效应，进一步证实了表 1 结论的同时，也表明了上证指数的波动从长期来看是趋于收敛的，估计出来的 GARCH 模型是平稳的；（2）从长期来看，参数估计结果因带入的货币政策因子不同，导致不同模型参数估计结果有所差异，但估计结果更能明显区分出各货币政策因子对股票市场长期的影响；（3）参数θ的估计结果表明，RV 的参数为-0.23561，说明其对股票市场高频波动率的长期部分具有显著的负向影响。M2_L 及 M2_V 的参数值分别为 0.04752、16.51534，表明货币供应量对股市波动有长期的正向影响，且水平值的影响明显小于波动率。INR_L 及 INR_V 对股票市场波动的长期部分存在一定影响，但未通过显著性检验。

## 4.2 双因子 GARCH-MIDAS 模型估计

表 3 双因子 GARCH-MIDAS 模型

| | RV+M2_L | RV+M2_V | RV+INR_L | RV+INR_V |
|---|---|---|---|---|
| μ | 0.02094 | 0.02098 | 0.02058 | 0.02051 |
| | (0.02332) | (0.02321) | (0.02322) | (0.02327) |
| α | 0.06266*** | 0.06370*** | 0.06609*** | 0.06639*** |
| | (0.00164) | (0.00162) | (0.00145) | (0.00126) |
| β | 0.93368*** | 0.93318*** | 0.93091*** | 0.93079*** |
| | (0.00003) | (0.00004) | (0.00004) | (0.00004) |
| m | 1.60434*** | 1.79575*** | 1.99458*** | 1.93741*** |
| | (0.39253) | (0.44693) | (0.50901) | (0.40938) |
| $\theta_{RV}$ | -0.22122*** | -0.21397*** | -0.23915*** | -0.23217*** |
| | (0.07061) | (7.55455) | (0.07107) | (0.07733) |

| | | | | |
|---|---|---|---|---|
| $\theta_{M2_L}$ | 4.22937* | | | |
| | (2.17532) | | | |
| $\theta_{M2_V}$ | | 11.2684*** | | |
| | | (5.40136) | | |
| $\theta_{INR_L}$ | | | -2.83865 | |
| | | | (22.7803) | |
| $\theta_{INR_V}$ | | | | 0.09339 |
| | | | | (0.10460) |
| *AIC* | 13079.33 | 13077.64 | 13083.05 | 13081.72 |
| *BIC* | 13141.32 | 13129.63 | 13145.04 | 13143.71 |
| *LL* | -6529.665 | -6528.82 | -6531.525 | -6530.86 |

注：RV+M2_L、RV+M2_V、RV+INR_L、RV+INR_V 表示在基于月度已实现波动率 RV 的 GARCH-MIDAS 模型的基础上再纳入货币政策因子的双因子 GARCH-MIDAS 模型，*、**、*** 分别表示在 10%、5%、1%的显著性下显著，括号内的值表示稳健标准误差。另外，受篇幅限制，在不影响分析的情况下，未列出权重函数的参数$\omega_1$与$\omega_2$的估计结果。

上表是根据货币政策各因子与低频月度已实现波动构建的双因子 GARCH-MIDAS 模型估计结果，结果显示，除了 INR-L 与 INR_V 的θ参数结果不显著外，其他变量的θ参数估计结果均显著。表明利率因子对股市的长期部分并没有产生大的影响。RV 的θ参数估计结果显著为负，说明考虑了低频已实现波动率的股票市场能显著降低股票市场高频波动中的长期成分，有益于股票市场的长期稳定。与单因子模型结果相一致的是，考虑 M2_V 的模型影响效果依然高于 M2_L 的效果；不同的是，在双因子 GARCH-MIDAS 模型中纳入不同货币政策因子的参数θ估计结果均小于单因子混频模型中的θ估计值，同时结合 AIC、BIC 信息准则与对数似然函数值 LL 值可知，双因子混频模型的估计效果要优于单因子模型。

## 5 模型样本外预测分析

为了检验各估计模型的预测能力，本文借鉴钟立新(2020)[14]的模型预测方法来探究基于货币政策变量的 GARCH-MIDAS 模型是否能提升模型的预测能力。具体做法是: 采用滚动窗口向前一步预测(本文设定的样本外预测区间为 2015 年 1 月至 2020 年 12 月共计 1462 天)的方法对模型进行预测，预测出下一个月(即 2021 年 1 月)的日度波动率值，将其日度已实现波动率作为真实值。并采用以下了 6 种损失函数来测度模型预测效果的优劣。

$$MSE = \frac{1}{T}\sum_{t=1}^{T}\left(\hat{\sigma}_t^2 - \sigma_t^2\right)^2 \tag{7}$$

$$MAE = \frac{1}{T}\sum_{t=1}^{T}\left|\hat{\sigma}_t^2 - \sigma_t^2\right| \tag{8}$$

$$HMSE = \frac{1}{T}\sum_{t=1}^{T}\left(1 - \hat{\sigma}_t^2 / \sigma_t^2\right)^2 \tag{9}$$

$$HMAE = \frac{1}{T}\sum_{t=1}^{T}\left|1 - \hat{\sigma}_t^2 / \sigma_t^2\right| \tag{10}$$

$$QLIKE=\frac{1}{T}\sum_{t=1}^{T}\left(\ln\hat{\sigma}_t^2+\frac{\sigma_t^2}{\hat{\sigma}_t^2}\right) \tag{11}$$

$$R^2LOG=\frac{1}{T}\sum_{t=1}^{T}\left(\ln\frac{\sigma_t^2}{\hat{\sigma}_t^2}\right) \tag{12}$$

其中，$\hat{\sigma}_t^2$是模型预测所得的条件方差，$\sigma_t^2$是股票市场的真实波动率，T 为样本外预测区间的大小。损失函数值越小，表明预测值与真实值越接近，模型预测效果越好[14]。

表 4 样本外预测分析

| 损失函数 | 单因子 GARCH-MIDAS 模型 | | | | | 双因子 GARCH-MIDAS 模型 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | RV | M2_L | M2_V | INR_L | INR_V | RV+M2_L | RV+M2_V | RV+INR_L | RV+INR_V |
| MSE | 0.259 | 0.305 | 0.253 | 0.554 | 0.484 | 0.161 | 0.099 | 0.478 | 0.426 |
| MAE | 0.421 | 0.485 | 0.462 | 0.489 | 0.666 | 0.303 | 0.256 | 0.447 | 0.505 |
| HMSE | 1.056 | 1.430 | 1.357 | 1.481 | 1.576 | 1.022 | 1.016 | 1.099 | 1.502 |
| HMAE | 0.693 | 0.780 | 0.829 | 0.835 | 0.935 | 0.710 | 0.669 | 0.731 | 0.791 |
| QLIKE | 0.179 | 0.261 | 0.191 | 0.329 | 0.298 | 0.169 | 0.047 | 0.313 | 0.216 |
| $R^2$LOG | 0.189 | 0.308 | 0.166 | 0.352 | 0.417 | 0.126 | 0.189 | 0.253 | 0.414 |

由表 4 可以看出，在 RV 的基础上加入货币政策变量的 GARCH-MIDAS 模型的预测能力均高于只加入货币政策变量的 GARCH-MIDAS 模型。且与模型估计结果相对应的是，纳入 M2_V 的模型预测精度均高于纳入 M2_L 的模型预测精度。预测精度最好的是在 RV 的基础上加入 M2_V 的 GARCH-MIDAS 模型。

但是，损失函数是具有局限性的，它们不能告诉我们预测性能的差异是否具有统计学意义上的显著性，且很难肯定地说损失值最小的模型就一定明显优于其他模型[13]，为了解决这个问题，我们使用 Diebold 和 Mariano (1995)[7[7]提出的 Diebold-Mariano 检验（以下简称 DM 检验）来比较基于已实现波动率的 GARCH-MIDAS 模型与加入货币政策变量之后的扩展模型之间预测准确性。以纳入已实现波动率的单因子 GARCH-MIDAS 模型为参照模型，使其与加入货币政策水平值或波动值的 4 个双因子 GARCH-MIDAS 模型分别进行比较。DM 检验的基本原理是：

$$DM=\frac{\bar{d}}{\sqrt{\mathrm{var}(d_t)}}\sim N(0,1),d_t=e_{A,t}^2-e_{B,t}^2 \tag{13}$$

其中$e_{A,t}$、$e_{B,t}$分别是两个比较模型 A 与 B 的预测误差，$\bar{d}$和$\mathrm{var}(d_t)$分别是

序列$d_t$的平均值和方差。

表 5　DM 检验

| 模型 | MSE | MAE | HMSE | HMAE | QLIKE | $R^2$LOG |
|---|---|---|---|---|---|---|
| RV+M2_L | 1.1337 | 1.3941 | 0.0872 | 0.0530 | 2.7167** | -2.3947** |
| RV+M2_V | 2.4404** | 2.5848** | 0.6407 | 0.0981 | 3.4270*** | -2.4135** |
| RV+INR_L | -1.0408 | -0.8908 | -0.2541 | -0.0583 | -0.4898 | 0.2408 |
| RV+INR_V | -1.0018 | -1.0883 | -0.8233 | -0.5828 | -0.6227 | -2.0070* |

注：*、**、***分别表示在 10%、5%、1%的显著性下显著

由表 5 可以看出，同时纳入 RV 与 M2-V 的 GARCH-MIDAS 模型通过 DM 检验的损失函数较多，这表明同时考虑这两个变量的 GARCH-MIDAS 模型能够有效提高股票市场波动率预测的准确性。此外，通过 DM 检验可知，RV+M2_L、RV+INR_L 与 RV+INR_V 模型在多个损失函数上并未通过显著性检验，表明虽然各双因子 GARCH-MIDAS 模型在损失函数表现出较好的预测能力，但在统计意义上不一定显著。

## 6．结论

本文基于货币政策变量构造混频 GARCH-MIDAS 模型，来研究货币政策对股市波动率的长短期影响。根据上述分析可获得结论如下：

（1）虽然有关货币政策与股票市场关系的研究已经很充分，但是多数研究只是基于传统低频 VAR 类模型进行建模，并没有充分利用金融高频数据中的丰富信息。经本文研究发现股票市场波动率具有很强的相关性，其相关系数具有持续性且无显著的平滑衰减趋势，仅用传统低频模型对波动率进行预测的波动可能是造成较大的偏误。

（2）通过样本内估计发现，各货币政策变量对股票市场波动率的短期部分都具有显著影响；GARCH-MIDAS 模型能有效的分析不同货币政策变量是否会长期影响股票市场的波动，月度已实现波动率会对股票市场的波动产生负向影响，即股市的波动会随着已实现波动的增大而减小。货币供应量水平值及波动率会对股票市场产生长期的正向影响，但波动率的影响明显大于水平值的影响，利率因子对股票市场波动的长期部分的影响不显著。相较于单因子 GARCH-MIDAS 模型，基于已实现波动率与货币政策的双因子 GARCH-MIDAS 模型具有更好的样本内估计能力，其中同时考虑已实现波动率与货币供应量波动值的 GARCH-MIDAS 模型表现出的估计效果最好。

（3）样本外预测结果表明，在模型中加入已实现波动率或货币政策变量能提升模型对波动率预测的精度。且加入两个变量的 GARCH-MIDAS 模型预测效果显著优于单个变量的 GARCH-MIDAS 模型；由 DM 检验的结果可知，同时纳入已实现波动率与货币供应量波动率的 GARCH-MIDAS 模型在样本内拟合和样本外预测上都表现的最好，此外，DM 检验也揭示了各 GARCH-MIDAS 模型虽然在损失函数表现出较好的预测能力，但不一定能通过显著性检验。

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# 货币政策对股票市场波动率的影响分析——基于 GARCH-MIDAS 模型

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**关键词：**货币政策；股市波动率；GARCH-MIDAS 模型；DM 检验

**摘要：**虽然有关货币政策与股票市场关系的研究已经很充分，但是多数研究只是基于传统低频 VAR 类模型进行建模，并没有充分利用金融高频数据中的丰富信息。本文在此基础上将高频股票数据与低频货币政策数据进行融合，构建 GARCH-MIDAS 模型研究我国货币政策对股票市场波动率的影响，选取 2001 年 1 月至 2020 年 12 月的货币政策月度数据与股票市场日度收益率数据作为研究数据，从货币政策水平值与波动率两个维度考察其对股票市场的长短期影响。在基于各货币政策变量建立单因子 GARCH-MIDAS 模型的基础进一步构建双

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因子 GARCH-MIDAS 模型，并通过损失函数与 DM 检验来测度模型的样本外预测能力。样本内模型估计结果表明，各货币政策变量对股市波动率均有显著的短期影响，月度已实现波动对股市波动率有长期的负向影响，而货币供应量水平值及波动率对股市波动有长期的正向影响，且货币政策波动率的影响明显大于水平值的影响。利率因子对股票市场波动的长期部分存在一定影响，但并不显著。在基于已实现波动率的 GARCH-MIDAS 模型中加入各货币政策变量构建双因子 GARCH-MIDAS 模型的估计结果显示，双因子 GARCH-MIDAS 模型能更有效的刻画出股票市场的长期波动成分。样本外预测结果表明，在 GARCH-MIDAS 模型中加入货币政策变量不仅可以用于分析不同货币政策对股票市场波动率的长期影响，还可以提升模型对波动率预测的精度。尤其是同时考虑已实现波动率与货币供应量波动率的 GARCH-MIDAS 模型，不但对应的损失函数值最小，而且通过了 DM 检验，具有最优的估计能力和预测效果。

# Research on Local Government Fiscal Risk and Sustainability

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**Keywords:** Debt Stock; Financial budget; Final accounts

**Abstract.** The high risk of local debt is a structural problem in China's fiscal system for a long time. According to the fiscal risk matrix, local government debt includes not only explicit direct debt, but also explicit contingent and implicit debt. Although the debt gradually become detectable, however, the huge stock of debt and the debt formed during the epidemic served to stimulate the economy have increased the repayment risk of local governments. In order to respond to the "new development concept" emphasized in the central economic work and carry out long-term economic structural adjustments and reforms, this paper used multiple indicators and full-caliber data to systematically analyze the local debt repayment risk in order to comprehensively measure the stock debt repayment risk, and make corresponding recommendations for risk management and control measures.

This article selected nearly 60,000 local state-owned enterprise bonds, local government bonds and urban construction & investment company bonds that will not be fully paid by the end of 2048. The indicators were explained in detail. The article analyzed the debt situation from the macro national level and the micro local level. At the macro level, the article focused on the analysis of the proportion of state-owned enterprise bonds, urban construction & investment company bonds, government bonds, and changes in the amount of debt caused by government policies in the time series. At the micro level, the article provided a comprehensive description of the future debt service and debt repayment to indicate debt service risk in Western China, Eastern China and Chinese middle-area separately, as well as corresponding policy recommendations for the provinces with the highest risk. The article also analyzed

how debt radio can be caused by changes in the factors affecting the debt stock, local comprehensive financial resources, economy and other related factors, and put forward corresponding policy recommendations for local government debt risk control. The causes of local government debt was finally proposed, with believes that in order to reduce the risk, we should increase the control of debt issuance, attach importance to the coordination of rights and risk sharing, and establish a reasonable budget system and supervision mechanism.

The advantage of the article is that most of the previous research directly used the amount of government stock debt, which failed to faithfully reflect the debt repayment risk and debt pressure. However, this paper chose debt service as the amount of debt, and at the same time adopted full-caliber data, based on a large amount of data processing work, the single bond was added up to describe the debt situation of each province and finally the whole country, and an accurate and fixed statutory debt service interest. This makes the government's debt situation more accurate and credible.

## 1．引言

2020年3月27日，在中共中央政治局会议上，中央提出“适当提高财政赤字率，发行特别国债，增加地方政府专项债券规模”三大手段，以积极有为的财政政策应对当前新冠疫情下的经济形势。

政府债务作为筹集财政资金的重要手段，是撬动经济发展的有力杠杆，是财政政策不可或缺的组成部分。其融资功能和资源配置功能可以为政府实现职能，稳定社会和推动经济发展助力。例如2008年后，伴随着大量政府债务发行的积极财政政策的实施稳定了国际金融危机下中国经济的增长。

然而另一方面，我国政府债务发行的规模化和市场化也使得政府债务风险凸显，其数额和规模的增长使得政府背负了巨额债务，并且近年来在地方政府愈发严重。当2008年后发行的债券逐渐到期后，不少地方政府因财力不足陷入了不得不“借新还旧”的尴尬处境。

我国政府债务风险呈现总体可控、地区差异大、局部高危的特点。此局面的形成与我国的财政体制和经济发展有关。分税制财政体制改革后财政权力向中央政府靠拢，财政事权与支出责任的不匹配使得地方财政困难，不得不通过发行债务等方式筹集资金。此外，政府举债制度的不规范、财政监督体系的不完善、行政考核体制的缺陷等因素都加剧了地方政府债务的增长。

政府债务风险不但影响了宏观财政政策的精准调控，也制约了地方政府对地区经济发展的带动能力。地方政府在债务压力下再无余力发展地区经济，地区经济发展滞后又削弱了政府综合财力，地方政府容易陷入债务累积的泥潭，甚至容易发生债务违约。

地方政府债务风险的凸显使得中央政府加强了对地方政府举债的规范。2014年新《预算法》明确规定政府部门不得通过企业事业单位等举债，以规范地方政府的举债行为，同时一系列政策规定的出台约束了政府举债的行为。

当下，中国经济正面临结构性调整和改革，中央经济工作强调“新发展理念”，在外部巨变、全球化放缓，内部地产泡沫、债务风险凸显的情形下兼顾财政支出

和债务风险管控。如何有效控制政府债务风险成为重大风险防范与化解的重要课题。

在此背景下，本文整理了1997年-2040 年的全国以及地方层面的政府债券数据和财政数据，系统计算和分析了全国以及全省的年发行额、发行数量、还本付息额和偿债率、负债率、债务率等债务指标。并以此为基础衡量政府债务风险，分析政府债务的成因，并对未来政府债务压力做出预测。本文的目的在于系统科学的衡量我国政府债务的真实情况，测算真实的债务风险，为研究我国政府债务和财政制度改革提供参考。

## 2．文献综述

### 2.1 地方政府债务统计口径

界定地方政府债务统计口径，是研究债务规模、实现债务管理的依据和逻辑起点(彭刚, 2014)。地方政府债务是整个社会债务的重要组成部分。地方政府作为债务人与债权人之间按照有偿原则发生信用关系来筹集财政资金弥补财政赤字，并借以调控经济运行 (赵全厚 and 孙昊旸, 2011)。

目前较为常用的债务统计口径，是世界银行Polackova (1998) 从经济社会视角出发，按照地方政府债务发生时间是否确定和债务发生依据是否得到法律或合同明确规定两个标准提出的债务矩阵。债务矩阵将债务划分为显性直接债务、显性或有债务、隐性直接债务和隐性或有债务四项债务。而我国财政部和审计署以是否由政府信用担保和是否由财政资金偿还为标准辨别地方政府性债务。财政部预算司(2009)通过直接债务（包括一般债务和专项债务）和担保债务对地方政府性债务进行分类。财政部分类中举债主体包括地方政府及其职能部门（机构）、有财政经常性拨款的事业单位、地方政府及其职能部门（机构）成立的公司等，并以政府信用直接借入债务或提供担保。但财政赤字、自收自支事业单位发生的债务等不纳入口径内。审计署(2013)通过政府负有偿还责任的债务、政府负有担保责任的债务和其他相关债务等标准划分地方政府性债务。审计署分类中举借主体主要包括五类：融资平台公司、政府部门和机构、经费补助事业单位、国有独资或控股企业（简称地方国有企业）以及自收自支的事业单位，以是否由财政资金偿还作为分类依据。

现有文献研究常常将我国债务划分与财政矩阵结合起来讨论。地方政府及其职能部门等主体的债务属于地方政府显性债务，这在众多学者中达成共识。但由于现有研究对隐性债务统计口径和计量方法的不同，得出了不同的政府债务规模，不仅难于相互比较，也是导致不同部门和不同学者对于政府债务风险拥有不同观点的关键所在(魏加宁等., 2012)。刘尚希 et al. (2012)指出地方政府隐性债务主要包含社会保障资金缺口、农村社会保障缺口、公共投资项目未来的资本性和经常性支出等直接隐性债务以及对金融机构支付危机的救助、国有企业的亏损、拖欠企业在职职工和农民工的工资等或有隐性债务。魏加宁等(2012) 则根据政府是否需要承担债务偿还责任以及债务与政府的紧密程度，构建地方隐性债务的多层次测算指标体系：口径一=省、市、县债务；口径二=口径一+乡镇债务；口径三=口径二+养老保险隐性债务；口径四=口径三+公路债务。而毛振华 et al. (2018) 认为政府部门和机构、经费补助事业单位和自收自支的事业单位三类是政府负有偿还责任债务，也是显性债务的主要举借主体；融资平台公司和地方国有企业是地方或有政府性债务，也是隐性债务的主要举借主体。地方政府隐性债

务主要包括融资平台、地方国企的债务以及PPP 项目中政府付费项目、政府投资基金等内容。

然而，考虑到我国现实情况中融资平台、事业单位等都是与地方政府“捆绑”在一起。彭刚 (2014)认为融资平台等举借债务一旦确定由财政资金偿还，实际上已经发生了债务继承，相应地其偿债义务也就转移给力地方政府，债务主体已经变为地方政府有关部门和机构。如果地方政府性债务主体扩大到了融资平台、企事业单位，那么这些债务主体的全部债务都应该是直接显性债务，其非公益性项目举债所担保的债务也都应该包括进来。简单来说，一旦确定了政府债务主体包括了融资平台公司、政府部门和机构、经费补助事业单位、国有独资或控股企业（简称地方国有企业）以及自收自支的事业单位，这些债务均是地方政府的直接显性债务。孙涛 和张晓晶 (2007) 在尚未允许地方政府发债的背景下，认为地方政府债务主要是地方政府通过地方信托投资机构在国内外的借款和地方的国有企业以财政为担保的债务。陈诗一和汪莉 (2016)将地方政府部门债务和地方国有企业债务加总作为地方政府债务的代理变量来考察东部和中西部地方政府债务对经济增长的影响及其差异。

因此，本报告从举债主体入手对地方政府性债务进行刻画。借鉴黄春元和毛捷 (2015)运用地方政府部门显性债务、城投债和国有企业债务，以及债券数据的完整性和可得性，对地方政府债券、城投债和国有企业债券债券情况及其债务风险情况进行分析。借鉴刘尚希 et al. (2012)的定义将地方政府性债务分为狭义地方政府债务和广义地方政府债务，将地方政府性债务分为狭义地方政府性债务和广义地方政府性债务，其中广义地方政府性债务分为宽口径地方国有企业债和窄口径城投债。

## 2.2 地方政府债务风险评估

现有关于地方债务风险的评估方式主要有两类，包括通过利率和利差分析以及构建债务指标分析。

### 2.2.1 通过利率和利差分析

国外研究政府风险多运用市政债券。一般认为政府债券市场的利率取决于贷款人承担的风险（Bernoth et al.,2004）。David et al.（2019）从市政债券收益率利差中观察到各级政府的信用风险溢价是不同的，即使存在中央政府隐性担保的可能，市政债券收益率也要高于中央政府，信贷市场并不十分相信中央政府担保的存在。Sergio et al. （2016）研究澳大利亚、加拿大、德国和美国的债券不平衡风险溢价（以主权债券利差衡量），发现债务存量和赤字存量较大的次级国家政府支付的市场溢价较高。一些研究表明利差与债务/GDP比率和赤字/GDP比率之间均存在正相关关系，省级债务的增加意味着更高的省级利差，即更高的债务风险（Schuknecht et al., 2011; Bernoth and Erdogan,2012;Ardagna,Caselli,and Lane ,2004）。在我国，由于新《预算法》实施之前不允许地方政府债券发行，研究者一般利用根据城投债进行研究。城投债性质上属于企业债券，但又发挥了市政债券的作用，其利差中也蕴含着地方性风险信息，城投债利差上升表明政府的隐性债务风险加剧（Ang et al.2003；张雯，2011；王克强等，2012）。牛霖琳、洪智武和陈国进（2016）从地方与中央债务结构性失衡的视角，将城投债利差与国债收益率曲线联合建模研究，城投债利差扩大表明地方政府债务负担加重，在存在中央财政隐性担保的可能性下，如果不能有效地控制可能爆发债券市场系统性风险以及引起国债溢价及收益率显著上升。这类研究一方法的优点是地方政府债券的利率、利差信息时滞短、频率高，能够直观反映省政府发行债券的风险溢

价，从而体现其债务风险。然而，地方国有企业债券利率更多是反映企业经营信息，齐天翔等（2012）研究发现非财务类指标对信用利差的解释力度更强，国内城投债券的信用利差与发债企业的总资产规模以及发债企业所在地区的人均GDP水平负相关，与企业债券收益率正相关。此外，地方国有企业债券多种类型债券利率无法混合讨论。因此，此类方式在衡量广义地方债务上具有一定的局限性。基于此，本文采用利率和利差指标分析狭义地方债务（地方政府债券）风险。

### 2.2.2 构建债务指标分析

目前较通行的做法是采用偿债率、负债率、违约率等简单风险测度指标及其指数测算地方债务风险。目前被普遍采纳的指标是债务率和负债率，即债务余额/地方政府综合财力和债务余额/GDP。一些学者认为，就负债率指标而言，目前我国政府性债务规模远低于欧洲、美国和日本，尚处于安全可控的范围（贾康，2011; 白景明，2012）。魏加宁、宁静和朱太辉（2012）计算了我国地方和中央的债务率和负债率，并与世界主要发达国家进行了比较，发现相比于主要发达国家，我国的总体债务风险虽然不高，但地方政府债务风险已处于过高水平。李燕和陈金皇（2017）依据债务率和负债率对西南地区各省市的地方债务发展现状进行分析，发现西南地区负债率及债务率均远高于全国平均水平，部分省份的债务率和负债率超过警戒线。然而，上述两个指标衡量的债务风险只是和地方财力水平和GDP相比的相对值，并不能反映债务风险的绝对规模，债务率相同的地方政府，债务规模也可能差异较大，对应的实际债务风险因此也不相同。刁伟涛、王楠（2017）利用熵值法，将反映债务风险的多个指标进行标准化处理、加权平均来度量债务风险，但这种方法也只是对于多个主体间债务风险进行横向排序，并不能直接反映债务风险的大小。这类构建债务指标分析的方法的优势是包含了隐性债务，可以从地方总体债务情况出发考察地方债务风险，较为全面。然而，此类方法大多在债务额的度量基础上量化债务风险，受制于国内宏观财政指标统计和发布时滞长、频率低的现状，往往债务额度测量的准确性可能会降低。因此，本文在分析广义地方债务（地方政府债券和城投债或企业债）风险时采用构建偿债率、负债率、债务率指标的方式进行全面分析。

### 2.2.3 地方政府债务可持续性

地方政府债务可持续性是其在不进行重大调整的情况下依然具备清偿债务的能力。衡量地方债务的可持续性主要采用量化的指标测算, 例如上述两类衡量地方债务风险的方法（明明,胡玉峰，2017）。关于地方债对财政可持续性的研究有主要两个方面。部分学者认为地方债从时间、空间上为财政运行带来了便利，合理的地方债务规模有利于发挥逆周期调节作用，促进财政的可持续运行（贾俊雪和郭庆旺，2011；贾康和赵全厚，2000；邓晓兰，黄显林和张旭涛，2013）。另一部分人则认为地方政府债务会导致财政运行不可持续。匡小平（2004）认为政府债务利息率与GDP增长率的相对大小是影响地方财政可持续性的重要因素，当GDP增长率相对较低时，地方政府发行债务将最终导致财政运行的不稳定。杨靖三（2016）认为财政可持续性受债务利息、经济增长及结构等影响，债务利息高于经济增长水平将导致财政运行不可持续。李燕和陈金皇（2017）研究发现西南地区各省市地方债虽然还未对财政运行造成显著不利影响，但财政运行可持续性弱，表明该区域财政运行存在一定风险。

## 3．数据处理及指标评价说明

### 3.1 数据来源

### 3.1.1 债务数据

全国层面的债务来源包括国债、中央企业债和地方的债务。地方层面债务来源包括显性债务和隐性债务，显性债务为地方政府负有直接偿还责任的债务，即地方政府债；隐性债务指地方政府负有间接偿还责任的债务负担，根据统计口径不同分为城投债和地方国有企业债。

1997年至2019年债务数据来自wind数据库、国泰安数据库等，包括全国31个省市（不含港澳台）发行的债券信息，并进行相应的数据处理。具体情况见下表所示：

表1　债券基本信息示意图

| 债券类型 | | 发行时间 | 发行数量（个） | 发行规模（万亿） | 口径 |
|---|---|---|---|---|---|
| 国债 | | 1997-2019 | 4594 | 32.18 | 全国 |
| 中央企业债 | | 1997-2019 | 812 | 1.24 | 全国 |
| 地方政府债 | | 2009-2019 | 5838 | 24.42 | 地方 |
| 地方国有企业债 | | 1997-2019 | 34466 | 32.39 | 地方（企业债口径[1]） |
| 城投债 | 宽口径[2] | 1997-2019 | 19062 | 17.97 | 地方（城投债口径[4]） |
| | 窄口径[3] | 2005-2019 | 6005 | 5.48 | |

表2　2009-2019年GDP及地方综合财力数据描述性统计

| | GDP（亿元） | 地方综合财力 | | |
|---|---|---|---|---|
| | | 地方公共预算收入（亿元） | 国有土地使用权出让收入（亿元） | 合计 |
| **最大值** | 107671.07 | 12651.46 | 8564.23 | 18180.25 |
| **最小值** | 441.36 | 30.09 | 1.20 | 31.28 |
| **均值** | 21901.62 | 2322.64 | 1188.71 | 3511.35 |
| **方差** | 18845.52 | 2071.06 | 1305.12 | 3235.23 |

[1]企业债口径：地方债务包括地方政府债和地方国有企业债
[2]宽口径城投债来源：国资委、中债、万得数据库
[3]窄口径城投债来源：国资委
[4]城投债口径：地方债务包括地方政府债和城投债

### 3.1.2 GDP及地方综合财力数据

1997年至2019年GDP来自于《中国统计年鉴（2019）》国民生产总值；地方政府综合财力包括地方公共预算收入和国有土地使用权出让收入。数据来源于万得数据库、中国经济和社会发展统计数据库和《中国国土资源统计年鉴》。

从图1中可以看出2018年地方GDP的数值远大于公共财政收入和国有土地使用权出让收入，公共财政收入基本大于国有土地出让收入，GDP数据和公共财政收入及国有土地出让收入高低排序大体上一致。

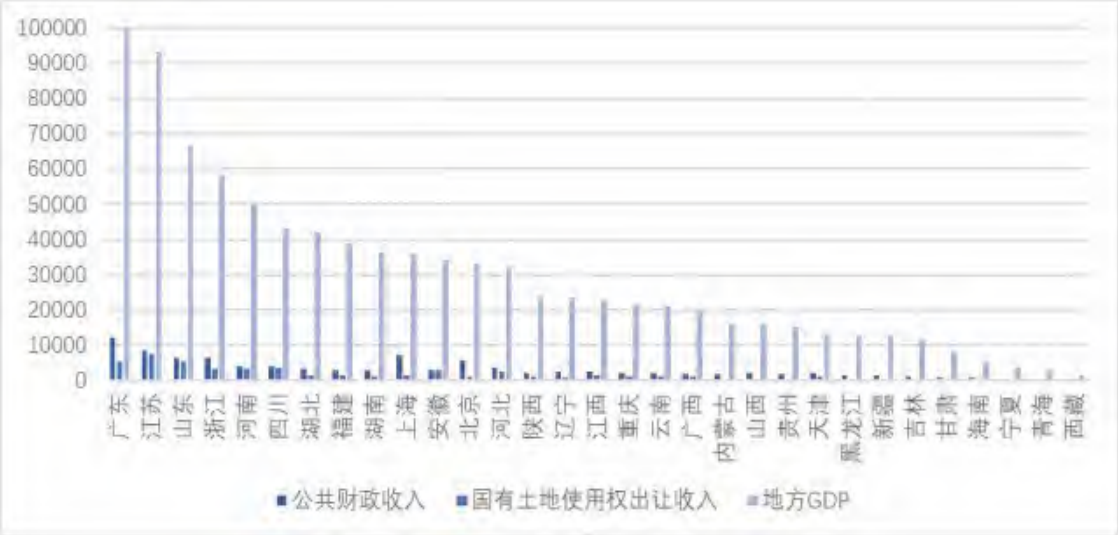



图1 2018年GDP及地方财力数据

### 3.2 利息计算说明

由于债券种类多样，我们分类计算债券利息。其中，城投债及地方企业债的票面品种、付息利率方式多样，利息计算过程最为复杂，我们以城投债为例对各种利息计算方式进行说明：

表3 城投债及地方企业债利息计算方式说明

| 一级分类 | 二级分类 | 利息计算说明 |
|---|---|---|
| 票面品种 | 到期一次还本付息 | 于最终兑付日一次性支付，$利息 = 发行额 * 票面利率$ |
| | 附息债 | 于每个兑付日支付，$每次兑付利息 = 发行额 * \frac{票面利率}{年付息次数}$ |
| | 贴现债 | 发行时折价发行，无利息 |
| 付息利率方式 | 固定利率 | |
| | 浮动利率 | 取发行期限内浮动利率的最大值和最小值<br>分别计算每年最大付息数额和最小付息数额 |

| | | |
|---|---|---|
| | 累进利率 | 将不同时间段内不同利率档次的债券拆解，分时间段计息 |
| 兑付方式 | 到期兑付 | 对于附息型本金提前兑付、回售及赎回类债券<br>债券已经兑付的本金部分不再计息 |
| | 本金提前兑付 | |
| | 回售 | |
| | 赎回 | |

## 3.3 指标选取及计算说明

### 3.3.1 指标选取

采用偿债率[5]、债务率[6]和负债率[7]指标是目前衡量地方债务各国通行的做法，这三个指标可以较好地反映地方政府的债务情况。

在偿债率上，国际上一般认为一般国家的偿债率的警戒线为20%，发展中国家为25%，危险线偿债率为30%

在负债率上，国际上通常以《马斯特里赫特条约》规定的负债率60%作为政府债务风险控制标准的参考值。

在债务率上，国际货币基金组织确定的债务率控制标准参考值低于150%。

### 3.3.2 本文指标计算公式：

$$\text{偿债率(城投债宽口径)} = \frac{\text{地方政府债还本付息额} + \text{宽口径城投债还本付息额}}{\text{地方综合财力}}$$

$$\text{偿债率(城投债窄口径)} = \frac{\text{地方政府债还本付息额} + \text{窄口径城投债还本付息额}}{\text{地方综合财力}}$$

$$\text{偿债率(企业债口径)} = \frac{\text{地方政府债还本付息额} + \text{地方国有企业债还本付息额}}{\text{地方综合财力}}$$

$$\text{债务率(城投债宽口径)} = \frac{\text{地方政府债存量} + \text{宽口径城投债存量}}{\text{地方综合财力}}$$

$$\text{债务率(城投债窄口径)} = \frac{\text{地方政府债存量} + \text{窄口径城投债存量}}{\text{地方综合财力}}$$

$$\text{债务率(企业债口径)} = \frac{\text{地方政府债存量} + \text{地方国有企业债存量}}{\text{地方综合财力}}$$

[5]偿债率=(地方政府债务还本付息额÷地方综合财力)×100%，地方综合财力包括地方公共预算收入和国有土地使用权出让收入。

[6]债务率=(地方政府债务余额÷地方综合财力)×100%，地方综合财力包括地方公共预算收入和国有土地使用权出让收入。

[7]负债率=(地方政府债务余额÷GDP)×100%

$$\text{负债率(城投债宽口径)} = \frac{\text{地方政府债存量} + \text{宽口径城投债存量}}{\text{GDP}}$$

$$\text{负债率(城投债窄口径)} = \frac{\text{地方政府债存量} + \text{窄口径城投债存量}}{\text{GDP}}$$

$$\text{负债率(企业债口径)} = \frac{\text{地方政府债存量} + \text{地方国有企业债存量}}{\text{GDP}}$$

### 3.4 未来数据预测说明

我们假设2020年起未发行新债，对未来年度由1997-2019年的存量债券引起的债务压力进行预测。我们参考经济新常态下近几年的财政收入增速，在2020-2050年GDP预测值的计算中，设置实际GDP增速为5%-7%，通货膨胀速度1%-3%，以此计算未来三十年名义GDP。在2020-2050年的财政收入预测值计算中，我们设置财政收入增速为4%-9%，以此计算未来三十年地方综合财力。

## 4．政府债务全国层面宏观分析

### 4.1 债券发行数分析

图2 1997-2019全国政府债券发行数统计图

图2展示了1997年至2019年三种口径的全国政府债券发行数及其变化情况。首先对城投债宽口径全国发行数进行分析。总体上，城投债宽口径的全国政府债券发行数呈上升趋势。1997年至2008年处于平缓增长时期，1997年全国总计发行数为5，2008年为118。2009年至2013年间全国总计发行数增长加快。2009年全国总计发行数为368， 2013年为1092。2014年至2016年全国总计发行数呈直线式上升趋势。2014年全国总计发行数为2098，接近上一年度的两倍，至2016年已经增长至4120。2017年小幅下降后，2018年、2019年再次增长，当年发行数为5563。

国债发行数总体增长较为平稳，但2015年出现剧烈增长。1997年国债发行数为2，2014年为169，2015年为1116。至2019年国债发行数为3438。

中央国有企业债发行数一直维持在较低水平，总体呈缓慢增长趋势。1997年中央国有企业债发行数为2， 2010年发行数为60。2011年至2014年中央国有企业债发行数呈“凹”形。至2019年，中央国有企业债发行数为3438。

地方政府债在2009年之前无发行，2009年发行数为50。2009年至2013年地方政府债发行数缓慢增长，2013年为72。2014年，新《预算法》放开了地方政府发行政府债的权限，同时地方对财政资金的需求也更为紧迫，因此2015年地方政府债发行数剧烈增长，为1035，接近上一年度的十倍。至2019年，当年发行数为2191。

宽口径城投债发行数呈现前期平稳增长，后期剧烈上升趋势。1997年至2008年为平稳增长时期，1997年发行数为1， 2008年发行数为63。2009年至2017年为高速上升时期，2009发行数为192，至2019年全国宽口径城投债发行数为4442。

以上为城投债宽口径的全国政府债券发行数情况。企业债口径的全国政府债券发行数数值上大于城投债口径，并且随着时间推后，其差值增大，2019年，企业债口径的全国政府债

券发行数为8753，为历年最大值，比当年城投债宽口径的全国政府债券发行数高出3173。由于宽口径城投债、企业债口径全国发行数变化趋势总体一致，此处便不具体分析。城投债窄口径的全国发行数在2017年数值上小于前二者，变化趋势与其相近，但在2018年及以后为上升趋势，与前二者不同。三者的差异是宽口径城投债、地方国有企业债和窄口径城投债不同的统计口径造成的，下图展示了三者具体的发行数变化和对比情况。

图3　1997-2019宽、窄口径城投债和地方国有企业债发行数对比图

地方国有企业发行数和宽、窄口径城投债发行数，三者变化趋势总体一致。1998年地方国有企业债发行数为2，之后缓慢增长，至2005年发行数为57，首次突破50。2006年至2013年增长速度加快，2006年为144， 2013年为1498。2014年至2016年为高速增长时期，2014年发行数为2782，接近上一年度的二倍。2017年小幅下降后再次连续增长，2019年为7613。

窄口径城投债发行数最小，2005年首次突破0，当年发行数为1。总体增长较为平缓，2019年则增长较快，当年发行数为2191。

以上为三种口径的全国政府债务发行数情况。

此外，目前国务院、发改委、财政部和审计署等部门的相关文件中虽然均涉及到融资平台的定义，但表述较为宽泛，口径也有差异，而wind资讯的城投债则根据中债登收益率曲线样本券进行划分，曲线样本券即属于城投债，其他不再计入。

## 4.2 债券发行额分析

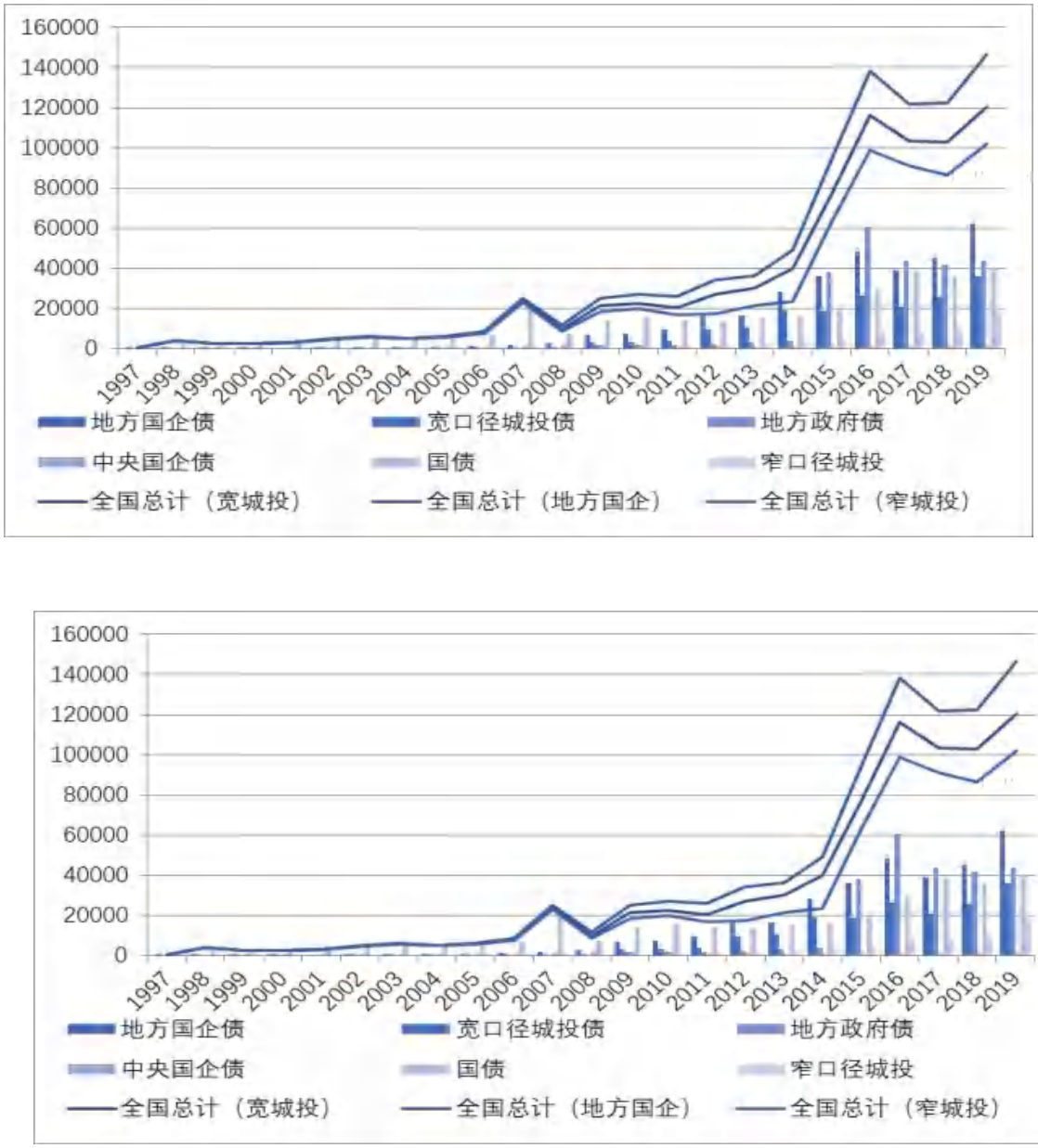



图4 1997-2019全国政府债券发行额统计图

图4展示了三种口径的全国政府债券发行额情况。以宽口径城投债进行分析，以全国角度来看，1997年至2019年全国政府债务发行额总体呈上升趋势，期间个别年份出现小幅下降。1997年至2006年发行数额较小，增长较为缓慢，1997年为535亿元，2006年为8029.3亿元。2007年至2014年增长较快，2007年总计23871.68

亿元，2014年为39686.53亿元。2015年至2019年为债券发行高速增长时期，2015年为77228.75，至2019年已经达到了120318.4亿元的水平。

政府债务发行额的增长与我国经济发展密切相关。1997年亚洲金融危机冲击了亚洲各国外贸市场，我国外向型经济也收到了影响，为此政府实施了积极的财政措施，发行了大量国债以稳定和推动经济发展。2004年后宏观财政政策开始转向稳健，但是政府债务增长的速度并未下降。2008年环球金融危机后中央政府再次采用积极财政政策，中央、地方或中央代地方发行了大量政府债券，以稳定就业、保障GDP增速。随着政府债务规模的扩大和债务压力的增加，社会各界开始重视政府债务风险的问题，中央也出台了一系列规定以规范政府债务的发行和资金流向。如2014年新《预算法》加强了对政府的财政约束，规范了地方政府的举债行为，以控制政府债务风险。然而此后，地方政府借助平台公司融资的现象时有发生，政策落实与监管力度不足。政府债务规模仍在持续扩大。

以下将分债券种类对政府债券发行额进行分析。

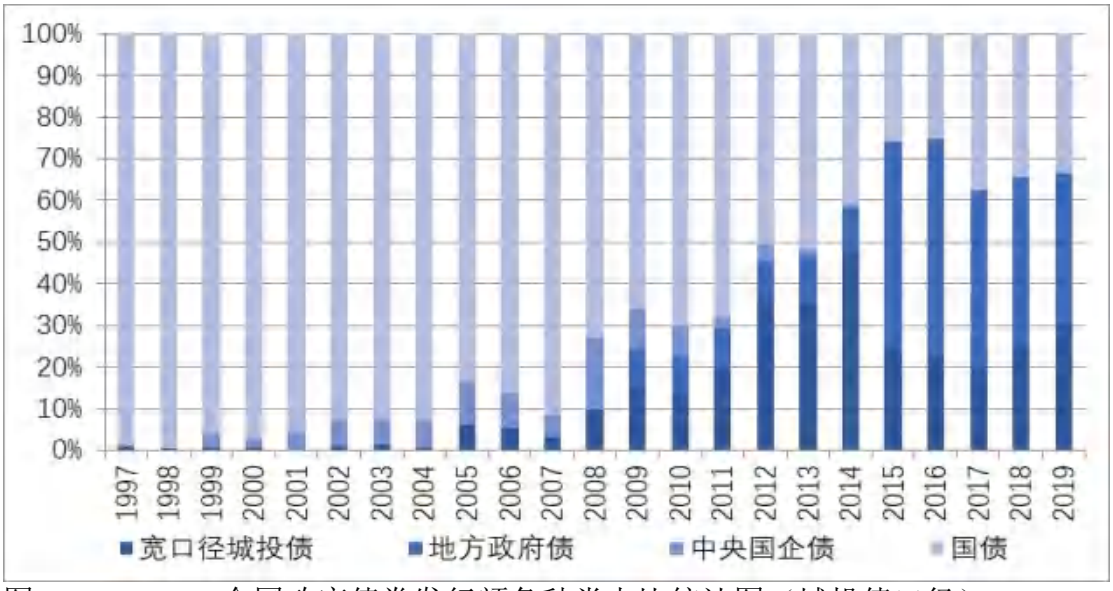



图5　1997-2019全国政府债券发行额各种类占比统计图（城投债口径）

图5表示了1997年至2019年城投债宽口径的各种类债券发行额的全国占比情况。其中国债情况较为突出，1997年至2013年一直为政府债券发行的最主要部分，2014年至2019年也占有全国发行额的三分之一左右，是政府债务发行举足轻重的部分。总体上看，国债发行额在全国总量中占比呈下降趋势。1997年，地方政府债尚未开始发行，中央国有企业债发行额为零，国债发行额在全国总额中占比接近100%。2005年至2007年在全国占比不低于80%。2008年至2014年间在全国政府债券发行额中占比下降较为明显。2015年国债发行额在全国政府债券中占比26%，为历史最低值， 2019年为34%。

中央国有企业债发行额在全国总额中占比较小。中央国有企业债发行额1999年首次突破零值，当年发行额为72.5亿元，占全国的2.86%。其后每年发行额在全国占比略有上升，但至2004年均未超过10%。2005年占比为10.01%。2008年为17.04%，为历史最高值，其后在全国占比总体呈下降趋势，2009年后已低于10%，至2015年已经仅占比0.47%，其后历年均不足0.10%。

地方政府债于2009年开始发行，当年发行额为2000亿元，在全国总额中占比8.84%。2009年至2014年间在全国占比变动幅度较小，在8%至12%间上下波动。2015年剧烈上升，占比49.66%，当年发行额为38350.62亿元，与2014年的4000亿元相比，接近其10倍。2016年发行额为60458.40亿元，并且占比51.93%，为历年最高值。其后年发行额在40000亿元至44000亿元间波动，在全国总发行额中占比逐渐下降，2019年降至36.55%的水平。

宽口径城投债在全国占比中呈现前期低水平，后期剧烈增长的趋势。1997年宽口径城投债发行额为5亿元，在全国政府债券发行总额中占比0.93%。1997年至2004年，宽口径城投债在全国占比均不超过1.5%。2005年至2014年间在全国占比总体呈上升趋势。2005年增长较为明显，年发行额为386亿元，当年占比6.40%。2014年，宽口径城投债发行额大幅增长，为19071.18亿元，在全国占比为48.05%，为历史最高值。其后其在全国占比水平在20%至30%间波动，2019年起发行额为36039.39亿元，占比29.95%。

以上为对宽口径城投债的全国债券发行额情况的分析，城投债窄口径、地方国企口径与其变化趋势相同，数额上不同，此处不对其进行更细致的分析。三者差异在于宽、窄口径城投债和地方国有企业债。

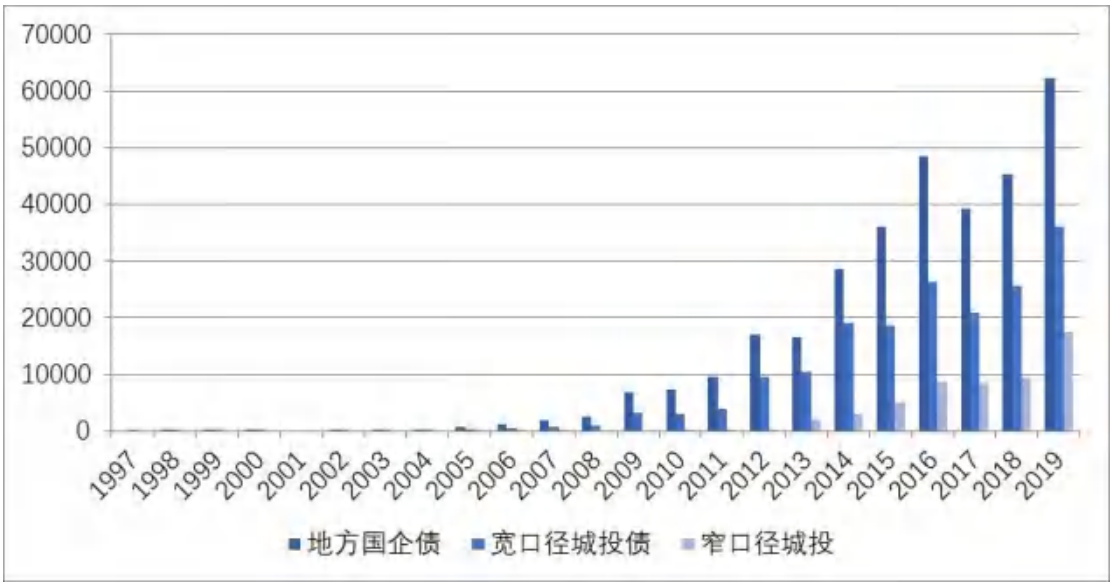



图6 1997-2019地方国有企业债和宽、窄口径城投债发行额细节展示统计图

图6显示地方国有企业债发行额在数额上均大于宽口径城投债，这是统计口径不同的结果。地方国有企业债发行额总体上呈现增长趋势。其于1998年突破零值，当年发行额为6亿元，至2019年其发行额已达62339.51亿元，增长十分迅速。窄口径城投债存量则小于宽口径城投债，总体变化趋势一致，但出现时间较晚，为2005年。2019年债务存量为17504.13。

### 4.3 债券还本付息额分析

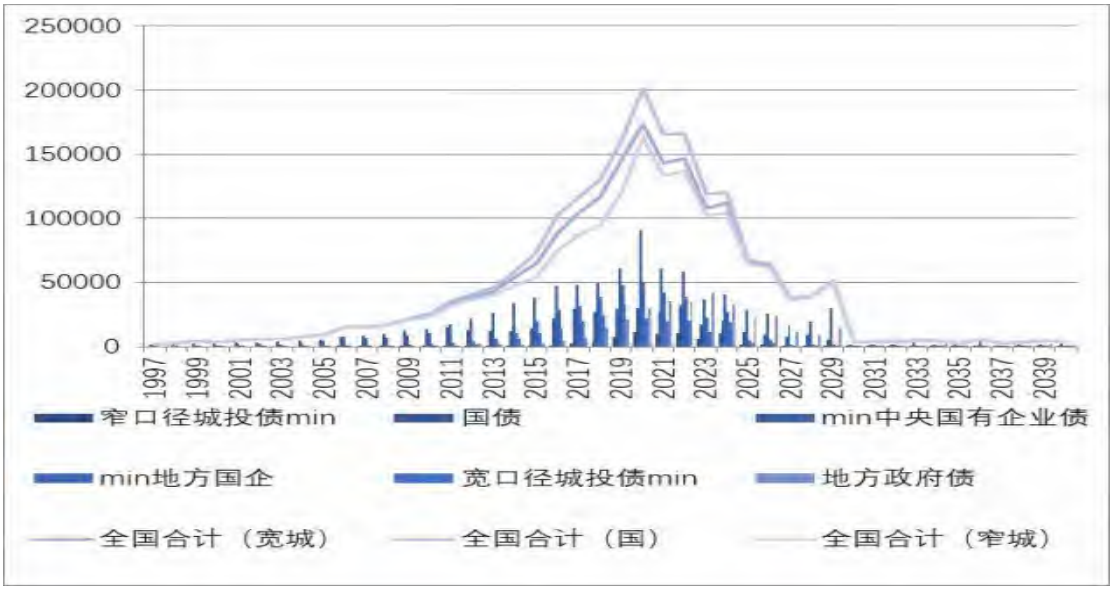



图7　1997-2019全国政府债务还本付息额统计图

由于全国口径的年度还本付息额最大值与最小值相对差别十分细微，下文我们使用年度还本付息额最小值进行分析。

上图显示了三种口径的全国还本付息值总额，三者趋势一致，地方国有企业债口径数额最大，宽口径城投债居中，窄口径城投债最小。首先以宽口径城投债口径为例分析全国还本付息额变化情况。

全国还本付息值总额呈持续增长趋势，1997年为2129.20亿元，2006年为15407.34亿元，首次突破10000亿元，2017年为103649.68亿元，首次突破100000亿元，2019年为144692.25亿元，截止2020年4月，当年还本付息额已达173448.07亿元。

全国政府债务还本付息额的增长率在1997年至2008年间波动较大，剧烈增长和缓慢增长交替出现，但由于数额体量较小，因此并不明显。2008年至2019年增长情况相对平稳，随着政府发债制度化、规模化、市场化，全国还本付息额增长率逐渐稳定。

全国政府债务还本付息额在逐年增加，政府债务压力在持续扩大。1997年积极财政政策时期，中央和地方发行了大量政府债券，在其后年分还本付息额迅速增长。尽管2004年宏观财政政策已经开始向稳健转变，政府债务增长的速度并未下降。2008年环球金融危机，中央政府又一次采用了积极财政政策，为稳定就业、保住GDP增速，以基础设施建设带动经济发展。此间中央、地方或中央代地方发行了大量政府债券，为以后年度还本付息造成了巨大的财政压力。

2014年新《预算法》加强了对政府的财政约束，规范了地方政府的举债行为，以控制政府债务风险。然而此后，地方政府借助平台公司融资的现象时有发生，政策落实与监管力度不足。其后，新债务陆续发行，旧债务纷纷到期，政府债务还本付息额持续攀升。

国债还本付息额总体呈上升趋势，期间个别年间略有下降。1997年国债还本付息额为1909.00亿元， 2019年为29584.75亿元，截止2020年4月，当年还本付息额为30240.03亿元，为历史最高值。中央国有企业债还本付息额1997年至2010年低于国债还本付息额，2010年后高于国债，并且在2018年至2020年迅速上升。1997

年其数值为220.19亿元，2019为60591.21亿元，截止2020年4月，当年还本付息额为90789.12亿元。

地方政府债自2009年开始发行，当年无还本付息额。2010年至2017年地方政府债还本付息额增长速度较慢，2010年为35.94亿元，2017年为6648.36亿元。至2019年，地方政府债还本付息额为21373.75亿元，截止2020年4月，当年还本付息额为30434.73亿元，为历年最高值。

地方国有企业债与宽、窄口径城投债还本付息额总体上增长趋势相似，在数值上最大。1997年地方国有企业债还本付息额为3.2亿元，同年城投债为0。1997年至2014年增长较为平缓，2014年地方国有企业债还本付息额为10711.62亿元，首次突破10000亿元，同年宽口径城投债为5786.57亿元，窄口径城投债为177.92。2015年至2019年增长速度较快，2015年地方国有企业债还本付息额为19301.97亿元，宽口径城投债为10882.54亿元，窄口径城投债为414.44。至2019年，地方国有企业债还本付息额为47836.55亿元，宽口径城投债为33142.54亿元，窄口径城投债为7740.40。截止2020年4月，地方国有企业债还本付息额当年数值为50304.18亿元，宽口径城投债为21984.20亿元，窄口径城投债为11115.86。

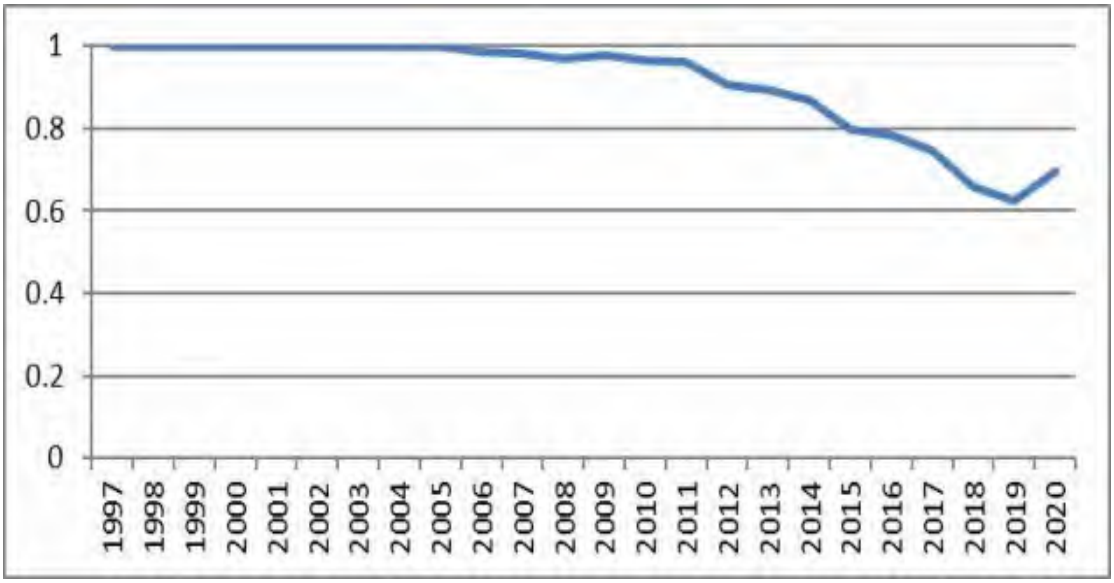



图8　中央债务还本付息额占比折线图（城投债宽口径）

以上为各种类债券还本付息额细节分析。此外，图4-7 展示了中央地方债务在全国的占比情况。中央政府债务包括国债和中央国有企业债。中央还本付息额大多数年份占全国的主体，1997年至2019年占比均在50%以上，表明中央政府债务占我国政府债务的主体。 然而地方政府债务自2005年开始快速增长，2005占比不足1%，2019年占比为47.68%，已经接近半数。

## 5．政府债务省份层面分析

### 5.1　省份层面情况展示

5.1.1 全国各省情况概览：

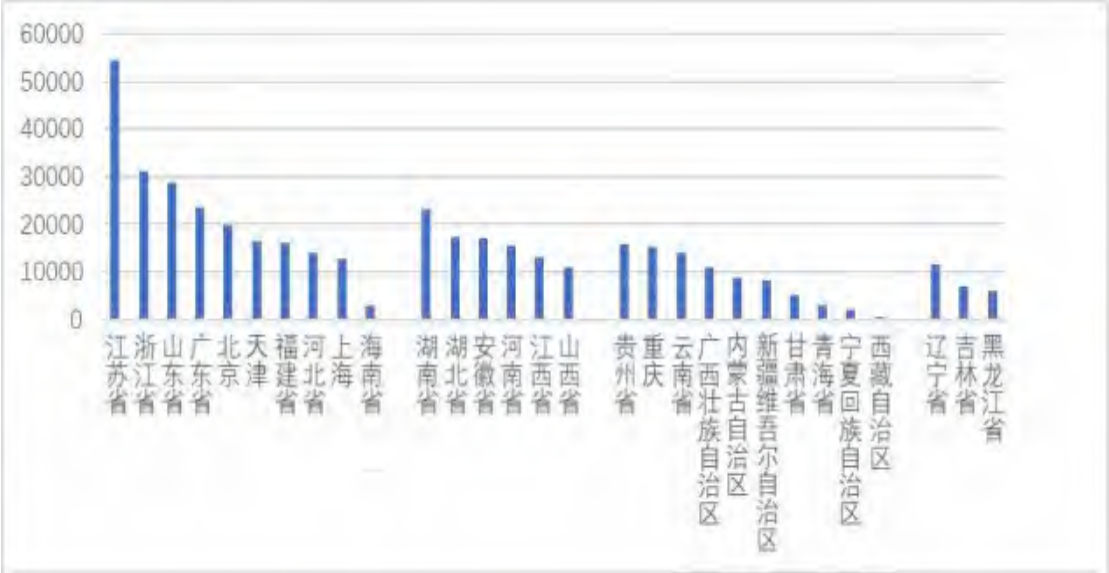



图9　2019年分区域各省存量债务柱状图

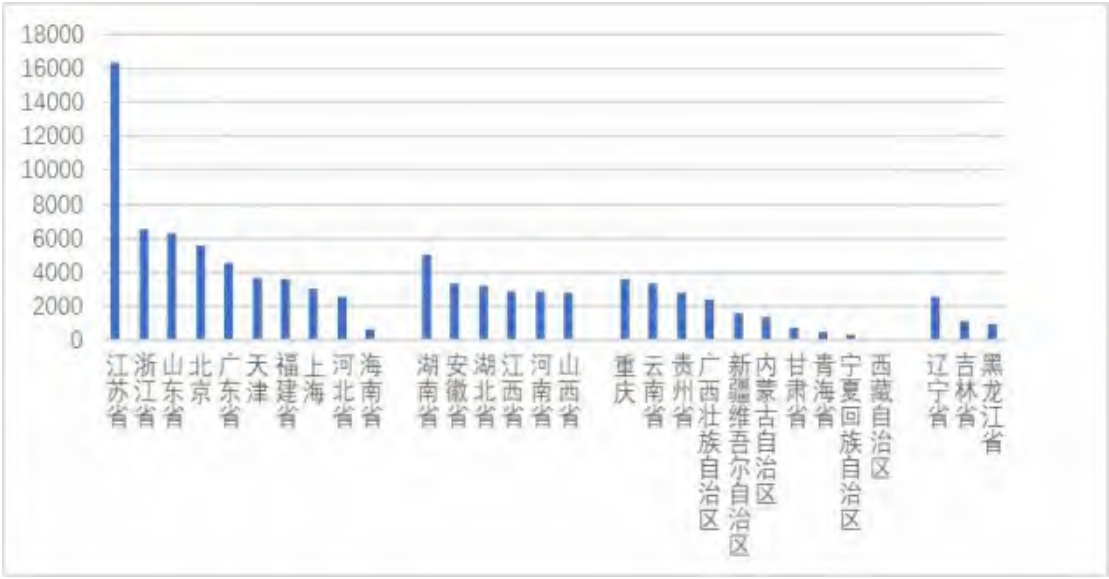



图10　2019年分区域各省还本付息数额柱状图

首先，选取2019年度的地方政府债务存量及其该年产生的还本付息数额，直观描述各经济片区各省份的债务压力状况。根据《中共中央、国务院关于促进中部地区崛起的若干意见》、《国务院发布关于西部大开发若干政策措施的实施意见》以及党的十六大报告的精神，我国的经济区域划分为东部[8]、中部[9]、西部[10]和东北[11]四大地区。图中每组第一个深色标明为四大地区[12]中债务存量或还本付

8 东部地区：北京市、天津市、河北省、上海市、江苏省、浙江省、福建省、山东省、广东省、海南省、台湾省、香港特别行政区、澳门特别行政区

9 中部地区：山西省、安徽省、江西省、河南省、湖北省、湖南省

10 西部地区：内蒙古自治区、广西壮族自治区、重庆市、四川省、贵州省、云南省、西藏自治区、陕西省、甘肃省、青海省、宁夏回族自治区、新疆维吾尔自治区

11 东北地区：辽宁省、吉林省、黑龙江省

息额最大的省份，分别为东部的江苏省、中部的湖南省、西部的重庆市和东北的辽宁省。

2019年政府存量债务为2万亿以上的省份有六个，分别为：江苏省、浙江省、山东省、广东省、湖南省和四川省，债务余额分别为5.5万亿、3.1万亿、2.9万亿、2.4万亿、2.3万亿和2.2万亿，前四全部属于东部省份，湖南为中部省份、四川为西省份。债务存量最低的省份为这表明东中部经济较发达地区债务余额更大。西藏自治区是唯一不足1000亿的省份，2019年存量债务仅达到509亿。

2019年各省还本付息数额和债务存量排名基本一致，然而仍然存在一定的额差异。在东部地区中，北京市和上海市的还本付息额排名均上移一个单位，中部地区中安徽和河南均上移一个单位，西部地区中重庆市和内蒙古排名前移，东三省排名不变。这些在2019年度还本付息额更大的省市自治区在未来年度偿还压力将得到一定程度的缓解。

另外，值得注意的是，江苏省2019年还本付息额为排名第二的浙江省的2.5倍，而债务存量仅为浙江省的1.75倍，这表明江苏省当年偿还额度较大，当年的债务压力可以得到及时的缓解，表明该省债务对未来形成的负担更小。

图11　2018年各省GDP及其增速组合图

图12　2018年度各省GDP增速变化对比柱状图

其次，整体描述各地区经济状况和支付能力。将某地区GDP总额作为该省经济发达程度的衡量指标，可以发现，东部地区往往拥有更高的国民生产总值而西部地区则明显经济水平更为落后。在全国各省份中，广东省和江苏省2018年拥有最高的GDP总额，分别为10.0万亿和9.3万亿，和其他省份拉开明显的额距离。而所有省份中共有四个省份GDP不及1万亿，由低到高依次为西藏自治区、青海省、宁夏回族自治区和海南省，分别为1548亿、2748亿、3510亿、4910亿和8104亿，西藏的GDP总额不足广东省的2%。

观察各省2018年GDP增速可以发现，全国一半以上的省份GDP相较2016至2018年均值发生了下滑，云南省和安徽省GDP增速明显，分别提高了11.89%和10.05%，辽宁省、内蒙古自治区GDP增速由负转正，河北省、山东省由正转负，黑龙江省、吉林省和天津市GDP负增速持续继续恶化，分别从-4.62%、-6.16%、-5.37%下滑至-19.22%、-24.70%、-27.96%。

观察各省2018年GDP增速可以发现，全国一半以上的省份GDP相较2016至2018年均值发生了下滑，云南省和安徽省GDP增速明显，分别提高了11.89%和10.05%，辽宁省、内蒙古自治区GDP增速由负转正，河北省、山东省由正转负，黑龙江省、吉林省和天津市GDP负增速持续继续恶化，分别从-4.62%、-6.16%、-5.37%下滑至-19.22%、-24.70%、-27.96%。

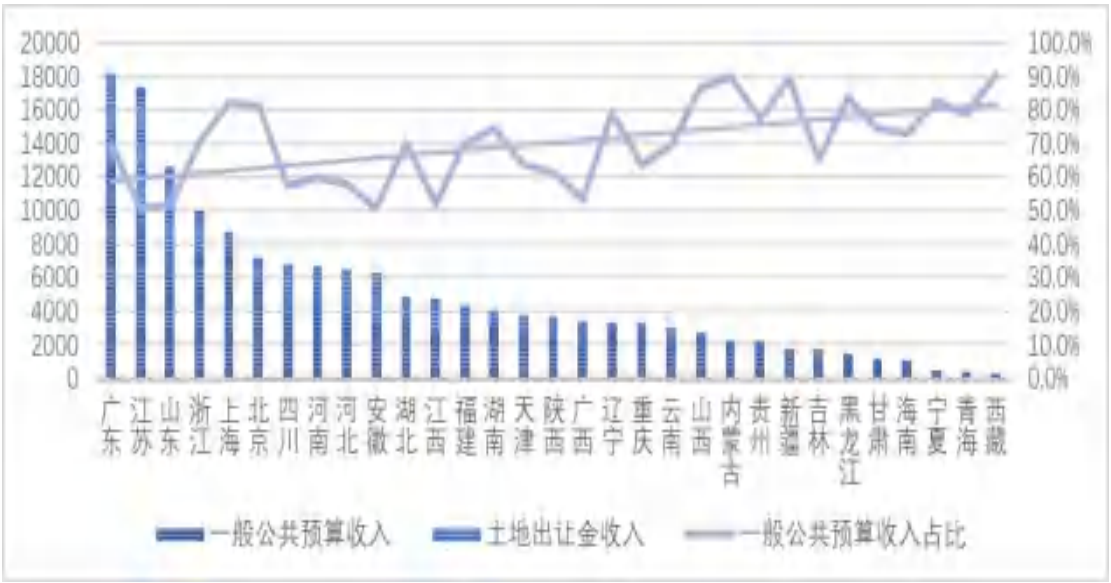



图13　2019年各省政府财力组合图

上图为2019年各省政府财力统计，从地区层面可以看出，东部发达省份地方政府往往拥有更高的财政收入，这也表明其具有更雄厚的债务支付资金。这里用政府一般公共预算收入和土地出让金收入总和作为地方政府总和财力的衡量指标，这里将其定义为广义财政收入。总和财力评价中，位列前三的省份为广东省、江苏省和山东省，其广义财政收入分别为1.8万亿、1.7万亿和1.3万亿，收入低于1000亿的省份从低到高依次为西藏自治区、青海省和宁夏自治区，分别为244亿、357亿和512亿，广义收入最低的西藏地区仅为最高省份广东省的1.35%，可以看出不同地区政府财力存在巨大差异。

广义政府财政收入包括一般公共预算收入和土地出让金收入，一般公共预算收入以税收为主，是具有较稳定来源的地方政府收入，而土地财政下的出让金收入是地方政府将土地整理后，利用招拍挂的形式形成的土地出让收入，和房地产的繁荣有紧密联系，存在政策调控的影响。观察各省政府收入的结构可以发现，

2019年土地出让金收入占广义政府财力的百分比达到40%以上的有8个省市自治区，其中安徽省和江苏省土地出让收入分别达到49.4%和49.3%，和一般公共预算收入几乎相同。

## 5.2 省份层面还本付息情况介绍

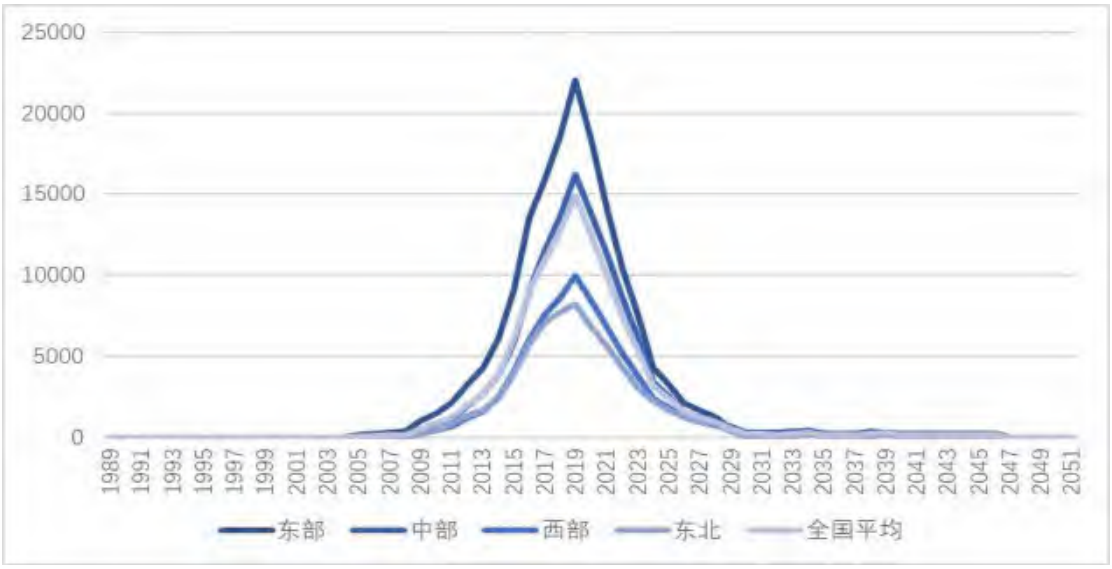
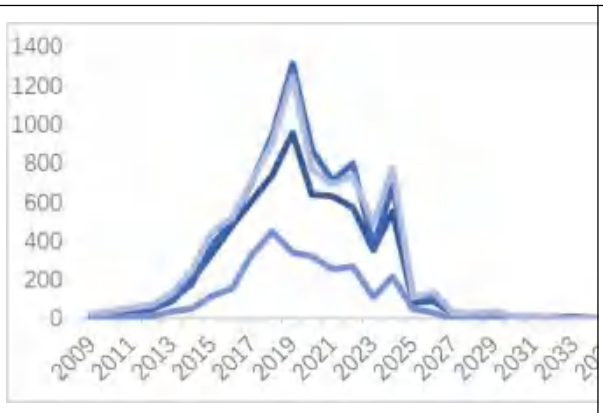
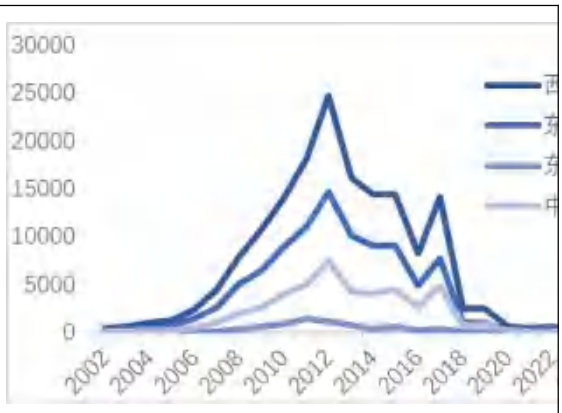
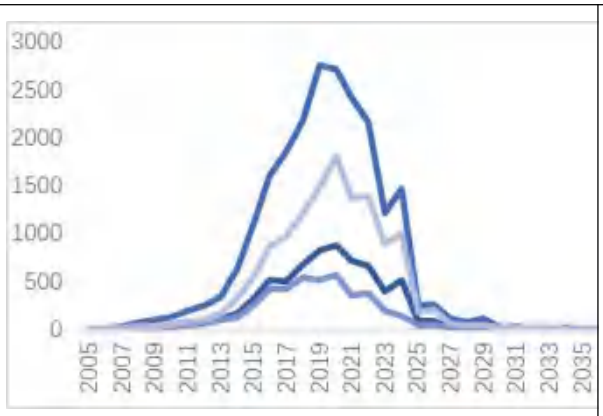


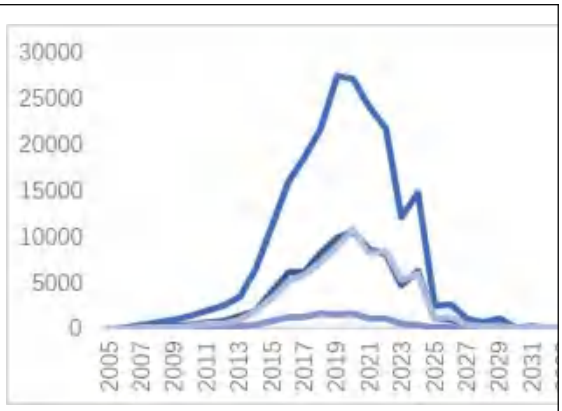

图14 1990-2050地方政府汇总债务年度债务存量折线图

按照时间序列汇总的各年度东部、西部、中部和东北的债务存量也可以看出，东部省份的债务量远高于全国平均，中部则和全国平均保持一致，另外，西部和东北部地区债务量差别不大。相比而言西部地区经济发达程度较差，财政收入对债务量的覆盖率更低，因此存在更高的债务偿付风险。

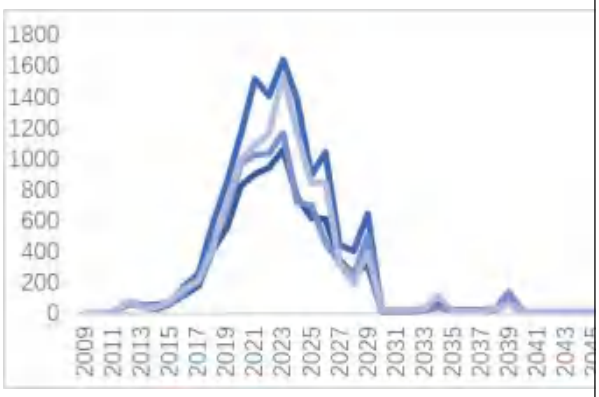
| | |
|---|---|
|  |  |
| 城投债（平均） | 城投债（总和） |



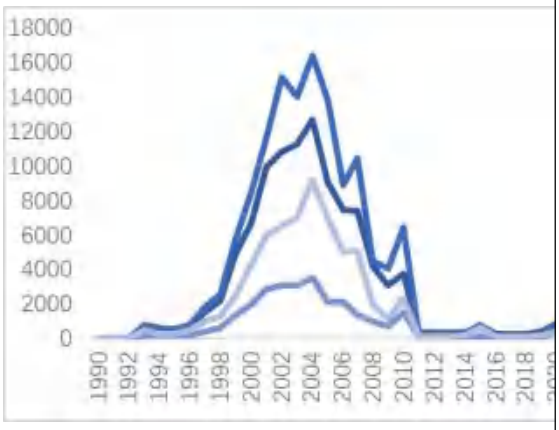

国企债（平均）




国企债（总和）




地方债（平均）




地方债（总和）

图15　2000-2040分区域各债务类型时间序列折线图

分别从地方债务的三种构成观测各经济区域的债务每年还本付息额，由于债务平均值和观测省份个数有关，因此分别选取平均值和和加总值描述。由图可以看出，各地区在不同债务额上存在显著差异。对于还本付息压力的时间趋势，整体对比来看，城投债和国企债均在2019年达到偿付压力峰值，而地方政府债券则在2021年的小高峰后迎来2023年的偿付压力峰值。

城投债还本付息方面，东部和中部省份每年平均额最大且相似；西部省份和前两者相差不大，可以从总和上看出，西部地区整体拥有最大的城投债还本付息总额。这是由于西部地区经济发展基础先天不足，且财政来源后天缺失，因此缺乏经济驱动来源，因此城投债成为地方政府筹集资金的主要平台。而东部省份经济更发达，经济收入来源广泛，因此对城投债务的依赖程度也较小。

国企债还本付息方面，东部地区和中部地区的差距变得明显，东部地区的当年额度超过西部地区成为最高，且2019年达到2.8万亿，几乎为其他各地区之和。说明东部省份地方政府更倾向于采用企业债的方式募集资金。

地方政府债券方面，四大经济区差距不再显著，东北片区更是超过西部地区平均值。这表明东北地区经济发展对政府债券的依赖度较大，由于地方债券为显性债务，这也可以看出国家政策对东北地区的偏爱。

5.2.1 东部还本付息情况介绍：

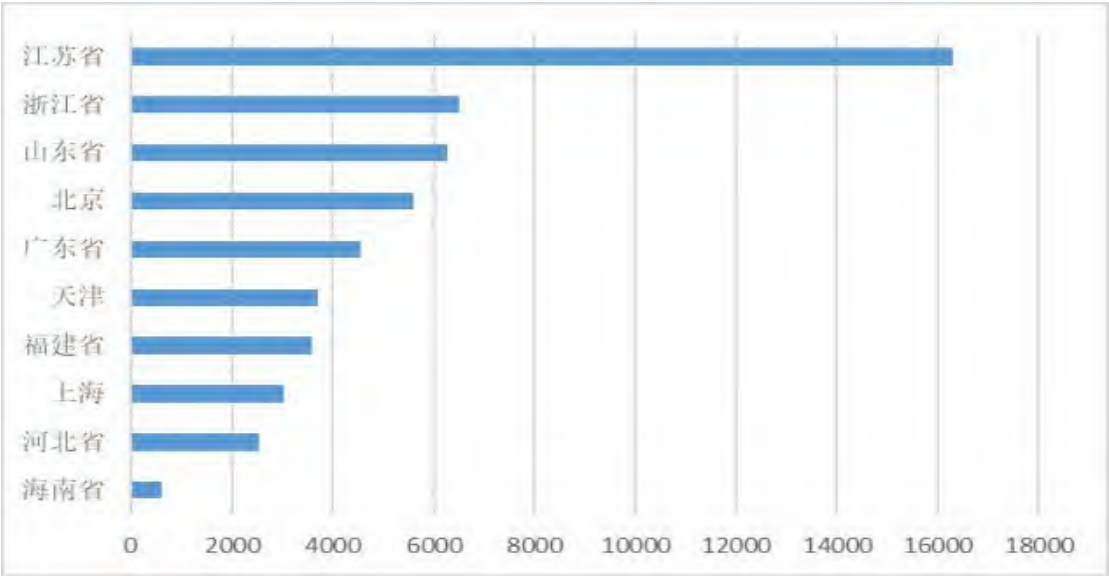



图16 东部地区汇总债务本息支付柱状图

对于2019年度地方债务本息支付总额，东部地区中江苏省应付本息约16000亿元，显著高于其他各省份，几乎达到第二至第四，即浙江省、山东省、北京市债务支付额的总和。而海南省则显著低于其他省份，是次低的省份河北省支付额的25%。除江苏省和海南省以外的地区本息支付额为2000亿至6000亿左右。

5.2.2 中部还本付息情况介绍：

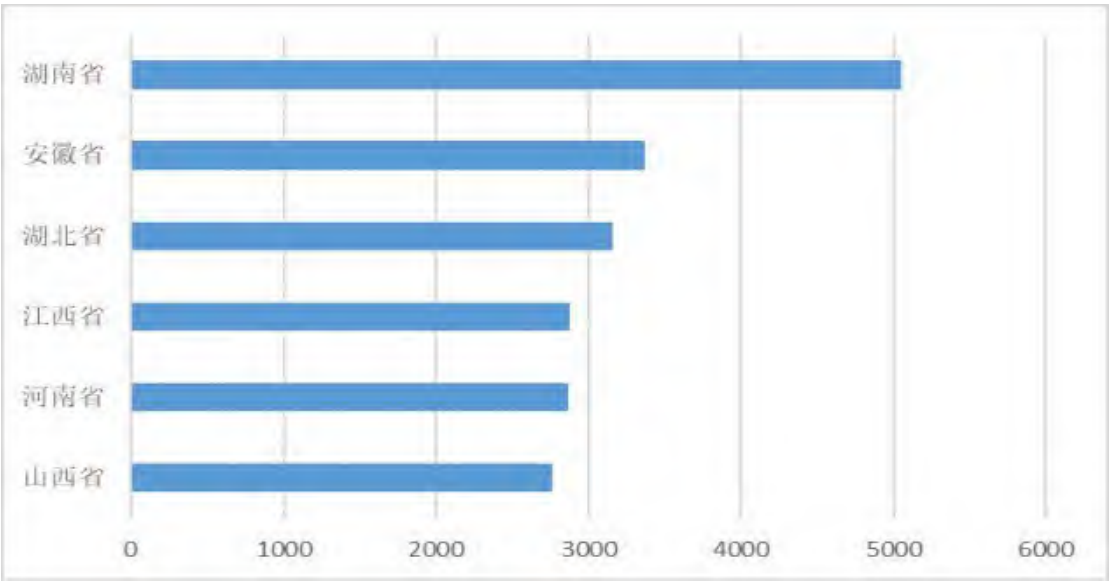



图17 中部地区汇总债务本息支付柱状图

中部地区中湖南省相较其他地区2019年支付额为最高，达到5000亿以上，其余省份支付额差异不大， 安徽省和湖北省均高于3000亿，江西省、河南省和山西省均低于3000亿。

5.2.3 西部还本付息情况介绍

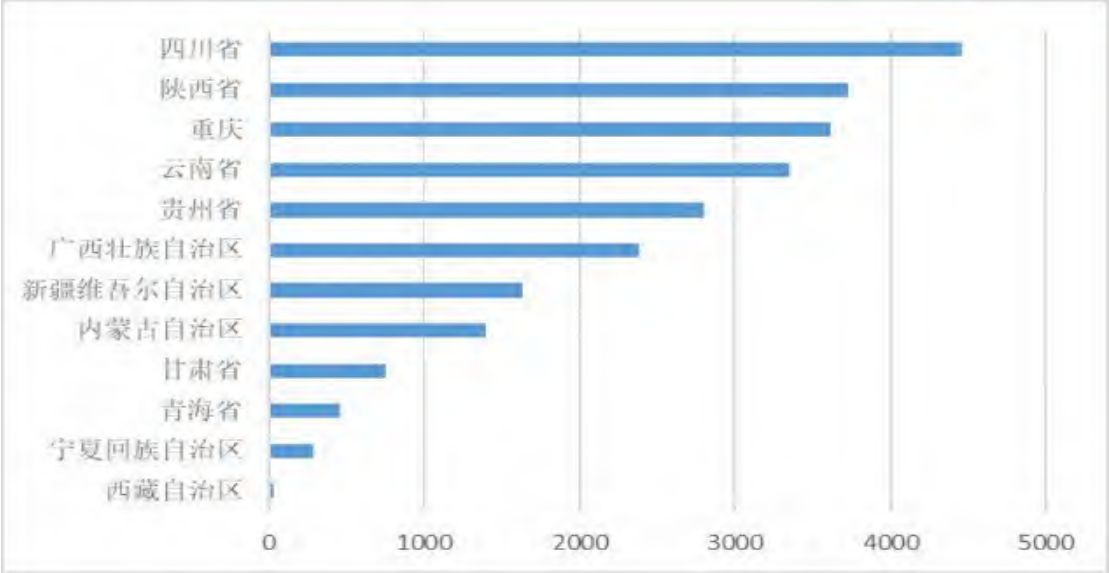



图18　西部地区汇总债务本息支付柱状图

西部地区各省市支付额差异较大，基本上呈现三个梯级。四川省、陕西省、重庆市和云南省支付额最大，处于3000亿至4500亿区间；贵州省、广西、新疆和内蒙古四个省和自治区呈现下降的趋势，支付额处于1000亿至2500亿区间；甘肃省、青海省、宁夏和西藏自治区支付额则均为1000亿以下。

5.2.4 东北还本付息介绍：

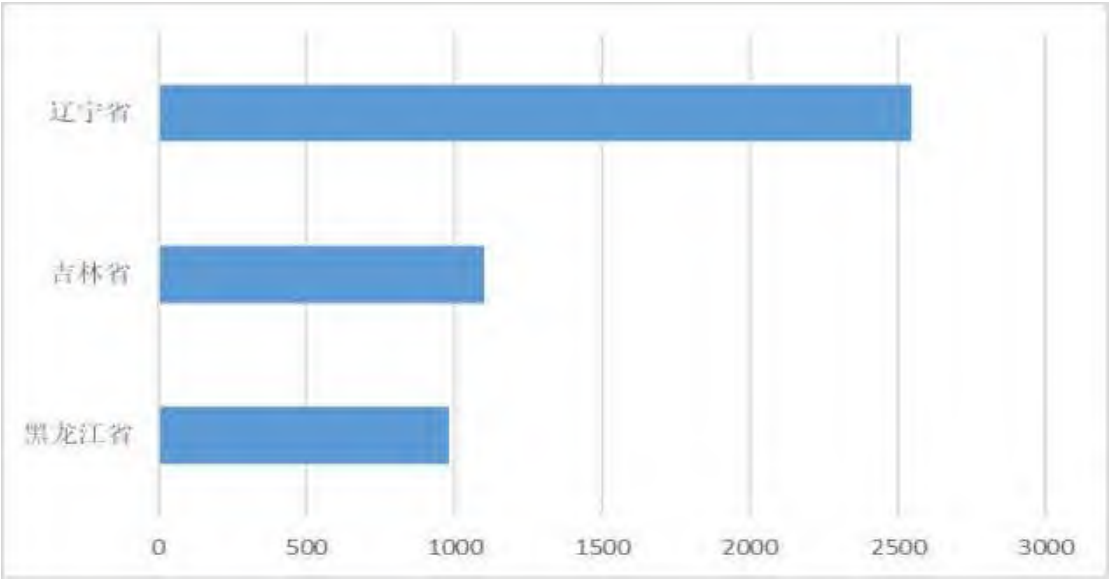



图19　东北部地区汇总债务本息支付柱状图

辽宁省的2019还本付息额显著小于其他两个省份，高达2500亿，偿债压力较大。吉林省和黑龙江省均约处于1000亿左右。

## 5.3 省份层面评价指标分析

5.3.1 全国各省情况概览：

图20 2017-2019各省负债率（城投债口径）柱状图

图21 2017-2019各省负债率（企业债口径）柱状图

首先，以2017-2019年各省负债率作为各省的偿债压力指标观测，重点从城投债口径和企业债口径下选取负债率最高的5个省份和负债率最低的3个省份分析各省偿债压力。

如图21，大部分省份的负债率均逐年增加，仅云南省、福建省、辽宁省和上海市2019年负债率相较2017年没有明显上升，两个口径下维持不变或上升在1%以内，其中唯一负债率出现下降的是云南省，负债率下降2%，说明其偿付压力存在缓解的趋势。

整体排名情况来看，青海、贵州和天津负债率超出安全范围60%，除了天津市是在2018年开始达到60%债务率以外，其他两个省份三年均维持60%以上的负债率，债务风险一时间难以化解。负债率排名后5的地区中多为东西部地区，这表明地方行政单位负债率的大小和其所处地理位置有紧密联系。多数西部地区GDP和本年债务余额都较低，然而GDP即经济水平不足以支持债务的偿付，因此在评价指标中拉高了该省的负债率。债务风险最低的省份为西藏自治区、广东省

和上海市，广东省2018年GDP排名全国第一，债务存量排名全国第四，说明其巨大的经济优势保证了负债率分母的稳定，由此大力支持了其债务偿付。相似具有代表性的是，在债务余额中排名第一的省份江苏省，在偿债率方面并没有危机预警，仅处于中位数附近，说明该地区发达的经济水平同样足以承担债务风险。

在两个指标下青海省都具有最高的负债率，且在3年内呈现上升趋势。同时，其在企业债口径下负债率相对更高，这表明企业债比城投债对青海形成的偿付压力更为显著。天津市负债率在2017至2018年发生了显著的增加，在两种口径下分别从36%上升到61%和从45%上升到76%，原因在于其2017-2018年度GDP增速负向下滑，经济发展状况不容乐观。

对比两种口径下不同省份负债率排名可以发现，山西省在城投债口径下排名发生明显上升，从企业债口径下排名正向第五到城投债口径下排名倒数第八。四川省、江西省、甘肃省、内蒙古自治区在城投债口径下排名发生明显回落，约下降4~6个位次。

图22　2017-2019各省偿债率（城投债口径）柱状图

图23　2017-2019各省偿债率（企业债口径）柱状图

其次，以2017-2019年各省偿债率作为各省的偿债压力指标观测，重点从城投债口径和企业债口径下选取偿债率最高的6个省份和偿债率最低的2个省份分析观测各省偿债压力。

在企业债口径下比城投债口径下超出偿债率危险线的省份明显更多，且在2019年仅有排名前四位的省市没有超出30%的危险线，城投债口径下2017年仅有6个省份偿债率超出30%，而2018年增加到了17个省份，2019年更是达到了23个省份之多。两种口径下3年均维持在25%的发展中国家警戒线以下的省份仅有广东省，偿债率均未突破20%，即发达国家的偿债率警戒线。

对风险最高的前六个省份进行分析可以看出，该六省偿债率均超出国际警戒线20%的水平。其中排名第一的青海省偿债率有下降趋势，虽然2019年仍旧维持第一的排名，但是可以看出该省在债务风险控制方面做出的巨大努力。贵州省在两种口径下偿债率都在2017至2018年度发生了显著的增加，分别由28%和34%和增加到了65%和73%，增加了一倍左右。陕西省和云南省也呈现出较为明显的增幅。

两种口径对比可以看出，山西省明显在企业债口径下具有更高的额偿债风险，这和负债率的相关分析情况类似；偿债率和负债率对比可以看出，青海省在两种指标下都有着全国最高的偿付风险，在企业债口径下3年均超过100%的偿债率，城投债口径下虽未超出100%，但2017年95%的水平也以暴露出巨大风险。陕西省在负债率指标下并未具有靠前的排名，然而偿债率指标下却暴露出较大的风险，由于负债率的分母为国民生产总值，是债务偿付的间接保证，偿债率分母是当年政府公共预算收入，描绘的是债务偿付的直接来源，陕西省GDP位于全国排名中上游，财政收入水平处于中下游，财政收入和地方经济发展关系较弱，表明其经济发展仍有更加其他支撑来源。

对风险最低的前两个省份进行分析可以看出，在负债率水平中处于第一至第二区间的西藏自治区在偿债率指标下排名发生了后移，这表明西藏自治区经济发展额来更多是地方财政收入。而相比之下，上海市和广东省就具有更加广泛的经济收入来源，无论在哪种指标下都维持了最低的债务偿付风险。

动态变化层面观察，大部分省份在三年内风险持续累积，偿债率呈现上升的趋势。值得注意的是，西藏自治区却成为少有的控制住债务风险的地区，从2017~2018年度的高于警戒线水平到2019年回落到了仅有9%。

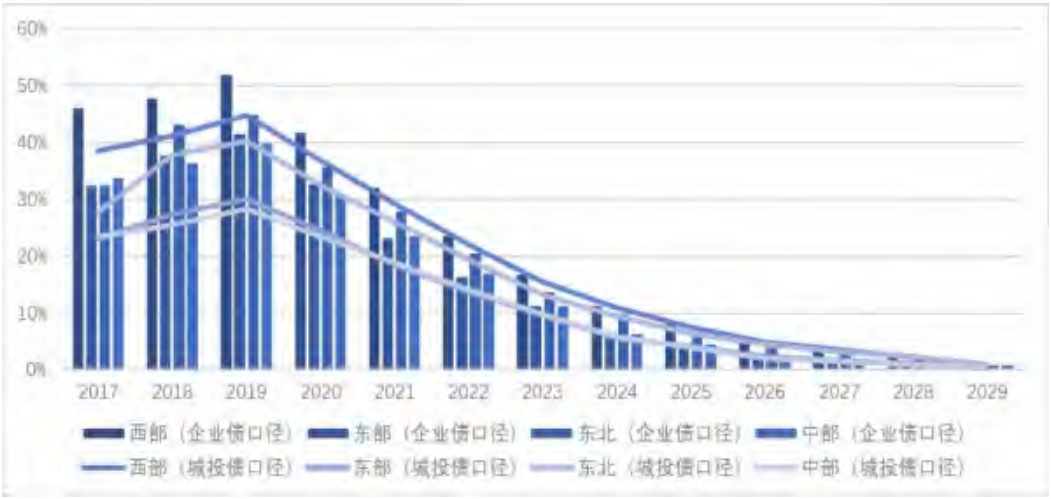
图24 2017-2019各省债务率（城投债口径）柱状图

图25　2017-2019各省债务率（企业债口径）柱状图

最后，以2017-2019年各省偿债率作为各省的偿债压力指标观测，重点从城投债口径和企业债口径下选取偿债率最高的5个省份和偿债率最低的3个省份分析观测各省偿债压力。

从总体情况上来看，绝大多数省份在三年内均超出国际警戒线的150%，且同样在企业债口径下拥有较为良好的表现。从动态表现上来看，河北省、陕西省、辽宁省是为数不多的在两种口径下债务率均发生回落的省份。

和前两个指标进行对比可以发现存在有一定差异。例如在债务率水平下排名后三、四位的湖南省和内蒙古自治区在负债率和偿债率指标下却并没有暴露出明显的风险。分析可知，债务率和偿债率的区别在于前者描绘的是存量债务的风险比率，而后者描绘的是当年还本付息额的偿还风险比率。债务率和负债率的区别在于前者使用了直接的偿付手段，即政府综合财力作为债务偿还能力的体现，而后者使用了GDP规模，而也就是间接偿还手段作为偿债能力的体现。因此可以认为内蒙古和湖南尽管存量债务规模较大，但是实际各年的还本付息额度并没有暴露出巨大风险；同时这两个地区存在经济发展状况和支付能力不对等的状况，即较好的经济发展状况下地方综合财力更显不足。



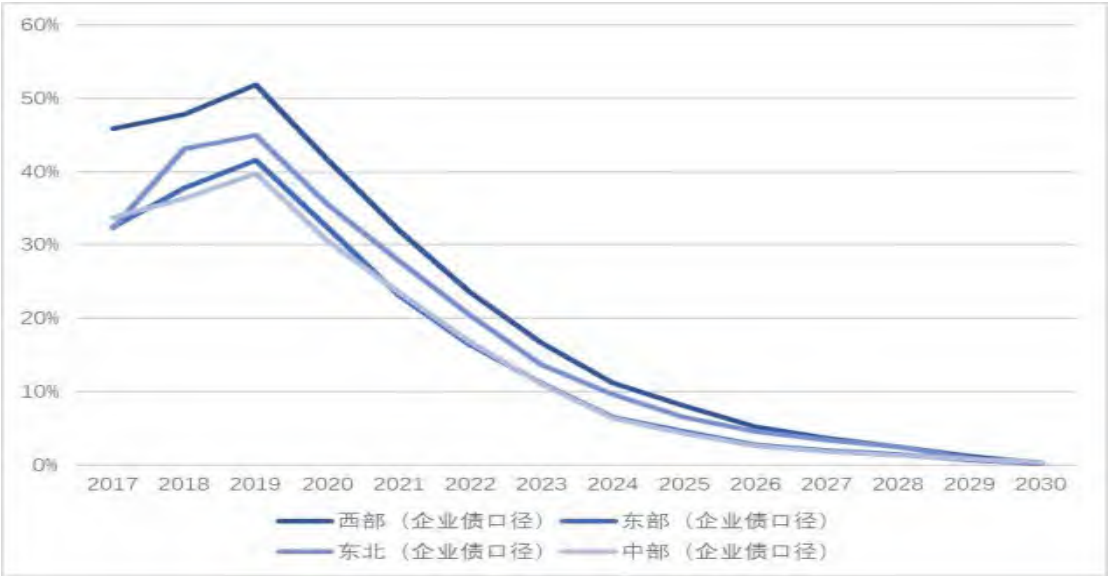



图26 2009-2039分区域负债率（企业债口径）折线图

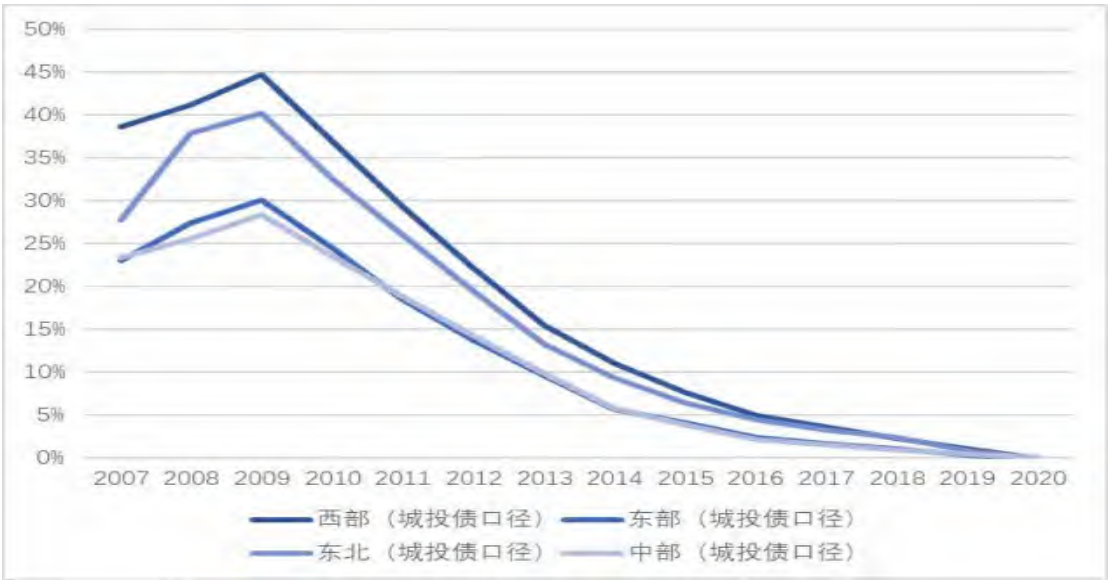



图27 2009-2039分区域负债率（城投债口径）折线图

对四大经济区的负债率水平分别在企业债和城投债水平下进行对比，可以发现西部地区具有最高的负债率水平，其次是东部地区，东部地区和中部地区的负债率没有明显差异。2017至2018年度年东北地区和西部地区的负债率差距显著减小，这和东三省老工业基地未能成功振兴，却在低效率的制造水平下投入大量资金，导致新经济发展动力不足而拖累GDP持续低增长甚至负增长有关。

图28　2009-2039分区域偿债率（企业债口径）折线图

图29　2009-2039分区域偿债率（城投债口径）折线图

各地区均在2019年达到偿付风险峰值，之后存量债务偿付风险回落，但是在整体经济发展状况没有明显改善、债务结构仍存在问题的情况下，叠加新冠疫情下巨额新增债务，预期仍会造成持续上升的额债务偿付压力。

其次对四大经济区的偿债率水平进行对比，发现在该指标下东北地区整体偿债压力仍然低于西部地区，但是在某些年份两个地区已经追平。且东部地区和中部地区的偿债风险被拉大，安全性更加凸显。各地区偿债率风险在各年中较为分散，在2019至2021年度风险集中体现。

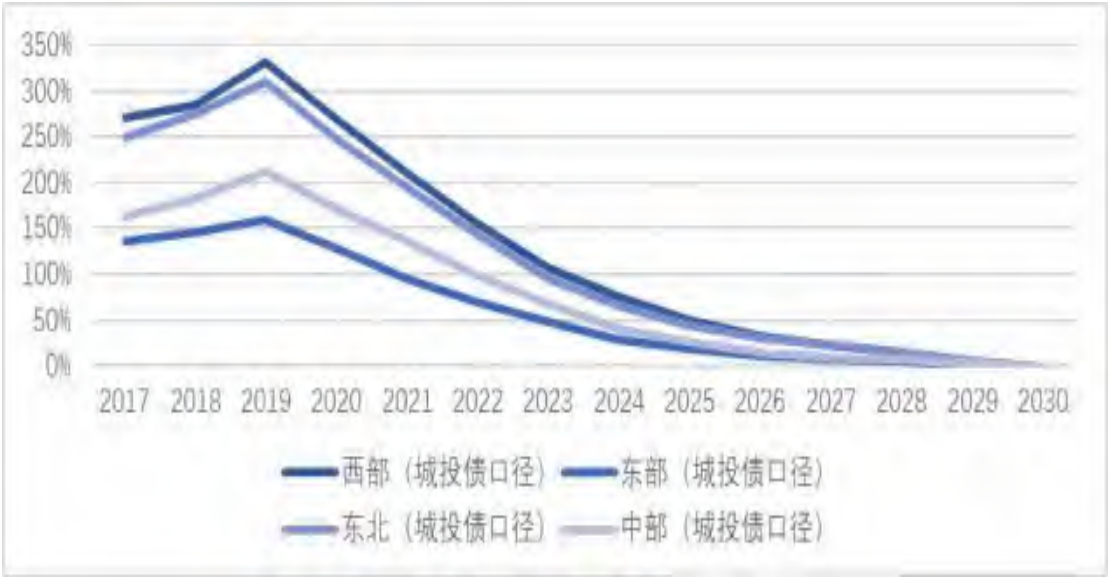



图30 2000-2039分区域债务率折线图13

最后对其次对四大经济区的债务率水平进行对比，发现大体走势和相对大小和前两个指标近似，也是在2019年达到偿付风险的峰值。其中西部地区在2018年度前后债务率增速发生拐点，2017至2018年度增速较平缓，2018至2019年度增速显著增大。

5.3.2 分经济区域分析：

（1）东部评价指标分析

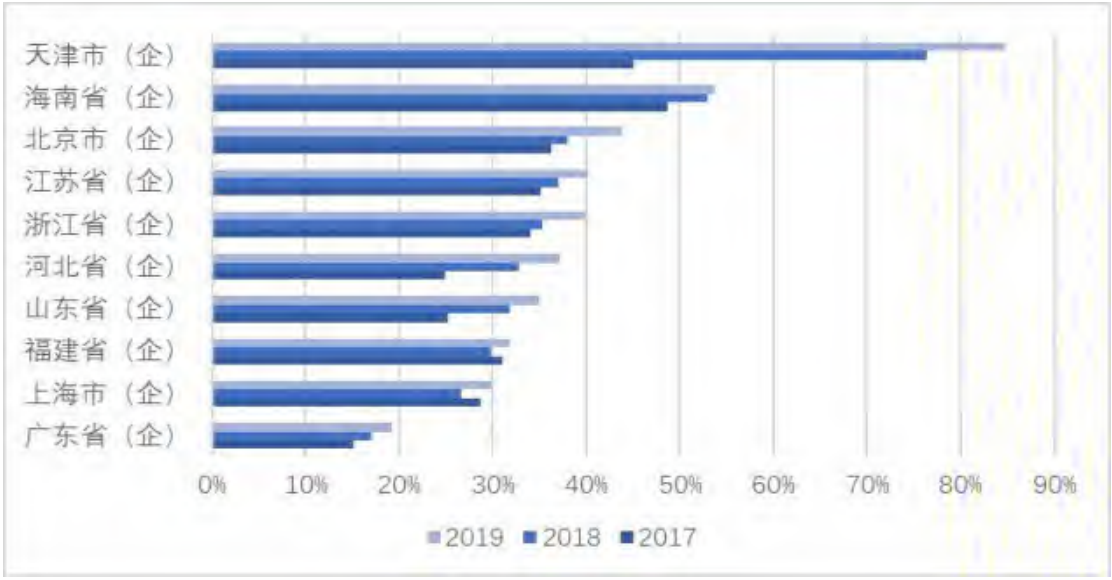



图31 东部地区2017-2019年负债率（企业债口径）

[13] 注：仅城投债口径，企业债口径下数据存在缺失。

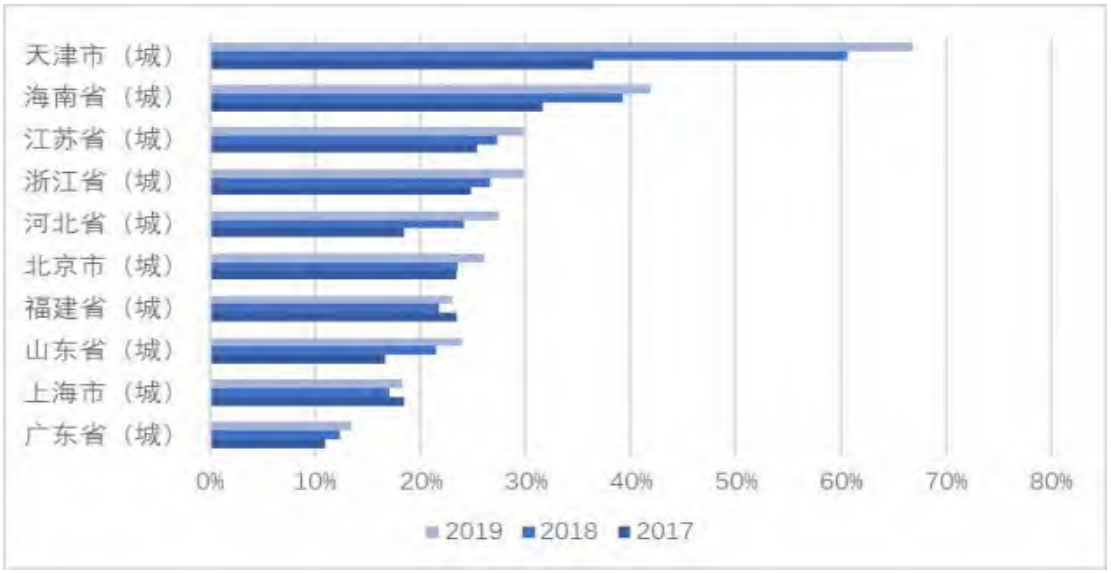



图32　东部地区2017-2019年负债率（城投债口径）

东部地区两种口径下各省负债率排名没有显著差异，但是负债率大小上，城投债口径下明显更小。其中超出国际警戒线60%的仅有天津市，其次为海南省，3年基本均高于50%，其余各省基本处于20%~40%的区间，广东省显著低于其他各省，平均进仅有15%的负债率，其良好的经济状况支持了较高的债务水平。虽然天津市2017年负债率尚低于海南省，并且维持在警界线以内，然而从2017至2018发生显著增加，突破60%。

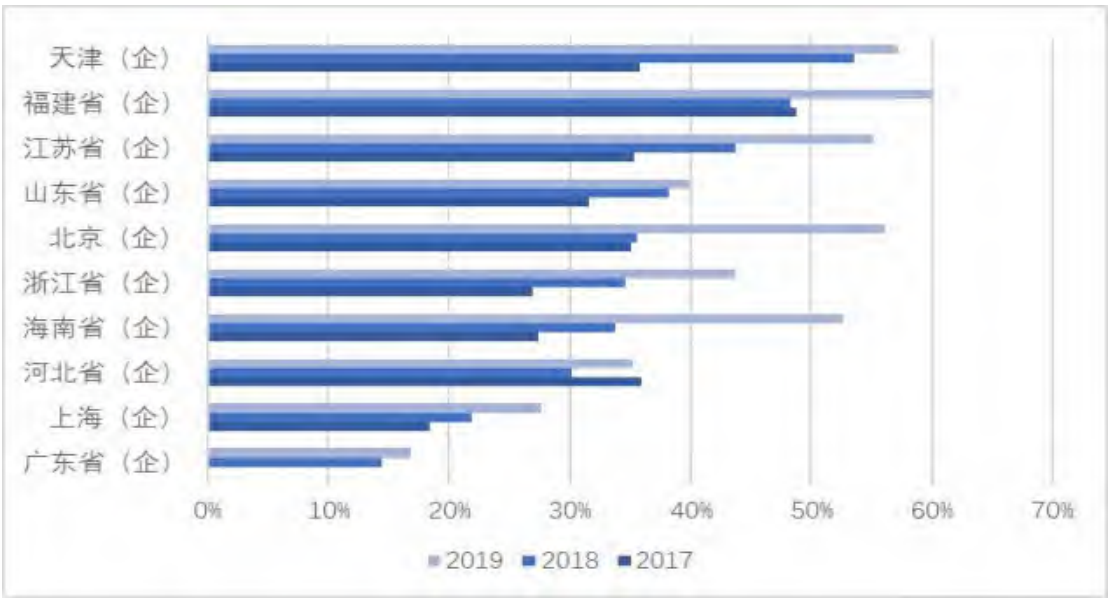



图33　东部地区2017-2019年偿债率（企业债口径）

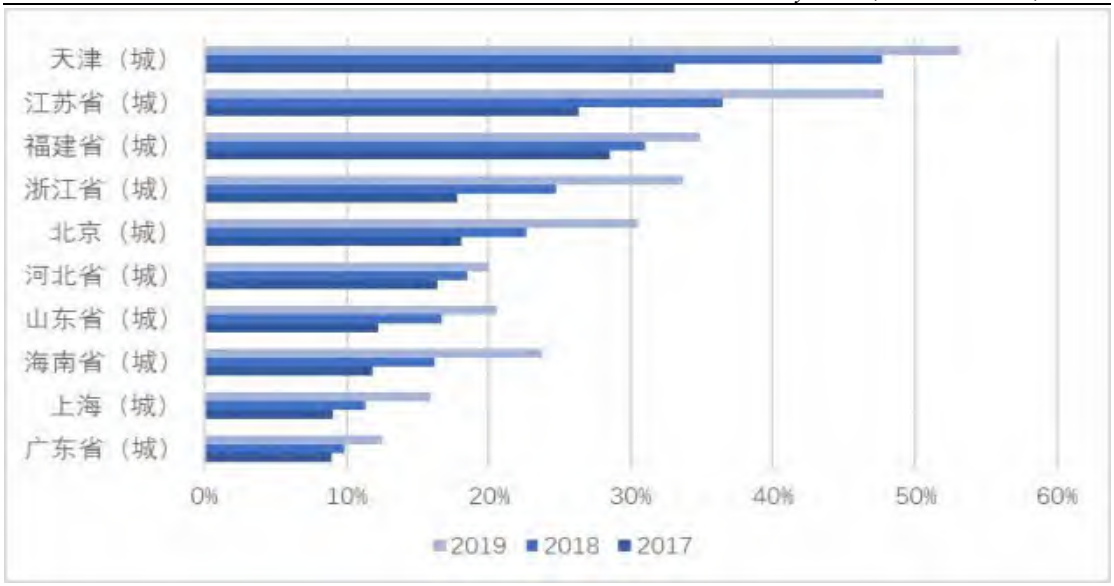



图34 东部地区2017-2019年偿债率（城投债口径）

企业债口径下仅有广东省和上海市未突破警戒线及危险线，城投债口径下却仅有浙江省、福建省、江苏省和天津市突破了危险线。和负债率比较，福建省和江苏省在偿债率指标下风险，表明这两个地区间接偿债能力较强而直接偿债能力不足。

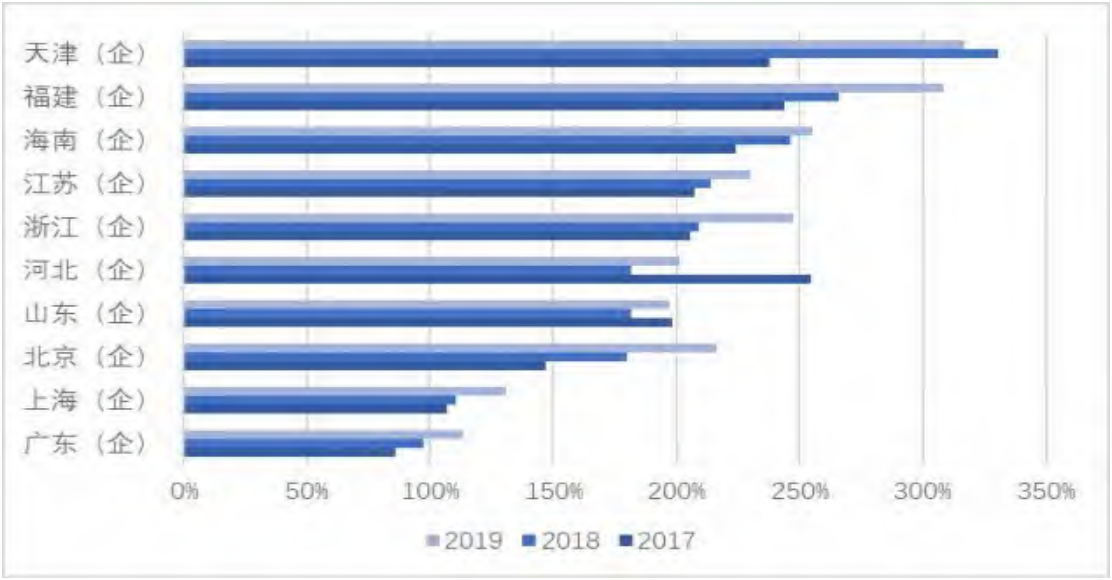



图35 东部地区2017-2019年债务率（企业债口径）

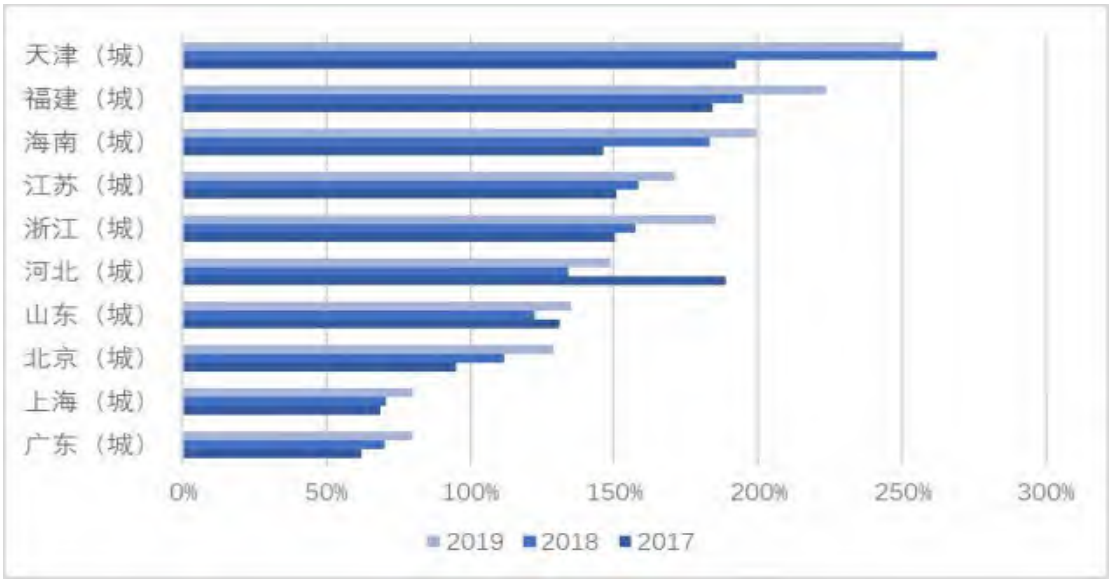



图36　东部地区2017-2019年债务率（城投债口径）

天津市在三种指标下均具有最高的偿债风险，广东省则相反，始终维持最良好的表现。在该指标下天津市2019年偿债风险有小幅回落，河北省则从企业债口径下250%和城投债口径下189%的债务率大幅下降至200%和150%以下。相较负债率和偿债率，北京市的债务率风险指标处于更安全的水平，成为仅次于广东省和上海市的表现良好的地区。

（2）中部评价指标分析

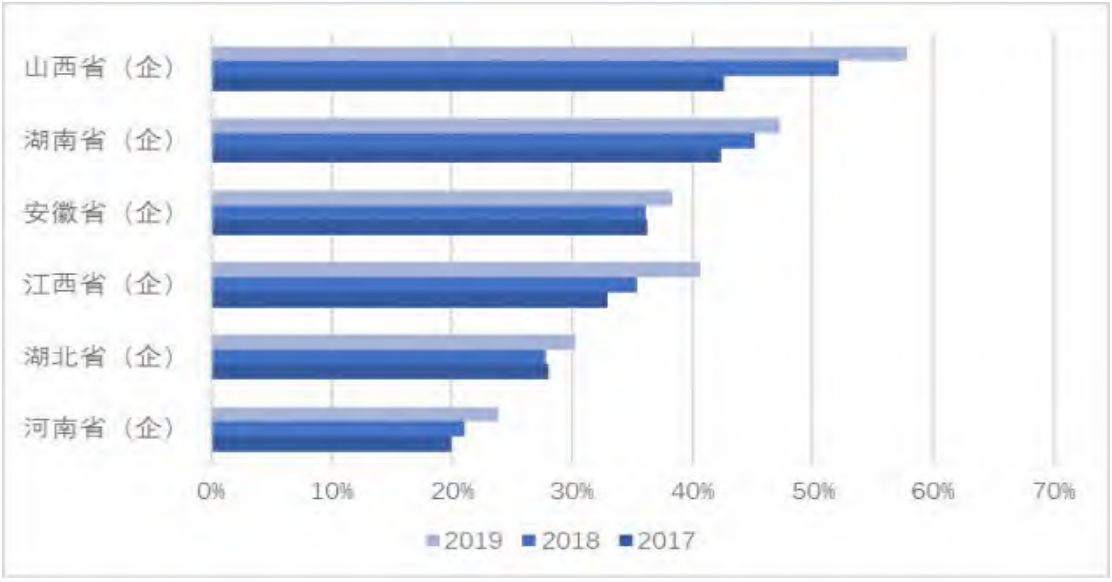



图37　中部地区2017-2019年负债率（企业债口径）

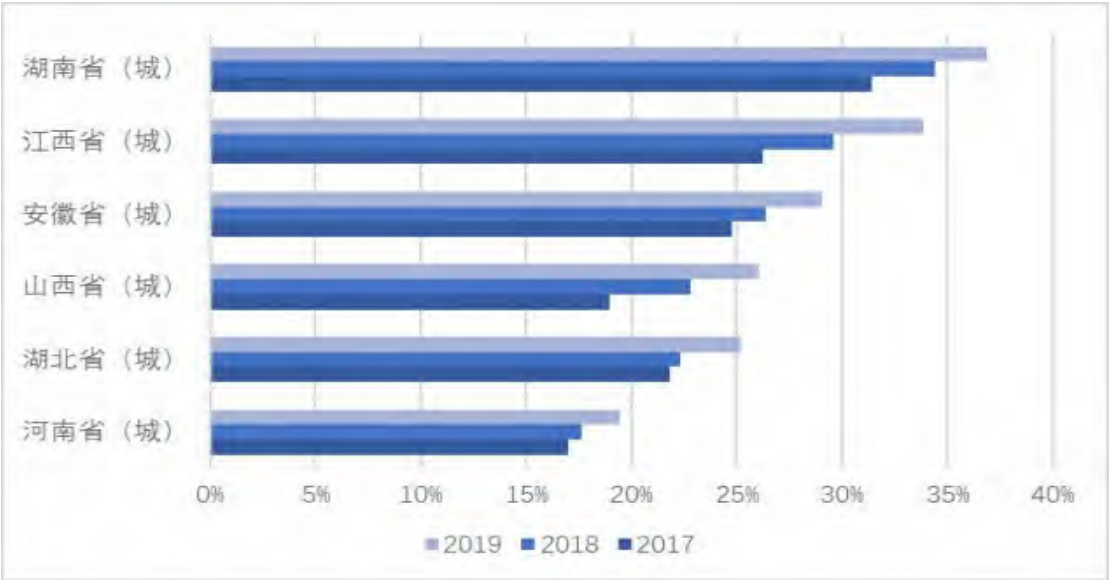



图38 中部地区2017-2019年负债率（城投债口径）

中部地区负债率水平在城投债口径下明显高于企业债口径，且负债率均呈逐年上升的趋势，然而均没有超出60%的危险线。观察较安全的省份，湖北省和河南省在两种口径下支付风险都不大，这二省并非中部地区债务偿付风险最低的省份，因此风险水平较低表明其拥有较好的经济水平和合理的债务控制能力，河南省是2018年GDP排名仅次于前四位东部地区的省份，湖北省则位列第七。反观风险暴露最大的省份，山西省在企业债口径下具有最大的偿付风险，而在城投债口径下回落至较安全的地位，正向排名第三，表明山西省隐性平台债相对较低，而或有债务企业债则相对更多。其余省份排名没有明显变化。

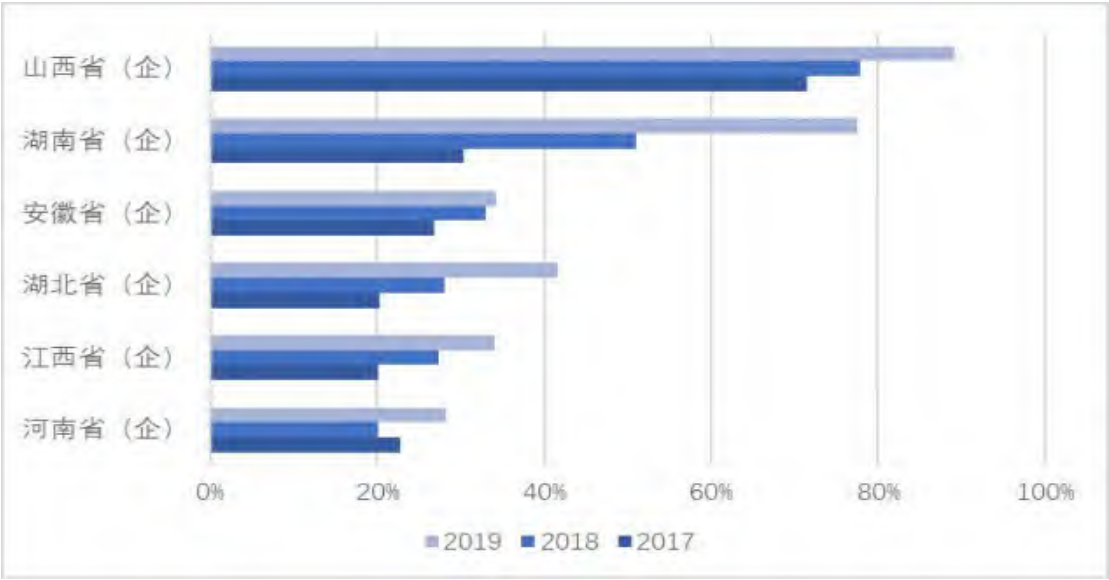



图39 中部地区2017-2019年偿债率（企业债口径）

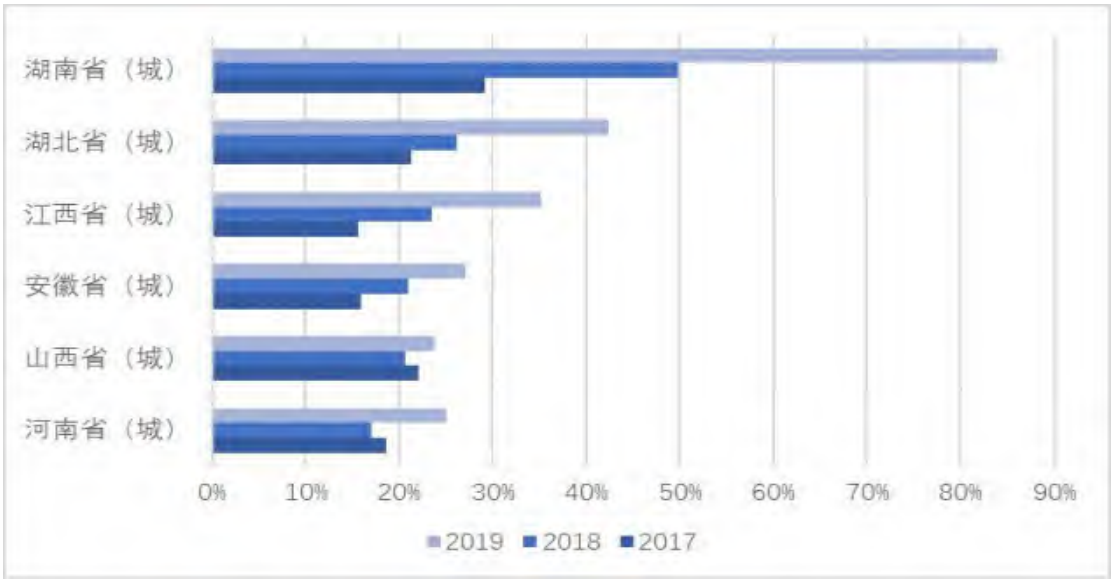



图40　中部地区2017-2019年偿债率（城投债口径）

偿债率指标下大多数省份都超出了25%的警界线水平，且基本均保持逐年风险累积的趋势。需要关注的是，湖南省在三年的偿债风险迅速累积，最大增幅20%，且整体排名也维持在一二位。而山西省在两个口径下发生了更加明显的差异，企业债口径下三年平均偿债率70%，而城投债口径下仅有20%左右。

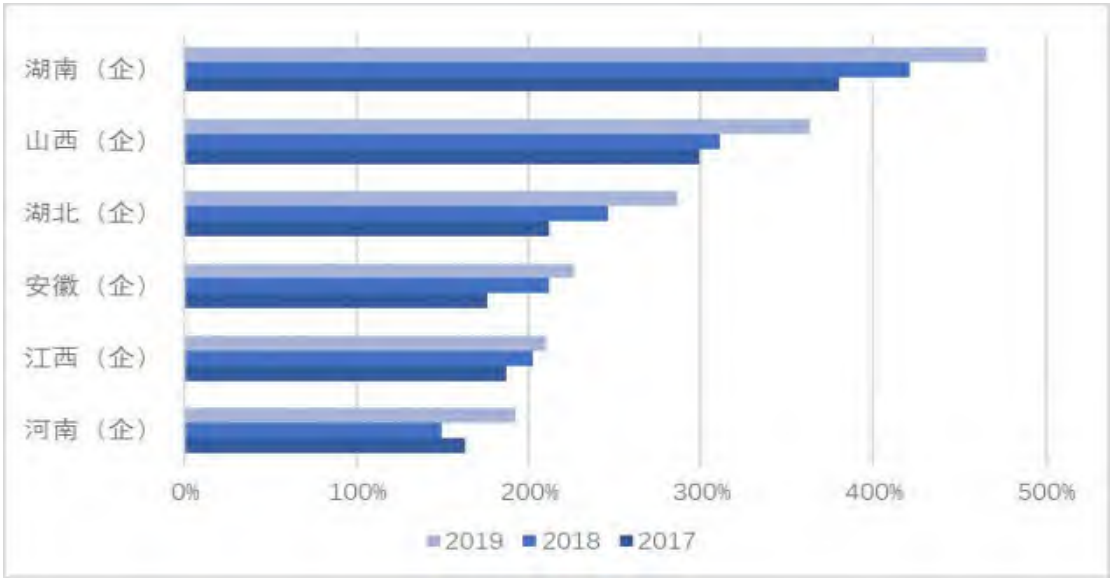



图41　中部地区2017-2019年债务率（企业债口径）

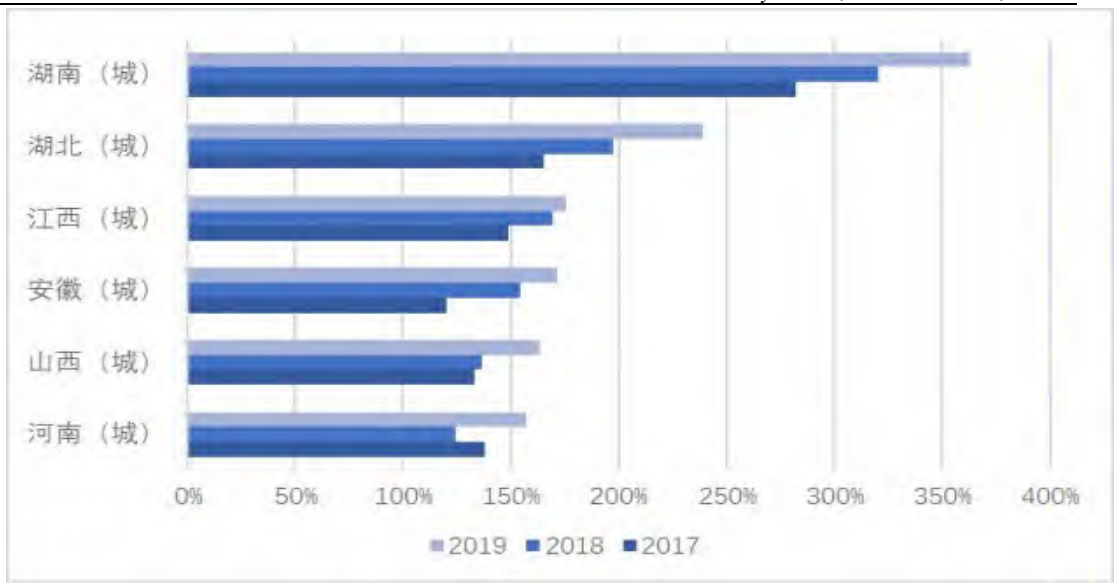



图42 中部地区2017-2019年债务率（城投债口径）

债务率指标下，所有中部省份均在2019年超出150%的风险警界线，排名方面和其他两个指标没有显著差异。

（3）西部评价指标分析

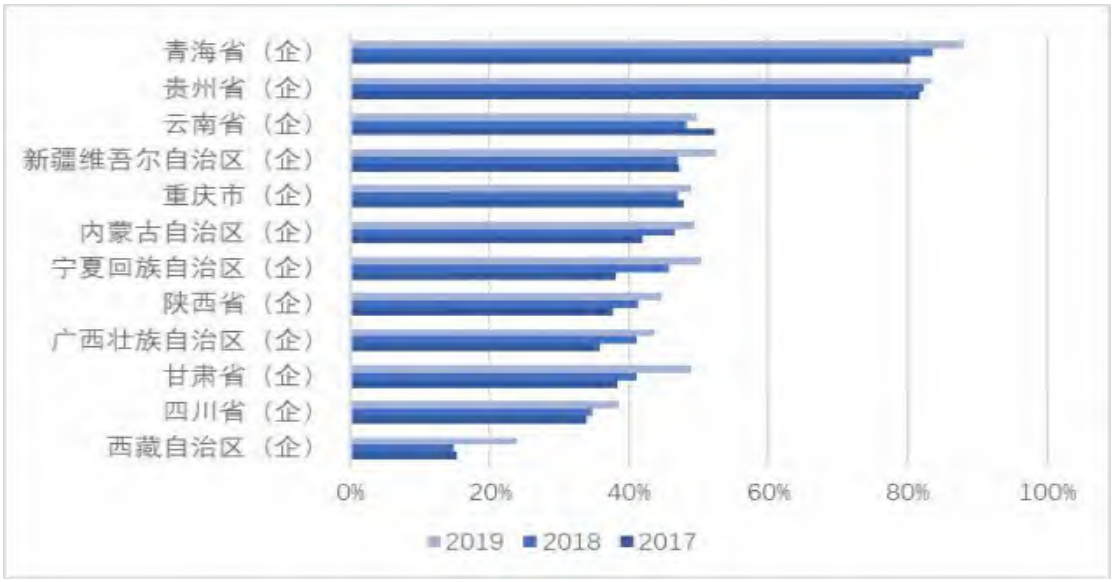



图43 西部地区2017-2019年负债率（企业债口径）

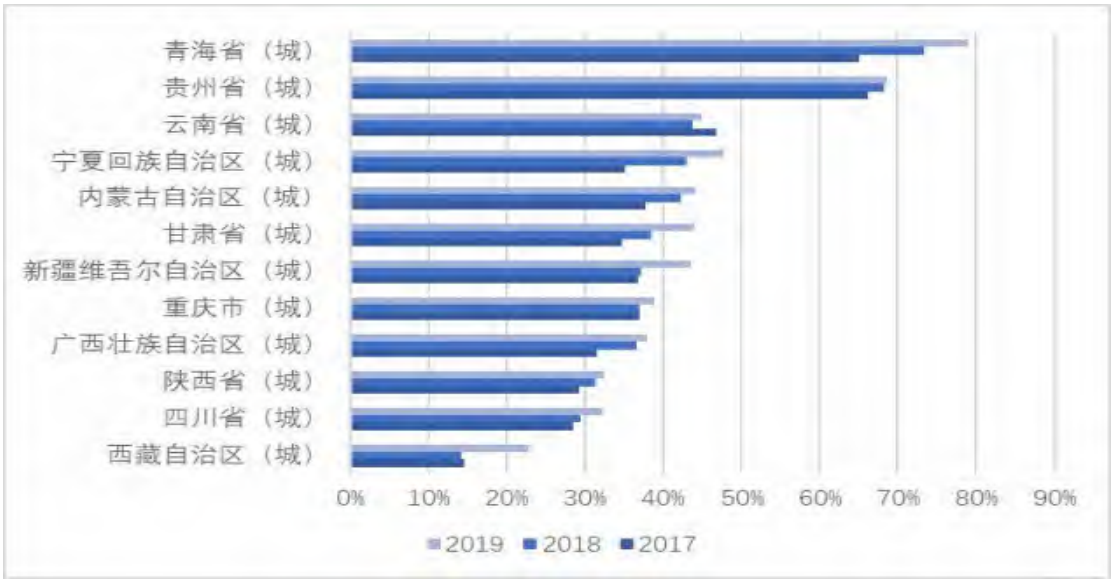



图44　西部地区2017-2019年负债率（城投债口径）

西部地区仅有青海省和贵州省超出60%的风险警界线，青海省三年内负债率上升的水平高于贵州省，在2017年低于其的风险水平后，2018年风险增大，并成为西部地区风险最大的省份。12个省市自治区大致可以分为三个部分，在最大的青海和贵州，以及最低的西藏自治区之外，其他地区负债率水平基本相等。

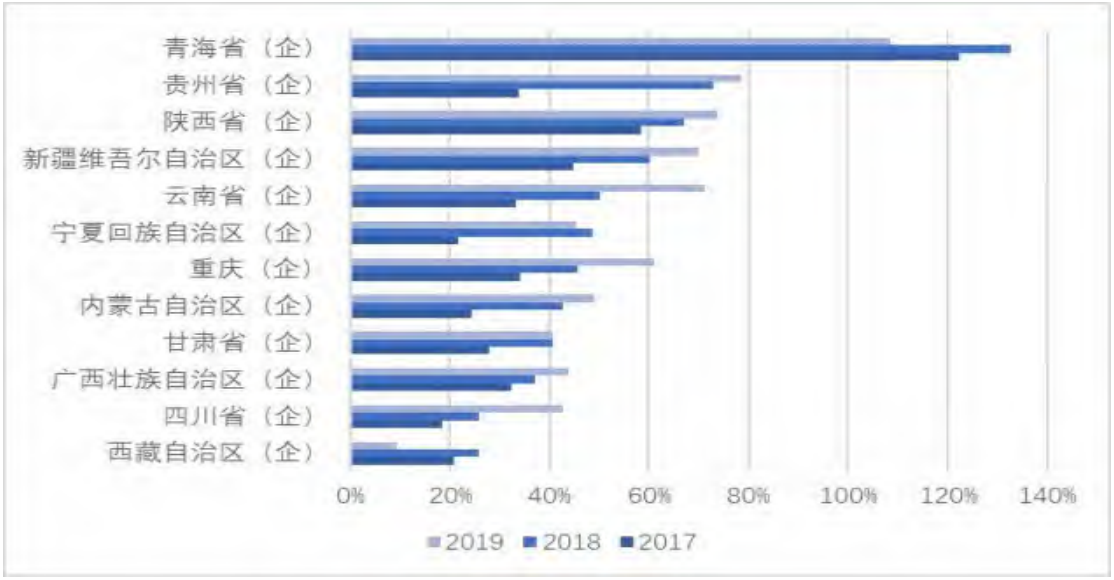



图45　西部地区2017-2019年偿债率（企业债口径）

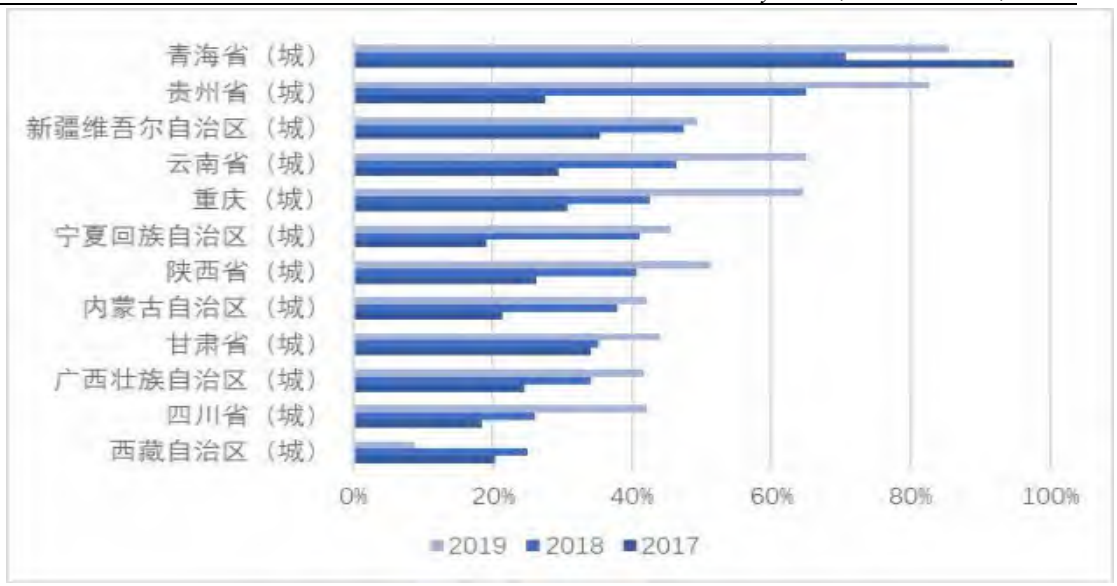



图46 西部地区2017-2019年偿债率（城投债口径）

偿债率指标下，西部地区几乎所有省份都发生风险累积，例如贵州省在企业债口径下从2017年的34%急速增加至73%，城投债口径下从2017年的28%增加到2018年的65%，2019年则高达83%。然而呈现不同趋势的是，青海省和西藏自治区则发生了回落。企业债口径下，青海省从2018年的133%下降到2019年的108%，西藏自治区则从从2018年的26%下降到2019年的9%；城投债口径下，青海省从2017年的95%下降到2019年的71%，2019年反弹至86%，西藏自治区则从从2018年的25%下降到2019年的9%.

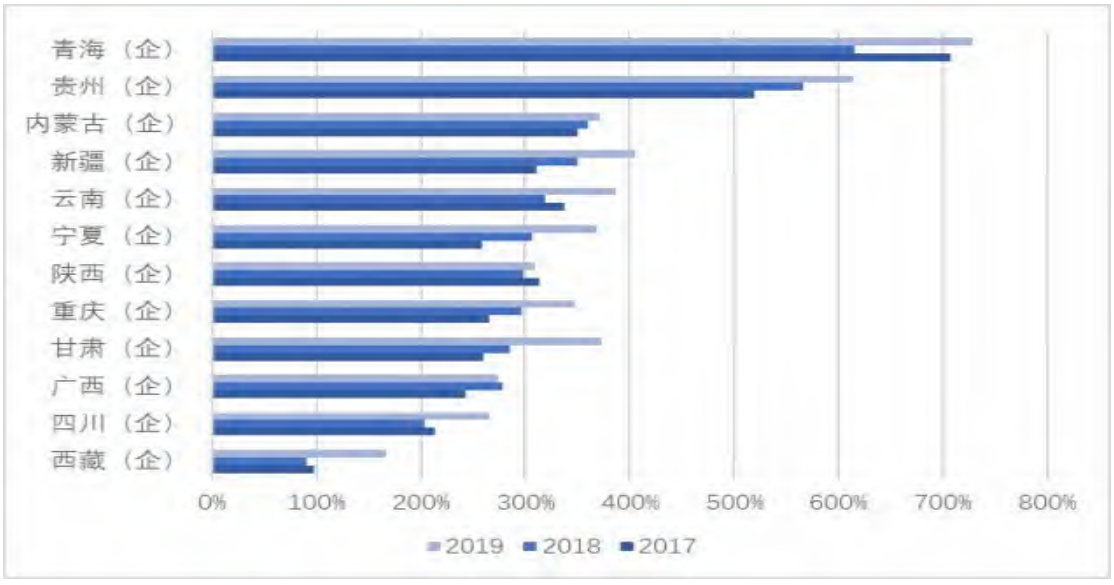



图47 西部地区2017-2019年债务率（企业债口径）

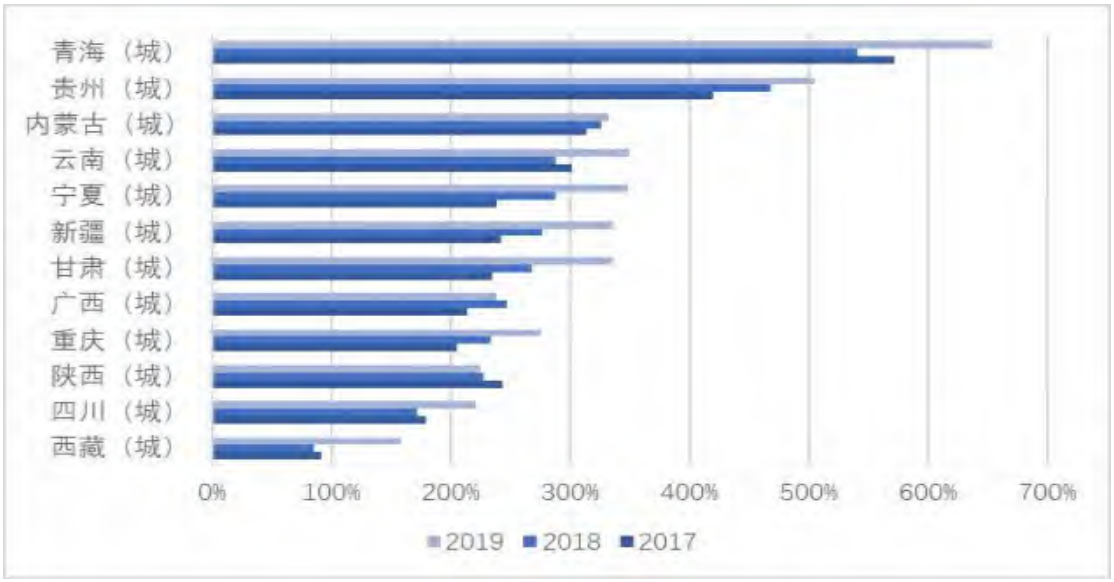



图48　西部地区2017-2019年债务率（城投债口径）

和中部地区相似，债务率指标下，所有西部省份均于2019年超出150%的风险警界线，排名方面和其他两个指标没有显著差异。

（4）东北地区分析

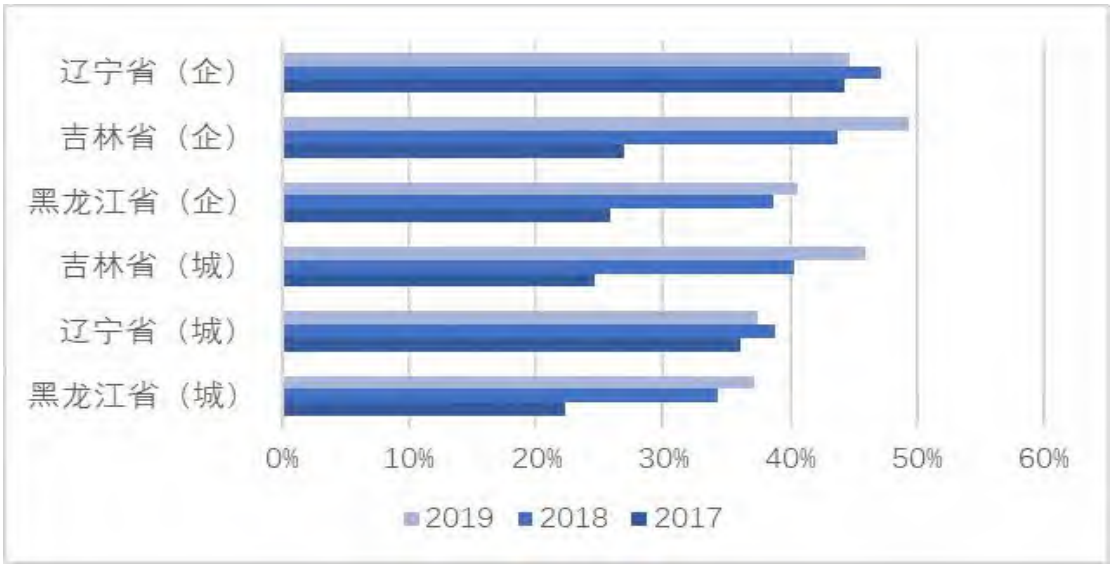



图49　东北地区2017-2019年负债率（城投债口径）

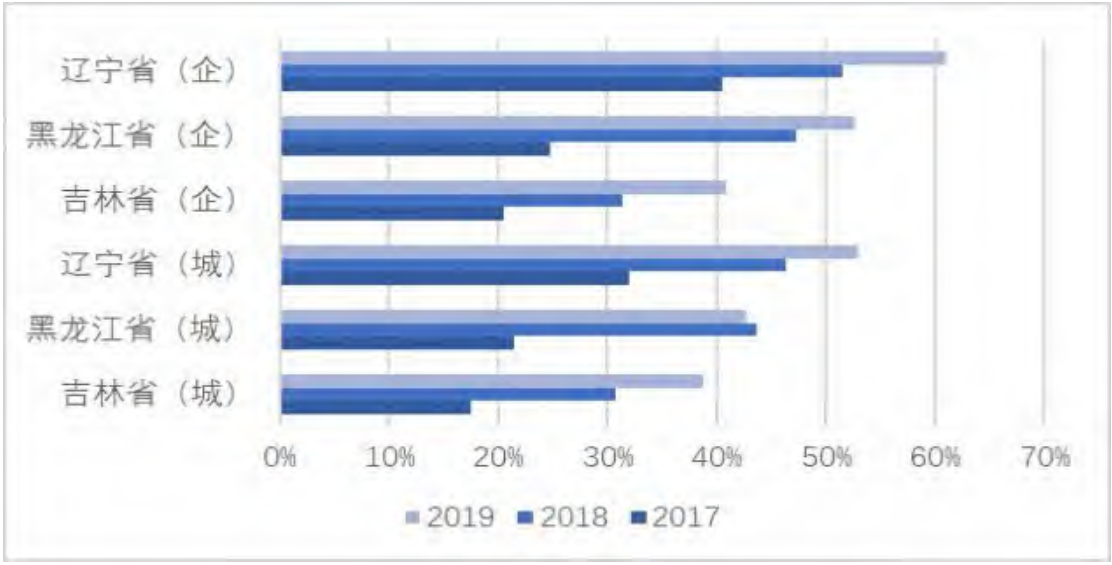



图50 东北地区2017-2019年偿债率（城投债口径）

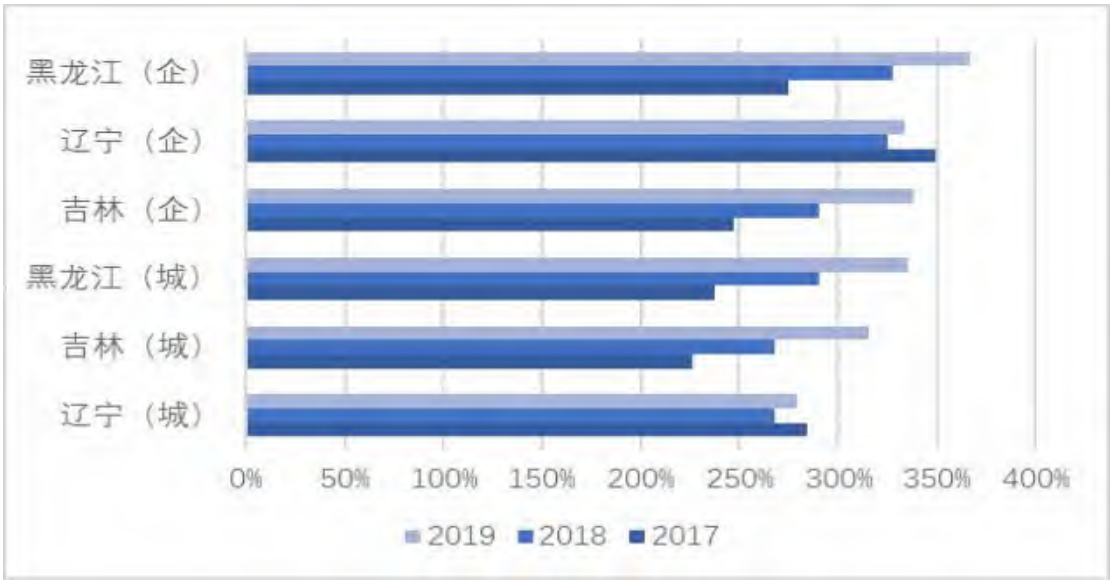



图51 东北地区2017-2019年债务率（城投债口径）

东北三省的三个指标没有十分明显的差异，其中负债率指标和偿债率指标各年基本均处于增长，尤其在2017至2018年增长显著。然而三省在各指标下排名发生了一定移动，其中黑龙江省负债率水平表现最为良好，偿债率居中，债务率暴露的风险最为显著。吉林省则和辽宁省在两种口径下顺序恰相反，表明吉林省城投债偿还压力更大，辽宁省企业债偿还压力更大。

5.3.3 代表性省份分析：

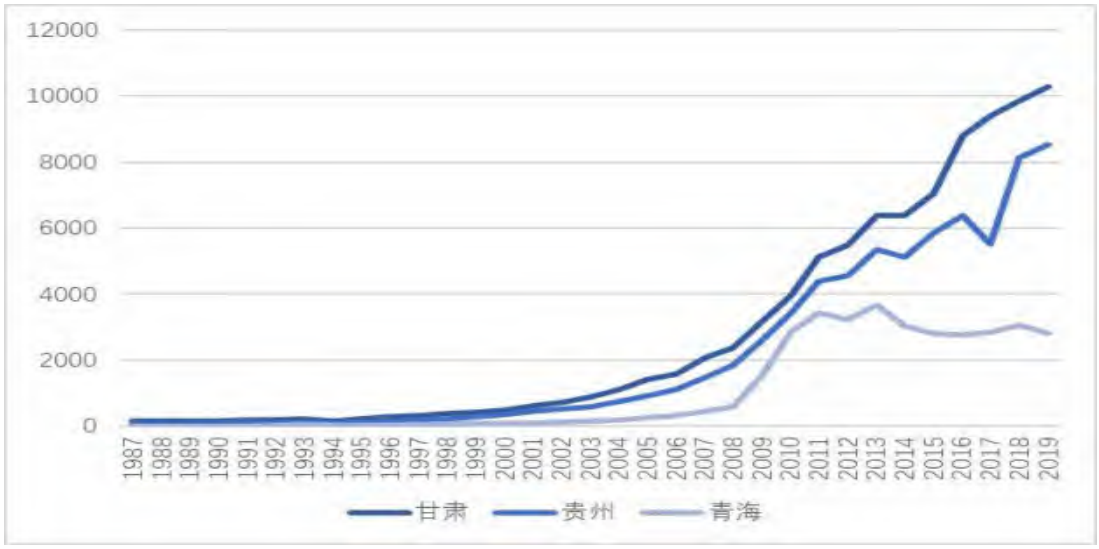



图52　贵州、甘肃、青海1988-2019年政府财力示意图

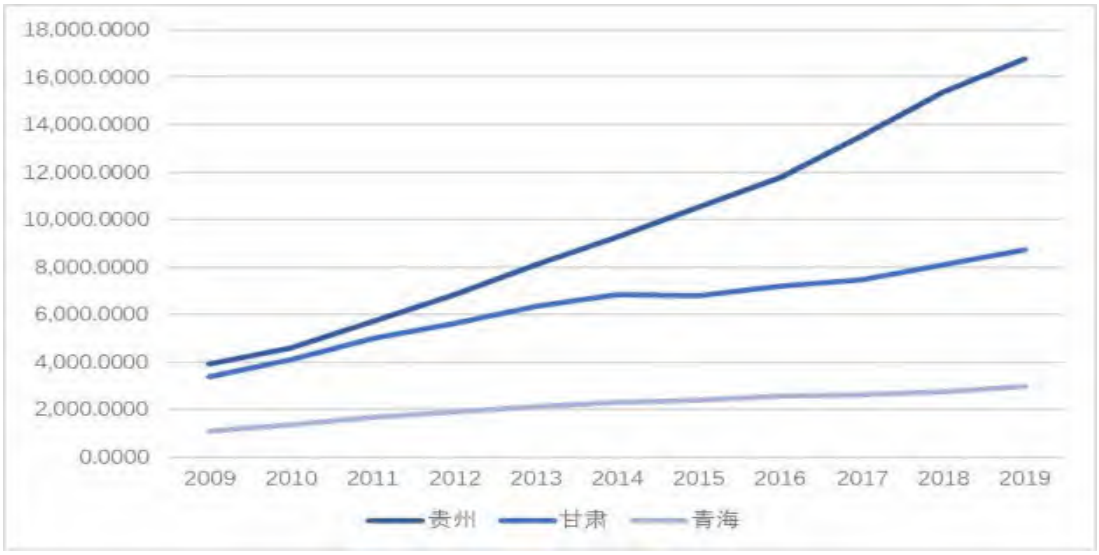



图53　贵州、甘肃、青海两省2009-2019各年GDP折线图

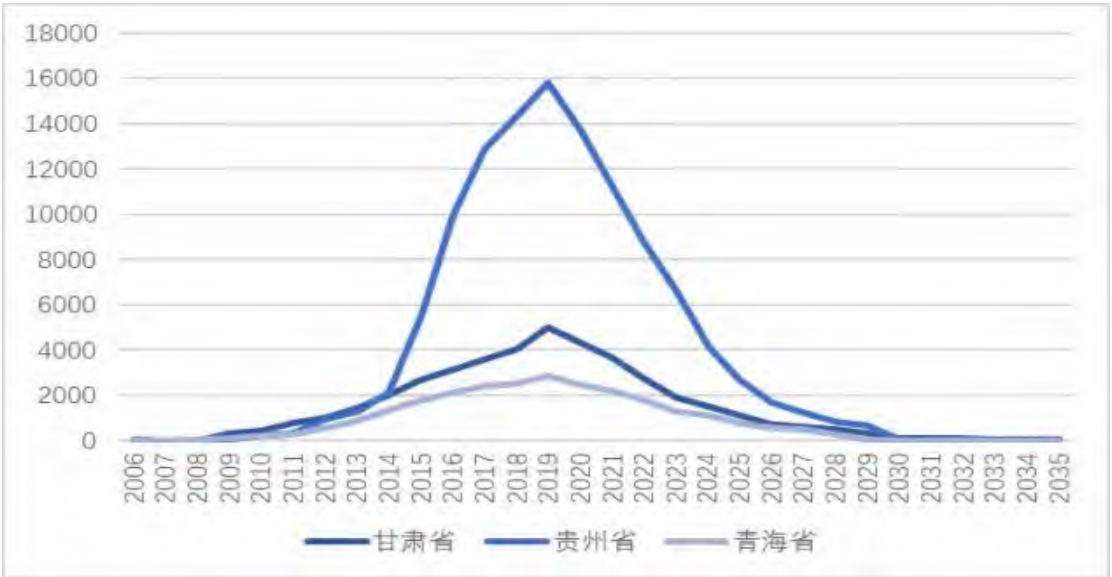



图54　贵州、甘肃、青海两省1990-2019年债务存量总额折线图

西部地区中选取了风险最高的贵州省、青海省和处于中位值附近的甘肃省进行分析，可以看出贵州省和青海省负债率高企的原因存在差异。贵州省无论是地方政府财政收入还是历年的GDP都相较甘肃省高出一倍以上，仅看2019年，贵州省财政收入为1767.36亿，GDP约为16769.34亿，青海省收入仅为282.14亿，GDP仅为2965.95亿，均不足贵州省1/6，同时也和中位数水平差距1/2以上。而在债务存量方面，青海省处于西部地区中位数水平，被贵州省远超。因此可以发现，不仅是全国层面，发达地区相较欠发达地区存在经济发展水平和债务存量双高的局面，各经济片区内部也有相似情况存在。遗憾的是，贵州省相对较良好的经济状况并不能覆盖其高筑的债台。在经济发展方面，很显然贵州省和青海省拥有不同的风险偏好。贵州省巨额的债务在一定程度上起到推动其经济建设的作用，经济发展状况较良好，政府收到正反馈，债务方面也会稍欠谨慎。而青海省则在借债水平方面和经济发展状况都欠佳，地方政府采取建设投资减少的措施以避免偿债风险，由此造成恶性循环。

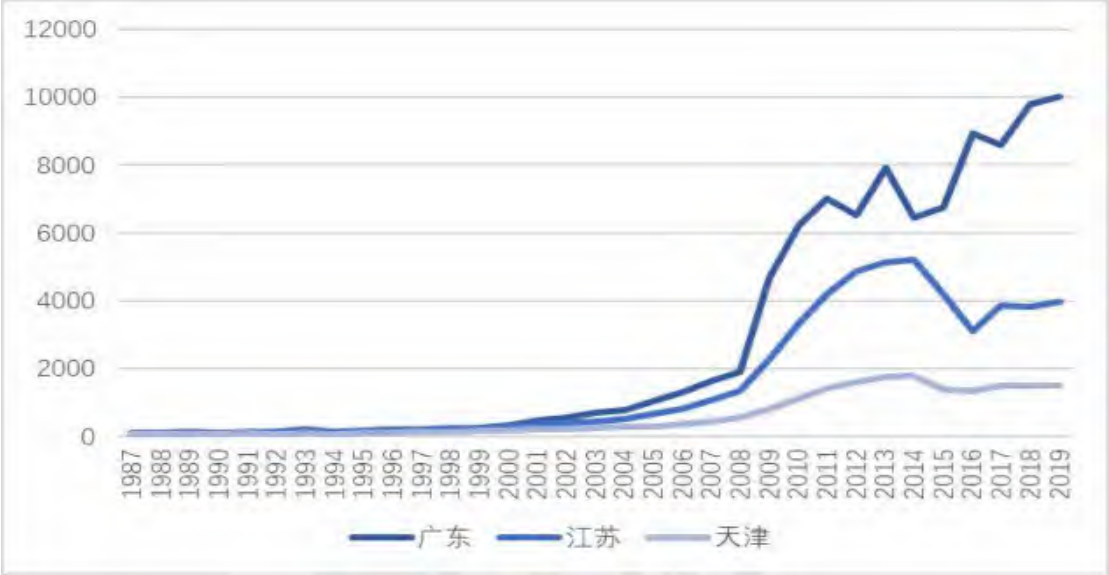



图55 广东、江苏、天津1987-2019各年政府财力

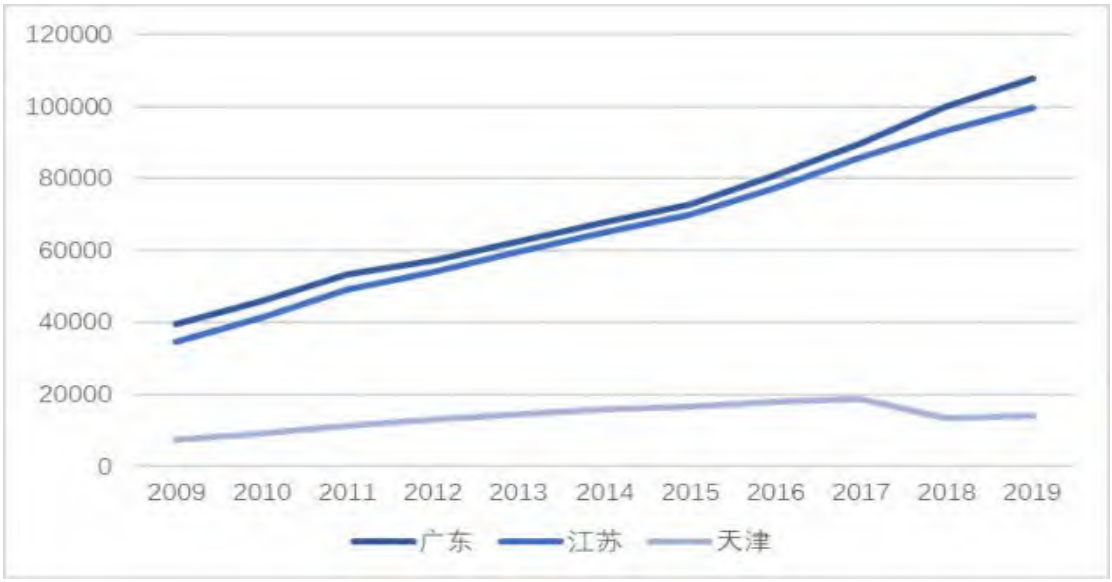



图56　广东、江苏、天津2009-2019各年GDP

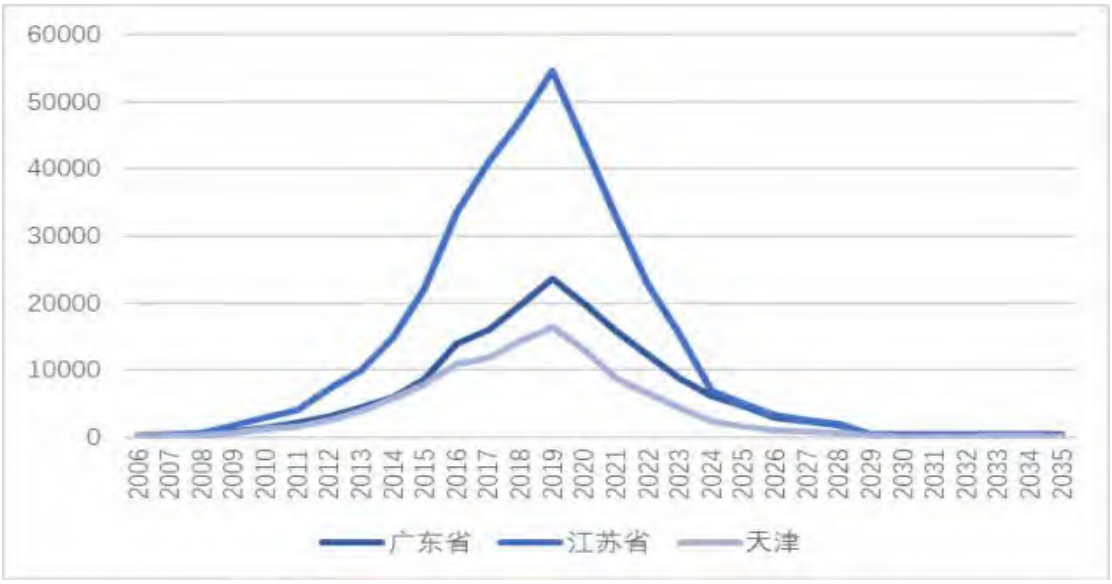



图57　广东、江苏、天津1990-2019年债务存量总额

此处分别列示广东、江苏和天津各年公共财政收入、GDP以及存量债务待支付总额。可以明显的看出，天津无论是GDP还是政府公共财政收入都和另外两个省份差距极大，天津2019年公共财政收入为2410.25亿元，GDP为14104.28亿元，债务本息余额为3719.16亿元，广东省2019年公共财政收入为12102.9亿元，GDP为107671.07亿，而债务本息余额为4579.81亿元，江苏省2019年公共财政收入为8802.4亿元，GDP为99631.52亿，而债务本息余额为16334.94亿元。广东省和江苏省的经济发达程度相似，然而江苏省政府保有大量债务，相比之下广东省政府债务本息余额仅为江苏省的1/3左右，这是由于广东省属于港口城市，对外开放程度更高，经济活跃度更大，具有更多例如外贸等其他经济增长刺激点，呈现贸易拉动而非地方政府借债投资拉动经济增长的状况。相较而言，天津和广东省的债务还本付息额相近，然而经济发达程度却远低于另外两个省份，尤其可以看出2017年至2018年度其GDP呈现罕见的下行态势。同等债务负担下，天津市因为偿债来源不足，更加显著地暴露了偿债风险。

## 6. 政府债务成因分析

### 6.1 债务管理本身的因素

政府债务种类繁多、发行方式不同，且显性债务和隐性债务并存，客观上增加了债务管理的难度。同时，多种原因共同作用导致债务信息失真。一是政府性债务缺少明确的统计口径，加大了政府债务统计工作的难度；二是各部门和单位基于各自的利益不愿公开真实数据，人为制造信息孤岛；三是借款人与使用人不一致，容易影响债务信息的准确性。债务数据不完整，直接影响科学决策和外部监督。

缺乏合理的规划也是地方债务存在的管理弊端。政府内部没有形成统一的债务管理机构，政府债务管理权限分散在计委、财政、监察、审计等部门，各部门管理重点、管理权限各不相同，难以达到规范管理的效果。地方政府各部门间同时缺乏有效的资金管理系统，信息交流平台不够统一，导致信息传递受阻，无法准确全面的了解债务资金的使用情况，更无法长效的监督和管控。同时各投融资机构和部门、单位都有独立融资权，没有统一的债务规划，缺乏有效的预算机制，导致债务资金的使用效率低下、投向不科学。

### 6.2 财政管理体制因素

1994年分税制改革使得财政集中度大大提高，然而财权事权不对等，权利划分不明晰，导致诸多弊端。

在财权方面，地方税收自主权严重不足。地方政府负责征管的地方税涉及到的权利有：税收执法权、税收收入归属权、税法解释权、政策调整权、立法权、对税率的调整权和减免税审批权等，而这些权利中仅仅只有税收执法权是归属地方政府所有，这就导致地方政府难以根据实际需求对税收额度进行调整。同时，转移支付制度也不够完善。总量上看，转移支付额度距离实际需求仍有较大差距，这在一定程度上也催涨了地方政府争做项目搞建设以求获得中央转移支付资金的行为。

在事权方面，中央的事务分配又对地方产生巨大压力。2008年四万亿计划的实施，中央在配套资金有限的前提下启动了大量地方政府为实际投资主体的项目。中央指挥地方加强改革力度、加快城市转型、加大社会保障和经济建设投入，却没有赋予地方与之相应的财权，这就迫使地方政府谋求多头举债的解决途径，甚至违规举债，以此来对冲财政赋权的不科学。

### 6.3 外部的监督和约束因素

一、债务管控不够完善。隐性债务存在不透明、难追踪、难管控的特征，其估算指标不易统一、总量规模巨大，然而目前，我国政府的隐性债务尚未纳入统计，使得政府的债务管控处于不完善状态，如不对其加以管控将加剧债务膨胀。

二、人大监督不够健全。目前，人大对政府预算的监督作用还很有限，有一部分债务游离于人大的监督之外，许多城投债和政府债等隐性债务并不经过人大审批，新预算法规定使得人大的监督地位在某种程度上被架空，缺乏专业的人员和有利的信息则进一步限制了人大监督约束作用的发挥。

政府借债存在“软约束”，外部未能形成长效的监督机制。由于前述不透明不规范的转移支付制度、事权与财权不匹配等现象，中央政府也被迫对地方政府

的债务进行担保，因此便存在对地方政府行为的“软约束”。而这一“软约束”不但为地方政府忽视风险大量举债提供契机，同时也造成了债券投资者对偿还的较高预期，使得地方政府能以相对低成本融资，进一步刺激了其借债需求。

监督层面，我国尚未构建完整的政府资产负债表，政府也未将债务纳入预算，信息的不透明为外部监督增加困难。同时，缺乏符合国情的外部监督机制也将政府债务暴露于失信的风险之下。我国缺乏地方政府失信惩罚制度，没有地方政府信用评估和失信测评机制，缺乏公众听证和民众监督的举措，削弱了地方政府缺乏对下负责的动机。当政绩和实际需求冲突的时候，很难保证地方政府不会做出“面子工程”。

### 6.4 其它因素

其它因素主要包括一些偶然性和突发性因素。财政政策的调整会对地方债务的规模和数量有一定影响，积极的财政政策需要刺激经济加大政府举债，解决财力不足的问题，从而增大了财政风险。同时，突发社会性事件（如，911事件、新冠肺炎疫情、常任理事国间战争等）也会引起短期内地方政府举债增长，进而债务风险增大。

近年快速膨胀的房地产行业为政府债务规模大幅度扩张提供了可能。一方面，政府土地出让收入占政府性基金收入80%以上，提供了财政开销和贷款偿还的资金；另一方面，土地作为可靠的抵押品，是政府通过地方融资平台从银行获得贷款的重要信用依赖。进一步地，政府债务规模的扩大又会反作用促进土地收入的增加，其举债资金一部分用于新征土地的费用，另一部分用于当地基础设施建设，而该基础建设投资逐渐资本化到该区域的土地和住房价值中，为土地带来附加值，进一步推涨房地产市场的繁荣。然而这将造成债务偿还的巨大隐患，一但房地产价格下跌，政府逾期的概率将会更大。

## 7. 结论和政策建议

本文测算了地方政府的债务规模并对其进行了风险分析，得出如下结论：

从时间序列层面分析，我国绝大多数省份自1997-2019年债务总量逐年增长，在2050年左右现存债务基本偿付完成；偿债率、债务率、负债率逐年攀升，在2010年之后增速加快，于2015年左右增速达到峰值。

从地区横截面层面分析，不同地区不同年份间差异较大，分化较为明显，偿债率、债务率、负债率整体上呈现出西高东低的特点。天津市、贵州省、青海省在2018、2019年负债率、偿债率、债务率上均超过国际通行的警戒线或在警戒线附近，呈现出较大的债务风险，而广东省和上海市的债务风险较低。

根据上述结论，本文提出如下政策建议：

一、细化管债方法。严格监管地方政府债务的发行，将借债规模纳入全口径预算；实行限额管理，根据各地区债务风险、财力状况等分地区安排限额。此外，在推出新型地方政府举债融资工具时，需结合各地方政府的实际情况谨慎论证、逐步推进、时刻调控，并对融资效果进行评估，及时采取相关措施予以控制，出台相关配套文件和实施细则改善其融资功能。

二、对老债进行善后处理。在清理甄别的基础上，对融资平台债务中属于政府应当偿还的部分纳入预算管理；对甄别后纳入预算管理的地方政府存量债务，允许各地区申请发行地方政府债务置换，以降低利息负担，优化期限结构，腾出

更多资金用于重点项目建设；对融资平台债务中不属于政府应当偿还的部分，要遵循市场规则处理，减少行政干预。

三、完善地方政府债券市场。建立地方政府信用评级制度，逐步健全合理的预算体系，建立健全地方风险债务监测预警体系，顾准、顾全隐性债务风险因素，督促地方政府严格执行预算约束，合理举债，提高资金运作效率。

四、加速融资平台转型。融资平台公司政府融资职能予以剥离，同时做好平稳过渡。融资平台公司不得新增政府债务，而实现市场化运作。

五、协调中央与地方的财政关系和权力结构，合理划分事权与财权，中央适当下放财权以缓解地方政府的财政压力或适当上收事权，建立事权与支出责任相匹配的支出分权体系，同时优化转移支付的规模、结构和分配方式。

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# 地方政府财政风险与可持续性研究
## ——全口径政府债务法定本息支付计划下的偿债率分析和预测

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**关键词:** 偿债率；负债率；债务率；债务风险；债务存量；还本付息量

**中文摘要.** 地方债务高风险是我国长期以来财政制度的结构性问题，根据财政风险矩阵，地方政府债务不仅包含显性直接债务，还有显性或有债务和隐性债务，尽管在中央的引导下债务渐趋显性化，然而巨额存量债务和疫情期间为刺激经济而形成的债务提高了地方政府的偿付风险。为了响应中央经济工作中强调的“新发展理念”，进行长效的经济结构性调整和改革，本文采用多重指标和全口径数据对地方债务偿付风险进行了系统的分析，以期全面衡量存量债务偿还风险，并对风险管控措施提出相应建议。

本文选取了截止2048年末未完全清偿的地方国企债、地方政府债券以及宽窄口径的城投债券总计近6万条，计算出各类地方存量债务的还本付息额，对数据来源以及风险评价指标进行了详细的阐释。文章分别从宏观全国层面和微观地方层面对债务情况进行了分析，宏观层面，文章着重分析了国企债、城投债、政府债的占比和时间序列上政府政策引起的债务额变动，微观层面，文章分东、中、西三个地区对未来年度还本付息情况和偿债风险进行了全面描述，并针对存在风险最值的省份提供相应的政策建议。本文还将引入影响债务存量、地方综合财力、经济等相关的因素作为控制变量，探讨地方政府偿债率、债务率和负债率的主要

影响因素，并对地方政府债务风险控制提出相应政策建议。本文最终提出政府债务的成因，文章认为，为降低政府债务风险，应加大债务发行的管控力度，重视权利的协调和风险的分担，并建立合理的预算体系和监督机制。

文章的优势在于，以往的研究大多直接选用政府存量债的余额，未能真实反映偿债风险和债务压力。但是，本文却选用还本付息额作为负债量，同时采取了全口径的数据，在大量数据处理工作的基础上将单支债券加总得到各省份和全国的负债情况，得到准确、固定的法定还本付息利息。这使得本文更准确地研究了政府的债务情况，对其风险的衡量也更加真实可信。

# Research on the Impact of Equity Change on the Operation Risk of Life Insurance

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**Abstract.** In recent years, the investors in the insurance market have also been chasing the insurance capital to quit the original shareholding insurance companies due to their operation, solvency and other reasons, which has brought about the frequent changes of the equity in the insurance market. Frequent changes in equity not only affect the value of the enterprise, but also bring great risks. On the basis of summarizing the domestic and foreign documents and combining the actual situation of Chinese life insurance industry, the 75 life insurance companies operating in China from 2007 - 2019 as the sample of the change of equity concentration and the change of equity balance. The following conclusion is reached: (1) the impact of the change of equity concentration on large and small companies is different. For large companies, the change of equity concentration reduces Operation Risk of enterprises, while small companies, the change of equity concentration increases the risk of life insurance companies. (2) The changes in the degree of equity checks and balances and the operating risk of large and small life insurance companies are not significant.

## 1. 引言

股权结构作为公司治理的重要组成部分，对于公司经营的诸多方面都有显著影响。股权的变动更会对企业未来的发展产生重大影响。鉴于此，国内外学者对股权结构与公司经营之间的关系做了大量的实证与研究，但总体上来看，现有文献大多研究的是股权结构与公司绩效之间的关系，但关于股权结构的变动与公司绩效和经营风险之间的研究比较少。在现实中企业最关心的可能是企业的利润与价值，往往忽略绩效背后存在的风险，但我们必须知道风险与公司活动是相伴相生的，如果只考虑公司的绩效而不重视风险，会给企业带来非常严重的后果。尤

其近些年来伴随着保险容量的扩大，保险机构的数量越来越多，保险对社会资本的吸引力越来越大，保险市场成为资本追逐的目标。但在众多投资者争相进入保险市场的同时，由于投资者面临的各种现实问题从而使得投资者频繁换手使得股权结构频繁发生变动。寿险市场股权结构的变动必然会影响到股东利益之间的争夺，最终导致会给公司的经营带来巨大的风险，影响寿险市场的稳定与未来的发展。中国寿险公司要想使企业得到可持续、稳定健康长期的发展，就需要对公司经营中的风险进行过多的关注与认识。鉴于此，研究股权结构变动对寿险公司经营风险影响的具体表现，有助于监管部门在监管过程中更好地起到防范与降低保险业风险的守护作用。

本文选取 2007 年--2020 年在中国境内经营的 75 家寿险公司为研究样本，从股东集中度的变动、股权制衡度的变动两个方面来对经营风险的影响进行研究。实证结果表明：股权集中度的变动对大小公司的影响是不同的，对大公司而言，股权集中度的变动降低了企业的经营风险，而小公司，股权集中度的变动增加了寿险公司风险。而股权制衡度与寿险公司的经营风险无显著相关关系。与已有文献相比，本文的创新点主要在于：第一，本文扩展了股权结构与公司经营的研究，丰富了有关股权结构与经营风险的问题文献；第二，先前的研究大多以上市企业或者银行为主，而对于保险的研究较少，尤其是对寿险市场的研究，本文扩展了相关研究领域。第三，本文在全样本的基础上，将寿险公司分为大公司和小公司进行异质性分析，使得结果更加具有针对性。

本文的安排如下：第一部分引言、第二部分文献综述与理论分析、第三部分数据与变量选取，第四部分股权结构变动对经营风险的影响的实证分析、第五部分稳健性检验，第六部分结论与建议。

## 2. 文献综述与理论分析

股权问题一直是学术界关系的重点问题，合理的股权结构对企业的发展至关重要。经营风险是指公司在经营的过程中，由于一些不确定因素的影响而对公司价值产生的影响。企业追求利润发展的过程中不可避免地会产生一些经营风险，且保险公司作为经营长期业务的企业，其风险是影响保险公司发展的核心因素之一。国内外学者大多从股权的集中度和股权的制衡度两方面来研究与经营风险的关系。

### 2.1 股权集中度与经营风险

股权集中度是指全部股东因持股比例的不同所表现出来的股权集中还是股权分散的数量化指标。大多数观点认为，股权集中度越高，企业的经营风险也就越大。例如 Mansfield（1986）认为，大股东与小股东相比更重视企业的短期利润与回报，从而使的公司出现短视行为给企业带来更大的风险。刘海鹰（2010）选取 2009 年深沪两市的数据研究发现股权集中度与经营风险显著正相关。王丽珍、 肖淦丹、 田嘉晴（2021）研究发现股权集中度越高，保险公司承担的风险

就越高。毛颖等（2019）也得出了类似的结论。但也有部分学者认为股权集中度与风险之间是负相关的。Cheng 和 Elyaisiani(2011)研究发现股权集中度与人身保险公司的风险负相关，夏喆和靳龙（2013）运用 截面数据研究发现股权集中度越高，保险公司的风险越小。潘敏等（2012）也得出相似的结论。

基于以上文献可以看出学者对股权集中度与经营风险的关系并没有统一的结论，之所以没有统一的结论，我们认为可能是研究的方法的不同或者是不同行业之间的特殊性所导致不同的结果。那股权集中度与经营风险到底是什么样的关系呢？尤其是股权变动的提高给企业又带来什么样的结论呢？本文认为，我国保险行业比较特殊，因为我国保险公司起步比较晚，基础比较薄弱，保险公司发展的时间比较短，各项经营运营都不太成熟，第一股东做为公司的大股东影响着公司的发展战略与决策，股权集中度变动率越高会影响着公司的经营，给公司带来风险。另外，目前我国保险业的发展还不够成熟，大股东希望通过积极治理公司来实现公司的发展与扩张，进而实现公司的长久稳定的发展的希冀不是太高。寿险公司股权集中变动提高后，大股东为了自身利益会在一定程度上侵害中小股东，不利于整个公司的整体发展。基于上述背景，因此本文提出如下假设[1]

H1：股权集中度变动与寿险公司经营风险正相关。

### 2.2 股权制衡度与经营风险

所谓股权制衡是指控制权由几个大股东共同拥有，通过内部的相互牵制，使得单独的任何一个大股东都无法进行独有的控制决策。

李维安和曹延求(2004)等学者研究表明股权制衡度越高可以降低银行的风险水平；李军（2003）实证结果表明，股权制衡度越高，越能现实可能存在的股东之间的掠夺行为，更好的治理公司，降低企业的经营风险。而张博等(2018)研究发现股权制衡度与其风险承担存在负相关关系。王振山等(2004)运用动态面板的系统 GMM 估计方法发现股权制衡度与风险没有呈现显著的相关关系。综上所述，国内现有的研究还没有达成一致的结论。本文认为，当股权制衡度变动越高，控股股东侵害其他股东的能力较弱。由于其他大股东持股比例较高，将会对控股股东行为进行密切的监督，在这种情况下，控股股东就会适当的选择规避风险，从而做出比较保守的投资决策，这在一定程度上会降低了公司的经营风险。而且由于多个大股东都有各自的利益诉求，在进行内部决策的时候，难以达成一致的决策，因而最终可能会选择风险较小的项目，从而抑制企业的经营风险。基于此，提出以下假设 2：

H2：股权制衡度变动会降低寿险公司的经营风险。

## 3. 变量选取与研究设计

## 3.1 数据来源与变量选择

### *3.1.1 样本的选择*

因为从 2007 以后我国保险公司使用了新的会计准则，在新的会计准则下保险公司财务报表与老准则相比发生了较大的变化，为了保持数据的一致性本文选取了 2007 年--2020 年寿险公司作为研究对象，共选取了 75 家公司。所用数据从寿险公司官方网站手工搜集所得。

## 3.2 指标的度量

### *3.2.1 被解释变量*

本文在学者研究的基础上，选取收益波动率和偿付能力作为寿险公司的经营风险的衡量指标。（1）收益波动率。本文借鉴刘娜、易佳和昊维（2014）学者的研究，将净资产收益率的标准差（本文采用三年滚动标准差）作为经营风险中收益波动的衡量指标。净资产收益率的标准差衡量了净资产收益率的波动，波动越大，也即风险也就越大 （2）偿付能力。本文参照边文龙和王向楠（2017）选取保险公司的偿付能力综合充足率作为保险公司偿付能力大小的指标。偿付能力充足率为实际资本与最低资本的比值，反映了公司的经营风险水平，一般情况下偿付能力越高，表明风险越小。

### *3.2.2 解释变量*

本文根据股权结构的特征来衡量解释变量，股权主要包括股权集中度和股权制衡度，股权集中度衡量的指标主要是第一大股东持股比例，所以本文股权变动的第一个解释变量为第一大股东持股比例的变动，股权制衡度衡量指标由第二大股东持股占比、第二至第三大股东持股占比之和、第二至第五大股东持股占比之和与第一大股东持股比例的比值，第二至第十大股东持股占比之和与第一股东持股比例的比值，本文选择第二至第五大股东持股占比之和的变动与第一大股东持股比例的比值的变动作为股权制衡度的指标。

### *3.3.3 控制变量*

本文借鉴 王丽珍、 肖淦丹、 田嘉晴（2021）学者的研究，将业务状况、重要股东个数、资产负债率、总资产收益率、是否上市作为控制变量。本文全部变量的具体设置情况如表 1 所示。

**表 1 变量定义**

| | | | |
|---|---|---|---|
| 被解释变量 | ROET | 收益波动率 | 净资产收益率三年滚动标准差 |
| | Solvency | 偿付能力充足率 | 实际资本/最低资本 |
| 解释变量 | ST | 股权集中度的变动 | （本年第一大股东持股比例-上一年第一大股东持股比例）/上一年第一大股东持股比例 |
| | ZT | 股权制衡度的变动 | （本年第二至第五大股东持股比例之和-上一年第二至第五大股东持股比例之和）/上一年第二至第五大股东持股比例 |
| 控制变量 | CIK | 是否上市 | 上市为 1，未上市为 0 |
| | NS | 重要股东人数 | 持股超过百分之五的个数 |

| | | | |
|---|---|---|---|
| | Premium | 保费收入 | 衡量保险公司的业务规模 |
| | DAR | 资产负债率 | 总负债与总资产的比值 |
| | ROA | 资产收益率 | 公司净利润占其资产总额的比率 |

### 3.3 模型的建立

（1）股权变动对收益波动率的影响

将基本的模型设定为如下：

$$ROET=\beta_0+\beta_1ST+\beta_2ZT+\beta_3DAR+\beta_4NS+\beta_5ROA+\beta_6CIK+\beta_7Premium+\varepsilon \quad (1)$$

（2）股权变动对偿付能力的影响：

基本模型设定如下：

$$Solvency=\beta_0+\beta_1ST+\beta_2ZT+\beta_3DAR+\beta_4NS+\beta_5ROA+\beta_6CIK+\beta_7Premium+\varepsilon \quad (2)$$

其中，ROET、Solvency 为被解释变量，$\beta_0$为截距项，ST、ZT 为解释变量，ε 为随机误差项。

## 4. 实证结果及分析

### 4.1 描述性统计分析

表 2 列出了股权变动变量、经营风险变量以及控制变量的的描述性统计结果。由表 2 可以看出净资产收益波动率和偿付能力指标显示出很大的差异，收益波动率的观察值为 802 个，均值为 0.282，最小值为 0，而最大值仅为 27.69，表明公司收益波动率存在非常大的差异；偿付能力的均值为 288.5%，最小值为 -155.6%，而最大值高达 287931%,标准差为 8821%存在着非常大的差异。第一大股东持股比例的变动差异性较小，均值接近为 0.007,最小值为-1%，最大值为 3.206.而二到五大股东持股比例的变动在样本期间也表现出很大的差异性，最小值为-36.而最大值为 327.2。从其他控制变量来看，样本数据也存在着很大的差距，便于考察公司股权变动对经营风险的影响。

**表 2 变量的描述性统计分析**

| 变量名称 | 样本量 | 均值 | 标准差. | 最小值 | 最大值 |
|---|---|---|---|---|---|
| ROET | 802 | 0.282 | 1.436 | 0 | 27.69 |
| Solvency | 1,066 | 288.5 | 8821 | -155.6 | 287931 |
| ST | 641 | 0.00698 | 0.235 | -1 | 3.206 |
| ZT | 99 | 2.649 | 33.34 | -36 | 327.2 |
| DAR | 789 | 1.259 | 3.872 | -1.267 | 58.5 |
| Premium | 1,050 | 21849 | 68081 | 0 | 853148 |
| ROA | 790 | -0.0169 | 0.0452 | -0.368 | 0.103 |
| NS | 1,066 | 2.283 | 2.291 | 0 | 11 |
| CIK | 1,103 | 0.039 | 0.194 | 0 | 1 |

## 4.2 回归分析

表 4 反映了股权变动对寿险公司经营风险的影响。本文尝试使用和面板回归模型中的固定效应模型和随机效应模型估计本文模型，在对股权变动对收益波动率影响研究时，Hausman 检验支持采用随机效应模型。而在对股权变动对偿付能力风险研究时 Hausman 检验支持采用固定效应模型。列 1、列 2 显示面板回归时，股权集中度变动、股权制衡度变动对寿险公司收益波动风险以及偿付能力的影响。综合来看，股权集中度的变动与收益波动率、偿付能力充足率都存在着显著的相关关系。而股权制衡度的变动与收益波动率、偿付能力充足率都没有呈现显著的相关关系，这一结论不支持假设 2。由列（1）可以看到股权集中度的变动与净资产收益波动率在 1%的水平呈现显著的正相关关系，即股权集中度的变动越大，收益波动性也越大，经营风险也越大。这一结论支持假设 1。由列（2）和可以看到股权集中度的变动与偿付能力也是呈现显著的正相关的。这一结论说明股权制衡度的变动与经营风险是负相关的。这一结论又拒绝了假设 1。股权集中度的变动与引收益波动率和偿付能力同时正相关，看似是互相矛盾的，对此，本文进行分样本回归来进行解释说明。

**表 3 股权变动对经营风险的影响(全样本）**

| | （1） | （2） |
|---|---|---|
| | ROET | Solvency |
| | RE | FE |
| ST | 0.291*** | 0.835** |
| | -2.85 | -2.19 |
| ZT | -0.00053 | -0.000217 |
| | (-0.55) | (-0.06) |
| DAR | 0.0422 | -0.41 |
| | -0.36 | (-0.75) |
| Premium | -0.00000149 | -0.0000231*** |
| | (-0.98) | (-2.68) |
| ROA | -3.619** | -1.19 |
| | (-2.05) | (-0.14) |
| NS | 0.0137 | 0.0736 |
| | -0.66 | -0.17 |
| CIK | 0.189 | 0 |
| | -1.13 | (.) |
| _cons | 0.0469 | 2.711 |
| | -0.3 | -1.41 |
| *N* | 91 | 92 |
| r2 | | 0.207 |
| r2_a | | -0.336 |
| F | | 2.356 |

*t* statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

大公司和小公司在经营战略以及管理方式与管理水平存在着一定的区别，大公司由于拥有了一定的资本积累，看中企业未来的长期发展,相比绩效，企业更加关注企业长期价值以及经营风险。而小公司由于资本积累比较薄弱，更加看中当前的短期利润，股动在采取战略决策时一般比较保守。因此二者股权变动对经营风险的影响也有所不同。因此本文以寿险公司总资产的的年度中位数作为衡量标准，将寿险公司分为中小型公司和大型公司，并对中小和大型公司的股权结构与经营风险的影响进行了回归。回归结果如表 4 和表 5。从表 4 可以看出对于大公司而言，股权集中度的变动与偿付能力正相关，股权集中度的变动增加了一个单位，偿付能力增加 1.409 个单位，且对收益波动性的影响不大。股权制衡度对经营风险没有显著相关关系。大型保险公司股权集中度变动提高，会改变某些大股东长期势力，而变动高的大股东，首先为了自身的利益，也会对公司采取积极的治理方式，从而增加偿付能力。另外一方面，偿付能力高离不开注册资本，股权变动提高后，可能某些新进的大股东就会对公司增资，以增加注册资本。从而提高了偿付能力。

**表 4 股权变动对大公司经营风险的影响**

| | （1） | （2） |
|---|---|---|
| | ROET | Solvency |
| | RE | FE |
| ST | 0.0418 | 1.409** |
| | -1.02 | -2.32 |
| ZT | 0.00394 | 0.0206 |
| | -1.01 | -0.88 |
| DAR | -0.0169 | 0.341 |
| | (-0.39) | -0.51 |
| Premium | -0.000000758 | 0.000000102 |
| | (-0.82) | -0.01 |
| ROA | -0.00347 | -30.5 |
| | (-0.00) | (-1.00) |
| NS | -0.0566 | 0.326 |
| | (-0.90) | -0.36 |
| CIK | 0.111 | 0 |
| | -0.76 | (.) |
| _cons | 1.148*** | 0.367 |
| | -11.74 | -0.1 |
| *N* | 50 | 51 |
| r2 | | 0.41 |
| r2_a | | -0.639 |
| F | | 2.084 |

由表 5 可以看到股权集中度的变动对小公司的收益波动性正相关，即股权集中度

变动越高，收益波动性越大，且对偿付能力的显著性不强。股权制衡度的变动对小公司的收益波动性无显著相关关系。小公司相比大公司而言，更加注重企业的短期绩效，大股东更容易对公司进行控制，当股权集中度变动大时，大股东对企业采取的战略不同，对企业绩效就产生不同的影响，进而引起收益的波动。

**表 5　股权变动对小型公司经营风险的影响**

| | （1）<br>ROET<br>RE | （2）<br>Solvency<br>FE |
|---|---|---|
| ST | 0.553*** | 0.0697 |
| | -3.18 | -0.29 |
| ZT | -0.000821 | 0.000409 |
| | (-0.66) | -0.31 |
| DAR | 0.560* | -7.989*** |
| | -1.7 | (-3.15) |
| Premium | -0.000000667 | -0.0000109 |
| | (-0.16) | (-1.31) |
| ROA | -3.732 | 1.359 |
| | (-1.46) | -0.3 |
| NS | 0.0251 | 0.14 |
| | -0.65 | -0.62 |
| CIK | 0 | 0 |
| | (.) | (.) |
| _cons | -0.436 | 8.457*** |
| | (-1.30) | -4.58 |
| *N* | 41 | 41 |
| r2 | | 0.556 |
| r2_a | | -0.48 |
| F | | 2.506 |

*t* statistics in parentheses* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

## 5．稳健性检验

考虑到风险的衡量可能与前一期有关，为了进一步验证研究结果的可靠性，本文在模型（1）和模型（2）中分别加入被解释变量的滞后一项进行回归检验。回归模型如下：

$$ROET=\beta_0+\rho\ ROET_{t-1}+\beta_1\ ST+\beta_2 ZT+\beta_3 DAR+\beta_4 NS+\beta_5 ROA+\beta_6 CIK+\beta_7 Premium+\varepsilon \quad (3)$$

$$Solvency=\beta_0+\rho\ Solvency_{t-1}+\beta_1\ ST+\beta_2 ZT+\beta_3 DAR+\beta_4 NS+\beta_5 ROA+\beta_6 CIK+\beta_7 Premium+\varepsilon \quad (4)$$

检验结果如下:对于大公司而言，ST 在 Solvency 方程中系数仍然为正的，但是却不显著，所以股权集中度的变动对寿险偿付能力的影响没有通过稳健性检验，原因可能是 2016 年在保险业开始正式实施中国第二代偿付能力监管规则，而本文部分样本期间的偿付能力充足率的计算是根据 2003 年创建的第一代偿付能力监管规则所得到的，所以在某种程度上，偿付能力充足率变量不能够充分的衡量寿险公司的经营风险。对于小公司而言，股权集中度的变动与收益波动性仍然是正向显著的,股权集中度的变动对偿付能力的影响仍然是不显著的，与原回归结果一致。

**表 6 稳健性检验**

| 变量名称 | 大型寿险公司 | | 小型寿险公司 | |
|---|---|---|---|---|
| | (1) ROET | (2) Solvency | (3) ROET | (4) Solvency |
| $ROET_{t-1}$ | 0.0903** | | 0.451*** | |
| | -2.71 | | -5.27 | |
| $Solvency_{t-1}$ | | 0.00497 | | -0.0328 |
| | | -0.11 | | (-0.15) |
| ST | 0.106 | 1.302 | 0.348** | -0.214 |
| | -1.82 | -1.5 | -2.57 | (-0.50) |
| ZT | 0.000814 | 0.0775 | -0.00138 | -0.00009 |
| | -0.28 | -0.95 | (-1.47) | (-0.04) |
| DAR | -0.0169 | 0.0411 | 0.324 | -12.74** |
| | (-0.57) | -0.04 | -1.29 | (-3.28) |
| Premium | -0.000000303 | -0.00000506 | 0.00000231 | -0.00000537 |
| | (-0.47) | (-0.26) | -0.73 | (-0.34) |
| ROA | 1.023 | -47.27 | -2.966 | -0.226 |
| | -0.63 | (-0.94) | (-1.54) | (-0.02) |
| NS | -0.011 | 0.335 | 0.0312 | 0.111 |
| | (-0.25) | -0.25 | -1.06 | -0.29 |
| CIK | 0.0137 | 1.03 | 0 | 0 |
| | -0.13 | -0.34 | (.) | (.) |
| _cons | 0.0823 | 2.173 | -0.411 | 13.77* |
| | -0.74 | -0.66 | (-1.62) | -2.88 |
| *N* | 48 | 51 | 40 | 41 |
| r2 | 0.996 | 0.88 | 0.631 | 0.996 |
| r2_a | 0.972 | 0.25 | 0.551 | 0.945 |
| F | 41.38 | 1.396 | 7.825 | 19.52 |

## 6．结论与建议

基于手动收集 2007 － 2020 年 75 家寿险公司的数据为样本，从多方面考察了股权变动与经营风险的关系，研究发现：（1） 股权集中度的变动对大小公司的影响是不同的，对大公司而言，股权集中度的变动降低了企业的经营风险，而小公司，股权集中度的变动增加了寿险公司风险。（2）而股权制衡度变动与大小寿险公司经营风险都无显著相关关系，其原因可能在于随着股权制衡度变动的提升，一方面大股东之间在进行股权之争时给公司内部治理带来了显著的不稳定性，从而可能导致公司产生巨大的经营风险，但另外一方面，由于股权制衡度变动的提高，股东之间会相互牵制，而且由于多个大股东都有各自的利益诉求，在进行内部决策的时候，难以达成一致的决策，因而最终可能会选择风险较小的项目，从而抑制企业的经营风险。两者相互影响最终没有对保险公司经营风险产生显著的影响。

对于如何降低寿险公司的经营风险，本研究有如下的政策含义。首先，虽然研究得出股权集中度变动可以降低大型保险公司的经营风险，但是大量文献表明股权集中度变动会影响到公司的绩效，所以应当保持一定程度的股权集中度，稳定股权之间的制衡，完善内部机制， 防止因股权之争而使股权发生很大变动而给企业带来巨大风险。其次，应当合理开括资金运用方式与渠道，优化资本结构，提高寿险公司收益率进而降低寿险公司的经营风险。最后，监管部门应当加强对寿险公司内部控制和股东准入监管，防止寿险公司成为投资者的融资平台从而给寿险公司带来巨大的风险。同时监管部门也要加强对保险公司股权结构相关信息的披露要求，对保险公司未能及时规范披露公司治理概要、重大事项、专项信息、年度报告等内容的公司，应采取相关惩罚措施，规范保险市场的发展。保险公司自身也应结合本公司的相关情况，具体问题具体分析，在相关机构和公司管理人才上的设置要更有针对性。

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# Chapter 3. Life and Health Insurance

# Family Situation and Supplementary Health Insurance Needs Analysis

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**Keyword:** Supplementary Health Insurance, Family Situation
**Abstract.** Although the coverage rate of basic medical insurance in China is large, it is difficult to adapt to the current situation of medical and health unemployment. Good medicine and medical technology emerge one after another, and people's medical needs are getting higher and higher. Under this background, the supplementary medical insurance, which is supported by the government, insured voluntarily by the masses, and undertaken by insurance companies, comes into being for all basic medical insurance participants with the same title as social medical insurance. Based on the data of the China Health and Retirement Longitudinal Study (CHARLS), this paper conducts an empirical analysis of individual supplementary medical insurance purchase according to the family situation. Using Xtlogit model, the analysis found that the number of children, children's education, transfer payments between children and their parents, higher income of children, household registration, and basic personal conditions have an important impact on the purchase of supplementary medical insurance. The results show that the number of children, the education level of children, the transfer payment between children and parents, and the age have negative effects on the purchase of supplementary medical insurance, while the income of children and the education level of individuals have positive effects on the purchase of supplementary medical insurance, and the purchase behavior of individual supplementary medical insurance has obvious adverse selection. Based on the above research results, and on the basis of in-depth analysis, this paper puts forward relevant suggestions for the development of supplementary medical insurance in China.

## 1. 引言

多层次体系发展是我国医疗保障以及养老保险领域建设中的重要举措，具体是指以基本医疗保险为主体，医疗救助为托底，补充医疗保险、商业健康保险、医疗互助等共同发展的医疗保障体系制度。目前我国基本医疗保险覆盖13.6亿人，但就目前我国居民健康保障现状来看，随着居民就诊和住院人数连年上升、

居民看病成本进一步提升以及个人医疗自费支出占比较高，基本医疗保险的报销比例却较低。近年来，为减轻市民医疗费用负担，以城市为单位定制的补充医疗保险开始出现，并凭借“覆盖广、费用低、高保额”等特点而遍布全国。投保补充医疗保险有助于减轻人民特重大疾病的负担，有效解决人们“因病致贫、因病返贫”问题，增加家庭抵御医疗支出风险能力。为促进补充医疗保险发展，本文从家庭角度研究个体对补充医疗保险需求，从而反映家庭情况对个体补充医疗保险需求的影响。

本文利用中国健康与养老追踪调查（CHARLS）数据，进行家庭情况对个体补充医疗保险购买情况进行了实证分析。主要结果是：第一，子女数量越多的家庭，父母越会减少对补充医疗保险的购买；第二，子女教育程度越高的家庭，父母越会减少对补充医疗保险的购买；第三，子女向父母进行转移支付的家庭，父母越会减少对补充医疗保险的购买；第四，子女的收入越高，父母会增加对补充医疗保险的购买；第五，个体年龄越大、有养老保险、有伴侣的情况下，会减少对补充医疗保险的购买；第六，个体受教育水平越高、身体情况越不好、有抽烟等伤身体的喜好，会增加对补充医疗保险的购买。

发展补充医疗保险是符合我国国情，适应社会主义市场经济发展的需要的产物，有利于逐步向全民医疗保险过渡。基本医疗保险覆盖面虽广，但还有部分人群没有被覆盖，在基本医疗用药、诊疗项目和服务设施标准等方面都受一定程度的限制。要满足不同人群的医疗需要，只有建立以基本医疗保险制度为主体的多种形式、多种层次的医疗保险制度，才能切实保障劳动者的医疗需求。探索多形式、多层次的医疗保障体系，是维护社会安定的重要保障，是促进社会文明进步的重要手段。

## 2．文献综述

家庭是社会生活的基本单位，承担着未成年子女的抚养、老人的赡养及家庭体弱病残者的照料等诸多方面的保障功能，商业保险和社会保障是家庭保障的重要补充，可以将家庭面临的风险从家庭内部转移到家庭外部，至此影响到家庭对人身保险的需求，樊纲治（2015）。陈文（2004）指出影响补充医疗保险需求的重要因素主要包括个人避险倾向、疾病发生概率、疾病风险所致损失、保险价格、个人收入等因素。李慧莉（2011） 运用灰色关联分析法对我国商业性补充医疗保险的 需求因素进行了分析，其选取的影响因素为居民人均可支配收入、人口老龄化、保险意识和医疗费用 等.郭华（2017）年龄、家庭人均收入、是否有慢性疾病等因素会影响人们对医疗保险的参保选择。Hurd 和 McGarry（1997）认为自评健康状况对拥有保险没有显著影响，而收入、财富与购买补充医疗保险有显著的关系。H. Holly WANG 和Robert ROSENMAN(2007)研究表明教育、财产、儿童等因素会影响人们的保险需求。Vial S B 研究表明健康风险高的人更愿意购买健康相关的保险产品。Hong L （2010）研究发现基本医疗保险的购买对私人保险购买产生积极的影响，会增加居民购买私人医疗保险的概率。

## 3． 数据来源及变量测度

### 3.1数据来源

本文数据来源于中国健康与养老追踪调查（CHARLS）2013、2015和2018年的数据，该数据库的数据涵盖全国28个省（自治区、直辖市）的150个县、450个社区

（村）开展调查访问，至2018年全国追访完成时其样本已覆盖总计1.24万户家庭中的1.9万名受访者，且其问卷内容包括个人基本信息，医疗保险，家庭结构和经济支持，健康状况，养老金等，数据具有较好的时效性和可信度。共得10,732个样本，本文主要用 Stata16 对数据进行处理，最终得共计1100个样本。

### 3.2变量测量

3.2.1被解释变量

本文研究目的是分析家庭情况对补充医疗保险需求的影响，故选取调查数据中“个人是否参加补充医疗保险”作为因变量，加入其中个体参加保险取值为1，个体未参加保险取值为0；以“个人是否参加商业医疗保险”作为参考因变量，加入其中个体参加保险取值为1，个体未参加保险取值为0。

3.2.2解释变量

解释变量涉及被访问者的子女相关情况，本文将以下变量作为被解释变量：子女学历（如果个体有两个及以上的子女，则取子女最高学历）、子女总数、子女收入、子女婚姻状况、子女户口情况，子女向父母的转移支付。

3.2.3控制变量

控制变量主要包括个体的性别、年龄（考虑到补充医疗保险对被保险人年龄的限制，样本只保留 25–65 岁的被调查者）、伴侣、受教育程度、健康状况、慢性病、是否参加养老保险、是否参加基本医疗保险、是否抽烟。伴侣以0、1变量形式，有伴侣则为1，主要原因是伴侣会与个体共同承担生活费用、医疗支出等；考虑个体是否有慢性病，如果个体有慢性病，则更需要商业补充医疗保险；考虑个体是否抽烟，抽烟伤身体且会增大个体患病几率，从而可能增加补充医疗保险需求。

慢性病、养老金这两个变量虽然在下文中从统计上不显著，但由于这两个变量有经济意义，因此本文在分析时仍将这些变量包含在内。慢性病具有病情、病因复杂、长期且可逆性较小，只可控制而无法治愈，补充医疗保险在不考虑子女情况的条件下，仅对个体的补充医疗保险购买情况与个体情况进行回归，这两个变量对个体补充医疗保险购买情况的影响还是十分显著的，因此本文在分析子女因素对个体补充医疗保险购买情况时仍将两个变量包含在内。以下表1是变量以及描述性统计结果。

表1 变量定义以及描述性统计

| 变量名称 | 变量定义 | 均值 | 标准差 | 最小值 | 最大值 |
|---|---|---|---|---|---|
| 子女学历 | 1-11表示学历从未受过教育到博士学历 | 5.642 | 2.401 | 1 | 11 |
| 子女总数 | 拥有多少位子女 | 2.540 | 1.439 | 1 | 16 |
| 子女收入 | 子女收入金额 | 2.047 | 1.407 | 1 | 11 |
| 子女婚姻 | 1=结婚，0=未婚 | 0.645 | 0.478 | 0 | 1 |
| 子女户口 | 1=农村户口，0=非农村户口 | 0.714 | 0.452 | 0 | 1 |
| 子女转移支付 | 子女转移支付金额 | 6349 | 13998 | 0 | 600000 |
| 年龄 | 调查当年的实际年龄 | 54.55 | 6.433 | 25 | 65 |
| 性别 | 1=女，0=男 | 0.530 | 0.499 | 0 | 1 |
| 受教育程度 | 1-11表示学历从未受过教育到博士学历 | 6.357 | 3.780 | 1 | 11 |
| 伴侣 | 1=有伴侣，0=没伴侣 | 0.929 | 0.256 | 0 | 1 |
| 养老保险 | 1=有养老保险，0=没养老保险 | 0.737 | 0.440 | 0 | 1 |
| 慢性病 | 1=有慢性病，0=没慢性病 | 0.449 | 0.497 | 0 | 1 |
| 基本医疗保险 | 1=有基本医疗保险，0=没基本医疗保险 | 0.877 | 0.329 | 0 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| 抽烟 | 1=抽烟，0=不抽烟 | 0.260 | 0.439 | 0 | 1 |

## 4.家庭情况与商业医疗保险需求的实证分析

### 4.1模型构建

本文通过构建以下模型来分析家庭情况对商业医疗保险需求的影响，其中i表示个体，Fit表示个体子女相关情况，即解释变量，Cit为控制变量，β 0、β 1、β 2为参数：

$$Y_{it} = \beta_0 + \beta_1 F_{it} + \beta_2 C_{it} + \varepsilon_{it} \tag{1}$$

### 4.2总体回归

本文选取的样本涉及2013、2015、2018三年的样本数据，属于面板数据，在以“个体是否参与上补充医疗保险”作为被解释变量的回归中，利用xtlogit模型进行回归；其中实际参与上商业医疗保险的样本占比只有6%左右，参与商业医疗保险可能是稀有事件，故在以“个体是否参与商业医疗保险”作为被解释变量的回归中，利用xtCloglog模型校正可能存在的稀有事件偏误。回归结果如下表2。

表 2 总体回归结果

| | （1）<br>补充医疗 | （2）<br>补充医疗 | （3）<br>商业保险 |
|---|---|---|---|
| 子女最高学历 | | -0.903*** | -0.252*** |
| | | (-14.04) | (-4.20) |
| 子女总数 | | -0.497*** | -0.326** |
| | | (-5.09) | (-2.84) |
| 子女收入 | | 0.221* | 0.148 |
| | | (2.30) | (1.89) |
| 子女婚姻状况 | | -0.188 | -0.175 |
| | | (-0.72) | (-0.56) |
| 子女户口 | | -0.824** | -0.823* |
| | | (-2.65) | (-2.56) |
| 子女的转移支付 | | -0.000153*** | -0.0000692* |
| | | (-4.32) | (-2.16) |
| 年龄 | -0.0915*** | -0.0754*** | -0.0764** |
| | (-20.99) | (-3.47) | (-2.78) |
| 性别 | -0.357*** | -0.0345 | 0.979* |
| | (-5.01) | (-0.10) | (2.25) |
| 受教育程度 | 0.0408** | 0.304*** | 0.321*** |
| | (2.89) | (3.93) | (3.60) |
| 伴侣 | -0.0794 | 0.0710 | -0.325 |
| | (-0.76) | (0.19) | (-0.77) |
| 养老保险 | -0.970*** | -0.527 | -0.572 |
| | (-15.59) | (-1.90) | (-1.72) |
| 慢性病 | 0.756*** | 0.357 | 0.247 |
| | (14.38) | (1.55) | (0.93) |
| 基本医疗保险 | 2.666*** | 1.271* | -0.951 |
| | (13.54) | (2.21) | (-1.65) |

| | | | |
|---|---|---|---|
| 抽烟 | 1.363***<br>(16.31) | 0.803*<br>(2.01) | 0.531<br>(1.05) |
| 常数 | 1.506***<br>(4.49) | 6.728***<br>(4.44) | 3.827*<br>(2.21) |
| 样本量 | 9903 | 1100 | 691 |

注：括号内为t值，*、**和***分别表示在 10%、5% 和 1% 的水平上显著。

### 4.3 计量结果分析

表2中一共包含三个回归结果，模型一是被访问者个体情况对补充医疗保险购买的影响，模型二是加上被访问者子女情况对补充医疗保险购买的影响，模型三是加上被访问者子女情况对商业医疗保险购买的影响。

4.3.1 子女因素对补充医疗保险、商业医疗保险购买的影响

4.3.1.1 子女学历

根据回归结果，可以看出在1%显著性水平下子女学历对商业医疗保险以及补充医疗保险购买有显著且负的影响。在其他条件不变的情况下，随着子女学历的提升，父母对补充医疗保险、商业医疗保险购买减少。其原因可能是随着子女学历的不断上升，教育支出占家庭收入的比重不断上升，“父母爱子，则为之计深远”，补充医疗保险、商业医疗保险支出就会相对减少。

4.3.1.2 子女总数

根据回归结果，可以看出在5%显著性水平下子女总数对补充医疗保险购买有显著且负的影响，以及在1%显著性水平下子女总数对商业医疗保险有显著且负的影响。其他条件不变的情况下，随着子女数量增大，父母越不愿意购买补充医疗保险、商业医疗保险。我国受传统的家庭养老观念—养“儿”防老的影响，即父母养育子女是为了防备变老、生病等突发情况，随着子女数量增加，在生病时子女为其承担部分医疗支出，父母会减少对补充医疗保险、商业医疗保险的购买。

4.3.1.3 子女收入

根据回归结果，模型二可以看出在10%显著性水平下子女收入对补充医疗保险购买有显著正的影响，在模型三中子女收入对商业医疗保险购买影响虽然不显著但是系数依旧为正。在其他条件不变的情况下，子女收入越高，父母会增加其对补充医疗保险、商业医疗保险的购买。子女收入越高，越有经济能力去负担父母生病时的补充医疗保险、商业医疗保险支出，因此父母补充医疗保险、商业医疗保险购买力也会更强。

4.3.1.4 子女户口

根据回归结果，可以看出子女户口对商业医疗保险以及补充医疗保险购买有显著且负的影响。就目前政策来看，如果子女是农村户口，其父母通常也是农村户口。实证结果表明在其他条件不变的情况下，如果子女为农村户口，父母会减少对商业医疗保险以及补充医疗保险的购买。

4.3.1.5 子女转移支付

根据回归结果，可以看出在1%显著性子女转移支付对补充医疗保险购买有显著且负的影响，在10%显著性子女转移支付对商业医疗保险购买有显著且负的影响。在其他条件不变的情况下，随着子女向父母转移支付金额的增加，父母对补充医疗保险购买减少。子女对父母的转移支付虽然会提高父母的可支配收入，但是也说明子女和父母的关系更好并且乐于赡养父母，父母老有所依、病有所养，自然而然的会不注重对补充医疗保险的购买。

4.3.2 其他变量影响

从表2中的回归结果可以看出在1%显著性水平下个体年龄对个体补充医疗保险购买有显著且负的影响，在5%显著性水平下个体年龄对个体商业医疗保险购买有显著且负的影响。在其他条件不变的情况下个体年龄越大，个体就会减少对补充医疗保险、商业医疗保险购买，其原因可能不是因为个体不想买，而是随着个体年龄的增加，患病几率上升，购买医疗保险受限制较多且价格高昂，故个体会减少购买。

此外，从回归结果可以看出，个体的受教育程度对个体补充医疗保险、商业医疗保险购买有显著且正的影响。在其他条件不变的情况下，个体受教育程度越高，个体就会增加对补充医疗保险、商业医疗保险购买。抽烟会对个体补充医疗保险购买有显著且正的影响，即在其他条件不变的情况下，如果个体抽烟，吸烟有害健康，个体患病几率上升，那么个体就会增加对补充医疗保险购买，这一结果反映出补充医疗保险市场存在逆向选择的问题。基本医疗保险购买个体补充医疗保险购买有显著且正的影响，即在其他条件不变的情况下，已经有基本医疗保险的个体具有保险意识和保险偏好，更倾向于通过购买保险来转移潜在风险，则个体就会更增加对补充医疗保险购买。

## 5. 结论与建议

本文是基于CHARLS三年的数据，从家庭视角研究家庭情况对个体购买补充医疗保险的影响，分别研究了子女状况和个体状况对补充医疗保险需求的影响。研究发现子女学历、子女数量、子女的转移支付、子女户口情况对补充医疗保险产生负效应，子女学历越高、子女数量越大、子女的转移支付金额越大、子女户口为农村户口则个体对补充医疗保险需求越小。子女的收入越高则个体对补充医疗保险需求越大。个体年龄、养老保险购买对补充医疗保险产生负效应，年龄越大、拥有养老保险则个体对补充医疗保险需求越小。个体受教育程度、拥有慢性病、抽烟、基本医疗保险的购买对补充医疗保险产生正效应，个体受教育程度越高、拥有慢性病、抽烟、有基本医疗保险则个体对补充医疗保险需求越大。

基于上述研究结果，提出以下建议和启示：首先，加大宣传力度，增强个人保险意识，化解子女帮助、其他保险对个体补充医疗保险需求的挤出效应。本文研究表明子女数量越大、子女的转移支付金额越大，个体越会减少对补充医疗保险的购买，子女对父母的帮助，导致父母不重视对于补充医疗保险的购买，但是就部分疾病来说，基本医疗保险报销比例较低，最终会导致家庭高度的医疗费用支出，进而增加家庭的生活压力。个体养老保险金购买对补充医疗保险的购买产生负效应。加大保险的宣传，使人们充分理解到子女的帮助和养老保险等产品与补充养老保险的购买并不应该是替代的关系，而应该是一种相辅相成的关系，购买补充养老保险可以在家人生病时减轻家庭以及子女的负担。其次，补充医疗保险的条款设定应该由政府主导，并且避免与其他相关保险的重复。补充医疗保险作为基本医疗保险的补充，应该在基本医疗保险条款设定的基础上扩展保险责任范围，政府主导更有利于补充医疗保险与基本医疗保险的衔接，同时使得补充医疗保险的保障更为大众所用、覆盖更广。最后，保障补充医疗保险的充分覆盖，同时避免保险消费者的逆选择行为。通过上述研究，抽烟或者患有慢性病的个体更乐于购买补充医疗保险，如果更多具有不健康的生活习惯或者已经患病的个体购买了补充医疗保险，可能会导致保费不断增长，降低补充医疗保险的抗风险能力。同时也要保障保险的覆盖，保险公司提供的补充医疗保险不能以居民健康状

况不佳为由拒保，也不能因居民患病拒绝续保。政府应避免患病人群被排斥在补充医疗保险计划之外，避免保险公司逆向选择，保证补充医疗保险作用正常发挥（俞卫，2015）。

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# 家庭情况与补充医疗保险需求分析

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**关键词：**家庭情况；补充医疗保险

**摘要.**目前我国基本医疗保险覆盖率虽大，但是逐渐呈现出难以适应当下医疗卫生失业发展的现状。好的药品与医疗技术层出不穷，人民群众医疗需求也越来越高。在此背景下，政府支持、群众自愿参保、保险公司承担保险责任、与社会医疗保险相衔、面向全体基本医疗保险参保人员的补充型医疗保险应运而生。本文本文利用中国健康与养老追踪调查（CHARLS）数据，针对家庭情况对个体补充医疗保险购买情况进行了实证分析，运用xtlogit模型，分析发现子女数量、子女教育、子女与父母转移支付、子女的收入越高、户口、以及个人基本情况对个体对补充医疗保险的购买有着重要影响。结果表明子女数量、子女教育程度、子女与父母转移支付、年龄对补充医疗保险购买有负效应，子女收入、个体受教育程度对补充医疗保险购买有正效应，而且个体补充医疗保险购买行为出现明显的逆选择。针对上述研究结果，并在此基础上进行深入分析，为我国补充医疗保险发展提出相关建议。

# Does Basic Medical Insurance Crowd out Commercial Medical Insurance

## --Analysis based on CHARLS data

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**Keywords:** Basic medical insurance; Commercial medical insurance; Crowding out effect; promotion effect;Logit model

**Abstract.** Basic medical insurance and commercial medical insurance are important components of China's medical security system. From the perspective of product functions, they have a complementary relationship, but from the perspective of people's purchase intention, they also have a mutually exclusive relationship. Using CHARLS data in 2015 and Logit model, this paper firstly analyzes the impact of basic medical insurance on commercial medical insurance demand, and then based on the difference between urban and rural areas in insurance level and payment form, This paper analyzes the impact of urban employee medical insurance and urban and rural resident medical insurance (including the new rural cooperative medical care system and urban resident medical insurance) on the demand for commercial medical insurance, and explores the utility relationship between basic medical insurance and commercial medical insurance. The results show that the basic medical insurance has a crowding out effect on the demand of commercial medical insurance, in which the medical insurance for urban and rural residents squeezes out the commercial medical

insurance, while the medical insurance for urban workers promotes the commercial medical insurance. Finally, this paper puts forward some constructive suggestions for the causes of the results.

## 1．引言

以保障人们身体健康为核心的医疗保障制度是我国的基本经济社会制度。为了弥补原先公费医疗和劳保医疗的弊端，实现全民医保，我国分别在1998、2003、2007年建立了针对城镇就业者的城镇职工医疗保险、针对农村居民的新型农村合作医疗保险（简称新农合）、针对城镇非就业者的城镇居民医疗保险。2009年，国务院提出建立和完善以基本医疗保险为主体，商业医疗保险等多种医疗保险为补充的医疗保障体系。据国家医疗保险保障局数据显示，截至2019年底，我国基本医疗保险参保人数135436万人，参保覆盖面95%以上，其中参与城镇职工医疗保险32926万人，较上年增长3.9%，参加城乡居民医疗保险102510万人，较上年减少0.3%。

在医疗保障体系中，基本医疗保险和商业医疗保险有着各自的优点和不足。基本医疗保险是一种“低标准”的保障，主要满足人们的基本生活需求，有着“广覆盖、多层次、保基本、可持续”的特点，但是保障范围和额度比较固定、单一，尚未完全覆盖到流动人群、灵活就业人群等。商业医疗保险是一种“高层次”的保障，用于满足人们高层次、多样化的保险需求，能够保障“保基本”之外的额外医疗费用，减轻医疗费用支出负担，但因其仍处于发展初级阶段，保险深度和保险密度均较低，尚未充分发挥补偿作用。

随着经济的发展和收入的提高，基本医疗保险的保障水平可能无法满足人们的需求，为此人们会将注意力转向具有更高保障的商业医疗保险，因此，基本医疗保险可能会提升商业医疗保险的关注度和需求量，形成“促进效应”。不过，从另一个角度看，随着基本医疗保险覆盖范围的扩大和待遇水平的提高，人们都可以从中找到适合自己的保险，获得基本的保障，由于两种保险在功能及覆盖上具有重合性，且商业医疗保险的保费较高，人们从基本医疗保险获得补偿后再从商业医疗保险获得的赔付额较低，部分公民还存在购买基本医疗保险后并没有经济能力再去支付商业医疗保险的情况，此时体现出“挤出效应”。

基本医疗保险和商业医疗保险都是我国医疗保障体系中的重要组成部分，任何单一的医疗保险都无法满足社会成员的需求，因此，研究基本医疗保险是否挤出商业医疗保险，为促进共同发展献计献策，具有重要的理论和现实意义。本文采用的是CHARLS数据，该问卷是针对年龄在45周岁及以上的中老年人，近年来人口老龄化问题日渐加剧，再加上中老年群里的身体状况相对较差，他们的需求情况更能反映我国医疗保险市场的情况。本文首先分析基本医疗保险对商业医疗保险需求的影响，接着分别分析城镇职工医疗保险和城乡居民医疗保险（包括新农合和城镇居民医疗保险，两者已于2016年合并）对商业医疗保险需求是促进效应还是挤出效应，一方面是因为新农合和城镇居民医疗保险的保障水平较城镇职工医疗保险而言相对偏弱；另一方面是因为应该新农合和城镇居民医疗保险的缴费形式类似，都是从可支配收入中拿出一部分进行购买的，而城镇职工医疗保险属

于强制缴费，得到的收入是扣除保费后的；因此，这样分类既符合实际情况，也符合政策安排。

## 2．文献综述

### 2.1 国外文献

国外关于社会医疗保险是否挤出了商业医疗保险的研究，最早出现于美国扩大特殊人群的社会医疗保险参保资格后，商业医疗保险的覆盖率大幅度下降，引发了学者们的研究兴趣，但研究结果不尽相同，主要有以下三种观点：挤出效应、互补效应和几乎无影响。

#### 2.1.1 关于“挤出效应”的研究

在国外的研究中，“挤出效应”最早是由Cutler＆Gruber（1996）提出的，他们采用线性概率和两阶段模型，指出在美国公共医疗保险（Medicaid）蓬勃发展的时期，商业医疗保险的参与人数下降，且在公共医疗保险提高孕妇和儿童的保障范围后，挤出效应随之扩大。Kronick＆Gilmer（2002）指出，当Medicaid的保障范围扩大到收入低于联邦贫困水平100%的人群时，对商业医疗保险的挤出效应并不明显；但当保障范围扩大到收入处于联邦贫困水平100%到200%的人群时，则会产生挤出效应。Brown＆Finkelstein(2007)通过动态模型，发现美国长期护理保险中的社会保险对商业保险存在较大的挤出效应，拥有医疗补助资格的家庭每增加一万美元资产，购买商业保险的概率就会下降1.1%。Shore-Sheppardetal(2000)通过1989至1995年的企业数据，发现公司员工中拥有政府医疗补助资格的比例越高，该公司为员工提供商业医疗保险的概率越低。

#### 2.1.2 关于“互补效应”的研究

KJ Rask＆KN Rask（2000）采用1996和1997年的33000个家庭数据，发现由于公共健康医疗的保障能力有限，居民收入水平和医疗需求水平的提高带来人们对商业医疗保险的需求的增加。Drechsler＆Jütting（2007）指出，在一些发展中国家中，商业医疗保险能够对社会医疗保险起到重要的补充作用，且社会医疗保险对商业医疗保险需求的影响程度与该国的经济、社会和体制有关。Sohn＆Jung（2016）采用13798名参与者的数据和多变量Poisson回归，发现在韩国医疗保险计划(NHI)推进过程中，民众对补充型私人医疗保险(PHI)的需求也在增加，原因可能是NHI的自付费用较高以及财政保障有限。

#### 2.1.3 关于“几乎无影响”的研究

Liu＆Chen（2002）以1998年台湾家庭收支资料为基础，运用Logistic、OLS和两部分模型，发现城镇居民比农村居民的商业医疗保险需求更强，且社会医疗保险和商业医疗保险之间不会相互影响。Ham＆Shore-Sheppard（2003）借鉴Cutler＆Gruber的结果，使用收入和项目参与调查（SIPP），发现无论儿童的Medicaid资格如何，均不会产生挤出效应。Buchmueller（2005）使用医疗支出小组调查保险部分（MEPS-IC）的截面数据和1997至2001年美国各州儿童医疗保险的面板数据，认为政府财政支持的儿童医疗保险计划(SCHIP)并不影响企业雇主提供商业医疗保险的概率。

### 2.2 国内文献

国内学者们对基本医疗保险与商业医疗保险的关系研究始于21世纪初期，文献相对较少，且与国外偏向实证分析不同，国内大多偏向理论分析。早期的文献

主要运用定性研究，后来学者们也尝试使用宏观、微观层面的数据开展定量实证研究。

### 2.2.1 关于“挤出效应”的研究

刘玉娟（2011）指出，商业医疗保险是对基本医疗保险的补充，二者也存在一定的竞争关系，基本医疗保险覆盖范围的扩大和待遇水平的提高，对商业医疗保险产生了挤出作用。张敏娟（2015）表示，基本医疗保险满意度与商业医疗保险需求呈反向相关，即基本医疗保险满意度较高的群体对商业医疗保险的需求相对较少。郑怡林（2014）使用2006年中国健康和营养调查（CHNS）数据，表明公共医疗保险覆盖范围的扩大减少了人们对商业医疗保险的需求，且经济水平越低，挤出效应越明显。

### 2.2.2 关于“互补效应”的研究

高岩（2008）表示，“互补”指的是基本医疗保险与商业医疗保险在保障层次和范围、缴费、待遇给付及运作流程的互补。安华和贺小琴（2009）认为，基本医疗保险目前停留在“低水平、广覆盖”的层面，要想更好地满足人们的医疗保障需求，“保额高、自愿投”的商业医疗保险是化解医疗支付风险的必要补充。瞿栋和王劲松（2010）采用2006年CHNS数据和似不相关二维probit模型，指出参加新型农村合作医疗保险（新农合）对农村居民购买商业医疗保险有着较为显著的刺激作用。罗洋（2020）选取某三甲医院2013至2016年高端患者196例和2015至2016年出院患者18399例，采用秩和检验和Logistic回归对其医保和商保费用数据进行分析，显示使用医保结算的费用显著高于使用医保加商保结算的费用，由此认为将医保与商保有效结合才能为民众提供更广、更高端的医疗保障。

### 2.2.3 关于“既有挤出效应又有互补效应”的研究

周坚（2020）基于2006、2011和2015年CHNS数据，运用双重差分（DID）和Logit模型，发现城镇居民医疗保险对商业医疗保险的作用从挤出变为促进，且居住在中西部地区的居民购买商业医疗保险的概率较低。许荣、张迪和吉学（2013）基于2004至2009年CHNS数据，运用DID和Probit模型，发现新农合与商业医疗保险之间先是替代关系，而后转为互补关系，且年龄大、患有慢性病、家庭规模大、家庭收入低的农户对商业医疗保险的需求更低。王天宇（2016）基于2004至2011年CHNS数据，运用DID和Logistic模型，发现在2004至2009年新农合建立与推广时期，新农合对商业医疗保险的作用从促进变为抑制，而在2009至2011年新农合全面覆盖农村时期，农民对商业医疗保险的需求出现下降趋势。

在现有的国内外文献中，关于基本医疗保险是否挤出了商业医疗保险仍存在着争论，本文将继续研究这两者之间的关系，同时把省份、教育程度、收入情况等地区因素、家庭因素和个体因素考虑其中。

## 3. 数据与变量

### 3.1 数据来源

本文使用的数据主要来源于中国健康与养老追踪调查（China Health and Retirement Longitudinal Study，简称CHARLS）2015年的问卷调查结果，还结合了2011年和2013年的部分信息。CHARLS是由北京大学国家发展研究院主持的调查项目，全国基线调查于2011年在27个省（自治区、直辖市）的150个县、450个社区（村）开展访问，每两年追踪一次，采用多阶段抽样方式，目的是收集能够代表45岁及以上的中国居民的数据，至2015年，其样本已覆盖12235户家庭中

的21095名受访者。CHARLS问卷内容涉及从社会到家庭再到个人等多方面内容，包括个人与家庭的基本信息、健康状况、收入水平、医疗保险、商业保险等，其数据满足本文的研究需求。

## 3.2 样本处理

CHARLS问卷调查是在2011年展开的全国性基线调查，2013年和2015年主要是回访2011年访谈的个体。本文主要收集的是2015年的调查结果，但考虑到教育程度等因素是追踪数据，便结合了2011年和2013年的部分调查结果，以保证数据的准确性。结合本文研究需要，对21095个样本进行了如下的处理。

（1）CHARLS问卷调查访谈的个体是年龄在45岁及以上的中老年人，旨在收集一套代表中国45岁及以上中老年人家庭和个人的高质量微观数据，因此删除了年龄在45岁以下的个体，剩余样本数为20985人。

（2）有些个体对调查问卷中的部分基本信息并未给出回答，如性别、年龄、婚姻等，删除这些数据缺失的个体后，剩余样本数为16567人。

（3）本文将收入水平作为一项较为重要的控制变量，但有些个体并没有填写具体的收入，甚至还出现了收入水平为负数的情况，这些问卷相当于有问题问卷，保留这些个体的数据会影响数据的有效性，从而影响最终的结果，删除后样本数为7909人。

（4）有些个体在投保方面未给出回答或是给出不符合逻辑的答案，比如同时参保了城镇职工医疗保险和城乡居民医疗保险，删除这些个体后最终确定样本数为7697人。

## 3.3 变量选取

### 3.3.1 被解释变量和解释变量

本文的被解释变量是“是否购买商业医疗保险”(Commercial Medical Insurance，cmi)，该变量是一项二元变量，“已购买”赋值为1，“未购买”赋值为0。

本文首先以“是否参加基本医疗保险”（Basic Medical Insurance，bmi）为解释变量，为进一步分析不同类别的基本医疗保险对商业医疗保险的影响，分别以“是否参加城镇职工医疗保险”（urban employee medical insurance，uemi）和“是否参加城乡居民医疗保险”（urban and rural resident medical insurance，urmi）为解释变量，这些变量均为二元变量，“参加”赋值为1，“未参加”赋值为0，其中，“是否参加基本医疗保险”是指参加了城镇职工医疗保险、城镇居民医疗保险和新农合这三者其中之一的即为1，否则为0。

### 3.3.2 控制变量

本文所涉及到的控制变量有性别（sex）、年龄（age）、省份（pro）、婚姻状况（mar）、教育程度（edu）、健康水平（hea）、收入情况（lni）以及是否购买商业养老保险（cpi）。

sex表示个体的性别，“男性”赋值为1，“女性”赋值为0。男性往往是一个家庭的主要劳动力和收入来源，家庭对其的依赖程度较高，或许会因而提高购买商业医疗保险的可能性，因此本文将性别作为一项控制变量。

age表示个体的年龄，是一项连续性变量。个体的年龄可以反映其身体状况和心理情况，所面临的疾病风险往往也会随着年龄的增长而增加，从而增加购买商业医疗保险的意愿也会随之增加，因此本文将年龄作为一项控制变量。

pro表示个体所在省份的医疗保障水平，“保障水平较高”赋值为1，“保障水平较低”赋值为0。各省份医疗保障水平的高低借鉴于Xian Huang（2015）发表的一篇论文，文中将31个省份按照保障水平的高低分为了四类，本文将其前两类的12个省份认定为保障水平较高，后两类的19个省份认定为保障水平较低。因此，在CHARLS数据所涉及到的27个省（自治区、直辖市）中，山东、江苏、浙江、福建、广东、北京、上海、天津、新疆、青海这10个省归为保障水平较高的省份，黑龙江、吉林、辽宁、内蒙古、河北、山西、陕西、湖北、广西、云南、河南、安徽、江西、湖南、甘肃、四川、重庆这17个省归为保障水平较低的省份。一般来说，一个地区的商业医疗保险发展水平与该地区的医疗保障水平有着较强的联系，因此本文将省份作为一项控制变量。

mar表示个体的婚姻状况，“有配偶”赋值为2，“曾经有配偶（包括离异、丧偶）”赋值为1，“从未有配偶”赋值为0。虽然“曾经有配偶”和“从未有配偶”都是一个人生活，但前者发生了婚姻状况的变化，而后者并未发生变化，所以两者在购买商业医疗保险上还是可能会存在差异的。个体的婚姻状况会影响其对未来生活的打算与保障，从而影响对商业医疗保险的购买意愿，因此本文将婚姻状况作为一项控制变量。

edu表示个体的教育程度，“中学以上学历”赋值为2，“中学学历”赋值为1，“中学以下学历”赋值为0。CHARLS数据访问的是45岁及以上的居民，教育水平普遍不是很高，因此本文以中学（初中和高中）为界，将教育程度分为三类。一般情况下，学历水平较高的个体会具备足够的资金实力、充分的保险认识和较高的保险意识，因此本文将教育程度作为一项控制变量。

Hea表示个体的健康水平，“健康”赋值为2，“一般”赋值为1，“不健康”赋值为0。由于商业医疗保险的购买行为可能会受到个体健康状况的影响，身体差的人可能会选择购买商业医疗保险给自己以后的生活多一份安全保障，因此本文将健康水平作为一项控制变量。

lni表示个体所在家庭的年收入情况，是一项连续性变量，由于该数据相对于其他变量数据较大，且数据本身差异较大，因而在实证分析时进行取对数处理。家庭的收入水平包括个体与家人的受雇工资收入及家庭的农业、商业与副业收入。之所以选择个体所在家庭的总收入而不是个体收入，是因为多数个体在家务农或经商，并没有受雇方面的工资的而言，而务农、经商所得的收入一般归于一个家庭的总收入，因此本文将收入情况作为一项控制变量。

cpi表示是否购买商业养老保险（包含人寿保险），“购买”赋值为1，“未购买”赋值为0。是否拥有这类保险可以反映个体的风险规避状况，相对而言，保守者更愿意借助某种保险来保障未来生活的稳定，因而，拥有这类保险可能会对购买商业医疗保险有一个促进的作用，另外，购买商业养老保险的个体可能有足够的资金用于支付多份保障的费用，因此本文将是否购买商业养老保险作为控制变量。

表1 变量及赋值表

| | 变量 | 符号 | 赋值 |
|---|---|---|---|
| 被解释变量 | 是否购买商业医疗保险 | cmi | 已购买=1，未购买=0 |
| 解释变量 | 是否参加基本医疗保险 | bmi | 已参加=1，未参加=0 |
| | 是否参加城镇职工医疗保险 | uemi | 已参加=1，未参加=0 |
| | 是否参加城乡居民医疗保险 | urmi | 已参加=1，未参加=0 |

| | | | |
|---|---|---|---|
| 控制变量 | 性别 | sex | 男性=1，女性=0 |
| | 年龄 | age | 2020年的年龄 |
| | 省份 | pro | 保障水平较高=1，保障水平较低=0 |
| | 婚姻状况 | mar | 有配偶=2，曾经有配偶（离异、丧偶）=1，从未有配偶=0 |
| | 教育程度 | edu | 中学以上=2，中学（初高中）=1，中学以下=0 |
| | 健康水平 | hea | 健康=2，一般=1，不健康=0 |
| | 收入情况 | lni | 家庭总收入的对数 |
| | 是否购买商业养老保险（包含人寿保险） | cpi | 已购买=1，未购买=0 |

## 3.4 描述性统计

为了更加直观地观察各变量在样本中的差异，本文对样本进行了描述性统计分析，以下为被解释变量、解释变量和控制变量的描述性统计结果，并对各项数据作了浅显的分析。

表2 描述性统计表

| 变量 | 样本数 | 均值 | 标准差 | 最小值 | 最大值 |
|---|---|---|---|---|---|
| 是否购买商业医疗保险 | 7697 | 0.037678 | 0.190426 | 0 | 1 |
| 是否参加基本医疗保险 | 7697 | 0.904248 | 0.294269 | 0 | 1 |
| 是否参加城镇职工医疗保险 | 7697 | 0.127976 | 0.344897 | 0 | 1 |
| 是否参加城乡居民医疗保险 | 7697 | 0.766273 | 0.423228 | 0 | 1 |
| 性别 | 7697 | 0.539171 | 0.498496 | 0 | 1 |
| 年龄 | 7697 | 63.16890 | 9.079542 | 45 | 97 |
| 省份 | 7697 | 0.328570 | 0.469724 | 0 | 1 |
| 婚姻状况 | 7697 | 1.884630 | 0.340362 | 0 | 2 |
| 教育程度 | 7697 | 0.438483 | 0.561119 | 0 | 2 |
| 健康水平 | 7697 | 1.069378 | 0.685739 | 0 | 2 |
| 收入情况 | 7697 | 9.668894 | 1.453884 | 0.693147 | 14.93281 |
| 是否购买商业养老保险 | 7697 | 0.073535 | 0.261030 | 0 | 1 |

从解释变量的描述性统计结果可以看出，在7697个样本中，参加基本医疗保险6960人，占比90.4248%，基本医疗保险的覆盖率超过90%，由此可见，我国的医疗保障体系发展得比较好。且国家医疗保险保障局发布，截至2019年底，我国基本医疗保险的覆盖面已达到95%以上，但距离“全覆盖”还有一定的差距，仍需要不断完善与改进。

其中，参加城镇职工医疗保险1062人，占比12.7976%，参加城乡居民医疗保险5898人，占比76.6273%。两者占比的差距可能是因为部分城镇职工参加的是公费医疗，不在本文统计的城镇职工医疗保险范围内，也可能是因为CHARLS问卷针对的45岁及以上的公民，存在部分无业人员或者原来未参加城镇职工医疗保险而在退休后参加的基本医疗保险的退休人员，导致调查对象大多是城乡居民医疗保险的参与者。

从被解释变量的描述性统计结果可以看出，在7697个样本中，购买商业医疗保险290人，占比3.7677%，相对于基本医疗保险而言，这是一个极小的数字，购买人数仅是基本医疗保险的4.1667%，这说明我国的商业医疗保险市场有待挖掘，还有很大的发展空间。

从控制变量的描述性结果可以得出以下结论：

在个人方面，性别的均值为0.539171，表明在样本中男女比例相差不大，男性略多一些；年龄的均值为63.16890，在我国，男女的退休年龄分别为60周岁和55周岁，表明样本中的个体大多为退休人员，这可能会影响收入水平，进而影响商业医疗保险的购买；省份的均值为0.328570，表明在样本中的27个省份中，医疗保障水平较低的偏多，也可以看出我国的医疗保障水平普遍偏低；婚姻状况的均值为1.884630，表明绝大多数人都是有配偶的；教育程度的均值为0.438483，表明大多数人只有中学以下学历，甚至是从未接受过教育；健康水平的均值为1.069378，表明个体对自身的健康评价普遍是在一般水平。

在家庭方面，收入情况的均值为9.668894，最小值和最大值分别为0.693147和14.93281，因为该数据取得是对数，所以原数据的均值、最小值和最大值分别为15818元、2元和3056600元，足以可见家庭的平均年收入仅在1.6万元左右，且差距之大。另外，该变量的标准差是1.453884，是除了年龄外的其他变量中最大，且远远超过其他变量，说明个体在家庭收入方面存在着较大的差距，这也是取对数的原因之一。

在其他商业保险方面，在7697个样本中，商业养老保险（包含人寿保险）的有566人，占比7.3535%。无论是商业养老保险还是商业医疗保险，参保率都远小于基本医疗保险。

## 4. 模型与实证

### 4.1 模型设定

本文采用的研究方法是Logistic回归分析，是一种简便的处理二分类因变量问题的分析方法，其基本特点是因变量必须是二分类变量。这是一种非线性模型，其模型为：

$$F(P)=\frac{e^{P}}{1+e^{P}}=\frac{e^{(x\beta)}}{1+e^{(x\beta)}}$$

$$x\beta=\beta_0+\beta_{1*1}+...+\beta_{k*k}$$

$$E(y)=LogitP=\beta_0+\beta_1x_1+\beta_2x_2+\ldots+\beta_kx_k$$

其中，函数F为Logistic函数，且0<F( )<1；参数P为常用极大似然估计；LogitP是发生概率P的转换单位；y只有0和1两种取值。

本文中，y代表因变量cmi，即被访问者是否参加商业医疗保险。在自变量中，是否参加基本医疗保险是最主要的变量，其他自变量还有性别、年龄、省份、婚姻状况、教育程度、健康水平、收入情况以及是否购买商业养老保险八个方面。因此，本文构建的Logit模型为：

$$Logit(cmi)=\beta_0+\beta_1bmi+\beta_2sex+\beta_3age+\beta_4pro+\beta_5mar+\beta_6edu+\beta_7hea+\beta_8lni+\beta_9cpi+u$$

由于城镇职工医疗保险和城乡居民医疗保险在医疗保障范围和程度上存在差异，再加上两者的缴费形式不同，前者属于强制缴费，得到的收入是扣除保费后的，而后者与商业医疗保险类似，需要拿出可支配收入中的一部分进行购买，因此，本文在上述研究的基础上，将基本医疗保险按照城镇和城乡区分开来，即城镇职工医疗保险和城乡居民医疗保险，分别研究两者对商业医疗保险需求的影响。同样，在自变量中，是否参加城镇职工医疗保险和城乡居民医疗保险是最主要的变量，其他自变量保持不变，构建Logit模型为：

$$Logit(cmi) = \beta_0 + \beta_1 uemi + \beta_2 sex + \beta_3 age + \beta_4 pro + \beta_5 mar + \beta_6 edu + \beta_7 hea + \beta_8 lni + \beta_9 cpi + u$$

$$Logit(cmi) = \beta_0 + \beta_1 urmi + \beta_2 sex + \beta_3 age + \beta_4 pro + \beta_5 mar + \beta_6 edu + \beta_7 hea + \beta_8 lni + \beta_9 cpi + u$$

## 4.2 实证分析

对所有的样本数据进行筛选处理后，共有7697个有效样本可以使用，采用state15计量软件进行Logit回归后，其统计结果如下所示。

表3 Logit回归结果表

| 变量 | 模型1<br>（基本医疗保险） | 模型2<br>（城镇职工医疗保险） | 模型3<br>（城乡居民医疗保险） |
|---|---|---|---|
| 商业医疗保险 | -0.3433405*<br>（-1.74） | 0.4081084**<br>（2.52） | -0.495798***<br>（-3.44） |
| 性别 | 0.0991861<br>（0.76） | 0.1161033<br>（0.89） | 0.1313694<br>（1.00） |
| 年龄 | -0.0386492***<br>（-4.34） | -0.0406302***<br>（-4.53） | -0.0417083***<br>（-4.67） |
| 省份 | 0.2304851*<br>（1.74） | 0.2414681*<br>（1.82） | 0.2239324*<br>（1.69） |
| 婚姻状况 | -0.3184725<br>（-1.53） | -0.3322824<br>（-1.61） | -0.302621<br>（-1.46） |
| 教育程度 | 0.6367848***<br>（5.86） | 0.5306568***<br>（4.50） | 0.4982871***<br>（4.30） |
| 健康水平 | 0.1138003<br>（1.14） | 0.0955523<br>（0.95） | 0.0916528<br>（0.91） |
| 收入情况 | 0.0811757<br>（1.52） | 0.0628795<br>（1.16） | 0.0566486<br>（1.05） |
| 商业养老保险 | 2.082793***<br>（15.54） | 2.076684***<br>（15.51） | 2.088824***<br>（15.56） |
| cons | -1.832508*<br>（-1.94） | -1.82012*<br>（-1.94） | -1.304685<br>（-1.37） |
| Prob>chi2 | 0.0000 | 0.0000 | 0.0000 |
| Log likelihood | -1048.1642 | -1046.4989 | -1043.8312 |
| Pseudo R2 | 0.1515 | 0.1528 | 0.1550 |

注：1、***，**，*分别表示在1%，5%和10%的水平上显著；2、表中数字为各变量的回归系数，括号内为各变量的Z值。

### 4.2.1 全样本回归的实证结果与分析

从回归结果表中可以看出，Prob>chi2=0.0000，说明模型无效假设检验对应的P值为0.0000，即模型整体是显著的；从对数似然值Log likelihood可以看出模型的适应性较好；从伪决定系数Pseudo R2可以说明模型中自变量对因变量具有一定的解释能力。

该模型中，最重要的解释变量是是否参加基本医疗保险，其P值为0.083，在10%的水平上显著，系数为-0.3433405，这说明基本医疗保险挤出了商业医疗保险，这与预计结果相符。商业医疗保险主要保障的是医保药品目录之外的用药费用和医保基金支付范围以外的医疗费用，尤其针对高额但发病率低的疾病，因此人们会抱有侥幸心理，再加上经济能力不足以支撑高额的保费，便不再考虑购买商业医疗保险。不过这种挤出作用呈微显著，接下来，本文对另外两个模型的实证进行分析，希望可以从中而出该P值微显著的原因。

### 4.2.2 城镇职工医疗保险对商业医疗保险的实证结果与分析

该模型中，最重要的解释变量是是否参加城镇职工医疗保险，其P值为0.012，在5%的水平上显著，系数为0.4081084，这说明城镇职工医疗保险的扩展在整体上对购买商业医疗保险呈现出“促进效应”，并且这种促进作用非常明显。

该促进效应可能有以下几点原因：第一，目前市场上大部分的商业医疗保险产品都会询问被保险人是否参加基本医疗保险，若已参保，商业医疗保险则会更加注重补偿基本医疗保险无法覆盖的部分，同时下调费率。第二，不同于城乡居民医疗保险是从可支配收入中拿出一部分进行购买的，城镇职工医疗保险属于强制缴费，人们得到的收入是扣除保费后的，且保费是由用人单位和职工本人共同缴纳的，给人一种不需要自己额外付钱的感觉，一定程度上减少了参保者的经济负担和心理负担。第三，城镇职工医疗保险自1998年建立以外深受政府的重视，财政补助水平和制度保障水平逐步提高，且重心向中西地区和弱势群体倾斜，补助的力度相对要高于城乡居民医疗保险，让参保者有经济能力去购买商业医疗保险。根据以上三点原因，再加上生活水平的改善和保险意识的提高，越来越多的个体在参加基本医疗保险的同时，也愿意购买商业医疗保险，以获得更加全面的医疗保障。

### 4.2.3 城乡居民医疗保险对商业医疗保险的实证结果与分析

该模型中，最重要的解释变量城乡居民医疗保险的P值为0.001，在1%的水平上显著，系数为-0.495798，这是一个较为可观的数据，说明城乡居民医疗保险对居民购买商业医疗保险有一个明显的“挤出效应”。

这种效应的产生原因可能是城乡居民医疗保险覆盖面的扩大和保障待遇水平的提高挤占了居民对商业医疗保险的部分需求。相对于城镇职工医疗保险，城乡居民医疗保险设有起付标准，在医疗消费不变的情况下，一定程度上降低了商业医疗保险的赔付金额。另一方面，商业医疗保险的缴费形式与城乡居民医疗保险类似，都是从可支配收入中拿出一部分购买的，因此两者在消费上存在一定的替代关系。总体来说，在居民对医疗保障需求和缴费能力一定的前提下，城乡居民医疗保险满足了大多数人的基本保障需求，那么他们对商业医疗保险的购买就会相应地减少。

城乡居民医疗保险对商业医疗保险需求的影响与城镇职工医疗保险恰好相反，一个是促进效应，一个是挤出效应，且挤出效应更加显著一些，这也可以解释为什么总体的基本医疗保险对商业医疗保险需求的影响为挤出效应，但并不明

显显著。另外，本文还认为，城镇职工医疗保险的建立时间要比城乡居民医疗保险提早几年，从而导致了商业医疗保险对城镇职工医疗保险的适应性更好，充分发挥了补充作用，因此，本文推断，随着时间的推移和政策的改进，城乡居民医疗保险对商业医疗保险的挤出效应可能会转变为促进效应。

#### 4.2.4 控制变量的实证结果与分析

在八个控制变量中，年龄、教育程度和是否购买商业养老保险这三个变量的P值均为0.000，可见具有很好的显著性，省份P值的显著性就不如前面三个变量，仅在10%的水平上显著。鉴于三次回归结果各控制变量的显著性和相关性一致，且系数相差不大，为了方面分析，以下选取基本医疗保险对商业医疗保险的回归结果进行简单的分析。

年龄的系数为-0.0386492，说明年龄与购买商业医疗保险之间存在着负关系，这与本文之前的预计有所出入。在进行回归之前，本文预测，随着年龄的增大，个体所面临的疾病风险会增加，从而购买商业医疗保险的意愿也会随之增加，两者应该是呈正相关的。但是，回归的结果是呈负相关，可能与商业医疗保险对购买者年龄的限制有关，年龄越大的个体健康状况越差，因此商业医疗保险对购买者设置了较为严格的限制，并且价格会随着年龄的增大而提高，也有可能是因为年纪大的人思想守旧，不愿意尝试新的事物，不排除老年人节约，不愿在医疗保险上多花钱的可能性。

省份的系数为0.2304851，意味着医疗保障水平较高省份的人口更愿意购买商业医疗保险。因为医疗保障水平较高的地区，商业医疗保险的发展水平也不错，人们的医疗保险意识以及对商业医疗保险的认知相对其他地区而言都会比较充分。

教育程度的系数为0.6367848，表明教育程度越高的受访者，越可能购买商业医疗保险，这个结果符合本文的预期，即教育程度对购买商业医疗保险有一定积极的促进作用。因为学历较高的个体往往有较为高的保险认识和保险意识，又具备一定的资金实力。但部分文献则认为，教育水平高的人更加注重养生，使身体保持在一个良好的状态，因此购买商业医疗保险没有多少意义，本文认为这种理解也有一定的道理。

是否购买商业养老保险的系数为2.082793，说明购买商业养老保险对购买商业医疗保险有非常明显的促进作用，也可以说明这两种商业保险之间不存在替代关系。因为购买商业保险能够反映行为主体的风险态度，他们更愿意也有经济能力购买商业保险来更好地保障未来的生活。

另外，健康水平和收入情况这两个变量不显著是出乎意料的，本文预计的是，健康水平与购买商业医疗保险呈负相关，而收入情况与购买商业医疗保险呈正相关。但是，这两个变量并不显著，本文认为可能的原因是，健康的人购买医保的意愿不强，但不健康的人却由于不符合可保条件而被拒保；而在收入情况方面，收入低的家庭无法承担高额的商业医疗保费，但收入高的家庭抗风险能力较强，保险意识不强。至于其他控制变量，虽然回归结果不显著，但也符合常理，故不做过多的分析与解释。

### 4.3 内生性检验

尽管本文在建立模型中通过控制一系列体现个体、家庭及地区特征的变量以尽可能地避免遗漏重要变量，但是否参加基本医疗保险仍然有可能与不可观察到的因素相关，从而产生一定的内生性，导致实证结果有偏，为此，本文采用工具

变量法（IV）降低内生性问题对回归系数带来的影响。本文认为，剔除本家庭后其所在社区剩余家庭的基本医疗保险、城镇职工医疗保险和城乡居民医疗保险参保率与该家庭个体是否购买商业医疗保险无关，符合与被解释变量无直接关系，而此参保率与该家庭个体是否参加此保险有联系，符合与内生变量有较强相关性，因此，本文将这一变量作为工具变量进行回归分析。

本文借助IV-Probit进行分析，以此矫正解释变量内生性带来的估计偏差。根据回归结果表显示，Wald检验的 P 值表明所有回归均在1%水平上拒绝了不存在内生性的假设，即原解释变量是存在内生性问题的，且根据Staiger and Stock在1997年的研究，模型第一阶段的F值均大于14，表明本文选用的工具变量是有效的，不存在弱工具变量问题。在使用参保率作为工具变量进行估计后，全样本和分样本城乡居民医疗保险依然是挤出商业医疗保险，而另一分样本城镇职工医疗保险是促进商业医疗保险。

表4 内生性检验回归结果表

| 变量 | 模型1<br>（基本医疗保险） | 模型2<br>（城镇职工医疗保险） | 模型3<br>（城乡居民医疗保险） |
|---|---|---|---|
| 商业医疗保险 | -1.107173*<br>（-1.66） | 0.6335414***<br>（4.04） | -0.5877411***<br>（-4.23） |
| 性别 | 0.0379261<br>（0.62） | 0.0478413<br>（0.79） | 0.0569661<br>（0.93） |
| 年龄 | -0.0177744***<br>（-4.24） | -0.0186707***<br>（-4.63） | -0.0196992***<br>（-4.83） |
| 省份 | 0.0782823<br>（1.21） | 0.1183356*<br>（1.91） | 0.098909<br>（1.59） |
| 婚姻状况 | -0.0790755<br>（-0.80） | -0.1132457<br>（-1.18） | -0.0897915<br>（-0.93） |
| 教育程度 | 0.2888273***<br>（5.60） | 0.1459415**<br>（2.28） | 0.1471705**<br>（2.35） |
| 健康水平 | 0.050574<br>（1.10） | 0.0341469<br>（0.461） | 0.0328881<br>（0.71） |
| 收入情况 | 0.0273839<br>（1.13） | 0.0122479<br>（0.50） | 0.0087472<br>（0.36） |
| 商业养老保险 | 1.065279***<br>（14.78） | 1.039264***<br>（14.80） | 1.053303***<br>（14.96） |
| cons | -0.2640325<br>（-0.33） | -1.028396**<br>（-2.40） | -0.4371883<br>（-0.92） |
| 第一阶段F值 | 23.79*** | 495.85*** | 382.20*** |
| Adj R-squared | 0.0260 | 0.3666 | 0.3083 |
| Wald检验 | 355.58*** | 372.02*** | 372.20*** |

注：1.***，**，*分别表示在1%，5%和10%的水平上显著；

2.表中数字为各变量的回归系数，括号内为各变量的Z值。

## 4.4 稳健性检验

为了检验上文实证结果的可信性，本文将被解释变量“是否购买商业医疗保险”替换为“各省人均健康险保费”，进一步进行稳健性检验。医疗险属于健康险中的一种，如今市面上的健康险险种主要分为医疗险和重疾险两种，因此，用“各省人均健康险保费用”替代“是否购买商业医疗保险”，具有一定的合理性。

考略到人均健康险保费不是二元变量，本文采用OLS回归进行稳健性检验。从检验结果表可以看出，无论是总样本基本医疗保险，还是分样本城镇职工医疗保险和城乡居民医疗保险，对人均健康险保费的显著性和正负相关性均与上文实证结果一致，虽然存在少量控制变量有所出入，但从整体看来，上文的回归结果是可信的。因此，基本医疗保险挤出了商业医疗保险，其中，城乡居民医疗保险挤出了商业医疗保险，而城镇职工医疗保险促进了商业医疗保险这一结论是具有稳健性的。

表5 稳健性检验回归结果表

| 变量 | 模型1<br>（基本医疗保险） | 模型2<br>（城镇职工医疗保险） | 模型3<br>（城乡居民医疗保险） |
|---|---|---|---|
| 人均健康险保费 | -9.001548***<br>（-3.75） | 16.5446***<br>（7.50） | -5.580533*<br>（-1.71） |
| 性别 | -4.364572***<br>（-2.92） | -4.351831***<br>（-2.92） | -4.71925***<br>（-3.15） |
| 年龄 | 0.4485701***<br>（5.16） | 0.3757447***<br>（4.30） | 0.4566246***<br>（5.25） |
| 省份 | 87.89931***<br>（56.25） | 88.28204***<br>（56.74） | 88.04057***<br>（56.26） |
| 婚姻状况 | 2.27258<br>（1.02） | 1.838445<br>（0.83） | 1.879487<br>（0.85） |
| 教育程度 | 7.189805***<br>（5.16） | 3.024401**<br>（2.03） | 7.208094***<br>（5.16） |
| 健康水平 | -3.067094***<br>（-2.83） | -3.538242***<br>（-3.27） | -3.079508***<br>（-2.84） |
| 收入情况 | 2.084901***<br>（3.99） | 1.58052***<br>（3.01） | 2.141293***<br>（4.10） |
| 商业养老保险 | 6.050346**<br>（2.16） | 5.700232**<br>（2.04） | 6.052995**<br>（2.16） |
| cons | 78.2506***<br>（7.98） | 80.16702***<br>（8.33） | 70.28559***<br>（7.35） |

注：1.***，**，*分别表示在1%，5%和10%的水平上显著；

2.表中数字为各变量的回归系数，括号内为各变量的T值。

## 5．结论与建议

### 5.1 结论

在我国的医疗保障体系中，基本医疗保险是主体，商业医疗保险是重要补充，两者的理想状态应该是一种相互补充，相互促进的关系。但是，很多国内外学者得出的结论与理想状态并未一致，基本医疗保险对商业医疗保险存在一定的挤出

效应。本文的研究发现，基本医疗保险与商业医疗保险需求之间呈现微显著的负相关，不过，城乡居民医疗保险对商业医疗保险具有显著的挤出效应，而城镇职工医疗保险对商业医疗保险是具有明显促进效应的。总的来说，两种基本医疗保险对商业医疗保险的效应一个是促进的，一个是挤出的，这也可以解释为什么总体的基本医疗保险对商业医疗保险需求的影响并不明显显著。对于该结论，我觉得有以下几点原因。

第一，基本医疗保险是我国医疗保障体系中的最基本、最核心的内容，尤其是新农合，近年来在我国的发展迅速。并且，国家医疗政策的不断完整，带来了基本医疗保险覆盖层面的增大及待遇水平的提高，保障对象已由最初的城镇就业者扩大到农村居民和城镇非就业者，使人们对商业医疗保险的依赖日渐减少。

第二，在基本医疗保险快速推广的同时，商业医疗保险公司并没有及时地与时俱进，在深入研究保险市场、合理定位自身业务、开发推行新型险种等方面做出合理的对策，使得与基本医疗保险在保障范围与程度上的重合越来越多，在一定程度上降低了商业医疗保险的赔付金额，再加上其昂贵的保费，大大降低了产品的“性价比”。

第三，部分公民尤其是农村中老年人的保险消费意识与行为不够成熟，对商业医疗保险的认知不够全面，再加上受一些损害商业保险声誉的不良事件影响，公民更加愿意选择由政府主导的、更具有公信力的基本医疗保险。

第四，随着城镇职工医疗保险保障的深入和人们生活水平的提高，民众的风险管理意识和医疗保险意识不断增强，从而商业医疗保险市场上的逆向选择行为有所减少，人们会选择购买商业医疗保险进一步提高自身的保障。且城镇职工医疗保险的建立时间早于城乡居民医疗保险，商业医疗保险对城镇职工医疗保险政策的适应性更好，起到了良好的补充作用。

在控制变量上，个体的年龄、教育程度和是否购买商业养老保险这三个变量较为显著，其中，年龄与商业医疗保险的购买呈负相关，教育程度与商业医疗保险的购买呈正相关，购买商业养老保险会促进商业医疗保险的购买。

## 5.2 建议

医疗保障体系是多形式、多层次的，基本医疗保险与商业医疗保险都是其重要组成部分，是满足人们保障需求的载体，基本医疗保险有助于促进医疗制度的深入改革，推进商业医疗保险的发展，而商业医疗保险能够弥补基本医疗保险在覆盖人群和保障水平上的有限性，因此，互补融合必将是二者发展的主流。我们应该妥善处理二者之间的关系，尽量减轻挤出效应，由此，本文从政府和商业保险公司两个角度提出以下几点建议。

1、政府应出台相应的税收优惠政策，鼓励商业医疗保险的发展

基本医疗保险挤出商业医疗保险一个重要原因在于商业医疗保险的价格和个体的收入。政府可以从保险公司和公民两个方面着手，为公民提供最为低廉的商业保险项目。

（1）对于保险公司在商业医疗保险的保费收入，政府可以给予一定的减税甚至免税政策。另外，还可以适当扣除公司在宣传和推广商业医疗保险过程中的合理费用，从而降低商业医疗保险产品的成本和保费。

（2）政府可以对商业医疗保险的购买给予一定的税收优惠，例如允许在个人所得税的缴税基数中扣除一定比例的保费，促进公民购买商业医疗保险。

2、商业保险公司应提高自身的创新能力，更好地起到补充作用

基本医疗保险挤出商业医疗保险的另一个重要原因在于两者在保障范围和程度上存在一定的重复，再加上商业医疗保险的高保费，大大降低了其性价比。商业医疗保险公司应改变目前与基本医疗保险机构各自为政、相互分割的局面，在保障内容及程度上合理分配与合作，从而实现基本医疗保险机构、商业医疗保险公司和参保者的三方共赢。

（1）合理划分基本医疗保险与商业医疗保险的保障内容。商业医疗保险公司应明确两种保险在医疗保障上的分工，寻找基本医疗保险存在的不足和空白，定位于其不能保障的医疗项目、药物和机构等方面，致力于满足不同人的不同需求，把精力放在开拓新市场、新产品和新内容上面，而不是和基本医疗保险争夺市场。例如，开发针对临时务工人员的医疗保险，公民因疾病引起的营养、交通、误工费等费用支出也可以通过商业医疗获得保障。

（2）提高商业医疗保险的待遇支付水平和保障程度。目前，商业医疗保险在赔付医疗费用时，会剔除基本医疗保险已经支付的费用和一些自费费用，再按照一定比例报销。对此，商业医疗保险公司应该调整支付政策，可以发展定额给付型医疗保险，也可以在遵循补偿原则的前提下提高赔付额，对于那些已经获得基本医疗保险待遇支付的参保人，其剩余医疗费用不再分自费项目或甲乙类药品，一律按照一定比例给予赔付，虽然这样做会让商业医疗保险公司在短期内损失一部分利润，但从长期来看，这是商业医疗保险维持经营的必然选择。

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# 基本医疗保险挤出了商业医疗保险吗
## ——基于 CHARLS 数据的分析

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**关键词：**基本医疗保险；商业医疗保险；挤出效应；促进效应；Logit模型

**中文摘要.**基本医疗保险和商业医疗保险是我国医疗保障体系的重要组成部分，从产品的功能上看，两者具有互补关系，但从人们的购买意愿上看，两者也存在互斥关系。本文使用2015年CHARLS数据，采用Logit模型，首先分析基本医疗保险对商业医疗保险需求的影响，接着基于城镇和城乡在保障水平和缴费形式上存在差异，分别分析城镇职工医疗保险和城乡居民医疗保险（包括新农合和城镇居民医疗保险）对商业医疗保险需求的影响，从而探究基本医疗保险与商业医疗保险两者之间的效用关系。结果显示：基本医疗保险对商业医疗保险的需求具有挤出效应，其中，城乡居民医疗保险挤出了商业医疗保险，而城镇职工医疗保险则促进了商业医疗保险。最后，本文针对结果产生的原因，提出了一些建设性的建议。

# Exploration on the "Channel" Payment Mode of Individual Account of Medical Insurance for Employees in Shanghai

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**Key words:** individual account, "channel" payment mode, "plate" payment mode

**Abstract.** In order to provide suggestions for the improvement of the individual account of urban employees' basic medical insurance, this paper analyzes the current situation and existing problems of the "channel" payment mode of the individual account of medical insurance for employees in Shanghai. Methods: Using macro statistics and micro survey data, this paper analyzes the overall balance of individual account and the distribution of individual balance of different groups in Shanghai, Jiangsu Province and the whole country from different angles. Results and Conclusion: The results show that the operation effect of individual account in Shanghai is good, and the "channel" payment mode of individual account can be implemented nationwide.

## 1．引言

2021 年 4 月，国务院办公厅发布《关于建立健全职工基本医疗保险门诊共济保障机制的指导意见》（国办发〔2021〕14 号）（以下简称《指导意见》），该《指导意见》明确了改进个人账户计入办法和规范个人账户使用范围的具体措施。职工医保个人账户改革关系到每个参保人的利益，《指导意见》的发布短时间内便引起了广泛关注。

我国城镇职工基本医疗保险正式确立于 1998 年，国务院发布《关于建立城镇职工基本医疗保险制度的决定》，明确要建立社会统筹与个人账户相结合的职工医保制度。从各地区的实践来看，个人账户支付模式主要有“板块式”和“通道式”两种。目前，大部分地区采用的是“板块式”支付模式，仅少部分地区，如上海市、镇江市等，采用的是“通道式”支付模式。“板块式”支付模式是指，统筹基金与个人账户分开管理，统筹基金负责住院和门诊大病医疗费用的报销，个人账户负责门诊小病及定点药

店购药的支出。“通道式”支付模式是指参保人发生的医疗费用支出，起付线以下的部分，先由个人账户进行支付；超过起付线部分，进入统筹基金报销范围，由统筹基金报销较大比例，个人支付较小比例。

## 2.“通道式”和“板块式”支付模式对比

“通道式”和“板块式”作为医保基金支付的两种模式，在理论和实践中存在各自的优缺点。“板块式”支付模式由于是分块管理，个人账户负责门诊和定点药店购药的支付，统筹基金负责住院医疗费用的报销，这种支付模式最大的优点在于对参保者的约束性较强[1]。缺点在于个人账户的使用范围狭窄，只能用于门诊和定点药店购药，导致个人账户资金积累过度[2]。另外，由于门诊慢性病在大部分省市并未纳入统筹基金的报销范围，门诊慢性病患者需长期服药，个人账户中的资金不足以支付长期的购药费用，患者医疗费用支出负担过重。这种支付模式导致一部分健康人群个人账户基金过度积累，另一部分老年人、慢性病患者等人群积累不足，资金得不到合理利用[3]。

“通道式”支付模式按照个人账户、起付线、统筹基金三段累计制进行报销。个人账户可用于支付起付线以内门诊和住院的医疗费用支出，个人账户中的资金用完后，由个人自付起付线以内的医疗费用支出。超过起付线以上部分的医疗费用支出，进入统筹基金的报销范围，由统筹基金报销较大比例，个人自付较小比例。这种支付模式不论是门诊还是住院，只要到达医疗费用总支出达到起付线以上的部分，统筹基金均可进行报销，统筹基金共济性较强，保障水平较高[4]。“通道式”支付模式对门诊服务的利用有很大的激励作用[5]。对于门诊慢性病患者来说，这种支付模式可使他们享受到医保报销，能较大程度减轻他们的医疗负担。“通道式”支付模式的缺点在于医疗费用难以控制，统筹基金的压力增大，易造成统筹基金严重的超支，导致收不抵支[3]。另外，“通道式”支付模式对医院和社区卫生服务中心没有进行区别对待，无法实现分流，导致一部分资源闲置的同时，另一部分资源过度利用[2]。

学者们也分别从“通道式”、“板块式”两种支付模式角度，对个人账户运行状况进行了相关分析。如李开基（2000）[1]通过对锦阳“通道式”支付模式医疗制度两年试点工作的总结，认为“通道式”支付方式存在明显的不足，如一卡多用、突击看病、突击开药、冒名就医等问题；刘潇（2008）[6]利用效用函数对不同支付模式下医疗保险的欺诈行为进行分析发现，“通道式”支付模式激励患者快速使用个人账户从而进入统筹基金报销范围，助长了基金浪费和保险欺诈行为；刘冬冬等（2009）[4]通过对 2001-2006 年镇江和南京医保数据的分析发现，“通道式”和“板块式”支付模式在个人账户人均结余率上并未表现明显差别，但“板块式”支付模式更有利于健康人群个人账户资金的积累，“通道式”支付模式更利于退休人员的积累。学者们对两种支付模式的研究结果差异较大，并缺少最新研究结论。本文拟通过宏微观数据分析上海市与全国、江苏省职工医保个人账户运行状况，研究个人账户“通道式”和“板块式”支付模式在实际运行中的效果，为上海市，乃至全国职工医保个人账户改革提供方向及建议。

## 3.上海市职工医保改革进程及个人账户历年人均结余情况

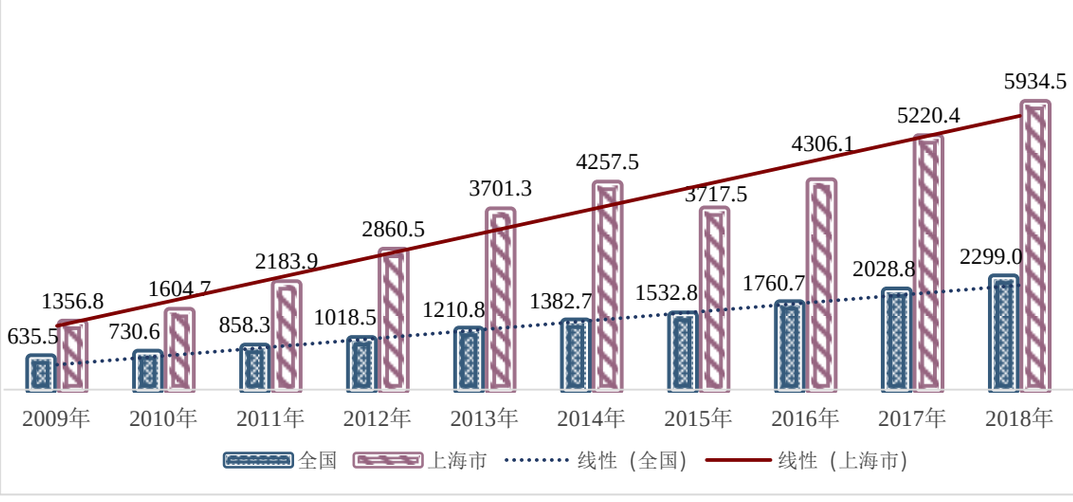
### 3.1 上海市职工医保改革进程

2000 年 10 月，上海市人民政府发布《上海市城镇职工基本医疗保险办法》（上海市人民政府令〔2000〕92 号），统账结合式职工医保制度正式在上海市开始实施。随后，上海市分别于 2008 年和 2013 年对该办法部分内容进行了调整。目前，上海市职工医保制度实施依据仍是按照 2013 年发布的《上海市职工基本医疗保险办法》（沪府令〔2013〕8 号），其中规定上海市职工医保个人账户主要用于支付定点零售药店购药费用和门诊急诊、门诊大病、住院、急诊观察室和家庭病床统筹基金及附加基金

报销以外的支出；附加基金主要用于门诊急诊报销；统筹基金主要用于住院、急诊观察室、门诊大病及职工家庭病床报销。上海市职工医保政策规定医保报销起付线以下部分的医疗费用支出，先由医保个人账户进行支付；起付线以上部分，使用附加基金或统筹基金按比例进行报销，报销以外的费用，个人自负。上海市医保基金的支付方式，符合”通道式“支付模式。

### 3.2 上海市职工医保个人账户人均结余情况

为了解上海市职工医保个人账户结余情况，本文对 2009-2018 年上海市和全国职工医保个人账户人均累计结余情况进行了分析，见图 1。2009-2018 年上海市个人账户人均累计结余均高于全国平均水平，且差距有逐年扩大趋势。根据《2019 年中国劳动统计年鉴》数据显示，2018 年末，全国职工医保参保人数 31680.8 万人，个人账户累计结余 7283.5 亿元，人均结余 2299.0 元；上海市职工医保参保人数 1523.3 万人，个人账户累计结余 904.0 亿元，人均结余 5934.5 元。上海市个人账户人均结余达到全国平均水平的 2.6 倍。




数据来源：2010-2019 年《中国劳动统计年鉴》

图 1　2009-2018 年上海市和全国职工医保个人账户人均累计结余情况（单位：元）

### 4.上海市与全国不同群体个人账户结余情况对比

通过对历年《中国劳动统计年鉴》数据分析，只能从整体上观察上海市职工医保个人账户结余水平。为更直观地观察不同群体个人账户结余情况，本文利用 2017 年中国家庭金融调查数据库数据进行微观个体分析。中国家庭金融调查数据是西南财经大学中国家庭金融调查与研究中心组织，在全国范围内开展的抽样调查项目，目前已经分别在 2011、2013、2015、2017 年实施四次调查。自 2013 年第二轮调查起，中国家庭金融调查在保证数据全国代表性的前提下，增加了省级代表性。本文选用该数据库 2017 年数据进行分析，其中参与城镇职工基本医疗保险，且个人账户结余统计有效的样本，全国 13084 个，上海市 1364 个。调查中“拥有城镇职工基本医疗保险”、“该医疗保险是否有个人账户”、“目前个人账户有多少余额”等是本文重点分析的问题。本文采用描述性统计方法，对上海市和全国个人账户不同群体个人账户结余情况进行对比分析，见表 1。

2017 年上海市个人账户人均结余 4410 元，明显高于全国平均水平 2937 元。从各结余段样本分布情况来看，上海市样本在低结余段 0-3000 元样本占比低于全国占比，尤其是在 0-1000 元结余段，全国样本占比达到 56.08%，而上海市样本仅占 43.55%；3000 元及以上各结余段上海市样本占比均高于全国占比，尤其在 10000 元及以上结余段差别最为明显，其中上海占比达到 12.76%，全国占比仅 7.24%。

从不同年龄段个人账户的分布来看，上海市和全国个人账户高结余段均集中于30-49岁年龄段。在30-49岁年龄段，上海市人均结余在7900元左右，全国人均结余在4100-4500元。出现这种情况的主要原因是由于，在该年龄段的参保人一般从事工作有一段时间，个人账户有了一定积累，并且该年龄段参保者身体多为健康，很少进行就诊使用个人账户中的资金。另外，青壮年（19-59岁）各年龄段个人账户人均结余水平，上海市明显高于全国平均水平。分析原因可能是由于，上海市收入水平相较于全国整体水平较高，个人账户缴费基数大，导致上海市个人账户人均结余高于全国平均水平；还有一个原因可能是由于，上海市与全国大部分地区个人账户支付模式不同所致，“通道式”相较于“板块式”支付模式可能更能激励参保人进行资金积累。

表1　2017年不同结余段、年龄段上海市和全国职工医保个人账户结余情况

| | | 上海市 | | | 全国 | | |
|---|---|---|---|---|---|---|---|
| | | 样本数（人） | 占比（%） | 人均结余（元） | 样本数（人） | 占比（%） | 人均结余（元） |
| 结余段（元） | 0-1000 | 594 | 43.55 | 81 | 7337 | 56.08 | 171 |
| | 1000-2000 | 186 | 13.64 | 1161 | 1756 | 13.42 | 1186 |
| | 2000-3000 | 114 | 8.36 | 2107 | 1103 | 8.43 | 2136 |
| | 3000-4000 | 80 | 5.87 | 3135 | 672 | 5.14 | 3125 |
| | 4000-5000 | 50 | 3.67 | 4126 | 339 | 2.59 | 4178 |
| | 5000-6000 | 76 | 5.57 | 5102 | 457 | 3.49 | 5095 |
| | 6000-7000 | 29 | 2.13 | 6028 | 177 | 1.35 | 6121 |
| | 7000-8000 | 30 | 2.20 | 7194 | 110 | 0.84 | 7152 |
| | 8000-9000 | 22 | 1.61 | 8059 | 128 | 0.98 | 8100 |
| | 9000-10000 | 9 | 0.66 | 9111 | 58 | 0.44 | 9189 |
| | 10000元及以上 | 174 | 12.76 | 23081 | 947 | 7.24 | 24768 |
| 年龄段（岁） | 29岁及以下 | 100 | 7.33 | 4160 | 1040 | 7.95 | 2443 |
| | 30-39 | 191 | 14.00 | 7875 | 1952 | 14.92 | 4138 |
| | 40-49 | 161 | 11.80 | 7972 | 2233 | 17.07 | 4465 |
| | 50-59 | 282 | 20.67 | 5661 | 2604 | 19.90 | 3547 |
| | 60-69 | 392 | 28.74 | 2441 | 3116 | 23.82 | 1727 |
| | 70-79 | 173 | 12.68 | 1270 | 1537 | 11.75 | 1580 |
| | 80岁及以上 | 65 | 4.77 | 594 | 602 | 4.60 | 1327 |
| 合计 | | 1364 | 100.00 | 4410 | 13084 | 100.00 | 2937 |

数据来源：2017年中国家庭金融调查数据库

### 5.上海市与江苏省不同群体个人账户结余情况对比

考虑到上海市人均工资水平高于全国平均水平，上海市个人账户高结余水平可能

并非因支付模式不同所致，而是受到个人账户缴费基数大的影响。为解决这一问题，特选人均 GDP 水平与上海市相近省市进行对比分析。

2019 年，上海市人均 GDP 为 157421 元，与上海市人均 GDP 水平相近的两个省市分别是北京市（164197 元）和江苏省（123755 元）。考虑到北京市实施的是个人账户开放式管理模式，而上海市实施的是封闭式管理，两个城市个人账户管理方式有所不同。因此，选取江苏省与上海市个人账户分布情况进行对比分析，见表 2。

上海市与江苏省个人账户分布情况对照结果：从个人账户结余角度进行分析，在 0-3000 元结余段，上海市样本占比低于江苏省样本占比；在 3000 元及以上各结余段，上海市样本占比均高于江苏省样本占比。从参保者年龄角度对个人账户分布情况进行分析，青壮年各年龄段，上海市个人账户人均结余均高于江苏省。上述结果与对全国样本对比分析结果一致，进一步证实了个人账户“通道式”支付模式确实会在一定程度上激励参保人进行个人账户资金积累，以更好的帮助参保人应对老年时医疗费用支出。

表 2　江苏省 2017 年不同结余段及年龄段个人账户分布情况

| | | 样本数（人） | 占比（%） | 人均结余（元） |
|---|---|---|---|---|
| 结余段（元） | 0-1000 | 342 | 49.85 | 215 |
| | 1000-2000 | 90 | 13.12 | 1198 |
| | 2000-3000 | 69 | 10.06 | 2164 |
| | 3000-4000 | 50 | 7.29 | 3092 |
| | 4000-5000 | 26 | 3.79 | 4165 |
| | 5000-6000 | 20 | 2.92 | 5158 |
| | 6000-7000 | 14 | 2.04 | 6193 |
| | 7000-8000 | 8 | 1.17 | 7183 |
| | 8000-9000 | 7 | 1.02 | 8030 |
| | 9000-10000 | 3 | 0.44 | 9200 |
| | 10000 元及以上 | 57 | 8.31 | 22491 |
| 年龄段（岁） | 29 岁及以下 | 59 | 8.60 | 2223 |
| | 30-39 | 82 | 11.95 | 3687 |
| | 40-49 | 118 | 17.20 | 4549 |
| | 50-59 | 146 | 21.28 | 3984 |
| | 60-69 | 160 | 23.32 | 2701 |
| | 70-79 | 93 | 13.56 | 1741 |
| | 80 岁及以上 | 28 | 4.08 | 2170 |
| 合计 | | 686 | 100.00 | 3217 |

数据来源：2017 年中国家庭金融调查数据库

## 6．结论与建议

## 6.1 研究结论

从宏观角度分析历年个人账户结余情况发现，2009-2018 年上海市职工医保个人账户人均结余均高于全国平均水平。利用微观数据库对个体样本个人账户人均结余情况进行分析发现，上海市高结余样本占比高于全国占比，低结余样本占比低于全国水平；青壮年各年龄段，上海市个人账户人均结余均明显高于全国平均水平。上海市与江苏省个人账户运行情况对比，也得到与上述一致结果。

另外，通过对不同年龄段个人账户结余情况分析可以看出，个人账户“通道式”支付模式在一定程度上激励了参保人资金的纵向分担，年轻的时候进行资金的积累，年老的时候将个人账户中的资金用于医疗费用的支出。40-49 岁年龄段上海市人均个人账户结余达到最高，人均 7972 元；而到了 80 岁以上年龄段，人均个人账户结余仅为 594 元。假设 80 岁死亡，个人账户中的资金足够大部分人用于一生的医疗费用支出，并且到死亡时，个人账户中的资金基本无剩余。通过从不同角度分析上海市个人账户运行状况均证实：上海市职工医保个人账户较为有效地发挥了资金积累功能。

## 6.2 未来建议

上海市职工医保个人账户虽然目前运行效果较好，但在实际运行中还存在个人账户支付范围较为狭窄、资金过度积累等问题。虽 2016 年，上海市对个人账户使用范围进行了改革，允许参保人员使用职工医保个人账户历年结余资金购买商业医疗保险专属保险，但个人账户资金使用范围仍较为有限。依据国务院办公厅近期发布得《指导意见》，国家层面对个人账户的改革更倾向于通过减少个人账户资金的划入比例，用于健全门诊共济保障；通过家庭共济等方式，活化个人账户中的资金。这也为上海市职工医保个人账户提供了一定的改革方向，上海市可根据本市的实际情况，进行相应的政策调整。

“通道式”模式作为个人账户运行的一种模式，在实际运行中效果较好。虽然，目前绝大部分省份使用的都是“板块式”支付模式，主要是依据当时国情所做选择；但在当下，随着我国经济、社会、人口环境的变化，“通道式”相较于“板块式”可能更适合我国目前国情。在今后的个人账户改革中，可在全国范围内尝试推行个人账户“通道式”支付模式，并探索新的支付模式。

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# The Impact of Basic Medical Insurance for Urban and Rural Residents on Residents' Health

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**Keywords:** Basic Medical Insurance for Urban and Rural Residents; Resident Health; Intermediary Effect; Resident Medical Insurance Integration.

**Abstract.** The integration of basic medical insurance for urban and rural residents will provide medical security for all unemployed residents. Whether it can improve the health level of insured residents has become a concern. Based on Grossman's health demand model and Anderson's health service utilization model, this paper analyzes the basic medical insurance of urban and rural residents and the health status of residents in China, selects profit model to study whether the basic medical insurance of urban and rural residents can promote the health of residents, and constructs a mediating effect model to explore the influence path, At the same time, the heterogeneity of different populations was analyzed. The results show that the basic

medical insurance for urban and rural residents does promote the health of residents, and the integrated medical insurance for residents has a more significant effect on health promotion, especially for young people, low-income residents and residents in eastern and central regions. This paper suggests that we should speed up the integration process, improve the security benefits of low-level medical institutions, and balance the differences in medical resource density, so as to speed up the construction of healthy China.

## 1. 引言

随着我国经济不断发展，居民健康状况和疾病问题逐渐突出。在“健康中国”战略和医药卫生体制改革的背景下，国务院印发了《关于整合城乡居民基本医疗保险制度的意见》（下称《意见》），开始推行城乡居民基本医疗保险整合。《意见》要求各省市于 2016 年 6 月底前对城乡居民基本医疗保险整合做出明确规划，12 月底前出台具体的方案，并且对城乡居民基本医疗保险统筹工作提出了明确的要求，从覆盖范围、筹资方式、保障水平、医保目录、基金及机构管理等方面作出部署。基本医疗保险制度是健康中国战略中重要的一环，其施行目的是为了保障居民在疾病发生时可以得到应有的治疗，降低参保者购买医疗服务时的实际价格，从而提高医疗服务的财务可及性和利用率，保障并促进居民健康。但居民医保是否达到了预期的目标，是否对居民健康起到了正向的促进作用？这是本文要研究的问题。本文在研究城乡居民基本医疗保险对居民健康的影响的同时，还进行了机制检验和异质性分析。以更加明确居民医保作用于健康的实质，为基本医疗保险制度改革提供下一步的方向。

## 2. 文献综述

大多数研究都支持基本医疗保险能够提高参保者的医疗服务利用率。基本医疗保险能够在参保者发生医疗支出时提供补偿从而降低获取医疗服务的成本，提高财务可及性[1]。于大川提出医保制度能够增加老年人的医疗支出，进而提升医疗消费水平和医疗服务利用率[3]。就单一险种而言，胡宏伟对城居保的研究中，全样本下医疗保险没有对卫生服务利用产生明显影响，但是以健康状况作为条件对样本进行分类研究后发现，健康状况较差的群体在投保后对卫生服务的利用显著增加[5]。此外，许多学者研究得出基本医疗保险对卫生服务利用的促进作用存在基础医疗和上层医疗的不同。潘杰的实证结果显示城居保有利于增加参保人的门诊医疗支出并降低门诊医疗负担，并且城居保对于门诊医疗支出和门诊医疗负担的影响都不显著，对住院医疗利用率和住院医疗负担城居保都有显著的影响[7]。

对于医疗服务与健康的关系，国内大多数研究显示医疗服务利用的提高对健康水平有积极影响，接受更多的医疗卫生服务能够引导居民形成积极的就医行为，改善健康状况[3]。但国外有研究表明医保报销增多对降低老年人小病、慢性病和重病的患病率无实质帮助。因为健康的决定因素很多，包括基因、环境、收入、生活习惯等，医保增加的卫生服务利用并不必然改善参保者健康状况[8,9]。甚至由于医疗卫生服务的边际效用递减还可能有害[10]。

而对于基本医疗保险是否能够促进健康水平这一话题的讨论一直没有停止，

但是目前学界对这一问题的研究结果并不一致。有学者认为投保后可以满足参保者的医疗服务需求，从而促进健康。于大川发现基本医疗保险可以提高老年人的健康水平，且仅对低龄老年人显著[3]。潘杰单独研究了城居保对参保者的健康促进作用，这一作用随收入提高和年龄增长而越来越小，一是由于低收入人群在未参保时会尽量不选择去医院治疗，在参保后医疗服务的实际价格下降；二是随着年龄的提高，卫生服务利用的边际效果越来越小，故健康效应减弱[7,12]。国内外学者对基本医疗保险影响健康水平的研究，大部分的文献在给出肯定态度的同时，也都证实了基本医疗保险对健康的促进作用存在各种方面的异质性。也有学者认为基本医保对健康没有太大的影响[9]。Polsky 等用“准自然实验”发现医疗保险与整体健康状况的改善无关[14]。周忠良比较参保城居保居民与未参保居民，生命质量指标不存在显著变化[15]。医疗保险对健康的促进作用不显著的原因，可能是对健康的指标选取不同导致结果差异，也可能是部分参保人群因基本医疗保险导致健康水平的提高并不能使全体参保人的健康水平达到统计的显著性。

## 3．理论基础

### 3.1 Grossman 健康需求模型

Grossman 将人一生的效用表达如下：

$$U = U\left(\varphi_0 H_0, \cdots, \varphi_n H_n, Z_0, \cdots, Z_n\right) \tag{2.1}$$

$\varphi_0$ 是每生产一单位的健康所带来的健康天数，$H_0$ 是初始健康存量，$H_i$ 是第 $i$ 期的健康存量，$\varphi_i H_i$ 为第 $i$ 期的健康天数，$Z_i$ 为第 $i$ 期消费者除健康外的其他消费品，$n$ 代表生命总年数。

每期的健康存量变化可以表示如下，$I_t$ 为 $t$ 期对健康的毛投资，$\delta_t$ 是健康的折旧率，Grossman 假设$\delta_t$ 随年龄增长而不断增大。

$$H_{t+1} - H_t = I_t - \delta_t H_t \tag{2.2}$$

而对健康的毛投资和消费者生产或消费其他消费品的生产函数表示如下

$$I_t = I_t\left(M_t, TH_t; E_t\right) \tag{2.3}$$

$$Z_t = Z_t\left(X_t, T_t; E_t\right) \tag{2.4}$$

$M_t$ 代表消费者购买的医疗卫生服务，$TH_t$ 是生产健康资本所用的时间，$E_t$ 是人力资本，一般为教育程度。类比(2.3)式，$X_t$ 为生产 $Z$ 消费品所投入的生产要素，$T_t$ 是生产 $Z$ 所用时间，$E_t$ 的定义同上。即消费者受到收入和时间的双重限制。

$$\sum_{t=0}^{N} \frac{P_t M_t + V_t X_t}{(1+r)^t} = \sum_{t=0}^{N} \frac{W_t TW_t}{(1+r)^t} + A_0 \tag{2.5}$$

$P_t$ 为 $t$ 期单位医疗服务的价格，$V_t$ 是 $t$ 期单位 $X_t$ 生产要素的价格。等式左边为折现后消费者购买所有生产要素所用收入。$W_t$ 是 $t$ 期工资率，$TW_t$ 是 $t$ 期工作时间，$A_0$ 为非薪资收入，$r$ 为利率。等式右边代表消费者折现后的所有收入加除薪酬外的其他收入。上式为消费者购买所有生产要素所用金额等于总收入。

$$TW_t + TL_t + TH_t + T_t = \Omega \tag{2.6}$$

承前所述，$TW_t$ 定义同上，$TH_t$ 是对健康进行毛投资所需时间，$T_t$ 是生产其他消费品所需时间，$TL_t$ 是生病时间，为当期总天数减去健康天数。生产和消费的时间总和受到总时间Ω的限制。

将上式带入到(2.5)式得式(2.7)，即消费者购买所有生产要素所用收入与生病损失的收入总和的现值，等于总收入。

$$\sum \frac{PM_t + VX_t + W_t\left(TL_t + TH_t + T_t\right)}{(1+i)^t} = \sum \frac{W_t\Omega}{(1+i)^t} + A_0 = R \tag{2.7}$$

综上，消费者要在时间和收入限制下进行最优消费组合决策$\left\{I_t, Z_t\right\}_0^N$，以达到一生最大效用。$H_0$ 和$\delta_t$ 是外生的，根据 $H_{t+1} = I_t + \left(1-\delta_t\right)H_t$ 可知，最佳的健康资本存量由毛投资 $I_t$ 决定。

最佳毛投资的决策条件为

$$\gamma_t + a_t = r + \delta_t \tag{2.8}$$

其中

$$\gamma_t = \frac{W_t G_t}{\pi_{t-1}} \tag{2.9}$$

$$G_t = \frac{\partial h_t}{\partial H_t} \tag{2.10}$$

$$\pi_{t-1} = \frac{dC_{i-1}}{dI_{i-1}} \tag{2.11}$$

$C_t = P_i M_i + W_i TH_i$ 即健康投资总成本，包括可直接购买到的医疗服务的价格和为投资健康所耗费的时间价格。$P_iM_i$ 为购买医疗卫生 $r$ 服务所用金额，$W_iTH_i$ 为生病损失的收入。投资于健康的总成本对毛投资的边际$\pi_{t-1}$ 即是对健康资本进行毛投资的边际成本。$\gamma_t$ 表示每单位健康资本所带来的货币价值比上投资健康的边际成本，即健康的边际回报率。

$$a_t = \left[\frac{\left(\frac{Uh_t}{\lambda}\right)(1+r)^t G_t}{\pi_{i-1}}\right] \tag{2.12}$$

$Uh_t = \frac{\partial U}{\partial h_t}$ 表示健康天数的边际效用，$\lambda$ 表示财富的边际效用，$\frac{Uh_t}{\lambda}$ 表示每一

健康天数所带来的效用换算为货币的价值。$a_t$为健康资本的边际效用货币体现。

$r$为利率，$\delta_t$为折旧率， (2.8)式代表对健康进行投资的直接货币回报与效用提高所代表的货币价值之和，即单位健康资本投资总回报。(2.8)式右边为健康投资的边际成本。消费者对健康进行投资的最佳决策也即边际收益等于边际成本。因此在成本极小化的条件下可以确定消费者医疗服务需求，即

$$\frac{P_{i-1}}{MP_i} = \frac{W_{i-1}}{MP_{ti}} \tag{2.13}$$

其中$MP_i = \frac{dI_i}{dM_i}$ 为医疗服务生产健康资本的边际能力，$MP_{ti} = \frac{dI_i}{dT_{hi}}$为时间对健康资本的边际生产能力。上式为增加一单位医疗服务所带来的健康资本增量等于增加一单位时间投入所带来的毛投资额，此时是最优毛投资水平。

为了简化分析，Grossman 将健康时间的边际效用假设为 0，忽略健康资本成本变动的影响，仅考虑健康资本投资属性，健康资本投资的最佳决策变为

$$\frac{W_i G_i}{\pi_{i-1}} = \gamma_i = r + \delta \tag{2.14}$$

在这一条件下，可以用图 1 来说明消费者的最优健康需求。曲线 *MEC* 为健康资本存量 $H_i$ 与投资回报率$\gamma_i$ 的关系。*S* 为健康资本供给，点 *H**为最优健康需求。

曲线斜率为

$$\frac{d\gamma_i}{dH_i} = \frac{d\frac{W_i G_i}{\pi_{i-1}}}{dH_i} = \frac{W_i}{\pi_{i-1}} \cdot \frac{dG_i}{dH_i} \tag{2.15}$$

$W_i$ 与$\pi_{i-1}$ 不受 $H_i$ 的影响， *MEC* 斜率取决于$\frac{dG_i}{dH_i}$。由式(2.12)知$G_t = \frac{\partial h_t}{\partial H_t}$，因投资健康资本时产出有上限，故斜率递减。

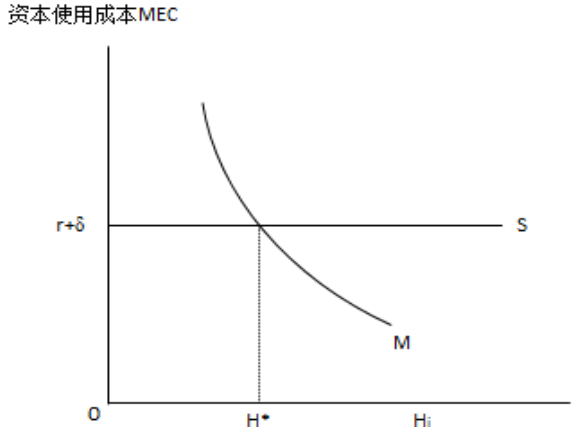


图 1　资本使用成本曲线

我们进一步研究年龄、工资率、医疗服务的价格和医疗保险最优健康需求的

影响。

（1）年龄

Grossman 假设$\delta_t$随年龄提高而增大，但$\delta_t$并不影响工资率（$W$）教育水平（$E$）对健康资本进行投资的边际成本（$\pi_{i-1}$）和健康天数对健康资本的边际生产能力（$G_i$）。MEC 不变时，折旧率提高，$S_0$上升至 $S_1$，最优健康需求降至 $H_1$*。

在毛投资不变时$\delta_t$提高，健康供给将不断减少，若 MEC 曲线弹性小于 1，减少的健康供给大于减少的健康需求，消费者会提高毛投资来弥补健康资本的不足。Grossman 模型中 MEC 曲线弹性必然小于 1[6]，即年龄不断增长，消费者对健康资本的毛投资不断增加，虽然健康需求在减少，但医疗服务需求增加了。

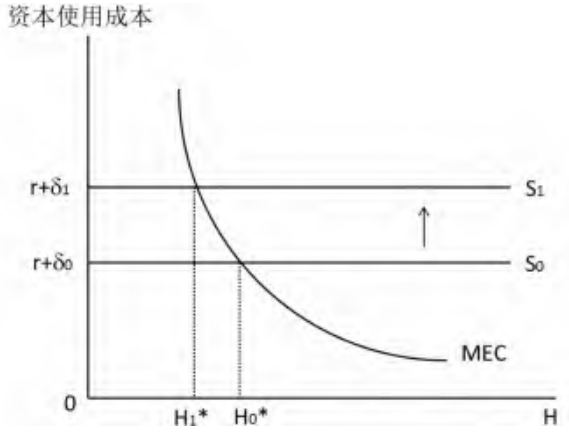


图 2　年龄对最优健康需求的影响

（2）工资率

健康资本投资成本$C = P_i M_i + W_i TH_i$，$W_i$上升则 C 上升，由式（2.11）知边际回报（$MG$）和边际回报率（$\gamma$）上升，MEC 曲线右移。

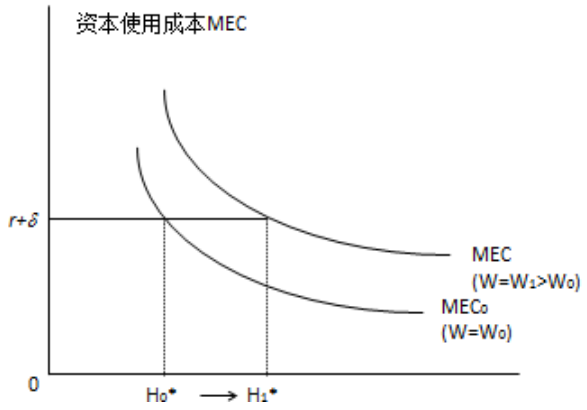


图 3　工资率对最优健康需求的影响

此时消费者健康需求将增加，$W$ 的变动不影响式(2.4)，健康需求增加后，健康投资将增加。若增加单位健康投资所消耗的医疗服务和时间之间无法替代，那么健康需求的增量与医疗服务的增量相等。若二者存在替代关系，当 $W$ 上升，

时间成本提高的情况下，消费者医疗服务的增量大于健康需求的增量,带动了医疗服务需求提高。

（3）医疗服务价格

类比对工资率的分析，但医疗服务价格变动不影响 *MG*，但会提高健康投资的边际成本，故而降低了边际回报率。*MEC* 曲线左移后，消费者对健康的需求减少，进而对医疗服务的需求减少。

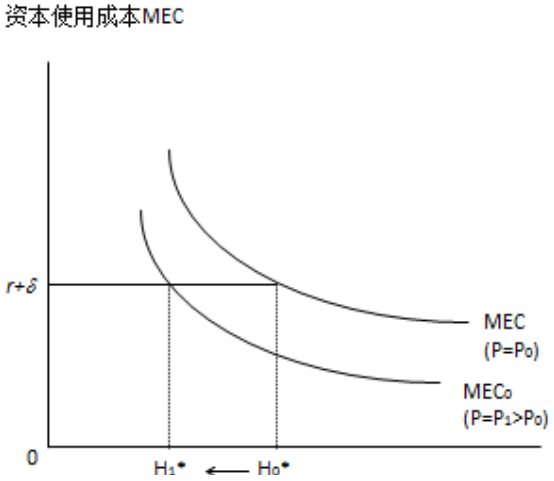


图 4　医疗服务价格对最优健康需求的影响

（4）医疗保险

Grossman 在模型中没有直接提及医疗保险，根据前述可知医疗服务需求曲线斜率为负。

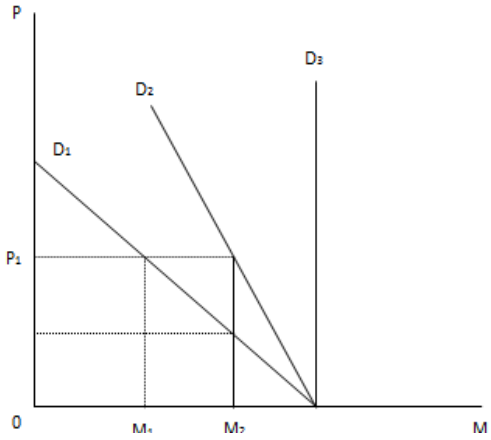


图 5　医疗保险对医疗服务需求的影响

医疗保险的介入对医疗服务需求的影响有三个方面：

①投保后实际医疗服务价格下降，医疗服务需求增加。医疗服务价格弹性越大，需求提高的越多。

②医疗保险改变了医疗服务需求曲线的斜率，医保负担率越高，医疗服务需求的价格弹性越小，越不受价格影响。

③当价格因素在医疗服务需求中的比重降低，时间的比重就会上升。即使医疗服务的购买价格为零，健康投资成本也大于零，仅靠医保制度不能消除就医障碍，还要提高医疗服务在地理上的可及性，降低就医成本。

### 3.2 安德森卫生服务利用模型

安德森卫生服务利用模型是由四部分组成的具有反馈路径的模型，反映环境因素和人群特征共同作用影响健康行为，健康行为决定健康结果，健康结果又反向作用于人群特征，如下图所示。

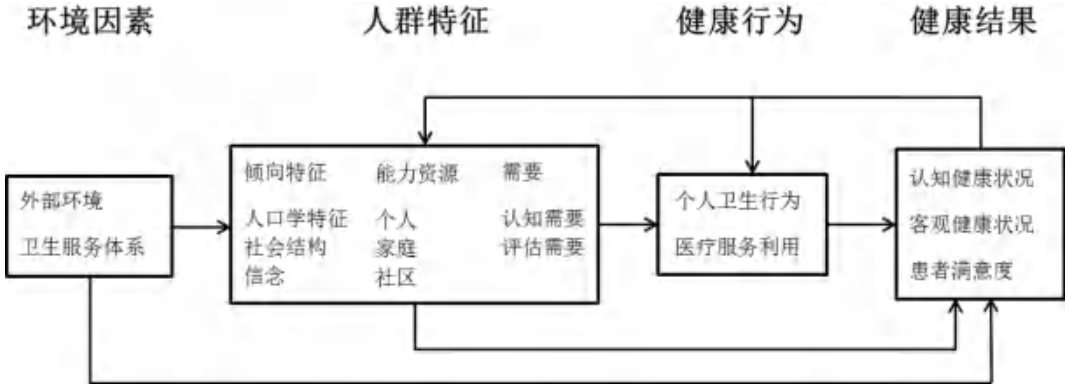


图 6 安德森卫生服务利用模型

## 4. 城乡居民基本医疗保险影响居民健康的理论分析

城乡居民基本医疗保险自整合以来，参保人数不断上升，覆盖范围不断扩大，基金规模也逐步增长。城乡居民基本医疗保险正在成为非从业城乡居民的医疗支柱，为居民健康提供有力的保障。同时，慢性病的发病率和死亡率逐年增长，但在我国医药卫生政策作用下，增长率逐步放缓。城乡居民基本医疗保险在这一过程中是否起到了促进居民健康的作用，通过何种途径产生作用，这是本文研究的主要问题。

由于城乡居民基本医疗保险难以直接影响居民健康，根据 Grossman 健康需求模型可知，投保后会直接降低参保者的实际医疗价格，由于医疗服务的需求曲线斜率为负，故价格降低后，医疗服务需求提高。同时，根据安德森卫生服务利用模型可知，医疗服务利用直接影响居民健康水平（包括主观健康和客观健康）。因此，我们可以从理论上搭建一条城乡居民医保影响居民健康的路径：投保城乡居民基本医疗保险后，居民面对的实际医疗价格下降，从而提高了医疗服务利用，促进了居民健康。

针对研究问题，本文提出如下假设：

假设 1：城乡居民基本医疗保险能够提高居民健康水平；

假设 2：城乡居民基本医疗保险是通过促进医疗服务利用来提高居民健康水平的；

假设 3：随着年龄的提高，居民健康水平下降，医疗服务需求增加；

假设 4：健康和医疗服务需求与收入正相关。

## 5. 城乡居民基本医疗保险影响居民健康的实证分析

### 5.1 变量选取与模型构建

#### 5.1.1 变量选取

本文选用中国家庭追踪调查（CFPS）2018 年的截面数据。CFPS 由北京大学中国社会科学调查中心实施，主要使用 2018 年数据中的家庭问卷和成人问卷。

对个人问卷和家庭问卷进行匹配，剔除 16 岁以下的样本、没有医疗支出的样本、投保多种医疗保险或仅投保城镇职工基本医疗保险的样本，以及变量缺失的样本，最终样本数量为 13345。

被解释变量“健康”从主观和客观两方面选择，以“自评健康”作为主观健康的评价指标，针对个人问卷中“您认为自己的健康状况如何”这一问题，设置虚拟变量“自评健康”，选择“一般”和“不健康”的受访者赋值 0，其余赋值为 1；以“过去两周是否感到不适”作为客观评价指标，选择“否”赋值 0，“是”赋值为 1。解释变量为“是否投保了城乡居民基本医疗保险”，由于问卷设置时全国居民医保整合尚未完成，且问卷选项对城镇居民基本医疗保险和新型农村合作医疗进行了区分，故选择二者任一选项赋值为 1，没有任何医疗保险赋值为 0。

城乡居民基本医疗保险非强制保险，居民自愿购买。由于道德风险存在，认为自己不健康的居民更可能投保，而认为自己健康的居民购买主动性低，故而居民健康和是否投保之间存在内生性。本文选取样本所在省的投保率作为工具变量，以控制内生性。从理论上讲，样本所在省的投保率与样本个体是否投保城乡居民基本医疗保险相关，一般一个地区的投保率越高，个体投保可能性就越大；而样本所在省的投保率与样本自身个体特征无关。因此，以此作为工具变量是合理的。

在机制检验中，以医疗服务利用作为中介变量，选择“医疗服务机构等级”和“家庭人均医疗费用支出”作为评价指标。前者根据个人问卷中“您若找医生看病，一般去哪？”这一问题构建虚拟变量，选择“综合医院”和“专科医院”的受访者赋值为 1，其余则赋值为 0。后者根据家庭问卷中的“家庭年医疗费用支出总额”和“家庭人口数”计算，由于“家庭人均医疗费用支出”具有很强的右偏性，取自然对数可以使数据更平滑，结论更合理。

控制变量根据安德森卫生服务利用模型和以往文献的资料，结合 2018 年 CFPS 的数据，选择了性别、年龄、工作状态、婚姻状况、家庭人均年收入、是否有自有住房、家庭是否有负债 7 个变量，其中家庭人均年收入取自然对数，原因同上。

表 1　变量设置

| | 变量设置 | 变量名 | 变量解释 |
|---|---|---|---|
| 解释变量 | 是否投保了城乡居民基本医疗保险 | medins | “投保”=1<br>“未投保”=0 |
| 被解释变量 | 自评健康 | health | “健康”=1<br>“不健康”=0 |
| | 过去两周是否感到不适 | unwell | “是”=1<br>“否”=0 |
| 中介变量 | 医疗服务机构等级 | hos_level | “较高等级”=1<br>“较低等级”=0 |
| | 家庭人均医疗支出（对数） | lnpermetotal | — |
| 控制变量 | 年龄 | age | — |
| | 性别 | gender | “男性”=1<br>“女性”=0 |
| | 婚姻状况 | marrige | “已婚”=1<br>“其他”=0 |
| | 工作状态 | work | “有稳定工作”=1<br>“其他”=0 |
| | 家庭人均收入（对数） | lnperincome | — |
| | 是否有自有住房 | owehouse | “是”=1<br>“否”=0 |
| | 家庭是否有负债 | debt | “是”=1<br>“否”=0 |

由于总样本中未投保基本医疗保险的样本占比较少，为避免结果偏误，本文采用了倾向得分匹配法进行样本匹配，以匹配后的数据进行回归检验。PSM 法的基本思想是寻找一组与制度参与者具有相同特征的非制度参与者作为比较组。由于两组样本的特征、禀赋相同或相似，唯一的区别在于是否接受了制度干预，因此两组样本在绩效结果上的差异就可以看作是制度的干预效应。

按照 1 对 3 最临近匹配来处理数据，结果如下：

表 2　倾向得分匹配平均处理效应

| Variable | Sample | Treate | Controls | Difference | S.E. | T-stat |
|---|---|---|---|---|---|---|
| health | Unmatched | .229019417 | .271235521 | -.042216105 | .013657254 | -3.09 |
| | ATT | .229078476 | .238012862 | -.089343867 | .017625578 | -5.17 |
| | ATU | .270793037 | .257686285 | -.013106751 | . | . |
| | ATE | | | -.009258326 | . | . |

如表 2 所示，ATT 为匹配后的平均处理效应，t 检验结果绝对值大于 1.96，拒绝匹配后两组不存在显著差异的原假设，匹配结果可用。

表 3 倾向得分匹配结果

| psmatch2: Treatment assignment | psmatch2: Common support | | |
|---|---|---|---|
| | Off support | On support | Total |
| Untreated | 2 | 1,034 | 1,036 |
| Treated | 25 | 12,284 | 12,309 |
| Total | 27 | 13,318 | 13,345 |

从表 3 看出，绝大部分的样本都处在共同支撑域内，满足匹配条件。

表 4 倾向得分匹配变量平衡性检验结果

| Variable | Unmatched Matched | Mean | | | %reduct | t-test | | V(T)/V(C) |
|---|---|---|---|---|---|---|---|---|
| | | Treated | Control | %bias | bias | t | p>t | |
| age | U | 48.892 | 42.829 | 39.3 | | 12.76 | 0.000 | 0.80* |
| | M | 48.85 | 48.956 | -0.7 | 98.3 | -0.56 | 0.574 | 0.95* |
| gender | U | .47941 | .49228 | -2.6 | | -0.80 | 0.426 | |
| | M | .47957 | .46479 | 3.0 | -14.8 | 2.32 | 0.020 | |
| work | U | .8666 | .82336 | 12.0 | | 3.89 | .0.000 | |
| | M | .86657 | .86047 | 1.7 | 85.9 | 1.39 | 0.163 | |
| marrige | U | .86888 | .67471 | 47.5 | | 17.17 | 0.000 | |
| | M | .86861 | .87439 | -1.4 | 97.0 | -1.35 | 0.176 | |
| lnperincome | U | 9.3822 | 9.5992 | -20.5 | | -6.55 | 0.000 | 0.86* |
| | M | 9.3926 | 9.4003 | -0.7 | 96.5 | -0.58 | 0.559 | 0.83* |
| owehouse | U | .88854 | .77027 | 31.8 | | 11.28 | .0.000 | |
| | M | .88831 | .87724 | 3.0 | 90.6 | 2.70 | 0.007 | |
| debt | U | .39329 | .37259 | 4.3 | | 1.31 | .0.190 | |
| | M | .39319 | .40625 | -2.7 | 37.0 | -2.09 | 0.037 | |

* if variance ratio outside [0.97; 1.04] for U and [0.97; 1.04] for M

表4展示的是倾向得分匹配后的平衡性检验，U代表匹配前，M代表匹配后。平衡性检验中，bias 值变小且小于 10%表示匹配结果较好。表中各变量的 bias 值在匹配后都小于 10%，除性别外都比匹配前小，表明匹配较好。T 检验验证匹配前后实验组和对照组的特征差异，故 P 值要尽量大，尽可能不显著从而拒绝两组存在特征差异的原假设。年龄、工作状态、婚姻状况、人均收入、自有住房变量在匹配后 t 值的显著性均下降，性别和负债的 t 值虽变小，但仍不显著。总体匹配结果良好。

表 5 倾向得分匹配样本总体平衡性检验结果

| Sample | Ps R2 | LR chi2 | p>chi2 | MeanBias | MedBias | B | R | %Var |
|---|---|---|---|---|---|---|---|---|
| Unmatched | 0.056 | 404.39 | 0.000 | 22.6 | 20.5 | 62.0* | 0.50 | 100 |
| Matched | 0.001 | 22.08 | 0.002 | 1.9 | 1.7 | 6.0 | 0.94 | 100 |

* if B>25%, R outside [0.5; 2]

表 5 为总体平衡性检验结果，meanbias 和 medbias 在匹配后均降至 5%以下，再次证明数据匹配良好。

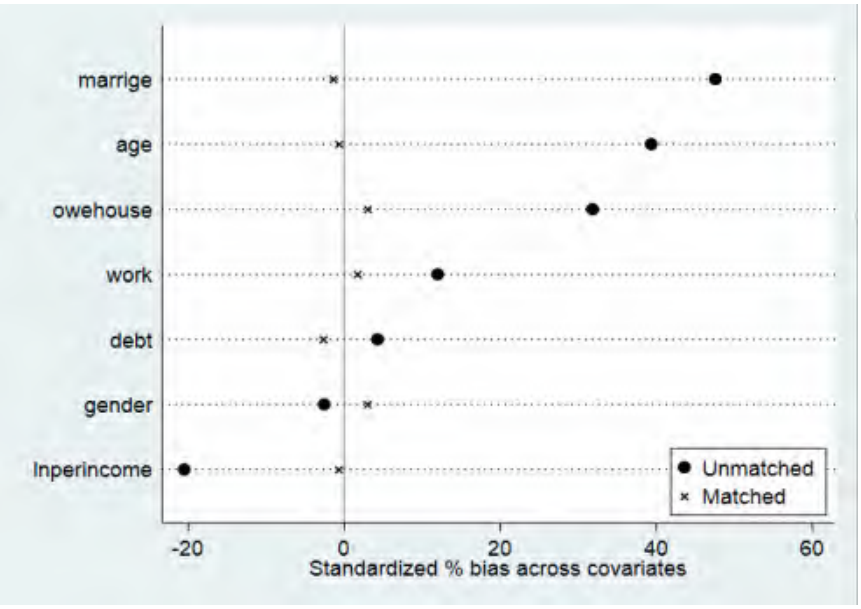


图 7　PSM 平衡性检验结果图示

从图 7 中可以看出匹配前 bias 值差异较大，匹配后集中在 0 附近。最终匹配样本量为 3200。

### 5.1.2 模型构建

由于被解释变量均为虚拟变量，本文采用 probit 模型进行回归分析，构建如下：

$$Y_i = c_0 + c_1 medins_i + c_2 X_i + \varepsilon_i \qquad (4.1)$$

$Y_i$ 表示个体 $i$ 的健康状况，包括主观和客观评价指标。$medins_i$ 表示个体 $i$ 是否投保城乡居民基本医疗保险，$X_i$ 为个体 $i$ 的社会特征，包括年龄、性别、婚姻状况、工作状态、家庭人均收入、是否拥有自有住房、家庭是否有负债。$\varepsilon_i$ 为随机扰动项。

中介效应模型常见方法有逐步检验回归系数法、sobel 法和 bootstrap 法，检验力逐步增强。逐步检验回归系数法的检验力虽然三者中最低，但优势明显。首先，该方法更容易理解；第二，从逐步检验回归系数法的结果中不仅可以得到直接效应、间接效应和总效应，还可得知解释变量、中介变量和被解释变量间的关系是否显著；第三，通过此检验的中介效应必然可以通过 sobel 检验和 bootstrap 检验，反之不一定；第四，检验力较高的方法，通常有较高的第一类错误率。

因此，本文采用逐步检验回归系数法，设定如下：

$$Y_i = c_0 + c_1 medins_i + c_2 X_i + \varepsilon_{i1} \qquad (4.2)$$

$$M_i = a_0 + a_1 medins_i + a_2 X_i + \varepsilon_{i2} \qquad (4.3)$$

$$Y_i = b_0 + b_1 medins_i + b_2 X_i + b_3 M_i + \varepsilon_{i3} \qquad (4.4)$$

(4.2)式为基准回归模型，(4.3)和(4.4)式中的*Mi*代表中介变量医疗服务利用，$\varepsilon_{i1}$-$\varepsilon_{i3}$为随机扰动项。系数 $c_1$ 代表城乡居民医保对居民健康的总效应；系数 $a_1$ 代表城乡居民医保对医疗服务利用的效应；系数 $b_1$ 代表控制中介变量的情况下，解释变量对被解释变量的效应，即城乡居民医保对居民健康的直接效应；系数 $b_3$ 代表控制解释变量的情况下，中介变量对被解释变量的效应。在这一模型中，中介效应与间接效应相等，即 $a_1$ 和 $b_3$ 的乘积。总效应、间接效应和直接效应之间存在如下关系：

$$c_1 = b_1 + a_1 b_3 \tag{4.5}$$

若 $c_1$ 显著，表明城乡居民基本医疗保险对居民健康存在显著影响；在 $c_1$ 显著条件下，$a_1$ 和 $b_3$ 都显著，则表明存在中介效应；存在中介效应的前提下，若 $b_1$ 显著则为部分中介，反之为完全中介。

## 5.2 描述性统计

从表 6 我们得知，medins 变量均值高达 0.92，表明绝大部分居民都投保了城乡居民医保，而 health 变量均值只有 0.63，部分居民对自身的健康状况并不满意。客观健康变量 unwell 均值 0.41，从一定程度上说明我国当前的居民健康状况确实存在一些问题，也反映了“健康中国”战略实施的必要性。

表 6 描述性统计

| 变量 | 均值 | 标准差 | 最小值 | 最大值 |
|---|---|---|---|---|
| medins | 0.92 | 0.27 | 0.00 | 1.00 |
| health | 0.63 | 0.48 | 0.00 | 1.00 |
| unwell | 0.41 | 0.49 | 0.00 | 1.00 |
| age | 48.42 | 14.77 | 16.00 | 96.00 |
| gender | 0.48 | 0.50 | 0.00 | 1.00 |
| marrige | 0.85 | 0.35 | 0.00 | 1.00 |
| work | 0.86 | 0.34 | 0.00 | 1.00 |
| lnperincome | 9.40 | 1.03 | 0.00 | 15.55 |
| debt | 0.39 | 0.49 | 0.00 | 1.00 |

## 5.3 实证分析

### 5.3.1 城乡居民基本医疗保险对居民健康的总效应分析

承前所述，本文从主观和客观两方面搭建相对全面的健康评价体系。

表 7 展示 probit 模型的回归结果。（1）列、（2）列分别为城乡居民基本医疗保险对自评健康和对过去两周是否感到不适的回归结果。由于回归系数没有直接可比性，表中结果为平均边际效应。可以看出投保后对居民健康有显著正向影响，且在 1%的显著性水平上显著为正，参保后有 50.6%的概率使参保者自评健康提高；投保后对居民过去两周感到不适的影响在 5%的显著性水平上显著为负，且有 44%的概率降低居民在过去两周感到不适的可能性。综合从两方面评价指标来看，都得到了参保城乡居民基本医疗保险对居民健康有利的结果。

表 7　城乡居民基本医疗保险对居民健康的总效应

| | (1) | (2) |
|---|---|---|
| 变量 | health | unwell |
| medins | 0.506*** | -0.440** |
| | (2.60) | (-2.37) |
| age | -0.020*** | 0.016*** |
| | (-11.46) | (10.33) |
| gender | 0.049 | -0.284*** |
| | (1.00) | (-6.15) |
| marrige | -0.093* | -0.059 |
| | (-1.66) | (-1.10) |
| work | 0.177*** | -0.006 |
| | (2.61) | (-0.10) |
| lnperincome | 0.028 | -0.061*** |
| | (-1.18) | (-2.76) |
| owehouse | 0.061 | -0.080 |
| | (0.97) | (-1.33) |
| debt | 0.007 | 0.213*** |
| | (0.14) | (4.52) |
| Constant | -0.023 | 0.094 |
| | (-0.07) | (0.32) |
| Observations | 3,200 | 3,200 |

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

个人特征上，年龄对居民健康总体呈现负向影响且显著，每年长 1 岁，自评健康会有 2%的概率降低，过去两周感到不适的可能性有 1.6%的概率提高，这与 Grossman 模型结果一致。性别对自评健康没有显著影响，对 unwell 变量影响的平均边际效应在 1%的显著性水平上显著为负，男性在过去两周感到不适的概率更低。婚姻状况对自评健康的影响在 10%的显著性水平上为负，系数仅为 0.093，对过去两周感到不适的概率无显著影响，已婚居民的健康状况稍差一些。工作稳定的居民身体健康水平更高，可能是他们在健康行为和医疗认知方面强于无稳定工作居民。

家庭层面上，家庭人均收入整体上对居民健康有正向作用，对自评健康影响不显著，对过去两周不适的概率有显著负向影响，这与 Grossman 模型结果一致；自有住房方面，owehouse 变量对 health 和 unwell 变量的回归平均边际效应均不显著；家庭负债对自评健康无显著影响，但对过去两周感到不适的概率有显著的正向影响，由于没有具体理论依据，在此不做过多深究。

### 5.3.2 城乡居民基本医疗保险对居民健康的中介效应分析

本文以医疗服务利用作为中介变量，以“医疗服务机构等级”和“家庭人均医疗费用支出”为评价指标，研究城乡居民基本医疗保险是否是通过提高医疗服

务利用来促进居民健康水平提升。表 8 的（3）列、（4）列分别展示投保后对医疗服务机构等级和家庭人均医疗费用支出的影响。从列（3）可以看出，投保后对医疗服务机构等级有显著的负向影响，有 91.7%的概率使居民选择更低等级的医疗机构，原因是城乡居民医保对低等级医疗服务机构的报销比例更大；（4）列表示投保后有 33.7%的概率提高家庭人均医疗费用支出，表明参保会提高参保者对医疗服务的利用。

表 8　城乡居民基本医疗保险对医疗服务利用的影响

| | (3) | (4) |
|---|---|---|
| 变量 | hos_level | lnpermetotal |
| medins | -0.917*** | 0.337** |
| | (-5.91) | (2.15) |
| age | 0.001 | 0.009*** |
| | (0.63) | (3.03) |
| gender | -0.059 | -0.094 |
| | (-1.31) | (-1.27) |
| marrige | 0.016 | 0.064 |
| | (0.30) | (0.59) |
| work | -0.311*** | -0.319*** |
| | (-5.18) | (-3.12) |
| lnperincome | 0.118*** | 0.168*** |
| | (5.02) | (4.86) |
| owehouse | -0.059 | 0.212** |
| | (-1.03) | (2.23) |
| debt | 0.043 | 0.247*** |
| | (0.94) | (3.27) |
| Constant | -0.562* | 3.652*** |
| | (-1.87) | (9.07) |
| Observations | 3,200 | 3,200 |

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

要证明假设 2，我们还需检验在分别控制解释变量和中介变量的情况下，中介变量和解释变量对被解释变量影响的系数方向和显著性的问题。

表 9　城乡居民基本医疗保险对居民健康的中介效应（1）

| 变量 | (5)<br>health | (6)<br>hos_level | (7)<br>health |
|---|---|---|---|
| medins | 0.506*** | -0.917*** | 0.315** |
| | (2.60) | (-5.91) | (2.19) |
| age | -0.020*** | 0.001 | -0.020*** |
| | (-11.46) | (0.63) | (-11.55) |
| gender | 0.049 | -0.059 | 0.043 |
| | (1.00) | (-1.31) | (0.86) |
| marrige | -0.093* | 0.016 | -0.096* |
| | (-1.66) | (0.30) | (-1.69) |
| work | 0.177*** | -0.311*** | 0.157** |
| | (2.61) | (-5.18) | (2.29) |
| lnperincome | -0.028 | 0.118*** | -0.019 |
| | (-1.18) | (5.02) | (-0.80) |
| owehouse | 0.061 | -0.059 | 0.056 |
| | (0.97) | (-1.03) | (0.88) |
| debt | 0.007 | 0.043 | 0.011 |
| | (0.14) | (0.94) | (0.22) |
| hos_level | | | -0.208*** |
| | | | (-3.93) |
| Constant | -0.023 | -0.562* | 0.037 |
| | (-0.07) | (-1.87) | (0.12) |
| Observations | 3,200 | 3,200 | 3,200 |

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

表 9 展示的是以自评健康为被解释变量，以医疗服务机构等级为中介变量的逐步回归检验结果。（5）列和（6）列为前述城乡居民基本医疗保险对居民健康和医疗服务利用的回归结果，（7）列为将解释变量和中介变量加入方程得到的结果，即逐步检验第三步。我们已知参保对自评健康有正向显著影响，对医疗服务机构等级有负向显著影响，从（7）列得知，在控制城乡居民医保变量的情况下，医疗服务机构等级对自评健康有负向影响，且在 1%水平上显著，中介效应成立。另外，加入中介变量后，居民医保对居民健康的影响仍正向显著，但显著性水平和系数大小均有所下降，证明前述中介效应为不完全中介，存在城乡居民医保对自评健康的直接效应或其他途径的中介效应。由于本文主要研究医疗服务利用的中介效应，故除此之外的效应一律视为直接效应。根据系数得出，城乡居民医保对自评健康的总效应为 0.506，直接效应为 0.315，通过影响医疗服务利用提高自评健康的间接效应为 0.917*0.208=0.191。

表 10 城乡居民基本医疗保险对居民健康的中介效应（2）

| | (8) | (9) | (10) |
|---|---|---|---|
| 变量 | health | lnpermetotal | health |
| medins | 0.506*** | 0.337** | 0.488*** |
| | (2.60) | (2.15) | (2.81) |
| age | -0.020*** | 0.009*** | -0.019*** |
| | (-11.46) | (3.03) | (-11.05) |
| gender | 0.049 | -0.094 | 0.044 |
| | (1.00) | (-1.27) | (0.90) |
| marrige | -0.093* | 0.064 | -0.083 |
| | (-1.66) | (0.59) | (-1.47) |
| work | 0.177*** | -0.319*** | 0.166** |
| | (2.61) | (-3.12) | (2.44) |
| lnperincome | -0.028 | 0.168*** | -0.020 |
| | (-1.18) | (4.86) | (-0.81) |
| owehouse | 0.061 | 0.212** | 0.071 |
| | (0.97) | (2.23) | (1.13) |
| debt | 0.007 | 0.247*** | 0.020 |
| | (0.14) | (3.27) | (0.40) |
| lnpermetotal | | | 0.053*** |
| | | | (4.49) |
| Constant | -0.023 | 3.652*** | 0.154 |
| | (-0.07) | (9.07) | (0.49) |
| Observations | 3,200 | 3,200 | 3,200 |

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

表 10 展示以自评健康为被解释变量，以家庭人均医疗支出为中介变量的逐步检验结果。列（10）为分别控制了解释变量和中介变量的情况下，中介变量和解释变量对被解释变量的影响。将家庭人均医疗费用支出加入方程后，在控制参保的情况下，家庭人均医疗费用支出对自评健康有显著正向影响，同时影响系数变小，说明通过提高家庭人均医疗费用支出进而促进了自评健康的提升。从系数中可得，城乡居民医保对自评健康的总效应为 0.506，直接效应为 0.488，间接效应为 0.337*0.053=0.018。由于加入中介变量后对自评健康影响仍显著，故也为不完全中介。

通过间接效应的大小和加入中介变量前后解释变量对被解释变量显著性的变化可知，城乡居民基本医疗保险更多的通过降低居民选择的医疗服务机构等级而促进居民自评健康。

表 11　城乡居民基本医疗保险对居民健康的中介效应（3）

| 变量 | (11)<br>unwell | (12)<br>hos_level | (13)<br>unwell |
|---|---|---|---|
| medins | -0.440** | -0.917*** | -0.219* |
| | (-2.37) | (-5.91) | (-1.89) |
| age | 0.016*** | 0.001 | 0.016*** |
| | (10.33) | (0.63) | (10.34) |
| gender | -0.284*** | -0.059 | -0.282*** |
| | (-6.15) | (-1.31) | (-6.08) |
| marrige | -0.059 | 0.016 | -0.060 |
| | (-1.10) | (0.30) | (-1.12) |
| work | -0.006 | -0.311*** | 0.026 |
| | (-0.10) | (-5.18) | (0.43) |
| lnperincome | -0.061*** | 0.118*** | -0.074*** |
| | (-2.76) | (5.02) | (-3.28) |
| owehouse | -0.080 | -0.059 | -0.074 |
| | (-1.33) | (-1.03) | (-1.23) |
| debt | 0.213*** | 0.043 | 0.211*** |
| | (4.52) | (0.94) | (4.46) |
| hos_level | | | 0.241*** |
| | | | (4.97) |
| Constant | 0.094 | -0.562* | 0.035 |
| | (0.32) | (-1.87) | (0.12) |
| Observations | 3,200 | 3,200 | 3,200 |

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

表 11 以过去两周是否感到不适作为被解释变量，以医疗服务机构等级作为中介变量的回归结果。控制是否参保后，将中介变量加入方程，结果显示医疗服务机构等级对过去两周感到不适有显著的正向影响，因此，参保会降低居民选择医疗服务机构时的等级，选择低等级的机构有利于降低过去两周感到不适的概率，中介效应成立。同时，由于参保对过去两周感到不适的平均边际效应的系数绝对值和显著性均有所下降，但仍显著，我们可以推测通过医疗服务机构等级影响客观健康这一机制在居民医保影响居民健康中起到了较大的作用，但仍为不完全中介。投保对过去两周感到不适的总效应为-0.44，直接效应为-0.219，间接效应为-0.917*0.241=-0.221。

表 12 城乡居民基本医疗保险对居民健康的中介效应（4）

| | (14) | (15) | (16) |
|---|---|---|---|
| 变量 | unwell | lnpermetotal | unwell |
| medins | -0.440** | 0.337** | -0.422*** |
| | (-2.37) | (2.15) | (-2.81) |
| age | 0.016*** | 0.009*** | -0.019*** |
| | (10.33) | (3.03) | (-11.05) |
| gender | -0.284*** | -0.094 | 0.044 |
| | (-6.15) | (-1.27) | (0.90) |
| marrige | -0.059 | 0.064 | -0.083 |
| | (-1.10) | (0.59) | (-1.47) |
| work | -0.006 | -0.319*** | 0.166** |
| | (-0.10) | (-3.12) | (2.44) |
| lnperincome | -0.061*** | 0.168*** | -0.020 |
| | (-2.76) | (4.86) | (-0.81) |
| owehouse | -0.080 | 0.212** | 0.071 |
| | (-1.33) | (2.23) | (1.13) |
| debt | 0.213*** | 0.247*** | 0.020 |
| | (4.52) | (3.27) | (0.40) |
| lnpermetotal | | | -0.053*** |
| | | | (-4.49) |
| Constant | 0.094 | 3.652*** | 0.154 |
| | (0.32) | (9.07) | (0.49) |
| Observations | 3,200 | 3,200 | 3,200 |

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

将中介变量换为家庭人均医疗费用支出，被解释变量仍选用客观健康指标，结果列示在表 12。由表 8 可知，参保提高了家庭人均医疗费用支出，降低过去两周不适的概率，中介效应成立。投保对居民过去两周感到不适的总效应为-0.44，直接效应-0.422，间接效应为 0.337*(-0.053)=-0.018

综上，城乡居民医保通过提高医疗服务利用而影响居民健康的中介效应均成立，并且通过降低医疗服务机构的等级来促进健康的中介效应在总效应中占比较大。

### 5.3.3 异质性分析

研究城乡居民医保整合对居民健康的影响，本文选择在 2016 年底前已完成城乡居民基本医疗保险整合的 8 个省的样本[①]，和 2018 年底前仍未完成整合的 5 个省的样本[②]，分别进行回归，结果如下。

[①] 天津、上海、浙江、山东、广东、重庆、宁夏、青海
[②] 辽宁、吉林、福建、海难、贵州

表 13　城乡居民基本医疗保险整合对居民健康的影响

| | 已完成整合 | | 未完成整合 | |
|---|---|---|---|---|
| | (21) | (22) | (23) | (24) |
| 变量 | health | unwell | health | unwell |
| medins | 1.482*** | -0.573** | 0.374** | -0.319* |
| | (4.74) | (-1.19) | (0.67) | (-0.63) |
| age | -0.010*** | 0.012*** | -0.021*** | 0.008** |
| | (-3.81) | (4.64) | (-5.46) | (2.39) |
| gender | 0.084 | -0.251*** | 0.177* | -0.287*** |
| | (1.13) | (-3.38) | (1.65) | (-3.04) |
| marrige | 0.037 | -0.115 | 0.017 | -0.249** |
| | (0.42) | (-1.32) | (0.14) | (-2.28) |
| work | 0.048 | 0.004 | -0.095 | -0.168 |
| | (0.45) | (0.04) | (-0.71) | (-1.43) |
| lnperincome | 0.023 | -0.088** | -0.023 | -0.121*** |
| | (0.64) | (-2.50) | (-0.54) | (-2.94) |
| owehouse | -0.097 | -0.170** | 0.160 | 0.021 |
| | (-1.17) | (-1.97) | (1.12) | (0.16) |
| debt | -0.033 | 0.253*** | -0.087 | -0.062 |
| | (-0.43) | (3.27) | (-0.79) | (-0.62) |
| Constant | -1.550*** | 0.762 | 0.566 | 0.846 |
| | (-3.71) | (1.63) | (0.97) | (1.47) |
| Observations | 1,270 | 1,270 | 774 | 774 |

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

完成与尚未完成整合的城乡居民医保对自评健康的影响分别在 1%、5%的显著性水平上显著为正，对过去两周感到不适的概率影响分别在 5%、10%的显著性水平上显著为负。不论是从平均边际效应大小还是从显著性水平上看，整合后的居民医保对居民健康的促进作用明显高于未完成整合。

为探究城乡居民医保对健康的促进作用在不同人群间是否存在异质性，本文选取了年龄、地区和收入三种分类方法。年龄按照国际标准分为青年、中年、老年，地区按照国家统计局标准划分为东、中、西部[①]。收入结合国家统计局标准、数据实际情况和部分文献的划分标准，以家庭收入和家庭人均收入将样本分为高、低收入人群。

[①]东部省份包括江苏、上海、浙江、福建、广东、山东、安徽、海南、黑龙江、辽宁、吉林、河北、天津、北京；中部省份包括河南、湖北、湖南、江西、山西、内蒙古；西部省份包括陕西、宁夏、甘肃、四川、重庆、贵州、广西、云南、西藏、青海、新疆。

表 14 城乡居民基本医疗保险对不同年龄人群的健康影响

| | 16-44岁青年 | | 45-60岁中年 | | 60岁以上老年 | |
|---|---|---|---|---|---|---|
| | (25) | (26) | (27) | (28) | (29) | (30) |
| 变量 | health | unwell | health | unwell | health | unwell |
| medins | 0.935*** | -0.732*** | 0.457* | -0.363 | 0.445 | 0.334 |
| | (4.01) | (-2.91) | (1.30) | (-1.17) | (0.80) | (0.70) |
| age | -0.033*** | 0.013** | -0.005 | 0.003 | -0.010 | 0.018* |
| | (-5.99) | (2.49) | (-0.45) | (0.35) | (-0.82) | (1.82) |
| gender | 0.025 | -0.174** | 0.081 | -0.457*** | 0.005 | -0.276*** |
| | (0.38) | (-2.57) | (0.85) | (-5.42) | (0.04) | (-2.68) |
| marrige | -0.074 | -0.006 | 0.264* | -0.138 | -0.070 | 0.035 |
| | (-0.92) | (-0.08) | (1.85) | (-1.19) | (-0.49) | (0.29) |
| work | 0.138 | -0.047 | 0.499*** | -0.051 | 0.145 | 0.080 |
| | (1.49) | (-0.51) | (3.18) | (-0.44) | (0.99) | (0.66) |
| lnperincome | 0.006 | -0.048 | -0.079* | -0.115*** | 0.007 | -0.048 |
| | (0.17) | (-1.34) | (-1.93) | (-2.95) | (0.15) | (-1.05) |
| owehouse | 0.098 | -0.107 | 0.030 | 0.083 | -0.184 | -0.141 |
| | (1.27) | (-1.38) | (0.21) | (0.67) | (-1.01) | (-0.87) |
| debt | 0.064 | 0.149** | 0.054 | 0.262*** | 0.001 | 0.218* |
| | (0.99) | (2.23) | (0.54) | (3.02) | (0.01) | (1.83) |
| Constant | -0.227 | 0.233 | -0.336 | 1.261* | -0.590 | -0.853 |
| | (-0.49) | (0.50) | (-0.41) | (1.74) | (-0.55) | (-0.92) |
| Observations | 1,595 | 1,595 | 976 | 976 | 629 | 629 |

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

表 14 中列示了对不同年龄阶段的样本分别进行回归的结果，其中（25）、（26）列是 16-44 岁青年样本的回归结果，参保城乡居民基本医疗保险对青年人群自评健康的影响在 1%的显著性水平上显著为正，平均边际效应为 0.935；对过去两周感到不适的影响在 1%的显著性水平上显著为负，平均边际效应为-0.732。平均边际效应的大小和显著性均高于全样本回归。（27）、（28）列结果表明，参保对中年人群的自评健康在 10%的显著性水平上有正向影响，平均边际效应为 0.457；对过去两周感到不适的概率没有显著影响。（29）、（30）列是 60 岁以上老年样本的回归结果，不论是对自评健康还是对过去两周感到不适的概率，城乡居民基本医疗保险均没有显著的影响。可以看到，城乡居民医保促进居民健康的作用随着参保者年龄增大而减小，原因可能是参保所提高的医疗服务利用的边际效果随年龄的增加而减小，健康效应也逐渐降低。

表 15　城乡居民基本医疗保险对不同地区人群的健康影响

| | 东部 | | 中部 | | 西部 | |
|---|---|---|---|---|---|---|
| | (31) | (32) | (33) | (34) | (35) | (36) |
| 变量 | health | unwell | health | unwell | health | unwell |
| medins | 0.725** | -0.721** | 0.226* | -0.935** | 0.735 | -0.435 |
| | (2.45) | (-2.57) | (0.37) | (-2.05) | (1.34) | (-0.78) |
| age | -0.014*** | 0.011*** | -0.016*** | 0.016*** | -0.026*** | 0.022*** |
| | (-5.22) | (4.65) | (-3.58) | (4.97) | (-7.13) | (7.91) |
| gender | 0.106 | -0.270*** | -0.053 | -0.195** | 0.063 | -0.347*** |
| | (1.37) | (-3.78) | (-0.54) | (-2.11) | (0.73) | (-4.21) |
| marrige | -0.095 | -0.106 | -0.011 | 0.086 | -0.157 | -0.044 |
| | (-1.09) | (-1.25) | (-0.09) | (0.82) | (-1.63) | (-0.48) |
| work | -0.001 | -0.007 | 0.359*** | 0.013 | 0.338** | -0.052 |
| | (-0.01) | (-0.08) | (2.65) | (0.11) | (2.49) | (-0.43) |
| lnperincome | -0.009 | -0.086*** | -0.002 | -0.082* | -0.067 | -0.016 |
| | (-0.26) | (-2.59) | (-0.03) | (-1.81) | (-1.56) | (-0.40) |
| owehouse | -0.095 | -0.049 | 0.270* | -0.104 | 0.086 | -0.115 |
| | (-1.06) | (-0.56) | (1.93) | (-0.86) | (0.73) | (-1.01) |
| debt | 0.044 | 0.191** | 0.086 | 0.224** | -0.065 | 0.176** |
| | (0.55) | (2.45) | (0.84) | (2.48) | (-0.75) | (2.13) |
| Constant | -0.286 | 0.680 | -0.340 | 0.466 | 0.333 | -0.448 |
| | (-0.62) | (1.58) | (-0.53) | (0.85) | (0.43) | (-0.61) |
| Observations | 1,301 | 1,301 | 860 | 860 | 1,029 | 1,029 |

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

从表 15 看出，城乡居民医保对东部和中部地区的居民健康有较大的促进作用，但对西部地区没有明显的促进作用。居民医保对东部地区居民健康影响的平均边际效应绝对值均在 0.7 以上，且在 5%的显著性水平上显著。对于中部地区，居民医保对自评健康的影响和对过去两周感到不适的影响在 10%、5%的显著性水平上显著。参保对西部地区居民健康的促进作用并不显著。这一现象可从两方面来解释：一是东部和中部地区居民的平均收入水平较西部地区更高，参保后释放更多的医疗服务需求；二是西部地区医疗条件相对落后，居民医保在条件限制下能够提高的医疗服务利用程度有限。

表 16 城乡居民基本医疗保险对不同收入人群的健康影响

| | 家庭低收入 | | 家庭高收入 | | 家庭人均低收入 | | 家庭人均高收入 | |
|---|---|---|---|---|---|---|---|---|
| | (37) | (38) | (41) | (42) | (43) | (44) | (39) | (40) |
| 变量 | health | unwell | health | unwell | health | unwell | health | unwell |
| medins | 0.535** | -0.375* | 0.525** | -0.434* | 0.635* | -0.468 | 0.449 | -0.535 |
| | (2.35) | (-1.72) | (2.24) | (-1.93) | (1.68) | (-1.25) | (1.10) | (-1.40) |
| age | -0.020*** | 0.017*** | -0.020*** | 0.017*** | -0.019*** | 0.012*** | -0.018*** | 0.012*** |
| | (-9.94) | (9.56) | (-10.24) | (9.87) | (-4.94) | (3.42) | (-5.57) | (4.11) |
| gender | -0.009 | -0.281*** | -0.016 | -0.271*** | 0.244** | -0.336*** | 0.173* | -0.300*** |
| | (-0.15) | (-5.04) | (-0.29) | (-5.06) | (2.49) | (-3.63) | (1.95) | (-3.58) |
| marrige | -0.105 | -0.018 | -0.106 | -0.026 | -0.019 | -0.127 | -0.089 | -0.137 |
| | (-1.56) | (-0.28) | (-1.62) | (-0.42) | (-0.17) | (-1.21) | (-0.83) | (-1.35) |
| work | 0.179** | -0.044 | 0.199** | -0.057 | 0.091 | 0.141 | 0.151 | 0.064 |
| | (2.18) | (-0.60) | (2.55) | (-0.82) | (0.64) | (1.10) | (1.24) | (0.58) |
| lnperincome | -0.023 | -0.041 | -0.038 | -0.048 | 0.090 | -0.015 | -0.048 | -0.041 |
| | (-0.78) | (-1.44) | (-1.25) | (-1.63) | (0.96) | (-0.17) | (-0.57) | (-0.54) |
| owehouse | 0.125 | -0.097 | 0.124 | -0.089 | -0.022 | -0.001 | -0.067 | -0.028 |
| | (1.60) | (-1.33) | (1.51) | (-1.17) | (-0.20) | (-0.01) | (-0.59) | (-0.26) |
| debt | -0.004 | 0.259*** | -0.004 | 0.236*** | 0.025 | 0.154 | 0.015 | 0.124 |
| | (-0.06) | (4.46) | (-0.07) | (4.30) | (0.25) | (1.64) | (0.17) | (1.45) |
| Constant | -0.075 | -0.200 | 0.039 | -0.076 | -1.408 | -0.322 | 0.216 | 0.087 |
| | (-0.21) | (-0.58) | (0.11) | (-0.23) | (-1.28) | (-0.30) | (0.20) | (0.09) |
| Observations | 2,202 | 2,202 | 2,375 | 2,375 | 825 | 825 | 998 | 998 |

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

表 16 是以家庭年总收入和家庭人均年收入进行收入划分后的回归结果。不论哪种划分方式，居民医保都对低收入居民健康促进更加显著。这也符合政策初衷，为全体居民提供基本的医疗保障，更有利于提高低收入群体的医疗服务利用。

## 6. 结论与政策建议

### 6.1 研究结论

本文通过理论与实证分析后，得到如下结论：

第一，城乡居民基本医疗保险对居民健康有促进作用。本文从主观和客观两方面选择指标来构建健康评价体系，结果显示投保城乡居民医保对主观和客观健康均有显著的正向作用。

第二，城乡居民基本医疗保险对居民健康的促进作用是通过影响医疗服务利用实现的。中介效应模型显示城乡居民基本医疗保险能够提高医疗服务利用，而医疗服务利用的提高对居民健康有显著正向影响。但本文所选取的中介变量带来的均是不完全中介效应，居民医保对居民健康的影响具有一定的直接效应。

第三，城乡居民基本医疗保险整合有助于发挥基本医疗保险对居民健康的促进作用。对已整合和仍未整合的省份样本分别检验，前者对居民健康的促进作用

明显强于后者，证明城乡居民基本医疗保险整合对居民健康更加有利。

第四，城乡居民基本医疗保险对居民健康的促进作用存在年龄、收入和地区上的差异。其中，对青年、低收入和东中部地区的居民促进效果更显著。

### 6.2 政策建议

第一，加快城乡居民基本医疗保险整合进程。对尚未完成整合的地区加强引导和监督，分析落后的原因，根据不同统筹区自身的情况有针对性地解决整合过程中的问题，尽快实现全国城乡居民基本医疗保险整合。对于已完成整合的地区，要认真贯彻落实《意见》中的内容，对城乡居民医保的筹资、保障、基金管理等方面做出妥善安排，部门之间密切合作，确保并轨后的医保工作与并轨前有效衔接。

第二，提高低等级医疗服务机构的保障待遇。进而提高居民医疗服务利用率，防止小病拖成大病，以提高居民整体健康水平。此外，低等级医疗机构利用率的提高可以减轻高等级医疗机构服务供给压力，减少医疗资源浪费，提高医疗资源使用效率。

第三，平衡不同地区间医疗资源密度的差异。从人才、物资、基础设施等方面提高居民的医疗服务可及性，增加供给的同时创造有效需求。中央财政可以对不同的地区或省市施行差异性补贴政策，根据各地区财政水平针对性制定补贴比例，平衡地区间的保险基金筹资水平和保障水平。提高医疗服务的可及性，在政策上对西部地区进行医疗资源倾斜，多方面提高西部地区的基本医疗条件。

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# 城乡居民基本医疗保险对居民健康的影响研究

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**关键词：**城乡居民基本医疗保险；居民健康；中介效应；居民医保整合

**中文摘要.** 城乡居民基本医疗保险整合将为所有非从业居民提供医疗保障，其能否提高参保居民的健康水平成为值得关注的问题。本文在Grossman健康需求模型和安德森卫生服务利用模型基础上，对我国的城乡居民基本医疗保险和居民健康的状况进行分析，选用probit模型研究城乡居民基本医疗保险能否促进居民健康，构建中介效应模型探究影响路径，同时针对不同人群的特征差异进行异质性分析。结果显示，城乡居民基本医疗保险对居民健康确有促进作用，整合后的居民医保对健康的促进作用更显著，且对青年、低收入和东中部地区的居民促进效果更显著。本文建议加快整合进程，提高低等级医疗机构保障待遇，平衡医疗资源密度差异，进而加快健康中国建设。

# Research on the Impact of Environmental Pollution on the Demand for Commercial Health Insurance

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**Keywords:** Environmental pollution; Demand for Commercial Health insurance; Personal health level; Mediating Effect

**Abstract.** Environmental pollution not only affects the quality of Chinese economic growth and national image, but also seriously affects the social public's physical and mental health. Therefore, people face huge health risks. Commercial health

insurance is an important part of the national multi-level medical security system, and also a critical role which insurance industry plays in people's livelihood. Does the impact of environmental pollution on public health increase the demand for commercial health insurance? How about the public perception of environmental pollution and health risks? In view of this, this thesis carried out a research in order to response those related and unsolved issues, and made a theoretical analysis on the relationship between environmental pollution and commercial health insurance demand by applying Grossman's health demand theory and environmental stress theory, proposed a mediating variable based on individual health level and further made a mechanism analysis. After investigating and analysing the macro panel data of 30 provinces, municipalities and autonomous regions (except Tibet) from 2007 to 2017, this thesis empirically tested the relationship between environmental pollution and commercial health insurance demand and the mediating effect by setting the panel data model and the mediating effect model, and further explored the residents' health risk attitude. Through this study, the following conclusions are drawn: from the national dimension, environmental pollution has a significant promoting effect on the demand for commercial health insurance. The sample studies show that such a positive effect is vital in the east and midwest of China, but the positive effect on the demand for commercial health insurance in the east of China is greater. Residents in China towards personal health risk still hold a "afterwards" attitude, personal health level in the pollution of the environment in the process of commercial health insurance demand plays a partial mediating effect, and the mediating effect of regional differences. Environmental pollution in the east of China can only directly affect the demand for commercial health insurance, there is no mediating effect. However, there is a complete mediating effect in the midwest, which implies that residents in the east have taken an "early avoidance" attitude towards personal health risks. Finally, the thesis puts forward some policy suggestions in order to provide reference for policy making and product business development of commercial insurance companies.

## 1. Introduction

In the past 40 years of reform and opening up, while China has made major economic achievements, the problem of environmental pollution has become increasingly prominent. Environmental pollution incidents such as haze, acid rain, marine pollution, and desertification are appearing with multiple frequency and high intensity. With the rapid development of township enterprises, the problem of environmental pollution is spreading from cities to villages. According to the 2017 *China Ecological and Environmental Status Bulletin* statistics, among the 338 prefecture-level and above cities in China, the number of cities with excessive ambient air quality has reached 239, accounting for 70.7% of the total, and the average number of good days has decreased by 0.8% compared with 2016. Environmental problems have posed a threat to the health of residents. Air pollution has caused the incidence of respiratory diseases among residents increasing year by year, and water pollution triggers outbreaks of resident pollutant poisoning or waterborne diseases. Meanwhile, noise and solid waste have seriously affected the normal lives of residents. These environmental pollution problems have seriously affected the health of residents and hindered people's yearning and pursuit of a better life. Therefore, they have become prominent shortcomings in building a well-off society in an all-round way.

At the same time, basic medical service resources in China are scarce, and the problem of "difficult and expensive medical treatment" is prominent. Social medical insurance cannot meet the growing diversified medical and health needs of the people. Commercial health insurance has been vigorously introduced as a supplement to social medical insurance. In February 2020, at a critical period in the national fight against the COVID-19, the *Opinions of the Central Committee of the Communist Party of China and the State Council on Deepening the Reform of the Medical Security System* was released. It puts forward the system reform goals of comprehensively building a multi-level medical security system, positioning the development direction, clarifying the commercial health insurance, and providing more opportunities for the development of commercial health insurance. Commercial health insurance provides risk management channels, and it has become an important part of the country's multi-level medical security system, as well as an important area for the insurance industry to serve the people's livelihood.

With the public's concern about environmental pollution affecting health and the improvement of living standards, in order to avoid the health risks caused by environmental pollution, will the willingness of public to purchase commercial health insurance increase? What is the perception of environmental pollution and health risk perception of people? In this regard, this thesis focuses on the impact of environmental pollution on the demand for commercial health insurance, and analyzes the mediating mechanism in order to explore the attitude of public about health risks and fully understand the risk management methods of residents, with a view to

providing reference for the development of health products and business development of commercial insurance companies.

## 2. Literature Review at Home and Abroad

Environmental quality is an important factor which affects the demand for commercial health insurance. Domestic and foreign scholars have rich researches on the health effects of environmental pollution and the factors affecting the demand for commercial health insurance. However, there are few literatures directly studying the impact of environmental pollution on the demand for commercial health insurance.

Liu Suchun and others used the spatial measurement model to study the impact of basic medical insurance on commercial health insurance. They measured the variables of environmental pollution as a control variable into the model in empirical analysis. The regression results show that environmental pollution is positively promoting the demand for commercial health insurance[1]. Yang Bo and Jiang Ruyue took environmental pollution factors as one of the factors influencing the unbalanced development of commercial health insurance in different regions to conduct empirical tests. The study shows that environmental pollution has played a role in promoting the development of commercial health insurance, and there were differences between regions[2].

A small number of scholars have used environmental pollution as the main research variable to directly study the relationship between it and the demand for commercial health insurance. Based on the impact of environmental pollution on personal psychology, Chang used an econometric model to study the impact of air pollution on residents' commercial health insurance decision-making behavior at the micro level. The results show that for every unit increase in daily AQI, daily sales will increase by about 0.072%. The impact of air quality index on sales will be significant only when the air quality index is higher than 150. It is also found that for every unit reduction in AQI in relative order day of the hesitation period, the probability of order cancellation increases by 0.001%. Finally, it is found that the projection bias phenomenon and significance can be used as the influence mechanism[3]. From the macro level, Wu Junqian and others used the spatial Dubin model to study the spatial spillover effect and direct impact of haze pollution on the development of commercial health insurance in China. It has shown that haze does not significantly affect the development of commercial health insurance, and through time-of-period empirical research. It is found that haze pollution has had a direct impact on the development of commercial health insurance after 2010. The increase in haze pollution in other regions has played a positive role in promoting the development of commercial health insurance in other regions. Haze pollution in the east and middle is more serious than in the west, and the spatial spillover effect in the east and middle is significantly higher than in the west[4]. Yuan Cheng and Liu Shuting studied the direct impact of air pollution on commercial health insurance consumption. At the same time, people’s risk perception level was used as a moderating variable to analyze its moderating

effect on the two processes, the results show that air pollution has a lagging positive effect on the consumption of commercial health insurance. People's risk awareness will deepen the impact of air pollution on commercial health insurance consumption, and the moderating effect is significant[5].

In summary, the impact of environmental pollution on commercial health insurance has received extensive attention from scholars in recent years. However, most existing studies focus on the air pollution level, and the scope of environmental pollution measurement is not comprehensive enough. Because of the different methods used, the conclusions obtained are not same. In view of this, on the basis of previous studies, this thesis adopts a more scientific method to construct a comprehensive index to measure environmental pollution, which serves as the basis for studying the relationship between environmental pollution and the demand for commercial health insurance. At the same time, it will further construct the mediating effect framework and use the mediating effect model to study the mediating mechanism of environmental pollution affecting the demand for commercial health insurance. Finally, based on the research conclusions, targeted policy recommendations for the better development of commercial health insurance are put forward in order to supplement the existing literature research.

## 3. Theoretical Analysis of Influence Mechanism

### 3.1 The Theoretical Basis of the Impact of Environmental Pollution on the Demand for Commercial Health Insurance

#### *3.1.1 Grossman's Health Needs Theory*

Grossman(1972) proposed that health will affect the utility level of people through two ways[6]. On the one hand, health can be regarded as a consumer product, which increases consumer happiness during consumption and directly enhances consumer utility. On the other hand, health can be regarded as an investment product. The increase in the stock of health capital will reduce the time people spend on sick, thereby increasing working time, increasing the income level of people, and indirectly increasing utility. Grossman built a health demand model for the first time on the basis of human capital theory, assuming that the utility function of a certain consumer at different stages is:

$$U = U(\varphi_t H_t, Z_t), t = 0,1,...,n \tag{1}$$

Among them, $H_t$ is the stock of healthy capital owned by consumers in period t, $\varphi_t$ represents the number of healthy days per unit of healthy capital stock, $\varphi_t H_t$ is the total healthy days available for consumption in period t, $Z_t$ represents the number of general commodities consumed in period t. The initial health capital stock $H_0$ owned by the consumer at birth is exogenous, and the $H_t$ in subsequent periods can be selected by the consumer and is endogenous. The incremental formula for health capital is as follows:

$$H_{t+1} - H_t = I_t - \delta_t H_t \tag{2}$$

Among them, $I_t$ represents the healthy capital investment in period t. $\delta_t$ is the healthy depreciation rate, which changes due to changes in age, the older the age, the greater the value, which is exogenous. $I_t$ and $Z_t$ are determined by the following formula, where $M_t$ represents the factors that can be purchased from the market and can be used to form health and need to be invested; $TH_t$ is the necessary time for the production of health; $X_t$ represents the production of $Z$ consumer goods and must be invested Element; $T_t$ is the time necessary to produce $Z$ consumer goods; $E$ is other human capital (education level, etc.), the formulas are as follows:

$$I_t = I_t(M_t, TH_t; E) \tag{3}$$

$$Z_t = Z_t(X_t, T_t; E) \tag{4}$$

Since consumers need to purchase goods and spend their own time to invest in health, they are faced with two limitations, one is the income limitation of traditional consumer theory, and the other is time constraint, the formulas are as follows:

$$\sum_{t=0}^{n} \frac{P_t M_t + Q_t X_t}{(1+r)^t} = \sum_{t=0}^{n} \frac{W_t TW_t}{(1+r)^t} + A_0 \tag{5}$$

$$TW_t + TH_t + T_t + TL_t = \Omega \tag{6}$$

Among them, $P_t$ and $Q_t$ represent the market prices of $M_t$ and $X_t$, respectively. $W_t$ is the wage rate determined by external factors, $r$ is the interest rate, and $TW_t$ is the working time. $A_0$ is the initial wealth, that is, discounted non-salary income. The total time in each period is $\Omega$ (if each period is one year, $\Omega$ is 365 days), $TL_t$ is loss of time due to illness and inability to work, etc.

The above framework constitutes a consumer health demand model, which is the goal of pursuing utility maximization under budget and time constraints. In order to obtain the best health capital stock, consumers can invest the best health investment level. On the basis of the above framework, Grossman does not consider the consumer product characteristics of health capital, but only considers the investment product characteristics of health capital, and then obtains the equilibrium conditions of the pure investment model:

$$\frac{G_t W_t}{\pi_{t-1}} + \frac{G_t \left\{ \left[ \frac{U_{ht}}{m} \right] (1+r)^t \right\}}{\pi_{t-1}} = r + \delta_t \tag{7}$$

Among them, $G_t$ is the health time that each new unit of health capital can increase, $m$ reflects the marginal utility of money income. $\pi_{t-1}$ represents the shadow price of health, which is affected by consumers' wages and prices of medical and health services. $U_{ht}$ is the marginal utility of health. This formula represents that

the marginal benefit of health is equal to the marginal cost of health. Therefore, the health benefit curve $D_1$ and the health cost curve $r+\delta_t$ can be represented in Figure 1, and the intersection of the two can be used to obtain the optimal health demand of consumer $H_t^*$.

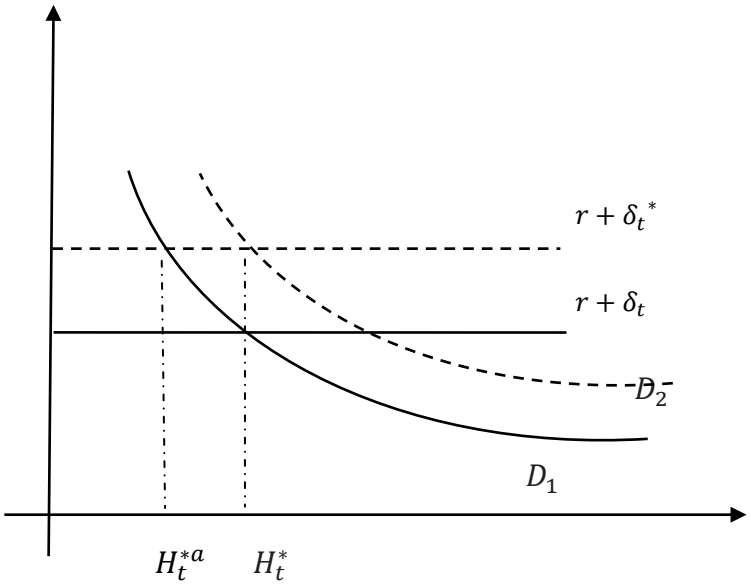


Fig. 1 Comparative Static Analysis of Health Needs

Cropper (1981) believes that the health of people in regions with severe environmental pollution will be harmed[7], thus introducing the level of environmental pollution into the equation of the healthy depreciation rate:

$$\delta_t = \delta_0 e^{\tilde{\delta}_t} C_t^{\varphi} K_t^{\varphi} \tag{8}$$

Among them, $\delta_0$ represents the initial healthy depreciation rate, $\tilde{\delta}$ is a constant elasticity, $C_t$ is the environmental pollution level in the area where consumers live, and $K_t$ represents other variables such as lifestyle.

It can be seen from formula (8) that the deepening of environmental pollution will increase the health depreciation rate $\delta_t$, which will shift the health supply curve upward, and the health demand will drop to $H_t^{*a}$. The reduction of the balanced health capital stock reduces the total utility of consumers from health. At this time, consumers will adopt the method of increasing investment to supplement the actual health capital stock. Assuming that people choose to buy commercial health insurance, the medical and health expenses paid due to illness will be reduced accordingly, and the demand of medical services will increase substantially. Specifically, because commercial health insurance bears part of the cost, the price of medical services faced by consumers when seeking medical treatment will be relatively lower, and the shadow price of health will drop accordingly, causing the health demand curve to shift to the right and reaching an equilibrium state again, the stock of health capital has also returned to the initial $H_t^*$, and the utility of consumers from health has been

maximized again.

*3.1.2 Environmental Stress Theory*

Environmental stress theory regards many factors in the environment as stressors. Environmental stressors are divided into three categories: catastrophic events, personal stressors and background stressors. Among them, the background stressor refers to the stressor that is relatively low in intensity, but is sustainable and routine. Background stimuli are divided into life events and environmental stimuli. Environmental pollution belongs to the environmental stimulus in the background stressor, and it has continuous harm to the human body and mind. After the individual's perception of environmental pollution is evaluated as threatening, he will quickly respond to environmental pollution stimuli. Individuals will adopt strategies to avoid or stop the harm caused by environmental pollution, for example, people will choose to buy masks or air purifiers, or even move out of areas with severe environmental pollution. Finally, the human body will either pay the price to adapt to environmental pollution stimulation, or produce psychological anxiety, fear, anger and other bad emotions, which will continue to affect the individual and cause damage to the health of individual.

In addition, to analyze the impact of environmental pollution on the demand for commercial health insurance, Lewin's field theory function formula must be introduced, B = f(P*E). Among them, B represents the behavior of an individual, P represents an individual, specifically, the psychological space or psychological tension system of person, which affects the needs and motivation intensity of individual. E represents the environment of personal life. From this point of view, the subjective needs and objective environment of people together determine individual behavior. Therefore, the externally polluted living environment (E), as well as the psychological instability and severe negative emotions (P) of the human body caused by environmental pollution, together determine the behavioral decision that individuals will choose to purchase commercial health insurance. People can transfer their own health risks by purchasing commercial health insurance, thereby satisfying their psychological security, and reducing the harm on their physical and mental health caused by environmental pollution to a certain extent.

## 3.2 Analysis on the Mechanism of Environmental Pollution Affecting Commercial Health Insurance Demand

In recent years, the commercial health insurance premium income of our country has risen rapidly, and the density and depth of commercial health insurance have reached to a certain extent. However, the proportion of commercial health insurance in the life insurance remains low, which accounts for only 16.41%[①] in 2017 , which is far below the standard of the mature insurance market. China has not yet formed a social foundation that is conducive to the development of commercial health

[①] Data source: calculated and compiled based on relevant data on the website of the China Banking and Insurance Regulatory Commission

insurance under the current culture background, concept, education level and urbanization stage. On the whole, the number of Chinese residents who purchase commercial health risks for the purpose of "preventing" health risks is still minority, and most residents are still at the level of "post-control" regarding health risks[8]. Therefore, this thesis proposes an mediating variable based on the personal health level. That is, environmental pollution firstly affects the personal health level, and then further affects the demand for commercial health insurance.

(1)Environmental Pollution and Personal Health

Environmental pollution will bring many kinds of harm to the mind and body of individual and pose serious threats to personal health. Studies have shown that sulfur dioxide in the air not only causes respiratory diseases such as asthma, but may also increase the risk of lung cancer and create a serious threat. A lot of smoke (powder) dust will not only breed bacteria and viruses, but also lead to various skin diseases when it is adsorbed on the surface of human skin. In addition, water pollution can enter the human body in the form of drinking water and cause infectious diseases and even poisoning events. It will also pollute the soil or other organisms, and finally spread through the food chain and ultimately harm the human bodies. On the whole, environmental pollution has reduced personal health and seriously threatened public health.

(2)Personal Health Level and Commercial Health Insurance Demand

The decline in personal health is the reason of the increasing demand for commercial health insurance. This thesis mainly proposes two influence paths.

On the one hand, the decline in personal health will affect residents' perceptions of costs and risks, which will affect the purchase decision of commercial health insurance. The decline in personal health will stimulate the behaviour of seeking medical services, increase medical and health expenditures, and increase pressure on the family economy. In order to reduce the potential economic burden resulted from this health risk, people tend to take proactive protective behaviors, which will increase the purchase of commercial health insurance. The greater the impact of environmental pollution on personal health, the more residents are willing to buy commercial health insurance, which is also a manifestation of adverse selection in the insurance industry.

On the other hand, the decline in personal health will affect the demand for commercial health insurance due to the projection bias effect. Projection bias refers to people will overestimate the consistency of future preferences with current preferences, and then project current preferences to the future[9]. While environmental pollution poses a threat to the health of residents, it will also be accompanied by emotional tension and fear, which will generate the psychological discomfort of people.

Loewenstein et al established such a model[10], firstly, suppose that the instantaneous utility $u$ brought by the consumption $c$ of a certain commercial health insurance policy will be affected by the state $s$ at the time of the purchase decision.

The above utility function can be expressed as $u(c,s)$. Then consider the utility of an individual whose current state is $s'$ to predict the future consumption of current commercial health insurance in state $s$ as $\tilde{u}(c,s/s') = \alpha\, u(c,s)$. Loewenstein et al believe that when people predict future utility, they will be affected by the current state, so after considering the effect of projection bias, there is：

$$\tilde{u}(c,s/s') = \alpha u(c,s') + (1-\alpha)u(c,s) \tag{9}$$

Among them, the value of $\alpha$ is between 0 and 1. If $\alpha = 0$, individual can more accurately predict the future utility in the state $s'$; if $\alpha > 0$, it means that the predicted future utility of the individual contains two parts, one part is the actual future utility, and the other part is the additional utility brought by the consumption of a certain commercial health insurance in the current state $s'$, this part is the size of the projection bias utility.

Therefore, the discomfort generated by environmental pollution on the human body will also influence the purchase of commercial health insurance due to the existence of the projection bias effect. Environmental pollution makes individuals feel uncomfortable through the negative impacts on human health. Individuals tend to project this uncomfortable state into future and match the future state with the current situation. As a result, the expected utility value of commercial health insurance consumption bases on the current discomfort state is higher than the actual value, and finally exhibits a strong demand for commercial health insurance. Moreover, the severity of the discomfort induced by environmental pollution on the individual affects the level of projection bias. The more serious the current discomfort is, the greater the projection bias effect produced, and the stronger the demand of commercial health insurance will be.

Based on what mentioned previously, the research framework of the mediating effect of personal health level proposed in this thesis can be displayed as below:

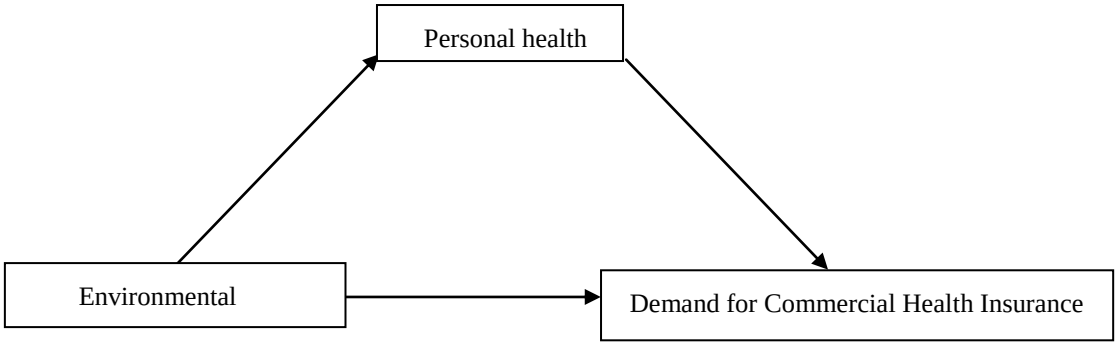


Fig. 2 The Research Framework of the Mediating Effect of the Impact of Environmental Pollution on the Demand for Commercial Health Insurance

## 4. Variable Selection and Model Construction

### 4.1 Data Source and Variable Selection

#### *4.1.1 Data Sources*

This thesis selects the panel data of 30 provinces in China from 2007 to 2017 (except Tibet). The data on commercial health insurance premium income comes from the *China Banking and Insurance Regulatory Commission*, and the data on total sulfur dioxide emissions, total waste water emissions, and smoke (dust) emissions are from the *National Bureau of Statistics of China*, *China Environmental Statistics Yearbook* and *CEIC* database. The data for other variables comes from the *China Statistical Yearbook*, *China Health Statistics Yearbook* and *China Labor Statistics Yearbook*, which are further calculated and compiled. Due to the lack of relevant data in recent years, the study of sample data in this thesis extends to 2017.

#### *4.1.2 Variable Selection*

(1) The explained variable

Commercial health insurance density (commercial health insurance premium income of a region/ the number of permanent residents in the region at the end of the year). This indicator reflects the popularity of commercial health insurance in a region and the degree of development of commercial health insurance in the region. The greater the density of commercial health insurance, the higher the consumption level of commercial health insurance in the region.

(2) Explaining variables

Comprehensive index of environmental pollution (env). This thesis selects the total emissions of sulfur dioxide, the total emissions of wastewater, and the emissions of smoke (dust) from the three dimensions of exhaust gas, wastewater, and solid waste as the measurement basis for measuring environmental pollution. Drawing on the methods of scholars Song Liying and Cui Fan[11], Use the entropy method[12] to assign weights and construct a comprehensive index of environmental pollution as an explanatory variable. This indicator comprehensively measures the degree of environmental pollution in an area. The larger the value is, the more serious the environmental pollution in the region is.

(3) Mediating variables

Number of attendees in hospitals by region (health). This thesis refers to the research of scholar Zhang Pengfei[13], and takes the number of patients (health) in hospitals in each region as an mediating variable. The number of consultations and treatments is counted according to the number of registrations, which can reflect the individual health level of residents in a region. The larger the number is, the worse the health of residents in the region is.

(4) Control variables

This thesis selects the following indicators as control variables:

Table 1 Related Content of Control Variables

| | Variable | Variable Definitions |
|---|---|---|
| Basic medical insurance density | medi | Premium income of urban basic medical insurance in a region/number of permanent residents in the region at the end of the year |
| Number of beds in medical institutions per 10,000 people | bed | |
| Regional GDP per capita | gdp | Gross domestic product of a region/number of permanent residents at the end of the year |
| Per capita health care expenditure of urban and rural residents | cost | Π(Per capita expenditure on health care of urban residents in a region/urban population in the region) +Π(Per capita expenditure on health care of rural residents in a region/rural population in the region) |
| Elderly dependency ratio | old | The number of people aged 65 and over in a region/the total population of the region |
| Education level | edu | Population 6 years old and above with college degree in a region/ Population with 6 years old and above |
| The proportion of local fiscal health expenditure | fin | A region's fiscal medical and health expenditure/general fiscal budget expenditure |
| Urbanization rate | city | Urban population in a region/total population in the region |

## 4.2 Model Construction

### *4.2.1 Panel Data Model*

In order to demonstrate the impact of environmental pollution on the demand for commercial health insurance, this thesis sets the following econometric model:

$$den_{it} = \alpha_0 + \alpha_1 env_{it} + \alpha_x C_{it} + \varepsilon_{it} \tag{10}$$

Among them, $den_{it}$ represents the commercial health insurance density of province i in year t, $env_{it}$ is the comprehensive environmental pollution index of province i in year t, $C_{it}$ represents the control variables; $\alpha_0$ represents the intercept term; $\alpha_1$, $\alpha_x$ are to be estimated coefficient term; $\varepsilon_{it}$ is a random error term.

Due to differences in environmental pollution between different regions and unbalanced economic development, the impact of environmental pollution on the demand for commercial health insurance may be heterogeneous. In order to investigate the possible heterogeneity between regions, on the basis of model (10), the virtual variable region of the east and midwest, as well as environmental pollution and its crossover terms are introduced, and the following model is constructed:

$$den_{it} = \alpha_0 + \alpha_1 env_{it} + \alpha_2 region + \alpha_3 env_{it} * region + \alpha_x C_{it} + \varepsilon_{it} \tag{11}$$

Among them, the east is assigned the value of 1, and the midwest is assigned the value of 0. Observe whether the coefficients $\alpha_1$ and $\alpha_3$ are significant. If they are both

significant, it indicates that the impact of environmental pollution on the demand for commercial health insurance has regional heterogeneity.

*4.2.2 Mediating Effect Model*

In order to explore whether there is an mediating path for the impact of environmental pollution on the demand for commercial health insurance, this thesis uses the new mediating effect model proposed by scholars such as Zhao et al[14] to test. This method combines the Bootstrap method proposed by Peracher and Hayes, and further enriching the analysis methods of the mediating effect, therefore, this thesis sets the following model:

$$health_{it} = \alpha_0 + \alpha_1 env_{it} + \alpha_x C_{it} + \varepsilon_{it} \tag{12}$$

$$den_{it} = \beta_0 + \beta_1 health_{it} + \beta_2 env_{it} + \beta_x C_{it} + \varepsilon_{it} \tag{13}$$

Among them, $health_{it}$ represents the mediating variable of personal health level, and the meaning of other variables is the same as that set in the panel data model.

The new mediating effect model does not need to consider whether the main effect is significant, and can directly test whether $\alpha_1 * \beta_1$ is significant (the coefficient $\alpha_1$ of $env_{it}$ in model (12) and the coefficient $\beta_1$ of $health_{it}$ in model (13) are both significant) to determine whether there is a mediating effect.

The inspection procedure is shown in the figure below:

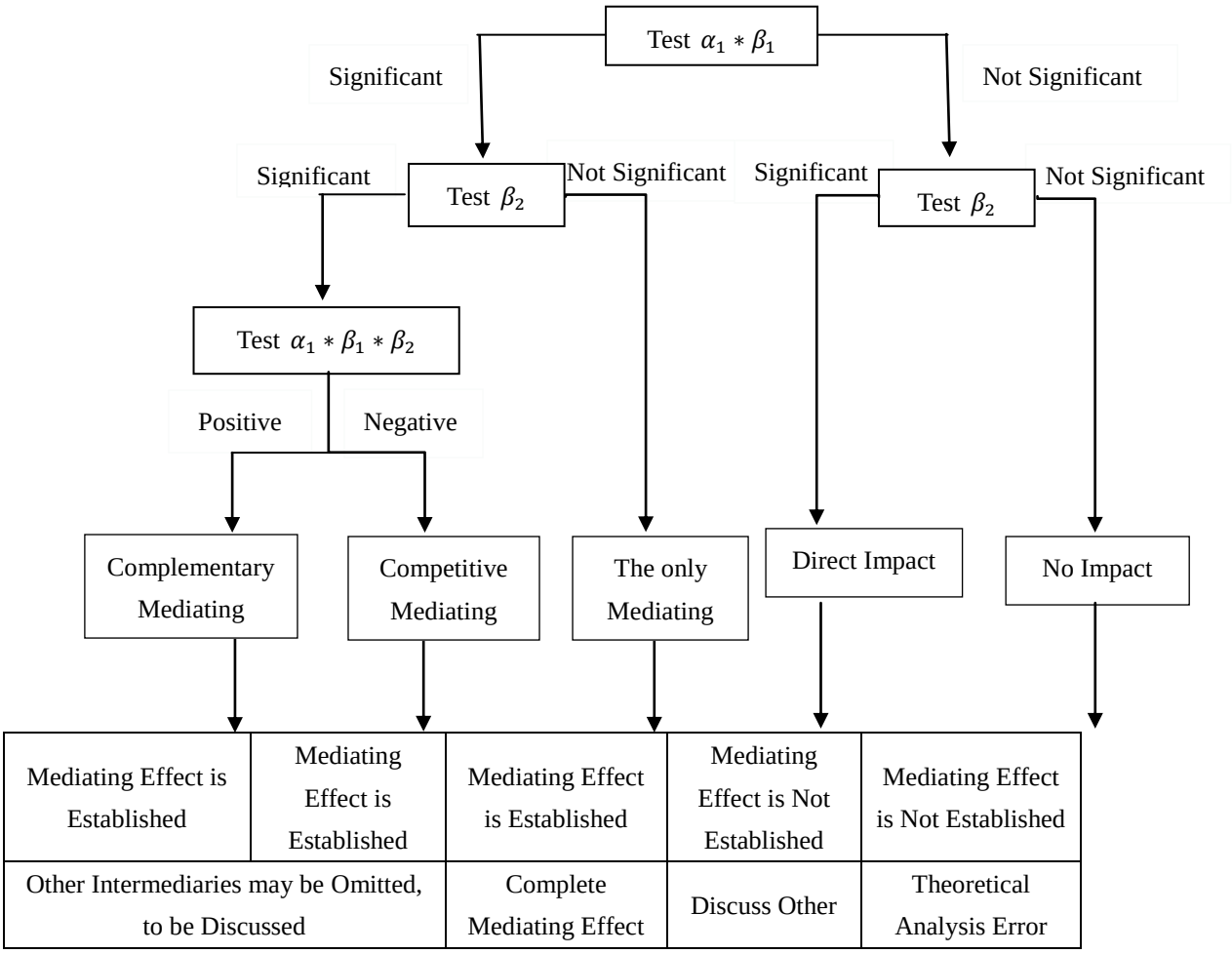


Fig. 3 Flow Chart of Mediating Effect Test

## 5. Empirical Results and Analysis

### 5.1 Benchmark Regression Results

Based on model (10), a fixed-effects model is used to perform regression analysis on national sample data, while controlling time factors and individual factors, and investigating the impact of environmental pollution on the demand for commercial health insurance.The results are shown in Table 2:

Table 2 Regression Results of National Sample Data

| Variable | Coefficient | T value | P value |
|---|---|---|---|
| env | 7.524*** | 2.67 | 0.008 |
| medi | 0.173*** | 10.40 | 0.000 |
| bed | 0.195 | 0.26 | 0.797 |
| gdp | 0.001** | 2.51 | 0.013 |
| cost | -0.057* | -1.75 | 0.081 |
| old | 13.477*** | 4.12 | 0.000 |
| edu | 8.787*** | 3.80 | 0.000 |
| fin | -5.629 | -1.01 | 0.314 |
| city | -0.348 | -1.35 | 0.178 |
| Constant Term | -243.763*** | -4.41 | 0.000 |
| $R^2$ | 0.857 | 0.857 | 0.857 |
| Observations | 330 | 330 | 330 |

Note: ***, **, and * indicate significant at the statistical levels of 1%, 5%, and 10%, respectively, and the values are the results after rounding.

Table 2 is the estimated results of the dual fixed effects model. The regression results show that from a national perspective, the regression coefficient of the comprehensive environmental pollution index is significantly positive at the level of 1%, indicating that the impact of environmental pollution on the demand for commercial health insurance is shown as a promotion.

In terms of controlling variables, the basic medical insurance density coefficient is significantly positive at the level of 1%, indicating that the impact of basic medical insurance on commercial health insurance is dominated by the crowd-in effect. The higher the degree of residents participating in basic medical insurance is, the stronger the insurance awareness is. At the same time, basic medical insurance can further reduce the uncertainty of future medical and health expenditures, reduce the preventive savings of residents, and increase non-medical consumption including the purchase of commercial health insurance. The coefficient of the number of beds in

medical institutions per 10,000 people is positive, but not significant, which may be due to the fact that the working indicators are different from the selected variables. The coefficient of per capita GDP is significantly positive at the level of 5%. The more developed a region is, the higher the income level of people and the higher the purchasing power of people, which can promote residents to relax budget constraints, thereby increasing the demand for commercial health insurance. The per capita health care expenditure coefficient of urban and rural residents is significantly negative at the level of 10%, indicating that residents choose more health care products, which will correspondingly reduce their consumption on commercial health insurance. The coefficient of the old-age dependency ratio is significantly positive at the level of 1%, indicating that the current acceleration of aging has aroused people's attention to health risk avoidance, and residents are willing to purchase more commercial health insurance to transfer health risks. The coefficient of education level is significantly positive at the level of 1%, the higher the education level of residents is, the stronger their insurance awareness is, and the easier it is to purchase commercial health insurance to transfer their own health risks. The coefficient of the proportion of local financial medical and health expenditure is negative, but not significant, indicating that the proportion of local government financial medical and health expenditure is negatively correlated with the demand for commercial health insurance, but the impact is not significant. The urbanization rate coefficient is negative, but not significant, the possible reason is that the urbanization of China is unique. A large number of rural people have entered cities and towns but still retain agricultural household registration. It may also be that the commercial health insurance market is not yet mature. There is no real change in the consumption philosophy of people of commercial health insurance, and there is a lack of preconditions for urbanization to promote commercial health insurance consumption.

### 5.2 Robustness Test

In order to further examine the robustness of the above conclusions, the following two methods are used for testing. First of all, learning from the practice of relevant scholars, in order to avoid the substantial impact of the measurement model selection, the random effects model is used to perform the regression again. The test results are shown in Table 3, and the results obtained are consistent with the benchmark regression results above.

Table 3 Random Effects Regression Results

| Variable | Coefficient | Z value | P value |
|---|---|---|---|
| env | 2.946*** | 3.15 | 0.002 |
| medi | 0.175*** | 11.55 | 0.000 |
| bed | -0.507 | -0.93 | 0.350 |
| gdp | -0.0006 | -1.27 | 0.206 |

| | | | |
|---|---|---|---|
| cost | 0.069*** | 2.78 | 0.005 |
| old | 5.697*** | 2.90 | 0.004 |
| edu | 5.744*** | 3.50 | 0.000 |
| fin | 5.022 | 1.36 | 0.173 |
| city | -0.340*** | -2.70 | 0.007 |
| Constant Term | -152.994*** | -4.93 | 0.000 |
| $R^2$ | 0.785 | 0.785 | 0.785 |

Note: ***, **, and * indicate significant at the statistical levels of 1%, 5%, and 10%, respectively, and the values are the results after rounding.

In addition, according to research conducted by Peng Haoran et al[15], the sex ratio of the permanent population in different regions is also an important factor affecting the demand for commercial health insurance. The sex ratio of male and female has a negative impact on the demand for commercial health insurance. Female tend to have higher risk aversion than male and are more willing to purchase commercial health insurance. In other words, when other variables remain unchanged, the higher the proportion of male, the more unfavorable the demand for commercial health insurance is. Based on this, this thesis adds the sex ratio to the control variables to re-regress. The regression results are shown in Table 4. It can be seen that after controlling the sex ratio of male and female, environmental pollution still significantly promotes the demand for commercial health insurance, which proves that the benchmark regression results have a certain degree of stability.

Table 4 Robustness Test Considering the Sex Ratio

| Variable | Coefficient | T value | P value |
|---|---|---|---|
| env | 7.882*** | 2.76 | 0.006 |
| sexratio | -0.948 | -0.79 | 0.432 |
| medi | 0.174*** | 10.36 | 0.000 |
| bed | 0.276 | 0.36 | 0.720 |
| gdp | 0.001** | 2.45 | 0.015 |
| cost | -0.051 | -1.55 | 0.122 |
| old | 10.096*** | 3.15 | 0.002 |
| edu | 8.756*** | 3.67 | 0.000 |
| fin | -5.183 | -0.92 | 0.359 |
| city | -0.373 | -1.42 | 0.157 |

| | | | |
|---|---|---|---|
| Constant Term | -111.036 | -0.75 | 0.452 |
| $R^2$ | 0.855 | 0.855 | 0.855 |
| Observations | 330 | 330 | 330 |

Note: ***, **, and * indicate significant at the statistical levels of 1%, 5%, and 10%, respectively, and the values are the results after rounding.

### 5.3 Heterogeneity Analysis

This thesis divides the national sample data into east and midwest sub-samples, and performs regression according to model (10) to test whether environmental pollution in the east and midwest has a significant impact on the demand for commercial health insurance, and then uses model (11) further test whether there is obvious regional heterogeneity in the impact of environmental pollution on the demand for commercial health insurance.

Table 5 Regression Results of Sample Data in the East and Midwest of China

| | East | | | Midwest | | |
|---|---|---|---|---|---|---|
| Variable | Coefficient | T value | P value | Coefficient | T value | P value |
| env | 12.655** | 2.31 | 0.023 | 3.550** | 2.48 | 0.014 |
| medi | 0.423*** | 10.38 | 0.000 | 0.099*** | 7.05 | 0.000 |
| bed | 5.142*** | 3.01 | 0.003 | -0.191 | -0.43 | 0.669 |
| gdp | 0.0009 | 1.15 | 0.254 | 0.001** | 2.15 | 0.033 |
| cost | -0.153*** | -2.66 | 0.009 | 0.053*** | 3.01 | 0.003 |
| old | 6.822 | 1.22 | 0.224 | 6.510*** | 3.40 | 0.001 |
| edu | 6.268 | 1.42 | 0.159 | 2.466** | 2.23 | 0.027 |
| fin | 18.966 | 1.30 | 0.196 | -1.198 | -0.51 | 0.614 |
| city | 0.056 | 0.03 | 0.973 | -0.227 | -1.43 | 0.155 |
| Constant Term | -617.305*** | -5.07 | 0.000 | 119.103*** | -4.52 | 0.000 |
| $R^2$ | 0.923 | 0.923 | 0.923 | 0.950 | 0.950 | 0.950 |
| Observations | 121 | 121 | 121 | 209 | 209 | 209 |

Note: ***, **, and * indicate significant at the statistical levels of 1%, 5%, and 10%, respectively, and the values are the results after rounding.

As shown in Table 5, the comprehensive index coefficients of environmental pollution in the east and midwest are both significantly positive at the level of 5%. Environmental pollution in the east and midwest has a significant positive impact on the demand for commercial health insurance.

Table 6 Regional Heterogeneity Test Results of the Impact of Environmental Pollution on the Demand for Commercial Health Insurance

| Variable | Coefficient | T value | P value |
|---|---|---|---|
| env | 2.966** | 2.43 | 0.015 |
| region | 23.325 | 1.35 | 0.176 |
| env * region | 0.0005** | 2.31 | 0.021 |
| Control variable | YES | YES | YES |
| Constant Term | -284.919** | -2.06 | 0.040 |
| $R^2$ | 0.672 | 0.672 | 0.672 |
| Observations | 330 | 330 | 330 |

Note: ***, **, and * indicate significant at the statistical levels of 1%, 5%, and 10%, respectively, and the values are the results after rounding.

Table 6 is the regression results based on model (11). Specifically, the comprehensive index coefficient of environmental pollution is significantly positive at the 5% level, and the cross-product coefficient of the comprehensive environmental pollution index and the region is significantly positive at the 5% level, indicating that there is obvious regional heterogeneity in the impact of environmental pollution on the demand for commercial health insurance. The positive effect of environmental pollution on the demand for commercial health insurance in the east is significantly higher than that in the midwest.

The reasons for the regional heterogeneity of the impact of environmental pollution on the demand for commercial health insurance is mainly manifested in the following aspects:

First, the population density varies among regions. In 2017, the population density in the east of China was about 538.91 people/$km^2$, while the population density in the midwest was about 94.05 people/$km^2$[②], the gap is obvious. Higher population density enables the impact of environmental pollution on the demand for commercial health insurance to be fully released, while too small population density will hinder the release of this impact to a certain extent. The population density in the east of China is high, and environmental pollution can play a full role through the impact on individuals, resulting in a significantly higher impact on the demand for commercial health insurance than in the midwest.

Second, there are differences in the degree of environmental pollution between regions. In terms of exhaust gas dimension, the annual emission density of sulfur dioxide in the east of China in 2017 was 2.66 tons/$km^2$, while that in the central region was 1.30 tons/$km^2$, and the west was 0.53 tons/$km^2$. In terms of wastewater dimension,

② Data source: calculated and compiled based on relevant data from the National Bureau of Statistics of China

the annual wastewater discharge density in east of China in 2017 was 33,800 tons/km$^2$, while the central region was 10,700 tons/km$^2$, and the west was 2300 tons/km$^2$. In terms of waste and solidity, the annual smoke (dust) emission density in the east of China in 2017 was 2.84 tons/km$^2$, compared with 1.31 tons/km$^2$ in the central region and 0.39 tons/km$^2$ in the west. The degree of environmental pollution in the east of China is obviously higher than that in the midwest, which makes the impact of environmental pollution on the demand for commercial health insurance higher than that in the midwest.

Third, there are obvious differences in the insurance awareness of residents between regions. In 2017, the average density of commercial health insurance in the east of China was 499.79 Yuan/person, compared with 230.26 Yuan/person in the central region and 232.36 Yuan/person③ in the west. It can be seen that the degree of development of commercial health insurance in the east of China is significantly higher than that in the midwest. As the economic development level of the east of China is higher than that of the midwest, and the residents have a higher education level, they will consider and foresee the probability of illness and the increase in medical and health expenditure in the future, which will encourage residents to improve risk management measures and strengthen family health and financial security. Therefore, residents in the east will be more willing to transfer health risks by purchasing commercial health insurance because of their strong insurance awareness. The education level of residents in the midwest is relatively low, the insurance awareness of residents is not high, the insurance culture atmosphere is not strong, so it is even more difficult to transfer health risks by purchasing commercial health insurance.

### 5.4 Mediating Effect

According to the analysis of the theoretical mechanism in the previous thesis, the reason why environmental pollution has played a positive role in promoting the demand for commercial health insurance is mainly that environmental pollution affects the health of individuals. Therefore, residents increase their purchases of commercial health insurance based on the risk attitude of "post-control". This thesis uses the mediating effect model to test the mediating mechanism, taking into account that there may be mutual causality between the number of patients in the current hospital and the density of commercial health insurance, leading to endogenous problems. Durbin-Wu-Hausman is used to test the exogeneity, and the result is that p=0.000, rejecting the null hypothesis.It indicates that the above variables do have endogeneity problems. This thesis draws on the method of scholars such as Peng Haoran[15], uses the lagging one and two periods of the number of hospital visits in the current period as instrumental variables, and applies the two-stage least squares method (2SLS) for estimation. The instrumental variables were tested for weak recognition and over-identification, and the test results showed that the instrumental variables passed

③ Data source: calculated and compiled based on relevant data from the China Banking and Insurance Regulatory Commission and the website of the National Bureau of Statistics of China

the validity test. The results are shown in Table 7:

Table 7 Mediating Effect Test Results of the National Sample

| | （1） | （2） | （3） |
|---|---|---|---|
| Variable | health | den | den |
| env | 6.643***<br>(10.59) | 2.567<br>(0.66) | 1.478<br>(0.32) |
| health | | 0.988***<br>(3.17) | 1.767***<br>(4.63) |
| Control variable | Yes | Yes | Yes |
| Constant Term | -19.434<br>(-1.62) | -117.891*<br>(-1.87) | 53.201<br>(0.29) |
| Regional Effects | Yes | Yes | Yes |
| Time Effect | Yes | Yes | Yes |
| Durbin-<br>Wu-Hausman | | | 14.730***<br>(p=0.000) |
| F-test | | | 731.526***<br>(p=0.000) |
| Sargan statistic | | | 2.433<br>(p=0.119) |
| $R^2$ | 0.809 | 0.806 | 0.904 |
| Observations | 330 | 330 | 270 |

Note: ***, **, and * indicate significant at the statistical levels of 1%, 5%, and 10%, respectively, columns (1) and (2) report t-values in parentheses, and column (3) report z-values in parentheses, and the values are the results after rounding.

Table 7 is the test result of the mediating effect based on the national sample data. Columns (1) and (2) are the results of using the regression model (12) and (13), and column (3) is the result of using 2SLS to estimate model (13). The environmental pollution comprehensive index coefficient in column (1) is 6.643, and it is significant at the 1% level. It indicates that there is a significant negative relationship between environmental pollution and personal health (the larger the value of the variable health is, the lower the personal health is ). The results estimated using 2SLS in column (3) is consistent with the benchmark regression results in column (2). The coefficient of the comprehensive index of environmental pollution is no longer significant, and the coefficient for measuring the individual's health level is 1.767, which is significant at the level of 1%. According to the flow chart of the mediating effect test, the personal health level plays a complete mediating role in the process of environmental pollution affecting the demand for commercial health insurance in the national dimension.

In order to examine whether there are differences in the mediating effect of environmental pollution on the demand for commercial health insurance in different regions, this thesis divides the data into two sub-samples in the east and midwest, and

uses the mediating effect models (11) and (12) set in this thesis to carry out the analysis. Test and get the test results of the sub-regional mediating effect, as shown in Tables 8 and 9:

Table 8 Mediating Effect Test Results of the east

| | （1） | （2） | （3） |
|---|---|---|---|
| Variable | health | den | den |
| env | 5.401***<br>(4.54) | 20.168***<br>(2.92) | 18.721***<br>(2.70) |
| health | | -0.269<br>(-0.49) | 0.399<br>(0.59) |
| Control variable | Yes | Yes | Yes |
| Constant Term | 3.005<br>(0.14) | -599.289***<br>(-5.37) | -992.910***<br>(-4.41) |
| Regional Effects | Yes | Yes | Yes |
| Time Effect | Yes | Yes | Yes |
| F-test | | | 147.611***<br>(p=0.000) |
| Sargan statistic | | | 0.603<br>(p=0.437) |
| $R^2$ | 0.907 | 0.920 | 0.958 |
| Observations | 121 | 121 | 99 |

Note: ***, **, and * indicate significant at the statistical levels of 1%, 5%, and 10%, respectively, columns (1) and (2) report t-values in parentheses, and column (3) report z-values in parentheses, and the values are the results after rounding.

Table 9 Mediating Effect Test Results of the Midwest

| | （1） | （2） | （3） |
|---|---|---|---|
| Variable | health | den | den |
| env | 3.827***<br>(6.36) | 2.074<br>(1.39) | 1.798<br>(0.83) |
| health | | 0.551***<br>(2.83) | 0.526**<br>(2.28) |
| Control variable | Yes | Yes | Yes |
| Constant Term | -17.217**<br>(-2.33) | -91.63***<br>(-3.32) | -5.310<br>(-0.11) |
| Regional Effects | Yes | Yes | Yes |
| Time Effect | Yes | Yes | Yes |
| F-test | | | 1078.610***<br>(p=0.000) |
| Sargan statistic | | | 2.152<br>(p= 0.142) |

| | | | |
|---|---|---|---|
| $R^2$ | 0.833 | 0.952 | 0.935 |
| Observations | 209 | 209 | 171 |

Note: ***, **, and * indicate significant at the statistical levels of 1%, 5%, and 10%, respectively, columns (1) and (2) report t-values in parentheses, and column (3) report z-values in parentheses, and the values are the results after rounding.

Table 8 is the results of the mediating effect test based on the sub-samples in the east. From column (1), it can be seen that the comprehensive index coefficient of environmental pollution is 5.401, so it is significant at the 1% level. It indicates that there is significantly a negative relationship between environmental pollution and personal health(the larger the value of the variable health is, the lower the personal health level is). In column (3), the empirical results obtained by using 2SLS estimation are consistent with the benchmark regression results. The coefficients for measuring personal health level variables are not significant, while the coefficient of the comprehensive environmental pollution index is significantly positive at the level of 1%. According to the mediating effect test procedure diagram, in the east, the personal health level will not play a mediating effect in the process of environmental pollution affecting the demand for commercial health insurance. However, the comprehensive index coefficient of environmental pollution in model (13) is 18.721, which is not 0 at the level of 1%. It is indicated that environmental pollution has a direct effect on the demand for commercial health insurance. Table 9 is the results of the mediating effect test based on the sub-samples in the midwest. It is consistent with the national data. The personal health level plays a completely mediating role in the process of environmental pollution affecting the demand for commercial health insurance.

There are regional differences in the mediating effect of environmental pollution on the demand for commercial health insurance. There is no mediating effect in the east of China, while there is a complete mediating effect in the midwest. The reason for this difference is mainly related to the environmental pollution awareness and insurance awareness of residents in the east and west of China. In 2017, the GDP value of the east of China was 47.124471 trillion yuan, while that of the central was 17.185573 trillion yuan, and the west was 20.272874 trillion yuan④. There is a large gap between the rich and the poor between the east and west of China, and the degree of development in the east is obviously ahead of other regions; In 2017, the average density of commercial health insurance in the east of China was 499.79 Yuan/person, compared with 230.26 Yuan/person in the central region and 232.36 Yuan/person⑤ in the west. Commercial health insurance in the east has a higher level of development. Compared with the midwest, the east of China has a higher degree of economic

④ Data source: calculated and compiled based on relevant data on the website of the National Bureau of Statistics of China

⑤ Data source: calculated and compiled based on relevant data from the China Banking and Insurance Regulatory Commission and the website of the National Bureau of Statistics of China

development, people's wages income is higher, and the education level is higher. Therefore, the local insurance culture atmosphere is strong, and residents' insurance awareness is relatively stronge. People have a more comprehensive subjective understanding of the impact of environmental pollution on personal health, and a higher degree of aversion to health risks. Therefore, residents in the east have a positive attitude toward 'preemptive avoidance' of health risks. Once they perceive serious environmental pollution, they will make an economic decision to directly purchase commercial health insurance. Residents located in the midwest adopt a passive attitude of "control after the fact" towards health risks. Residents are less aware of insurance and will only choose immediate risk management methods, such as directly wearing masks. Only after environmental pollution affects personal health and the awareness of environmental pollution affecting health is stronger, they will choose to purchase commercial health insurance risk management methods.

## 6. Research Conclusions and Policy Recommendations

### 6.1 Research Conclusions

This thesis selects the discharge of representative pollutants from the three dimensions of wastewater, waste gas, and waste solids as the basis. Using the entropy method constructs a comprehensive index to measure environmental pollution as the core explanatory variable, which is based on China's 30 2007-2017 the macro-panel data of the provinces. By setting the panel data model, study the relationship between environmental pollution and the demand for commercial health insurance, and examine the heterogeneity of different regions by samples. Finally, using the mediating effect model affects the impact of environmental pollution on commercial health insurance Empirical test of the mediating mechanism.The following conclusions are drawn:

(1) Environmental pollution has a significant role in promoting the demand for commercial health insurance. A sub-sample study found that this positive impact is significant in the east and midwest of China, and there is regional heterogeneity. Environmental pollution has a greater positive impact on the demand for commercial health insurance in the east of China.

(2) Chinese residents are still in the attitude of "post-control" toward personal health risks, and there is an adverse selection problem. Personal health levels play a complete mediating effect in the process of environmental pollution affecting the demand for commercial health insurance. There are regional differences in the mediating effect. In the east, environmental pollution has only a direct impact on the demand for commercial health insurance, and there is no mediating effect, while there is a complete mediating effect in the midwest.

(3) In recent years, as China has paid more and more attention to environmental pollution problems and continuously strengthened governance, people may feel that environmental pollution problems are improving while commercial health insurance is still developing rapidly. First of all, from the perspective of the research process, the changes of the two are jointly affected by the level of economic development. The

higher the level of economic development is, the higher the effectiveness of environmental governance is, and the higher the level of development of commercial health insurance is. In addition, the data in this thesis spanned to 2017. *The 18th National Congress of the Communist Party of China* included the construction of ecological civilization into the overall layout. In recent years, the effects of environmental governance have gradually emerged, so there may be a time gap between intuitive feelings and empirical results. Although environmental pollution factors have a positive impact on the demand for commercial health insurance, they cannot become an export that promotes the development of commercial health insurance. Promoting the development of commercial health insurance requires exploring new and lasting power.

### 6.2 Policy Recommendations

(1) From the government side. First, vigorously publicize the importance of health risk management, promote healthy lifestyle and disease prevention education throughout the country, especially in schools and communities in remote areas of the midwest, and improve people's risk management awareness. Secondly, in response to the problem of people’s adverse selection, on the one hand, it is necessary to complete personal electronic medical record system to further improve the standardization of medical information in our country; on the other hand, actively promote the sharing of data and information in the insurance industry in the fields of "medical, healthcare, health, and nursing", expand the scope of commercial insurance companies’ participation in social medical insurance management, break the medical and health "information islands", and realize the effective connection between insurance companies and social medical insurance in terms of data. Finally, in order to prevent the leakage of user information, laws and regulations should be formulated to regulate the use of information and clarify the ownership and use rights of personal information. Before the data is used, a strict qualification review should be carried out on the users, and the data should be managed through authorization.

(2) From the insurance companies. In order to determine the insurance premium rate more scientifically and develop more scientific insurance products, the heterogeneity of environmental pollution should be considered, and environmental pollution indicators should be included in the actuarial assumptions of commercial health insurance. In addition, insurance companies should adjust measures to local conditions, divide insurance areas according to the degree of environmental pollution, design insurance products that meet market needs according to the characteristics of people in different regions, and launch differentiated products. In the long run, precise customization of regional health insurance products based on regional environmental pollution conditions may occupy an advantageous position in market segments. When formulating product marketing strategies, commercial health insurance companies can subdivide user groups based on the development level, economic development level, aging level, and education level of social medical insurance in different regions, carry out precision marketing and promotion. At the same time, practicing the principle and

concept of "insurance" in the insurance industry, promoting the reform of the supply side of commercial health insurance, striving to develop medical and health services and health management products can better cater to people's needs and realize the interaction and supply between individuals, insurance companies, and medical institutions.

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# Research on the Impact of Commercial Medical Insurance on Health Inequality

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**Keywords:** Commercial medical insurance, Health inequality, Ordered logit.

**Abstract.** In recent years, the issue of health inequalities has received widespread attention. This study explores the impact of purchasing commercial medical insurance on health inequality from the perspective of purchasing commercial insurance, and puts the variables that affect health level mentioned in Grossman's model into the same research framework. Using China General Social Survey 2017(CGSS2017) data and using Ordered Logit regression model, the results of this research show that whether to purchase commercial health insurance, gender, education level, personal income and other factors have significant effects on respondents' self-rated health level. In addition, education level and marital status have moderating effects on participating in commercial insurance. In view of this, the author proposes that policies should be introduced to improve the status quo of health inequality, and commercial medical insurance underwriters should learn from advanced experience and apply it into practice according to local conditions.

## 1. Introduction

The 14th Five-Year Plan makes it clear that ensuring people's health is a strategic priority for development, adhering to the principle of putting prevention first, and deepening the implementation of the Healthy China Initiative. The comprehensive construction of a new era of socialist medical security system with Chinese

characteristics, the establishment and improvement of a multi-level medical security system covering urban and rural residents, is an important measure to provide people with a full range of full-cycle health services.

At present, China has established the basic medical insurance system for urban employees, the new rural cooperative medical system and the basic medical insurance system for urban residents. The National Medical Insurance Administration has released a statistical bulletin on the development of medical security undertakings in 2020. By the end of 2020, the number of people covered by the full coverage of basic medical insurance had reached 1.361 million, with coverage stabilizing at more than 95 percent. Commercial medical insurance is an important supplement to social medical insurance, which has the characteristics of flexible mode and rich types. Liu Suchun (2020) analyzed the influence of basic medical insurance on commercial health insurance based on the provincial panel data of 30 provinces in China from 2007 to 2017. The results showed that, on the whole, China's basic medical insurance promoted the development of commercial health insurance. With the continuous expansion of the scale of basic medical insurance, the influence of basic medical insurance on commercial health insurance is firstly restrained and then promoted. The Opinions of the CPC Central Committee and the State Council on Deepening the Reform of the Medical Security System was released, which set out the reform and development goal of comprehensively establishing a multi-level medical security system by 2030, and set clear requirements for accelerating the development of commercial health insurance, providing more opportunities for the development of commercial health insurance. This research will explore whether commercial medical insurance can affect the health status of residents, which is of great significance for the development of commercial medical insurance in the context of "Healthy China".

In recent years, the issue of health inequalities has received widespread attention. The influencing factors of health inequality have always been one of the topics that scholars at home and abroad pay more attention to.

Foreign scholars have studied the factors that affect the self-rated health status of insured people from different perspectives. Hullegie and Klein (2010), based on the panel data of German Social and Economic Survey from 1995 to 2006, found that commercial health insurance can significantly promote the self-rated health of German participants. Joan Costa-Font (2021) found that insurance coverage alone may not be sufficient to reduce health disparities, and that health inequalities may depend on other factors unexpected in health care, by examining data from the Mexican Household Life Survey from 2002 to 2009. Kawachi (2002) argue that the analysis of health inequality must take into account the descriptive characteristics (such as gender and race) that appear at birth. In addition, political power, social assets, honorary status and other factors have an impact on health inequality. Katikireddi (2013) argue that attention should be paid to upstream factors with considerable potential, such as education, to reduce health inequalities. 이동성 (2019) used the ordered Logit model and the "2017 Community Health Survey" to study and analyze the impact of individual and regional environmental factors on

health level. The results show that the influence of independent variables on health level varies with the difference of physical health and mental health. Choi Dong Hee and Chae Young Ran (2017) found that income was an important factor affecting the health level of elderly people in rural areas by studying the health level of elderly people in rural areas.

The factors that affect residents' self-rated health have also been studied by many scholars in China. The influencing factors of health inequality mainly include socio-demographic characteristics variables, capital factors, health service utilization and other factors. However, Zhao Wenchuan (2017) proposed that age, job, region, gender and education were the most important influencing factors, followed by family size and living environment. Liu Xiaoting (2014) proposed that the difference in age, education level and urban and rural household registration is one of the factors affecting residents' self-rated health level. Ni Xiuyan and Zhao Jianmei (2014) used quantile regression to confirm the difference in the influence of education on residents with different health status. Zhou Guangsu (2014) found that the expansion of income gap has a significant negative effect on the health level of residents, and social capital has a significant positive effect on the health level of residents, and alleviates the negative impact of income gap on health, which is especially reflected in the rural areas where the security mechanism is not sound. Wang Fuqin (2012) believes that the difference in people's health level mainly comes from the difference in lifestyle caused by the difference in social and economic status. Many scholars have found that there are spatial distribution differences in health inequality among Chinese residents. Du Benfeng and Wang Xuan (2013) found that there were significant differences in the health status of the elderly in different provinces, the eastern region was better, the western region was the worst, and the urban area was better than the rural area. Xie E (2009) uses a more detailed and specific QWB as an indicator to measure health status. Through analysis, it is found that health inequality in China is pro-rich, and the degree of inequality in rural areas is greater than that in urban areas.

In the research on the relationship between commercial medical insurance and health inequality, many scholars have found the importance of commercial health insurance on self-rated health. Qi Zipeng (2019) made use of the data of China Health and Retirement Longitudinal Study, in 2013 and 2015, and found that commercial health insurance has generally improved the health level of the insured population, but this study only analyzed the samples of people over 45 years old. Fan Hongli (2019) found that by analyzing CHNS micro data, commercial health insurance can improve individual health behaviors and residents' health level by promoting individuals' use of medical services. Tian Ling (2014) analyzed the impact of medical insurance on individual health with the data of CHARLS, and the research results supported the health effects of commercial medical insurance and other medical insurance: commercial medical insurance has a significant promoting effect on individual health.

This research will use the data of "2017 China General Social Survey" (CGSS2017) and econometrics methods to empirically test the impact of commercial medical insurance on health inequality, and on this basis, understand the impact of different factors on self-rated health level. The author believes that although the

above-mentioned existing studies have conducted beneficial exploration on the phenomenon of health inequality, there are still some defects in these studies. First of all, existing studies only focus on individual factors affecting health inequality, without comprehensive investigation of multiple factors under the same analytical framework, so the analysis lacks pertinence. Secondly, the Grossman model is rarely used in existing studies to explore health inequality from the perspective of commercial medical insurance. In this paper, the relationship between commercial medical insurance and residents' self-rated health level is established, and multiple influencing factors are put into an analytical framework to comprehensively explore the impact of commercial medical insurance on residents' self-rated health level.

## 2. Data and model

### 2.1 Theoretical model

In 1972, Grossman successfully introduced Becker's household production function into the analysis of health utility function, and constructed the health human capital demand model from it. In a departure from previous demand theories, Grossman emphasized that consumers do not need medical services per se, but rather health. Consumers produce health capital through activities such as purchasing medical services and food, as well as time investments. The demand for medical services is the derived demand of consumers for the production of health.

Grossman examined health as a function of medical services, income, education, age, gender, race, marital status, environmental pollution, and personal behaviors such as smoking, diet and exercise. According to Grossman, there are two reasons why consumers need health: on the one hand, health is a kind of consumer goods, directly into the utility function of consumers, so that consumers are satisfied; On the other hand, health is an investment product that reduces the time lost to market or non-market activities due to disease, and Grossman believes that education has a positive relationship with health. The basic framework of Grossman's model is derived from the utility function of consumers, and its structure is as follows:

$$U = U(\Phi_t H_t, Z_t), t = 0,1,\cdots,n\#(1)$$

Where, $H_t$ is the accumulated health capital stock in period t, $\Phi_t$ is the income of unit health capital, $h_t = \Phi_t H_t$ represents the health consumed in period t, and $Z_t$ represents the quantity of other goods other than health consumed in period t.

After Grossman, many researchers extended the Grossman health human capital model and turned their focus to the research of medical service demand. The construction of the health demand model of commercial medical insurance is inseparable from the existing framework and theory of Grossman's health human capital model. As the derived demand of health demand, the commercial medical insurance service demand model can follow Grossman's existing model, and be modified and improved appropriately. Based on this, this research will take Grossman model as the basis and draw on Andersen, Kasper, Becker and Samuelson's in-depth study on health care demand to construct Grossman's extended model commercial medical service demand model. The author put the variables mentioned in the

Grossman model, such as gender, age, urban and rural areas, and education level, into an analysis framework to comprehensively examine the impact of commercial medical insurance purchase on health inequality.

## 2.2 Data source

Data from the China General Social Survey 2017 (CGSS2017) are used in this paper. The CGSS2017 survey covers urban and rural areas in 28 provinces and municipalities across the country, using multi-stage stratified probability sampling method and household survey. The survey content includes basic information of individuals and families, subjective well-being, family gender roles, cultural consumption and other parts. Since most insurance companies limit the insurance age of commercial medical insurance to below 60 years old, urban and rural residents aged 30 to 60 years old are used in this research. After processing such as removing missing values, this research adopts 6410 respondents tested in this survey as samples.

## 2.3 Variable selection

### *2.3.1 Explained variables*

Since self-rated health level is a comprehensive health indicator that can comprehensively reflect the individual's health status, this paper uses "self-rated health level" as the dependent variable to measure the individual's health status. In this paper, "what do you think your current physical health status is" is selected as a health indicator to evaluate the individual's health level. The values of self-rated health indicators in the CGSS2017 questionnaire ranged from 1 to 5, which represented the respondents' choices of "very unhealthy", "relatively unhealthy", "average", "relatively healthy" and "very healthy" respectively in self-rated health. In this paper, this variable was used to generate dummy variables of "self-rated health level", "very unhealthy" and "relatively unhealthy" were regarded as "unhealthy", with a value of 1; The value of "general healthy" is 2; "relatively healthy" and "very healthy" were considered as "healthy", with a value of 3 (" inapplicable ", "don't know" and "refuse to answer" samples were excluded from the study for better analysis of the influence mechanism).

### *2.3.2 Core explanatory variables*

The main purpose of this research is to investigate the impact of purchasing commercial medical insurance on residents' self-rated health. Therefore, "whether residents have purchased commercial medical insurance" is the core independent variable of this paper. In all the statistical models in this research, commercial medical insurance is a dummy variable, and the value of participating in commercial medical insurance is set as 1 and that of not participating in commercial medical insurance is set as 0.

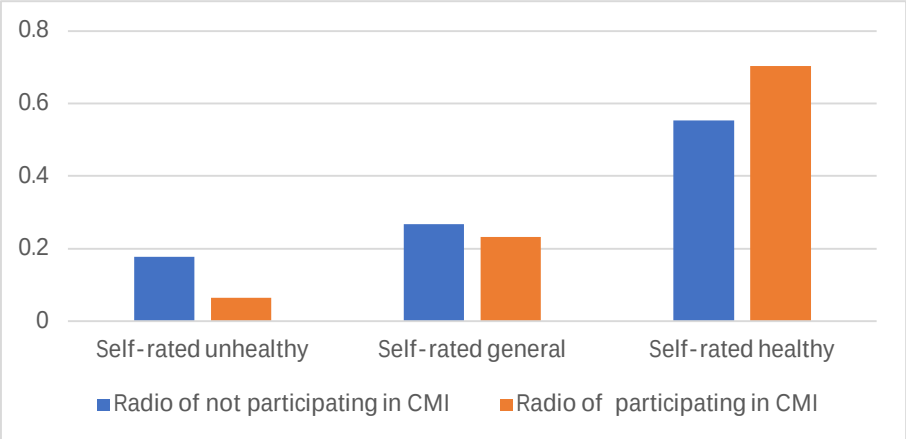


Fig. 1. Impact of commercial medical insurance purchase on self-reported health of respondents

As can be seen from Figure 1, among the self-rated unhealthy interviewees, a large proportion did not purchase commercial medical insurance, while among the self-rated healthy interviewees, a large proportion purchased commercial medical insurance. This indicates that the purchase of commercial health insurance or not has an impact on the self-reported health level of respondents.

*2.3.3 Control variables*

According to the Grossman model and existing literature, the main factors affecting residents' self-rated health level include gender, household registration status (urban and rural), age, education level, etc. Therefore, The control variables in this research include the gender, household registration status (urban and rural), age, education level, number of children, personal annual income, economic belt, marital status, political status and well-being level of the interviewees.

Gender. Gender is one of the factors that may cause differences in commercial health insurance among residents with different health levels. In this research, gender is a dummy variable, and female value is 1, male value is 0.

Household registration status. Due to China's urban-rural dual social structure, there are huge differences in economy, society and culture between urban and rural areas. It is an indisputable fact that the gap between urban and rural areas in commercial medical insurance leads to health inequality. Rural areas lag behind urban areas in financial and economic knowledge level. In this research, household registration is a dummy variable, and the value of rural household registration is 1.

Age. Age is a widely considered influence factor in the literature on self-rated health. Different age groups have different evaluations on the health level of commercial medical insurance, and because the insurance company limits the age of commercial

medical insurance, we choose the group aged 30-60 as the research object. In this research, age was a categorical variable.

Levels of education. Since education was not free and compulsory until 1990, the level of education received by different groups varies. The higher the education level, the smaller the difference in the commercial medical insurance under the health inequality. In this research, education level is a numerical variable.

Kid. The family planning policy was set as China's basic national policy in 1982. Since the implementation of this national policy, China's population has been controlled. However, as the traces of traditional thoughts are difficult to eliminate in a short time, the number of children has different effects on the self-rated health level of different groups. In this research, the number of children is a numerical variable, and the result of more than 3 children is uniformly assigned as 3.

Income. Since the reform of personal income, China's economy has developed rapidly, and residents' personal income has continued to rise. At the same time, personal income has become one of the most important factors affecting respondents' self-rated health. In this research, we chose the logarithm of respondents' personal annual income to replace the effect of income on self-rated health. To smooth things out, we add 1 to each individual's annual income and take the logarithm.

Economic Belt. Due to the different location of economic belt, the resources attached to the geographical location are also different, the residents of the developed area and the less developed area have different evaluation of their health level. In this research, the economic belt is a classification variable, the western economic belt =1, the central economic belt =2, and the eastern economic belt =3.

Marital status. Marital status is one of the necessary factors to consider in the literature on health inequalities. Being married or not had a significant impact on respondents' self-rated health status. In this research, marital status is a dummy variable. A first marriage with a spouse, a remarriage with a spouse, and a separation without divorce are considered married and assigned a value of 1; otherwise, they are considered unmarried and assigned a value of 0.

Political status. In China, Party members are synonymous with advanced members, and the membership of Party members represents honor and glory. From this perspective, the membership of Party members will have an impact on the self-rated health status of interviewees. In this research, political affiliation is a dummy variable, interviewees are party members =1, otherwise =0.

Well-being level. Well-being level is the subjective evaluation of the respondents on their current living conditions, which is similar to the self-rated health level. In this research, the indicators of whether the interviewees are happy or not are adopted, i.e. unhappy =1, general =2, and happy =3.

Please refer to Table 1 for the definition and descriptive statistics of variables used in the data analysis part of this paper.

Table 1. Definition and descriptive statistics of variables

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Self-rated health | 6410 | 2.413 | 0.753 | 1 | 3 |
| Female | 6410 | 0.534 | 0.499 | 0 | 1 |
| Age | 6410 | 1.929 | 0.812 | 1 | 3 |
| Rural | 6410 | 0.55 | 0.498 | 0 | 1 |
| Education | 6410 | 9.622 | 4.249 | 0 | 19 |
| Kid | 6410 | 1.496 | 0.759 | 0 | 3 |
| Ln Income | 6410 | 8.7 | 3.737 | 0 | 16.111 |
| Region | 6410 | 2.152 | 0.711 | 1 | 3 |
| Married | 6410 | 0.885 | 0.319 | 0 | 1 |
| Party | 6410 | 0.097 | 0.296 | 0 | 1 |
| Well-being | 6410 | 2.666 | 0.641 | 1 | 3 |
| CMI | 6410 | 0.143 | 0.35 | 0 | 1 |

## 2.4 Model setting

Since the explained variable residents' self-rated health level is a multi-classified and Ordered variable, this research adopted the Ordered Logit model to conduct an empirical analysis on the impact of commercial medical insurance on residents' self-rated health level.

In Ordered Logit prediction model, the observed value of explained variable $y_i$ is the ordering result, and the value of $y_i$ is 1 (self-rated unhealthy), 2 (self-rated general), and 3 (self-rated healthy). The independent variable $x_i$ is the influencing factors of the value of dependent variable $y_i$, and multiple dependent variables $x_i$ may explain the value result of dependent variable $y_i$. The dependent variable yi can be a linear representation of multiple independent variables xi, then the linear equations of the dependent variable $y_i$ with respect to the dependent variable $x_i$ can be obtained. Based on the above explanation, the general form of the ordered Logit prediction model is as follows:

$$y^* = X\beta + \varepsilon, \varepsilon | X \sim Logit(0,1) \#(2)$$

Where, y represents the explained variable; y* is the representation of the latent variable corresponding to y; X is the vector of the dependent variable $x_i$; β represents the estimated coefficient of the dependent variable $x_i$, that is, the degree to which each dependent variable $x_i$ explains the dependent variable y; ε represents the random error term, it means that ε represents the addition of other factors not considered in this model for the time being, and ε is subject to Logistic Distribution.

Let $w_i$, i = 1,2,3 be the Cutoff Point. Since y value depends on the comparison relationship between y * and Cutoff Point, y value can be expressed as:

$$y = \begin{cases} 1, y^* \le w_1; \\ 2, w_1 \le y^* \le w_2; \\ 3, y^* \ge w_2; \end{cases} \#(3)$$

Where, y=1,2,3 represent the actual meaning of self-rated unhealthy, self-rated general, and self-rated healthy in order. According to the above y value and the conditional probability knowledge in mathematics, the probability value of respondents' self-rated health level can be obtained as follows:

$$\begin{cases} P(y=1|X)=P(y^*\le w_1|X)=\varphi(w_1-X\beta) \\ P(y=2|X)=P(w_1<y^*\le w_2|X)=\varphi(w_2-X\beta)-\varphi(w_1-X\beta) \\ P(y=3|X)=P(y^*>w_1|X)=1-\varphi(w_2-X\beta) \end{cases} \#(4)$$

Where, f(x) is the Logistic Distribution function. The estimation parameters in the expression can be estimated by the maximum likelihood method. In the ordered Logit model, the economic meaning of the coefficient term is not intuitive, and only contains the statistical significance and action direction information of explanatory variables. Therefore, by calculating the marginal effect of each variable, the degree of influence of each explanatory variable on the dependent variable is further obtained.

## 3. Empirical Analysis

### 3.1 Analysis of basic regression results

First, the statistical software Stata was used to analyze the whole sample, and the regression results in Table 2 were obtained. From the empirical results, in this research, the number of kids, political status and household registration status differences did not have a significant impact on the health inequality of respondents.

If we choose a significance level of 5%, we find that gender, age, education level, logarithm of personal annual income, economic belt, marital status, and well-being level have significant effects on respondents' self-reported health.

Firstly, the self-rated health probability of females is lower than that of males, which may be due to the fact that females have to bear more pressure from taking care of family and raising children than males, and females have a lower self-rated health probability than males.

Secondly, the age variable and the variable of years of education are significant at the 1% significance level, which indicates that the older the group with more years of education, the higher the probability of its self-rated health level being "healthy". On the one hand, middle-aged people have more time to focus on their health because their work and family are already on track than when they are busy balancing work and family in their youth. On the other hand, with the increase of the number of years of education, this group obtains more abundant social resources, which has a positive impact on their self-rated health.

Table 2. Regression results of influencing factors of self-rated health level

| Variable | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Female | -1.114** | 0.116** | -0.111** | -0.111** |
| | (0.054) | (0.054) | (0.054) | (0.543) |
| Age 40-50 | 0.555*** | 0.550*** | 0.554*** | 0.550*** |
| | (0.060) | (0.060) | (0.060) | (0.060) |
| Age 50-60 | 1.041*** | 1.031*** | 1.037*** | 1.034*** |

| | | | | |
|---|---|---|---|---|
| | (0.069) | (0.069) | (0.069) | (0.069) |
| Rural | -0.096 | -0.085 | -0.086 | -0.085 |
| | (0.065) | (0.065) | (0.065) | (0.065) |
| Education | 0.040*** | 0.038*** | 0.042*** | 0.038*** |
| | (0.008) | (0.008) | (0.008) | (0.008) |
| Kid | -0.057 | -0.057 | -0.056 | -0.057 |
| | (0.039) | (0.039) | (0.039) | (0.039) |
| Ln Income | 0.056*** | 0.056*** | 0.056*** | 0.056*** |
| | (0.007) | (0.007) | (0.007) | (0.007) |
| Region central | 0.488*** | 0.479*** | 0.483*** | 0.480*** |
| | (0.073) | (0.073) | (0.073) | (0.073) |
| Region eastern | 0.388*** | 0.384*** | 0.383 *** | 0.384*** |
| | (0.072) | (0.072) | (0.072) | (0.072) |
| Married | 0.184** | 0.184** | 0.177** | 0.120 |
| | (0.083) | (0.083) | (0.083) | (0.088) |
| Party | 0.154 | 0.151* | 0.159 | 0.151 |
| | (0.099) | (0.099) | (0.098) | (0.099) |
| General happy | 0.517*** | 0.514*** | 0.505 | 0.519*** |
| | (0.100) | (0.100) | (0.100) | (0.100) |
| Very happy | 1.266*** | 1.259*** | 1.253 | 1.262*** |
| | (0.086) | (0.087) | (0.866) | (0.087) |
| CMI | | 0.183** | 0.725*** | -0.250 |
| | | (0.082) | (0.261) | (0.216) |
| CMI*Education | | | -0.047** | |
| | | | (0.021) | |
| CMI*Married | | | | 0.495** |
| | | | | (0.230) |
| cut1 | 0.898 | 0.883 | 0.922 | 0.838 |
| | (0.162) | (0.163) | (0.164) | (0.164) |
| cut2 | 2.436 | 2.423 | 2.463 | 2.378 |
| | (0.165) | (0.165) | (0.167) | (0.167) |

Note: 1. The figures in parentheses are Standard Errors

2.*** p<0.01, ** p<0.05, * p<0.1 (two-tailed test)

Thirdly, we can see that the logarithm of personal annual income and the economic belt in which the interviewee is located are also significant at the 1% significance level. That is to say, the higher the income level, the more developed the economic belt in which the interviewee is, the higher the probability of his/her self-rated health being healthy is, which is not difficult to understand. Low-income people may be so busy trying to improve their income that they tend to neglect their health status, while high-income people may spend extra money on their health care to make sure they are in good health and thus continue to improve their income. The more developed the economic belt is, the stronger the health awareness of its residents will be, and they

will pay more attention to their own health. Therefore, this group has a high probability of self-rated health as "health".

Fourthly, from Table 2, we can see that the variables of marriage status and self-rated well-being level significantly improve the probability of respondents' self-rated health being "healthy". In addition, participating in commercial health insurance can also have a significant impact on the self-rated health of respondents. Generally speaking, after purchasing commercial medical insurance, respondents have less concern about the possibility of suffering from serious diseases in the future and being unable to pay the high medical expenses, which will have a positive impact on their self-rated health at present.

### 3.2 Robustness test

In order to further verify the effect of purchasing commercial health insurance on health inequality, this paper also tests the robustness of the model by changing the estimation method. Because the explained variables in this study are Ordered qualitative variables, Ordered Probit model was adopted to conduct robustness test on the models (1) and (2) in the table 2. The regression results in Table 3 show that the regression results of the Ordered Probit method are similar to the original results in significance, and the replacement of the estimation method does not change the regression results of the basic model. This shows that the regression results of the basic model are robust.

Table 3: Results of Ordered Probit Regression on Influential Factors of Self-rated Health Level

| Variables | (1) | (2) |
|---|---|---|
| Female | -0.062* | 0.116** |
| | (0.032) | (0.054) |
| Age 40-50 | 0.338*** | 0.550*** |
| | (0.036) | (0.060) |
| Age 50-60 | 0.627*** | 1.031*** |
| | (0.040) | (0.069) |
| Rural | -0.054 | -0.085 |
| | (0.039) | (0.065) |
| Educ | 0.025*** | 0.038*** |
| | (0.005) | (0.008) |
| Kid | -0.023 | -0.057 |
| | (0.039) | (0.039) |
| Lnincome | 0.034*** | 0.056*** |
| | (0.004) | (0.007) |
| Region mid | 0.295*** | 0.479*** |
| | (0.043) | (0.073) |
| Region east | 0.233*** | 0.384*** |
| | (0.043) | (0.072) |
| Married | 0.110** | 0.184** |
| | (0.083) | (0.083) |

| | | |
|---|---|---|
| Party | 0.098* | 0.151* |
| | (0.058) | (0.099) |
| General happy | 0.310*** | 0.514*** |
| | (0.060) | (0.100) |
| Very happy | 0.749*** | 1.259*** |
| | (0.052) | (0.087) |
| CMI | | 0.183** |
| | | (0.082) |
| cut1 | 0.548 | 0.883 |
| | (0.097) | (0.163) |
| cut2 | 1.456 | 2.423 |
| | (0.098) | (0.165) |

Note: 1. The figures in parentheses are Standard Errors

2.*** p<0.01, ** p<0.05, * p<0.1 (two-tailed test)

### 3.3 Endogeneity test

There may be some endogeneity problems in the research of commercial medical insurance under the condition of health inequality. On the one hand, there may be omission of variables, and on the other hand, there may be directional causality. In order to solve the above-mentioned possible directional causality problems, this study adopts the propensity score matching (PSM) method for estimation, matching all the control variables in the basic regression. In order to avoid the impact of a single matching method on the regression results, three matching methods, including the K-nearest neighbor matching, Nearest neighbor matching and Radius matching, were adopted in this study to study the impact of purchasing commercial medical insurance on health inequality.

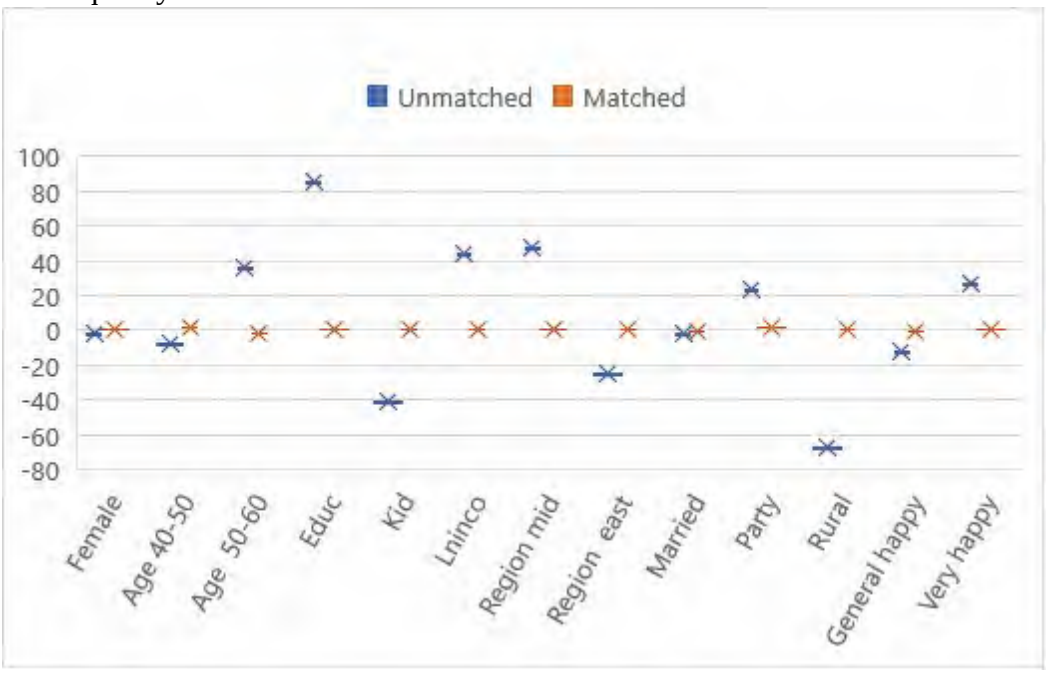


Fig. 2. Graph of standardized bias across covariates in the K-nearest neighbor matching

In this research, three methods of matching all passed the balance to the test, after the matching standardized bias across covariates less than 10%,take an example of K-nearest neighbor matching (Fig.2.) , and the p-value was significantly greater than 0.1, it's rejected "no obvious difference was found between the control group and experimental group" of the original hypothesis, matching results well meet the requirements of the balance, after the match variable degree of fitting better than they did before the match. Results of propensity score matching are shown in Table 4.

Table 4. Matching results of propensity scores

| Explained variables | Explanatory variables | K-nearest neighbor matching | | Nearest neighbor matching with caliper | | Radius matching | |
|---|---|---|---|---|---|---|---|
| | | ATT | T value | ATT | T value | ATT | T value |
| CMI | Other Control Variables | 2.23*** | 0.074 | 2.45*** | 0.062 | 2.23*** | 0.074 |

### 3.4 Heterogeneity analysis

In order to further analyze the impact of commercial medical insurance purchase on health inequality, this research introduced two interaction terms based on the basic model to study the heterogeneity of the impact of commercial medical insurance purchase on health inequality. The regression results are shown in Table 2.

Firstly, this research added the interaction item between commercial medical insurance and years of education on the basis of the basic model, with the purpose of testing the difference of the impact of commercial medical insurance on years of education under the condition of health inequality. It can be seen that the interaction term coefficient between commercial medical insurance and education level is -0.047, and it is statistically significant (P-value<0.05), which indicates that under the condition of health inequality, whether you participate in commercial medical insurance has a certain influence on the years of education. After controlling for other factors, for each additional year of education, those with commercial health insurance were 9.7% less likely to be healthy than those without. This seems to contradict our stereotype, but it can be explained in another way. The higher the education level of the group, the essence is likely to be basic health insurance in effect. To town worker, their basic medical insurance guarantee scope is widest, compensation rate is highest. Therefore, the role of basic medical insurance for urban workers on medical service demand is obviously higher than that of other insurance forms. Based on the VAR model, Li Yaguo (2017) concluded that the impact of social insurance on commercial medical insurance varies in different periods, showing an inhibiting effect in the short term and a promoting effect in the long term. Under these circumstances, it is not difficult to understand that participation in commercial health insurance has a weak impact on respondents' self-rated health level.

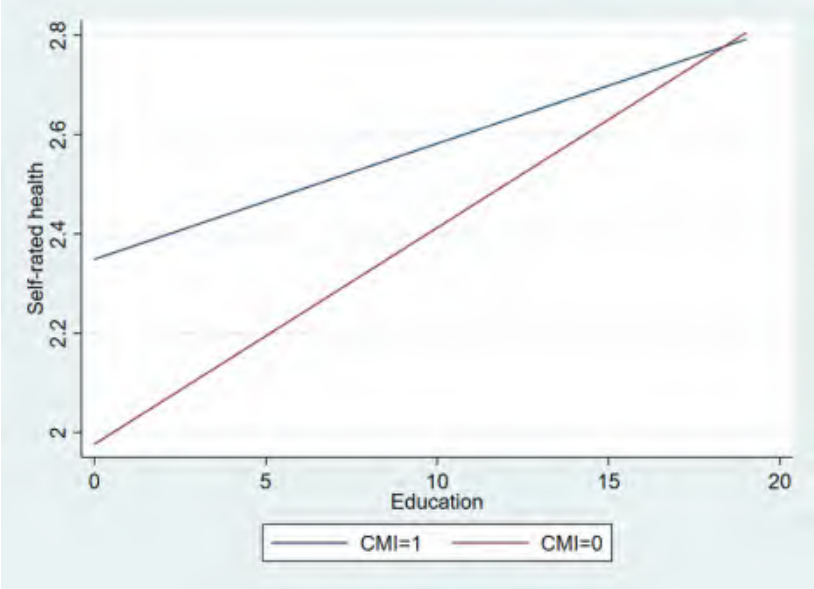


Fig. 3. The moderating effect of education level on participating in commercial medical insurance

Secondly, marital status differences in commercial medical insurance participation were estimated. It can be seen that the interaction term coefficient between commercial medical insurance and marital status is 0.495, and it is statistically significant (P-value <0.05), which indicates that the participation of commercial medical insurance in the context of health inequality has a certain influence on marital status. After controlling for other factors, married individuals with commercial health insurance were calculated to be 10.4% more likely than unmarried individuals to self-report their health. This may be because at the wedding, commercial medical insurance to share the future may be suffering from serious illness psychological risks, and for unmarried group, in addition to prevent future possible health risks, and such as the pressure from family, so even if the group to insure the commercial medical insurance, the probability of their self-reported health than married group probability is low.

## 4. Conclusion

Using data from the China General Social Survey 2017 (CGSS2017), this study examines the impact of commercial health insurance coverage under health inequality, and examines specifically whether the effects of factors affecting health status are affected by commercial health insurance coverage or not. The research findings of this paper can be summarized as follows:

Firstly, among people aged 30 to 60, participation in commercial medical insurance, gender, age, education level, personal annual income, location of economic belt, marriage and happiness have significant effects on self-rated health status, which is consistent with Grossman's model.

Secondly, years of education and marital status had moderating effects on self-reported health status of respondents. For each additional year of education, the

likelihood of health in the group with commercial health insurance was 9.7% lower than that in the group without commercial medical insurance, and the likelihood of health in the group with commercial medical insurance was 10.4% higher than that in the group without commercial medical insurance.

The author believes that the results of this research will help us to understand the long-term impact of commercial medical insurance on health inequality in China more comprehensively and deeply. Based on the results of the data analysis in this paper, we can infer that many factors, such as the long-term expansion of education in China (the increase of per capita education level in China), have contributed to the self-assessment of health status of residents. Accordingly, this paper draws the following enlightenment.

Policy perspective. Health is the right of everyone and an important indicator for the sustainable development of a nation and a country. In order to better promote the "Healthy China" strategy and improve the health level of the whole people, how to deal with the health inequality is the key. We already know that participating in commercial medical insurance, education level, and marital status are powerful explanations for health inequality, and that socioeconomic circumstances, political processes, and other factors largely determine a population's education, income, and other health risks. Therefore, to improve this inequality requires a high level of policy intervention.

Commercial medical insurance underwriting institution perspective. As an important part of medical security system, commercial medical insurance plays a positive role in the health status of residents. But at present, the most prominent problem of commercial medical insurance is the high price and low level of security. The price of medical insurance is beyond people's reach, but many insurance companies operating in this business still lose money. Insurers should perhaps strengthen the construction of commercial medical insurance talent team, strengthen personnel exchanges with foreign commercial medical insurance undertakers, learn from their successful experience, and apply it into practice according to local conditions. In addition, insurers can also manage the whole process of health risks, focusing on strengthening pre-illness preventive care services, which can not only reduce the probability of insurance payment, but also become a bright spot to attract consumers.

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# The Impact of the Long-term Care Insurance Policy on the Health Level of Middle Age and Elderly People

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**Keywords:** LTCI, Middle-aged and Elderly People, Health level, CHARLS, DID

**Abstract:** Objective: To explore the impact of the implementation of long-term care insurance(LTCI) on the physical and mental health indicators of the middle-aged and elderly people in the pilot areas and the level of impact. Method: Using the 2015 and 2018 China Health and Retirement Longitudinal Study (CHARLS) data, Difference-in-Differences(DID) was established to identify the five health indicators of LTCI: self-reported health, ADL (Activities of Daily Living) ), IADL

(Instrumental Activity of Daily Living), CES-D (Center for Epidemiological Studies-Depression) and health satisfaction. Results: The analysis results showed that LTCI significantly improved the self-reported health status and depression level of the middle-aged and elderly people, and optimized the self-care ability and health satisfaction in daily life. However, the impact of key instrumental skills in their community life is not significant. Conclusion: In view of the poor degree of optimization of instrumental daily activities of middle-aged and elderly people by LTCI, we believe that it is necessary to promote the organic integration of formal care and informal care, improve the core skills of nursing staff, and further promote differentiated long-term care packages.

## 1. 引言

伴随着全球人口老龄化水平的加剧，上世纪 60 到 70 年代，荷兰和美国等国家就先后开始了长期护理保险(Long-term Care Insurance,LTCI)的探索。1995 年，德国率先建立了系统化的 LTCI 制度，很大程度上满足了人群的长期护理（Long-term Care,LTC）需求，改善了人群健康水平[1]。而我国的调查数据显示：截至 2019 年底，失能半失能人员超 4000 万，其中有 20%左右（即 800 万）为中老年（年满 45 周岁）失能人员[2]。如此庞大的中老年失能人群必然给失能家庭及社会带来沉重的经济负担和事务性压力。与此同时，中老年失能人群还面临精神慰藉服务严重不足的问题，其中农村中老年人精神孤独问题尤为突出，导致心理健康长期受影响[3]。面对如此严重的中老年失能问题，2016 年 7 月，国家人社部印发了《关于开展长期护理保险制度试点的指导意见》（下简称“《试点意见》”），决定选择青岛、重庆等 15 个地区开展长期护理保险（下简称为“长护险”）试点。在取得初步成效的基础上，2020 年 9 月，国家医保局会同财政部联合印发了《关于扩大长期护理保险制度试点的指导意见》，决定进一步扩大试点范围，新增试点城市 14 个，更加公平可持续的社会保障体系将因此而进一步完善[4]。长护险试点四年多来，取得了哪些成效？还存在哪些问题？一直为学界所关注。

从发展现状来看，长护险试点取得的成效可谓有目共睹。围绕政策实施的效果，学界从制度建设、相关产业的发展、医疗费用和健康等角度开展了广泛而又深入的探讨。从制度建设视角出发，郑秉文等通过比较 15 个试点地区的保障范围、受益规模、筹资渠道异同，并借鉴国内外的先进经验提出了一系列针对性建议[5-7]。同时，蒋曼等从医疗护理服务、健康保险、健康管理的角度，评价 LTCI 对老年服务产业的影响。研究证实了 LTCI 的推进对框架内人才、医疗机构、健康管理等多产业的发展有积极作用[8]。此外，关于 LTCI 对于医疗费用的影响则存在争议，于新亮等认为长护险会导致基层医疗机构的医疗费用显著上升，Jin Feng 等则认为长护险能够显著降低住院天数和医疗保险支出，成本效益分析显示每增加 1 元 LTCI 投入，医保支出将减少 8.6 元[9-11]。

不论是制度建设、产业发展还是费用或哪些角度，LTCI 的最终落脚点一定是提高人群健康水平。因此也有很多学者关注于长护险是否有助于改善人群的

健康水平。Buscher[12]等人的研究发现，德国长护险能够显著改善受益人群的身体健康水平，特别是接受良好家庭护理的人群改善更为明显。Choi[13]等人利用Cox 回归模型，识别服务利用率对死亡风险比的影响，调整协变量后，证实韩国长护险受益人群死亡的危险比率明显低于非受益人群,同时也改善了 65 岁及以上老年人群的总体健康水平。日本学者利用老年人日常生活自理能力指标（ADL：Activities of Daily Living)、老年人工具性日常活动能力指标（IADL：Instrumental Activity of Daily Living）研究显示，长护险项目可以显著改善日本老年男性的功能性残疾发生率[14-16]。Lee 等采用倾向得分匹配方法，进行配对样本 Student’s t-test 检验和 Logistic 回归分析，比较了韩国长护险护理和个体护理 1 年内认知功能、行为症状和身体功能的变化，发现中老年人在长护险护理组中认知功能和残疾水平下降较低[17, 18]。就我国而言，长护险作为社会保障网络的重要一环，其作用与其他社会保险一样毋庸置疑。如在医疗保险领域，多项研究证实其对中老年人群健康起正向促进作用[19]。2013 年利用城镇居民基本医疗保险试点评估入户调查数据(URBMIS 数据)的研究发现，医疗保险提高了参保者卫生服务利用，进而促进了参保居民的健康水平[20]。还有研究通过细化 CHARLS 数据，从身体机能健康和心理健康两个维度，证明了医疗保险对中老年人健康有显著作用[21]。也有个别研究使用地区性样本，构建双重差分模型（DID）发现，LTCI 作为医疗保险重要补充，在医疗费用的控制的同时，不仅没有损害中老年人群的健康，还在一定程度上还改善了精神健康水平，减少了身体疼痛的状况[9]。然而，这方面的研究还较少，尤其是 2016 年我过才开始推行长护险政策的试点工作，政策实施效果仍不明确，因此还有待做进一步的强化和补充。本文基于 2016 年的全国性长护险政策，利用 2015、2018 年中国健康与养老追踪调查（CHARLS）数据，分析长护险政策对中老年人群健康的影响。

## 2.方法

### 2.1 数据来源

本研究以 2015、2018 年中国健康与养老追踪调查（CHARLS）数据库为数据来源。CHARLS 是一项代表中老年人个人及其家庭基本情况的微观数据。调查内容包括基本信息、健康状况和功能、医疗保险、退休和养老金等，是一项为研究老龄化问题提供数据基础的全国性调查[22]。CHARLS 首次调查开始于 2011 年，调查范围覆盖 150 个县级单位，450 个村级单位。2020 年 9 月 23 日，CHARLS 第四期（2018 年）全国追访数据正式发布。CHARLS 数据是公开可用的，因此本文不需要伦理批准。当然，数据获取需要在其网站（http://charls.pku.edu.cn）上进行注册申请，本文的获取账户是 c_chores@163.com。

首先，通过原始数据识别受访者的所在城市，并根据《试点意见》确定的国家试点城市和各地市政府网站政策文件数据检索结果，将所有样本城市分为“国家试点城市”、“自行探索城市”、“从未实施城市”三类。并剔除只有一次受访记录的样本，剔除基本信息异常的数据。其次，剔除地市政府自行探索长

护险制度的城市；仅保留国家试点城市以及从未进行任何长护险探索的地市，以此分析长护险政策对结局变量产生的净效应。最后经过以上数据筛选后的样本其纳入模型的基期样本量（具体见图 1）。

利用 CHARLS 数据库研究长护险实施效果的优势在于：第一，调查对象符合研究需求。CHARLS 数据是面对 45 岁以上中老年人的调查，符合长护险保障的目标人群要求。第二，调查内容契合研究目标。本文关注的是长护险对健康水平及医疗费用的影响，而 CHARLS 中有专门针对健康水平、ADL、IADL、抑郁自评量表（CES-D：Center for Epidemiological Studies-Depression）和健康满意度等指标。第三，数据节点吻合研究要求。对长护险实施具有强干预作用的是 2016 年 6 月发布的长护险政策。试点政策的颁布时间处于 2015 年之后，2018 年之前。因此双重差分法刚好适用于本研究的设定要求。

## 2.2 变量选择

### 2.2.1 健康水平相关指标

长护险以改善人群健康水平为目标，为保障人群提供生活照料、医疗护理服务以及给予一定的经济补偿[5]。学者们在利用 CHARLS 数据库做人群健康水平相关的研究时，多采用 ADL、IADL、CES-D 指标[23, 24]。ADL 指标一般用于评估人们为了维持生存及适应生存环境，而每天必须反复进行的、最基本的、最具有共性的活动能力，是康复医学中最基本和重要的内容。IADL 指标用于评估人们在社区中独立生活所需要的关键性的、要求较高的技能。CES-D 指标是由美国国立精神卫生研究所研制，用于筛查抑郁人群或评定抑郁程度的指标。除上述三个指标外，本文还将选用受访者的自评健康和健康满意度打分，共 5 个指标反应中老年人群的健康水平[25]。

自评健康状况能够反应中老年人群的健康状况。CHARLS 中，对“您认为您的健康状况怎样？”的选项，即“很好；好；一般；不好；很不好”依次从 4-0 分进行赋值[19]。

CHARLS 中，针对失能人群的身体功能障碍指标包括 ADL 和 IADL 两项指标，这两项指标为失能人群提供了有效的健康衡量标准[26, 27]。ADL 与 IADL 指标的选项均为四项，分别为：“没有困难；有困难但仍可以完成；有困难，需要帮助；无法完成 ”，对四个选项从 3-0 分依次赋值[28]。

心理健康也是个人健康的重要组成部分[29]。CHARLS 将反应抑郁水平的 CES-D 指标纳入评估指标体系，对其中的十个问题设定四个选项，分别为“大多数的时间（5-7 天）;有时或者有一半的时间（3-4 天）;不太多（1-2 天）;很少或者根本没有（<1 天）”，将第 3 个及第 8 个问题从 3-0 分依次赋值，其余 8 个问题从 0-3 分依次赋值[30]。

满意度相关指标在 CHARLS 中的相关问题是“您对您的健康满意吗？”，其选项为“极其满意；非常满意；比较满意；不太满意；一点也不满意”五项，依次从 5-0 分进行赋值[31]。

### 2.2.2 控制变量

通过查阅文献，将年龄、性别、城乡差异、婚姻状况、受教育程度、参保类型[27, 32]等，可能会对中老年人群健康水平产生影响的变量纳入研究范围。性

别、城乡差异、婚姻状况、参保类型选择使用 0、1 变量，受教育水平从 0-6 进行赋值（具体见表 1）。

表 1 变量定义与赋值表

| 项目 | 指标 | 赋值说明 |
|---|---|---|
| **自评健康状况** | 健康状况怎么样 | 很好=4；好=3；一般=2；不好=1；很不好=0 |
| **老年人日常生活自理能力（ADL）** | 穿衣服<br>洗澡<br>吃饭<br>上下床<br>上厕所<br>控制大小便 | 没有困难=3；有困难但仍可以完成=2；有困难，需要帮助=1；无法完成=0 |
| **老年人工具性日常活动能力（IADL）** | 做家务<br>做饭<br>去商店<br>拨打电话<br>吃药<br>管钱 | 没有困难=3；有困难但仍可以完成=2；有困难，需要帮助=1；无法完成=0 |
| **抑郁自评量表(CES-D)** | 我因一些小事而烦恼<br>我在做事时很难集中精力<br>我感到情绪低落<br>我觉得做任何事都很费劲<br>我感到害怕<br>我的睡眠不好<br>我感到孤独<br>我觉得我无法继续我的生活 | 大多数的时间=0；<br>有时或者说有一半的时间=1；<br>不太多=2；<br>很少或者根本没有=3 |
| **健康满意度** | 我对未来充满希望<br>我很愉快<br>您对您的健康满意吗 | 大多数的时间=3；<br>有时或者说有一半的时间=2；<br>不太多=1;很少或者根本没有=0<br>极其满意=4；非常满意=3；<br>比较满意=2；不太满意=1；<br>一点也不满意=0 |
| **社会人口学变量** | 性别 | 男性=1；女性=0 |
| | 城乡差异 | 农村=1；城镇=0 |
| | 婚姻状况 | 在婚=1；不在婚=0 |
| | 受教育程度 | 小学未毕业=0；小学毕业=1；初中毕业=2；高中毕业=3；中专毕业=4；大专毕业=5；本科及以上=6 |
| | 是否参保 | 是=1，否则=0 |

## 2.3 统计方法

本文数据来源为 CHARLS2015 年与 2018 年两期调查数据，连续变量使用 Student’s t-test 检验，分类变量使用 Pearson’s chi-squared 检验，比较从未实施 LTCI 地区和国家试点 LTCI 地区健康相关变量的差异。建立双重差分模型，用以分析长护险政策对中老年人群健康水平的影响[33]。由于长护险试点开始于 2016 年，因此，本文根据 2016 年确定的 15 个试点地区以及受访人群所在地政府官网，判断该地区是否为国家试点地区或从未实施地区，以此划分控制组与政策干预组[34]。具体而言，本文的控制组为从未进行长护险探索的地区，处置组为国家指定的长护险试点地区。双重差分回归模型为：

$$Y_{it} = \beta_0 + \beta_1 Treat_i + \beta_2 After_t + \beta_3 Treat_i \times After_t + e_{it} \quad (1)$$

式（1）中，i 代表个体，t 代表年份，$Y_{it}$为被解释变量，代表个体 i 在 t 年的健康状况。$Treat_i$是分组的虚拟变量，如果个体 i 为国家试点地区，则 $Treat_i$=1；否则 $Treat_i$=0。$After_t$是试点期的虚拟变量，如果年份 t 在处置事件发生之后，即 2018 年，则 $After_i$=1；否则 $After_i$=0。$\beta_0$代表未探索地区长护险试点前的中老年人群健康水平均值，$\beta_1$代表未探索地区与国家试点地区长护险试点前的中老年人群健康水平差异，$\beta_2$代表探索地区在长护险试点后的中老年人群健康水平变化，$\beta_3$代表长护险试点对中老年人群健康水平的影响。双重差分法系数说明如表 2 所示。

表 2 双重差分法系数说明表

| | 从未实施城市 | 国家试点城市 | 横向差异 |
|---|---|---|---|
| 2015 年 | $\beta_0$ | $\beta_0+\beta_1$ | $\beta_1$ |
| 2018 年 | $\beta_0+\beta_2$ | $\beta_0+\beta_1+\beta_2+\beta_3$ | $\beta_1+\beta_3$ |
| 纵向差异 | $\beta_2$ | $\beta_2+\beta_3$ | $\beta_3$ |

简单的双重差分回归模型只控制了个体和时间的固定效应，隐含的假设是试点地区和探索地区随时间变化在同一时间上的变化是相同的。因此，在分析过程中为了更好地控制其他因素对中老年人群健康产生的影响，应进一步加入其他可观测的随时间变化的控制变量 $\mathbf{X}_{it}$，以降低估计值的方差。模型形式为：

$$Y_{it} = \beta_0 + \beta_1 Treat_i + \beta_2 After_t + \beta_3 Treat_i \times After_t + \gamma \times X_{it} + e_{it} \quad (2)$$

构建模型中包含交互项。为避免自变量之间高度相关性问题而导致系数估计值不可靠，为此本文在回归前通过方差膨胀因子得到变量之间的依赖程度，判断是否同时满足最大的 VIF(variance inflation factor)大于 10 和 VIF 平均值大于 1 的标准，从而进行多重共线性的诊断。同时考虑到 DID 的主要挑战是平行趋势假设，但鉴于样本数据为两期面板数据，因此考虑建立伪改革模型。仅纳入从未实施地区，以产生随机数的方式，选取排名前 15 个未探索地区，并赋值为 1，其余未探索地区赋值为 0，测试“平行趋势”假设。在回归模型中，根据因变量自评健康、ADL、IADL 和健康满意度定序变量特点和 CES-D 连续变量特点，依次采用 order logit 和 pooled 进行回归，分析长护险试点对自评健康、ADL、IADL、CES-D 和健康满意度的影响。$P$<0.05 被认为具有统计学意义。统计

分析使用 Windows 版 Stata 15 版软件。

## 3 实证结果分析

### 3.1 人口学特征分析

通过数据整理发现 2015 年和 2018 年 CHARLS 数据库中，调查城市均为 126 个，调查人数分别为 21069 人和 19816 人。匹配两期数据 ID 后发现两年数据库共涉及 22766 人。保留 CHARLS 中有受访记录的国家试点城市 12 个，从未实施长护险的城市 92 个。最终本研究纳入 104 市，样本量共计 14709 人，29418 条数据。

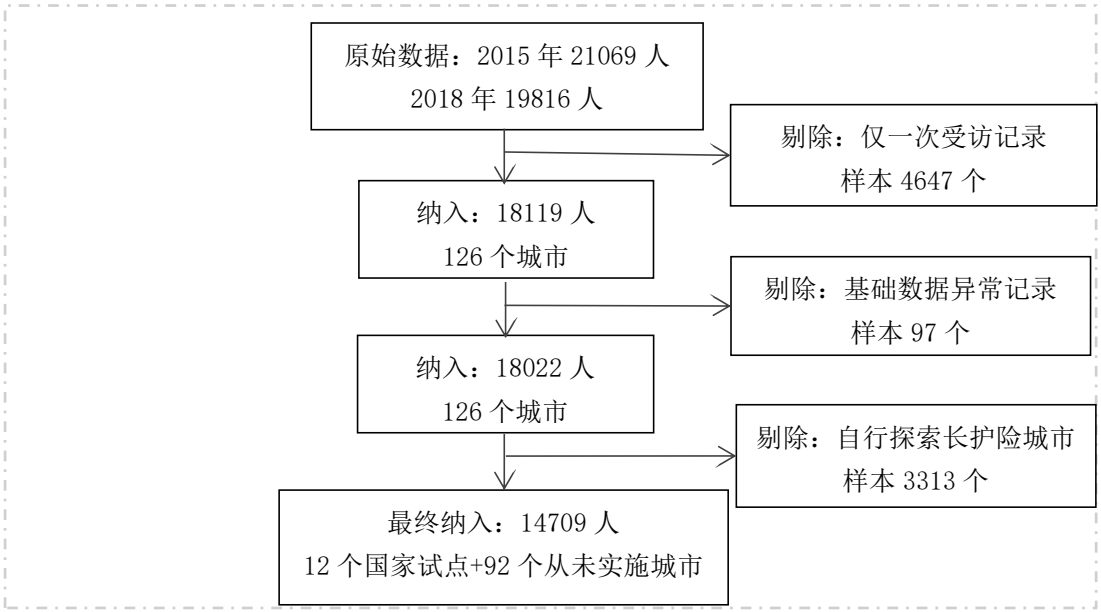


图 1 数据筛选流程图

通过数据统计发现，调查对象中从未实施过长护险的地区有 13035 人，占比 88.62%；国家试点地区有 1674 人，占比 11.38%。基期样本数据中从未实施地区和国家试点地区平均年龄一致且组间没有显著差异，性别分布相对均衡（男 46.74% vs 47.49%, $P$=0.56）。两组受访人群的城乡分布也相似，农村地区人群占比较大(农村 71.28% vs 72.28%, $P$=0.56)。处于在婚状态的人群占比高(在婚 87.56% vs 89.61%, $P$<0.05)。两组受访者平均受教育水平都不高(平均受教育水平, 1.03 vs 0.83, $P$=1.00)，但健康保险的参保水平普遍较高（参保人群, 89.57% vs 89.25%, $P$=0.68）（见表 3）。

表 3 基期样本社会人口学变量描述性统计

| 指标 | 2015 年从未实施地区 | 2015 年国家试点地区 | $P$ 值 |
|---|---|---|---|
| Number of obs | 13035 | 1674 | |
| Age，Mean(SD) | 59(10.38) | 59(10.26) | 0.61 |
| Gender，N(%) | | | |
| Male | 6092(46.74) | 795(47.49) | 0.56 |

| | | | |
|---|---|---|---|
| Female | 6943(53.26) | 879(52.51) | |
| Urban or Rural，N(%) | | | |
| Rural | 9291(71.28) | 1210(72.28) | 0.39 |
| Urban | 3744(28.72) | 464(27.72) | |
| Marital status，N(%) | | | |
| Married | 11413(87.56) | 1500(89.61) | <0.05 |
| Not married | 1622(12.44) | 174(10.39) | |
| Level of education，Mean(SD) | 1.03(1.29) | 0.82(1.04) | 1.00 |
| Insurance，N(%) | | | |
| Yes | 11676(89.57) | 1494(89.25) | 0.68 |
| No | 1359(10.43) | 180(10.75) | |

注: “Mean”, “SD”, “Min” and “Max”分别为平均值，标准误，最小值和最大值。 表中除分类变量使用样本数（百分比）外其余以均值（标准差）表示；数值除年龄、样本数（保留整数）外其余均保留两位小数。

## 3.2 开展长护险试点的影响分析

本文所涉及变量的描述性统计如表 4 所示，为检验各项指标是否因长护险试点而存在差异，且发现其中具体差异如何，故根据变量特征分别运用 Student’s t-test 检验和 Person’s chi-squared 检验。数据显示，2018 年从未实施长护险地区自评健康均值较 2015 年下降 0.01（95% confidence interval[CI]:-0.03,0.01）；但国家试点地区自评健康均值从 2.02 提高到 2.12（95%CI:0.05,0.14），且试点地区受访人群的自评健康的前后变化水平高于从未实施长护险地区 0.10（$P$<0.05）。2018 年从未实施地区 ADL 均值较 2015 年变化-0.02（95%CI:-0.03,-0.11），但试点地区 ADL 均值增加 0.02（95%CI:-0.00,0.04），试点地区 ADL 前后变化水平高于从未实施地区 0.04（$P$<0.05）。从未实施长护险地区的 IADL 均值下降 0.07（95%CI:-0.08,-0.05），同样试点地区 IADL 均值也有一定程度下降 0.02（95%CI:-0.07,0.02），试点地区 IADL 前后变化水平高于从未实施地区 0.05（$P$<0.05）。从未实施地区 CES-D 均值出现了下降 0.40（95%CI:-0.68,-0.44）；试点地区 CES-D 均值也出现了下降 0.38（95%CI:-0.82,-0.15）。同样从未实施地区满意度均值出现了下降 0.04（95%CI:-0.06,-0.03），试点地区也出现了下降 0.04（95%CI:-0.09,-0.00）。

## 3.3 双重差分模型分析

当仅考虑政策干预与时间变量时，实证结果显示除 ADL 外，患者的自评健康(-0.78, $P$<0.01),IADL(-0.16，$P$<0.01)（表 5），CES-D(-0.40,$P$<0.01)和健康满意度 (-0.12, $P$<0.01)4 个指标随时间变化而降低。长护险试点地区受访人群的 ADL（0.18,$P$<0.05），IADL(0.19,$P$<0.01),CES-D(0.73,$P$<0.01) 和健康满意度（0.10,$P$<0.05）明显高于从未实施过长护险的地区。然而，长护险政策仅在 ADL 方面对受访者有正向显著影响（0.20,$P$<0.05）（图 6）。

进一步考虑影响受访者健康的其他因素，将年龄、性别、城乡差异、婚姻

状况、教育水平、参保类型纳入模型作为控制变量。实证结果显示，长护险政策与受访者的自评健康水平（0.24,*P*<0.05）、ADL（0.43,*P*<0.05）、CES-D（0.91,*P*<0.05）和健康满意度（0.25, *P*<0.05）存在显著的正向相关性（表 6）。年龄对多维度健康变化都有显著的负向影响，对 IADL 的影响明显（-0.06，*P*<0.05）。性别对健康水平有正向显著影响，特别对 CES-D 的影响系数最大（1.55,*P*<0.01）。户籍对健康水平也有显著影响，对 CES-D 的影响系数也是最大（-1.39,*P*<0.01）。婚姻状态对 ADL、IADL 和 CES-D（0.74,*P*<0.01）有显著正向影响。受访人群的受教育水平对健康也有显著的正向影响，受教育水平越高，长护险对健康指标的影响也就越大，本科及以上人群对自评健康（0.54,*P*<0.01）、ADL(1.38,*P*<0.01)、IADL(1.75,*P*<0.01)、CES-D(3.53,*P*<0.01)四个指标的影响系数都相对较高。

表 4 变量的统计描述

| 指标 | 从未实施地区 | | | 国家试点地区 | | | Difference Between Groups (95%CI) | *P* 值 |
|---|---|---|---|---|---|---|---|---|
| | Before | After | Different (95%CI) | Before | After | Different (95%CI) | | |
| Self-reported health，Mean(SD) | 2.01(0.70) | 2.00(0.97) | -0.01(-0.03 to 0.01) | 2.02(0.68) | 2.12(0.95) | 0.09(0.05 to 0.14) | -0.10(-0.15 to -0.05) | <0.05 |
| ADL，Mean(SD) | 2.78(0.51) | 2.76(0.54) | -0.02(-0.03 to -0.01) | 2.81(0.46) | 2.83(0.45) | 0.02(-0.00 to 0.04) | -0.04(-0.07 to -0.01) | <0.05 |
| IADL，Mean(SD) | 2.55(0.87) | 2.49(0.92) | -0.07(-0.08 to -0.05) | 2.61(0.84) | 2.59(0.85) | -0.02(-0.07 to 0.02) | -0.05(-0.10 to 0.00) | <0.05 |
| CES-D，Mean(SD) | 22.33(6.44) | 21.93(6.72) | -0.40(-0.68 to -0.44) | 23.05(6.22) | 22.67(6.48) | -0.38(-0.82 to -0.15) | -0.07(-0.43 to 0.28) | 0.34 |
| Satisfaction, Mean(SD) | 2.35(0.83) | 2.31(0.82) | -0.04(-0.06 to -0.03) | 2.40(0.79) | 2.35(0.79) | -0.04(-0.09 to -0.00) | 0.00(-0.05 to 0.05) | 0.53 |

注：SD: standard deviation, minimum value；CI:Confidence Intervals；表中变量使用均值（标准差）表示；数值均保留两位小数；95%CI 同样保留两位小数。

表 5 长护险政策对中老年人群健康水平的粗影响（N=29418）

| 变量 | 自评健康状况 (order logit) | ADL (order logit) | IADL (order logit) | CES-D (pooled) | 健康满意度 (order logit) |
|---|---|---|---|---|---|
| treat1 | 0.08 | 0.18** | 0.19*** | 0.73*** | 0.10** |
| | (0.163) | (0.070) | (0.062) | (0.170) | (0.048) |
| after | -0.78*** | -0.06* | -0.16*** | -0.40*** | -0.12*** |
| | (0.065) | (0.031) | (0.028) | (0.084) | (0.023) |
| treatafter | 0.33 | 0.20** | 0.09 | 0.01 | -0.00 |
| | (0.210) | (0.101) | (0.086) | (0.248) | (0.068) |

注：括号内数值为标准误；系数保留 2 位小数，标准误保留 3 位小数；*、**、*** 分别表示在 10%、5%、1%的水平上显著。

表 6　长护险政策对中老年人群健康影响的模型估计结果（N=29418）

| 变量 | 自评健康状况 (order logit) | ADL (order logit) | IADL (order logit) | CES-D (pooled) | 健康满意度 (order logit) |
|---|---|---|---|---|---|
| treat1 | 0.03 | 0.01 | 0.14 | -0.02 | -0.15 |
| | (0.104) | (0.154) | (0.135) | (0.361) | (0.104) |
| after | 0.03 | -0.09 | -0.01 | -0.66*** | -0.07** |
| | (0.038) | (0.055) | (0.048) | (0.132) | (0.038) |
| treatafter | 0.24** | 0.43** | 0.21 | 0.91** | 0.25** |
| | (0.116) | (0.172) | (0.149) | (0.403) | (0.115) |
| Age | -0.02*** | -0.05*** | -0.06*** | 0.03*** | -0.01*** |
| | (0.002) | (0.002) | (0.002) | (0.005) | (0.001) |
| Gender(Male) | 0.21*** | 0.36*** | 0.42*** | 1.55*** | 0.24*** |
| | (0.031) | (0.043) | (0.038) | (0.106) | (0.029) |
| Urban or rural(Rural) | -0.29*** | -0.29*** | -0.36*** | -1.39*** | -0.14*** |
| | (0.036) | (0.053) | (0.046) | (0.122) | (0.034) |
| Marital status(Married) | 0.02 | 0.18*** | 0.18*** | 0.74*** | 0.03 |
| | (0.044) | (0.053) | (0.047) | (0.157) | (0.042) |
| Level of education | | | | | |
| Elementary school | 0.08** | 0.31*** | 0.56*** | 0.89*** | 0.18*** |
| | (0.039) | (0.052) | (0.046) | (0.134) | (0.037) |
| Middle school | 0.29*** | 0.45*** | 0.85*** | 1.61*** | 0.21*** |
| | (0.042) | (0.062) | (0.055) | (0.142) | (0.040) |
| High school | 0.46*** | 0.64*** | 1.11*** | 2.35*** | 0.33*** |
| | (0.059) | (0.102) | (0.093) | (0.203) | (0.059) |
| Vocational school | 0.35*** | 0.77*** | 1.20*** | 2.40*** | 0.33*** |
| | (0.101) | (0.179) | (0.162) | (0.349) | (0.103) |
| Two-/Three-Year College/Associate degree | 0.70*** | 1.46*** | 1.31*** | 3.61*** | 0.53*** |
| | (0.128) | (0.347) | (0.254) | (0.463) | (0.134) |
| Four-Year College/Bachelor's degree | 0.54*** | 1.38*** | 1.75*** | 3.53*** | 0.16 |
| | (0.169) | (0.400) | (0.356) | (0.602) | (0.171) |
| Insurance | -0.08 | 0.12 | 0.02 | -0.54** | 0.02 |
| | (0.062) | (0.085) | (0.076) | (0.220) | (0.060) |
| R-squared | 0.014 | 0.075 | 0.089 | 0.061 | 0.007 |

注：括号内数值为标准误；系数保留 2 位小数，其余保留 3 位小数；*、**、*** 分别表示在 10%、5%、1%的水平上显著。

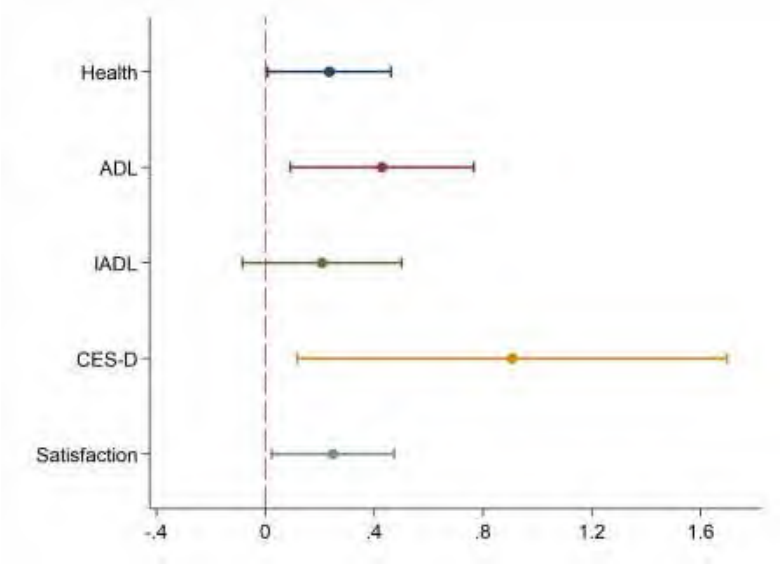


图 2　长护险政策对中老年人群健康影响系数图

注：图片展示的是 LTCI 对中老年人群健康产生的影响系数及 95%CI。图中点为影响系数，实线为 95%置信区间。ADL:Activities of Daily Living. IADL:Instrumental Activity of Daily Living. CES-D:Center for Epidemiological Studies-Depression.

## 3.4 稳健性分析

通过多重共线性诊断，数据没有多重共线性问题。另外，双重差分模型成立的关键前提是，证明中老年人健康水平各项指标的差异，不是由于预先存在的差异发展后的结果。为了证明该问题，同样根据变量特征分别进行 order logit 与 pooled 回归。回归结果显示（表 7 所示）：对自评健康状况（0.17，$P>0.10$）、ADL（0.05，$P>0.10$）、IADL（0.24，$P>0.10$）、CES-D（-0.11，$P>0.10$）、健康满意度（0.27，$P<0.10$）的影响皆不显著。参考表 4 中回归结果，表明上述主要发现:自评健康水平、ADL、CES-D 和健康满意度的改善是由长护险试点的实施所引起，而非来自模型设计之外的非观察因素所驱动。

表 7 稳健性检验（N=13035）

| 变量 | 自评健康状况 (order logit) | ADL (order logit) | IADL (order logit) | CES-D (pooled) | 健康满意度 (order logit) |
|---|---|---|---|---|---|
| treat1 | -0.03 | 0.21 | 0.007 | -0.06 | -0.31** |
| | (0.134) | (0.216) | (0.177) | (0.471) | (0.136) |
| after | 0.02 | -0.09 | -0.02 | -0.67*** | -0.09** |
| | (0.039) | (0.057) | (0.049) | (0.136) | (0.039) |
| treatafter | 0.17 | 0.05 | 0.24 | -0.11 | 0.27* |
| | (0.156) | (0.244) | (0.203) | (0.551) | (0.156) |
| Age | -0.02*** | -0.05*** | -0.06*** | 0.04*** | -0.01*** |
| | (0.002) | (0.002) | (0.002) | (0.006) | (0.002) |
| Gender(Male) | 0.19*** | 0.38*** | 0.42*** | 1.55*** | 0.22*** |
| | (0.032) | (0.045) | (0.040) | (0.113) | (0.031) |

| | | | | | |
|---|---|---|---|---|---|
| Urban or rural(Rural) | -0. 29*** | -0. 32*** | -0. 39*** | -1. 45*** | -0. 13*** |
| | (0. 038) | (0. 056) | (0. 049) | (0. 130) | (0. 036) |
| Marital status(Married) | 0. 03 | 0. 12** | 0. 14*** | 0. 70*** | 0. 02 |
| | (0. 047) | (0. 056) | (0. 050) | (0. 166) | (0. 044) |
| Level of education | | | | | |
| Elementary school | 0. 11** | 0. 28*** | 0. 57*** | 0. 83*** | 0. 16*** |
| | (0. 041) | (0. 055) | (0. 048) | (0. 143) | (0. 039) |
| Middle school | 0. 31*** | 0. 43*** | 0. 86*** | 1. 62*** | 0. 19*** |
| | (0. 044) | (0. 065) | (0. 058) | (0. 151) | (0. 042) |
| High school | 0. 51*** | 0. 65*** | 1. 15*** | 2. 32*** | 0. 30*** |
| | (0. 062) | (0. 107) | (0. 098) | (0. 214) | (0. 062) |
| Vocational school | 0. 38*** | 0. 79*** | 1. 24*** | 2. 42*** | 0. 30*** |
| | (0. 106) | (0. 189) | (0. 172) | (0. 370) | (0. 109) |
| Two-/Three-Year College/Associate degree | 0. 73*** | 1. 42*** | 1. 30*** | 3. 55*** | 0. 53*** |
| | (0. 129) | (0. 348) | (0. 254) | (0. 468) | (0. 135) |
| Four-Year College/Bachelor's degree | 0. 51*** | 1. 31*** | 1. 69*** | 3. 42*** | 0. 20 |
| | (0. 175) | (0. 401) | (0. 357) | (0. 628) | (0. 176) |
| Insurance | -0. 09 | 0. 13 | 0. 018 | -0. 46** | 0. 017 |
| | (0. 065) | (0. 089) | (0. 079) | (0. 233) | (0. 063) |
| R-squared | 0. 014 | 0. 074 | 0. 090 | 0. 061 | 0. 006 |

注：括号内数值为标准误；系数保留 2 位小数，其余保留 3 位小数；*、**、*** 分别表示在 10%、5%、1%的水平上显著。

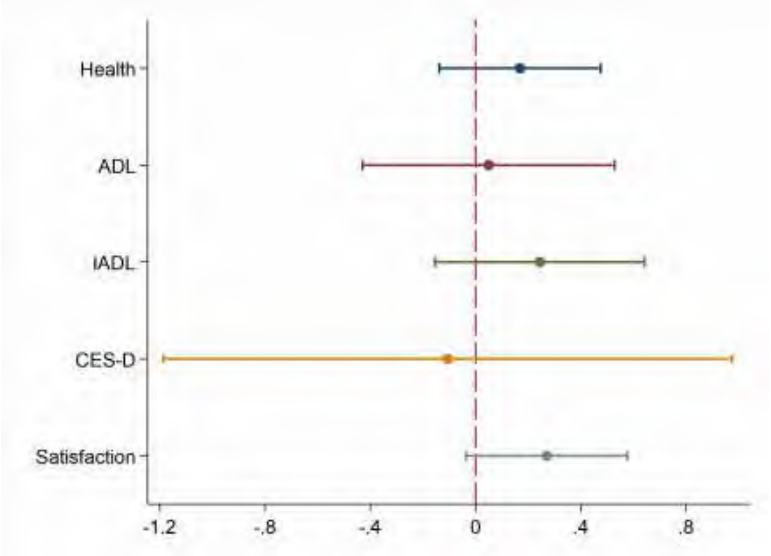


图 3 稳健性检验系数图

注: 图片展示的是伪改革模型设计的长护险对中老年人群健康影响系数及 95%CI。图中点为影响系数，实线为 95%置信区间。ADL:Activities of Daily Living. IADL:Instrumental Activity of Daily Living. CES-D:Center for Epidemiological Studies-Depression.

## 4 讨论

本文基于 2016 年中国实施的全国性的长护险政策试点，使用 CHARLS2015 和 2018 两全国性调查数据,通过构建 DID 模型分析长护险政策对人群健康的影响。研究发现长护险政策和中老年人群的自评健康、ADL、CES-D 和健康满意度存在显著正向相关性，但与中老年人 IADL 的相关性并不显著。

首先，我们发现长护险实施对中老年人群自评健康有显著正向影响，这与大部分国内外相关研究一致。Buscher 等认为长护险制度通过为受益人提供良好的家庭护理而改善了人群的自评健康[12]。而 Choi 等关注了长护服务使用者与未使用者的死亡率差异，发现长护险能够降低使用者的死亡率（使用者，33.9% vs 27.3%，$P<0.05$），改善健康水平[13]。马超等研究证实长护险减少了中老年人慢性病数量（-0.10，$P>0.10$），从而减少了自评健康差的概率(-0.001,$P>0.10$)。长护险的设计就是通过提供专业化、全方位的长护服务，提高受益人群对自我健康水平的认可。阳义南基于 CHILS 数据的研究也证明了这一点，研究发现长护险的照护支出对受访者的健康自评、生活满意度等有显著正向影响（1.29，$P<0.1$）[25]。

其次，我们发现发现长护险可以显著改善中老年人群 ADL 指标。这与 Olivares 等基于日本 A 市长护险数据库的研究结论一致。在他们的研究中发现使用的服务量每增加 1 天，改善功能状态的可能性估计增加 3%[16]。Nishiwaki 等发现长护险项目认证的老年人，伴随长护险护理水平的提高，中老年人群的日常活动能力如握力($P<0.00$)降低，简易精神状态得分($P<0.00$)改善，但老年抑郁量表评分($P<0.05$)却伴随护理水平的提高而加重[35]。

再次，ADL 与 IADL 指标均为用于衡量活动能力的指标，但 IADL 指标更偏重于工具性能力，Bae 等针对韩国居家照护和机构照护的 LTCI 使用者的调查结果显示:居家照护和机构照护使用者的 ADL 未见显著差异,但居家照护人群 IADL 指标显著更优($P<0.05$)[36]。但基于本文的分析，长护险对 IADL 的正向影响还不够显著，是否缘于我国长护服务模式仍有待改善与细化之处。第一，正式照护利用率较低。有研究显示我国的非正式照护利用率较高，为 58.3%；正式照护利用率仅为 3.16%左右[37]，而且正式照护又以居家护理为主。大部分居家护理服务仅提供基本生活照料项目，护理水平有限，难以对中重度失能人群的 IADL 水平产生逆转性影响。第二，护理人员专业能力有限。一方面，我国长护服务的提供，绝大部分只能满足某一专科护理需求，难以应对合并多种疾病导致的功能性损伤护理问题[38]。另一方面，还容易忽视轻、中度失能人群的主观能动性，给予过度护理，不利于人群的 IADL 水平的恢复与改善[39]。第三，护理服务项目缺乏完整性设计。在实践探索中，15 个试点地区护理服务项目多集中于生活照护与医疗照护[40]，且极少地区针对不同失能等级人员区分护理项目与护理时间。轻、中、重度失能人员日常自理能力与功能性活动能力水平不同，相对应的，他们获取的护理项目与护理时间也应有所区别。只有划分等级才有利于

把握轻、重度人群的能动性，改善中老年人群的活动能力。

最后，我们发现长护险对 CES-D 指标和健康满意度的影响正向显著。Lee 等发现接受长护险的专业护理与非正式的家庭护理会对认知功能与精神状况产生显著影响（$P<0.01$）[17]。同时，马超等研究发现的：长护险显著减少了中老年人的身体疼痛感(-0.13，$P<0.01$)，并减弱了他们的抑郁倾向(-0.37,$P<0.01$)[9]。本文不仅再次证明了马超等的结论，并在全国视角从功能、满意度等更多的健康维度丰富了 LTCI 效果研究。

综上所述，长护险政策的推进对中老年人群自评健康、ADL、CES-D 和健康满意度都有一定程度的改善，可以为探索性扩大长护险政策的积极意义提供依据。但就目前的研究结果来看，长护险对受访者的 IADL 正向影响并不显著。因此在扩大长护险试点工作的同时，政府角度，需要通过政策引导、经济支持等多种方式，提高长护服务的高质量发展，进一步推动正式照护与非正式照护的融合，明确改善受益人群的功能性指标的重要性。护理人员角度，需规范从业资质、人员等级评定标准，并通过在职培训等途径，强调除了关注受益人群的身体健康状态，也不能忽视人群的心理健康建设和满意度问题。长护服务提供机构角度，需要针对不同等级的失能人群，更需要提供差别化护理服务包。借鉴日本和德国针对不同的失能原因、不同层级的护理需求，提供与之相匹配的护理项目、时长与频次；护理项目重视预防照护、康复护理、心理干预等项目，同时推广差别化护理服务包，才能更好的服务于不同失能等级的患者，更高效的改善 IADL 指标。

本研究使用了最新的全国性调查数据来研究 LTCI 对中老年人的健康水平的影响,弥补了中国长护险效果研究中基于真实世界证据的全国性研究的空白。同时，在研究健康水平时，考虑到自评健康、身体功能、心理和满意度等多个维度，全面研究 LTCI 的可能影响。但我们的研究同样存在一些问题：首先，本研究数据来源的时间序列不够长，因此在验证平行趋势假设时只构建了伪改革模型。其次，长护险从 2016 年刚开始试点实施，政策的落实需要时间，长护险的效果也需要时间才能展现，故而，我们的研究可能低估了长护险对中老年人健康水平的影响。

## 5.结论

综上所述本研究发现，长护险的实施对全国试点地区中老年人群的自评健康、ADL、CES-D 和健康满意度有正向显著影响，但对 IADL 指标的正向影响并不显著。为此，本研究认为在结合各地实际情况不断扩大 LTCI 试点范围的基础上，还要更好地改善中老年人群的工具性活动能力。长护险政策监管部门有必要与政策执行部门通力合作，整合正规与非正规长期护理服务；提高护理人员的核心竞争力与稳定性；同时在条件允许的情况下，根据中老年人失能等级的差异提供个性化、差别化护理服务包。

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# 长护险政策对中老年人健康水平的影响

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**关键词**:长期护理保险；中老年人群；健康水平；CHARLS 数据；双重差分模型

**摘要.**探讨长护险的实施对试点地区中老年人群身心健康指标的影响及影响水平。利用 2015 年和 2018 年中国健康与养老追踪调查（CHARLS）数据，建立双

重差分回归模型，识别长护险对中老年人群自评健康、日常生活自理能力、工具性日常活动能力、抑郁水平和健康满意度五个健康指标的多维度影响。研究结果表明，长护险的实施，显著改善了中老年人群的自评健康状况和抑郁水平，优化了中老年人群日常生活自理能力和健康满意度，但对其社区生活中工具性关键技能的影响不显著。针对长护险对中老年人群工具性日常活动能力优化程度不佳的现状，本文认为，需推动正式照护与非正式照护有机融合、提高护理人员的核心技能，并进一步推广差别化护理服务包势在必行。

# Does the Qianhai Shenzhen-Hong Kong Modern Service Industry Cooperation Zone Promote the Development of the Health Insurance? Counterfactual Analysis Based on Province-Level Panel Data

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**Keywords:** counterfactual analysis; Qianhai Shenzhen-Hong Kong modern service industry cooperation zone; policy effect; financial opening; premium growth

**Abstract:** Based on the panel data of health insurance premium growth rates of 36 provinces in mainland China, this paper employs HCW (2012) counterfactual analysis to measure the policy effect via the growth of health insurance premiums in Shenzhen by the Qianhai Modern Service Industry Cooperation Zone. The empirical results show that the establishment of the cooperation zone did not significantly promote the growth of Shenzhen health insurance premiums, but significantly increased its phased growth rate, magnifying the volatility of growth. The short-term and guaranteed financial services demand is determined by the basic factors such as the scale of economic activities and the number of people. Financial openness has a small pulling effect on its growth, but it can significantly amplify the volatility of its growth. In the process of expanding the opening up of the financial industry, regulators should be highly vigilant against the abnormal growth of short-term liability products, timely reduce the mismatch of financial institutions' assets and liabilities, prevent their improper use of short-term financial products, and improve the financial system stability.

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## 1. Introduction

Since the outbreak of the international financial crisis, trade protectionism and unilateralism have emerged one after another, and economic globalization has suffered setbacks. Faced with the severe external situation, it has become the social consensus and collective action of China to expand opening up to deal with trade protectionism. The leaders of China have also repeatedly emphasized that the door of opening will not be closed, but will only open wider and wider [1]. Among the achievements made in the past 40 years of reform and opening up, financial openness has been indispensable. When anti-globalization is prevalent, the pace of China's financial opening will not stop or slow down, but will only get faster and faster[2]. Only further opening up can enhance the competition and vitality of the financial industry, further enhance the effective supply of funds, and increase financial support to the real economy [3] (Wang Zhaoxing, 2018). In order to further open up to the outside world, China introduced 11 new policies and measures for the opening up of the financial industry on July 20, 2019, marking the overall acceleration of the opening up of the financial industry and reflecting China’s unswerving determination to deepen reform and opening up (Shen Jianguang, 2019). However, it is undeniable that the current round of expansion of China's financial industry is facing an extremely harsh external environment. The latest 11 opening-up measures are completely "going against the wind." Financial opening is a gradual and prudent process. China generally establishes pilot free trade zones and financial innovation pilot zones first, and then replicates and promotes the successful experience of these free trade zones and innovation zones, so as to open up and innovate in a wider range. Due to the high liquidity of financial resources and the strong integrity of the financial market, financial opening needs to pay special attention to the relationship between individual advancement and overall coordination [4] (Liu He, 2016) to prevent open sectorization and fragmentation. In the current extremely complex and uncertain international and domestic economic environment, it is necessary to unswervingly promote and expand financial opening[5] (Chen Liang, Wang Xiruo and Zhang Yuan, 2018), it is urgent to summarize the experience and lessons of reform and opening up in the financial pilot area to improve the level of subsequent opening up. In June 2012, when the financial crisis was still raging and economic development was facing difficulties, China initiated the construction of the "Shenzhen Qianhai Shenzhen-Hong Kong Modern Service Industry Cooperation Zone" to support Qianhai's implementation of a more special pilot policy than a special economic zone. [6] (Lian Xirui, 2012), allowing it to cooperate and support the development of Hong Kong's RMB offshore business and build a cross-border RMB business innovation pilot zone [7] (Zhang Bojun, 2014). Financial innovation is the core of Qianhai's "new policy", and cooperating with Hong Kong to develop RMB cross-border business is the "core core"[8]. The Qianhai Cooperation Zone undertakes the mission of exploring and accelerating financial opening, and aims to become a model window for the opening up experiment of China's financial industry [9]. At the new round of financial industry opening up to the outside world, it is particularly important to summarize the experience of the Qianhai Cooperation Zone. The insurance industry is one of the key areas of new round of financial opening up. Five

of the “New 11 Articles” of financial liberalization are related to the insurance industry. The Qianhai Cooperation Zone has made remarkable achievements in the opening up of the insurance industry, which is bound to play a demonstrative role in expanding the opening up of China's financial industry. Since the pilot project, Shenzhen Qianhai has established the first social capital-led mixed-ownership reinsurance company: Qianhai Reinsurance Company[10]; the first batch of mutual insurance institutions: Zhonghui Property Mutual Insurance Co., Ltd. Qianhai Life Insurance, which has been profitable for two years and has doubled its premium income every year since foundation, has become famous in the first battle of Vanke acquisition [11] (Song Jiayan, 2013). However, from a nationwide perspective, China's financial industry still has great potential to be tapped in opening up to the outside world. At present, foreign-invested insurance accounts for less than 6% of the market share, which is in urgent need of improvement (Shang Fulin, 2019). When the Qianhai Cooperation Zone has been built for 7 years, the state has introduced a policy to support Shenzhen's construction of a pilot demonstration zone of socialism with Chinese characteristics, which highlights the importance of summing up the experience and lessons of existing financial opening. The achievements of the Qianhai Cooperation Zone in the opening up of the insurance industry, the strength of the new 11 opening up to the insurance industry, and the opening of Shenzhen's construction of a pioneering demonstration zone of socialism with Chinese characteristics enable the evaluation of the policy effects of the construction of the Qianhai Cooperation Zone from the perspective of the opening of the insurance industry. In the process of rapid social transformation, "difficult and expensive medical treatment" has become one of the focus issues of general concern in society. Accordingly, health insurance has become one of the fastest-growing types of insurance in China [12]. Health insurance has a short term and is more sensitive to macroeconomic policies. Therefore, this article attempts to measure the policy effect of the Qianhai Cooperation Zone from the perspective of whether it has an impact on the growth rate of health insurance premiums, in order to further expand the opening up of financial industry.

## 2. Methodology

On June 27, 2012, the Shenzhen Qianhai Shenzhen-Hong Kong Modern Service Industry Cooperation Zone was formally established with the approval of the State Council, marking a new stage in the opening up of China's financial industry. The Central government supports Qianhai to take the lead in financial reform and innovation, and build a pilot demonstration window for the opening of financial industry [13] (Li Fanfeng, Yang Qiting, Xu Hao, et al., 2014). The Qianhai financial opening pilot has just gone through 7 years, and China then introduced 11 new measures to further expand financial opening to the outside world. On August 18, 2019, it issued policies and measures to support Shenzhen's construction of a pilot demonstration zone of socialism with Chinese characteristics. As the financial industry further opens up to the outside world, what is the effect of the establishment of the Qianhai Cooperation Zone on Shenzhen’s financial industry? What kind of promotion effect does it have? What is the guiding significance for further expansion of the

opening up of the financial industry? It has become a question that must be answered by the academical, practical, and policy makers.

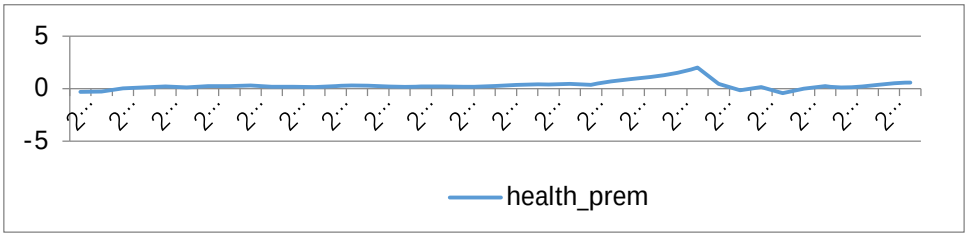


Figure 1 Quarterly growth rate of health insurance premiums in Shenzhen

This article uses the quarterly year-on-year growth rate of Shenzhen health insurance premiums (health_prem) to examine the policy effects of the establishment of the Qianhai Cooperation Zone. Figure 1 shows that after the establishment of the Qianhai Cooperation Zone, Shenzhen Health Insurance experienced great volatility. The increase in volatility began in the first quarter of 2015 and ended in the third quarter of 2016. However, based on Figure 1, it is impossible to judge whether the establishment of the cooperation zone has an impact on the development of health insurance, and it is impossible to observe the "counterfactual" of not establishing the Qianhai cooperation zone from its premium growth rate [14].

The impact of policy changes on premium growth can be assessed by establishing a regression model. The endogenous nature of the factors affecting the premium growth rate can also be treated with instrumental variables (IV). The influence of the establishment of the Qianhai Cooperation Zone on the growth of Shenzhen health insurance premiums can be carried out by natural experiment methods, including synthetic control method (SCM), breakpoint regression design (RDD), propensity score matching (PSM) and double difference method (DID), etc. But RDD, PSM and DID all have strict applicable conditions. The choice of treatment group and control group must be random, and the two must also be affected by common factors, and the degree of influence must also be the same [15] (Ke X, Chen H, Hong Y, et al., 2017). However, the Shenzhen Special Economic Zone is completely heterogeneous to other provinces and municipalities, and other regions cannot set up a financial opening demonstration zone that “cooperates with Hong Kong”. In ordinary regression analysis, IV-2SLS requires the cross-section responses to shocks be homogeneous (Heckman, 1997), which is difficult to meet in reality.

In recent years, the academic circles have been more controversial about HCW and SCM. In fact, the ideas of the two are similar, and both are based on the explained variables of each entity in the candidate control group. Build a foundation for "counterfactuals." HCW believes that the explained variable is the result of the comprehensive effect of the explanatory variable, which has concentrated or reflected the information of each explanatory variable, and is its "realization" in reality, so there is no need to introduce additional explanatory variables. SCM not only uses the explained variable to construct the "counterfactual", but also selects the control group closest to the treatment group based on the explanatory ability of the explanatory

variable to the explained variable. In the distribution of individual weights in the selected control group, HCW advocates improvements based on simple linear regression to increase the economic significance of weights, relax non-negative constraints but ensure that the weight values are unique, and SCM must first make synthetic control by appropriately weighting explanatory variables The economic characteristics of the area are as close as possible to the treatment area, and then the combined treatment area is as close as possible to the real treatment area by appropriately weighting the alternative control areas, the so-called "secondary planning". In short, the two ideas are the same, but HCW is more convenient and easier to implement, it is "regression control" rather than "synthetic control."

This article uses the "counterfactuals" analysis method proposed by Hsiao et al. [16] (HCW, 2012) to evaluate the impact of the establishment of the Qianhai Cooperation Zone on the growth of Shenzhen's health insurance premiums. This method believes that there is a common factor that has a common influence on the growth of health insurance premiums in various regions. The impact of this common factor on the growth of health insurance premiums varies from place to place, but due to the commonality of the factor, there will be some linkage or correlation between the growth of health insurance premiums in various places. The "counterfactual" of the post-processing group established in the Qianhai Cooperation Zone can be constructed by the correlation between the pre-processing group and the control group established in the Qianhai Cooperation Zone, and the difference between the predicted growth rate and the real growth rate based on the "counterfactual" To assess the impact of the establishment of the Qianhai Cooperation Zone on the growth of health insurance premiums.

## 3. Data

### 3.1 Data source

The data in this article is the “original insurance premium income” of 31 provinces, municipalities, and 5 coastal cities in mainland China, with a unit of 10,000 yuan. The original data comes from the former China Insurance Regulatory Commission's official website (http://bxjg.circ.gov.cn/web/site0/tab5205/) "The original insurance premium income of each region of the country". The reporting period for this data began in January 2006 and ended in May 2019. Since the international financial crisis began with the collapse of Lehman Brothers on September 15, 2008 and the Qianhai Cooperation Zone was established on June 27, 2012, this article selects the quarterly year-on-year growth rate of health insurance premiums in the first 4 years and 6 years after the establishment of the cooperation zone, a total of 10 years, that is, a total of 40 quarters from 2009 to 2018, was used as the dataset. Due to the excessive seasonality of the monthly premium income year-on-year growth rate, this article draws on the practice of Hsiao et at. (2012) and adjusts it to a quarterly year-on-year growth rate.

### 3.2 Descriptive statistics

This article aims to evaluate the policy effect of the establishment of the Qianhai Cooperation Zone by examining the impact of Shenzhen's health insurance premium growth rate. Table 1 shows a descriptive statistical analysis of the quarterly growth rate of health insurance premiums in 36 provinces, municipalities, and coastal cities in the country.

Table 1 Descriptive statistics of the growth rate of health insurance premiums in China

| variables | Obs. | min | max | mean | std | skewneww | kurtosis | Jarque-bera |
|---|---|---|---|---|---|---|---|---|
| hubei | 40 | -0.142 | 1.254 | 0.345 | 0.288 | 0.774 | 3.691 | 4.790 |
| tianjing | 40 | -0.332 | 0.696 | 0.217 | 0.224 | -0.325 | 3.070 | 0.712 |
| zhejiang | 40 | -0.395 | 1.474 | 0.308 | 0.414 | 1.063 | 4.176 | 9.838 |
| beijin | 40 | -0.326 | 1.283 | 0.242 | 0.347 | 1.057 | 4.014 | 9.162 |
| liaonin | 40 | -0.561 | 2.394 | 0.271 | 0.520 | 1.736 | 8.584 | 72.060 |
| chongqing | 40 | -0.453 | 3.244 | 0.388 | 0.624 | 2.856 | 12.65 | 209.582 |
| ninxia | 40 | 0.0452 | 0.752 | 0.259 | 0.190 | 1.306 | 3.702 | 12.192 |
| yunnan | 40 | -0.201 | 0.884 | 0.254 | 0.265 | 0.491 | 2.628 | 1.838 |
| shenzheng | 40 | -0.410 | 2.014 | 0.329 | 0.446 | 1.830 | 7.410 | 54.740 |
| xiamen | 40 | -0.314 | 1.440 | 0.259 | 0.334 | 1.518 | 6.191 | 32.333 |
| hunan | 40 | -0.214 | 0.712 | 0.310 | 0.218 | -0.741 | 3.110 | 3.681 |
| helongjiang | 40 | -0.239 | 1.999 | 0.383 | 0.478 | 2.510 | 8.873 | 99.488 |
| shandong | 40 | -0.218 | 1.467 | 0.317 | 0.336 | 1.388 | 5.230 | 21.132 |
| shanxijin | 40 | -0.245 | 0.841 | 0.294 | 0.226 | -0.119 | 2.981 | 0.095 |
| fujian | 40 | -0.237 | 1.052 | 0.278 | 0.304 | 0.600 | 3.178 | 2.453 |
| shanxishan | 40 | -0.225 | 1.529 | 0.340 | 0.341 | 0.794 | 5.029 | 11.064 |
| shanghai | 40 | -0.638 | 1.052 | 0.187 | 0.343 | -0.0178 | 3.775 | 1.003 |
| jiangxi | 40 | -0.155 | 1.067 | 0.362 | 0.344 | 0.342 | 2.219 | 1.796 |
| guangdong | 40 | -0.564 | 2.974 | 0.367 | 0.656 | 2.039 | 8.182 | 72.472 |
| sichuan | 40 | -0.293 | 1.630 | 0.294 | 0.361 | 1.317 | 6.084 | 27.415 |
| neimong | 40 | -0.100 | 0.820 | 0.363 | 0.194 | 0.0858 | 3.325 | 0.225 |
| xinjiang | 40 | 0.0051 | 0.671 | 0.260 | 0.142 | 0.338 | 3.343 | 0.958 |
| anhui | 40 | -0.298 | 1.531 | 0.366 | 0.393 | 0.763 | 3.583 | 4.448 |
| guizhou | 40 | -0.141 | 1.280 | 0.370 | 0.329 | 0.779 | 3.039 | 4.048 |
| henan | 40 | -0.301 | 0.932 | 0.357 | 0.294 | 0.0321 | 2.364 | 0.681 |
| qinghai | 40 | -0.659 | 3.119 | 0.424 | 0.605 | 2.794 | 12.69 | 208.536 |
| jiangsu | 40 | -0.430 | 1.599 | 0.313 | 0.459 | 1.186 | 4.782 | 14.670 |
| jiling | 40 | -0.288 | 1.496 | 0.375 | 0.404 | 1.048 | 3.965 | 8.874 |
| hainan | 40 | -0.249 | 2.935 | 0.419 | 0.578 | 2.962 | 12.47 | 207.958 |
| dalian | 40 | -0.409 | 0.955 | 0.202 | 0.245 | 0.767 | 5.330 | 12.970 |
| qingdao | 40 | -0.330 | 1.835 | 0.292 | 0.445 | 1.816 | 7.004 | 48.706 |
| xizang | 40 | -0.663 | 250.6 | 7.175 | 39.51 | 6.068 | 37.89 | 2274.324 |
| gansu | 40 | -0.290 | 2.123 | 0.324 | 0.372 | 2.935 | 14.98 | 296.629 |
| guangxi | 40 | -0.091 | 1.078 | 0.330 | 0.228 | 0.643 | 4.314 | 5.634 |
| hebei | 40 | -0.166 | 0.920 | 0.322 | 0.286 | 0.345 | 2.386 | 1.422 |
| ninbo | 40 | -0.093 | 0.798 | 0.258 | 0.224 | 0.697 | 2.876 | 3.264 |

In Table 1, the skewness, kurtosis, and JB statistics show that the growth rates of health insurance premiums in the five provinces and municipalities of Tibet, Gansu, Hainan, Qinghai and Chongqing are completely not following the normal distribution. The growth rates of health insurance premiums in the five provinces and municipalities of Shanxi, Inner Mongolia, Shanghai, Tianjin and Xinjiang are more in line with the normal distribution. From the minimum point of view, health insurance premiums in Ningxia and Xinjiang have both shown strong growth, and have not even shown signs of decline. From the perspective of skewness, the growth rates of health insurance premiums in Hunan, Tianjin, Shanxi, and Shanghai showed a clear left-biased characteristic, and it took longer to recover after falling into a recession. long. From a regional point of view, the trajectory of the growth rate of health insurance premiums in Tibet is completely different from other regions and behaves uniquely [17].

## 4. Evaluation of the treatment effect

Based on the "counterfactual" analysis method of HCW (2012) and the software package developed by Vega-Bayo (2015) [18], the samples before the establishment of the Qianhai Cooperation Zone are used to fit the "counterfactual" of the growth rate of health insurance premiums, and the optimal control group is selected based on the AICC criterion, and the weight of the optimal control group is obtained (see Table 2).

Table 2 Weights of the optimal control group

| Control group | Growth rate of health insurance premiums | Standard error | T statistics |
|---|---|---|---|
| tianjing | 0.6822*** | 0.1166 | 5.8532 |
| jiangxi | -0.1504* | 0.0591 | -2.5462 |
| qinghai | 0.4848* | 0.1613 | 3.0061 |
| xizang | -0.0018** | 0.0004 | -4.6688 |
| 截矩 | 0.0108 | 0.0453 | 0.2371 |
| Adj_R2 | 0.934 | | |

notes: *** p<0.01, ** p<0.05, * p<0.1

Table 2 shows that the growth rate of health insurance premiums in Shenzhen can be explained by 93.4% by the growth rates of health insurance premiums in Tianjin, Jiangxi, Qinghai and Tibet. The coefficients of each explanatory variable are very significant, and the coefficient of determination of the regression equation has also reached an ideal level, indicating that the “counterfactual” of the Shenzhen health insurance premium growth rate after the establishment of the Qianhai Cooperation Zone is well fitted.

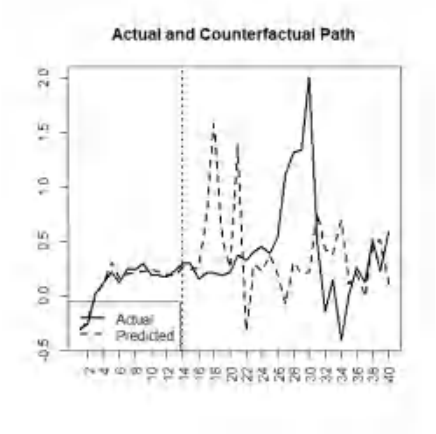


Figure 2 True value and "counterfactual" value of Shenzhen health insurance premium

Figure 2 shows that the establishment of the Qianhai Cooperation Zone has restrained the fluctuations in the growth of Shenzhen health insurance premiums in the short term, which is manifested in the fact that the real growth rate is more stable than the "counterfactual" growth rate from the second quarter of 2014 to the second quarter of 2016. Subsequently, under strict supervision and control, the real growth rate and the "counterfactual" growth rate gradually converged. On the whole, the establishment of Qianhai Cooperation Zone has two effects, restraining and amplifying the fluctuations in Shenzhen health insurance premiums. In the early stage of policy implementation, the industry often adopted a cautious strategy of waiting and seeing, experimenting, learning, and summarizing. Once policies and market opportunities were discovered, they would boldly advance and amplify volatility. Figure 2 also shows that in the mid-term implementation of the Qianhai Cooperation Zone policy, Shenzhen's insurance industry may improperly use health insurance to raise short-term liquidity.

Table 3 The Pulling effect from the establishment by the Qianhai Cooperation Zone

| quarter | Real growth | Predicted growth | odds |
|---|---|---|---|
| 2012Q3 | 0.294 | 0.243 | 0.050 |
| 2012Q4 | 0.159 | 0.268 | -0.109 |
| 2013Q1 | 0.209 | 0.728 | -0.520 |
| 2013Q2 | 0.207 | 1.585 | -1.378 |
| 2013Q3 | 0.184 | 0.508 | -0.324 |
| 2013Q4 | 0.215 | 0.256 | -0.041 |
| 2014Q1 | 0.372 | 1.408 | -1.036 |
| 2014Q2 | 0.329 | -0.328 | 0.657 |
| 2014Q3 | 0.408 | 0.298 | 0.109 |
| 2014Q4 | 0.456 | 0.225 | 0.231 |
| 2015Q1 | 0.388 | 0.376 | 0.011 |
| 2015Q2 | 0.551 | 0.193 | 0.358 |
| 2015Q3 | 1.115 | -0.080 | 1.196 |
| 2015Q4 | 1.321 | 0.309 | 1.012 |

| | | | |
|---|---|---|---|
| 2016Q1 | 1.348 | 0.202 | 1.146 |
| 2016Q2 | 2.014 | 0.215 | 1.799 |
| 2016Q3 | 0.472 | 0.766 | -0.294 |
| 2016Q4 | -0.141 | 0.430 | -0.571 |
| 2017Q1 | 0.146 | 0.384 | -0.238 |
| 2017Q2 | -0.410 | 0.694 | -1.104 |
| 2017Q3 | 0.009 | 0.110 | -0.101 |
| 2017Q4 | 0.260 | 0.200 | 0.060 |
| 2018Q1 | 0.126 | -0.012 | 0.138 |
| 2018Q2 | 0.515 | 0.471 | 0.044 |
| 2018Q3 | 0.229 | 0.513 | -0.284 |
| 2018Q4 | 0.590 | 0.112 | 0.478 |
| Mean | 0.437 | 0.388 | 0.050 |
| St dev. | | | 0.706 |
| T statistic | | | 0.702 |

Table 3 shows that the establishment of the Qianhai Cooperation Zone has an average pulling effect on Shenzhen's health insurance premium growth rate of 5%. The t-test shows that this pulling effect is more significant at the 10% level. The policy effect of the establishment of the Qianhai Cooperation Zone on the growth of health insurance premiums in Shenzhen is mainly manifested in increasing the periodic growth rate of health insurance premiums and amplifying the volatility of the growth. It can be seen that Shenzhen's insurance industry has the possibility of using health insurance to raise short-term liquidity, and the abnormal increase in health insurance premiums is more in line with Qianhai Life's acquisition attempt of Vanke in terms of time.

## 5. Placebo test

Due to the small number of potential control areas, HCW is not suitable for large-sample statistical inference. The “placebo test” of Abadie et al. (2010) should be used for testing to determine whether the health insurance premium growth effect of the Qianhai Cooperation Zone is just caused by random factors. To this end, it is necessary to randomly select one from the control areas to conduct a "counterfactual" analysis, to examine whether this randomly selected area has a "placebo effect", and to compare this effect with the treatment effect in Shenzhen.

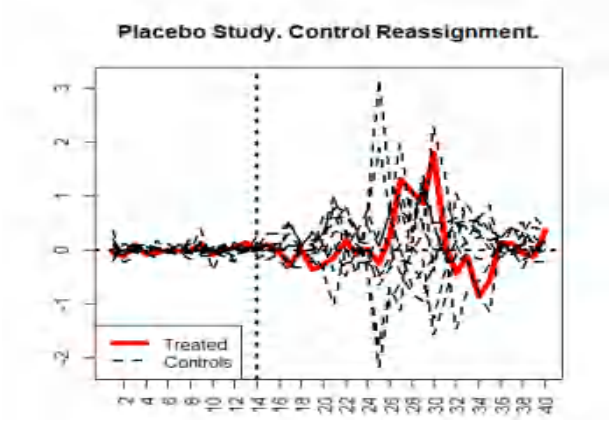


Figure 3 Placebo test of the adjustment control group

Figure 3 shows that in the placebo test of the adjustment control group, the growth rate sbe seen that if other regions have similar policies, their health insurance premiums will also increase rapidly. The rapid growth and phased abnormal growth of health insurance premiums in Shenzhen are all related to the establishment of the Qianhai Cooperation Zone.

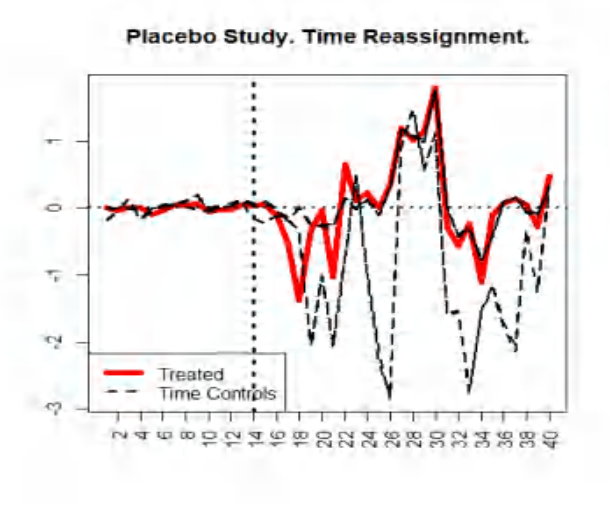


Figure 4 Placebo test under the reset establishment time of the cooperation zone

Similarly, has the growth trend of health insurance premiums in Shenzhen started long before the establishment of the Qianhai Cooperation Zone? In order to test whether it is due to the policy, we assume that the cooperation zone is established 5 quarters in advance to examine whether there is any change in the growth of Shenzhen health insurance premiums. In Figure 4, the placebo test results of the adjustment of the establishment time of the cooperation zone show that the overall trend of Shenzhen health insurance premium growth has not changed significantly. The real growth rate is generally higher than the "counterfactual" growth rate, and the fluctuation range is less than the "counterfactual" growth rate. The growth rate shows that the establishment of the Qianhai Cooperation Zone has promoted and stabilized the development of Shenzhen's health insurance.

## 6. Conclusions and implications

Based on the panel data of health insurance premium growth rates in 36 provinces, municipalities, and coastal independently-budgeting cities in China, the HCW (2012) model was used to construct a counterfactual on the growth rate of Shenzhen health insurance premiums to measure the policy effect of the establishment of the Qianhai Cooperation Zone. Empirical results show that the establishment of the cooperation zone stabilized the growth rate of Shenzhen health insurance premiums in the early stage, and that it significantly increased the growth of health insurance premiums and magnified the growth rate in the medium term. In the end, with the joint efforts of the industry and the supervisory authorities, the policy effect of the cooperation zone gradually returned to stability.

From the two-dimensional perspective of supervision and the industry, the policy effect of the establishment of the Qianhai Cooperation Zone on the growth of Shenzhen health insurance premiums has undergone a trial and error, from slow release to potential explosion and rapid growth, and then to rationality and stable promotion. It can be seen that the financial reform innovation experiment may cause abnormal market volatility due to improper policy design at the initial stage. After the initial multi-party and multi-round game , cautious trial and adjustment, the policy effect may will erupt in the middle of the experiment, which will trigger huge market volatility.

The policy effect of the Qianhai Cooperation Zone on the growth of Shenzhen's health insurance premiums shows that the financial reform experiment can promote the development of the insurance industry and amplify market volatility. The establishment of the Qianhai Cooperation Zone has created incentives for the Shenzhen insurance industry to improperly use health insurance and other short-term debt instruments. The industry has the possibility of unreasonable use of health insurance to raise short-term liquidity. This is evidenced by the fact that Vanke's placard is more consistent.

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# Effect of Basic Medical Insurance & Critical Illness Insurance on Health and Poverty Alleviation

## —Take the Hospital Costs of Rural Patients With Cardiovascular Diseases in Henan Province as an Example

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**Keywords:** new rural cooperative medical insurance, basic medical insurance for urban and rural residents,critical illness insurance,catastrophic medical expenditure

**Abstract.** Today, disease has become the most prominent poverty-causing factor among the rural poor. Since 2016, my country has implemented the health poverty alleviation project. This is an important deployment for safeguarding the health rights of the rural poor and solving the problem of poverty caused by illness and the return of poverty due to illness. The basic medical insurance and critical illness insurance system are important components of my country's multiple medical security system. Realizing full coverage of basic medical insurance and critical illness insurance is one of the most important measures for health poverty alleviation. With the continuous deepening of poverty alleviation through health, the coverage of basic medical insurance and critical illness insurance in rural areas has continued to expand. In order to thoroughly investigate the effects of basic medical insurance and critical illness

insurance systems in reducing catastrophic medical expenditures and avoiding poverty and returning to poverty due to illness, in the context of health poverty alleviation, the following will use the average hospitalization cost of cardiovascular disease patients in a third-class hospital in Henan Province, combined with the local The medical insurance policy measures out-of-pocket medical expenses, combined with catastrophic medical expenditure standards, analyzes the risk gap of poverty-returning poverty among rural residents of different income groups, and then evaluates the health and poverty alleviation effects of basic medical insurance and critical illness insurance.

## 1. 研究背景

因病致贫返贫已成为农村居民陷入贫困的首要原因。截至 2015 年底，国务院扶贫办建档立卡数据显示，因病致贫返贫人数占到全部建档立卡人数的 40%以上。为解决农村居民因病致贫返贫问题，2016 年 6 月，多部门联合印发《关于实施健康扶贫工程的指导意见》，对健康扶贫的工作重点做出了详细安排，确保农村贫困人口获得基本医疗保障，并加大大病保险的支持力度，有效降低就医负担，是解决因病致贫返贫的重要方面。国家医保局发布的《2019 年医疗保障事业发展统计快报》的数据显示，基本医疗保险覆盖面不断扩大，截至 2019 年底，农村建档立卡户参保率达 99.9%，政策惠及贫困人口超两亿人次。为建立起长期高效的健康扶贫机制，需探索基本医疗保险+大病保险的减贫效果。我国有近 3 亿的心血管疾病患者，其致死率居各类疾病之首，且农村地区的致死情况更加糟糕，致死人数占农村总死亡人数的比例超过 45%。心血管疾病次均住院费用一直处于高位。以心血管疾病患者的次均住院费用为例，研究基本医保+大病保险的健康扶贫效果具有代表意义。

## 2. 河南省基本医疗保险与大病保险政策

### 2.1 基本医疗保险政策

2014-2016 年期间，河南省实施新型农村合作医疗保险制度，省级三甲医院住院补偿的起付线为 2000 元，2000-7000 元（包含）、7000 元以上的报销比例分别为 45%、65%，住院补偿封顶线为 20 万元（表 1）。

表 1 2014-2016 年河南省新型农村合作医疗保险住院起付标准和报销比例

| 医院层级 | 起付标准（元） | 住院医疗费用 | 报销比例 |
|---|---|---|---|
| 省级三级医院 | 2000 | 2000—7000 元 | 45% |
| | | 7000 元以上 | 65% |

资料来源：河南省人民政府网站

2017 年 1 月 1 日起，河南省开始实施统一的城乡居民基本医疗保险制度，省级三级医院的起付标准下降至 1500 元，1500-7000 元、高于 7000 元之间，报

销比例依次为50%、68%。为推动分级诊疗，引导患者合理就医，2018年河南省上调省级三级医院的住院补偿起付线至2000元，且报销比例保持不变（表2）。

表2 2017-2018年河南省城乡居民医疗保险住院起付标准和报销比例

| 医院层级 | 时间 | 起付标准（元） | 住院医疗费用 | 报销比例 |
|---|---|---|---|---|
| 省级三级医院 | 2017 | 1500 | 1500-7000元 | 50% |
| | | | 7000元以上 | 68% |
| | 2018 | 2000 | 2000-7000元 | 50% |
| | | | 7000元以上 | 68% |

资料来源：河南省人民政府网站

## 2.2 大病保险政策

2014年-2016年期间河南省实施新农合大病保险制度，省内三甲医院就医的参保患者住院补偿起付线均为1.5万元，2014年三段区间报销比例依次为50%、55%、65%，2015年上调了部分区间的报销比例，2016年延续2015新农合大病保险报销政策（表3）。

表3 2014-2016年河南省新农合大病保险报销比例

| | 2014年 | 2015年 | 2016年 |
|---|---|---|---|
| 起付线 | 1.5万 | 1.5万 | 1.5万 |
| 第一档次 | 区间：1.5-5万（含5万）<br>报销比例：50% | 区间：1.5-5万（含5万）<br>报销比例：50% | 区间：1.5-5万（含5万）<br>报销比例：50% |
| 第二档次 | 区间：5-10万（含10万）<br>报销比例：55% | 区间：5-10万（含10万）<br>报销比例：60% | 区间：5-10万（含10万）<br>报销比例：60% |
| 第三档次 | 区间：高于10万<br>报销比例：65% | 区间：高于10万<br>报销比例：70% | 区间：高于10万<br>报销比例：70% |
| 支付限额 | 30万 | 30万 | 30万 |

资料来源：河南省人民政府网站

河南省自2017年1月起，实施城乡居民大病保险，将封顶线上调至40万元，采用分段报销方式，1.5-5万元、5-10万元、高于10万元三段区间的报销比例依次为50%、60%、70%。除此之外，2018年实施了农村贫困人口的倾斜报销政策，大病保险住院补偿起付线降至0.75万，三段区间的报销比例也有了显著提高（表4）。

表 4 2017-2018 年河南省城乡居民大病保险报销比例

| 项目 | 2017 | 2018 | |
|---|---|---|---|
| 适用人群 | 参加城乡居民基本医保 | 参加城乡居民基本医保 | 参加城乡居民基本医保的农村贫困人口 |
| 起付线 | 1.5 万 | 1.5 万 | 0.75 万 |
| 第一档次 | 区间:1.5-5 万(含 5 万) 报销比例：50% | 区间：1.5-5 万（含 5 万）报销比例：50% | 区间：0.75-5 万（含 5 万）报销比例：80% |
| 第二档次 | 区间：5-10 万（含 10 万）报销比例：60% | 区间:5-10 万(含 10 万) 报销比例：60% | 区间：5-10 万（含 10 万）报销比例：85% |
| 第三档次 | 区间：高于 10 万 报销比例：70% | 区间：高于 10 万 报销比例：70% | 区间：高于 10 万 报销比例：95% |
| 支付限额 | 40 万 | 40 万 | 40 万 |

资料来源：河南省人民政府网站

## 3. 基本医疗保险+大病保险减贫效果的测算分析

### 3.1 数据来源

为进一步研究 2014-2018 年基本医保＋大病保险的减贫效果，下文使用河南省心血管患者次均住院费用进行测算[1]。该项目记录的 2015-2017 年心血管疾病手术患者次均费用，费用计算包含床位费、检查费、治疗费、手术费、药品费等数据。根据 2015-2017 年城乡居民心血管疾病次均住院费用的年均增长率计算得出 2014 年与 2018 年城乡居民心血管疾病次均住院费用（表 5）。

表 5 2014-2018 年心血管疾病手术患者次均费用

| 年份 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| 费用（元） | 51071.65 | 52204.69 | 54441.34 | 54473.47 | 55655.54 |

数据来源:《基于结构变动度的城乡居民医保心血管疾病手术患者次均住院费用控制研究》

### 3.2 基本假设

假设 1：合规费用的假定。本文假设心血管疾病患者的住院就医费用全部是合规费用。

假设 2：报销比例假定。我国药品与医疗服务项目分为甲乙丙三类，三类药品与医疗服务项目报销规则差异较大。本文假设住院所产生的医疗费用均属于社保目录之内且无自费。

[1] 河南省心血管患者次均住院费用的数据来源于河南省医学科技攻关计划项目资助的《基于结构变动度的城乡居民医保心血管疾病手术患者次均住院费用控制研究》一文，文章的第一作者来自阜外华中心血管病医院，第二作者来自河南省人民医院。

假设 3：住院医疗报销待遇假定。本文假设患者产生的次均住院费用仅享受住院医疗补偿待遇，未享受普通门诊医疗、门诊慢性病医疗、重特大疾病医疗补偿待遇。

假设 4：灾难性医疗支出的假定。本文按照世界卫生组织标准，将医疗支出占家庭非食品支出的 40%，作为灾难性医疗支出界定标准，结合河南省政府公布的五类农村居民家庭人均生活消费支出、食品消费支出，与《中国统计年鉴》公布的河南省平均户规模，综合计算出 2014-2018 年五类收入分组的河南省农村居民灾难性医疗支出（表 6）。

表 6 2014 年-2018 年河南省农村居民灾难性医疗支出标准

| 时间 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| 低收入户 | 4626.57 | 5520.28 | 5860.32 | 6249.81 | 7413.34 |
| 中低收入户 | 5672.66 | 6336.59 | 6955.82 | 6936.51 | 8793.71 |
| 中等收入户 | 6829.63 | 7288.50 | 7985.90 | 7836.98 | 9527.54 |
| 中高收入户 | 7853.01 | 8234.99 | 9358.42 | 10402.10 | 11351.21 |
| 高收入户 | 10456.87 | 11782.28 | 14194.22 | 15684.64 | 16159.31 |

资料来源：作者计算整理

## 3.3 报销后自付水平与风险缺口

### 3.3.1 基本医疗保险

假设心血管疾病次均住院费用全部为合规费用，次均住院费用记为 $X$；基本医疗保险住院补偿起付线记为 $A_1$；第一档次基本医疗保险报销比例记为 $\alpha_1$；第二档次基本医疗保险报销起付标准记为 $A_2$，报销比例记为 $\alpha_2$；基本医保报销金额记为 $X_1$；基本医保报销限额记为 $L_1$；基本医保报销后但未经大病保险报销的住院自付费用记为 $M$，则具有以下关系：

若 $X \le A_1$，则 $X_1 = 0$

（1）

若 $A_1 < X \le A_2$，则 $X_1 = (X - A_1) * \alpha_1$

（2）

若 $X \ge A_2$，则 $X_1 = (X - A_2) * \alpha_2 + (A_2 - A_1) * \alpha_1$，但当 $X_1 \ge L$ 时，$X_1 = L_1$

$M = X - X_1$

（3）

根据心血管疾病手术患者次均费用及当地基本医疗保险报销政策，测算出经基本医保报销后的自付费用 $M$。2014-2016 年河南省新农合的报销政策没有变

动，综合报销比例维持在 60.50%-60.78%。2017 年河南省开始实施统一的城乡居民基本医疗保险制度，在政策影响下 2017 年基本医保综合报销比例增长了近 4 个百分点，但由于 2018 年上调了省级三级医院的起付标准，因此 2018 年综合报销比例有了小幅的回落，但仍高于 2014-2016 年的综合报销比例（表 7）。

为进一步衡量基本医疗保险的健康扶贫效果，故使用经基本医疗保险报销后的自付费用与该年不同收入分组的灾难性医疗支出标准进行比较，进而考察基本医疗保险的减贫效果。表 8 显示，2017 年整合城乡居民医疗保险，提高了农民基本医疗保险保障程度，但经基本医保报销后的住院自付费用仍居高位，自付费用高于不同收入分组的农村家庭灾难性医疗支出标准，仅仅依靠基本医保缓解因病致贫返贫现象的程度有限，且收入较低家庭的自付压力远高于收入较高的家庭。因此，为保证健康扶贫的效果，需进一步加大报销比例，并要将大病保险作为衔接制度进行二次报销，以降低因病致贫返贫的发生频率。

表 7 基本医保报销后自付费用与综合报销比例

| 时间 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| 基本医保报销后住院自付费用 M（元） | 20175.08 | 20571.64 | 21354.47 | 19441.51 | 20069.77 |
| 综合报销比例 | 60.50% | 60.60% | 60.78% | 64.31% | 63.94% |

资料来源：作者计算整理

表 8 不同收入分组的自付费用（$M$）与灾难性医疗支出差额

| 年份<br>类别 | 高收入户 | 中高收入户 | 中等收入户 | 中低收入户 | 低收入户 |
|---|---|---|---|---|---|
| 2014 年 | 9718.21 | 12322.07 | 13345.45 | 14502.42 | 15548.51 |
| 2015 年 | 8789.36 | 12336.65 | 13283.14 | 14235.05 | 15051.36 |
| 2016 年 | 7160.35 | 11996.05 | 13368.57 | 14398.65 | 15494.15 |
| 2017 年 | 3756.87 | 9039.41 | 11604.53 | 12505.00 | 13191.70 |
| 2018 年 | 3910.46 | 8718.56 | 10542.23 | 11276.06 | 12656.43 |

资料来源：作者计算整理

3.3．2 大病保险

根据前文基本假设，将基本医保报销后且未经大病保险报销的住院自付费用记为 $M$；第一档次大病保险报销起付标准记为 $B_1$，报销比例记为 $\beta_1$；第二档次大病保险报销起付标准记为 $B_2$，报销比例记为 $\beta_2$；第三档次大病保险报销起付标准记为 $B_3$，报销比例记为 $\beta_3$；大病保险报销金额记为 $X_2$；大病保险报销限额记为 $L_2$；经基本医保＋大病保险报销的住院自付费用记为 $M_1$。则具有以下关系：

若 $M \le B_1$，则 $X_2 = 0$， $M_1 = M$ （4）

若 $B_1 < M \le B_2$，则 $X_2 = (M - B_1) * \beta_1$ （5）

若 $B_2 < M \le B_3$，则 $X_2 = (B_2 - B_1) * \beta_1 + (M - B_2) * \beta_2$ （6）

若 $M \ge B_3$，则 $X_2 = (B_2 - B_1) * \beta_1 + (B_3 - B_2) * \beta_2 + (M - B_3) * \beta_3$，且当 $X_2 \ge L_2$ 时，$X_2 = L_2$

$$M_1 = X - X_2 \quad (7)$$

根据未经大病保险报销的住院自付费用 $M$、2014-2018 年河南省大病保险住院起付标准和报销比例，计算得出经基本医疗保险＋大病保险报销后的住院自付费用 $M_1$。

测算结果显示，经大病保险进行二次报销后，患者次均住院费用的综合报销比例普遍上升 5-6 个百分点。2014-2018 年期间，综合报销比例呈持续上升趋势，尤其是实行倾斜政策后，综合报销比例提高至 82.01%，农村贫困人口的医疗保障程度显著提升。

经测算，2014-2018 年基本医疗保险＋大病保险报销后一般家庭自付费用依次为 17587.54 元、17785.82 元、18177.24 元、17220.76 元、17534.89 元，政策的调整显著减小了农村居民医疗负担，自付住院费用与当年灾难性医疗支出划定标准的差距不断缩小。经 2018 年大病保险倾斜政策报销后农村贫困人口自付费用为 10013.95 元，倾斜政策的实施使自付费用降低了 7520.94 元（表 9）。如果假设低收入户享有倾斜政策的农村贫困人口，那在倾斜政策的保护下，中低收入家庭风险缺口更大，更易因发生大额医疗费用。

由此可见，政策的调整显著减小了农村居民医疗负担，自付住院费用与当年灾难性医疗支出标准的差距不断缩小，尤其是 2018 年的倾斜政策，大幅降低了建档立卡贫困户的住院自付费用（表 10）。尽管如此，经基本医保＋大病保险报销后的自付费用仍高于五类不同收入分组家庭灾难性医疗支出标准，尤其是非建档立卡户但收入偏低的家庭风险敞口最大，发生因病致贫返贫的可能性最高，针对此类人群的健康扶贫效果不明显。

表 9 基本医疗保险＋大病保险报销后自付费用与综合报销比例

| 年份 | 2014 | 2015 | 2016 | 2017 | 2018 | |
|---|---|---|---|---|---|---|
| 适用人群 | 参加基本医疗保险 | | | | | 贫困人口 |
| 基本医保＋大病保险报销后的住院自付费用 $M_1$（元） | 17587.54 | 17785.82 | 18177.24 | 17220.76 | 17534.89 | 10013.95 |
| 综合报销比例（%） | 65.56% | 65.93% | 66.61% | 68.39% | 68.49% | 82.01% |

资料来源：作者计算整理

表 10 不同收入分组的自付费用（$M$）与灾难性医疗支出差额

| 年份<br>类别 | 高收入户 | 中高收入户 | 中等收入户 | 中低收入户 | 低收入户 |
|---|---|---|---|---|---|
| 2014 年 | 7130.67 | 9734.53 | 10757.91 | 11914.88 | 12960.97 |
| 2015 年 | 6003.54 | 9550.83 | 10497.32 | 11449.23 | 12265.54 |
| 2016 年 | 3983.02 | 8818.82 | 10191.34 | 11221.42 | 12316.92 |
| 2017 年 | 1536.12 | 6818.66 | 9383.78 | 10284.25 | 10970.95 |
| 2018 年 | 1375.58 | 6183.68 | 8007.35 | 8741.18 | 2600.61 |

资料来源：作者计算整理

## 4. 基本医疗保险+大病保险的健康扶贫政策优化

### 4.1 进一步提高基本医疗保险与大病保险的保障水平

基本医疗保险与大病保险制度一定程度上减少了农村居民的自付费用，但其起付线与报销比例的设置决定了制度的保障水平。上文分析得出：基本医疗保险与大病保险缓解了因病致贫返贫现象，但是却不能避免因病致贫返贫。因此，应参考当地的经济发展水平、医保基金运行状况、医疗膨胀状况等因素，调整基本医疗保险与大病保险的起付线和报销比例，建立相应起付标准与报销比例的调节机制。与此同时，各地政府应该建立常见门诊慢性病和重特大疾病的报销政策，并不断扩展病种范围，进一步提高农村居民的医疗保障水平。

### 4.2 增强边缘贫困人口的保障水平

现行健康扶贫政策下，大病保险对于低收入家庭的保障水平更加充分。但边缘贫困人群、脆弱人群的抗风险能力也普遍较弱，如果不设置特殊的政策保护，发生灾难性医疗支出陷入贫困的概率很高。因此在健康扶贫过程中，应当对边缘贫困人口等脆弱人群进行精准识别，并根据当地的经济发展水平、医保基金收支状况，出台照顾政策，以确保健康扶贫政策惠及更多农村的居民，切实发挥基本医疗保险与大病保险的减贫作用。

### 4.3 促进商业健康保险对医疗保障体系的补充作用

基本医疗保险与大病保险是我国多层次医疗保障体系的重要组成部分，“广覆盖、保基本”的制度定位，决定了仅仅依靠基本医疗保险和大病保险制度难以转移大病风险，亟须发挥商业健康保险对医保制度的补充作用。近年来，商业保险公司积极创新保险产品与商业思维下沉健康险市场，普惠保险发展速度极为迅猛。为发挥商业健康保险对医保体系的补充作用，并为农村地区的健康扶贫工程添砖加瓦，各商业保险公司应在控制道德风险的基础上，开发“低门槛”的针对农村人口的普惠保险。同时，为增加农村居民对商业健康险的认可度，应由当地政府部门牵头设计和推广农民普惠保险，例如举办惠民保险发布会，由当地主要领导解说产品并呼吁农民参保，并通过当地官方媒体进行强宣传，又如联合当地

农商行等农民心中可信度较高的金融机构联合推广普惠保险产品，助力发挥商业健康保险对医保体系的补充作用。

### 4.4 推进信息化体系建设、推行互联网+健康扶贫

随着互联网、大数据、人工智能等技术的快速发展，互联网+健康扶贫作为助力脱贫攻坚的新模式，大幅提高了扶贫效率与质量。政府应出台相关政策鼓励并规范健康扶贫综合信息化基础平台的建设，运用大数据、物联网、人工智能等新兴技术助力精准识别困难户、搭建远程诊疗平台、搭建在线慢病健康管理平台、搭建家庭医生诊疗服务平台，努力补齐城乡医疗资源分配不均、农村地区医疗服务水平低的短板。在互联网+健康扶贫的模式下，投入较少的成本就可以让农村贫困人口获得优质的医疗资源。与此同时，基于电子健康档案、电子医保支付体系，实现农村贫困人口就医与诊疗支付的监测与“一站式”结算，通过规范医院医生的诊疗服务，减轻农村贫困人口的就医经济负担。

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# 基本医疗保险＋大病保险的健康扶贫效果研究

## ——以河南省心脑血管农村患者住院费用为例

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**摘要：**如今，疾病已成为农村贫困人口中最为突出的致贫因素。我国自 2016 年实施健康扶贫工程，这是维护农村贫困人口健康权益，解决农村贫困人口因病致贫、因病返贫问题的重要部署。基本医疗保险与大病保险制度是我国多重医疗保障体系的重要组成部分，实现基本医疗保险与大病保险的全覆盖是健康扶贫工作的最重要举措之一。随健康扶贫工作的不断深入，农村地区基本医疗保险与大病保险的覆盖面不断扩大。为详尽考察健康扶贫背景下，基本医疗保险与大病保险制度在减少灾难性医疗支出，避免因病致贫返贫的效果，下文将运用河南省某三甲医院心脑血管患者次均住院费用，结合当地医保政策，对自付医疗费用进行测算，结合灾难性医疗支出标准，分析不同收入分组的农村居民的因病致贫返贫的风险缺口，进而评估基本医疗保险与大病保险的健康扶贫效果。

**关键词：**新农合；城乡居民基本医疗保险；大病保险；灾难性医疗支出

# Investigation and Research on the Purchase Behavior and Satisfaction of Million Medical Insurance in Hebei

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**Key words:** Million medical insurance；Questionnaire survey method；Dual logistics model

**Abstract：** With the rapid development of my country's economy, people's living standards and fast-paced daily life make our residents in a sub-healthy state is called a common phenomenon, and the overall health status of residents needs to be improved. The rapid advancement of science and technology has brought about new medical technology diagnosis and treatment methods that have increased the cost of residents' medical treatment. Given that my country's basic medical insurance is still insufficient, the development of commercial health insurance is also very necessary. As an important part of commercial health insurance, one million medical insurance occupies an important position in my country's multi-level medical security system.

However, the current development of one-million-dollar medical insurance is stuck in bottlenecks such as product homogeneity and lack of innovation. Consumers' buying behavior and product satisfaction are the direct driving factors to further tap the potential of the million-dollar medical insurance market. The development of millions of medical insurance is of great significance.

This article first conducted a questionnaire survey on residents of 11 cities in Hebei Province to understand their millions of medical insurance purchase behaviors and satisfaction. The survey content mainly includes three parts: the basic information of the interviewee, the satisfaction of the insured person and the reason for not purchasing. The survey lasted for three months, and 1195 valid questionnaires were returned. Subsequently, based on the results of the questionnaire survey, a descriptive analysis and empirical research on the factors affecting the purchasing behavior and satisfaction of millions of residents in Hebei Province were conducted. The empirical results show that age and the strength of social medical insurance have a significant negative impact on the purchase of million medical insurance, while occupation, income level, insurance claim experience and understanding of the million medical insurance significantly positively affect the purchase of million medical insurance Behavior; education level, insurance claim experience, product classification by social insurance, waiting period and humanized services significantly affect the satisfaction of the insured with the millions of medical insurance purchased. Finally, based on the analysis of the status quo of Hebei Province million medical insurance and the empirical research results of purchase behavior and satisfaction factors, the countermeasures and suggestions for the development of Hebei Province million medical insurance are proposed, including that insurance companies should strengthen online and offline cooperation and correctly guide Consumers; target specific groups of people and dig deeper into customer needs; integrate medical resources to enhance customer experience; carry out product form innovation and product technology innovation, and provide differentiated services; consumers should correctly understand the insurance category and establish a correct insurance concept.

# 1 研究背景

人生可期，健康无价。健康，是人类美好的愿望与追求之一。习近平总书记在十九大报告中将 “健康中国”的发展战略提升为国家发展基本方略，国务院也于 2019 年 7 月印发《国务院关于实施健康中国行动的意见》。随着我国经济的飞速发展和人民生活水平的稳步提高，变化的饮食结构、快节奏的城市生活使得我国部分城镇人口长期处于亚健康状态，我国居民健康状况仍有待提升，与此同时，人口老龄化的快速发展也在进一步降低居民整体健康状况。近年来我国居民就诊人次、住院人数连年攀升，一方面或因公共医疗卫生资源覆盖面更广，但另一方面也揭示了居民健康状态仍然有待提升。与此同时，随着科技的快速发展与科技水平的逐步提高，新的医疗技术、诊疗手段和新的药品层出不穷，这既是广大居民的“福音”，又为一些收入不高的家庭带来了沉重的负担。门诊费用和住院费用的连年增长均揭示着居民看病成本进一步提升，“看病贵”“看病难”的问题仍有待进一步解决。

商业医疗保险作为商业健康险的重要组成部分，在我国多层次医疗保障体系中占据着重要地位。商业医疗保险包括低端、中端和高端三个种类，百万医疗保险是中端商业医疗保险的主体部分，主要包括普通医疗保险、意外伤害医疗保险、住院医疗保险、手术医疗保险和特种疾病保险等险种，因其保额高（可达上百万）而被称为“百万医疗险”。2016 年，众安保险公司创新推出“众安医疗尊享 e 生”，此后随着互联网技术的发展，众多百万医疗险产品如雨后春笋般频繁推出。2019 年百万医疗险原保费收入达 345 亿元，用户规模已达 6300 万人，发展速度极快。然而随着百万医疗险的快速发展，市场竞争激烈，各家保险公司提供的百万医疗险产品大同小异，缺乏创新，产品面临同质化的风险；同时因其不保证续保、免赔额高等缺点，在市场上引起了诸多争议，监管部门也多次发文监管百万医疗险，百万医疗险的发展已达到瓶颈状态。

中国保险行业协会发布的《2018 中国商业健康保险发展指数报告》调研报告显示，2018 年我国商业健康险市场的渗透率仅为 9.1%，商业健康险发展指数为 63.0，整体发展水平处于低位，要促进我国商业健康险行业的健康快速发展，促进百万医疗险行业攻克瓶颈继续发展，探究居民不愿购买百万医疗险、商业健康险的原因显得很重要。在此背景下，研究河北省百万医疗险发展现状，利用实地调研数据分析河北省居民百万医疗险购买需求及影响因素，对化解河北省百万医疗险发展面临的难题有着重要意义。

# 2 文献综述

## 2.1 关于商业健康险及百万医疗险发展的研究

商业健康保险在国外兴起的比较早，因而国外学者们对于商业健康险的理论研究也开始的较早。Arrow（1963）认为商业保险是规避风险的需要，他第一次运用期望效用函数论证了信息不对称问题对商业健康保险的影响，同时讨论了风险厌恶情况下逆向选择和道德风险对商业健康保险有影响；Browne M（1992）同样认为信息不对称会对消费者投保商业健康保险有影响，他研究了个人健康保险市场的相关数据，发现处于低风险状态的消费者反而购买保险较少，这也揭示了商业健康险市场的逆向选择现象;Krosnick 和 Gilmer(1999)在研究了 1979-1995

这 16 年间的美国健康险数据后发现，在员工个人偏好和人均医疗费用支出增速过快的影响下，美国健康保险覆盖率呈逐步下降趋势；学者 Gordon（2003）在对中国农村健康水平进行考察研究后提出商业健康保险的产生和发展会完善社会保障的范围，进而对整个社会的保障水平产生积极的促进作用，因而政府需要对商业健康险的发展给予高度重视；Butler（2006）则侧重于考察商业健康险与社会医疗险之间的关系，他认为这两类保险是相辅相成互相促进的关系，最终共同提高居民的健康保障水平；

我国于 1994 年开始正式发展商业健康险，从那之后关于商业健康保险发展的研究也逐步展开。李珍（1995）是国内最早开始研究商业健康险的学者之一，她借鉴日本和美国商业健康保险的发展经验，提出我国应发展多层次、多类型、多品种的商业健康保险来满足人民群众对健康的需求；陈滔等（1998）在讨论了我国商业健康保险的市场潜力和当前经营环境后，提出在政府加大支持力度提供政策优惠的同时，保险公司也要同国家配合共同建立好我国的社会保障体系，两方协力构建中国特色社会保障制度；王沁等（2017）总结出我国商业健康保险在供需关系、市场主体、产品种类和行业竞争等方面存在着不同发展趋势，对此保险公司应当找准自身定位，提升风险管理能力，建立起完备的健康产业；蒋丽彤（2018）基于空间杜宾模型，提出基本医疗保险对我国的商业健康保险发展有明显的促进作用，各地区之间商业健康保险的发展呈共同促进的趋势，因此我国在发展商业健康保险时务必要注意地区发展失衡的问题；而崔梦宵（2019）则从保险公司内部视角和经济社会外部视角来分析北京地区商业健康险的发展现状，通过将潜在影响因素代入多元回归模型，她发现生活环境的改善和人口健康水平的提升会抑制北京市商业健康保险的发展。

因百万医疗险出现时期较晚，截止 2020 年底仅有 4 年时间，故而国内学者对百万医疗险的相关研究较少。董斌（2018）运用保险精算定价相关知识，结合众安“尊享 e 生 2016 款”，创新产品设计和费率设计；李浩（2019）认为我国的高端医疗保险可以在百万医疗险的基础上借鉴西方国家的私人医疗保险制度发展得来；孙东雅（2019）认为百万医疗险具有一定创新价值，可以完善我国的医疗保障体系，但是需要政府和相关部门加强政策引导与监管；陈诗秋（2020）则从百万医疗险与重疾险的对比角度找出百万医疗险的特点与优点，同时结合银保监会的文件对百万医疗险的不足提出了相应解决方案。

## 2.2 关于商业健康险及百万医疗险需求的研究

Dardanoni 和 Wagstaff（1987）构建了不确定性投资模型，在对大量数据进行实证研究的基础上提出不确定性收入对商业健康保险的需求有着正向促进作用；Jeske 和 Kitao（2007）在细分了不同收入阶层的人群后，认为税收优惠政策对高收入群体的商业健康险需求与正向促进作用，对低收入群体反而有一定制约作用；Appiah 和 Aryeetey（2012）运用主成分分析方法对加纳共和国 3301 户家庭调查数据进行分析，发现政策因素与商业健康保险需求的相关性最强；Krueger 和 Kuziemko（2013）对美国失业人群进行了抽样调查，分析得出对失业人群来说，商业健康保险价格越高，他们越不会购买，但对投保商业健康保险进行财政拨款后会增加其覆盖规模。

国内学者对商业健康险需求影响因素的研究较多。锁凌燕等（2015）创造性的构建健康保险发展指数，对 2004-2013 年这 10 年数据进行实证检验，研究发现各地区经济水平、医疗卫生资源、教育水平和预期寿命等因素的差异是导致我

国健康保险区域发展失衡的重要影响因素；朱铭来等（2016）采用天津市抽样调查数据构建税收优惠政策下的“需求—收入”两部模型,预测出个人收入对购买商业健康保险正向相关,且税收优惠政策对商业健康保险的购买有极大促进作用；杨波等（2018）利用固定效应模型对我国 31 个地区 2006-2015 年面板数据进行实证研究，结果显示人均收入与预期寿命对商业健康险的需求存在正相关关系；唐琳（2019）同样利用固定效应模型，从人口结构角度对我国 31 个地区面板数据进行实证研究，认为人口少儿化、老龄化和高教育水平化可以显著地增加商业健康险的需求；黄可心（2019）采用灰色模型预测出成都市商业健康保险存在需求缺口,之后分别从需求侧和社会层面给出缓解成都市商业健康保险发展不均衡的对策建议；姜俏（2020）采用系统 GMM 模型对河南省商业健康险需求做了分析，发现市场集中度对商业健康保险需求有显著正向影响，因而需要加大保险宣传；朱铭来等（2020）再次利用天津市调研数据测算出商业健康险的需求价格弹性为-0.22，提出通过提高免税限额、提高从价补贴率和实行补充医疗保险附加税方案来刺激商业健康保险需求。

谢园（2019）运用问卷调查法与二元 logit 模型对我国居民对百万医疗险的认知度和认可度做了分析，分别从基本特征和产品特征入手，认为理赔经历、免赔额、认知程度、治疗手段和用药范围这几个因素都会影响居民对百万医疗险的认可度；李家琦（2019）分析了人保健康、泰康在线和华夏健康三家公司各自百万医疗险产品对比后，为消费者提出投保建议；宋占军（2020）则结合银保监会的规定和百万医疗险的特征对居民配置投保百万医疗险和保险公司改进百万医疗险产品给出了相应建议。

综合国内外对于商业健康险及百万医疗险的研究文献来看,学者们多从宏观经济角度入手,运用常见经济指标来分析商业健康保险与百万医疗保险的发展与需求。首先，对于商业健康保险和百万医疗保险的发展，国内外学者们大多基于保险公司和整个健康险市场的角度来提出对策,少有学者直接从消费者视角出发来研究商业健康保险和百万医疗保险的发展。而对其需求的研究，也多从宏观经济运行的视角来研究商业健康保险和百万医疗保险的需求,采用人均可支配收入、经济发展水平和人口结构等指标构建需求模型,少有通过对消费者的调研来分析个体需求的影响因素。其次国内外研究中大都针对我国健康险及百万医疗险的整体状况，对于以省为单位的研究较少，比较欠缺地区视角的分析。最后，因百万医疗险在国内兴起较晚，关于百万医疗险的相关研究文献较少，对于分地区的百万医疗险发展与需求尚属空白。

因此本文将在借鉴之前学者研究结果的基础上,从河北省居民百万医疗险购买行为入手，运用问卷调查法调研得出河北省居民百万医疗险购买行为画像，利用二元 Logit 回归模型分析出影响河北省居民购买百万医疗险的因素,同时在调查问卷里设计了投保者对于百万医疗险产品设置和附加服务的认可度问题,以期为保险公司进一步改进百万医疗险产品提出参考,最终共同促进河北省商业健康保险和百万医疗保险市场高质量发展。

## 3 河北省百万医疗险发展现状分析

### 3.1 发展历程

市场一般认为我国百万医疗保险首款产品是 2016 年 8 月众安保险推出的“众安尊享 e 生”系列产品，但事实上在 2015 年市场上已经出现了产品雏形。2015

年 8 月 3 日，中宏保险公司正式推出“中宏·宏悦万家团体医疗保险”，已经具有 1 万免赔额和最高 50 万的保额特征。该款保险具有家庭版和企业版两个版本，家庭版是其最亮眼的部分。“宏悦万家”首创家庭共享保额模式，最低参保人数为 3 人；家庭版限定投保人为 22-60 周岁男性或 20-60 周岁女性，子女参保年龄为出生 30 天-23 周岁；在费率方面按被保险人有无社保身份有所区分，已经具有现代百万医疗保险的雏形。

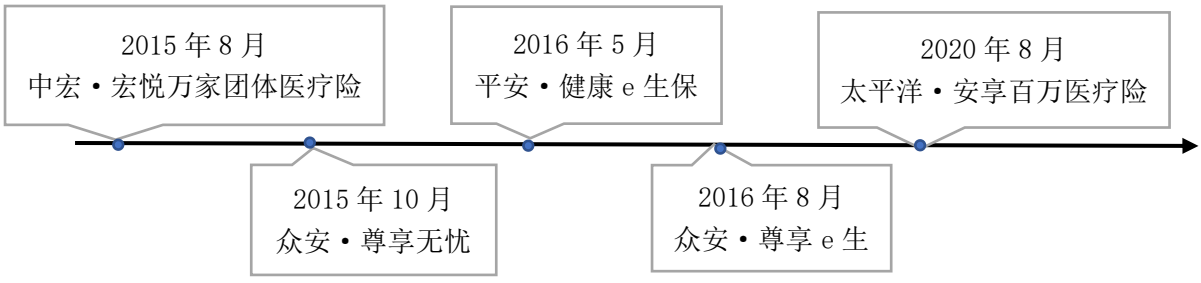
2015 年 10 月，众安保险公司推出“众安·尊享无忧个人住院医疗保险”，实现了由团体险到个险的跨越。“尊享无忧”产品定位在中高端医疗保险，费率一年最低仅 108 元，保额最高可达 30 万；同样，其免赔额为 1 万，保险期限是 1 年，等待期 30 天。但其产品赔付范围仅包括住院期间产生的医疗费用，尚未涵盖全部个人医疗费用支出。

2016 年 5 月，平安保险公司推出“平安·健康 e 生保”，已经与现代百万医疗险形态类似。“健康 e 生保”产品保额最高已经可以达到 100 万，免赔额也为 1 万，保障期限 1 年。该款产品首次区分了有无社保的赔付比例的差别：有社保的被保险人可以做到 100%赔付（赔付限额内），而无社保的被保险人最多只赔付 70%；保险条款里未给出续保承诺，但是实际销售过程中按可持续续保政策执行。

2016 年 8 月，众安保险在“众安·尊享无忧个人住院医疗保险”和“平安·健康 e 生保”基础上，创新推出“众安·尊享 e 生”产品，成为第一款现代百万医疗险。产品最高保额 100 万，罹患癌症后保额翻倍至 200 万，投保年龄在 0-60 周岁，可续保至 80 周岁，1 万免赔额，保险期间 1 年，保费因被保险人有无社保而不同。凭借强大的互联网营销手段，迅速成为当年的爆款网红产品，奠定了百万医疗险的江湖地位。

随着“众安·尊享 e 生”产品的爆红，保险公司纷纷入围百万医疗险战场。截至 2019 年底，共有 69 家保险公司在经营 113 种百万医疗险系列产品，然而随着市场竞争的激烈，不同保险公司之间产品同质化严重，缺乏创新点；产品大多不保证续保，消费者面临产品随时停售的风险。监管部门为了改善这种局面，连续出台了《关于组织开展人身保险产品专项核查清理工作的通知》、《健康保险管理办法》、《关于规范短期健康保险业务有关问题的通知（征求意见稿）》和《关于长期医疗保险产品费率调整有关问题的通知》等规定，为百万医疗险市场创新扫清了法律障碍。

2020 年 8 月，太平洋人寿推出“太平洋·安享百万医疗险”，拉开了百万医疗保险长期保证续保的序幕。该款产品最大亮点是保证续保 15 年，打破了市面上百万医疗保险产品最高仅能续保六年的“传统”，开启了百万医疗保险长期保证续保的新纪元。




综上所述，百万医疗保险产品的发展历程是在保险市场不断竞争的状态下逐步推进的，主要包括产品赔付范围的扩大、有无社保赔付比例的实施、保额的逐

步固定、保证续保的实施、保险期间的延长等方面内容，随着百万医疗保险产品之间同质化现象日趋严重，未来百万医疗保险的发展既需要保险公司对产品做出改进，更需要监管部门的保驾护航。

## 3.2 监管政策梳理

自 2016 年众安保险推出首款百万医疗保险之后，百万医疗保险市场发展极为迅速，监管部门对其的监管也毫不放松。2017 年 5 月原保监会发布的《中国保监会关于弥补监管短板构建严密有效保险监管体系的通知》提出要促进人身保险产品回归保障功能，支持并鼓励大力发展健康险产品，这为百万医疗保险的发展提供了更为广阔的空间，推动其快速发展。

然而随着百万医疗保险的蓬勃发展，一些市场乱象也频繁出现，诸如保险条款模糊、产品投诉过多、保额虚高、虚假宣传等问题层出不穷。2018 年 3 月，原保监会点名批评众安在线保险公司，原因就在于该公司的百万医疗保险产品受到的投诉过多。2018 年 4 月，天津保监局发布《天津保监局加大对“百万医疗”类短期医疗保险监管力度的通知》，通知中对百万医疗保险产品提出具体监管要求，在销售环节要求保险公司在销售百万医疗保险产品时必须向投保人解释清楚产品期限，要明确区分“连续投保”和“保证续保”的概念，明确告知本产品存在停售风险；在理赔环节要求保险公司明确核保细则，提升理赔专业性。紧接着 2018 年 5 月银保监会办公厅同时发布《关于组织开展人身保险产品专项核查清理工作的通知》和《人身保险产品开发设计负面清单》，对百万医疗保险提出了详尽具体的监管意见，首先就是针对市场上产品保额虚高的情况进行整治，其次要求保险公司明确区分长期保险和短期保险，在保险条款中需明确“连续续保”和“保证续保”等概念。6 月，银保监会再次发布《关于互联网渠道短期健康保险续保问题的消费提示》，提示消费者仔细阅读保险条款，在购买时确定能否续保，防止被虚假宣传所误导。

随着监管部门多次出台相关法律法规，百万医疗保险市场得到规范，市场竞争开始有序。2019 年 11 月，银保监会先后发布《健康保险管理办法》、《关于落实<健康保险管理办法> 做好产品过渡有关问题的通知》和《互联网保险业务监管办法（征求意见稿）》，为商业健康保险与百万医疗保险的设计、销售和理赔等方面做出规范。2020 年 1 月，银保监会 2 号文发布《关于规范短期健康保险业务有关问题的通知（征求意见稿）》，通知专门对短期健康险的产品设计、续保、停售、定价等方面进行规范，而百万医疗保险就属于短期健康险，因此可以说这是银保监会对于百万医疗保险在续保问题上最大力度的整治。随后，2020 年 4 月，银保监会发布《关于长期医疗保险产品费率调整有关问题的通知》，为百万医疗保险将保险期间拓展至长期扫平了法律障碍，很快，市场上就出现了诸如“太平洋·安享百万医疗险”这样的长期百万医疗保险产品。

2020 年 11 月，银保监会办公厅发布《关于推进粤港澳大湾区人身保险产品有关工作的通知》，提出发展“粤港澳大湾区创新型跨境医疗保险产品”，这是首款仅在特定区域发售的跨境商业医疗保险产品，对我国百万医疗保险产品的进一步发展具有积极引领作用。

2021 年，银保监会办公厅正式发布《关于规范短期健康保险业务有关问题的通知》，对短期健康险产品续保、费率、免赔额、赔付比例、保险金额、信息发布、销售等做出明确规范，并要求已通过审批但不符合规范的产品应于 2021 年 5 月 1 日前停止销售，打响了规范百万医疗保险的“最严一枪”。

表 1 百万医疗保险相关监管政策规定

| 时间 | 相关监管法规 | 签发单位 |
|---|---|---|
| 2017.5 | 中国保监会关于弥补监管短板构建严密有效保险监管体系的通知 | 原保监会 |
| 2018.4 | 天津保监局加大对“百万医疗”类短期医疗保险监管力度的通知 | 原天津保监局 |
| 2018.5 | 关于组织开展人身保险产品专项核查清理工作的通知 | 银保监会办公厅 |
| 2018.5 | 人身保险产品开发设计负面清单 | 银保监会办公厅 |
| 2018.6 | 关于互联网渠道短期健康保险续保问题的消费提示 | 银保监会 |
| 2019.11 | 健康保险管理办法 | 银保监会 |
| 2019.12 | 关于落实《健康保险管理办法>》做好产品过渡有关问题的通知 | 银保监会办公厅 |
| 2019.12 | 互联网保险业务监管办法（征求意见稿） | 银保监会 |
| 2020.1 | 关于规范短期健康保险业务有关问题的通知（征求意见稿） | 银保监会 |
| 2020.1 | 关于促进社会服务领域商业保险发展的意见 | 银保监会 |
| 2020.4 | 关于长期医疗保险产品费率调整有关问题的通知 | 银保监会 |
| 2020.9 | 关于规范保险公司健康管理服务的通知 | 银保监会办公厅 |
| 2020.11 | 关于推进粤港澳大湾区人身保险产品有关工作的通知 | 银保监会办公厅 |
| 2021.1 | 关于规范短期健康保险业务有关问题的通知 | 银保监会办公厅 |

资料来源：银保监会官网 http://www.cbirc.gov.cn/

## 3.3 河北省百万医疗保险现状分析

### 3.3.1 产品数量众多、集中度高

综合中国保险行业协会及各商业保险公司产品库数据，截止 2020 年底，在河北省销售百万医疗保险产品的保险公司共 87 家，共有 192 种产品及系列在售，产品数量较多，主要销售途径为线上销售。其中寿险及健康险公司 61 家，在售产品共 156 种；财险公司共 26 家，有 36 个产品系列在售（具体产品名录详见附录 2）。

然而，尽管市面上在售产品数量多，但是知名头部产品市场份额占比极高。平安·e 生保系列与众安·尊享 e 生系列作为我国百万医疗保险市场的开拓者与引领者，2019 年系列产品占据市场总份额 80%，二者的成功归因于其强大的销售网络与与时俱进的产品设计。

对于产品销售，平安健康险公司作为国内首批专业商业健康险公司，在健康

险领域深耕多年，其在 2016 年 5 月首推的“平安·健康 e 生保”作为百万医疗保险的雏形产品，市场反响强烈。而众安财险作为全球首家互联网保险公司，在 2016 年创新推出“众安·尊享 e 生”产品，这是市面上第一款现代百万医疗险，借助于其强大的互联网营销手段，“尊享 e 生”系列迅速成为爆款网红产品，从此也奠定了该产品系列在百万医疗险界的地位。

产品精良的设计与优质的服务是其成功的第二大原因。如“平安 e 生保·长期医疗”版，不仅明确表示 20 年保证续保，还推出了专案管理服务，会为每位客户匹配专属的就医管家，为客户匹配合适的医疗资源、定制专业的就医规划，并提供专业医学建议。“众安·尊享 e 生 2020 版”在保险责任 100 种重大疾病医疗的基础上，加入了 121 种罕见病的保障，同时还将罕见病纳入了 0 免赔范围（在首次确诊罹患且在医院接受治疗，自确诊之日起，该被保险人保单的免赔额为 0）。优质的服务与精良的产品设计也使得这两款系列产品一直引领着百万医疗保险产品变更的潮流。

3.3.2　创新获客模式、多方合作推出线上产品

随着互联网的快速发展，线上销售已成为保险公司产品销售的重要途径，而百万医疗保险的产品销售主要途径就是线上。对此，多家传统保险公司与互联网平台合作推出特色百万医疗保险，拓宽销售渠道的同时，也明确了产品特色。如 2019 年，太平财险与水滴保险商城合作推出“太平水滴保百万医疗险 2019 系列”，传统财险公司与互联网保险中介平台强强联合，实现共赢；亚太财险与运动保合作推出特色产品“‘运动无忧’含运动猝死百万医疗险”，突出了运动特色，得到了市场好评。

传统财险公司与互联网巨头的强强联合推出产品也在成为一种趋势。2020 年 4 月，永诚财险与趣头条合作推出“趣易保百万医疗险”，国寿财与京东合作推出“国寿财安心疗百万医疗险”，这些产品的推出，既为传统保险公司的互联网转型提供了新思路，也借助平台高流量推动百万医疗保险产品销售，一举多得。

3.3.3　区域特色产品较少、河北省及雄安区域亟需开发

2020 年 11 月，银保监会办公厅发布《关于推进粤港澳大湾区人身保险产品有关工作的通知》，提出发展“粤港澳大湾区创新型跨境医疗保险产品”。中国人寿保险公司与交银康联人寿保险公司率先响应，分别推出“国寿粤港澳大湾区医疗保险”和“交银康联粤港澳大湾区慧选医疗保险”，具有地区特色。而我国其他地区并无特色百万医疗保险产品，雄安新区作为我国的“千年大计”，未来也亟需地区特色百万医疗保险产品。

## 4　河北省百万医疗保险购买行为与满意度调查分析

### 4.1　问卷基本信息

本调研问卷标题为“河北省居民百万医疗险购买行为及满意度调查问卷”，问卷主要包括卷首部分和主体部分。其中卷首部分包括介绍本次调研目的和介绍开设百万医疗险的主要公司及常见产品，主体部分由受访者基本信息、投保者满意度和未购买原因三部分构成，问卷共设置 28 道题，对已投保者与未投保者分别做了调查，层次分明。

因疫情防控原因，本次调研采取线上发放途径，通过“问卷星”制作并发放问卷。本次问卷的发放与回收持续两个月，时间跨度为 2020 年 10 月 1 日至 2020 年 11 月 30 日，调查面向河北省公众。

问卷设置第11题“您曾经是否购买过商业保险”与第14题“您曾经是否购买过百万医疗险”为矛盾选题，若受访者第11题选择了“否”而第14题选择了“是”，则判定该问卷为无效问卷；另一个无效问卷判定标准为完成度，若未完成即退出填写，则判定为无效问卷。本次问卷共发放1213份，回收有效问卷1195份，有效回收率为98.52%。其中承德市114份，衡水市102份，邢台市97份，保定市116份，张家口市95份，邯郸市122份，沧州市101份，秦皇岛市104份，石家庄市120份，廊坊市110份，唐山市114份。

## 4.2 河北省居民百万医疗保险购买情况分析

问卷中设计了“您曾经是否购买过百万医疗保险?”这一问题，在有效的1195份问卷中，47.62%的受访者购买过百万医疗险，52.38%的受访者没有购买过百万医疗险。总体来看，在抽取的样本中未购买过百万医疗保险产品的受访者比例略低于投保过百万医疗险的受访者，这说明河北省百万医疗险市场发展尚有一定空间。

表2 河北省居民百万医疗保险购买情况

| | 购买过百万医疗险的居民 | 未购买过百万医疗险的居民 | 总计 |
|---|---|---|---|
| 人数 | 569 | 626 | 1195 |
| 比重 | （47.62%） | 52.38% | （100%） |

## 4.3 投保者对百万医疗保险产品设置满意度

根据回收的有效问卷，投保者对百万医疗保险产品的保费定价、免赔额、按社保区分和等待期的满意度如表3所示。对很不合理、不合理、合理、较合理、很合理选项分别赋值为1、2、3、4、5，投保者对保费定价、免赔额、按社保区分和等待期的满意度分别为2.47、2.51、2.84和2.59，各项平均得分均低于3，综合来看满意度较低。

综合来看，投保者对按社保区分的满意度最高，认为区分百万医疗险在投保保费和赔付比例因有无社保而有差别这一设置比较合理。而对保费定价满意度最低，均认为保费偏高，保费定价需要调整。

表3 投保者对百万医疗保险产品设置满意度

| | | 保费定价 | 免赔额 | 按社保区分 | 等待期 |
|---|---|---|---|---|---|
| 很不合理 | 样本数 | 62 | 74 | 49 | 69 |
| | 占比 | （10.9%） | （13.01%） | （8.61%） | （12.13%） |
| 不合理 | 样本数 | 211 | 204 | 122 | 188 |
| | 占比 | （37.08%） | （35.85%） | （21.44%） | （33.04%） |

| | | | | | |
|---|---|---|---|---|---|
| 合理 | 样本数 | 265 | 223 | 283 | 233 |
| | 占比 | （46.57%） | （39.2%） | （49.74%） | （40.95%） |
| 较合理 | 样本数 | 26 | 62 | 103 | 65 |
| | 占比 | （4.57%） | （10.9%） | （18.1%） | （11.42%） |
| 很合理 | 样本数 | 5 | 6 | 12 | 14 |
| | 占比 | （0.89%） | （1.05%） | （2.11%） | （2.46%） |
| 平均值 | | 2.47 | 2.51 | 2.84 | 2.59 |

## 4.4 投保者对百万医疗保险产品附加服务满意度

调查结果显示，投保者对百万医疗保险产品附加服务的赔付范围、就医服务、治疗手段、用药范围和人性化服务的满意度如表 4 所示。对很不满意、不满意、满意、较满意、很满意选项分别赋值为 1、2、3、4、5，投保者对赔付范围、就医服务、治疗手段、用药范围和人性化服务的满意度分别为 2.99、3.00、3.14、3.17、3.20，除赔付范围外各项平均得分均大于 3，投保者总体对百万医疗保险产品附加服务满意度较高。

综合来看，投保者对赔付范围的的满意度最低，目前百万医疗保险产品的赔付范围主要包括一般医疗保险金、恶性肿瘤医疗保险金和住院垫付等服务，消费者认为保险公司应适当增加赔付范围或住院垫付金额。人性化服务的满意度得分最高，目前百万医疗保险产品的人性化服务主要包括体检服务、住院陪同服务和术后护理服务等，消费者对能直接体验到的服务满意度相对较高。

表 4　投保者对百万医疗保险产品附加服务满意度

| | | 赔付范围 | 就医服务 | 治疗手段 | 用药范围 | 人性化服务 |
|---|---|---|---|---|---|---|
| 很不满意 | 样本数 | 25 | 28 | 22 | 19 | 25 |
| | 占比 | （4.39%） | （4.92%） | （3.87%） | （3.34%） | （4.39%） |
| 不满意 | 样本数 | 107 | 112 | 80 | 75 | 68 |
| | 占比 | （18.80%） | （19.68%） | （14.06%） | （13.18%） | （11.95%） |
| 满意 | 样本数 | 301 | 278 | 288 | 304 | 282 |
| | 占比 | （52.90%） | （48.86%） | （50.62%） | （53.43%） | （49.56%） |
| 较满意 | 样本数 | 123 | 135 | 152 | 140 | 154 |
| | 占比 | （21.62%） | （23.73%） | （26.71%） | （24.60%） | （27.07%） |
| 很满意 | 样本数 | 13 | 16 | 27 | 31 | 40 |
| | 占比 | （2.28%） | （2.81%） | （4.75%） | （5.45%） | （7.03%） |

| | | | | | |
|---|---|---|---|---|---|
| 平均值 | 2.99 | 3.00 | 3.14 | 3.17 | 3.20 |

## 4.5 未购买百万医疗保险原因的描述性分析

在对未购买百万医疗保险的626位受访者进行调研后，可以发现受访者不愿购买百万医疗保险的原因都是多样的。受访者大都出于对百万医疗保险产品设置的原因而不愿购买百万医疗保险，相关选项占比都在60%以上。而另外两项“身体健康，若无赔付，保费白交”和“不信任保险公司，保险公司不‘保险’”占比较小，说明因自身原因和保险公司原因不购买百万医疗保险的人相对较少。

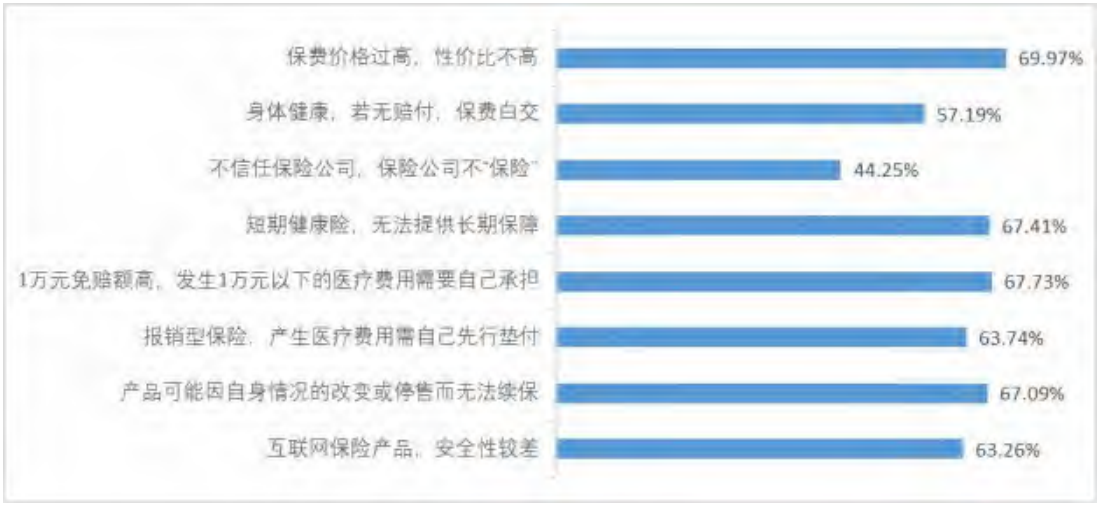



图1 受访者未购买百万医疗保险的原因

## 5 百万医疗保险购买行为与满意度影响因素实证分析

### 5.1 百万医疗保险购买行为实证分析

#### 5.1.1 模型建构

此处研究河北省居民百万医疗保险购买行为的影响因素，在研究购买意愿和购买行为的相关文献中，李雪（2020）、张蕊（2020）和梁玉涛（2019）等人在研究商业保险购买意愿时多采用二元Logistics回归模型进行分析。由于本文中因变量“河北省居民是否购买过百万医疗保险”是分类变量，Logistics回归模型又适用于研究行为主体的意愿等问题，因此本文选取二元Logistics模型做回归分析。模型规划式为：

$$Y_i=E(\alpha+\sum\beta_i X_i)=1/\left\{1+\exp\left[-\alpha+\sum\beta_i X_i\right]\right\}+\mu_i$$

其中，$Y_i$表示因变量“河北省居民是否购买过百万医疗保险”，$X_i$表示自变量“河北省百万医疗保险购买的影响因素”，$\beta_i$表示待估计参数，$\mu_i$表示随机误差项。

5.1.2 指标选取与赋值

综合李雪（2020）、张蕊（2020）、赵冬娴（2020）和王伟男（2019）等学者的研究，结合问卷实际情况，最终选取河北省居民是否购买过百万医疗保险为因变量，从个人特征维度选取 12 个自变量，具体见表 5：

表 5 河北省居民百万医疗险购买行为影响因素模型指标设置

| 变量维度 | 变量代码 | 变量名称 | 赋值情况 |
|---|---|---|---|
| 因变量 | Y | 河北省居民是否购买过百万医疗保险 | 是=1；否=0 |
| 自变量 | $X_1$ | 性别 | 男=1；女=0 |
| | $X_2$ | 年龄 | 30 周岁及以下=1；31-45 周岁=2；46-60 周岁=3；61 周岁及以上=4 |
| | $X_3$ | 职业 | 学生=1；务农或打工=2；医生、教师、公务员或其他企事业单位=3；自由职业、创业、私营企业、个体工商户老板=4；其他=5 |
| | $X_4$ | 受教育程度 | 初中及以下=1；高中或中专=2；本科或大专=3；硕士及以上=4 |
| | $X_5$ | 地区 | 承德市=1；衡水市=2；邢台市=3；保定市=4；张家口市=5；邯郸市=6；沧州市=7；秦皇岛市=8；石家庄市=9；廊坊市=10；唐山市=11 |
| | $X_6$ | 婚姻状况 | 已婚=1；未婚=0 |
| | $X_7$ | 收入水平 | 3 万元以下=1；3-10 万元=2；10-20 万元=3；20-30 万元=4；30 万元以上=5 |
| | $X_8$ | 家庭大额医疗支出经历 | 是=1；否=0 |
| | $X_9$ | 对看病价格的看法 | 看病贵=1；看病价格适中=2；看病便宜=3 |
| | $X_{10}$ | 社会医保保障力度 | 是=1；否=0 |
| | $X_{11}$ | 保险理赔经历 | 是=1；否=0 |
| | $X_{12}$ | 对百万医疗保险了解程度 | 完全不了解=1；了解一点=2；了解一般=3；了解较多=4；完全了解=5 |

5.1.3 实证分析

本文运用 SPSS20.0 软件进行二元 Logistics 回归分析，首先进行似然比检验，结果显示 p=0.000＜0.05，即说明构建的模型中，放入的自变量具有有效性，此次的模型构建有意义。通过 Hosmer-Lemeshow 拟合度检验来分析模型拟合优度情况，结果显示 p 值大于 0.05（ $x^2$=8.1，p=0.424>0.05），因而说明本次模型通过 HL 检验，模型拟合优度较好。实证结果如表 6 所示：

表 6 二元 Logistics 模型回归结果

| 变量 | 回归系数及显著度 |
|---|---|
| C | -4.937 |
| $X_1$ | 0.278 |
| $X_2$ | -0.325** |
| $X_3$ | 0.391*** |
| $X_4$ | -0.145 |
| $X_5$ | -0.006 |
| $X_6$ | -0.34 |
| $X_7$ | 0.297*** |
| $X_8$ | 0.354 |
| $X_9$ | 0.149 |
| $X_{10}$ | -0.781*** |
| $X_{11}$ | 1.231*** |
| $X_{12}$ | 1.413*** |

注：**表示在 5%水平下显著，***表示在 1%水平下显著

如表 6 所示，年龄 $X_2$ 的回归系数值为-0.325，并且呈现出 5%水平下的显著性(z=-2.058，p=0.040<0.05)，意味着年龄越大，越不愿意购买百万医疗保险。目前市面上的百万医疗保险产品费率呈倒 U 形增长趋势，在 30 岁之后随着年龄的增加，产品费率也在增加，消费者会觉得产品“性价比”降低了，因而不愿意购买百万医疗保险。

职业 $X_3$ 的回归系数值为 0.391，并且呈现出 1%水平的显著性(z=4.249，p=0.000<0.01)，由于问卷赋值时是根据岗位收入情况进行赋值，这意味着从事收入越高的职业，越愿意投保百万医疗保险。职业收入高，家庭的年收入越高，就会有充足的资金去投保百万医疗保险，为自己的健康多一份保障。

收入水平 $X_7$ 的回归系数值为 0.297，并且呈现出 1%水平的显著性(z=3.391，p=0.001<0.01)，这意味着家庭年收入越高，就会越考虑自己的健康保障，从而会购买一份百万医疗保险，与“职业”变量回归结果相似。

社会医保保障力度 $X_{10}$ 的回归系数值为-0.781，并且呈现出 1%水平的显著性(z=-3.984，p=0.000<0.01)，居民在认为社会基本医疗保障不能满足家庭医疗费用支出后，就会转而寻求商业健康保险来规避健康风险，保障家人健康。

保险理赔经历 $X_{11}$ 的回归系数值为 1.231，并且呈现出 1%水平的显著性(z=10.491，p=0.000<0.01)，对于有过保险理赔经历的居民来说，其对保险有了基本的认知，不会认为“保险不保”或“保险骗人”，会愿意相信保险能够保障自身和家庭健康，因而会倾向于购买保险。

对百万医疗保险了解程度 $X_{12}$ 的回归系数值为 1.413，并且呈现出 1%水平的显著性(z=14.068，p=0.000<0.01)。居民对百万医疗保险的了解程度越高，越能理解百万医疗险的性价比与优点，因此会倾向于购买百万医疗保险。

## 5.2 百万医疗保险产品满意度实证分析

### 5.2.1 模型建构

此处研究河北省居民百万医疗保险投保满意度的影响因素，在研究产品满意度的相关文献中，谢园（2019）、陈章旺（2016）和刘小勇（2020）等人多采用二元 Logistics 回归模型进行分析。由于此处因变量“投保者对百万医疗保险是否满意”是分类变量，Logistics 回归模型又适用于研究行为主体的意愿等问题，因此本文选取二元 Logistics 模型做回归分析。模型规划式为：

$$Y_i=E(\alpha+\sum\beta_i X_i)=1/\left\{1+\exp\left[-\alpha+\sum\beta_i X_i\right]\right\}+\mu_i$$

其中，$Y_i$ 表示因变量“投保者对百万医疗保险是否满意”，$X_i$ 表示自变量“投保者对百万医疗保险满意度的影响因素”，$\beta_i$ 表示待估计参数，$\mu_i$ 表示随机误差项。

### 5.2.2 指标选取与赋值

综合谢园（2020）和刘小勇（2020）等学者的研究，结合问卷实际情况，最终选取投保者对百万医疗保险是否满意为因变量，从居民基本特征维度和产品特征维度共选取 15 个自变量，具体见表 7：

表 7 河北省百万医疗保险产品满意度模型指标设置

| 变量维度 | 变量代码 | 变量名称 | 赋值情况 |
|---|---|---|---|
| 因变量 | Y | 投保者对百万医疗保险是否满意 | 是=1；否=0 |
| 居民基本特征 | $X_1$ | 受教育程度 | 初中及以下=1；高中或中专=2；本科或大专=3；硕士及以上=4 |
| | $X_2$ | 收入水平 | 3 万元以下=1；3-10 万元=2；10-20 万元=3；20-30 万元=4；30 万元以上=5 |
| | $X_3$ | 对看病价格的看法 | 看病贵=1；看病价格适中=2；看病便宜=3 |

| | | | |
|---|---|---|---|
| | $X_4$ | 社会医保保障力度 | 是=1；否=0 |
| | $X_5$ | 保险理赔经历 | 是=1；否=0 |
| | $X_6$ | 对百万医疗保险了解程度 | 完全不了解=1；了解一点=2；了解一般=3；了解较多=4；完全了解=5 |
| 产品设置 | $X_7$ | 保费定价 | 很不合理=1；不合理=2；合理=3；较合理=4；很合理=5 |
| | $X_8$ | 免赔额 | 很不合理=1；不合理=2；合理=3；较合理=4；很合理=5 |
| | $X_9$ | 按社保区分 | 很不合理=1；不合理=2；合理=3；较合理=4；很合理=5 |
| | $X_{10}$ | 等待期 | 想很不合理=1；不合理=2；合理=3；较合理=4；很合理=5 |
| 附加服务 | $X_{11}$ | 赔付范围 | 很不满意=1；不满意=2；满意=3；较满意=4；很满意=5 |
| | $X_{12}$ | 就医服务 | 很不满意=1；不满意=2；满意=3；较满意=4；很满意=5 |
| | $X_{13}$ | 治疗手段 | 很不满意=1；不满意=2；满意=3；较满意=4；很满意=5 |
| | $X_{14}$ | 用药范围 | 很不满意=1；不满意=2；满意=3；较满意=4；很满意=5 |
| | $X_{15}$ | 人性化服务 | 很不满意=1；不满意=2；满意=3；较满意=4；很满意=5 |

5.2.3 实证分析

本文运用 SPSS20.0 软件进行二元 Logistics 回归分析，首先进行似然比检验，结果显示 p=0.000＜0.05，即说明构建的此模型中，放入的自变量具有有效性，因此本次模型构建有意义。通过 Hosmer-Lemeshow 拟合度检验来分析模型拟合优度情况，结果显示 p 值大于 0.05（ $x^2$=2.216，p=0.974>0.05），因而说明本次模型通过 HL 检验，模型拟合优度较好。实证结果如表 8 所示：

表 8 二元 Logistics 模型回归结果

| 变量 | 回归系数及显著度 |
|---|---|
| C | -4.635 |
| $X_1$ | -0.328** |
| $X_2$ | 0.021 |
| $X_3$ | 0.167 |
| $X_4$ | 0.115 |
| $X_5$ | -0.404* |
| $X_6$ | -0.236 |
| $X_7$ | -0.051 |

| | |
|---|---|
| $X_8$ | -0.067 |
| $X_9$ | 0.455*** |
| $X_{10}$ | 0.314** |
| $X_{11}$ | 0.150 |
| $X_{12}$ | 0.186 |
| $X_{13}$ | 0.068 |
| $X_{14}$ | 0.138 |
| $X_{15}$ | 1.040*** |

注：*表示在 10%水平下显著，**表示在 5%水平下显著，***表示在 1%水平下显著

实证结果显示，受教育程度 $X_1$ 通过显著性检验，说明投保者的受教育程度显著影响了其对所购买的百万医疗保险的满意度。学历越高的投保者对所购百万医疗保险的满意度越低，受教育程度越高的投保者，他们对相关保险知识的了解程度也就越高，因而可能更了解百万医疗保险产品的不足与缺点，从而影响了其对百万医疗保险产品的满意度。

保险理赔经历 $X_5$ 通过显著性检验，且有过理赔经历的投保者对所购买的百万医疗保险满意度较低。可能的原因是有过理赔经历的投保者之前的理赔经历并非一帆风顺，有过不愉快的经历，经历过结案时效长、赔付金额较少或不予理赔等原因，由此引起投保人对商业保险或百万医疗保险的满意度有所下降。而未曾有过理赔经历的投保人则可能不了解保险理赔过程，他们通过百万医疗保险产品介绍认为产品很有价值，因而满意度会较高。

按社保区分 $X_9$ 通过显著性检验，说明百万医疗保险投保费用和赔付比例按社保区分显著影响了投保者对百万医疗保险的满意度。认为按社保区分这一设置合理的居民更加认可百万医疗保险，而认为这一设计不合理的居民则倾向于不满意该产品。对于有社保的投保人来说，他获得了较低的保费和较高的赔付比例，自然而然会满意该设计；而对于没有社保的投保人，与有社保的投保人对比之后就会发现需要缴纳的保费高而且赔付比例还低，自然对该设置不满意，因此按社保区分是影响百万医疗保险产品满意度的重要因素。

等待期 $X_{10}$ 通过显著性检验，说明百万医疗保险的等待期设置显著影响了产品的满意度。认为等待期这一设置合理的居民会更加认可百万医疗保险，而认为这一设计不合理的居民则倾向于不满意该产品。对于有保险知识的居民来说，他们知晓保险等待期是为了筛选掉那批“病急才投保”的人，因此会倾向于认为等待期这一设置合理；而对于缺乏保险常识的投保人来说，他们会认为等待期的设置妨碍了他们的健康保障，因而会认为该设计不合理，因此等待期是影响百万医疗保险产品满意度的重要因素。

人性化服务 $X_{15}$ 通过显著性检验，说明百万医疗保险的人性化服务显著影响了产品满意度。对人性化服务满意的居民也会对百万医疗保险满意，而对这一服务不满意的投保人则倾向于不满意百万医疗保险。目前百万医疗保险附加的人性化服务主要包括体检服务、住院陪同和术后护理等服务，接受过其中部分服务的投保人会对产品很满意，而未接受过此类服务的投保人则会认为这一类服务不属

实，是在欺骗他们，自然倾向于不满意产品。因此人性化服务是影响百万医疗保险产品满意度的重要因素。

# 6 结论与建议

## 6.1 研究结论

我国百万医疗保险产品的发展历程主要有五个标志性产品，实现了从团险雏形到个险、从线下为主要销售手段到线上为主要销售手段和从短期保险到长期保证续保的跨越。与此同时，监管政策的历次更新也为百万医疗险的发展做出了规范。目前河北省百万医疗保险产品存在以下现状：产品数量多、知名产品市场份额大，产品由多方合作推出，缺乏河北地区特色产品等，因此河北省的百万医疗保险产品存在进一步改善的空间。

投保者对百万医疗保险产品满意度的调研结果显示，有接近一半的投保者通过互联网保险中介平台购买该种产品；投保者购买百万医疗保险的主要原因既有自身健康及医疗费用高的原因，也有百万医疗保险产品设计较好的原因；投保者对按社保区分这一产品设置的满意度最高，对保费定价的满意度最低；投保者对产品附加服务满意度均较高，其中人性化服务满意度最高，对赔付范围满意度最低。

通过实证分析影响河北省居民购买百万医疗保险及对其满意度的影响因素，得出：职业、家庭收入水平、保险理赔经历和对百万医疗保险的了解程度会对百万医疗保险购买具有显著正向影响，而年龄和社会医保能否覆盖医疗支出会对百万医疗保险购买具有显著负向影响。

显著影响百万医疗保险满意度的因素在基本特征方面为受教育程度和保险理赔经历，其对百万医疗保险的满意度均呈显著负向影响；在产品特征方面主要有按社保区分和免赔额，在附加服务方面主要是人性化服务，同时投保者对产品附加服务的满意度明显高于对产品设计的满意度，说明保险公司接下来需要对产品设计进行改

## 6.2 对策建议

### 6.2.1 保险公司应加大宣传力度，正确引导消费者

从调查结果我们可以看出，当前百万医疗保险虽然有比较高的知名度，但是百万医疗保险目前主要在线上进行宣传与销售，河北省居民对该险种的了解程度还比较低，目前河北省内尚有 41%的消费者对其不了解或仅了解一点。

对于这种情况，经营百万医疗保险的保险公司首先必须加大宣传力度。从调研中了解到，当前河北省百万医疗保险主要通过线上渠道进行宣传与销售，然而一些经济相对落后地区的居民对互联网的了解较少，他们了解保险的渠道更多是线下保险销售人员的宣传，因此销售百万医疗保险的保险公司应当加大线下宣传力度，促进客户与保险公司销售人员沟通交流，明确双方责任，从而增加客户对保险公司的信任度。同时这样也可以拓展农村市场，为脱贫户提供更多的健康保障，为国家的乡村振兴政策出一份力。

针对目前河北省百万医疗保险宣传销售过程中存在的虚假宣传、夸大百万医疗保险作用等现象，保险公司可以在销售的前中后端分别进行管控。在销售前端，保险公司在选拔培训销售人员时应注重对员工职业道德的培养，既要加强对销售人员专业保险知识的培训，又要提高他们的职业道德，只有这样才能够选拔出优

秀的百万医疗险销售人员。在销售中端，销售人员应尽职尽责，正确宣传百万医疗保险，要以简单易懂的方式为消费者介绍百万医疗保险产品，提示消费者百万医疗保险是短期健康险且不保证续保，扩大市场影响力。在销售后端，保险公司应加强售后追踪和服务，及时提醒消费者享受百万医疗保险附加的相关服务，提高客户对投保的百万医疗保险满意度，从而提高客户黏度。

6.2.2 提高服务质量，改善产品设计

通过受访者百万医疗保险购买行为调查我们可以发现，河北省投保百万医疗保险的受访者具有以下特征：男性、年龄处于 30-45 周岁间、从事收入较高的职业、高中或中专学历、已婚、家庭收入位于中上层、家庭有过大额医疗支出经历、有过保险理赔经历等，因此保险公司在销售百万医疗保险时，要瞄准好特定人群，取长补短。对于已投保者要提高服务质量，改善产品设计，进而提高用户粘度；而对于未投保者，保险公司可发掘其未投保原因，对症下药，在产品设计和销售上针对性的做出改善。

在受访者提出的增加产品保障范围方面，保险公司可以进行产品创新，将百万医疗保险与重疾保险进行创新性的融合，融合重疾险给付型和可保大病范围大的优点，对百万医疗保险产品进行创新，增加产品在重疾方面保障范围，同时对普通疾病进行小额垫付，减轻投保人的财务负担，提高其满意度。

在百万医疗保险续保问题方面，保险公司可以对客户风险状况进行综合评估。对于身体状况良好，出险风险小的客户在续保问题上可以适当放松限制，保证其在某个时间范围内可以以相同条件续保，同时给予保费优惠；对于身体状况较差的受访者，可以以增加保费的方式承诺其在某一时间段内保证续保，并且对出险后的赔付的也要进行明确的规定。

对于提高服务质量和服务效率方面，在保险销售过程中，要做到真实宣传，切忌虚假宣传误导和欺骗消费者。在报销过程中，保险公司可以简化医药费用报销手续，提高审核效率和准确度，尽快为被保险人报销医药费用，减小被保险人经济和心理压力。

6.2.3 试行“差别等待期”，拓展健康服务

通过对河北省百万医疗保险满意度进行分析可以发现，百万医疗保险按社保区分、等待期、人性化服务是影响对百万医疗保险满意度的重要因素，因此保险公司应该在这三个方面进一步做出改进。

目前百万医疗保险对按有无社保区分主要体现在两个环节：投保环节与理赔环节。在投保环节，有社保的投保人需缴纳的保费相对无社保的投保人保费低，且大都能低 40%-50%；在理赔环节，有社保的投保人在将医疗费用扣除社保报销和免赔额后能得到 100%全额赔付，而无社保的投保人再将医疗费用扣除免赔额后仅能得到 60%-80%的赔付（各产品设置不同）。鉴于截止 2020 年底，我国基本医疗保险已覆盖超过 13 亿人，无社保的居民不足一亿人，河北省无社保的居民仅有 500 余万人，相对来说无社保居民占比较少，因而保险公司可以在保费设置上和赔付比例上进一步扩大“剪刀差”，进而提高有社保投保者的满意度，从而整体提高整个产品的满意度。

在等待期方面，目前市面上百万医疗保险的等待期绝大部分为 30 天，也有少部分长期险种的等待期为 90 天。等待期的设置是为了防止道德风险，防止投保人带病投保。然而相较于一年的保险期间来说，30 天的保险等待期仍然有压缩空间。保险公司试行“差别等待期制”，依托医疗数据与保险数据，经过保险精算，对不同年龄段、不同健康状态的人群试行差别等待期制度，青少年、身体

健康程度评估高的投保人等待期可以适当缩减，而老年人、有健康风险的投保人可以继续试行现有等待期或适当延长等待期。

人性化服务是让所有投保者都能直观感受到的附加服务，目前既有服务包括体检服务、住院陪同服务、术后护理服务等，保险公司可以在此基础上守成创新，与健康管理机构深入合作，拓展更多的服务种类与服务范围，如体检服务可以提供三甲医院或专业体检机构的体检服务，术后护理服务拓展更大的服务范围。同时保险公司可以建立健康管理服务平台，帮助客户更好的对个人身体健康状况进行管理。健康险机构与健康管理机构需充分发挥各自优势，对预防、治疗、康复过程提供咨询、指导、评估、干预等多种形式的服务，形成完整的服务流程与服务计划。

6.2.4 开展产品和技术创新，提供差异化服务

针对目前河北省百万医疗险市场上存在的产品结构单一、同质化严重等问题，各保险公司应积极主动开展产品和技术创新，不断丰富发展百万医疗保险市场。首先，保险公司应当持续关注前沿科学技术，运用大数据、区块链、云技术等金融科技手段，推动技术创新，提升自己的核心竞争力。其次，百万医疗保险行业可以由银保监或行业协会牵头建设信息共享平台，整合保险行业内部研发资源，实现各保险公司之间数据的互通，推动百万医疗保险行业内部信息披露，在确保信息安全的基础上建立客户数据档案，为消费者提供高效而又精准的服务，最终实现智慧运营。最后，在推进技术创新时保险公司应特别注意保护客户隐私，确保消费者信息安全，提升消费者信任度，这样才能使百万医疗保险行业稳定健康发展。

保险公司在设计百万医疗保险产品时，应将设计重心转移到以客户需求为中心，运用大数据等新技术手段深入研究不同人群的需求特点，根据不同人群的不同特征进行针对性设计，从而提供差异化产品。与此同时，在百万医疗保险销售时，保险公司可以仿照汽车销售时的“选装”政策，允许消费者在投保时根据自己需要自行“选装”各类服务，进而实现百万医疗保险产品的差异化选择。在此过程中，保险公司可以针对消费者的需求进行产品改进，实现良性互动，最终突破现有产品单一化的困局，提升市场对百万医疗保险的体验与满意度。

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# 河北省居民百万医疗保险购买行为及满意度调查研究

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**关键词**：百万医疗保险；问卷调查法；二元 logistics 模型

**中文摘要**：随着我国经济的快速发展，人民生活水平和快节奏的日常生活使得我国居民处于亚健康状态成为常见现象，居民整体健康状况有待提升。而科技水平快速提高带来的新型医疗技术诊疗手段则提升了居民看病成本，鉴于目前我国基本医疗保障仍不够充分，商业健康保险的发展也就非常有必要。百万医疗保险作为商业健康险的重要组成部分，在我国多层次医疗保障体系中占据着重要地位。但目前百万医疗保险的发展陷入产品同质化、缺乏创新等瓶颈，消费者的购买行为和对产品满意度是进一步挖掘百万医疗保险市场潜力的直接推动因素，因此对其开展调查研究对于百万医疗保险的发展具有十分重要的意义。

本文首先通过对河北省 11 市居民进行问卷调查，了解其百万医疗保险购买行为及满意度。调查内容主要包括受访者基本信息、投保者满意度和未购买原因三部分，调研工作历时三个月，回收有效问卷 1195 份。随后，根据问卷调查结果对影响河北省居民百万医疗保险购买行为和满意度的因素进行描述性分析和实证研究。实证结果表明年龄和社会医保保障力度对百万医疗保险购买行为有显著负向影响，而职业、收入水平、保险理赔经历和对百万医疗保险了解程度则显

著正向影响百万医疗保险的购买行为；受教育程度、保险理赔经历、产品按社保区分、等待期和人性化服务显著影响了投保者对所购百万医疗保险的满意度。最后针对河北省百万医疗保险的现状分析以及购买行为、满意度影响因素的实证研究结果，对河北省百万医疗保险的发展提出对策建议，包括保险公司应加强线上线下的合作，正确引导消费者；瞄准特定人群，深入挖掘客户需求；整合医疗资源，提升客户体验；进行产品形式创新和产品技术创新，提供差异化服务；消费者应正确认识该险种，树立正确的保险观。

# The Influence of Women's Marital Status on the Decision of Supplementary Medical Insurance

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**Keywords:** Marital Status, Supplementary Medical Insurance, Risk Decision.

**Abstract.** Based on the data of the 2018 China Family Panel Studies (CFPS), this paper empirically studied the impact of Chinese women's marital status on the insurance decision of supplementary medical insurance. The results show that: firstly, there is a significant difference purchasing of supplementary health insurance between different marital status women. Marriage and divorce significantly increase the probability of women's purchasing of supplementary health insurance, while unmarried have a negative impact, and the influence of widowhue is not significant. Secondly, compared with divorced women, unmarried, married and widowed women had lower demand for supplementary health insurance, and unmarried women had the lowest demand. Finally, individual medical expenses and personal income had no

significant impact on women's supplemental medical insurance, while family income and expenditure had a significant impact on women's supplemental medical insurance. Based on the above research results, this paper provides relevant suggestions for insurance companies and the government from the perspectives of targeted exhibition of insurance institutions, insurance product design, risk and insurance awareness popularization.

## 1. 引言

随着社会的不断进步，人们逐渐摒弃了传统“谨慎”的婚姻观，开始追求更加自由、完美的爱情，因此我国婚姻观不断朝着开放化和多元化的方向发展，离婚、丧偶和高龄单身等群体也逐年增加。这主要体现在两个方面，首先，传统的早婚普婚转变为现实中的晚婚普婚，国家统计局数据显示自 1990 年至 2017 年我国女性的初婚年龄上升了 4.3 岁。其次，社会转型的加速使得各年龄段的离婚率持续上升，自 2003 年起我国离婚率连续 15 年上涨。

虽然日趋多元化的婚姻状况是社会发展的必然趋势，但是离婚、丧偶和高龄单婚这些处于“亚状态”的婚姻对人们身心健康和经济收入等方面会产生比较严重影响，进而大大降低了个体抵御风险的能力，这必将会提高个体对保险保障的需求。相较男性而言，女性更易受到情绪波动和外界因素的影响，会产生更大的风险感知变化，因此本文选择女性为研究对象。具体而言，悲观的情绪会显著降低女性的安全感，而乐观的情绪会降低女性对风险的关注度，在医疗保健领域，体现为对更高层次的医疗服务和医疗保险需求。

补充医疗保险是相对于基本医疗保险而言，为满足参保人员基本医疗保障范围之外的医疗保障需求而建立的补充性医疗保障制度，是基本医疗保险的有力补充。目前现有的文献主要从健康状况、经济收入、教育水平等方面研究补充医疗保险投保决策行为，少有学者关注于婚姻状况的角度。此外，学者在研究婚姻状况对经济变量的影响时，大多仅把婚姻状况分为在婚和单身（未婚、离婚和丧偶）两类，没有深入地探讨单身群体内部的差异性。基于此，本文运用 2018 年 CFPS 数据分析女性婚姻状况对补充医疗保险投保决策的影响，从理论上来说，“亚状态”的婚姻状况会增加女性对补充医疗保险的需求，但事实上是否会引起这种现象，则需要进一步的验证。

## 2. 文献综述

### 2.1 婚姻状况对居民投保决策的影响

以往也有学者研究过婚姻状况与投保决策之间的联系，总体来看不论是健康险还是寿险已婚人群的投保率都比单身人群高。Wei Xiao（2018）通过挖掘中国家庭财务调查数据库（CHFS），利用 probit 模型和 Tobit 模型进行了实证检验，发现婚姻对参与商业健康保险有积极的影响，即已婚居民更倾向于购买商业健康保险，并且在不同年龄段，婚姻状况对商业健康保险的需求有重大影响，其中 30 岁以下人群购买商业健康保险最容易受到婚姻状况的影响。邱月（2012）也得出了类似的结论，她以 2006 年中国城乡老年人口状况追踪抽样调查数据为依托，探讨了中国老年商业医疗保险消费影响因素，结果发现除了性别、教育、户

籍、健康状况之外，婚姻状况也与老年人商业医疗保险存在显著关系，处于在婚状态中的人安全感程度更高，而有偶分居和离婚群体出于安全感的考虑，购买商业医疗保险的倾向性更高。王英子等人（2008）对影响南京市居民投保人寿保险的因素进行了实证分析，她发现已婚人群更愿意在一个家庭的角度上考虑问题，因此已婚人群购买人寿保险的比例远大于未婚人群购买保险的比例。此外，刘佩琳（2018）等人通过构建有序 Probit 模型研究了婚姻状况对寿险投保意愿和投保类型的影响，也证实了王英子等人的观点，结果显示婚姻状况会显著影响人寿保险的投保决策和寿险类型，具体来看离婚和丧偶人群偏向投保人寿保险，未婚和已婚人群对人寿保险无明显偏好；离婚、丧偶和未婚人群偏向投保传统保障型寿险，已婚人群偏向投保投资储蓄型寿险。

## 2.2 补充医疗保险投保决策的其他影响因素

国内外学者对补充医疗保险投保决策的影响因素已经展开了较为丰富的研究，主要可分为个人特征和社会环境两个维度。

### 2.2.1 个人特征

李艳珍（2017）基于 2011 年中国家庭金融调查数据，从社会互动角度分析了影响居民参加商业医疗保险行为的因素，她发现性别、年龄、受教育程度、家庭收入、家庭总资产等因素会显著影响居民参保决策，具体来讲，女性为受访者的家庭参保商业健康保险的可能性高于于男性为受访者的家庭。张敏娟（2015）通过对大学生的抽样调查分析，支持了李艳珍的观点，她发现女性医疗保险消费倾向明显高于男性，并且更能接受商业医疗保险消费。王红波和孙向谦（2018）选取了 2013 年中国社会综合调查数据（CGSS），通过对农村居民商业医疗保险需求的影响因素进行研究，同样验证了李艳珍的观点，他们发现家庭收入对参保选择有显著正向影响，而自评健康状况、是否有社保对参保无显著影响。同样是基于中国综合社会调查（CGSS）数据，沈勤、张虹对我国城镇居民购买补充医疗保险的行为进行了分析，却发现经济收入对城镇居民补充医疗保险需求的影响不显著，反而健康状况与补充医疗保险的投保决策显著相关。还有学者提出，健康保险需求并不直接取决于客观的疾病风险，而是取决于人们对疾病风险的感知和主观决策的心理过程，风险认识能力不足，一定程度上抵消了客观疾病风险的推力（朱铭来，2011）。进一步，陈文（2002）等人通过对上海市企事业单位职工的补充医疗保险需求的分析，表明影响补充医疗保险需求最主要的因素是居民的保险意识、主观风险态度和对保险市场的信息，而非家庭收入和保险价格。

### 2.2.2 社会环境

高敏（2018）通过对 31 个省份的商业健康保险数据进行实证分析，人均社会保险保障享有水平在大多数区域可以显著促进健康保险需求的增加，并未产生替代效应，这与国家近年鼓励社会医疗保险与商业健康保险互补发展的政策是相契合的。贾洪波（2005）利用多阶段抽样方法以全国六个省份的调查数据为基础，发现已参保人群的示范效应、补充医疗保险灵活的管理方式和保障能力等对补充医疗保险参保有正向显著性影响。在抑制医疗服务供给者诱导需求道德风险的前提下，增加居民对补充医疗保险的认知程度、提高用人单位推动员工参加补充医疗保险的积极性、加强补充医疗保险生产者的业务能力建设能有效提升补充医疗保险的参保率。此外，2002 年国外学者 Finkelstein 通过对加拿大职工补充医疗保险的研究发现，补充医疗保险保费的税收优惠能有效提高职工购买补充医疗保险的概率，2003 年 Thomasson 也得出了类似的结论，他发现政府提供税收优

惠对居民购买医疗保险的行为有一定的促进作用。

### 2.3 文献评述

随着婚姻状况多元化的发展以及人们对医疗保健重视程度的不断加深，关于婚姻状况与人身保险的研究也越来越多，涉及主题包括婚姻状况对商业健康保险的影响、婚姻状况对老年人商业医疗保险的影响、婚姻状况对寿险投保意愿和投保种类的影响。综合分析以上文献可知，学者们普遍认为已婚状态的人群相较于单身群人更倾向于购买人身保险来抵御未知风险。在以婚姻状况作为补充医疗保险的影响因素这一研究领域中，存在着以下几点不足。第一，在已有研究婚姻状况与投保决策两者关系的文献中，以寿险为对象的研究居多，而研究补充医疗保险投保因素的研究中，则仅把婚姻状况作为控制变量简单提及，聚焦女性婚姻状况的补充医疗保险研究非常少。第二，在研究婚姻状况对经济变量的影响时，大多学者仅把婚姻状况分为在婚和单身（未婚、离婚和丧偶）两类，并没有深入地探讨单身群体内部的差异性。事实上，未婚、离婚和丧偶对女性风险感知的影响机理是截然不同的，因此不能简单地将未婚、离婚和丧偶女性划归为一类。

综上所述，本文试图通过分析女性不同婚姻状况所引起的的经济、心理、健康等差异对补充医疗保险投保决策的影响，拟使用 2018 年中国家庭追踪调查（以下简称 CFPS）数据，利用 Logit 模型进行探究。

## 3．理论分析

### 3.1 理论基础

#### 3.1.1 期望效用理论

1783 年荷兰数学家 Daniel Bernoulli 提出了期望效用理论，又叫做理性风险决策理论，用于解释赌博和保险中的期望值。在保险领域，期望效用理论是指在完全理性假设下，投保人面对可保风险时，会选择使自己的期望效用最大化的行动方案。

理性保险决策理论暗含一系列假设条件，只有在消费者满足如下条件的情况下，消费者才会做出上述的“理性选择”的保险决策。第一，完全信息假设。即个体对自己的每一行动方案（投保和不投保）的结果及其对应的概率拥有完全信息。第二，个体遵从期望效用理论的各个公理，包括有序性公理、相消性公理、可传递性公理、恒定性公理等。第三，个体的效用函数适用基数效用理论，个体能够在掌握风险信息的基础上依照期望效用理论进行计算，并选择期望效用较大的行动方案。第四，保费充足假设，或者说理性保险决策理论假设有足够的保费预算。

但在现实世界中，上述各条假设都可能得不到满足：第一，消费者很难准确估计自己面临的风险。如果消费者低估了自己面临的风险，按照期望效用理论，消费者很可能就不会选择购买保险。第二，消费者也不一定能够遵从期望效用理论的各个公理。例如，框架效应的研究成果表明，决策者经常违背恒定性公理，人们的选择会受到问题呈现的顺序、问题出现的情境、答案选项的范围等因素的影响。第三，效用其实只是个人的一种主观感觉，很难将其量化，基数效用理论在现实世界很可能并不适用。第四，消费者在保险决策中显然会受到收入水平的限制。

1953 年 allais 对 100 人的测试实验结果显示，由于现实生活中的人并非经济学基本假设中纯粹的理性人，因此复杂的心理因素导致被测试人员的决策结果

与期望效用最大化的目标相悖。事实上，人们对保险的需求除了受一些客观因素的限制，往往还会受到个人处境的影响，表现为“有限理性”的保险决策模式，随后大量理论被提出来，挑战期望效用理论。

3.1.2 风险感知

风险感知的研究起源于心理学，最早可以追溯到上世纪六十年代。Starr（1969）发现风险的可接受性不仅与风险本身可能带来的收益有关，还受到人们主观态度的影响。风险的可接受性并不仅仅关系到风险本身的收益评估，更要考虑到人们的主观尺度。因此，风险感知是指个人在信息不完全而且处于不确定情况下，对风险的种类和特征做出直觉上的判断，并对损失进行预测的思维过程，即自身对客观存在的风险的主观感知。

人们在多维度测量中使用了不同类型的风险、不同文化风险意识的心理测量范式模型，并衍生出一系列对个体风险感知产生影响的因子，包括未知因子、致命性因子、新奇因子、评估因子、情感因子等。利用这些影响因素可以使人们的风险感知外显化并以图形或数字形式呈现，从而个体和决策者可以借此分析量化、沟通及决策制定。例如，风险感知会受到个人认知偏差的影响，当个体没有认识到自身知识水平、个体能力存在的各种限制时，那么认知偏见会降低个体对风险的感知能力。Johnson 和 Tversky（1983）指出情绪也会影响个体对风险的感知，正面情绪使人们对风险的评估偏向乐观，而负面情绪则倾向于悲观估计风险。此外，由于灾难的潜在性、不确定性和人们因此产生的无助感等因素的存在，也会调节人们对于风险感知的认知。Kahneman 和 Tversky（1979）也在前景理论中证明了人们在缺少风险学习过程时，突发的巨灾事件会使人们高估风险，当风险事件的信息逐渐增加经过了风险学习后，人们对风险的评估将会趋于客观。

随着对风险感知水平的变化，个体对于风险的应对行为也会随之发生改变，从而导致保险需求的变化。因此，风险感知理论就是考虑到个体的差异性，观察并研究其心理状态，从而通过有限理性行为来在合理范围内预测人们在不同的外部条件下对于风险的评估，以及人们可能做出的风险决策或者应对措施。

3.1.3 感知价值

在消费者感知价值概念方面，国内外许多学者从不同视角对其进行了分析和研究，并提出很多观点。以 Zeithaml（1988）和 Woodruff（1997）对感知价值的定义较为权威和经典，Zeithaml 指出感知价值是消费者在面对产品或服务时主观感受到的利得和付出成本之间的衡量，以此得到对产品或服务的一个整体的感知评价。Woodruff 则将感知价值定义为顾客对特定情景下有助于或有碍于实现自己目的的产品性能、属性以及使用效果的综合感知偏好与评价。学者对于感知价值的的表述虽有差异，但本质趋同，他们一致认为感知价值是消费者对产品或服务的评价，与消费者主观感知密切相关。

对于感知价值的构成，汇总各位学者的观点基本可以分为两类：权衡学说（感知价值是对所得和所失的权衡）以及多维度构成说（感知价值可以用多个具体维度来进行描述）。相比多维度构成说，权衡学说更能体现出消费者的一种动态抉择过程。Zeithaml 认为感知利得包括产品、质量以及其他精神层次上的感受；感知利失包括货币与非货币因素等。Carothers(1991)认识到感知质量不仅包括有形产品质量，还包括无形的服务质量。在我国，二维论也受到不少学者的认可。如杨龙和王永贵等（2002）认为，感知利得是在整个产品购买和使用过程中所发挥出来的作用及功效等；感知利失包括产品价格、获得成本、运输、订购成本、维护修理以及质量不尽人意的风险等在内的全部成本。

综上所述，顾客在消费某一产品或服务时对他所感知的利益和成本之间进行权衡，当感知到的利益大于所要付出的成本时，消费者便倾向于购买此产品或服务；当感知到的利益小于所要付出的成本时，消费者便不愿意购买此产品或服务。

## 3.2 理论分析：女性婚姻状况对投保决策的影响

婚姻状况对个人处境的影响主要体现在心理情绪、经济状况、健康状况等方面，这将进一步影响个体的风险感知水平。在健康医疗领域，当个体感知到他所面临的医疗费用风险越高时，就会提高对补充医疗保险的感知价值从而增加他的购买意愿，并影响之后的购买决策。此外，个体对补充医疗保险的感知价值不仅受到感知风险的影响，还会受到商品价格、社会环境等因素的影响，因此个体是否购买补充医疗保险最终取决于拥有补充医疗保险和没有补充医疗保险两种情况下个体主观效用的权衡。

### 3.2.1 不同婚姻状况下心理情绪对女性的影响

认知心理学认为个体的行为决策符合“认知—情感—态度—行为”的逻辑顺序。情感被认为会影响个体对未来感觉的预测，这反过来又会影响当前的决定，因此情感对个体的决策有着直接的影响。在健康医疗领域，当女性感知到越来越高的医疗费用风险时，就会寻找方法降低自身所感知到的风险，一旦她发现补充医疗保险能有效降低医疗费用的损失时，那么她对补充医疗保险的感知价值就越高，从而促使了投保行为。

未婚女性还处于社会探索期，她们相对来说情感压力较小，这些压力可能来源于失恋、催婚等小压力事件，这不会剥夺她们乐观、积极的生活态度，反而往往会憧憬着婚后的美好生活，因此很少有未婚女性会主动关注到悲观事件。这种愉悦的情绪很大程度上降低了未婚女性对未来医疗费用的风险感知。

越来越多的研究表明，婚姻对人的身心健康是利远大于弊。家庭和睦、夫妻关系融洽能使人精神饱满的对待生活和工作并充满信心，既有利于防止心理创伤，也有利于身心健康，所以已婚人群心理健康优于单身人群。因此，婚姻不仅会降低已婚女性的社会心理压力，还会增强她们的安全感，使她们处于一种相对幸福的状态。情绪效价在决策行为中起着重要作用，当个体处于愉悦的情绪下，会更地多想到让自己心情愉悦的事情，并对事情做出积极的判断，所以已婚女性往往会低估其面临的风险。

对于绝大多数女性而言，离婚是一个难以忘怀的巨大创伤，国内的一些相关研究认为，离婚对女性的影响主要体现在心理和经济方面，其中心理方面的影响是最严重的。离异女性比在婚女性的心理健康状况差很多，包括较低水平的幸福感、心理压力以及较差的自我认知，这意味着离婚对女性存在很强的负面心理影响。离婚对女性来说，意味着婚姻的离散和家庭的解体，缺少了往日家庭的支持与包容，巨大的心理压力使得女性倍感无助和恐惧，这显著提高了女性的风险感知。情感在风险决策中起到了重要的作用，当其负面事件使个体处于悲伤、焦虑或抑郁状态时，个体往往会高估风险。Lerner 和 Keltner(2001)通过评估倾向框架研究了不同负面情绪对风险感知的影响，并证实了恐惧感使人们夸大对风险的评估、提升风险感知水平并显著影响行为决策。因此离异女性为了以防未来不确定的风险损失，她们往往会持有一种更加谨慎的态度，在医疗费用领域表现为补充医疗保险投保率的显著上升。

丧偶作为一种恶性生活事件，给女性造成了巨大的心理创痛，使其产生严重的情绪障碍，所带来的负性情绪一般至少要经过一年左右才能平复。相对于离异

女性，丧偶女性遭受的精神打击更为严重，独居后物质上、社会心理上缺乏支持也更甚于离异人群。此外，丧偶后的悲痛也会影响他们的自我照顾能力，她们常常独自待在家里，回忆往事。情绪往往会影响个体的风险决策倾向，消极情绪使个体更倾向于风险规避，因此理论上丧偶女性对未来灾害性事件的风险感知更高。

3.2.2 不同婚姻状况下经济收入对女性的影响

婚姻在一定程度上影响经济状况的结论，在理论和实证方面都已经得到了证实。例如，Schmidt 和 Sevak（2006）从实证分析出得出结论，美国单身女性和已婚夫妇在家庭财富上存在巨大的差异，即使控制教育等因素也无法消除这种经济差距。而经济状况是影响个体购买补充医疗保险的重要因素之一，例如对于经济收入较低的个体而言，与其购买补充医疗保险，不如将这个支出用于生活必需品上，因此低收入群体会降低对补充医疗保险的感知价值，从而减少对补充医疗保险的需求。

社会的多元化和开放化使得越来越多的未婚女性开始追求自我实现，她们试图通过自己的努力换取更好的生活条件。然而新时代的独立女性却面临着沉重的经济负担，绝大部分未婚女性刚刚从学校步入社会，工作经验较少，所以相对应的工资也更低，即使不考虑房贷车贷，她们仍然面临着房租水电物业费用、伙食费用、游玩交际费用等等，常常使得她们入不敷出。虽然年轻人的补充医疗保险保费比较便宜，但是经济上的压力在一定程度上会降低未婚女性对补充医疗保险的感知价值。

家庭是一个基本的经济单位，婚姻的形成会增加家庭财富，家庭还是一个基本的情感单位，婚姻的形成让女性背负起更多的责任。首先，在财富创造方面，由于优势互补的存在，已婚家庭的财富创造会大于两个单身居民的收入之和，即“1+1 大于 2”的形式，因此充裕的收入客观上提高了女性对补充医疗保险的感知价值。其次，在家庭责任方面，已婚家庭特别是有孩子和房贷车贷的家庭，消费刚性更强，收入依赖性高于单身家庭，因此为了防止未来不确定的高额医疗费支出对家庭经济的影响，女性购买补充医疗保险的意愿将会增加。另一方面，在婚女性较大的年龄跨度导致保费的跨度也很大，以商业医疗保险为例，保费从几百到几千不等，因此保费对不同年龄段的女性购买补充医疗保险意愿的削弱作用也不同，低保费的个体削弱作用小，高保费的个体削弱作用大。

离婚时的财产分割，虽然遵循公平原则，对夫妻共同财产平等划分，但在一般情况下，妻子的工资比丈夫低，还有一部分没有工作。离婚后女性所得到的经济补偿不足以自己独立面对生活，尤其是当涉及未成年子女的抚养问题时，女性的经济会变得更加困难。此外，目前国家对单亲妈妈的社会保障制度未建立起来，不能从社保层面缓解单亲妈妈的经济压力。因此，经济压力在客观上降低了离异女性对补充医疗保险的感知价值。由于丧偶群体往往年龄较大，面临更多的健康风险，保险公司基于盈利目的会相应地提高保费，因此丧偶群体由于保费预算的限制，会减少保险消费。

3.2.3 不同婚姻状况下健康状况对女性的影响

健康风险包括客观和主观两部分，客观健康状况可以由慢性病、住院次数、医疗费用等因素进行衡量，不同婚姻状况的女性由于年龄、生活压力等方面的影响，他们的客观健康状况往往会不一样。主观健康状况是个体对自己健康的评价，是基于客观健康状况的主观评价，受到个体心理因素和风险态度的影响。健康风险所带来的经济损失可以通过补充医疗保险的方式进行补偿，因此往往健康风险

越高的个体对补充医疗保险的感知价值就越高，保险需求就越高。

未婚女性往往精力充沛、富有朝气，通常这类人更加自信、独立。不少研究表明，未婚人群的健康状况是最好的，这源于两方面的因素。首先，未婚者多属于年轻人，因此客观健康状况相对较好，而在婚、离婚与丧偶女性平均年龄则要大一些，各种疾病的发生率也随之上升，这也与健康状况随年龄的分布状况是一致的。其次，未婚女性相对更自信，她们自认为年轻有活力，身体非常健康，认为不幸的事情不会发生到自己的身上，因此未婚女性的主观健康状况也相对较好。这两方面的原因共同降低了未婚女性对补充医疗保险的需求。

国内外的研究一致表明在婚女性的健康状况要明显好于离婚和丧偶女性，但是对于未婚女性和在婚女性健康状况的差异性有一定的歧义。我国学者郝虹生（1995）认为有配偶的婚姻生活最有利于个体的健康和寿命，而其它婚姻状况的群体则明显有较高的死亡风险，其中尤以未婚和丧偶的负面影响最大。而 2014 年杨硕等人却认为在婚者的生理健康情况要比未婚者差一些，比离婚与丧偶者好一些。婚姻对女性健康的优势表现在家庭有利于建立和保持良好生活习惯，饮食起居方面也有爱人的关心与监督，然而在婚女性不仅承受着工作上的压力，而且还承担着家务的压力，“工作－家庭”冲突对女性的健康有一定的影响。因此在婚女性的健康状况对补充医疗保险投保决策的影响还需进一步探讨。

离婚和丧偶在一定程度上都可以看做是婚姻的解体，对于女性而言是一个巨大的打击，这种严重的心理冲击很有可能会导致躯体上的不适。罗乐宣等人（2006）通过对深圳市居民的调研发现丧偶女性与其他婚姻状况的女性相比，其生理健康、心理健康、社会健康均最差，离异女性仅次于丧偶人群。就现实状况分析，较低的健康水平会提高女性的风险感知，从而增加对补充医疗保险的感知价值，进而提高投保意愿。

3.2.4 不同婚姻状况下其他因素对女性的影响

现实生活中，补充医疗保险投保决策的影响来自方方面面，经济、情感、健康只是其中重要的影响因子，除此之外还有其他方面的因素也会影响到女性的投保决策。首先，在投保交易成本方面，个体在购买保险前需要了解保险条款内容、保障范围以及比较各种产品的优劣，而大多数个体欠缺保险知识，难以理解这些生涩难懂的条款，因此需要花费大量的时间成本和精力成本，而这无疑会降低女性对补充医疗保险的感知价值，由于未婚女性常常忙于工作、学习、加班、交友等各种活动之中，因此相较于其他女性来说投保交易成本对未婚女性的挤出效应更明显，因此未婚女性的投保概率会相对来说更低。其次，在一个家庭中男性的收入往往高于女性，因此家庭收入波动风险主要集中于男性，此外妻子出于对丈夫的爱，往往会优先为丈夫投保，所以已婚家庭更偏向于为男性投保。再者，离异女性在日常社交网络、邻里交流等过程中会了解到其他离异女性的生活，尤其是当她们看到身患重病、无依无靠而且负债累累的离异女性，由此就会联想到自己，生怕自己处于相似的境地，所以她们就会提升对补充医疗保险的感知价值，从而提高投保需求。最后，虽然根据上面分析得出丧偶女性对补充医疗保险的感知价值很高，甚至高于离异女性，但是补充医疗保险对于投保人的健康状况和年龄都有一定的限制，因此大部分丧偶女性难以通过保险公司的筛选。

## 4．研究设计

### 4.1 模型设定

本由于被解释变量——是否参保补充医疗保险的取值为 0-1 变量，即不参保=0、参保=1，且各变量数值为离散型变量，切合 Logit 模型的要求和优点，因此本文使用 Logit 模型来研究女性婚姻状况对补充医疗保险投保决策的影响，并对个人经济收支与家庭经济收支进行差异化研究，具体模型设定形式如下：

$$y_i^* = \alpha marriage + X_i\beta_i + \mu_i, insurance = 1[y_i^* > 0] \quad (1)$$

其中，$y_i^*$ 为不可观察的潜在变量，可以理解为受访者选择购买补充医疗保险带来的效用，[. ]为示性函数。当 $y_i^*$ 大于 0 时，insurance 取值为 1，即选择购买补充医疗保险；当 $y_i^*$ 小于 0 时，insurance 取值为 0，即选择不购买补充医疗保险。marriage 则为本文重点关注婚姻状况，X 为本文系列的控制变量，包括受访者的年龄、户籍、受教育年限、工作状态等其他个体特征信息。$\mu$ 为独立同分布的随机误差项，代表不可观测的因素的汇总。在给定影响受访者购买补充医疗保险的因素下，受访者选择购买补充医疗保险的概率可以表示如下：

$$prob(insurance = 1 | X) = E(y_i^* > 0 | X) = \Lambda(\alpha marriage + X_i\beta_i) \quad (2)$$

## 4.2 数据来源

CFPS 数据（China Family Panel Studies）即中国家庭追踪调查，该数据调查样本覆盖全国几乎所有地区，通过问卷调查的形式得到大规模数据库，用于反映中国社会、健康、经济、教育和人口不同年份的不断改变和进步，也为社会学科进行实证分析、国家和政府完善法律法规提供强有力的数据支持。CFPS 数据库中有社区、家庭和个体三个层面的数据库，本文实证部分使用的数据来自 CFPS 的 2018 年个体和家庭数据库。CFPS 数据问卷中包含的个人基本信息、保险状况、个人和家庭收入、家庭消费等数据可以满足文章实证研究的需要。本文使用 CFPS 的 2018 年数据库共有 37355 条个人数据，这些数据的分布无论是从地区、年龄、文化水平等方面来看都十分广泛，从质量和数量上都能很好地满足本文女性婚姻状况对补充医疗保险投保决策分析的数据要求。

## 4.3 样本筛选

为了结合本文需要，更精确地对女性婚姻状况影响补充医疗保险决策的分析，本文对样本数据进行了部分筛选和处理，具体处理如下：

4.3.1 删掉18周岁以下个体和男性个体

本文研究婚姻状况对补充医疗保险投保决策的影响，将 CFPS 数据库中的是否参加补充医疗保险作为被解释变量，将婚姻状况为解释变量。由于年龄在 18 周岁以下群体尚未成年，无法进行独立投保，会对结果造成误差。且 18 周岁以下人群尚未大到国家规定的法定结婚年龄，都属于未婚女性，所以无论是从数据差异的角度还是理论分析的角度，18 周岁以下个体对本次实证研究会存在影响和误差，故本次样本选择将剔 18 周岁以下个体。由于本文研究的群体是女性，因此剔除男性群体。

4.3.2 删除个人数据异常的个体

在剩下的样本数据中，需要用到性别、年龄、户籍等个人数据作为控制变量。

这些个人数据便于填写，答案明确，具有很强的客观性，对于填写者没有难度。在样本筛选时，对于个人数据未填写或是数据填写出现逻辑性错误的样本，将不会用于后续实证分析中。

4.3.3 删除收入数据异常的个体

在所有变量中，其他所有数据在 CFPS 问卷中都有准确的问题询问，问卷回答主观性弱，便于填写和收集。唯一比较例外的控制变量是收入变量，由于收入变量有个体差异大、主观性强、难以估计、隐私性强、数据不稳定等特点，无论是访问还是填写都有很大难度。本文没有明确的问题询问个体每年所有收入的总和，只有部分收入来源如工资收入、兼职收入、年终奖金、个体收入、父母或者子女提供的经济帮助等数据，因此本文对所有收入来源进行加总作为收入数据，并对未填写收入数据和收入数据有明显异常的样本进行筛选和删除。CFPS2018 年数据库共有 32669 条个人数据，经过筛选处理，最后共有有效数据 13955 条。

## 4.4 变量选取

本文在参考其他文献和不同理论基础后，从 CFPS 的 2018 数据库中选取了影响补充医疗保险投保决策的部分变量，根据数据作用的不同将各变量主要分为三类：被解释变量、解释变量和控制变量。

4.4.1 被解释变量

本文所关注的受访者是否购买补充医疗保险的信息位于 CFPS 问卷中公共模块的“医疗保险”部分，我们将“购买补充医疗保险=1”定义为受访者回答“享有补充医疗保险”的人群，其余则设定为 0。问卷详细询问了受访者拥有各种医疗保险的情况，包括公费医疗、城镇职工医疗保险、城镇居民医疗保险、补充医疗保险、新型农村合作医疗。问卷对补充医疗保险界定如下：补充医疗保险是社会医疗保险的一种补充形式，也是我国建立多层次医疗保障的重要组成部分之一。与社会医疗保险不同，补充医疗保险不是通过国家立法强制实施的，而是由用人单位和个人自愿参加的。补充医疗保险一般有两种方式，一种是由某一行业组织按照保险的原则筹集补充医疗保险基金，自行管理的自保形式；另一种是由商业保险公司来操作管理的商保形式。

4.4.2 解释变量

CFPS 数据库将婚姻状况分为 5 类，分别是未婚、有配偶（在婚）、同居、离婚、丧偶。对于同居个体，一方面样本量相对来说较少，在 13955 条有效数据中仅占 59 条，另一方面虽然同居在法律上不被认可，但是在心理和行为上同居与在婚已非常相似，而本文正是通过风险的心里感知来研究不同婚姻状况对补充医疗需求的影响，所以将同居女性归为在婚女性群体一类。在实证分析中，“未婚、同居和在婚、离婚、丧偶”被赋值为 0、1、2、3，婚姻作为无序多分类变量，数值的大小并没有实际意义，各种情况的赋值间不存在大小上的差异，因此本文在模型中引入哑变量的概念。

4.4.3 控制变量

本文在其他文献的基础之上，通过综合分析和考量，最终选取了 13 个变量作为控制变量。

（1）年龄。不同年龄阶段的女性对补充医疗保险的需求存在显著差异，年轻人年龄小，健康风险低，所以补充医疗保险需求小，而中老年人健康状况较差，所以补充医疗保险需求较高。

（2）户籍。在户籍变量上，本文将农业户口设定为“户口=0”，城镇户口等

其他非农户口统一设定为“户口=1”。

（3）受教育水平。受教育水平会影响个体的健康理念，也会影响人的保险意识。CFPS 问卷将个体学历分为 9 类，本文根据受教育程度将其归为 4 类，“从未上过学、文盲/半文盲、小学和初中”赋值为 0，“高中/中专/技校/职高”赋值为 1，“大专、大学本科”赋值为 2，“硕士、博士”赋值为 3。

（4）工作状态。本文将处于工作状态定义为从事农业工作、挣工资的工作或个体 / 私营经济活动之一（不包括在家作家务和义务的志愿劳动），并将其赋值为 1，失业和退出劳动力市场赋值为 0。

（5）自评健康状况和慢性病。由于补充医疗保险以保大病和住院费用为主，因此个人的健康状况和慢性病特征可能是影响保险决策的重要因素。因此，本文将受访者的五级健康自评简化为四级，将“不健康”赋值为 0，“一般”赋值为 1，“比较健康”赋值为 2，“很健康”和“非常健康”赋值为 3；将受访者“患慢性病”赋值为 l，“未患慢性病”赋值为 0。

（6）社会医疗保险。虽然补充医疗保险是对社会医疗保险的补充，但是有不少研究显示社会医疗保险对补充医疗保险有挤出效应。CFPS 问卷询问了受访者拥有各种医疗保险的情况，包括公费医疗、城镇职工医疗保险、城镇居民医疗保险、新型农村合作医疗，本文将拥有上述任意一种医疗保险的个体赋值为 1，都不具有上述保险的赋值为 0。

（7）家庭规模。家庭规模与收入和财富积累都有重要关系，在收入一定的情况下，家庭规模越小，家庭消费支出就越少，财富积累越多。同时小规模家庭面临的风险相对来说比大规模家庭所面临的风险更小，因此本文选取 CFPS 数据库中家庭人口数来度量家庭规模。

（8）家庭消费支出。本文引入家庭人均消费作为控制变量之一，消费水平在一定程度上体现了个人的消费理念和经济水平。有不少研究指出补充医疗保险会显著促进家庭的消费支出，而事实上家庭消费支出也会影响补充医疗保险的投保决策。

（9）个人收入和家庭人均资产。经济收入和资产是影响受访者购买补充医疗保险的重要因素，购买能力越高，则补充医疗保险投保的可能性越大，因此我们选定个人收入和家庭人均资产作为其中的影响因素来进行分析。

（10）个人医疗费用和家庭医疗费用。医疗费用一方面可以反映出个体所患疾病的费用高低，另一方面，上一期的医疗费用会显著影响到个体对未来医疗费用的风险感知，从而影响其补充医疗保险投保决策，因此本文引入个人医疗费用和家庭人均医疗费用。

对以上变量进行相关性分析，结果显示任意两个变量之间的 Pearson 相关性都低于 0.5，因此是可以接受的。

表 4-1 变量相关性检验表

| | 年龄 | 户籍 | 受教育水平 | 工作状态 | 自评健康 | 慢性病 | 社会医疗保险 | 家庭规模 | 家庭消费支出 | 个人收入 | 家庭人均资产 | 个人医疗费用 | 家庭人均医疗费用 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 年龄 | 1 | | | | | | | | | | | | |
| 户籍 | -0.03** | 1 | | | | | | | | | | | |
| 受教育水平 | -0.41** | 0.27** | 1 | | | | | | | | | | |
| 工作状态 | -0.25** | -0.01** | 0.09** | 1 | | | | | | | | | |
| 自评健康 | -0.336* | 0.06** | 0.18** | 0.12** | 1 | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 慢性病 | 0.28** | -0.01* | -0.11** | -0.11** | -0.35** | 1 | | | | | | |
| 社会医疗保险 | 0.04** | -0.03** | -0.02* | 0.04** | -0.01* | 0.02* | 1 | | | | | |
| 家庭规模 | -0.18** | -0.12** | -0.07** | 0.05** | 0.07** | -0.05** | 0.05** | 1 | | | | |
| 家庭消费支出 | -0.12** | 0.19** | 0.21** | -0.01 | 0.06** | -0.02** | 0.01 | 0.13** | 1 | | | |
| 个人收入 | -0.05** | 0.06** | 0.08** | 0.07** | 0.02** | -0.02** | -0.01 | -0.05** | 0.06** | 1 | | |
| 家庭人均资产 | 0.02** | 0.20** | 0.16** | -0.05** | 0.01 | 0.03** | -0.01 | -0.15** | 0.19** | 0.08** | 1 | |
| 个人医疗费用 | 0.13** | 0.02** | -0.04** | -0.12** | -0.19** | 0.18** | -0.01 | -0.05** | 0.06** | 0.01 | 0.03** | 1 |
| 家庭人均医疗费用 | 0.02** | 0.01 | -0.01 | -0.06** | -0.07** | 0.06** | 0.01 | 0.05** | 0.25** | -0.01 | 0.01* | 0.30** |

**. 在 0.01 水平（双侧）上显著相关。

*. 在 0.05 水平（双侧）上显著相关。

表 4-2 所有变量含义及赋值表

| 变量名称 | 变量解释 |
|---|---|
| 是否购买补充医疗保险 | 未购买医疗保险=0，购买补充医疗保险=1 |
| 婚姻状况 | 未婚=0，同居&在婚=1，离婚=2（对照组），丧偶=3，生成无序多分类变量 |
| 年龄 | 受访者年龄 |
| 户籍 | 农村户口=0，非农户口=1 |
| 受教育水平 | 初中及以下=0，高中/中专/技校/职高=1，大专&大学本科=2，硕士&博士=3 |
| 工作状态 | 失业&退出劳动力市场=0，有工作=1 |
| 自评健康 | 不健康=0，一般=1，比较健康=2，，很健康&非常健康=3 |
| 慢性病 | 未患慢性病=0，患慢性病=1 |
| 社会医疗保险 | 公费医疗&城镇职工医疗保险&城镇居民医疗&新农合=1，未参与=0 |
| 家庭规模 | 受访者家庭人口数 |
| 家庭消费支出 | 家庭总消费/家庭人口数 |
| 个人收入 | 受访者每年全部收入总和 |
| 家庭人均净资产 | 家庭总资产/家庭人口数 |
| 个人医疗费支出 | 受访者每年全部医疗费总和 |
| 家庭医疗费支出 | 家庭医疗费总支出/家庭人口数 |

## 5. 实证结果与分析

### 5.1 描述性统计

在完成样本数据的处理后，为更直观地了解样本数据的总体情况，本文对总体样本各变量进行描述性统计，具体结果如下表：

表 5-1 各变量数据描述性统计

| 变量 | 样本数 | 平均值 | 标准差 | 最小值 | 最大值 |
|---|---|---|---|---|---|
| 是否购买补充医疗保险 | 13955 | 0.0146 | 0.1200 | 0 | 1 |
| 年龄 | 13955 | 48.4627 | 15.7021 | 18 | 95 |

| | | | | | |
|---|---|---|---|---|---|
| 户籍 | 13955 | 0.5108 | 0.4999 | 0 | 1 |
| 受教育水平 | 13955 | 0.3622 | 0.6925 | 0 | 3 |
| 工作状态 | 13955 | 0.6773 | 0.4675 | 0 | 1 |
| 慢性病 | 13955 | 0.1971 | 0.3978 | 0 | 1 |
| 社会医疗保险 | 13955 | 0.9175 | 0.2751 | 0 | 1 |
| 自评健康状况 | 13955 | 1.6943 | 1.0609 | 0 | 3 |
| 家庭规模 | 13955 | 4.2422 | 2.0503 | 1 | 21 |
| 家庭消费支出 | 13955 | 59866 | 69965 | 0 | 1820360 |
| 个人医疗费用 | 13955 | 3666 | 13113 | 0 | 520000 |
| 家庭人均医疗费用 | 13955 | 6186 | 15881 | 0 | 380000 |
| 个人收入 | 13955 | 30457 | 57365 | 0 | 4100000 |
| 家庭人均净资产 | 13955 | 229093 | 624794 | -361667 | 25088444 |

从描述性统计中我们可以简单得知：参保补充医疗保险的样本比例只有1.46%，因此我国补充医疗保险发展仍处在初级阶段，参保人数较少，市场占有率有待提升。在其他个人特征方面，剔除 18 周岁以下人群以后，所有样本的平均年龄在 48 周岁，处在中年的个体较多；样本中非农村户口占比为 51.1%，说明农村户口和非农村户口数量均衡，样本可信度高；教育水平方面样本受教育程度的均值仅为 0.362，接近小学初中文化程度，说明样本中 18 周岁以上人群平均学历不高，文化程度相对较低；工作状态的均值为 0.6773，说明大部分女性在劳动力市场上工作；19.7%的人患有慢性病，说明女性患有慢性病的概率较高；社会医疗保险的参保率高达 91.75%，说明我国社会医疗保险已经基本达到广覆盖的目标，个体可以获得基本的医疗保障；个人自评健康水平的平均值约为 1.7，相对应的健康水平接近比较健康，说明大部分人对自己健康水平的评价大多为亚健康水平，对自己的身体状况不是特别乐观；家庭人口数的均值接近 4，最大值高达 21，说明样本中存在着多人的族系家庭；样本家庭消费支出均值约为 6 万元/年，而最高达到 182 万元/年，说明我国家庭消费差距较大；2018 年家庭医疗费支出均值约为 6186 元，而女性个人医疗费支出均值约为 3658 元，占一半以上，说明女性医疗费支出高于男性；样本的个人收入均值为 3.05 万元/年，2018 年我国的人均可支配收入为 2.8 万元，两者差异较小；家庭人均净资产均值为 22.9 万元，而最大值达到 250.9 万元，大于均值的 11 倍，表现出显著的贫富差距。

为了进一步显示购买补充医疗保险的人群与未购买补充医疗保险的人群的特征差异，本文将全体样本按照“不同婚姻状况”和“是否购买补充医疗保险”进行分类并比较差异，表 5-2 和表 5-3 为描述统计结果。

表 5-2 女性的不同婚姻状况对补充医疗保险投保决策的差异性描述

| 变量 | 样本 | | 参保补充医疗保险 | | 未参加补充医疗保险 | |
|---|---|---|---|---|---|---|
| | 人数 | 比例 | 参保人数 | 参保率 | 未参保人数 | 未参保率 |
| 未婚 | 1153 | 8.262% | 28 | 2.428% | 1125 | 97.572% |
| 在婚 | 11579 | 82.974% | 159 | 1.373% | 11420 | 98.627% |
| 离婚 | 182 | 1.304% | 9 | 4.945% | 173 | 95.049% |
| 丧偶 | 1041 | 7.460% | 8 | 0.768% | 1033 | 99.232% |

表 5-3 参保补充医疗保险与未参保补充医疗保险的女性人群差异性描述

| 变量 | 参保补充医疗保险的样本 | | | | | 未参保补充医疗保险的样本 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 样本数 | 平均值 | 标准差 | 最小值 | 最大值 | 样本数 | 平均值 | 标准差 | 最小值 | 最大值 |
| 是否购买补充医疗保险 | 204 | 1.000 | 0.000 | 1 | 1 | 13751 | 0 | .000 | 0 | 0 |
| 年龄 | 204 | 41.721 | 12.969 | 20 | 83 | 13751 | 48.563 | 15.718 | 18 | 95 |
| 户籍 | 204 | 0.779 | 0.416 | 0 | 1 | 13751 | 0.507 | 0.500 | 0 | 1 |
| 受教育水平 | 204 | 1.083 | 0.935 | 0 | 3 | 13751 | 0.351 | 0.683 | 0 | 3 |
| 工作状态 | 204 | 0.784 | 0.412 | 0 | 1 | 13751 | 0.676 | 0.468 | 0 | 1 |
| 慢性病 | 204 | 0.176 | 0.382 | 0 | 1 | 13751 | 0.197 | 0.398 | 0 | 1 |
| 社会医疗保险 | 204 | 0.691 | 0.463 | 0 | 1 | 13751 | 0.921 | 0.270 | 0 | 1 |
| 自评健康状况 | 204 | 1.936 | 0.843 | 0 | 3 | 13751 | 1.691 | 1.063 | 0 | 3 |
| 家庭规模 | 204 | 3.819 | 1.751 | 1 | 10 | 13751 | 4.248 | 2.054 | 1 | 21 |
| 家庭消费支出 | 204 | 94780 | 98354 | 0 | 827520 | 13751 | 59348 | 69329 | 0 | 1820360 |
| 个人医疗费用 | 204 | 3102 | 7248 | 0 | 63656 | 13751 | 3674 | 13180 | 0 | 520000 |
| 家庭人均医疗费用 | 204 | 8639 | 27404 | 0 | 300000 | 13751 | 6150 | 15645 | 0 | 380000 |
| 个人收入 | 204 | 42711 | 100386 | 0 | 1337400 | 13751 | 30275 | 56467 | 0 | 4100000 |
| 家庭人均净资产 | 204 | 530575 | 1069454 | -5020 | 10710000 | 13751 | 224620 | 614739 | -361667 | 25088444 |

通过表 5-2 描述性分析可得四种婚姻状况的女性补充医疗保险参保率存在较大差异，离异女性的参保率高达约 5%，而未婚和在婚女性的参保率仅为 2.4%和 1.4%，丧偶女性最低仅 0.8%。从表 5-3 可以看出参保补充医疗保险个体的年龄较小，城镇人口比例、受教育水平、家庭消费支出、家庭医疗费支出、个人收入和家庭人均净资产明显高于未参保的个体，而且参保个体的工作性质更偏向稳定工作。未参保补充医疗保险的群体社会医疗保险参保率高达 92.1%，而参保补充医疗保险的群体社会医疗保险参保率仅 69.1%，两者有显著差异。此外，慢性病、自评健康状况、家庭规模和个人医疗费支出的差异不大。当然通过描述性分析无法准确判断女性婚姻状况对补充医疗保险投保决策的影响，需要通过模型进行具体分析才能得出结论。

## 5.2 女性婚姻状况的补充医疗保险投保决策的实证分析

为了了解女性婚姻状况与其购买补充医疗保险之间的关系，本文对 CFPS

2018 年的截面数据进行回归，Logit 模型回归结果如下表。

表 5-4 女性婚姻状况对补充医疗保险投保决策的影响的对比回归结果

| 变量 | 实证分析 | （1） | （2） | （3） | （4） |
|---|---|---|---|---|---|
| 未婚 | -0.01444*** | -0.00595*** | | | |
| | （-4.26） | （-3.85） | | | |
| 在婚 | -0.01022** | | 0.0029* | | |
| | （-2.85） | | （1.69） | | |
| 离婚 | | | | 0.00745*** | |
| | | | | （3.08） | |
| 丧偶 | -0.01126* | | | | -0.00201 |
| | （-1.55） | | | | （-0.20） |
| 年龄 | -0.000032 | -0.000039 | 0.000007 | 0.0000261 | 0.000038 |
| | （-0.8） | （-0.91） | （0.37） | （0.46） | （0.44） |
| 户籍 | 0.001409*** | 0.00498*** | 0.00527*** | 0.00527*** | 0.00549*** |
| | （2.41） | （2.55） | （2.73） | （2.63） | （2.79） |
| 受教育 | 0.006624*** | 0.00666*** | 0.00658*** | 0.00642*** | 0.00646*** |
| 水平 | （11.24） | （11.29） | （10.80） | （10.66） | （10.67） |
| 工作状 | 0.00401*** | 0.00409*** | 0.00421*** | 0.00441*** | 0.00442*** |
| 态 | （3.11） | （3.07） | （3.18） | （3.42） | （3.37） |
| 慢性病 | 0.00273* | 0.002756* | 0.00270 | 0.00266 | 0.00266 |
| | （1.40） | （1.41） | （1.36） | （1.33） | （1.35） |
| 社会医 | -013773*** | -0.01390*** | -0.01391*** | -0.01360*** | -0.13798*** |
| 疗保险 | （-11.94） | （-12.00） | （-11.87） | （-11.74） | （-11.78） |
| 自评健 | 0.000838 | 0.000834 | 0.000817 | 0.0008085 | 0.0008032 |
| 康状况 | （0.72） | （0.72） | （0.67） | （0.62） | （0.61） |
| 家庭规 | -0.000392 | -0.000464 | -0.000387 | -0.000194 | -0.000265 |
| 模 | （-1.20） | （-1.42） | （-1.19） | （-0.81） | （-1.04） |
| 家庭消 | 0.000126** | 0.000128** | 0.000135** | 0.000140*** | 0.000142*** |
| 费支出 | （2.78） | （2.79） | （2.93） | （2.98） | （2.99） |
| 个人医 | -0.0000342 | -0.000034 | -0.0000389 | -0.0000386 | -0.0000411 |
| 疗费用 | （-0.94） | （-0.88） | （-0.91） | （-0.99） | （-0.92） |
| 家庭人 | 0.0000489** | 0.0000494** | 0.0000496** | 0.0000503** | 0.0000503** |
| 均医疗 | （1.85） | （1.83） | （1.77） | （1.81） | （1.78） |
| 费用 | | | | | |
| 个人收 | 0.0000149 | 0.0000143 | 0.0000175 | 0.000021 | 0.0000208 |
| 入 | （1.00） | （0.96） | （1.00） | （1.07） | （1.02） |
| 家庭人 | 0.0000123*** | 0.0000122*** | 0.0000119*** | 0.0000121*** | 0.0000142*** |
| 均净资 | （3.45） | （3.43） | （3.35） | （3.38） | （3.34） |
| 产 | | | | | |

注:***，**，*分别表示在 1%，5%，10%的水平上显著；系数已转换为边际效应值。

首先将离异女性作为对照组，回归结果表明离异女性与未婚女性、在婚女性、丧偶女性的投保决策存在较大差异，分别在 1%，5%，10%的水平上显著。从 Logit

模型估计结果来看，与其他三类女性群体相比，离异女性投保补充医疗保险的概率更高。首先是因为女性离婚后没有了家庭的庇护，安全感明显降低，从而提高了对未来未知医疗费用的风险感知，其次有不少离异女性在离婚后感觉到躯体不适，这种心理和生理上的双重打击显著增加女性对风险的厌恶程度，从而提高了对补充医疗保险的感知价值，因此离异女性更倾向于投保补充医疗保险。

分别将四种婚姻状况作为自变量进行回归分析，得出女性在不同婚姻状况下的补充医疗保险决策存在显著差异。在婚女性良好的经济基础提高了她们投保的客观概率，但是幸福的家庭氛围让女性忽视了对风险的感知，因此在婚女性对补充医疗保险的感知价值弱于离异女性。未婚女性不仅在经济角度、心理情绪角度还是健康状况角度都不会增加对补充医疗保险的需求，经济的拮据从客观上降低了未婚女性的投保概率，良好的心理情绪和健康状况从主观上降低了未婚女性保障的需求。理论上丧偶女性心理状况比离异女性更差，而且丧偶女性也常常面临着各种各样的健康隐患，所以从这两方面看来，丧偶女性对投保补充医疗保险的意愿应该是非常高的。但是较高的主观意愿并不意味着较高的投保率，因为投保具有一定的门槛，例如大多商业医疗保险不接受 60 岁以后的人群首次投保，并且对投保人有既往病史的要求。此外，针对高龄群体的保费相对来说非常高，这在一定程度上也降低了丧偶人群对补充医疗保险的需求。

在受访者其他个体特征上，没有发现受访者的年龄、自评健康状况和慢性病与购买补充医疗保险有显著关系。正如前文所解释，健康的年轻人往往是保险公司最青睐的客户，但是这类群体的投保意愿普遍不高；而高龄不健康群体虽然投保补充医疗保险的主观意愿比较强烈，但是往往会受到投保门槛的制约。高教育水平群体会更愿意购买补充医疗保险，首要原因是高教育水平的群体有较高的保险意识，并且相对稳定、高收入的工作也会提高其补充医疗保险的投保概率。相比于没有工作的人群，有工作的受访者购买补充医疗保险的可能性要多出 0.5%左右。另外，相较于没有社会医疗保险的女性，有公费医疗、城镇职工医疗、城镇居民医疗或新农合会显著降低受访者购买补充医疗保险的概率，这说明社会医疗保险对商业医疗保险的挤出和替代效应明显。此外，没有发现家庭规模与补充医疗保险有显著相关关系。

在经济相关指标上，本文引入了个人医疗费支出、个人总收入、家庭消费支出、家庭人均医疗费支出和家庭人均净资产。其中家庭消费支出、家庭人均医疗费支出和家庭人均净资产对女性投保补充医疗保险有显著的正向影响，也就是说，随着这些家庭经济变量的增长，受访者购买补充医疗保险的概率增加，但是与之对应的个人医疗费支出和个人收入对补充医疗保险投保决策的影响不大。这说明女性的经济行为决策更侧重于家庭层面，而不单单取决于个人自身利益。

## 5.3 稳健性检验

为了使上述结果更加稳健，本文扩充了 0-18 岁年龄段的样本，以进行全样本的稳定性检验。表 5-5 为稳健性检验结果，第一排和第二排分别为边际效应值和 t 值。

表 5-5 女性婚姻状况对补充医疗保险投保决策影响的稳健性结果

| 变量 | 实证分析 | （一） | （二） | （三） | （四） |
|---|---|---|---|---|---|
| 未婚 | -0.0143*** | -0.00577*** | | | |
| | （-4.21） | （-3.78） | | | |
| 在婚 | -0.0102** | | 0.00282** | | |

| | | | | | |
|---|---|---|---|---|---|
| | （-2.84） | | （1.67） | | |
| 离婚 | | | | 0.00741*** | |
| | | | | （3.06） | |
| 丧偶 | -0.01123* | | | | -0.00201 |
| | （-2.55） | | | | （-0.21） |

注:***，**，*分别表示在 1%，5%，10%的水平上显著；系数已转换为边际效应值。

表 5-5 中的回归结果显示，在加入 0-18 岁样本后，虽然回归结果与实证结果在边际效应和显著性上有细微差异，但整体和各分类下的回归结果与实证结果基本保持一致，因此判断本文的回归结果是稳健的。

## 6. 结论与建议

基于上述理论分析和实证检验，本节将对文章的主要结论进行总结，并对保险公司如何精准化市场营销和针对性产品设计、政企提高女性风险和保险意识提出若干建议。

### 6.1 实证结论

（1）从整体来看，不同婚姻状况对女性购买补充医疗保险存在显著差异。其中，在婚和离异的婚姻状况显著增加了女性投保补充医疗保险的概率，而未婚因素则产生了负向影响，丧偶对女性购买补充医疗保险的影响不显著。对于未婚女性而言，较低的经济收入水平、较高的心理情绪、良好的健康状况等因素共同降低了未婚女性对补充医疗保险的投保意愿。在婚女性在经济较为宽裕的情况下，出于家庭责任的考虑，为了减少自身医疗费用对家庭经济的巨大冲击，她们会增加对补充医疗保险的需求。离异女性由于心理情绪和健康水平降低的效应抵消并远超经济水平降低的效应，因此更倾向于投保补充医疗保险。理论上丧偶女性是最需要补充医疗保险保障的群体，但是由于保费、投保门槛等各种因素的制约，丧偶女性的投保率并不高。

（2） 相比较于离婚的女性群体，未婚、在婚和丧偶的女性对补充医疗保险的需求较低，其中未婚女性最低。本文认为婚姻状况对女性投保补充医疗保险的影响主要体现在心理情绪上，经济收入和健康状况次之，离婚对女性造成巨大的心理打击往往使她高估风险，从而更倾向于投保补充医疗保险，以此来规避未知风险。周路平和孔令明（2010）也指出，由于女性主观损失感远远高于男性，所以女性所表现出的风险规避决策事实上更多的受到情绪取向的影响，这与本文结论高度契合。

（3）个人层面的医疗费支出、个人收入对女性投保补充医疗保险无显著影响，而家庭层面的消费支出、医疗费支出和家庭人均资产对女性投保补充医疗保险投保有显著正向影响。这是因为，女性的家庭观念往往比男性更深刻，因此她们的行为决策更容易受到家庭因素的影响。

### 6.2 政策建议

根据结论我们可以发现，婚姻状况对女性购买补充医疗保险有显著影响，离异女性和在婚女性投保补充医疗保险的概率更高，未婚女性最低。以离异女性为例，婚姻的打击使得女性的风险感知水平显著提升，从而提高了离异女性对补充医疗保险的感知价值，因此离异女性更倾向于投保补充医疗保险。这些结论可以给我们新的启示，本节将主要围绕保险机构针对性展业、产品设计、风险意识普

及等方面提出以下建议。

6.2.1 细分消费群体，提高精准化营销

补充医疗保险市场营销更适合非价格竞争，这就对保险公司营销的专业性和服务性提出了更高的要求。对于投保人来说，补充医疗保险并不是一种普通的消费品，而是一项基于个体风险处境的财务保障计划和风险管理计划，因此保险公司在营销展业过程中应该了解不同婚姻状况的女性群体的行为特征和消费偏好，并对此进行细分。例如未婚女性群体普遍收入不高，但健康状况较好，因此她们主要面临低概率的高费用的疾病风险，由此保险公司可向其推荐免赔额较高的补充医疗保险。这类补充医疗保险不仅保费较低，而且也能抵御高费用的疾病风险，可以有效契合未婚女性的保障需求。对于离异女性，情绪上的低落让她们背负着巨大的压力，因此保险公司应该主动加强沟通，为其提供保障更加全面的补充医疗保险产品，减低她们的风险压力，提升体验感。

6.2.2 细化产品设计，满足多样化保险需求

目前补充医疗保险市场上产品同质性问题严重，导致供给端和需求端结构性不匹配，大多数投保人无法获得称心如意的保险产品。例如离婚和丧偶因素在提高女性的风险感知水平的同时，也常常伴随着健康水平的下降，因此保险公司在设计面向离婚和丧偶女性的补充医疗保险时可以引入更高水平的健康管理服务，从源头降低疾病发生的概率，一方面可有效降低保险公司的赔付率，另一方面还能提升女性对该保险产品的感知价值。因此保险公司应以不同女性消费群体的风险特征为出发点，加强补充医疗保险的险种创新，主动适应现代社会婚姻观多元化下的差异化保障需求。

6.2.3 政企合作，提高女性风险意识和保险意识

本文发现，自评健康状况、慢性病和个人医疗费对女性购买补充医疗保险的决策影响不大。这不仅仅是因为保险公司会采取系列措施排除高风险女性群体，更是因为女性对疾病风险和医疗保险产品认知的有限性有关，风险认识能力和保险意识不足在一定程度上抵消了客观疾病风险对投保决策的推力。因此保险公司在开展营销活动时应注重风险意识的普及，特别是针对于补充医疗保险购买需求不高的未婚和丧偶女性。此外，政府机构在金融布局中应凸显补充医疗保险的重要作用，不仅要利用优惠政策，更要进行补充医疗保险基本原理的全面推广，让广大女性对补充医疗保险有更充足的获得感和认知感，从而真正地构建起全民健康防护墙，跟进“健康中国”战略大格局。

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# 女性婚姻状况对补充医疗保险投保决策的影响

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**关键词:** 婚姻状况;补充医疗保险; 风险决策

**摘要.** 本文利用2018年中国家庭追踪调查（CFPS）数据，实证研究我国女性婚姻状况对补充医疗保险投保决策的影响。结果表明：首先，不同婚姻状况对女性购买补充医疗保险存在显著差异，在婚和离异因素显著增加了女性投保补充医疗保险的概率，而未婚因素则产生了负向影响，丧偶因素的影响不显著。其次，相比较于离异女性，未婚、在婚和丧偶的女性对补充医疗保险的需求较低，其中未婚女性最低。最后，个人层面的医疗费支出、个人收入对女性投保补充医疗保险无显著影响，而家庭层面的经济收支情况对女性投保补充医疗保险有显著影响。基于上述研究结果，本文从保险机构针对性展业、保险产品设计、风险和保险意识普及等角度，为保险公司和政府提供了相关建议。

# Chapter 4. Pension and Social Security

# The Impact of Basic Endowment Insurance on Family Intergenerational Support for the Disabled Elderly: An Empirical Study Based on CHARLS Data

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**Keywords:** Basic endowment insurance, Family intergenerational support, Disabled elderly,

**Abstract.** The study will highlight the influence of social endowment insurance on family intergenerational support using data form 2011, 2013, 2015 and 2018 drawn from the China Health and Retirement Longitudinal Survey (CHARLS). This paper identifies the influence of social endowment insurance on family intergenerational support using the the least square method (OLS) estimation and makes robustness checks using binary choice logit model for panel data. We also employ the fixed effects model to examine heterogeneous effects.

This work found that the social endowment insurance system has produced an unexpected result. In concrete terms, the fixed effects model results provide relatively stable empirical support. The influence of social endowment insurance system on family intergenerational support shows the difference characteristics: the social endowment insurance has not had a significant negative impact on the obvious life care and spiritual comfort of children, but significantly “squeeze out” the economic support of children to the elderly. We further discovered that the substitution effect of social endowment varied according to disabled degree, sex, and residential area. In

particular, and this phenomenon is more sensitive and significant for mild disabled degree, females, and rural residents. We also distinguished insurance types and studied the effects of different insurance types on family intergenerational support. By mechanism analysis, we find that living way has the mediation, which acts on the relationship between the social endowment and economic support.

From the framework of the total welfare of the disabled elderly, this study found social endowment insurance affects the family's resource allocation status and internal intergenerational relationship, which leads to the "vacuum" phenomenon in the acquisition of care resources. Thus, it's necessary to coordinate the relationship between social endowment insurance and family role, to develop social pension and family situation of the development of complementary pension and fusion, and expand the social supply of care resources to improve the living standard of the disabled elderly.

## 1. 引言及文献综述

我国目前正处于老龄化迅速发展时期。老年人口比重明显增加，我国的重度老龄化和高龄化问题将变得越来越突出[1]。第七次全国人口普查结果显示，我国 60 岁及以上人口为 26402 万人，占 18.70%，其中，65 岁及以上人口为 19064 万人，占 13.50%。还有学者预测我国社会人口老龄化将在 2050 年达到高峰阶段，将有超过 1 亿失能老人[2]。随着我国人口老龄化程度持续加重，失能老年人的数量会出现相应地增长，与此相伴的还有家庭规模小型化、家庭结构核心化和少子化等现象，这些现状的出现及发展对传统的家庭养老提出了前所未有的挑战。人口老龄化不是简单的人口结构和养老问题，党的第十九届五中全会通过的"十四五"规划提出要实施积极应对人口老龄化国家战略，推动养老事业和养老产业协同发展。因而，社会养老的重要性日渐凸显。失能老年人因其身体机能和服务需求的特殊性，对日常生活帮助和照料依赖更大。关注失能老年人晚年生活质量和养老问题，构筑人类生命周期终端的安全网成为影响我国养老事业发展的重要方面[3]。

我国的养老方式主要是家庭养老[4]，老年家庭养老的实质是代际支持，主要发生在老年父母和成年子女之间，在内容上包含了子女对父母的经济支持、生活支持和情感支持。经济支持指各种金钱和物质形式的帮助，生活支持通常涉及日常照料和家务帮助等，情感支持则是指精神慰藉和陪伴等活动[5][6]。我国学者田北海[7]认为家庭养老内涵的文化传承是中国社会生存与发展的重要基石，对于身处传统与现代转折点的老年群体来说有着强大的形塑力。穆光宗则指出家庭养老作为一种世代承袭的养老观念，对于多数老年人而言，家庭仍是首选的养老支持来源。杨菊华[8]认为中国人家庭养老观念比较强，使传统的家庭形式对代际成员依然具有较强的吸引力，经济供养、生活照料和日常服务大多仍由家庭承担。然而也有学者认为，由于城市化的发展及老龄化与少子化等因素导致的养老风险，我国家庭养老功能衰退[9][10]。范成杰[11]认为，在工业化进程中，子女的经济水平和经济地位明显提高，父母与子女之间代际关系下位运行，从而

导致子女对父母的依赖性弱化，进而使家庭养老受到冲击。穆怀中等人[12]发现农村家庭养老已经全面弱化，以社会养老为主的农村养老保障将成为必然趋势。

在当下背景下，家庭养老支持与正式的养老支持（如社会养老等）形成了互补机制，寻求社会养老支持是对当下家庭养老困境的一种替代选择,会对老年人养老产生重要的影响，虽然制度性社会养老主要提供养老保险金，但是也可能对家庭提供的生活支持与精神支持产生直接或者间接的影响。国内外对社会保障和家庭代际支持的研究产生了丰富的成果。一种观点认为养老保险金会对子女的代际支持具有“挤出”效应[13]。如 Reil-Held[14]和 Zhang[15]指出社会保障会挤出子女的经济支持以维持自身的消费水平，实现自身效用最大化。程令国[16]和焦娜[5]的研究发现了我国新农保的实施会挤出子女的时间和服务支持。Thoman[17]研究认为，养老金会挤出成年子女对父母的经济支持，降低了成年子女为老年父母提供经济资源的可能性。Juarez[18]通过使用墨西哥调查数据也得出了老年人获得养老金会挤出家庭代际经济支持的结论。另一种观点则认为养老保险金对子女的代际支持具有“挤入”效应。Brandt and Deindl [19]研究发现，基本养老保险对老年人获得来自于子女的照料时间具有挤入效应。解垩[20]认为养老保险金增加并提高了老年人的可支配资源和支付能力，将代际支持从家庭内部扩大到全社会的福利水平提高，最终出现“挤入”效应。郑旭辉、王小莲、宁满秀[21]研究认为，子女受到交换动机的影响，会相应提高父母提供劳务支持的价格，老年人便会获得子女更多的经济供养。靳卫东、王鹏帆、何丽[22]在研究新农保对农村家庭养老质量和养老模式的影响时得出老年人参加新农保对于子女提供的代际经济支持具有挤入效应。

纵观已有文献不难发现，作为研究社会养老的方向之一，基本养老保险与家庭代际支持的关系是国内外学者深入探讨的热点问题，政策的实施与研究都取得了一定的进展。然而，已有文献的研究仍存在不足之处：一方面，大多数学者主要研究的是基本养老保险对经济支持的影响，较少涉及到生活照料和精神慰藉方面。而家庭养老不但包括经济供养行为，还包括精神慰藉与生活照料，基本养老保险可能对两者起到直接或者间接的作用；另一方面，目前有关基本养老保险对家庭代际支持影响的研究中并未关注到失能老年人这一特殊群体，考虑到目前中国正在探索老年人照料方式的最佳选择，失能老年人是被照料的主体，而且失能老年人因其身体机能和服务需求的特殊性，对代际支持的需求和依赖可能有所不同。因此，我们聚焦失能老年人这一特殊群体，考察基本养老保险对其家庭代际支持的影响。

本文主要研究基本养老保险对失能老年人家庭代际支持的影响，主要贡献和创新有三点：①本文基于 2011-2018 年 CHARLS 的面板数据，具有明显的时效性，并且利用固定效应模型控制遗漏变量导致的内生性问题，使结果更加严谨可靠。②本文进行了丰富的异质性检验，全面细致地考察了基本养老保险对不同失能程度、性别和居住地区等失能老年人家庭代际支持的影响，进一步区分研究了不同保险种类对家庭代际支持的影响，使研究结果更具现实意义。③本文创新性地通过中介效应模型检验了基本养老保险对失能老年人家庭代际支持的作用机制，明确基本养老保险影响家庭代际支持的途径，有助于为完善基本养老保险体系提供针对性的政策建议。

## 2. 数据来源、变量选取及描述性统计

### 2.1 数据来源

本文使用的数据来自北京大学国家发展研究院、北京大学中国社会科学调查中心和北京大学团委联合进行的中国健康与养老追踪调查（CHARLS）。CHARLS是一套代表中国45岁及以上中老年人家庭和个人的高质量微观数据，旨在用作研究我国人口老龄化问题，推进老龄化问题的跨学科发展。该调查项目在2011年进行基线调查，此后分别于2013年、2015年和2018年进行了4期的跟踪调查。这个数据库包含了老年人个人及其家庭丰富的社会经济指标，而且还对失能老年人进行了调研。此外，在其他实证研究中也证明该数据在有关老年人其他各方面数据上质量较好，因而具有很强的代表性、参考性和科学性。

### 2.2 变量选取

在CHARLS的全部调查样本中，本文保留了60岁及以上的老年人受访者，然后进一步筛选出失能的老年人作为本文的研究对象。以往研究单纯使用躯体活动能力KATZ量表衡量老人失能情况，这会在一定程度上低估老人失能的规模和程度，本文参考刘亚飞、张敬云[23]和温兴祥等人[24]的做法构建了全面衡量老人失能状况的两个维度指标—ADL和IADL。如果一个老年人在无人帮助下自身不能完成某一项基本日常活动（Activity of Daily Living, ADL）或工具性日常活动（Instrumental Activity of Daily Living, IADL)，则被视为失能老人。本文所涉及的ADL是一些日常生活的最基本的活动，包括穿衣、洗澡、吃饭、起床、上厕所等五项；IADL是较ADL更为复杂的日常活动，包含做家务、做饭、购物、打电话、吃药等五项。基于本研究需要，按照我们的定义在对主要变量和相关变量的样本进行筛选、鉴别和剔除后，最终我们的样本包含8516位失能老年人。

本文旨在考察基本养老保险对失能老年人家庭代际支持的影响。本研究的被解释变量是“家庭代际支持”，参照穆光宗[25]把家庭养老的功能具体化为生活照料、精神慰藉以及经济支持三个方面，本文中将调查问卷中的“在日常生活中一些行为有困难时，谁帮助您最多”定义为“生活照料”，如果回答是子女帮助最多赋值为“1”，否则赋值为“0”[26]；将“您多长时间见到孩子”定义为“精神慰藉”，根据父母与子女见面的频率，将回答“有时”、“经常”的赋值为1，“几乎不”、“偶尔”的赋值为0[27]；“经济供养”本文选取的是“过去一年，您或您的配偶从您的孩子那里收到过多少经济支持（对于实物支持，进行货币化核算）”，如果没有给钱或物回答赋值为“0”，否则赋值为“1”[28]。核心解释变量为被访者是否有基本养老保险，如果受访者参加了基本医疗保险则赋值为“1”，否则为“0”。

我们还包括了各种家庭代际支持影响因素的协变量，包括1）年龄和性别的人口统计学特征[29]；2）社会经济特征、包括婚姻状况、受教育程度、医疗保险[30]；3）健康状况，包括慢性疾病人口数量、社会活动参与、情感感受和自评健康[31]吸烟状况和饮酒量；和4）家庭变量，包括居住类型、是否有住房保障、子女数量和家庭收入水平[32]。我们使用家庭收入的自然对数来解释右偏斜性。变量的定义见表1。

表 1 变量定义

| 变量 | 定义 |
|---|---|
| 被解释变量: | |
| 基本养老保险 | 1=参加,0=未参加 |
| 核心解释变量: | |
| 生活照料 | 1=是，0=否 |
| 精神慰藉 | 1=是,0=否 |
| 经济支持 | 1=是,0=否 |
| 控制变量: | |
| 年龄 | 连续变量 |
| 性别 | 1=男性,0=女性 |
| 婚姻状况 | 1=已婚,0=离婚、丧偶和其他 |
| 城乡类别 | 1=城市,0=农村 |
| 受教育程度 | |
| 小学及以下※ | 1=是,0=否 |
| 初中 | 1=是,0=否 |
| 高中 | 1=是,0=否 |
| 大学及以上 | 1=是,0=否 |
| 医疗保险 | 1=参加,0=未参加 |
| 慢性病数目 | 连续变量 |
| 社会活动参与 | 连续变量 |
| 情感感受 | 1=快乐和不孤独，0=其他 |
| 自评健康 | 1=健康(很好或好)，0=其他 |
| 是否抽烟 | 1=是,0=否 |
| 是否喝酒 | 1=是,0=否 |
| 住房保障 | 1=是,0=否 |
| 子女数量 | 连续变量 |
| 家庭收入对数 | 年收入数（元） |
| 样本量 | 8,516 |

## 2.3 描述性统计

表2给出了本文的主要变量的基本统计量，在全体样本的基础上，我们进一步对参加了基本养老保险的失能老人和未参加基本养老保险的失能老人进行了分组，并对两组子样本进行比较。从结果看，失能老人中参保个体收到的家庭代际支持低于未参保组和总体平均水平。参保个体往往年龄更小，更健康，更乐于社交，更少吸烟、喝酒，有医疗保险，有自己的住房，有更多的孩子。相比之下，那些被抽样的老年人已经参保的更有可能是城市居民，并有更高的教育水平和家庭收入。

表 2 全样本描述性统计

| 变量 | 全样本 | | 未参加养老保险者 | | 参加养老保险者 | | T-检验 |
|---|---|---|---|---|---|---|---|
| | 均值 | 标准差 | 均值 | 标准差 | 均值 | 标准差 | |
| 被解释变量： | | | | | | | |
| 生活照料 | 0.7925 | 0.4055 | 0.7933 | 0.4050 | 0.7964 | 0.4056 | |
| 精神慰藉 | 0.4615 | 0.4985 | 0.4769 | 0.4995 | 0.4554 | 0.4980 | |
| 经济支持 | 0.8888 | 0.3144 | 0.9426 | 0.2327 | 0.8688 | 0.3376 | *** |
| 核心解释变量： | | | | | | | |
| 养老保险 | 0.7287 | 0.4446 | 0 | 0 | 1 | 0 | |
| 年龄 | 76.3271 | 9.9780 | 78.5611 | 9.2796 | 75.4161 | 10.1085 | *** |
| 性别 | 0.4758 | 0.4994 | 0.4821 | 0.4997 | 0.4731 | 0.4993 | ** |
| 婚姻状况 | 0.8711 | 0.3351 | 0.8815 | 0.3232 | 0.8667 | 0.3399 | |
| 城乡类别 | 0.4079 | 0.4914 | 0.2553 | 0.4360 | 0.4701 | 0.4991 | *** |
| 受教育程度 | | | | | | | |
| 小学及以下※ | 0.7322 | 0.4428 | 0.7512 | 0.4633 | 0.6881 | 0.4323 | *** |
| 初中 | 0.1665 | 0.3725 | 0.1526 | 0.3990 | 0.1987 | 0.3596 | *** |
| 高中 | 0.0817 | 0.2739 | 0.0770 | 0.2897 | 0.0925 | 0.2667 | *** |
| 大学及以上 | 0.0196 | 0.1386 | 0.0191 | 0.1423 | 0.0207 | 0.1370 | *** |
| 医疗保险 | 0.9640 | 0.1861 | 0.9307 | 0.2540 | 0.9787 | 0.1444 | *** |
| 慢性病数目 | 0.9503 | 0.5429 | 1.0029 | 0.2505 | 0.9306 | 0..6161 | *** |
| 社会活动参与 | 1.3259 | 0.6120 | 1.1291 | 0.4143 | 1.3991 | 0.6560 | *** |
| 情感感受 | 0.7538 | 0.4308 | 0.6068 | 0.4885 | 0.8085 | 0.4885 | *** |
| 自评健康 | 1.5419 | 0.7181 | 1.4663 | 0.6899 | 1.5728 | 0.7271 | *** |
| 是否抽烟 | 0.3552 | 0.4786 | 0.3983 | 0.4895 | 0.3376 | 0.4729 | *** |
| 是否喝酒 | 0.3177 | 0.4656 | 0.3386 | 0.4733 | 0.3091 | 0.4621 | *** |
| 住房保障 | 0.4581 | 0.4982 | 0.3680 | 0.4823 | 0.4837 | 0.4997 | *** |
| 子女数量 | 2.1443 | 0.7488 | 2.0650 | 0.4908 | 2.1738 | 0.8226 | *** |
| 家庭收入对数 | 9.3773 | 1.9349 | 9.3450 | 2.3311 | 9.4494 | 1.9963 | *** |
| 样本量 | 8,516 | | 2,784 | | 5,732 | | |

注：***、**和*分别表示两端 t 检验在 1%、5%和 10%的水平上显著；※代表基组。

## 3. 实证模型和实证结果分析

### 3.1 实证模型

本文的基本模型设定如下：

$$Y_{it} = \alpha_1 + \beta_1 D_{it} + \beta_2 X_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

其中，$Y_{it}$表示失能老人 i 在第 t 年的代际支持。$D_{it}$表示老人 i 在第 t 年参加基本养老保险的情况，参保则 $D_{it}$取值为 1，否则取值为 0。$X_{it}$是个体 $i$ 在时间 $t$ 时可观察到的个体和家庭层次特征的向量；$\mu_i$是个体固定效应；$\varepsilon_{it}$是一个随机误差项。系数 $\beta_1$是我们关注的核心参数。由于模型中可能存在遗漏变量

的问题，我们采用固定效应模型解决。

## 3.2 基准结果分析

表 3 到表 5 给出了基本养老保险影响家庭代际支持的 OLS 估计结果以及固定效应回归结果。其中 OLS 的结果表明，基本养老保险对失能老年人的生活照料没有显著的负向影响，但对精神慰藉和经济支持具有显著的负向影响。接下来考虑到个体的异质性和遗漏变量问题导致的内生性，我们进一步利用面板固定效应模型进行分析，面板固定效应模型的回归结果发现，基本养老保险在 1%的水平上显著降低了失能老年人的经济支持，并且系数有所增加，说明不考虑遗漏变量的问题会低估基本养老保险对失能老年人家庭代际支持的影响。而且 Hausman 检验也进一步强调了用固定效应模型解决内生性的必要性。因此，后续对结果的分析和检验均采用固定效应模型。

### 3.2.1 基本养老保险对失能老年人生活照料的影响

根据前文构建的面板固定效应模型首先分析基本养老保险对老年人生活照料的影响，结果如表 3 所示。基本养老保险对生活照料没有显著的负向影响，可能的原因是失能老年人由于身体的特殊护理需求，对养老服务的需求更大，子女提供的生活保障与照料服务并没有显著减少。对于失能老年群体来说，他们的居住地、婚姻状况以及家庭的经济收入等控制变量，对生活照料均具有显著影响。回归结果显示随着年龄的增加，老年人获得的生活照料呈减少趋势。这可能是因为高龄老年人失能的程度更高，子女更多地会选择向社会购买养老服务，对老人的关怀减少[33]。与刘一伟得出的结论一致，我们发现城市老年人与农村老年人相比更有可能获得子女的生活照料，可能的原因是随着“捆绑式缴费”的基本养老保险在农村实施，大量农村劳动力外流，子代无法在家照料老人[34]。而城镇老年人与子女的基本养老保险属不同的系统，且城镇老年人与子女的空间距离更近，提供生活照料则更为便捷[26]。

表 3 基本养老保险影响生活照料的基准回归结果

| 变量 | 模型 1：OLS | | 模型 2：FE | |
|---|---|---|---|---|
| | 边际效应 | 标准误 | 边际效应 | 标准误 |
| 基本养老保险 | -0.0180 | 0.0212 | -0.0228 | 0.613 |
| 年龄 | -0.0025*** | 0.0007 | -0.0033*** | 0.0021 |
| 婚姻状况 | 0.4208*** | 0.0108 | 0.1709*** | 0.0558 |
| 城乡类别 | 0.1263*** | 0.0138 | 0.1283*** | 0.0285 |
| 初中 | -0.0068 | 0.0249 | 0.1671** | 0.0661 |
| 高中 | 0.0438 | 0.0384 | -0.1941*** | 0.0648 |
| 大学及以上 | 0.2279*** | 0.0883 | 0.5222** | 0.2426 |
| 医疗保险 | 0.0197 | 0.0340 | -0.0042* | 0.0602 |
| 慢性病数目 | 0.0349*** | 0.0079 | 0.0627*** | 0.0178 |
| 社会活动参与 | 0.0071 | 0.0118 | 0.0131 | 0.0274 |
| 情感感受 | 0.1311*** | 0.0142 | 0.1317*** | 0.0284 |
| 自评健康 | 0.0002 | 0.0119 | -0.0252 | 0.0271 |

| | | | | |
|---|---|---|---|---|
| 是否抽烟 | 0.0191 | 0.0147 | 0.0136 | 0.0506 |
| 是否喝酒 | -0.0299* | 0.0170 | 0.0528 | 0.0588 |
| 住房保障 | -0.0280* | 0.0131 | -0.0607** | 0.0265 |
| 子女数量 | 0.0024 | 0.0047 | -0.0055 | 0.0073 |
| 家庭收入对数 | -0.0245*** | 0.0025 | -0.0252*** | 0.0079 |
| 常数项 | 0.9402*** | 0.0774 | 0.6724*** | 0.2728 |
| $R^2$ | 0.1828 | | 0.0954 | |
| Hausman test | | | 30.55*** (p=0.0452) | |
| 样本量 | 8,516 | | 8,516 | |

注：***、**和*分别表示 1%、5%和 10%的显著性水平；文章采用稳健标准误。

### 3.2.2 基本养老保险对失能老年人精神慰藉的影响

表 4 分析给出了基本养老保险参保行为对失能老年人精神慰藉的影响。总体上，基本养老保险对其子女提供精神慰藉的负向影响不显著。关于其它控制变量的结果显示，基本医疗保险对精神慰藉具有显著正向影响，这可能是因为由于医疗保险增加了老人对医疗服务需求，同时子女对老年人的健康更加关注，增加了子女对老年人的关怀[35]。自评健康状况对精神慰藉具有显著负向影响，原因可能是对于自评健康的参保老年人来讲，领取养老金增加了一定的经济收入，可以通过购买社会养老服务，减少了对子女的依赖[36]。

表 4 基本养老保险影响精神慰藉的基准回归结果

| 变量 | 模型 1：OLS | | 模型 2：FE | |
|---|---|---|---|---|
| | 边际效应 | 标准误 | 边际效应 | 标准误 |
| 基本养老保险 | -0.0027 | 0.0029 | -0.0031 | 0.0047 |
| 年龄 | -0.0006** | 0.0001 | -0.0003* | 0.0002 |
| 婚姻状况 | 0.4208*** | 0.0108 | -0.0111 | 0.0117 |
| 城乡类别 | 0.0060** | 0.0029 | 0.0008 | 0.0042 |
| 初中 | -0.0038 | 0.0106 | -0.0003 | 0.0112 |
| 高中 | -0.0169 | 0.0208 | -0.0412 | 0.0219 |
| 大学及以上 | -0.0098*** | 0.0208 | -0.0093 | 0.0062 |
| 医疗保险 | 0.0197 | 0.0340 | 0.5596*** | 0.0473 |
| 慢性病数目 | 0.0028 | 0.0018 | 0.0002 | 0.0026 |
| 社会活动参与 | 0.0003 | 0.0022 | 0.0021 | 0.0040 |
| 情感感受 | 0.0001 | 0.0026 | 0.0051 | 0.0049 |
| 自评健康 | -0.0087 | 0.0019 | -0.0252** | 0.0271 |
| 是否抽烟 | -0.0026 | 0.0027 | -0.0080 | 0.0102 |
| 是否喝酒 | 0.0047* | 0.0028 | -0.0046 | 0.0069 |
| 住房保障 | -0.0075** | 0.0025 | -0.0108** | 0.0048 |
| 子女数量 | 0.0026** | 0.0009 | 0.0042** | 0.0018 |
| 家庭收入对数 | 0.0013 | 0.0010 | -0.0017 | 0.0014 |
| 常数项 | 0.3667*** | 0.0344 | 0.4254*** | 0.0531 |
| $R^2$ | 0.3931 | | 0.3020 | |

| | | |
|---|---|---|
| Hausman test | | 38.87** (p=0.0046) |
| 样本量 | 8,516 | 8,516 |

注：***、**和*分别表示 1%、5%和 10%的显著性水平；文章采用稳健标准误。

### 3.2.3 基本养老保险对失能老年人经济支持的影响

表 5 结果显示，总体上基本养老保险对老年人子女提供经济支持具有显著影响，模型整体解释力较好，证实了基本养老保险对失能老年人子女给予其经济支持具有挤出效应。在其他变量中，家庭中子女的数量对于代际互动的影响，学者们开展过较多经验性研究。有研究指出[30]，家庭子女数量对代际间经济支持有着较为显著的影响，子女数量越多，老年人获得相应经济支持的可能性就越大，支持程度也更高。我们的研究结果也发现，随着孩子数量的增加，老年人从子女那里所获得的经济支持也随之增加。与刘佩得出的结论一致[37]，回归结果表明婚姻变量对代际经济支持的边际影响显著为正，这也符合我们的日常认知。我们的研究结果显示经济收入对获得子女的生活照料具有显著负向影响，个人年收入水平越高，老年人所获得生活照料的概率就越小，当老年人自身收入水平提高时，可以寻求社会照料的支持，在某种程度上挤出了子女对父母的生活照料[33]。

表 5 基本养老保险影响经济支持的基准回归结果

| 变量 | 模型 1：OLS | | 模型 2：FE | |
|---|---|---|---|---|
| | 边际效应 | 标准误 | 边际效应 | 标准误 |
| 基本养老保险 | -0.1525*** | 0.0075 | | 0.0120 |
| | | | -0.1939*** | |
| 年龄 | 0.0003 | 0.0004 | -0.0025** | 0.0008 |
| 婚姻状况 | 0.2059*** | 0.0101 | 0.2282*** | 0.0373 |
| 城乡类别 | 0.1320*** | 0.0072 | 0.1832*** | 0.0132 |
| 初中 | -0.0227* | 0.0128 | -0.0755** | 0.0261 |
| 高中 | -0.0306 | 0.0189 | -0.1353 | 0.0531 |
| 大学及以上 | -0.0095 | 0.0382 | -0.0546 | 0.0620 |
| 医疗保险 | 0.0197 | 0.0340 | 0.0079 | 0.0299 |
| 慢性病数目 | 0.0028 | 0.0018 | -0.0182* | 0.0099 |
| 社会活动参与 | -0.0369*** | 0.0080 | -0.0308** | 0.0133 |
| 情感感受 | -0.0607*** | 0.0075 | -0.0661*** | 0.0126 |
| 自评健康 | -0.0085 | 0.0072 | -0.0032 | 0.0124 |
| 是否抽烟 | 0.0086 | 0.0077 | 0.0762** | 0.0314 |
| 是否喝酒 | 0.0026 | 0.0088 | 0.0215 | 0.0208 |
| 住房保障 | -0.0075** | 0.0025 | -0.0954*** | 0.0127 |
| 子女数量 | 0.0639*** | 0.0027 | 0.0933*** | 0.0058 |
| 家庭收入对数 | 0.0070 | 0.0031 | 0.0072 | 0.0042 |
| 常数项 | 0.6280*** | 0.0467 | 0.7602*** | 0.0919 |
| $R^2$ | 0.1552 | | 0.1057 | |
| Hausman test | | | 186.23*** (p=0.0000) | |

| | | |
|---|---|---|
| 样本量 | 8,516 | 8,516 |

注：***、**和*分别表示1%、5%和10%的显著性水平；文章采用稳健标准误。

### 3.3 稳健性检验

为了验证结论的稳健性，本文进一步使用面板二值选择模型（xtlogit）对以上实证结果做了稳健性检验。结果发现基本养老保险对失能老年人的生活照料没有显著的负向影响，但对精神慰藉和经济支持具有显著的负向影响。结论与上文基准回归结果基本保持一致，这表明本文的结论是稳健可靠的。

表6 基本养老保险影响家庭代际支持的稳健性检验

| | Panel A: 生活照料（FE Logit） | Panel B:精神慰藉（FE Logit） | Panel C:经济支持（FE Logit） |
|---|---|---|---|
| | 生活照料(1=子女提供) | 精神慰藉(1=子女提供) | 经济支持(1=子女提供) |
| 基本养老保险 | -0.0199 | -0.2378 | -2.2178*** |
| | (0.3272) | (0.5002) | (0.1936) |
| 控制变量 | Yes | Yes | Yes |
| 样本量 | 2,435 | 2,435 | 2,435 |

注：***、**和*分别表示1%、5%和10%的显著性水平；文章采用稳健标准误。

## 4. 异质性分析

对于不同群体，基本养老保险对失能老年人获得家庭代际支持的影响可能会存在异质性差异。因此，我们区分失能程度、性别的个体特征差异，以及居住地区和家庭收入的家庭差异进行异质性讨论，具体结果见表7-9。

### 4.1 失能程度差异分析

基本养老保险对于失能老人家庭代际支持的影响可能与他们的失能程度有关，前文已经说明，我们根据CHARLS中被调查者对两个维度指标的回答设置了2个失能程度分组：轻度失能和重度失能。我们将研究样本分为轻度失能和重度失能两个子样本进行回归分析。表7-9 Panel A 回归结果显示，基本养老保险显著减少了轻度失能老年人获得子女生活照料的概率，系数为-0.1063，并且在10%水平上统计显著，但对重度失能老年人影响不显著，这可能是因为重度失能老年人对照料的需求相对更高，其子女对老人的关怀更多。精神慰藉方面，基本养老保险显著减少了重度失能老年人获得子女精神慰藉的概率，系数为-0.0307，并且在5%水平上统计显著，其中的原因可能在于重度失能的老年人由于身体机能严重退化，更加依赖子女，更需要心理抚慰，子女忽略了养老金无法代替来自家庭养老中的精神慰藉。基本养老保险显著促进了失能老年人获得子女经济支持的概率，并对轻度失能老年人的影响更大。

### 4.2 性别差异分析

考虑到不同性别对代际支持的需求不同，我们还分性别考察了不同的照料方式对失能老年人的家庭代际支持的异质性。表7-9 Panel B报告了基本养老

保险对不同性别的失能老人的家庭代际支持的影响，结果表明，与男性失能老年人相比，基本养老保险对女性影响更显著，这可能是因为女性在情感方面比男性更细腻，与子女的交流更多，参加基本养老保险后，女性老年人与子女相处减少，挤出了子女为其提供精神慰藉的频率。与男性相比，基本养老保险对女性收到的代际经济支持的影响更大，原因可能是女性在经济和生活上从属于男性，对经济收入的敏感度更高。

## 4.3 居住地差异分析

在我国的城镇和农村，失能老人占老年人口的比重具有较大的差别。农村的失能率最高，城市的失能率最低，城镇的失能率介于城市和农村之间[38]；而且由于现阶段我国快速城镇化、城乡经济发展差距及养老医疗资源分配不均等现象的存在，城市和农村基本养老保险的普及率不同，使得基本养老保险可能会对不同地区的失能老年人家庭代际支持产生不同的影响。因此，我们有必要分城镇和农村两个子样本分析其异质性特征。基本养老保险显著降低了农村失能老年人从子女那里获得的生活照料，对城市老年人影响较小。这可能因为相对农村老年人来说，城市老年人更倾向于社会化照料，对子女照料依赖程度小。无论是农村还是城市，基本养老保险对其所获得的经济支持都具有显著负向影响，城乡老年人所获得的经济分别减少22.23%和11.83%。

表 7 基本养老保险对生活照料异质性影响的估计结果

| | Panel A: 失能程度 | | Panel B：性别 | | Panel C: 居住地 | |
|---|---|---|---|---|---|---|
| | 轻度失能 | 重度失能 | 女性 | 男性 | 农村 | 城市 |
| 基本养老保险 | -0.1063* | -0.1388 | -0.0268 | -0.1546 | -0.0506* | 0.1437 |
| | (0.1212) | (0.2077) | (0.1051) | (0.1748) | (0.1345) | (0.2285) |
| 控制变量 | Yes | Yes | Yes | Yes | Yes | Yes |
| Fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.0319 | 0.1757 | 0.0761 | 0.0579 | 0.0233 | 0.1522 |
| Hausman test | 25.7 (p=0.1069) | 13.5 (p=0.7610) | 16.81 (p=0.5363) | 23.46* (p=0.0735) | 27.57** (p=0.0503) | 11.57 (p=0.6408) |
| 样本量 | 5,632 | 2,884 | 5,278 | 3,238 | 5,160 | 3,356 |

注：***、**和*分别表示1%、5%和10%的显著性水平；文章采用稳健标准误。

表 8 基本养老保险对精神慰藉异质性影响的估计结果

| | Panel A: 失能程度 | | Panel B：性别 | | Panel C: 居住地 | |
|---|---|---|---|---|---|---|
| | 轻度失能 | 重度失能 | 女性 | 男性 | 农村 | 城市 |
| 基本养老保险 | -0.0005 | -0.0307** | -0.0045* | 0.0038 | -0.0045 | -0.0123 |
| | (0.0059) | (0.0127) | (0.0055) | (0.0059) | (0.0055) | (0.2222) |
| 控制变量 | Yes | Yes | Yes | Yes | Yes | Yes |
| Fixed | Yes | Yes | Yes | Yes | Yes | Yes |

| | | | | | | |
|---|---|---|---|---|---|---|
| effect | | | | | | |
| $R^2$ | 0.3110 | 0.1180 | 0.3694 | 0.3749 | 0.3694 | 0.1399 |
| Hausman test | 21.19 (p=0.2701) | 76.65*** (p=0.0000) | 26.04* (p=0.0738) | 22.54 (p=0.2581) | 26.04* (p=0.0738) | 38.30** (p=0.0022) |
| 样本量 | 5,632 | 2,884 | 5,278 | 3,238 | 5,160 | 3,356 |

注：***、**和*分别表示1%、5%和10%的显著性水平；文章采用稳健标准误。

表 9 基本养老保险对经济支持异质性影响的估计结果

| | Panel A: 失能程度 | | Panel B：性别 | | Panel C: 居住地 | |
|---|---|---|---|---|---|---|
| | 轻度失能 | 重度失能 | 女性 | 男性 | 农村 | 城市 |
| 基本养老保险 | -0.2093*** | -0.1566** | -0.1996*** | -0.1931*** | -0.2223*** | -0.1183*** |
| | (0.0170) | (0.0296) | (0.0146) | (0.0690) | (0.0156) | (0.0298) |
| 控制变量 | Yes | Yes | Yes | Yes | Yes | Yes |
| Fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.1145 | 0.1151 | 0.1349 | 0.3749 | 0.1260 | 0.0238 |
| Hausman test | 98.45*** (p=0.0000) | 24.59 (p=0.1366) | 114.07*** (p=0.0000) | 63.42*** (p=0.0000) | 41.66*** (p=0.0088) | 100.50*** (p=0.0000) |
| 样本量 | 5,632 | 2,884 | 5,278 | 3,238 | 5,160 | 3,356 |

注：***、**和*分别表示1%、5%和10%的显著性水平；文章采用稳健标准误。

## 5. 进一步分析

上述研究表明，基本养老保险确实一定程度上影响了失能老年人的家庭代际支持，但是不同基本养老保险类型对失能老年人的家庭代际支持影响是否存在差异呢？本文将基本养老保险区分为城镇职工养老保险、城镇居民养老保险、新型农村养老保险和城乡居民养老保险考察不同养老保险类型对生育意愿影响的差异。研究发现不同基本养老保险类型对于生活照料的影响确实有所差异，其中，城镇居民养老保险显著提高了失能老年人的生活照料，新农保则显著降低了失能老年人的生活照料。新农保显著降低了失能老年人获得的精神慰藉，城镇职工养老保险、新型农村养老保险和城乡居民养老保险都显著降低了失能老年人的经济代际支持，其中城镇职工养老保险的影响作用最大，其次为城乡居民养老保险，新型农村养老保险的影响很小。可能是因为不同参保类型存在缴费档次和保障水平的差异，从而导致这种差异性。

表 10 基本养老保险类型对失能老年家庭代际支持的差异分析

| 区分不同的基本养老保险类型 | 城镇居民养老保险 | 城镇职工养老保险 | 新农保 | 城乡居民养老保险 |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| 生活照料 | 0.2279*** | -0.0022 | -0.1527** | 0.0438 |
| | (0.0664) | (0.0051) | (0.0640) | (0.0399) |
| 精神慰藉 | -0.0318 | -0.0106 | -0.0221*** | -0.0150 |
| | (0.0301) | (0.0243) | (0.0191) | (0.0190) |
| 经济支持 | -0.0416 | -0.0945* | -0.0105*** | -0.0161*** |
| | (0.0607) | (0.0525) | (0.0239) | (0.0608) |
| 控制变量 | Yes | Yes | Yes | Yes |
| Fixed effect | Yes | Yes | Yes | Yes |
| 样本量 | 3，176 | 1，967 | 3，847 | 4，278 |

注：***、**和*分别表示1%、5%和10%的显著性水平；文章采用稳健标准误。

## 6. 机制检验

基本养老保险可能通过居住方式来影响失能老年人获得的家庭代际支持[37]，从实证结果来看，基本养老保险只显著挤出了子女的经济支持，所以本文选取居住方式作为中介变量检验了基本养老保险影响失能老年人经济代际支持的作用机制。我们首先探讨了基本养老保险对居住方式的影响（表11 模型1）。本文选取CHARLS调查中关于被访者对“居住方式的选择”地回答定义为“居住方式”，“与子女居住在一起” 赋值为“0”，其他则赋值为“1”。

本文基于中介效应模型，首先检验基本养老保险对中介变量（居住方式）的影响，如果基本养老保险能够显著影响居住方式，则再将中介变量和养老保险纳入代际支持影响因素的方程中进行分析，如果该中介变量在代际支持方程中是显著的，并且基本养老保险对代际支持的影响程度下降或系数变得不显著则存在中介效应。表11呈现了以“居住方式”为中介变量的分析结果。第一列模型1表明基本养老保险显著提高了失能老年人不与子女居住的概率，在基准模型中加入中介变量“居住方式”进行固定效应回归后，模型2基本养老保险的系数变得不显著。以上分析结果验证了基本养老保险通过影响居住方式进而减少了失能老年人获得的经济代际支持。

表 11 基本养老保险对中介变量的影响以及对经济代际支持影响机制的检验结果

| Panel A: 基本养老保险对中介变量的影响 | |
|---|---|
| | 模型 1:居住方式 |
| 基本养老保险 | 0.1718*** |
| | (0.0268) |
| 控制变量 | Yes |
| $R^2$ | 0.0821 |
| Hausman test | 56.04*** |
| | (p=0.0000) |
| 样本量 | 8,516 |
| Panel B: 居住方式作为中介 | |

| | 模型 2:居住方式 |
|---|---|
| 基本养老保险 | 0.0074 |
| | (0.0143) |
| 居住方式 | 0.0653*** |
| | (0.0228) |
| 控制变量 | Yes |
| $R^2$ | 0.0435 |
| Hausman test | 179.78*** |
| | (p=0.0000) |
| 样本量 | 8,516 |

注：***、**和*分别表示1%、5%和10%的显著性水平，文章采用稳健标准误。

## 7. 结论及政策建议

本文基于 CHARLS 2011 年、2013 年、2015 年和 2018 年四年全国追踪调查数据，采用 OLS、个体固定效应模型，将家庭养老分为生活照料、精神慰藉与经济供养三个维度，实证分析了基本养老保险对家庭养老模式的影响。研究结果发现，旨在提升老年人福利水平的基本养老保险却对失能老年人产生了一种意料之外的反作用：子女的经济支持和非经济性支持因为基本养老保险制度的介入而发生弱化，在家庭外部照料制度长期缺位的情况下，这一结果影响了老年人总体福利的获得。具体来看，基本养老保险制度对家庭代际支持的影响呈现出了“局部化”的差异性特征，未对失能老年人的生活照料支持和精神支持产生显著影响，但是显著“挤出”了子女对失能老年人的经济支持。研究还发现基本养老保险的替代效果因失能程度、性别和城乡类别而异，我们再次区分基本养老保险的类型发现研究了不同保险种类对家庭代际支持的影响,发现相比其他类型的基本养老保险，新农保对家庭代际支持产生更大的影响。通过机制检验发现基本养老保险可以通过影响失能老年人的居住方式来影响经济代际支持。

事实上，社会养老作为重要的养老模式，旨在提高老年人福利，降低子女负担，还有助于实现我国老年人“老有所养，老有所依”。即一个理想化的结果是基本养老保险在发挥其作用的同时，弥补家庭养老在某些功能上的不足或缺失，实现与家庭养老的良性互补。从本文的研究结果看，养老保险初步达到了引导家庭资源配置的作用。但家庭是情感交流和精神慰藉的场地，在某种程度上具有不可取代性，社会养老仍未根本性动摇我国老年人的家庭养老模式，原因可能在于我国仍遵循传统的养老安排，加上国家目前的养老保险制度难以完全替代子女赡养。因此，大多数失能老人依然以家庭为依托，成年子女为父母的晚年生活提供经济、生活和情感各个方面的支持。

本文的研究发现具有重要的政策意义。1.大力发展社会照料，提供差异化服务，让社会养老有效替代家庭照料，更好地满足老年人生活照料的需求。2.发展社会养老的同时并不否定家庭照料的重要性，建议尽快制定家庭非正式照料支持政策，加强政府、社会和家庭等多方资源建立科学的失能老人长期照料服务模式，以化解失能老人规模不断增多的照料危机，保障不同照料供给主体能有效满足老年人多层次需要，提高养老服务的供给水平和质量。3.增加养老金投入，提高参保人待遇水平。政府要在国家财力允许的情况下增加对养老金

的投入，提高参保人的待遇水平，不断推进社会养老保障政策的完善与发展，进一步扩大基本养老保险的基本覆盖面，而发挥社会养老对家庭养老的互补作用，满足老年人的基本生活需要，提高老年人尤其是失能老年人的生活水平。

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# 基本养老保险对失能老年家庭代际支持的影响
## ——基于 CHARLS 数据的实证研究

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**关键词：**基本养老保险；家庭代际支持；失能老年人；

**中文摘要.** 随着我国社会养老保险制度的完善和保障水平的提高，考虑到家庭在养老中的角色逐渐削弱，中国政府正在探索建立一个综合的社会护理系统，使家庭和公共部门可以为失能老年人提供养老服务。但政府并没有明确说明如何平衡社会对家庭养老的支持。在两者的互动过程中，家庭代际支持是否会因为社会养老保险制度的介入而在内容和实质上发生改变？老年人的总福利又会发生何种改变？然而，在现有的文献中，人们将社会养老保险纳入相同的分析框架估计其对家庭代际支持的影响知之甚少。

为了回答上述问题，从失能老年人的角度更好地理解社会养老保险对家庭代际支持的影响。本文考察了社会养老保险与家庭在提供失能老年人照料过程中的相互作用机制。具体来说，本研究的目的是评估社会养老保险对失能老年人家庭支持的绝对和相对贡献。文章参照社会支持理论将家庭代际支持划分为子女的经济支持、劳动支持和精神支持，利用中国健康与养老追踪调查（CHARLS）2011 年、2013、2015 年和 2018 年的面板数据，利用最小二乘法(OLS)估计了社会养老保险对家庭代际支持的影响，使用 Probit 模型和面板二值选择模型进行了稳健性检验。我们又进一步利用固定效应模型来检验其异质性。

我们研究发现，旨在提升老年人福利水平的社会养老保险却对失能老年人

产生了一种意料之外的反作用：子女的经济支持和非经济性支持因为社会养老保险制度的介入而发生弱化，在家庭外部照料制度长期缺位的情况下，这一结果影响了老年人总体福利的获得。具体来看，社会养老保险制度对家庭代际支持的影响呈现出了“局部化”的差异性特征：社会养老保险并未对失能老年人的生活照料支持产生显著影响，但是显著“挤出”了子女对失能老年人的精神支持与经济支持，我们并对其精神支持和经济支持的强度进行了进一步探究。研究发现社会养老保险的替代效果因失能程度、性别和城乡类别而异。特别是，对轻度失能老年人，女性，和农村居民这一现象更为敏感和显著。我们再次区分险种研究了不同保险种类对家庭代际支持的影响。通过解释机制，发现了居住方式具有调节作用，它作用于社会养老保险与精神慰藉及经济支持的关系。

本研究从失能老年人总福利获得的框架出发，研究发现：社会养老保险一定程度上影响了家庭内部的资源分配状态和代际关系，造成了失能老年人在照料资源获取上的“真空”现象。因此，要协调社会养老保险与家庭角色两者的关系，促进社会养老保险和家庭养老相互补充和融合，扩大养老资源的社会供给，提高失能老年人的生活水平。

# Fertility Policy, Delayed Retirement and Secondary Demographic Dividend

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**Keywords:** The second demographic dividend, Delayed retirement, Fertility policy.

**Abstract.** Based on the neoclassical economic growth theory, this paper studies the impact of the delayed retirement policy on the secondary demographic dividend in the context of the full liberalization of China's birth policy. By introducing the human capital equation, the article extends the traditional two-stage overlapping generation (OLG) model to the three-stage overlapping generation model, and uses numerical simulation to compare and analyze the changes in China's per capita capital accumulation under the environment of implementing the delayed retirement policy alone, the fertility policy alone, and the two policies implemented together. It finds that: First, the implementation of the delayed retirement policy alone will reduce per capita capital accumulation in the short term and reduce China's second demographic dividend; Secondly, implementing the childbirth policy alone will also have a negative impact on per capita capital accumulation. If the improved Engel coefficient value of 0.4 is used as the quantile value that distinguishes low-income families from high-income families in China, in the case of fertility remain the same for both families, the pressure of human capital accumulation for children of low-income families will reduce their per capita capital accumulation by an additional 11% compared with that of high-income families. Finally, under the background that other conditions remain unchanged

and the delayed retirement policy and the birth policy are implemented at the same time, the reduction in per capita capital accumulation is not equal to the linear sum of the reduction in the two policies implemented separately, Which is greater than the reduction of implementing the two policies separately, and by further sensitivity analysis we found that the sensitivity of per capita capital accumulation to fertility is higher than that of per capita capital accumulation to delayed retirement age.

## 1. Introduction

Due to the rapid economic development, the improvement of medical and health conditions, and the adjustment of family planning policies and other factors, the age structure of my country's population has been rapidly aging in the past 40 years (see figure1). According to Figure 1, it can be found that since the third census in 1982, the proportion of children aged 0-14 in my country has dropped rapidly, from 33.6% in 1982 to 16.9% in 2018, a drop of more than 50%; The proportion of the working-age population aged 15-64 reached the maximum value of 74.5% in 2010 and showed a clear downward trend. With the birth rate remaining unchanged, this downward trend will continue and cause my country's labor supply to be less than labor demand in the future. Figure 1 shows that the demographic dividend that my country's economic growth has relied on for a long time has gradually disappeared. The most fundamental reason for the disappearance of my country's demographic dividend is that my country's fertility policy has undergone an important transition from liberalizing births to increase the population base to limiting the population base of family planning. The change in the birth policy has accelerated the process of population aging in our country. According to Figure 2, it can be found that the proportion of people aged 65 and over in my country has increased from 7.0% in 2000 to 11.9% in 2018, far exceeding the United Nations standard of 7.0% for aging society, and the aging of the population is very severe. With the gradual intensification of population aging, the total working age population will gradually decrease, the demographic dividend will gradually decline, and the cost of economic development will continue to rise.

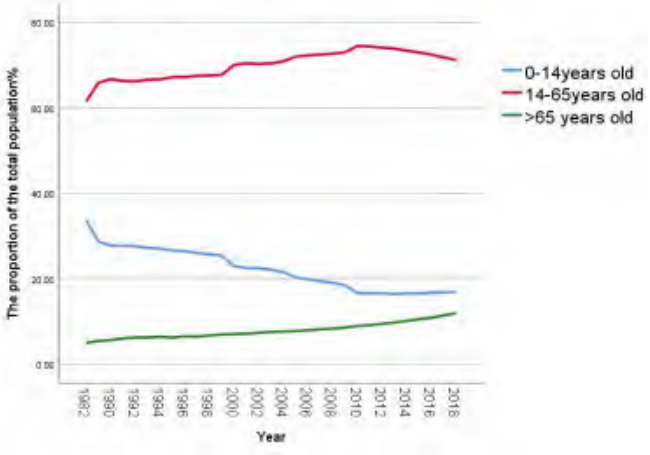


Fig. 1. The proportion of the total population

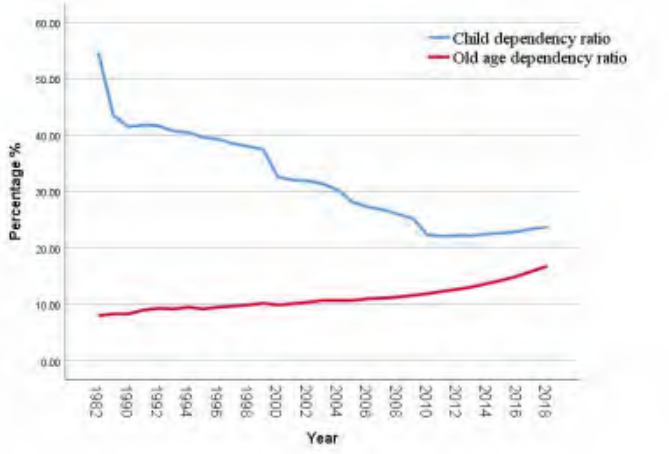


Fig. 2. Changes in the dependency ratio of young and old

In order to deal with the problems caused by the aging of the population, extending the retirement age has become a necessary means. The current retirement age in my country originates from the regulations in the 1950s, based on a series of documents such as the "Regulations of the People's Republic of China on Labor Insurance" (1951), "Interim Regulations of the State Council on the Retirement of Workers and Employees" (1957), and the "State Council on the Retirement and Retirement of Workers Interim Measures"(1978, No. 104) established my country's initial retirement policy and has been in use today, that is male employees are at least 60 years old, female officials are at least 55 years old, and female employees are at least 50 years old, in some special industries, the statutory retirement age can be reduced by another five years. With the improvement of medical conditions, the average life expectancy is getting longer and longer, it is obviously unreasonable that the retirement age in our country still follows the regulations in the early days of the founding of the People's Republic. In recent years, extend the retirement age is a hot issue and the focus of the whole society of common concern.

In November 2013, the Central Committee of the Communist Party of China announced the launch of a separate two-child policy in the "Decision on Several Major Issues of Comprehensively Deepening Reforms", and proposed to study and formulate a gradual delay in retirement age policy. In October 2015, the Fifth Central Committee of the 18th National Congress further proposed the introduction of a gradual delay in retirement policy, and at the same time, it was decided to implement the "comprehensive two-child" policy nationwide. Although the delay retirement policy has not yet formally implemented in China, but earlier entered the aging society, such as the United Kingdom, Sweden, South Korea, has as its basic policy for solving the population and welfare issues. Most domestic and foreign scholars hold a positive attitude towards the delayed retirement policy, and believe that it cannot only improve the pension gap, but also promote the second demographic dividend. Geng Zhixiang (2017) believes that the decline in the fertility rate reduces the dependence of individual's family pension on the elderly in the family for the elderly, and the increase in average life expectancy makes the retirement period longer. As a result, individuals and families have a strong motivation to save and accumulate assets for pensions, which increases savings and increases capital accumulation, thereby generating a second demographic dividend. Although the current research on the second demographic dividend is still in the theoretical stage, it is expected that the second demographic dividend will become a new source of economic growth before the retirement policy and fertility policy of our country take effect.

## 2. Theory and hypotheses development

### 2.1 Research on demographic dividend

Regarding the study of the demographic dividend, Bloom and Williamson (1998) explained the miracle of rapid economic growth in East Asia and proposed that when the increase in the proportion of the working-age population exceeds the increase in the dependency ratio, it will bring a demographic dividend [1]. Since then, Mason and Lee (2006) found that further study on the basis of Bloom, according to different production pathways, the demographic dividend can be further divided into first and second demographic dividend demographic dividend [2]. The demographic dividend proposed by Bloom is the first demographic dividend, the declining fertility rate, the extension of the retirement period, and the weakening of individual's family pension dependence in old age, the saving motive and the motive of accumulating assets for retirement, resulting in increased savings and capital accumulation are defined as the second demographic dividend. Wang Dewen and Cai Fang (2004) used regression analysis to find that the child dependency ratio and the elderly dependency ratio have a significant impact on the savings rate, it is also estimated that the contribution rate of the decline in the total dependency ratio to China's savings rate is about 5%, but due to the aging of the population, this demographic advantage no longer exists [3]. Wang Guixin and Chen Guanchun (2010) studied the economic growth trend and its influencing factors since the reform and opening up, and found that the "demographic factor" should be taken as the most important factor explaining my country's economic growth since the reform and opening up, however, this "demographic factor" due to an aging population turning changes will take place, the demographic dividend is difficult to exist [4]. Wang Weitong (2012) believes that the decline of the demographic dividend under the background of aging will bring resistance to economic growth, and estimated that its impact is about 1.5-2.0% per year [5].

From the analysis of the ways in which the demographic dividend is generated, the first demographic dividend is based on the fact that the growth rate of the working population is greater than the growth rate of the dependency ratio, aging population makes the original proportion of imbalance, thereby reducing

the first demographic dividend, but aggravated the aging of the population older workers, especially the imminent retirement pension concerns of workers. Aging population makes the original proportion of imbalance, thereby reducing the first demographic dividend, but aggravated the aging of the population older workers, especially the imminent retirement pension concerns of workers, for this reason, worker motivation to increase private pension savings for the purpose, and increase savings promote the accumulation of capital, thereby generating a second demographic dividend. Cai Fang (2010) considered the first demographic dividend can enter through rural non-agricultural labor force continued economic growth, while an aging population structure can unearth a second demographic dividend [6]. Meng Lingguo and Wang Qing (2013) took the Lewis turning point as the starting point and believed that the first demographic dividend has disappeared, and the second demographic dividend can still be harvested through three levels of human capital, savings and investment, and institutional innovation [7]. Wang Ying, Deng Bowen, Wang Jianmin (2016) combed the research literature on the second demographic dividend and found that the research on the second demographic dividend is only just beginning, Should be the second demographic dividend policy research combined with the reality of the system, these institutions or policies, including the education system, capital management system, delay retirement policy, two-child policy, and then fully tap the second demographic dividend [8].

### 2.2 Research on delayed retirement policy

Scholars' research on delayed retirement policies mainly focuses on whether delayed retirement can improve the financial sustainability of pension accounts and promote the balance of pension accounts. For example, Cremer and Pestieau (2003) believe that extending the statutory retirement age can effectively improve the imbalance of income and expenditure caused by the aging of the population, and has the effect of increasing income and reducing expenditures for basic pensions, thereby promoting the financial sustainability of basic pension accounts [9]. Galasso (2008) , Lacomba and Lagos (2010) through macro analysis based on a sample of developed countries, and found that delaying retirement helps alleviate the government's future pension payment crisis, and can effectively promote the financial viability of the pay-as-you-go pension system in the future[10 11]. However, the research of Martins and Pedro (2009) showed that delayed retirement forced companies to reduce the employment of new labor, lowering the overall contribution level, and had a negative impact on increasing pension account income [12]. Miyazaki (2014) further found that delaying retirement will lead to a decline in tax benchmarks, and it is difficult to solve the problem of long-term pension financial crisis [13].

Wang Yuxi, Wang Hong, Xiao Jun (2010) conducted a quantitative analysis on the amount of pension funds in my country on the basis of actuarial theory showed that delaying retirement in the short term can reduce the size of the fund gap, but from a long-term perspective, increasing the pension payment standard makes the pension fund gap increase again[14]. Peng Haoran, Chen Binkai (2012) believes that the pay-as-you-go pension insurance system will increase the possibility of early retirement of workers, and will have a negative incentive effect on the implementation of delayed retirement policies [15].In addition to studying the impact of delayed retirement on pension accounts, the implementation of a delayed retirement plan is also another research focus of domestic scholars. Zhang Qin and Guo Yan (2015) constructed a pension revenue and expenditure model, respectively measuring the balance of my country's basic pension revenue and expenditure in the next 20 years under retirement strategies such as "one-off delayed retirement age" and "stepwise delayed retirement age", thinking that stepwise retirement is the best retirement method[16]. Liu Xiaoyan (2018) further studied the impact of gender on retirement plans. Under three different benefits and risks, considering the retirement methods of "simultaneous retirement of both men and women" and "females first and men later" respectively, the dynamic evolution trajectory of the optimal retirement ages of male and female workers is obtained [17].

The quantitative research model of delayed retirement is mainly the Overlapping Generation Model (the OLG model), Compared with the traditional endogenous model, the OLG model can better explain the intergenerational utility. Among them, the most representative is the dynamic life cycle model (AK model) created by Auerbach and Kotlikoff. After the creation of the A-K model, it has been continuously revised and improved, and has become an important model for studying dynamic economic changes after the reform of the insurance system; Zhang and Zhang (2007) in a substance containing external capital investment, proved within the framework of endogenous fertility OLG model of altruism and positive legacy of the effectiveness of pay-as-you-go pension insurance system, and numerical simulation of the optimal payment tax rate [18]. Kang Chuankun, Chu Tianshu (2014) introduced the social welfare function on the basis of the model set by D'Autume, and combined it with the personal utility function to find the optimal pension insurance contribution rate. The conclusion that the increase in the growth rate will increase the optimal overall payment rate [19], making up for the lack of dynamics in previous studies. Liu Rumei, He Guosheng (2018) conducted a sensitivity analysis on the parameters of the OLG model, and

suggested that the pension structure should be adjusted in the medium and long term, and related reform measures should be supported[20].

Although the related theoretical research and model construction of delayed retirement have been relatively complete, however, there is still a lack of direct research on whether delayed retirement will produce a second demographic dividend and what kind of demographic dividend will delayed retirement generate. The existing literature mainly studies the effect of retirement age on the savings rate, labor supply rate and other factors indirectly studying the effect of delayed retirement on the second demographic dividend.

### 2.3 Research on Delayed Retirement and the Second Demographic Dividend

Prskawetz and Sambt (2014) used national transfer account data to analyze the ratio of economic indicators to dependency rates in European countries to analyze the second demographic dividend [21]. Abio, Patxot, Sanchez-Romero, Souto (2017) used the OLG model to compare and analyze the second demographic dividend of Spain, Sweden, and the United States, and found that the difficulty of obtaining the second demographic dividend depends on the speed of aging and the development of the public transfer payment system[22]. Meng Lingguo (2015) analyzed the impact of different flexible retirement ages on the labor force contribution rate and the replacement rate of the elderly population by constructing a two-period generation overlap model based on the perspective of the secondary demographic dividend, believing that the government should gradually delay the retirement mechanism according to the different characteristics of gender, age, region and industry [23]. Since then, Geng Zhixiang and Sun Qixiang (2017) analyzed the impact of delayed retirement on economic variables such as savings rate, capital accumulation and output by constructing an extended OLG model, Studies have shown that whether delaying the retirement year will produce a second demographic dividend depends on the negative effect of the reduction of working-period savings by rational actors and the positive effect of increased labor supply [24].

It can be seen from the above research that the generation overlap model has become an important model tool for studying the second demographic dividend, but scholars tend to regard fertility rate as an exogenous variable in parameter setting, and believe that fertility rate should remain unchanged. But the fertility rate, like aging, is an important component of the dependency ratio and also an important factor affecting the future population structure, is it possible to question the fertility rate will have an impact on the second demographic dividend.

### 2.4 Research on the Fertility Policy and the Second Demographic Dividend

The research on fertility rate and demographic dividend in foreign countries first focused on the impact of pension scale on fertility willingness. Rosati (1996) believes that when the individual's risk aversion coefficient is large, expanding the size of the social pooled security fund will reduce family fertility [25]. After considering the consumption and investment attributes of childbirth, Wigger (1999) used the OLG model to simulate that an appropriate pension scale level would promote family fertility, while an excessively high or too low pension scale would reduce family fertility [26]. Based on the neoclassical growth theory, Miyazaki (2013) believes that factors such as the material cost of raising children, fertility levels, and interest rates play an important role in the impact of pension scale on fertility [27]. Sun Bo and Dong Keyong (2011) simulated the development trend of my country's urban population under different fertility policies, in contrast to the results of basic pension gap change under different scenarios after the town, indicating that the gradual liberalization of two-child policy can significantly improve the financial situation of pension[28]. Zeng Yi, Ren Chaoran Liu Qian (2015) used actuarial models to estimate the financial situation of the medical insurance pooled fund under the "two-child alone" policy, it is concluded that the "two children alone" policy cannot improve the payment ability of the employee medical insurance pooling fund, but it can improve the financial status of the pension fund to a certain extent [29]. Mao Chunmei and Li Meicun (2016) used PADISINT to predict China's dependency ratio in the future. They believe that the demographic dividend of the two-child policy is realized mainly by increasing the number of working people in cities, while the rural areas are reflected in the form of a balanced sex ratio [30].

### 2.5 Research on Fertility Policy, Delayed Retirement and Demographic Dividend

On the issue of whether the birth policy and the delayed retirement policy can be implemented at the same time, Zhou Liqun and Zhou Xiaobo (2016) believes that the social pension and family pension will squeeze the family's fertility expenditure, reduce the fertility rate, and delay retirement can reduce or even avoid the squeeze of reproductive resources due to the old age, thereby increasing the fertility level [31].

Yang Hualei and Wu Yigen (2018) found that, after the government introduced a subsidy program supporting fertility, delayed retirement will help to improve the home birth rate [32].

Wei Jiang, Ni Xuanming, He Aichen (2018) based on neoclassical growth theory and found that in order to alleviate the negative impact of population aging on the economy, the government implemented a comprehensive two-child policy to adjust the population structure, Although encouraging childbirth can reduce the degree of aging, in the long run, both the output and consumption will have a negative impact, and the delayed retirement policy can play a positive role in the long run [33].

Existing studies have found that the impact of the delayed retirement policy on the birth policy is mainly through two channels: intergenerational education and intergenerational income. Guo Kaiming, Yan Se (2016), when studying the growth of labor supply, found that delaying retirement through the degree of family intergenerational income transfer has an impact on the substitution relationship between family quality and quantity during childbirth, affecting labor supply[34] . On the other hand, Zhou Peng (2017) believes that delaying retirement will reduce the inter-generational education of grandparents to grandchildren, increase the cost of childbirth, and reduce the fertility level [35]. Yan Chengliang (2018) introduces intergenerational parenting in the inter-generational iterative model of the endogenous population's birth rate, predicting the impact of delayed retirement on the population's birth rate. The results show that delayed retirement will increase income in old age, and rational behavior people tend to spend less time when they are young for labor, more time is spent on upbringing, but the time spent on inter-generational parenting decreases in old age [36].

Through the above-mentioned literature review, the article found the following problems: First of all, when domestic scholars study delayed retirement policies and fertility policies, they usually only consider the impact of delayed retirement on fertility policies. There is a lack of reverse research on fertility policies on delayed retirement policies. Secondly, most domestic studies have studied the changes in the labor supply and fertility rate of delayed retirement, but they have not penetrated into the second demographic dividend, that is, whether the fertility policy will affect the second demographic dividend is still in a blank stage. Finally, when studying the impact of the delayed retirement policy on the second demographic dividend, scholars often ignore the changes in the birth policy, which does not fit the current policy background of our country. This article uses this as the starting point for research, based on the neoclassical economic growth theory, elaborating on the path of the fertility rate on the delayed retirement policy, then analyzing the effect of the delayed retirement on the secondary demographic dividend, what role the fertility rate will play. And on the basis of the OLG model constructed by Geng Zhixiang and Sun Qixiang (2017), it is extended into a three-period general equilibrium iterative model by introducing the human capital equation，combining adulthood and juvenile period to make up for the research flaws of the second-phase OLG model. And using numerical simulation method to compare and analyze the changes in per capita capital accumulation in the three cases of using the delayed retirement policy alone, the fertility policy alone, and the two policies simultaneously. This makes the fertility policy, delayed retirement and the second demographic dividend research comprehensive.

## 3. Model building

Based on the two-phase OLG model constructed by Diamond (1965)[37], this paper follows the development model of neoclassical growth theory, assuming that the production function is A-K type, and the utility function draws on the setting form of Kang Chuankun (2014) and Geng Zhixiang (2017). The model constructs constraint conditions from the micro decision-making of individuals, manufacturers, and the government. By introducing the human capital accumulation equation established by Guo Mingkai, Yan Se (2016), the second-phase OLG model was expanded into a three-phase OLG model that considers fertility changes, to study the changes in per capita capital accumulation in the context of the implementation of the second-child policy, the delayed retirement policy, and the joint use of the two policies.

### 3.1 Individual behavior decision

This article divides the life of the agent into three periods, namely, childhood, adulthood, and old age, and the length of each time is assumed to be 1. This article divides the life of the agent into three periods, namely, childhood, adulthood, and old age, and the length of each time is assumed to be 1. Individuals receive a certain percentage of their parents' labor income when they are in their infancy to meet their survival needs and receive education, thereby accumulating human capital, and surviving to adulthood with probability 1. In adulthood, people use their own accumulated human capital to inflexibly provide a

unit of labor to the society. Individuals use the income from labor for their own consumption, savings, and raising children, and they also survive to old age with a probability of 1. When a person enters old age, the average survival time of an individual in old age is $T(0<T<1, It\ is\ also\ equivalent\ to\ the\ survival\ rate\ of\ the\ perpetrator\ in\ old\ age)$.

At the same time, during the old age, assuming the delayed retirement policy is implemented, the individual will have to work for a period of time $X(0<X\le T)$ before he can retire, In the study of the end-use utility of individuals, if the only factors affecting the agent's utility are consumption and leisure, then the lifetime utility function of the agent born at $t-1$ is:

$$U=\sigma\ln C_{t-1}^{t-1}+\ln C_t^{t-1}+\beta T\left[\ln C_{t+1}^{t-1}+\gamma\ln\frac{T-x}{T}\right] \tag{1}$$

Among them, $C_{t-1}^{t-1}$, $C_t^{t-1}$, $C_{t+1}^{t-1}$ respectively represent the consumption of people born at $t-1$ in childhood, adulthood, and old age. $\sigma$ and $\beta$ are subjective time discount factors. $(T-X)/T$ is the length of leisure time in old age, and $\gamma$ is the preference of the agent for leisure, where $\sigma$, $\beta$, $\gamma$>0.

Under the pay-as-you-go social pension insurance system, individuals born at $t-1$ survive to become adults at $t$, and their human capital level is $h_t$. The effective wage rate means that the unit human capital return is $w_t$, the labor income is $w_t h_t$ and the pension insurance premium is paid at the social pooling account contribution rate $\theta$. At the same time, the expenditure ratio $v$ is used for the upbringing of children, and the remaining part of labor income is used for self-consumption $C_t^{t-1}$ and savings $S_t^{t-1}$. When a person born at $t-1$ survives to old age, he still needs to work for a period of time $x$ to obtain wage income $xw_{t+1}h_t$, pay according to the same overall payment rate $\theta$. When the elderly retire, their retirement time is $T$-$x$, and $P_{t+1}^{t-1}$ represents the pension income of a unit time, after retirement, the elderly get pension income $(T\text{-}x)\ P_{t+1}^{t-1}$.In addition, the agent's savings $S_t^{t-1}$ in period $t$ will accumulate to old age at the rate of return $R_{t+1}$, in summary, the actor's budget constraints are:

$$C_t^{t-1}+\eta_t C_t^t+S_t^{t-1}=(1-\theta)w_t h_t \tag{2}$$

$$C_{t+1}^{t-1}=R_{t+1}S_t^{t-1}+(T-x)P_{t+1}^{t-1}+(1-\theta)xw_{t+1}h_t \tag{3}$$

$$\eta_t C_t^t=vw_t h_t \tag{4}$$

$$h_t=Be_{t-1}^u h_{t-1}^{1-u} \tag{5}$$

Among them, $\eta_t$ represents the birth rate at time $t$, $C_t^t$ represents the consumption of people born at time t in their infancy, $\eta_t C_t^t$ represents the expenditure of adults at time $t$ for raising children. In the human capital equation, $h_t$ represents the individual's human capital situation during $t$, $B$ is the production efficiency of human capital, $e_{t-1}$ represents the proportion of education expenditures received by the actor at $t-1$ in parenting expenditures, and $u$ is the representative International income elasticity.

### 3.2 Manufacturer behavior decision

Assuming that there are countless homogeneous producers in a perfectly competitive market, they use the two production factors of capital and labor to produce goods, and their production function adopts the Cobb-Douglas function with constant scale. Its form is: $F(K_{t+1},H_{t+1})=AK_{t+1}^{\alpha}H_{t+1}^{1-\alpha}$, Where $F(K_{t+1},H_{t+1})$ represents the total output in $t$+1 period, $A$ represents total factor productivity, $\alpha$ represents the elasticity of capital output, $K_{t+1}$ is the total capital stock accumulated in $t$+1 period, $H_{t+1}$ represents the total human capital involved in production in $t$+1 period, it is equal to the sum of the quantity and quality of adult and elderly workers in period $t$+1.

$$H_{t+1}=h_{t+1}N_{t+1}^t+h_t xN_{t+1}^{t-1} \tag{6}$$

$N_{t+1}^{t}$ represents the number of adults who were born in $t$ and survived to $t$+1, and the corresponding human capital level is $h_{t+1}$. At the same time, $N_{t+1}^{t-1}$ represents the number of elderly who were born at $t$-1 and survived to $t$+1, and the corresponding human capital water is $h_t$. The dense form of the production function is $f(k_{t+1}) = Ak_{t+1}^{\alpha}$, and the capital accumulation per capita is expressed as $k_{t+1} = K_{t+1}/H_{t+1}$, We assume that capital is fully depreciated in a period, then when the manufacturer organizes production according to the marginal production equal to the marginal return, the marginal rate of return of capital and the marginal rate of return of labor costs are obtained as:

$$R_{t+1} = 1 + r_{t+1} = \alpha A k_{t+1}^{\alpha-1} \tag{7}$$

$$w_{t+1} = (1-\alpha) A k_{t+1}^{\alpha-1} \tag{8}$$

### 3.3 Government behavior decision

In the system, the government collects social pension insurance fees from the working population and distributes pensions to retired elderly people to achieve the goal of balance of pension accounts. Therefore, the government's pension account budget balance condition is:

$$\theta h_{t+1} w_{t+1} N_{t+1}^{t} + \theta x h_t w_{t+1} N_{t+1}^{t-1} = (T-x) P_{t+1}^{t-1} N_{t+1}^{t-1} \tag{9}$$

Divide the left and right sides of the equation by $N_{t+1}^{t-1}$ to get:

$$\theta h_{t+1} w_{t+1} \eta_t + \theta x h_t w_{t+1} = (T-x) P_{t+1}^{t-1} \tag{10}$$

### 3.4 Capital market clearing

The capital produced by the enterprise in period $t$+1 comes from the personal savings of individuals in period $t$, and it is assumed that the agent does not save in old age. Therefore, the capital accumulation of $t$+1 only comes from the total savings of adults in period $t$, and the capital accumulation $K_{t+1} = N_t^{t-1} S_t^{t-1}$.

Capital accumulation per capita is

$$k_{t+1} = \frac{K_{t+1}}{H_{t+1}} = \frac{N_t^{t-1} S_t^{t-1}}{h_{t+1} N_{t+1}^{t} + h_t x N_{t+1}^{t-1}} = \frac{S_t^{t-1}}{\eta_t h_{t+1} + T x h_t} \tag{11}$$

### 3.5 Equilibrium solution

If the entire economic system satisfies all the above constraints, then the economy is in equilibrium.

Under the constraints of equations (2), (3), and (4), we simplify equation (3), and obtain $C_t^{t-1}$ and $C_{t+1}^{t-1}$ Equation relationship, although $C_{t\text{-}1}^{t\text{-}1}$ is the consumption of an individual in childhood, but the source of consumption is the income of his parents. On this basis, the first derivative of the utility function (1) with respect to $C_{t+1}^{t-1}$, the result is:

$$\frac{C_{t+1}^{t-1}}{C_t^{t-1}} = \beta T R_{t+1} \tag{12}$$

Bringing equation (12) back to constraint (2), we can get $C_{t+1}^{t-1}$, $C_t^{t-1}$, and $S_t^{t-1}$.

$$C_t^{t-1} = \frac{1}{1+\beta T}\left[(1-\theta) w_t h_t - \eta_t C_t^{t} + \frac{(T-x) P_{t+1}^{t-1} + (1-\theta) x w_{t+1} h_t}{R_{t+1}}\right] \tag{13}$$

$$S_t^{t-1} = \frac{\beta T}{1+\beta T}\left[(1-\theta) w_t h_t - \eta_t C_t^{t}\right] - \frac{(T-x) P_{t+1}^{t-1} + (1-\theta) x w_{t+1} h_t}{(1+\beta T) R_{t+1}} \tag{14}$$

Substituting formula (7), (8), (10) into formula (14), the specific expression of personal savings $S_t^{t-1}$:

$$S_t^{t-1} = \frac{\beta T(1-\theta-v)(1-\alpha)Ak_t^{\alpha}h_t}{1+\beta T} - \frac{(1-\alpha)(\eta_t\theta h_{t+1}+xh_t)k_{t+1}}{(1+\beta T)\alpha} \tag{15}$$

Putting (14) into (11) to get per capita capital accumulation $k_{t+1}$:

$$k_{t+1} = \frac{\beta T(1-\theta-v)(1-\alpha)Ak_t^{\alpha}h_t}{(1+\beta T)(\eta_t h_{t+1}+Txh_t)} - \frac{(1-\alpha)(\eta_t\theta h_{t+1}+xh_t)k_{t+1}}{(1+\beta T)\alpha(\eta_t h_{t+1}+Txh_t)} \tag{16}$$

Replace $h_{t+1}$ with the human capital equation to obtain

$$k_{t+1} = \frac{\beta T(1-\theta-v)(1-\alpha)Ak_t^{\alpha}}{\left[\alpha(1+\beta T)+\theta(1-\alpha)\right]\eta_t Be_t^{u}h_t^{-u} + x\left[\alpha T(1+\beta T)+(1-\alpha)\right]} \tag{17}$$

When the accumulation of capital per capita reaches a steady-state level, it converges to $k^*$. The expression of $k^*$ is:

$$k^* = \left\{\frac{\beta T(1-\theta-v)(1-\alpha)A}{\left[\alpha(1+\beta T)+\theta(1-\alpha)\right]B\eta e^{u}h^{-u} + x\left[\alpha T(1+\beta T)+(1-\alpha)\right]}\right\}^{\frac{1}{1-\alpha}} \tag{18}$$

## 4. Empirical analysis

In order to specifically explore the impact of delayed retirement and the second-child policy on the second demographic dividend, this chapter collects and organizes relevant data and compares relevant parameters, a numerical analysis method is used to simulate and predict the changes in per capita capital accumulation in the three cases of using the delayed retirement policy alone, the fertility policy alone and the two policies together. Finally, the forecast results of the three situations are compared and analyzed, and the reasonable suggestions of the two policies in the implementation process are summarized based on the comparison results.

### 4.1 The length of life of the agent and the determination of the subjective discount factor

We assume that the length of life of the actor in the first period is 20 years, and the individual survives to the beginning of the second period with probability 1 (that is, regardless of the death of the actor in the first period), the second period is the adult working period. The legal retirement age of the Ministry of Human Resources and Social Security is 60 years old for males, 55 years old for female officials, and 50 years old for female workers. In this article, the average retirement age is set as 55 years old, the perpetrator's survival length in the second period is 35 years, and the perpetrator also survives to the third period with a probability of 1. The perpetrator's survival length in the third period is 35 years, the survival length of the second period of an individual is 35 years, and the individual also survives to the third period with a probability of 1, the survival length of the individual in the third period is 35 years. According to Zhao Xintong (2016), the life expectancy of China's population in 2030 is 79.2 years [38]. Here we approximate the life expectancy to 80. Then the survival rate of the actor in the third stage is $T = 25/35 \approx 0.71$. Discount factor $\beta$ from the third period to the second period, according to $(1+i)\ \beta = 1$, $i$ can be obtained by weighting the nominal interest rate of 0.01 for 35 years, the result is 0.417, and then the discount factor $\beta$=0.71.

### 4.2 Determination of factors related to production

When studying the Chinese economy, when the production function adopts the Cobb Douglas function, scholars hold different opinions on the determination of the capital output elasticity $\alpha$.Bai Chongen (2008) estimated that my country's capital output elasticity was 0.5[39], and Guo Han (2014) used FE and SFA models to estimate that my country's capital output elasticity from 1997 to 2012 fluctuated from 0.40 to 0.50[40]. In this paper, $\alpha$ is 0.5; and total factor productivity $A$ is assumed to be a fixed value, and we take the standard value of 100.

### 4.3 Determination of factors related to manpower

In terms of fertility, when we separately studied the delayed retirement policy, we assumed that the fertility rate remained unchanged, and the fertility rate $\eta$ was taken as 1.12 after referring to the average of the 2008-2017 comprehensive fertility rate of the National Bureau of Statistics. In terms of support, the ratio of parenting expenditure to wage income $v$ and the social pooling contribution rate $\theta$ will vary with family income, unabling to obtain specific data. This article distinguishes two social families with different contribution rates and parenting ratios according to the level of improved Engel coefficient. In the case of stable social prices and no inflation, for families with a higher Engel coefficient after improvement, Its expenditure on food accounts for a large proportion, if a family wants to raise a child at the social average level, its parenting expenditure will also account for a large proportion of personal income. We assume that $v$ is 40%, and the proportion of education expenditure in parenting expenditure $e$ is assumed to be 50%. At the same time, according to the personal income tax reform in 2019, the social pooling payment rate $\theta$ should be calculated at a lower payment rate, here we take $\theta$ as 10%.

For families with a lower improved Engel coefficient after the improvement, the situation is quite different. First, the individual's social pooling payment rate $\theta$ will all increase, and here is 25% of mid-to-high-end. At the same time, when the amount of parenting expenditure is consistent with that of families with higher improved Engel coefficients, the percentage of parenting expenditure in personal income $v$ will decrease accordingly, accounting for 15% of income. The proportion of education expenditure in upbringing remains unchanged at 50%.

In the human capital equation, $B$ is the production efficiency in the human capital equation, according to the definition of $h_t = Be_{t-1}^{u} h_{t-1}^{1-u}$, To ensure a monotonic increase in human capital, the proportion of education expenditure $e$ and production efficiency $B$ should satisfy $Be_{t-1}^{u} > 1$, And to ensure $h_t$ convergence within a finite interval, we assume that $B$ is 1.5, and assume that the initial per capita capital level takes the standard value of 1. According to the study of Guo Kaiming (2014), the international income elasticity $u$ is 0.5.

In summary, all parameters are shown in Table 1

Table 1 Related parameter

| Parameter | Symbol | Value |
|---|---|---|
| full factors production rate | $A$ | 100 |
| Human productivity | $B$ | 1.5 |
| Discount factor | $\beta$ | 0.71 |
| Average lifetime | $T$ | 0.71 |
| Social pooling contribution rate | $\theta$ | 10% |
| Intergenerational income | $u$ | 0.5 |
| Capital output elasticity elasticity | $\alpha$ | 0.5 |
| Percentage of education expenditure | $v$ | 40% |

In the case of only implementing the delayed retirement policy, we will take factors related to human factors as exogenous variables, and the fertility rate $\eta$ as an exogenous variable remains unchanged, taking the average of the comprehensive fertility rate from 2000 to 2017 by the National Bureau of Statistics of 1.12. After the delayed retirement age $x$ changes, the change in per capita capital is simulated, and the change in per capita capital accumulation is shown in Figure 3:

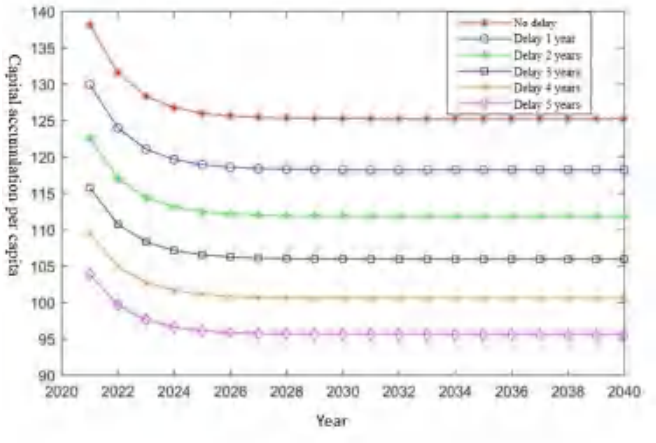


Figure 3 Changes in the delayed retirement age and per capita capital accumulation

*Conclusion one:* It can be seen from Figure 3 that compared with not implementing delayed retirement, the delayed retirement policy reduces per capita capital accumulation, and with the increase of retirement age, per capita capital accumulation will gradually decrease, which is not conducive to the second demographic dividend.

*Proof:* Find the first derivative of the delayed retirement age for per capita capital accumulation, and the result is negative

$$\frac{\partial k^*}{\partial x}=\frac{-\left[\alpha\left(1+\beta T\right)+\theta\left(1-\alpha\right)\eta\right]}{1-\alpha\left[\beta T\left(1-\theta-v\right)\left(1-\alpha\right)A\right]^{\frac{1}{1-\alpha}}}\left\{\left[\alpha\left(1+\beta T\right)+\theta\left(1-\alpha\right)\right]\eta+x\left[\alpha T\left(1+\beta T\right)+\left(1-\alpha\right)\right]\right\}^{\frac{\alpha}{1-\alpha}} \quad (19)$$

*Explanation:* The degree of human capital accumulation of workers delayed in retirement is lower than that of adult workers in the same period, and their return to the labor market to participate in work will squeeze the employment opportunities of adult workers, it will reduce the degree of realization of human capital to per capita capital, thereby reducing the accumulation of per capita capital, thereby reducing the second demographic dividend.

In recent years, China's living standards have improved significantly, and household expenditures on food consumption as a percentage of income have gradually declined. On the other hand, families are paying more and more attention to the education of their children, and the proportion of investment is increasing, the cost of education is increasing, resulting in total expenditure on education expenditure exceeded expenditure on food, so we will improve the traditional Engel, and make a new definition, we define the percentage of household expenditure on food and children's education in total income as the improved Engel coefficient. The improved Engel coefficient can better reflect the percentage of household expenditure under the birth policy, and it can also reflect the tax structure better.

In the case of only implementing the fertility policy, we regard the factors related to delayed retirement as exogenous variables, that is, the delayed retirement age $x$ takes 0, assuming that the fertility rate has increased due to the implementation of the policy, here the fertility rate $\eta$ is gradually increased from 1.12 to 1.22. We use the improved Engel coefficient 0.4 as the quantile point for high- and low-income families. The parenting expenditure $e$ of families with high Engel coefficient is set to 0.4, and the parenting expenditure of families with low Engel coefficient is set to 0.15. At the same time, the social pooling contribution rates of the two families are 10% and 25% respectively, so as to study the changes in per capita capital of different families after the implementation of the fertility policy, the result is shown in Figure 4 and Figure 5:

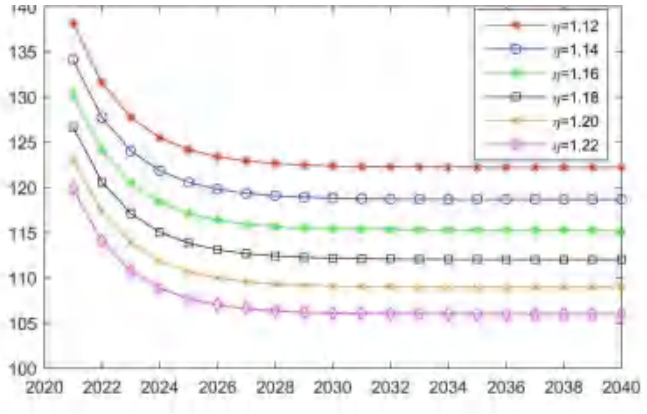


Figure 4: High Engel coefficient per capita capital accumulation change graph

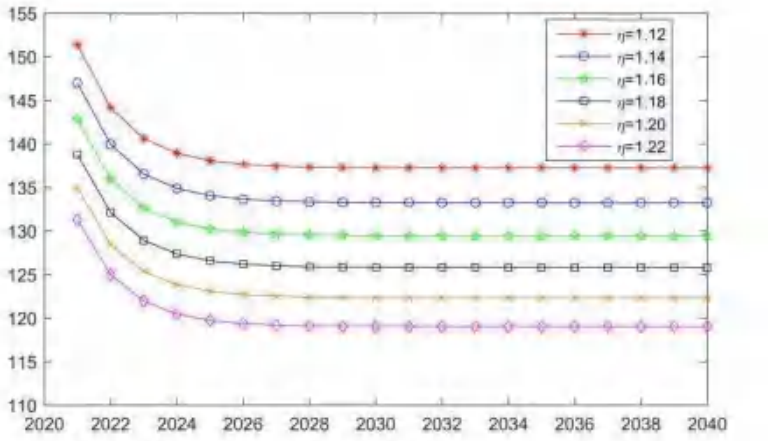


Figure 5: Changes in per capita capital accumulation with low Engel coefficient

*Conclusion two:* From Figure 4 and Figure 5, it can be seen that the fertility policy will reduce per capita capital accumulation. Compared with families with a lower Engel coefficient after the improvement, the reduction in per capita capital accumulation of families with a higher Engel coefficient after the improvement will be greater, and it will be more difficult for them to obtain the second demographic dividend. Adults' increase in educational expenditures for children's education will reduce the individual's per capita capital accumulation in the current period and increase the individual's per capita capital accumulation in the next period. The per capita capital accumulation in the steady state has nothing to do with the production efficiency of human capital. At this time, the production factors that affect the accumulation of capital per capita have nothing to do with human capital factors, but only with production technology factors, such as the elasticity of capital output $\alpha$ , total factor productivity $A$ .

*Proof:* We calculate the first derivative of per capita capital accumulation to the proportion of education expenditure and human capital accumulation, and the results are as follows:

$$\frac{\partial k^*}{\partial e} = -u \frac{\frac{\left[\beta T(1-\theta-v)(1-\alpha)A\right]^{\frac{1}{1-\alpha}}}{1-\alpha}\left\{\left[\alpha(1+\beta T)+\theta(1-\alpha)\right]B\eta e^{u}h^{-u}\right\}}{\left\{\left[\alpha(1+\beta T)+\theta(1-\alpha)\right]B\eta e^{u}h^{-u}+x\left[\alpha T(1+\beta T)+(1-\alpha)\right]\right\}^{\frac{2-\alpha}{1-\alpha}}} < 0 \tag{20}$$

$$\frac{\partial k^*}{\partial h}=u\frac{\frac{\left[\beta T\left(1-\theta-v\right)\left(1-\alpha\right)A\right]^{\frac{1}{1-\alpha}}}{1-\alpha}\left\{\left[\alpha\left(1+\beta T\right)+\theta\left(1-\alpha\right)\right]B\eta e^{u}h^{-u}\right\}}{\left\{\left[\alpha\left(1+\beta T\right)+\theta\left(1-\alpha\right)\right]B\eta e^{u}h^{-u}+x\left[\alpha T\left(1+\beta T\right)+\left(1-\alpha\right)\right]\right\}^{\frac{2-\alpha}{1-\alpha}}}>0 \tag{21}$$

*Explanation:* From the derivative results, it can be seen that the first-order derivative of per capita capital accumulation $k^*$ to the share of education $e$ is negative, so when people increase the proportion of education expenditures, the per capita capital accumulation will be reduced in the current period. But according to the human capital equation, before the accumulation of human capital reaches a steady state, the increase in the proportion of education expenditure will increase the human capital level of the agent in the next period. The first derivative of per capita capital accumulation $k^*$ to human capital level $h$ is positive. Therefore, increasing the proportion of education expenditure will reduce the individual's per capita capital accumulation in the current period and increase the individual's per capita capital accumulation in the next period.

When the production elasticity of human capital is great, when the economic system reaches the final steady state, according to the limit convergence theorem $e^{u}h^{-u}=1/B$ , thus, the expression of capital accumulation per capita can be transformed into:

$$k^*=\left\{\frac{\beta T\left(1-\theta-v\right)\left(1-\alpha\right)A}{\left[\alpha\left(1+\beta T\right)+\theta\left(1-\alpha\right)\right]\eta+x\left[\alpha T\left(1+\beta T\right)+\left(1-\alpha\right)\right]}\right\}^{\frac{1}{1-\alpha}} \tag{22}$$

At this time, when the proportion of education expenditure $v$ remains unchanged, neither increasing the proportion of education nor increasing the level of human capital will have an impact on per capita capital, Moreover, the accumulation of capital per capita in the steady state has nothing to do with the production efficiency of human capital, the main exogenous variable that affects the accumulation of capital per capita is production-related factors, such as capital output elasticity $\alpha$ total factor productivity $A$ ,not human factors. Adults may more comprehensively consider the number of children born and the willingness to delay retirement from the social pooling contribution rate and life expectancy. For families with a higher modified Engel coefficient, when compared with families with a lower coefficient, when the support expenditure exceeds their tolerance. In other words, when $(1-\theta-v)$ is negative, the actor often chooses to borrow from banks or other institutions to maintain their own consumption, which leads to negative per capita capital accumulation, at this time, the family's decision is often to reduce births and maintain current consumption, thus reducing the effectiveness of the fertility policy. On the other hand, although the policy of encouraging childbirth reduces the accumulation of capital per capita and reduces the second demographic dividend generated by individuals, the policy of encouraging childbirth increases the total population, Furthermore, the accumulation of the second demographic dividend for the entire society is not necessarily a reduction, and a comprehensive consideration must be made from both the per capita capital accumulation and the population size.

When the two policies are implemented at the same time, the delayed retirement age $x$ and the fertility rate $\eta$ are both endogenous variables. Without increasing the proportion of parenting expenditure, we select families whose parenting expenditure $v$ is 40%, the three-dimensional images of per capita capital accumulation $k$ and delayed retirement age $x$ and fertility rate $\eta$ when the simulation is in equilibrium are shown in Figure 6.

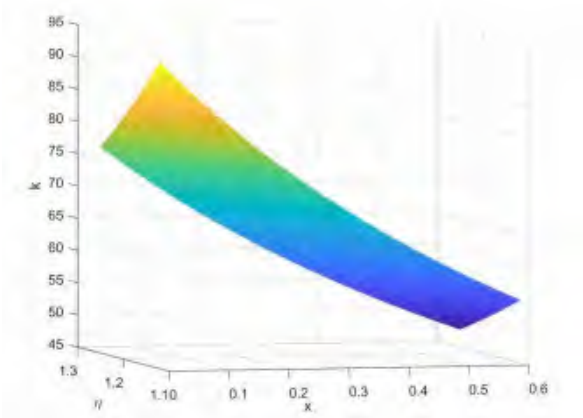


Figure 6 Three-dimensional change of capital accumulation per capita

*Conclusion three:* From Figure 6, we can see that under the condition that other conditions remain the same, after using the two policies at the same time, per capita capital accumulation gradually decreases with the increase of the delayed retirement age $x$ and the fertility rate $\eta$, the reduction in capital accumulation per capita is greater than when the two policies are used separately, the decrease value is not the linear summation of the two strategies to decrease the value. It shows that the fertility policy has had an impact on the effect of the retirement policy on per capita capital accumulation, and the fertility policy has accelerated the rate of decrease in per capita capital accumulation and lowered the equilibrium value.

*Explanation:* When the government uses the fertility policy and the delayed retirement policy at the same time, it will reduce the savings of adults motivated by the retirement age, and use this part of the savings for children's upbringing expenses, thereby reducing the family savings rate. Here we get the same result as Geng Zhixiang(2018), the policy implementation reduces the accumulation of capital per capita by reducing the savings rate, and the fertility policy further reduces per capita capital accumulation in the form of increasing the population base.

The research in this paper finds that per capita capital accumulation and the second demographic dividend will decrease with the implementation of the delayed retirement policy and the second-child policy. However, in order to solve the population problem in our country, the implementation of the two policies has become an inevitable trend. Can we consider adjusting the priority of the short-term policy to delay the decline in per capita capital accumulation?

A sensitivity analysis was made on this, and the sensitivity coefficients of per capita capital accumulation to retirement age and fertility rate are $S_{xk}$ and $S_{\eta k}$ respectively. The specific results are shown in Table 2

$$S_{xk} = \frac{\Delta x / x}{\Delta k / k} \tag{23}$$

$$S_{\eta k} = \frac{\Delta \eta / \eta}{\Delta k / k} \tag{24}$$

Table 2 Sensitivity coefficient table

| | | | | | |
|---|---|---|---|---|---|
| $k_1$ | 118.223 | 111.814 | 105.943 | 100.551 | 95.585 |
| $x$ | 0.02857 | 0.05714 | 0.08571 | 0.11429 | 0.1428 |
| $S_{xk}$ | -16.847 | -8.328 | -5.4903 | -4.0727 | -3.2232 |
| $k_2$ | 118.653 | 115.263 | 112.025 | 108.931 | 105.97 |
| $\eta$ | 1.14 | 1.16 | 1.18 | 1.20 | 1.22 |
| $S_{\eta k}$ | -0.586 | -1.1725 | -1.7594 | -2.3468 | -2.9345 |

From the sensitivity coefficient table, we find that in the process of per capita capital accumulation from high to low, the sensitivity coefficient of per capita capital accumulation to retirement age gradually decreases, and the sensitivity coefficient of per capita capital accumulation to fertility gradually increases. That is, when per capita capital accumulation is at a high level, the reduction in per capita capital accumulation caused by the delayed retirement policy is greater than that of the birth policy, when the accumulation of capital per capita is low, the conclusion is the opposite. This means that in the process of policy implementation, government departments can first take the fertility policy as the main policy orientation, with the goal of increasing the fertility rate and increasing labor supply, when the fertility rate rises to a certain level, the delayed retirement policy will be implemented to solve the pension gap problem.

## 5. Conclusion

Based on the neoclassical economic theory, this paper constructs a three-phase OLG model by introducing the human capital equation, simulating the changes in per capita capital accumulation when the fertility policy alone, the delayed retirement policy alone, and the two policies are implemented together. The study found that raising the delayed retirement age and implementing the fertility policy can alleviate the pressure of the pension gap and improve the labor structure, but to a certain extent reduce the per capita capital accumulation, thereby reducing the second demographic dividend.

This paper compares the per capita capital accumulation level of different improved Engel coefficient families and finds that: one of the main factors affecting the effect of the implementation of the birth policy is the taxation level of the family and the parenting expenditure of the children, at this stage, the family’s demand for education is not only satisfied with compulsory education, and higher quality education means higher expenditures, increasing the burden on laborers' survival and reduces their willingness to have children.

It has become a general trend to implement a delayed retirement policy to solve the problem of aging, but in the process of policy implementation, it will be affected by the fertility policy. The fertility policy will exacerbate the negative impact of the delayed retirement policy on the second demographic dividend. Through sensitivity analysis, this article finds that when per capita capital accumulation is at a high level, the reduction in utility caused by the implementation of the delayed retirement policy is greater than that of the fertility policy, when per capita capital accumulation is at a low level, the result is the opposite. Combined with the lag in the effectiveness of the fertility policy, this article advocates that the fertility policy at the current stage should be prioritized over the delayed retirement policy, the government should focus on reducing the cost of raising families at the current stage. At the current stage, the government should focus on reducing the cost of raising families, and provide appropriate education subsidies to families with higher improved Engel coefficients, so as to ensure the family’s willingness to bear children, after the fertility rate reaches a certain level, a more moderate delayed retirement policy will be implemented.

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# How Top Management Team Capability and Heterogeneity Influence the Decision-making of Corporate Pension Plan

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**Keywords:** TMT capability and heterogeneity, corporate pension, rent-seeking

**Abstract.** As the "second pillar" of China's pension system, corporate pension is a key move to cope with the aging condition and relieve the pressure of Social Security Funds' deficit. Based on the non-balance panel data of Chinese A-share non-financial enterprise listed companies from 2009 to 2019, this paper discusses the influencing factors of corporate pension participation in company's decision-making, starting from the capability and heterogeneity of Top Management Team(TMT). Empirical results show that the average cognitive and social capabilities of the management team are positively associated with the participating decisions of the corporate pension, and the average professional ability and its heterogeneity are negatively associated with participating decisions. Further research has found that the impact of the management team on corporate pension decision-making is more significant in the western region, family businesses and companies with weak governance, which shows rent-seeking. The findings could provide some reference for expanding the participation of corporate pension plan and inhibiting the possible unfair distribution of corporate pension system.

## 1．引言

随着我国老龄化的加剧，以现收现支为基础的基本养老保险的支付能力频频告急，数据显示，2020年我国养老金赤字达1700多亿元。联合国《世界人口展望》预测到，中国老龄人口抚养比到2050年将达到44.6%。“十四五”规划纲要提出，要发展多层次、多支柱养老保险体系，提高企业年金覆盖率，规范发展第三支柱养老保险。

企业年金作为中国养老保障体系中仅次于基本养老保险的“第二支柱”，是企业及其职工在依法参加基本养老保险的基础上，自主建立的补充养老保险制度。自2009年国家出台企业年金税收优惠政策，建立了全面统一的企业年金制度

以来，企业年金计划越来越受到企业的认可，但是仍存在覆盖率不足、地区和行业发展失衡（郑秉文，2019）等问题。人力资源和社会保障部发布的《2019年度全国企业年金基金业务数据摘要》显示，截至2019年末，全国仅有95963家企业建立企业年金计划，参与职工2547.94万人，占国内劳动人口的5%左右。

国内外许多学者对企业年金的参与决策问题进行了研究，现有研究主要从企业和员工个人层面切入分析其影响因素。在公司层面，Black(1980)认为税收优惠是企业参与年金计划的激励因素，企业可以利用国家的税收优惠政策实现企业价值的最大化。基于我国上市公司数据的研究发现，上市公司的企业年金投保决策显著受到实际所得税率、企业规模、信贷约束等因素的影响（朱铭来，2015）。另外，高管持股比例、实际所得税率、企业规模以及雇员素质也对于企业建立年金制度呈正向影响（于新亮，2015）。异质性分析发现，企业的规模、产权性质以及垄断行业属性均与年金参与概率显著正相关，大型、国有、垄断企业更可能参与年金计划（张东旭，2017）。个人层面的研究受限于数据可得性，主要是基于调查数据分析员工的个人特征对参与率的影响，其研究结论存在一定的不稳定性。可能是由于企业是年金决策的主体，基于个人层面的调查数据并不能反映企业年金的决策过程（郭磊、苏涛永，2015）。

企业年金计划作为一项由企业自主选择是否实施的制度，其参与决策是经理人与所有者、高管与员工等多方协商博弈的结果。高层梯队理论提出，企业战略布局会受到管理者特质的影响，管理者特质主要是指管理者在认知、感知上的能力和价值观等心理结构（Hambrick、Mason）。由于延期支付的特点，企业年金的参与决策是企业现时成本与长远利益的权衡，是对高管团队能力的考验。国内学者对高管团队与企业社会责任的关联做了大量研究，研究发现，高管团队作为企业履行社会责任的重要参与者，其内部成员的构成对企业社会绩效具有重要影响（朱永明，2021）。基于我国上市公司的实证研究表明，变革型领导比交易型领导的企业社会责任表现更好（Du，2013），年龄大的高管更加注重企业社会价值与长期利益的实现（朱永明，2021），另外高管在年龄、任期、教育背景方面的异质性构成了团队认知、思维的多样性，有利于企业社会绩效的提高（李东伟、吴菁）。

企业年金作为员工福利的重要组成，是企业社会责任在员工层面的关键体现，关于高管团队能力对企业年金参与决策的影响的研究尚需完善。因此，本文将基于2009-2019年中国A股非金融企业上市公司的非平衡面板数据，从高管团队的认知能力、社会能力、专业能力入手，探讨其对企业年金参与决策的影响。其次，对于企业年金被视为“富人俱乐部”可能带来的收入分配不公平，本文通过对不同产权结构、治理水平、地区地域的个体的异质性分析，探究管理层操纵企业年金进行寻租的可能性。希望通过本文的研究，对扩大企业年金参与率、抑制企业年金制度推行中可能带来的分配不公平提供一定的参考。

## 2．理论分析与研究假设

熊彼特的创新理论关注变革的具体因素和这些因素的运作方式，而企业家是变革机制的承担者，是新政策实施的决策人。高层梯队理论认为，面对日益复杂多变的企业经营环境，研究管理者团队人口背景特征比研究管理者个人(如 CEO)人口背景特征对企业决策及绩效的影响更有解释力。这是因为，在企业所有权与控制权相分离的情况下，管理者团队掌握着企业的控制权，对企业发展至关重要。因此，本文分两个阶段来逐层深入研究：一是高管团队不同能力特征对企业年金

参与决策的影响；二是高管团队不同能力特征的异质性对企业年金参与决策的影响。

## 2.1 认知能力

企业年金制度的实施是企业对薪酬福利方面的变革和创新，受过高等教育的管理团队在适应新环境、对战略变革敏感程度和风险承受度上都会更具优势，会更倾向于变革和创新（Wiersema 和 Bantel）。另一方面，企业年金延付薪酬的特性有利于筛选高素质人才（于新亮，2015）、降低离职率，有助于企业的长期发展。受教育程度高的高管通常具有更强的信息处理能力和认知水平（Wally 和 Baum），他们更注重企业长期发展的战略，更加积极主动地集中企业资源（Carmen）。因此我们认为平均学历高的团队更乐于主动建立企业年金制度，提出假设：

H1：高管团队平均学历与企业年金制度参与决策正相关。

## 2.2 社会能力

根据资源依赖理论，行政权力是提供重要资源的有效途径( Pfeffer & Salancik，1978) ，政治关系是组织拥有的关键性稀缺资源。企业如果获得政治支持，不仅可以便捷地获得重要资源，还可以克服过度的监管负担，并减少正式或非正式的税收负担( Li 等，2006)，更甚至于规避法规，并得到政府的保护。因此我们认为政治关联度高的团队更乐于主动建立企业年金制度，提出假设：

H2：高管团队平均政治关联与企业年金制度参与决策正相关。

## 2.3 专业能力

拥有不同专业背景的高管，决策偏好也不同。经历过技术和市场而成长起来的CEO比经过会计、财务或法律成长起来的CEO更支持公司研发投入的战略决策（Barker 和Mueller）；具有工程专业背景的管理者大多倾向于实施产品创新战略（胡燕华等，2018）。所以，企业在基于利润最大化原则进行决策时，专业背景强的高管会倾向与分配资本到产品研发等战略上，从而导致员工福利的忽视。因此我们认为平均专业能力低的团队更乐于主动建立企业年金制度，提出假设：

H3：高管团队平均专业背景与企业年金制度参与决策负相关。

## 2.4 能力异质性

社会同一性理论是由英国社会心理学家率先提出的，主要是研究个体处于群体中行为选择以及群体发展动力的心理过程。该理论认为，在一个群体或社会中，个体之间的关系或交往在很大程度上取决于个体之间的相似性。如果个体之间存在境遇相似、兴趣相投或某些特征相同，则彼此之间就容易产生认同感和亲近感，加强合作与交往；否则，彼此之间就容易产生分歧和冲突，甚至是歧视（张兆国，2018）。与社会同一性理论相反，信息与决策理论认为，在集体决策中，具体不同境遇、兴趣或特征的个体便有着不同的观点和信息，因此面对复杂而多变的环境，这些多样性的个体将有助于全面理解和深入认识决策问题，从而有助于提高

决策质量。因此，高管团队能力的异质性对于企业年金制度的参与决策的影响是不确定的。

历史研究表明，个人为了提高自尊，将会进行自我归类并与他人比较，而学历可能成为自我归类的一个重要标准，相同学历的个体更易于合作，反之则较不易信任（柯江林）。基于代理理论，高管团队任期异质性带来沟通无效等问题，不利于达成一致决策（吕音）。专业技术背景异质性表明高管在看待问题时的角度不同，不同专业技术背景的高管在分析问题时更侧重于分析自己所熟悉的方面（杨芳，2021）。因此基于以上分析，本文提出假设：

H4：高管团队学历异质性与企业年金制度参与决策负相关；

H5：高管团队政治关联异质性与企业年金制度参与决策负相关；

H6：高管团队专业背景异质性与企业年金制度参与决策负相关。

## 3．研究设计

### 3.1 样本选择与数据来源

本文采用非平衡面板数据，以2009—2019年沪深A股上市公司为研究对象，并对样本进行了如下处理：（1）剔除ST和*ST企业；（2）剔除金融类企业；（3）剔除在研究期间高管信息披露不全的公司；（4）对连续型变量进行了Winsorize上下1%的缩尾处理。研究所需的高管人员资料信息和财务信息主要来源于CSMAR数据库，企业年金数据在CSMAR应付职工薪酬数据库的基础上手工筛选整理得到。共得到涉及3293个个体的26005个企业年度样本。

### 3.2 模型设定与变量定义

本研究将企业当年是否执行企业年金计划作为被解释变量，当年有缴纳企业年金费用时pendum=1，否则取0。解释变量为高管团队学历、政治关联、专业技术背景的平均值与异质性。其中，政治关联依据高管个人简历中的历史任职进行筛选，参考张祥建2015年的研究，将包括人大、政协、政府机关、军方、税务和工商等工作的经历界定为政治关系，有政治关系则porelate=1，否则赋值0。考虑到取值是否具有连续性，本研究对异质性使用了产业经济学中常用的Herfindahl-Hirschman系数来度量，公式如下：

$$H = 1 - \sum_{i=1}^{n} P_i^2 \tag{1}$$

其中，Pi 表示高管团队中第 i 类成员所占比重，n为类别数量，H 取值范围在 0-1 之间，H 值越大说明异质性越高。

对于控制变量，本文参照历史研究，从税收负担、内控能力、经营能力、偿债能力等方面，选择企业规模（size）、实际税率（realtax）、股权制衡度（holcom）、资产负债率（DEratio）作为控制变量，另外加入了行业和年份作为虚拟变量。主要变量的定义如下表1所示。

表1 变量定义及描述

| 变量代码 | 变量名称 | 取值方法及说明 |
|---|---|---|
| pendum | 参与决策 | 哑变量，表示是否参与企业年金 |
| mdegree | 认知能力 | 学历平均值：中专及中专以下学历为1,大专学历为2本MEDU 平均学历科学历为3,硕士研究生学历为4,博士研究生学历为5,个体情况加总求均值 |
| mporelate | 社会能力 | 高管团队中具有政治关系的高管所占的比例 |
| mproback | 专业能力 | 高管团队中具有专业技术背景的高管所占的比例 |
| hdegree | 认知能力异质性 | 高管团队学历Herfindahl系数 |
| hporelate | 社会能力异质性 | 高管团队政治关联Herfindahl系数 |
| hproback | 专业能力异质性 | 高管团队专业技术背景Herfindahl系数 |
| size | 企业规模 | 以百万计企业资产总额取对数 |
| realtax | 税收负担 | 实际税率=所得税费用/利润总额 |
| holcon | 内控能力 | 股权制衡度=第一大股东持股/前2-5大股东持股 |
| fcf | 经营能力 | 经营现金净流量/总资产 |
| DEratio | 偿债能力 | 资产负债率 |
| region | 地域特点 | =1为东部地区，=2为中部地区，=3为西部地区 |
| nat | 产权性质 | 哑变量，表示是否为国有企业 |
| year | 年度 | 以2010年为基准,设立了9个虚拟变量 |
| industry | 行业 | 根据中国证监会2020年行业分类指引,将INDU行业样本公司划分为17个行业 |

为检验对企业年金参与决策的影响，本文建立模型（1）、（2），使用Logit回归进行检验。

$$pendum = \alpha_0 + \beta_1 mdegree + \beta_2 mporelate + \beta_3 mproback + \beta_i controls + year + \varepsilon \quad (2)$$

$$pendum = \alpha_1 + \chi_1 hdegree + \chi_2 hporelate + \chi_3 hproback + \chi_i controls + year + \gamma \quad (3)$$

## 4．实证结果

### 4.1 描述性统计

表2为主要变量的描述性统计结果。表2中参与组中变量mdegree的均值为3.16，显著低于非参与组，表明参与年金计划的企业有更高的平均学历;变量D/E的均值为1.77、中位数为1.20，也均高于非参与组，表明参与组中的企业具有更高的负债比率。虽然这两组表征企业的变量与本文有关付现成本的假设预期不太一致，但是，考虑到此处的分析结果仅仅是单变量的分析结果，会存在计量上的偏差，更准确的判断还要控制其他变量的影响。表2中ROA变量也可能受到此影响，参与组中ROA变量的均值和中位数均为0.03，均要显著小于非参与组的0.04，表明盈利能力越好的企业越不愿意参与企业年金计划。除此以外，表2中其余变量的统计结果与本文的假设预期基本保持一致。具体而言，参与组比非参与组具有更高的自由现金流(FCF)、第一大股东持股(Top1)、董事会会议次数(Meeting)、规模(Size)、实际所得税税率(Taxr)，且参与组样本更多的是国有企业、垄断行业

内的企业，与本文有关风险成本的假设预期以及现有文献中的认识基本相一致;参与组企业的投资机会(TQ)、高管持股数量(MSH)要显著低于非参与组的统计结果，与本文关于机会成本的预期基本相一致。且本文的研究发现，参与组中高科技企业的占比均值为0.33，要显著小于非参与组的占比0. 47，表明高科技企业可能更不愿意参与企业年金计划。

表2 变量的描述性统计

| 变量 | 参与组均值 | 非参与组均值 | 均值差异 | 显著性 |
|---|---|---|---|---|
| mdegree | 3.160 | 3.401 | -0.242 | 0.000*** |
| mporelate | 0.134 | 0.236 | -0.102 | 0.000*** |
| mproback | 0.472 | 0.417 | 0.0550 | 0.000*** |
| hdegree | 0.651 | 0.687 | -0.0360 | 0.000*** |
| hporelate | 0.181 | 0.258 | -0.0770 | 0.000*** |
| hproback | 0.401 | 0.385 | 0.0170 | 0.000*** |
| realtax | 0.117 | 0.148 | -0.0310 | 0.502 |
| holcon | 2.717 | 4.364 | -1.647 | 0.000*** |
| fcf | 0.0440 | 0.0390 | 0.00500 | 0.003*** |
| DEratio | 0.379 | 0.504 | -0.125 | 0.000*** |
| size | 7.899 | 8.905 | -1.006 | 0.000*** |

## 4.2 实证结果分析

表3为高管团队能力特征平均值与企业年金参与决策回归结果，表4为高管团队能力特征异质性与企业年金参与决策回归结果。其中回归( 1) ～ 回归( 4) 为未控制行业变量的结果，回归( 5) 为控制了所有行业哑变量的回归结果。与回归( 4) 相 比，回归( 5) 的模型拟合度并未有大的提高，且主要解释变量的回归系数基本与回归( 4) 保持一致，表明行业 因素并非年金参与决策的主要影响因素，仅控制部分特定行业特征就可以较好的拟合年金参与决策的影响 因素模型。

表3中模型（1）、模型（2）、模型（3）回归结果对应平均学历、平均政治关联、平均专业技术背景对企业年金参与决策的影响。平均学历的系数在1%的水平上显著为正，即学历越高的高级管理者，越倾向于推动建立企业年金制度;平均政治关联的系数在1%的水平上显著为正，即政治关联度越高的高级管理者，越倾向于推动建立企业年金制度；平均专业能力背景的系数在1%的水平上显著为负，即专业能力背景越低的高级管理者，越倾向于推动建立企业年金制度。表4中模型（1）、模型（2）、模型（3）回归结果对应学历异质性、政治关联异质性、专业技术背景异质性对企业年金参与决策的影响。学历异质性的系数在5%的水平上显著为正，即学历差异越大的高管团队，越倾向于推动建立企业年金制度；政治关联异质性的系数在1%的水平上显著为正，即政治关联度差异越大的高管团队，越倾向于推动建立企业年金制度；专业能力背景异质性的系数在1%的水平上显著为负，即专业能力背景差异越大的高管团队，越倾向于推动建立企业年金制度。

表3 高管团队能力特征平均值与企业年金参与决策回归结果

| 变量 | （1） | （2） | （3） | （4） | （5） |
|---|---|---|---|---|---|
| mdegree | 0.630*** | | | 0.584*** | 0.569*** |
| | (8.06) | | | (7.38) | (7.01) |
| mporelate | | 1.847*** | | 1.821*** | 1.698*** |
| | | (10.04) | | (9.23) | (8.49) |
| mproback | | | -0.564*** | -0.801*** | -0.474*** |
| | | | (-3.80) | (-5.03) | (-2.85) |
| realtax | -0.00201 | -0.0000497 | -0.000350 | -0.00184 | -0.00202 |
| | (-0.45) | (-0.01) | (-0.09) | (-0.43) | (-0.46) |
| holcon | 0.0541*** | 0.0430*** | 0.0497*** | 0.0453*** | 0.0433*** |
| | (4.27) | (4.00) | (4.54) | (3.71) | (3.56) |
| fcf | -0.172 | -0.421* | -0.402** | -0.211 | -0.429 |
| | (-0.65) | (-1.92) | (-2.09) | (-1.04) | (-1.44) |
| DEratio | 1.094*** | 0.729*** | 0.648*** | 0.976*** | 1.008*** |
| | (4.83) | (3.19) | (3.10) | (4.26) | (4.22) |
| size | 0.467*** | 0.491*** | 0.536*** | 0.417*** | 0.388*** |
| | (11.13) | (12.16) | (13.86) | (9.84) | (8.79) |
| constant | -6.265*** | -4.597*** | -4.410*** | -5.619*** | -5.030*** |
| | (-17.19) | (-16.35) | (-15.39) | (-14.95) | (-9.62) |
| year | Y | Y | Y | Y | Y |
| industry | N | N | N | N | Y |
| N | 22240 | 24184 | 24184 | 22240 | 22240 |

注: *** 、** 、* 分别表示在1%、5%以及10%水平上显著; 括号中的为经过稳健调整的 z 值

表4 高管团队能力特征异质性与企业年金参与决策回归结果

| 变量 | （1） | （2） | （3） | （4） | （5） |
|---|---|---|---|---|---|
| hdegree | 0.335** | | | 0.316** | 0.251 |
| | (2.17) | | | (2.04) | (1.59) |
| hporelate | | 1.392*** | | 1.411*** | 1.338*** |
| | | (8.37) | | (8.46) | (7.98) |
| hproback | | | -0.458*** | -0.497*** | -0.219 |
| | | | (-2.83) | (-3.05) | (-1.33) |
| realtax | 0.0000363 | -0.000109 | -0.000364 | -0.0000157 | -0.000415 |
| | (0.01) | (-0.03) | (-0.10) | (-0.00) | (-0.11) |
| holcon | 0.0496*** | 0.0462*** | 0.0502*** | 0.0446*** | 0.0421*** |
| | (4.53) | (4.24) | (4.54) | (4.14) | (3.95) |
| fcf | -0.398** | -0.401** | -0.395** | -0.387* | -0.643* |
| | (-2.12) | (-2.01) | (-2.12) | (-1.90) | (-1.66) |
| DEratio | 0.701*** | 0.717*** | 0.708*** | 0.672*** | 0.645*** |
| | (3.25) | (3.20) | (3.25) | (3.06) | (2.78) |

| | | | | | |
|---|---|---|---|---|---|
| size | 0.537*** | 0.515*** | 0.542*** | 0.514*** | 0.477*** |
| | (13.72) | (12.90) | (13.75) | (12.99) | (11.62) |
| constant | -4.901*** | -4.783*** | -4.547*** | -4.798*** | -4.050*** |
| | (-17.00) | (-17.00) | (-16.09) | (-16.16) | (-8.74) |
| year | Y | Y | Y | Y | Y |
| industry | N | N | N | N | Y |
| N | 24184 | 24184 | 24184 | 24184 | 24184 |

注: *** 、** 、* 分别表示在1%、5%以及10%水平上显著; 括号中的为经过稳健调整的 z 值

### 4.3 稳健性检验

本文通过更换控制变量，分别用衡量企业的内控能力、经营能力、偿债能力，回归结果的显著性与原模型相似。

## 5．进一步的研究

通过对不同产权结构、治理水平、地区地域的个体的异质性分析，本文发现高管团队对企业年金参与决策的影响在西部地区、家族企业和治理薄弱的公司更显著，存在管理层寻租的现象。针对参加了企业年金的个体，本文用高管团队的平均能力对企业年金的规模进行回归分析，再次验证了主回归的显著性

## 6．研究结论与建议

实证研究发现，高管团队的平均认知能力和社会能力与企业年金的参与决策正相关，高管团队的平均专业能力及其异质性与参与决策负相关。进一步研究发现，高管团队对企业年金参与决策的影响在西部地区、家族企业和治理薄弱的公司更显著，存在管理层寻租的现象。本文的研究结论对于扩大企业年金参与率、抑制企业年金制度推行中可能带来的分配不公平有一定的参考意义。

基于本文的研究结果，建议上市公司可从以下方面来优化高管团队结构：选拔学历高的人员加入到企业高层管理团队中，并且在引入高管人员时考虑选聘人员的专业技术背景，合理配置高管团队成员的专业组成。另外，加强高管团队成员之间的沟通与交流，降低异质性带来的负面影响，并尽可能地发挥成员各自优势，做到优势互补，提高团队凝聚力。

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# 力出一孔还是政出多门？
# ——高管团队能力及异质性对企业年金参与决策的影响

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**关键词：**高管团队能力及异质性，企业年金，管理层寻租

**中文摘要.** 企业年金作为中国养老保险体系的“第二大支柱”，是应对老龄化、缓解社保基金支出压力的关键一招。本文基于2009-2019年中国A股非金融企业上市公司的非平衡面板数据，从高管团队能力入手，探讨企业年金参与决策的影响因素。实证结果表明，高管团队的平均认知能力和社会能力与企业年金的参与决策正相关，高管团队的平均专业能力及其异质性与参与决策负相关。进一步研究发现，高管团队对企业年金参与决策的影响在西部地区、家族企业和治理薄弱的公司更显著，存在管理层寻租的现象。本文的研究结论对于扩大企业年金参与率、抑制企业年金制度推行中可能带来的分配不公平有一定的参考意义。

# Population Ageing, Industrial Structure and Export Growth

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**Keywords:** Aging Population, Population Structure, Industrial Structure, Export Growth.

**Abstract.** This paper selects the data of 31 provinces in China from 2005 to 2017, mainly to study the impact of population aging and industrial structure changes on China's exports. Analyze the mechanism of action from both theoretical and empirical analysis. Through research, it is found that:(1) Increasing aging population, to dampen exports;(2) Human capital has a significant role in promoting exports;(3) The increase in the proportion of the added value of the secondary and tertiary industries will create an incentive for exports;(4) When returning to a subregion, the value added of the secondary and tertiary industries in the central region increased, while exports declined. We made the following recommendations on the basis of research and analysis on: First of all,In the grim situation of an aging population, should accelerate the transformation from "demographic dividend" to "talent dividend"; Secondly, Since the central region is dominated by the primary industry, it is particularly necessary to optimize and innovate the industrial structure over-adjustment mode in the face of the adjustment of the structure; Finally, Improve welfare policy and education environment, encourage fertility to increase the birth rate.

## 1. 引言

出口作为拉动经济的“三驾马车”之一，在我国经济中占据重要地位。1995年，我国的出口总额为12451.81亿元，国内生产总值为61339.9亿元，出口占比为20.3%，2018年出口占国内生产总值的比例为18.2%，虽略有下降，但依旧占较大的比例。“人口红利”优势为我国发展出口优势提供了良好的条件，劳动人口数量较多，吸引大量的资本，使得出口快速发展。陈松（2013）在研究指出，“人口红利”优势及较低的城镇化水平是我国成为出口导向型国家 的重要原因。近年来，全球较多国家已经步入人口老龄化阶段，且部分国家老龄化形势颇为严峻。由第七次全国人口普查所公布的数据可知，我国65岁以上人口占比为13.50%。图1为1995-2018年全国人口出生率、死亡率及自然增长率走势图，从图示可以清晰发现：我国常住人口自然增长率呈下降态势，常住人口死亡率为稳定的趋势，常住人口出生率的变化不明显，1995-2018年整体变动不大，通过折线图清晰看出我国人口结构的变化，人口增长率及老年人口死亡率的下降。老龄化进程的加剧，给社会经济生活带来了一系列变化。改革开放以来，我国凭借“人口红利”优势迎来经济快速发展的时期，社会保障支出较少，财政负担较轻，充足的劳动要素促使我国逐渐成为出口大国和经济强国。随着我国步入老龄化时代，人口结构发生变化，人口优势逐渐弱化，对我国经济各方面的影响较为深刻。龚锋（2019）从代际平衡的视角出发，论证人口老龄化与财政支出的关系，并建议在老龄化背景下政府一方面要提高公共福利支出，另一方面要注重财政支出的代际平衡。铁瑛（2019）研究人口老龄化对出口的影响，指出：人口结构的变化会对出口造成影响，劳动人口占比的降低、老年抚养比的上升会抑制出口的增长，并建议应加快向“人才红利”的转变。顾雪松（2016）主要研究产业结构与对外投资出口，并发现：贸易往来国家之间产业结构差异越大，对出口有显著的负向影响。基于上述分析，文章选取2005-2017年的省级数据，主要研究：人口老龄化、产业结构对出口的影响。

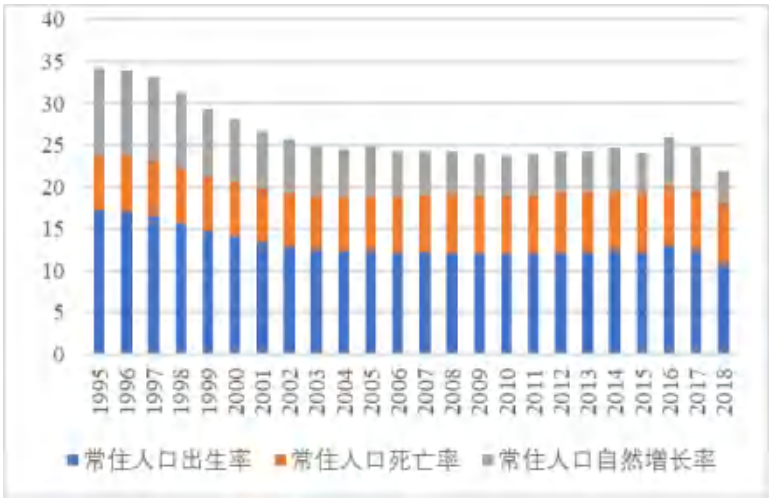


图1　我国1995-2018人口结构走势图（单位：%）

## 2．文献综述

### 2.1 人口老龄化与出口增长

国外最早展开人口老龄化对经常账户的影响，Coale（1958）指出抚养比对储蓄率的作用为负，储蓄李的降低从而导致经常账户的失衡。Tylor（1995）通过研究显示人口结构变化会影响储蓄水平，从而影响经常账户。Ferrero（2005）在研究中指出劳动人口占比的降低是影响出口的主要原因。持有相同观点的有Domeij（2006）；Brooks（2003）、Bryant（2004）。国内学者针对人口结构与出口增长等方面也做了大量研究。赵雅婧（2013）以日本为例选取误差修正模型研究老年人口比重上升对制造业出口的影响，通过研究指出：日本由于人口老龄化的加剧，使得原有的出口优势呈现逐渐下降的趋势。朱超等（2012）以亚洲国家为样本，研究人口结构改变能否影响经常账户的变动？经过实证分析得出：人口结构的变化会带来经常账户的变动；且老年人口占比的变化对经常账户的影响比少年人口占比更为明显。最后，建议应采取措施缓解人口老龄化趋势。汪伟（2012）以中国省级面板数据为样本进行研究，通过理论分析可知：人口老龄化会降低经常账户的余额，进而从实证角度分析并验证理论。持有类似观点的有朱超（2018）；铁瑛（2017）；王有鑫（2015）；田巍（2013）等。铁瑛等（2019）在原有储蓄率影响机制的基础上，创新性提出“成本机制”、“人力资本机制”，从不同角度阐释人口老龄化对出口的影响。选取劳动人口占比和抚养比表示人口结构，通过研究显示：人口结构的变化对出口有显著影响，劳动人口占比上升能够显著增加出口比例，抚养比的上升则会显著降低出口比例。而人力资本水平的提升在一定程度上能够缓解人口结构变化所带来的影响。建议实现“人口红利”向“人才红利”的转变。

### 2.2 产业结构与出口增长

我国初期为劳动密集型产业模式，在跨国公司的影响下及政府的支持下，逐渐实现由劳动密集型模式向资金密集型模式、技术密集型转变。产业模式的转变对贸易是否有影响？针对这一论点，已有较多文献进行研究与阐述。国内外学者对产业结构及产业升级对贸易活动的影响，分别进行了大量的研究。国外学者最早展开产业结构与外贸关系的相关研究。Krugman（1980）在研究中指出在非完全竞争的市场中，产业对出口有显著影响。Bekkersa（2013）通过建立寡占模型，主要研究产业结构与贸易的关系。Benedictis（2007）以欧盟相关国家为样本，通过研究得出产业结构对经常账户的影响显著。Baxter（2003）则从周期角度研究产业结构与外贸结构的相关性，构建模型，得知产业周期与外贸周期的有一定的关系。产业形成的根本在于生产要素的集聚。国内学者李磊（2000）用产业结构衡量生产要素禀赋的变动，实证分析产业结构与外贸间的关系，旨在研究生产要素对进出口的影响，并指出产业结构、资金及技术等因素对出口有影响。王艳（2004）假设在古诺均衡的市场状态下，利用博弈论的分析方法研究产业结构与贸易政策的关系，并为关税政策的制定提供相关建议。文东伟（2009）主要分析我国产业结构、贸易结构对出口竞争力的影响，在研究中指出：产业结构与出口呈现高度的一致性，直接投资有利于产业结构升级，且技术及劳动要素均有利于提高出口规模。王冬（2009）在金融危机的背景下研究刺激出口的途径，并指出产业结构升级可以使出口突破困境。翟士军（2016）与以往研究的不同之处在于

建立泰尔指数衡量产业结构的合理性，使用城市层面的数据进行回归分析，得出泰尔指数对出口的影响为负，产业结构合理化有利于出口导向型城市的发展。

上述文献为产业结构与对外贸易、出口的相关研究综述，通过对已有文献的梳理发现：产业结构对出口有显著的负面影响。

### 2.3 文献述评

已有文献中关于出口、经常账户的相关研究较多，但尚未有研究综合考虑产业结构与人口结构两种因素对出口的影响，本文在已有文献的基础上作出改进，引入变量人口老龄化、产业结构进行细致分析。

## 3．理论机制

### 3.1 人口结构变动与经常账户盈余

在基本的收入—支出模型中引入净出口NX构造开放经济下的收入—支出模型（不考虑政府支出水平）。将人口分为劳动人口$N_L$与非劳动人口$N_x$，总人口$N=N_L+N_x$，设定劳动人口所占比例为$n_L=N_L/N$，非劳动人口所占比例为$n_x=Nx/N$，则可以推出：$n_L+n_x=1$和$Nx/N=n_x=1-n_L$。

在将人口区分为劳动人口与非劳动人口的基础上，产出Y也可以区分为劳动人口储蓄和消费带来的产出$Y_L$与非劳动人口消费所带来的产出$Y_x$，用β表示非劳动人口人均收入与人均总产出的比值，则有$\beta=\frac{Y_x}{Y(1-n_L)}$，非劳动人口消费带来的产出$Y_x=\beta(1-n_L)Y$，经济增长的统计口径往往不包含非劳动人口通过消费带来的产出增长。

$$Y_L=[1-\beta(1-n_L)]Y \tag{1}$$

加入净出口NX时，产出的基本表达式为：Y=C+I+NX，假定经济主体的全部收入仅用于储蓄和消费，则有C=（1-s）Y（s为储蓄率）。在模型中引入人力资本折旧$\delta k$、增加劳动力所需的资本成本$nk$及技术改进所需成本$gk$，$\Delta K$为经济中资本存量的变动。通过上述分析构建索罗模型如下：

$$\Delta K=(sf(x)-nx)-(n+g+\delta)k \tag{2}$$

将公式1代入公式2得到关于净出口nx的表达式（3），如下所示：

$$NX=s[1-\beta(1-n_L)]Y-(n+g+\delta)k-\Delta K \tag{3}$$

在保持折旧、储蓄率、技术、雇佣劳动及资本存量等因素不变的情况下，净出口NX与变量劳动人口占比$n_L$成正相关关系，劳动人口越多，净出口越高，反之则结论相反。通过构建经济增长模型，从影响机制角度分析人口结构与净出口的关系。

### 3.2 人口老龄化与比较优势理论

比较优势理论的代表性观点有：李嘉图理论、要素禀赋理论及罗伯津斯基定理。大卫·李嘉图从供给角度分析并指出相对比较优势是决定国际贸易发展的重要因素，在出口时国家应集中生产具有相对优势的产品而非绝对优势的产品，当一国的所有产品均处于劣势地位时，选择生产相对劣势较小的产品有利于出口增长。李嘉图理论主要从供给角度进行研究，分析角度具有一定的局限性。在李嘉图理论的基础上，赫克歇尔－俄林从需求分析视角进行研究提出要素禀赋论，认为在国际贸易发展中的主要影响因素为不同国家之间要素禀赋的差异，不同国家应较好的利用其禀赋充足的要素生产需求量较大的商品。在两部门的假设下，罗伯津斯基利用一般均衡原理进行分析并提出某种要素供给的增多会导致其中一个部门产出的增多与另一部门产出的下降，最终达到均衡状态。

文章依据比较优势理论，理论分析人口老龄化对出口的影响的。假设模型中只存在A、B两个国家，且仅存在劳动L和资本K两种要素，在其他条件不变的情况下，若A、B两个国家的人均资本相同：KA/LA= KB/LB且A老龄化水平低于B的老龄化水平，则有KA/ELA＞KB/ELB，即A国劳动人口较多，B国资本数量充裕，因此A国为劳动密集型国家，占据人口优势，B为资本密集型国家，在资本密集型产品出口方面享有优势地位。

## 4．指标选取与数据来源

在对文献研究及机制分析的基础上，在该部分选取变量及进行数据说明。

### 4.1 变量说明

被解释变量。已有文献在研究时对出口的衡量主要分为两类，第一种方法为汇总的进出口数据，白恩重（2018）在分析我国交通设施对出口的影响时，选取出口值/国内生产总值为被解释变量。第二种方法为构建多维出口数据。代表性文献较多，铁瑛（2019）分析并建立高维度数据，用“企业－产品－目的国－贸易方式”代表出口数据。顾雪松（2016）在研究中采取相同的处理方法。海关公布数据往往仅具体到省级，若样本为市级则需采用方法二。本文以省级数据为样本，故选取方法一衡量出口增长，数据来自于海关数据库。

解释变量。文章有两个核心解释变量，分别为人口老龄化与产业结构。人口老龄化指标选取方法较多，主要分为三种：老年人口抚养比、劳动人口占比与65岁以上人口占比。杨恺钧（2018）用老年人口抚养比表示老龄化程度；铁瑛（2019）用抚养比、劳动人口占代表人口结构的变化；张鹏（2019）在研究时以65岁以上人口占比表示人口老龄化。文章在上述研究的基础上，综合选取三种表示方式衡量人口老龄化程度。改革开放以来，我国逐渐实现由第一产业向第二、三产业转变。文章借鉴杨恺钧（2018）在研究中关于产业结构的表达方式，即为（第二、产业增加值+第三产业产业增加值）/GDP。

控制变量。控制变量的选取主要借鉴张鹏（2019）与铁瑛（2019）中所选取的指标。文章对经济发展水平、人力资本水平、城镇化率、固定资产投入及地方财政支出水平五个方面进行分析，选取指标作为控制变量。当地的经济水平直接决定其对外贸易的强度，经济水平越高其出口比例越多，文章选取当地国内生产

总值的对数表示经济水平。人力资本借鉴已有的做法，用受高等教育人数（专科及以上学历）占比表示。在一定程度上城镇化水平影响出口水平，城镇化率越高，人口集中，有利于发挥人口优势，从而对出口产生影响。城镇化可以由人口城镇化与城市面积所占比重表示，本文在研究时选取城市人口占比衡量城镇化水平。Y=F（K，L），Y表示经济的产出函数，K为资本投入，每个省份的固定资产投资额及地方财政补贴值会对当地的经济产生有利影响，从而促进对外贸易的发展。技术改变经济生活，创新能力、创新水平对生产过程、经济增长均有较明显的作用，人工智能、大数据的运用改革且加速经济发展的进程，创新水平的度量本文则选取专利的申请及授权等数据进行度量。

表1　变量的定义与说明

| 变量类型 | 变量名称 | 变量解释 | 符号表示 |
|---|---|---|---|
| 被解释变量 | 出口增长 | Log（当年的出口额） | Export |
| 解释变量 | 老龄化 | 65岁以上人口数/总人口 | Age |
| | 劳动人口占比 | 劳动人口数/总人口 | Lp |
| | 老年人口抚养比 | 65岁以上人口数/劳动年龄人口数 | Epder |
| | 产业结构 | （第二、三产业增加值和）/国内生产总值 | Ins |
| 控制变量 | 经济发展水平 | Log（国内生产总值） | Economics |
| | 人力资本 | 大学（专科）及以上毕业人数/劳动人口 | Hcapital |
| | 城镇化水平 | 城市人口数/总人口 | Urban |
| | 固定资产投入 | 固定资产/国内生产总值 | Fassets |
| | 财政支出 | 一般公共预算支出/国内生产总值 | Fiscal |
| | 创新能力 | 专利数之和 | Innovation |
| | 地区 | 东部、中部、西部 | Area |

## 4.2 数据来源

选取我国2005-2017年31个省份面板数据为样本，运用Stata进行回归分析。数据来自于《中国统计年鉴》、国家统计局官网、海关数据库等。在数据处理时，根据实际情况对变量取对数，缺失数据采用插值法获取。

## 4.3 模型构建

$$Export_{it} = \beta_0 + \beta_1 Age_{it} + \beta_2 Ins_{it} + \beta_3 Economics_{it} + \beta_4 Hcapital_{it} + \beta_5 Urban_{it} + \beta_6 Fassets_{it} + \beta_7 Fiscal_{it} + \beta_8 Innovation_{it} + \mu_i + \varepsilon_{it} \quad (4)$$

其中，$\beta_0$为截距，$\beta_i$为回归系数，$\mu_i$为个体效应，$\varepsilon_{it}$为随机扰动项，$i$为个体，t为年份。

为验证回归的准确性，用劳动人口占比、老年人口抚养比代替老龄化水平进行稳健性检验，分别构建模型如下：

$$Export_{it} = \gamma_0 + \gamma_1 Lp_{it} + \gamma_2 Ins_{it} + \gamma_3 Economics_{it} + \gamma_4 Hcapital_{it} + \gamma_5 Urban_{it} + \gamma_6 Fassets_{it} + \gamma_7 Fiscal_{it} + \gamma_8 Innovation_{it} + \mu_i + \varepsilon_{it} \quad (5)$$

$$Export_{it} = \theta_0 + \theta_1 Epder_{it} + \theta_2 Ins_{it} + \theta_3 Economics_{it} + \theta_4 Hcapital_{it} + \theta_5 Urban_{it} + \theta_6 Fassets_{it} + \theta_7 Fiscal_{it} + \theta_8 Innovation_{it} + \mu_i + \varepsilon_{it} \quad (6)$$

由于指标间可能存在内生性问题，对解释变量出口增长（Export）做滞后一期处理得到L(Export)，模型表达式如下：

$$L(Export_{it}) = \varphi_0 + \varphi_1 Epder_{it} + \varphi_2 Ins_{it} + \varphi_3 Economics_{it} + \varphi_4 Hcapital_{it} + \varphi_5 Urban_{it} + \varphi_6 Fassets_{it} + \varphi_7 Fiscal_{it} + \varphi_8 Innovation_{it} + \mu_i + \varepsilon_{it} \quad (7)$$

## 5．基准回归

### 5.1 描述性统计

表2　变量描述性统计表

| 变量 | 均值 | 标准差 | 最小值 | 最大值 | 25%分位数 | 50%分位数 | 75%分位数 |
|---|---|---|---|---|---|---|---|
| Export | 25.324 | 1.707 | 21.031 | 29.070 | 24.136 | 25.295 | 26.441 |
| Age | 0.094 | 0.019 | 0.048 | 0.144 | 0.080 | 0.092 | 0.108 |
| Lp | 0.734 | 0.036 | 0.635 | 0.838 | 0.708 | 0.730 | 0.761 |
| Epder | 12.843 | 2.686 | 6.710 | 20.6 | 10.78 | 12.7 | 14.51 |
| Ins | 0.885 | 0.061 | 0.659 | 0.996 | 0.845 | 0.885 | 0.921 |
| Economics | 27.661 | 1.098 | 23.947 | 29.825 | 27.074 | 27.867 | 28.415 |
| Hcapital | 0.006 | 0.002 | 0.0012 | 0.012 | 0.004 | 0.006 | 0.007 |
| Urban | 0.520 | 0.147 | 0.207 | 0.896 | 0.430 | 0.503 | 0.587 |
| Fassets | 0.697 | 0.243 | 0.237 | 1.507 | 0.505 | 0.682 | 0.857 |
| Fiscal | 2.637 | 1.342 | 0.4 | 7.4 | 1.8 | 2.4 | 3.3 |
| Innovation | 9.741 | 1.760 | 4.477 | 13.408 | 8.650 | 9.870 | 11.061 |

表2为变量数字特征的汇总表，被解释变量出口（Export）的均值为25.324，50%分位数值为25.295，均值大于50%分位数，表明我国出口的整体水平较高。老龄化（Age）、劳动人口占比（Lp）、老年人口抚养比（Epder）三个指标分别代表人口老龄化程度，老龄化（Age）的最小值为0.048，最大值为0.144，均值为0.094，且大于50%分位数的值，表明各省份老龄化水平整体偏高。劳动人口占比（Lp）与老年人口抚养比（Epder）二者的均值均大于50%分位数，可以看出我国各省份均一致进入老龄化时代。产业结构（Ins）的均值为0.885且均值处于50%分位数的位置，说明第二、三产业在我国各省份的情况趋于一致，在经济发展中占据重要地位。经济发展（Economics）的均值为27.661，大于最小值23.947，且25%分位数的值为27.074，由均值和分位数值可以看出，改革开放以来，我国

经济水平有了突飞猛进的增长，整体经济水平较高。人力资本（Hcapital）的均值为0.006，本科及以上毕业人数在劳动人口中占比较低，“人才红利”的发展尚有较大空间。随着经济的发展，城乡二元经济结构有所改善，城镇化水平（Urban）最高值达到0.896，处于较高的城镇化水平，均值为0.520，可以看出各个省份城镇化整体水平较高。控制变量固定资产投入（Fassets）、财政支出（Fiscal）及创新能力（Innovation）均处于中等水平。地区变量主要依我国行政区域划分时对东部、中部及西部的划分方法。31个省份中，14个省份为东部地区，11个省份为西部地区，剩余的为中部地区。该部分主要通过描述性统计对变量数字特征进行分析。

## 5.2 回归分析

表3 全样本回归结果表

| 变量 | 固定效应回归 | 随机效应回归 |
|---|---|---|
| Age | -6.423**（-2.24） | -4.87**（-2.47） |
| Ins | 1.907**（2.04） | 1.812***（2.71） |
| Economics | 0.328*（1.85） | 0.415***（3.77） |
| Hcapital | 105**（2.30） | 67.459**（2.46） |
| Urban | 4.282*（2.22） | 3.251***（4.45） |
| Fassets | -0.201（-0.63） | -0.47***（-3.54） |
| Fiscal | 0.252*（2.11） | 0.416***（7.10） |
| Innovation | -0.101（-1.21） | -0.021（-0.32） |
| 截距 | 12.796***（2.90） | 10.058***（3.92） |
| YEAR | 控制 | 控制 |
| 样本量 | 403 | 403 |
| $R^2$ | 0.7283 | 0.8533 |

（注：“***”、“**”、“*”分别表示在1%、5%、10%的显著性水平下显著，括号内数值为估计的t或z值。）

由表3全样本回归分析可以看出，在固定效应回归模型下，核心变量老龄化（Age）的回归系数为-6.423，且在5%的显著性水平下显著，表明人口老龄化对我国出口有显著的负面影响。在其他外部条件不变的情况下，人口结构转型、人口老龄化会降低一国经济发展的速度。人口结构转型使得固有的劳动密集型产业不再具有优势，劳动人口的相对比较优势逐渐消失，企业应加速调整实现劳动密集型产业逐步向技术密集型及资本密集型产业转变。变量人力资本（Hcapital）对出口有显著的正向影响，这一结果表明：在人口老龄化浪潮中，实现由“人口红利”向“人才红利”转变的必要性。在固定效应与随机效应模型中，产业结构（Ins）的回归系数均为正值，说明第二、三产业的增加值对出口有显著的促进作用，人口结构的变动会带来产业结构的一系列变化，老年人口的增多，与之而来，所需服务业类型多样化与需求量的增长，伴随着人口结构的变动，产业结构迎来转轨时期，亟待调整结构适应需求的变动。固定效应回归与随机效应回归在结果上具有一致性，通过豪斯曼检验选取最优估计结果，检验表明使用固定效应回归模型更优。不同区域经济发展水平不同、存在区位优势且交通网络等方面均有差异，这种差异会对出口有一定的影响，因此将样本分为东部、中部及西部分别进行回归分析，结果如下表4所示。由地区维度的回归结果可知，人口老龄化在地区间存在差异现象，东部及中部地区与全样本回归结果保持一致性，即人口

老龄化的深化会抑制出口规模，但在西部地区的表现则不同，人口老龄化对出口的影响并不显著，究其潜在的原因，可能在于西部地区由于交通限制及经济联动性较小，导致西部地区经济发展处于弱势地位，西部地区所能提供的劳动岗位、工作机会较少，人口流动性较大，因此西部地区人口老龄化对出口的影响不显著。陈松（2013）在分东部、中部及西部地区回归时，总人口抚养比、少儿抚养比对出口的影响不显著，并指出由于西部地区劳动要素流动性较大，因此人口老龄化对当地出口的影响作用很小。核心变量产业结构（ins）在东部、中部及西部的回归结果亦存在不一致现象，具体表现为，中部地区的出口规模随着第二、三产业增加值占比的上升而下降。中部地区的自然条件及历史固化原因，几千年来使其形成以耕种、劳作的主要生产模式。搜集6个中部地区1995~2018年农、林、牧、渔业总产值与全国农、林、牧、渔业总产值，通过比值可以看出中部地区农、林、牧、渔业总产值在全国占比高达26%，超过1/4的比例。对于中部地区以第一产业为主的模式，第二、三产业占比的增多，对其原有的生产模式带来巨大的冲击效应，需要过渡期用以调整产业结构，因此中部地区会表现为出口会随着第二、三产业占比的上升而下降。东部与西部地区则与产业结构在全样本回归中的结果一致。在上述实证的基础上，继续补充实证检验—稳健性检验。

表4 分样本回归结果表

| 变量 | 东部 | 中部 | 西部 |
|---|---|---|---|
| Age | -1.111（-0.38） | -10.393***（-3.14） | 7.137（0.91） |
| ins | 2.577（1.42） | -0.307（-0.24） | 2.194*（1.74） |
| economics | 0.512*（3.08） | -0.962*（-1.84） | 0.892***（2.86） |
| fassets | -0.455（-1.52） | 0.597**（2.32） | -0.203（-0.56） |
| fiscal | 0.068（1.65） | 0.642**（2.64） | 0.326（1.62） |
| urban | 2.262***（3.38） | -1.823*（-1.79） | -4.475（-1.31） |
| innovation | 0.518***（11.93） | 0.515***（4.07） | -0.149（-0.95） |
| hcapital | -108.356***（-4.85） | 217.582***（4.26） | 276.214***（3.28） |
| 截距 | 3.678（1.06） | 45.389***（4.26） | -0.922（-0.12） |
| YEAR | 控制 | 控制 | 控制 |
| 样本量 | 182 | 78 | 143 |
| $R^2$ | 0.7806 | 0.8592 | 0.6878 |

（注：“***”、“**”、“*”分别表示在1%、5%、10%的显著性水平下显著，括号内数值为估计的t值。）

## 5.3 稳健性检验

首先，进行指标替换完成表5的稳健性检验，其次，为避免研究中可能存在的内生性问题，对被解释变量做滞后一阶处理进行稳健性检验，回归结果如表6所示。选取劳动人口占比（lp）与老年人口抚养比（epder）做指标替换，由表6可以看出，劳动人口占比（lp）越高，越有利于出口的增长。老年抚养比（epder）的增长则对出口形成抑制作用。指标替换的结果与老龄化（Age）的结果相吻合。由表5可知，产业结构（Ins）的回归结果显著，且符号为正，该结果一方面表明所选被解释变量之间不存在影响回归可靠性的关系；另一方面也从侧面印证上述理论分析、实证研究的准确性。

表5 稳健性检验—指标替换

| 变量 | （1） | （2） |
|---|---|---|
| lp | 4.099***（3.38） | |
| epder | | -0.044***（-3.28） |
| Ins | 2.163***（3.26） | 1.935***（2.91） |
| Economics | 0.308***（2.59） | 0.321***（2.71） |
| Hcapital | 77.345***（2.72） | 100.781***（3.53） |
| Urban | 4.322***（3.84） | 4.441***（3.90） |
| Fassets | -0.2（-1.26） | -0.205（-1.29） |
| Fiscal | 0.244***（3.43） | 0.248***（3.49） |
| Innovation | -0.116*（-1.72） | -0.105（-1.56） |
| 截距 | 9.812***（3.61） | 12.908***（4.70） |
| YEAR | 控制 | 控制 |
| 样本量 | 403 | 403 |
| $R^2$ | 0.6831 | 0.7101 |

（注：“***”、“**”、“*”分别表示在1%、5%、10%的显著性水平下显著，括号内数值为估计的t值。）

为保证实证结果的准确性，避免可能存在的内生性问题，进行如表6所示的稳健性检验。三次回归中，被解释变量均为滞后一期的出口增长（LExport），解释变量人口老龄化不同，分别用老龄化（Age）、劳动人口占比（lp）与老年人口抚养比（epder）表示。由回归结果可以看出，人口老龄化的替代指标在回归中不显著，但符号与理论分析保持一致，导致这一现象的原因可能是：当期的解释变量不能够较好的解释滞后一期的被解释变量。变量产业结构（ins）依旧显著，且与上述回归的符号一致。通过分析滞后一期被解释变量回归的结果可知，其与前文的理论研究与上述实证分析结果的高度一致性。经过补充实证检验—稳健性检验佐证了研究结果的真实性、可靠性。

表6 稳健性检验—被解释变量滞后一期

| 变量 | LExport | | |
|---|---|---|---|
| Age | -2.374（-1.16） | | |
| lp | | 1.512（1.23） | |
| epder | | | -0.016（-1.16） |
| ins | 1.426**（2.10） | 1.521**（2.26） | 1.438**（2.13） |
| 截距 | 12.454***（4.46） | 11.352***（4.10） | 12.478***（4.47） |
| YEAR | 控制 | 控制 | 控制 |
| 样本量 | 403 | 403 | 403 |
| $R^2$ | 0.7583 | 0.7386 | 0.7523 |

（注：“***”、“**”、“*”分别表示在1%、5%、10%的显著性水平下显著，括号内数值为估计的t值。）

## 6．结论与建议

文章在理论机制分析的基础上，对2005-2017年省级面板数据进行实证分析，回归结果表明：首先，老龄人口占比的上升、劳动人口比例的下降及老年人口抚养比的增高会抑制出口的增长；其次，第二、三产业增加值占比的上升能够促进

出口，但在中部地区则相反；最后，人力资本对出口有显著的正向影响，人力资本的提升能够在一定程度上缓解人口老龄化所带来的负面影响。

文章在上述研究的基础上，给出相关建议如下：

### 6.1 加快实现由“人口红利”向“人才红利”的转变

随着全球人口结构进入老龄化阶段，人口的相对优势逐渐弱化，如何在劳动力优势消融的情况下维持生产力稳中增长？该种背景下，“人才红利”发挥着至关重要的作用。通过提升薪资待遇水平、加强对职工的技能培训及实施人才引进策略等途径，实现人力资本的积累及劳动技能的提升。提高劳动报酬，在一定程度上能够提高劳动者的生产热情，从而提高生产效率。企业对员工培训有利于其熟练掌握劳动技能，从而有助于降低对劳动的需求。在老龄化趋势下，多数城市进入“抢人大战”阶段，放开落户政策、发放补贴基金等策略吸引流动人口落户。在人口老龄化趋势下，“人才红利”的实现，有利于保持城市经济生活的稳中前进，从而扩大出口的规模。

### 6.2 优化与创新产业结构调整过度模式

产业结构高级化的演变对以第一产业生产为主的地区造成较大的冲击，如何实现过度？过度的模式选择显得尤为重要。在原有的产业结构基础下，利用原有优势产业，优化产业调整模式，以实现不同产业模式的衔接，缓冲产业结构的变动对中部地区出口的负面作用。

### 6.3 鼓励生育以提高人口出生率

人口老龄化的根源在于人口出生率的下降。政府应着手改善教育质量、改变福利政策等，鼓励生育，从而从根本上解决人口老龄化问题。

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# 人口老龄化、产业结构与出口增长

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**关键词:**人口老龄化；人口结构；产业结构；出口增长

**中文摘要.** 文章选取我国31个省份2005-2017年的数据主要研究人口老龄化、产业结构变动对我国出口的影响。从理论研究与实证分析两个方面分析作用机制。通过研究发现：（1）人口老龄化的加剧，对出口产生抑制作用；（2）人力资本对出口有显著的促进作用；（3）第二、三产业增加值占比的增加，则对出口形成激励作用；（4）在分地区回归时，中部地区第二、三产业增加值占比的增加，出口反而下降。在研究分析的基础上提出以下建议：首先，在严峻人口老龄化形势下，应加快实现由“人口红利”向“人才红利”的转变；其次，由于中部地区以第一产业为主，因此在面临调结构的大环境中，优化与创新产业结构调整过度模式显得尤为必要；最后，改善福利政策与教育环境，鼓励生育以提高人口出生率。

# Postponing Retirement, Fertility Rate and Optimal Social Security Tax Rate

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**Keywords:** Delayed Retirement Age; Fertility Rate; Pension Contribution Rate; OLG Model

**Abstract.** Under the framework of Unified Growth Theory, this paper measures the optimal contribution rate of China's pay-as-you-go pension through the general equilibrium of overlapping generation model, and studies the impact of postponing retirement on fertility choices and the optimal contribution rate. The results show that under different retirement age, the optimal contribution rate is range of 7.91%-14.09%, which is lower than the current standard. Therefore, appropriately reducing the contribution rate is conducive to maximizing social welfare. The numerical results also show that when the retirement age is postponed, the optimal contribution rate increases, the private savings rate decreases; the household's investment in the child's human capital decreases, and the fertility rate increases. Overall, postponed retirement leads to the substitution of social saving for private saving, and fertility quantity for fertility quality.

## 1. 引言

养老金缴费率是养老保险制度的重要参数之一，缴费率设定是否合理关系到养老保险制度的运行效率和整个社会的福利水平。从国际范围看，世界各国社会基本养老保险的费率范围在 6.3%-34.5%之间（苏中兴，2016），与多数国家相比，我国的养老金缴费率（缴费工资的 28%）偏高。白重恩（2010）指出，按照世界银行 2009 年测算的实际承受税率，中国的社会保险缴费在 181 个国家中排名第一，约为“金砖四国[①]”其他三国平均水平的 2 倍，是 G7 国家的 2.8 倍，是东亚

[①] 美国高盛公司经济师吉姆·奥尼尔在 2001 年首次提出“金砖四国”的概念，四个国家是中国、巴西、俄罗斯和印度，2010 年，南非加入。

邻国和邻近地区的 4.6 倍。较高的养老保险缴费率给企业和个人带来了沉重的负担。在中美贸易战持续升级的背景下，如何降低企业的负担已成为各方关注的热点问题。事实上，自 2015 年以来，我国先后 4 次降低社保费率，总体社保费率从 41％降到 37.25％，总体的幅度接近 10%，其中，养老保险缴费率从 20%降低到 19%。那么，现行的费率水平是否存在进一步下降的空间？是否达到了社会福利最大化？养老金最优缴费率是多少？这些都是值得深入研究的问题。

另外，近些年，随着人口预期寿命的延长和生育率的下降，我国面临的人口老龄化问题日渐凸显。数据显示，我国 65 岁及以上人口占总人口比例从 2000 年的 7. 0%[②]上升到 2017 年的 11.4%，正在朝“深度老龄化”的社会发展（耿志祥，2016）。人口老龄化给现收现付制养老保险体系带来严峻挑战，导致养老基金的盈余规模减少或缺口增加。为了应对人口老龄化带来的上述不利影响，减缓人口红利消失的速度，十八届五中全会，我国正式提出“出台渐进式延迟退休年龄政策” 和“全面实施一对夫妇可生育两个孩子政策”。延迟退休和“全面二孩”政策的主要目的之一便是改善养老金体系的制度赡养率，显然，制度赡养率的降低意味着可以在保持养老金待遇不变的条件下适当降低缴费率，或者是在缴费率不变的条件下提高退休者的待遇，不管是降低在职者的缴费率还是提高退休者的待遇均会影响个人的效用以及整个社会的福利水平。那么，延迟退休和“全面二孩”的政策如何影响养老保险的最优缴费率？三者之间又存在什么样的互动关系？本文的研究将会给出答案。

目前，关于养老保险最优缴费率的文献还比较少，现有研究多是在一般均衡世代交叠模型的框架下，使用效用最大化方法得到最优费率水平。例如，Samuelson(1975)最早在戴蒙德模型的基础上，通过物质资本回报率等于经济处于黄金律水平时的人口增长率，从而求出最优的社会保障税。Arjona(2000)使用动态一般均衡世代交叠模型分析了西班牙养老保险的最优缴费率问题，研究发现，当贴现率小于 1 时，不存在最优社会保障制度，如果贴现率大于 1，在初始均衡和最终均衡条件下，效用最大化的替代率分别为 40%和 10%，对应的养老金缴费率为 10.42%和 7.13%之间，最优缴费率和替代率均小于西班牙养老保险的现行标准。Zhang & Zhang (2007)构建了一个包含储蓄、遗产赠与以及内生生育率的王朝模型（dynastic model），并使用该模型分析了社会保障对福利的影响，数值计算得到的最优养老金费率介于 10%-20%之间。Yew & Zhang (2009)在上述王朝模型的基础上，分析了人力资本外部性对最优社会保障税率的影响。研究结果表明，人力资本外部性降低了人力资本投资的回报，从而导致人力资本投资不足和人口的过度增长，如果社会对儿童的数量偏好远低于对其福利偏好，社会保障可以通过降低生育率和增加每个儿童的人力资本投资来提高福利。在不同的参数设定下，文章计算得到的最优养老金费率介于16%-22%之间。Yew & Zhang (2011)进一步分析了公共卫生支出与最优社会保障税率的关系。他们发现，通过降低生育率和提高资本密集度来扩大社会保障或公共卫生支出可以改善福利，而社会保障和公共卫生制度的结合能使社会福利最大化，文章测算得到的最优社会保障税率为 21%，最优人均公共卫生税率为 6％。

国内方面，封进和宋铮（2006）在研究人口年龄结构对养老保险制度福利效应影响时测算了养老金最优缴费率，他们得到的高生育和低生育方案下最优缴费率分别为 22%和 25%，但是，文章并没有对相关参数进行敏感性分析。孙雅娜

[②] 根据联合国的划分标准，当一个国家或地区 65 岁及以上老年人口数量占总人口比例超过 7% 时，意味着这个国家或地区进入人口老龄化。

等（2009a）通过社会福利最大化求解养老金最优费率，数值计算结果显示，最优社会统筹缴费率因缴费年限的不同处于 16.86%-23.85%之间，平均最优缴费率为 20.36%，较接近于现行标准，他们认为，现行统筹账户缴费率是符合福利最大化的最优费率。此外，他们还发现，缴费期以及有效劳动增长率与最优统筹账户缴费率均呈正相关关系。孙雅娜等（2009b）随后又测算了不同行业的最优缴费率，计算得到的行业最优缴费率介于 8.78%-39.58%之间，其中，住宿和餐饮业的最优缴费率最低，而金融业的最优缴费率最高，各行业的平均缴费率为 20.48 %。杨再贵（2010）借鉴 Samuelson(1975)的方法通过数值模拟测算得到的最优缴费率区间为 12.16%-17.05%。彭浩然和陈斌开（2012）在世代交叠模型中研究了养老保险缴费率和养老金待遇水平之间的关系，结果发现，降低缴费率能够促进物质资本和人力资本积累，缴费率与养老金待遇水平之间呈现倒 U 型关系，养老金最优缴费率的阈值在 15.6%左右。康传坤和楚天舒（2014）建立一般均衡世代交叠模型，测算全国统一的养老保险最优社会统筹缴费率。文章计算的最优统筹账户缴费率变动区间为 10.22%-19.04%。另外，他们还发现，人口预期寿命延长将提高最优统筹缴费率。景鹏和胡秋明（2016）测算得到的 60 岁退休的最优缴费率区间为 19.18%-19.63%，若退休年龄提高到 65 岁，最优费率区间为 10.77%- 11.64%，他们发现，延迟退休导致最优缴费率降低。

**纵观现有国内文献，**一个共同特点是在模型构建时均将生育率作为外生变量进行处理。在严格实行计划生育政策的背景下，家庭的生育选择自由度较低，上述假设是合理的，然而，随着“全面二孩”政策的实施，生育率外生假设已经难以符合我国家庭的生育选择自由度不断提高的现实趋势（郭凯明和颜色，2016）。根据严成樑（2016）的研究，延迟退休会影响生育率，而生育率的变化导致人口结构发生改变[③]，人口结构的改变又会对养老金的收支产生影响。由此可见，延迟退休可以通过改变生育率影响养老金的收支状况。因此，将生育率内生化能够更好地分析延迟退休与养老金最优缴费率的互动关系。另外，由于家庭生育选择存在数量和质量的替代关系(Rosenzweig and Zhang, 2009; Liu,2014)，因此，生育率的变化必然会引起家庭对子女质量（人力资本）投入的改变。显然，在收入一定的条件下，当家庭的生育数量增加时，父母对每个子女的人力资本投入会下降。人力资本的变化也会对养老金的收支产生影响，缴费者的平均人力资本提高引起单位时间的工资水平的上升，在其他条件不变且养老金满足收支平衡的情况下，单位工资的上升意味着可以适当降低养老金缴费率。**综上所述，由于延迟退休可以通过改变家庭的生育选择（包括数量和质量的选择）影响养老金的收支状况，因此，将生育选择内生化可以更好地分析延迟退休条件下的养老金最优缴费率问题。**

**需要强调的是，**国外的部分文献虽然考虑到了生育率内生化问题，但是依然存在一定的缺陷。例如，Zhang & Zhang (2007) 虽然将生育率内生化，但并未考虑到父母对子女的人力资本投入问题。Yew & Zhang (2008)虽然研究了父母对子女的人力资本投入，但是，他们没有考虑到家庭生育数量和质量的相互关系，而且，也没有深入分析延迟退休对家庭生育选择和最优缴费率的影响。

有鉴于现有文献的上述缺憾，本文的在统一增长理论的框架下，将家庭生育的数量和质量选择纳入世代交叠模型的分析中，通过个人效用最大化和社会福利最大化方法测算得到养老金最优缴费率，并分析了延迟退休政策对家庭生育选择与最优养老金缴费率的影响。统一增长理论的一个显著特征是考虑家庭生育选择

[③] 影响人口结构的因素有两个：生育率和预期寿命。

数量和质量的替代关系，将人口增长内生化，能够更好地描述人口变化与经济变量之间的互动关系。本文的数值计算结果显示，在不同退休年龄下，养老金的最优缴费率在 7.91%-14.09%之间，低于现行标准。另外，我们的研究还发现，延迟退休导致最优缴费率提高。这个结论看似与直觉相违背，一般认为，延迟退休能够降低制度赡养率，而制度赡养率的下降意味着可以在养老金待遇水平保持不变的条件下适当降低缴费率，但是，上述结论成立的条件是养老金待遇水平不变。在本文中，我们根据缴费率确定养老金的待遇水平[④]，研究发现，随着最优缴费率的提高，养老金待遇（替代率）也会显著增加。

除引言外，本文第二部分为理论模型的构建，第三部分对模型进行分析，第四部分为数值计算，第五部分给出结论。

## 2. 基本模型

### 2.1 家庭决策

本文把代表性个体的生存期分为三期：少年期、成年期和老年期。在少年期，个人不参加工作，接受父母的培养，并积累人力资本。到了成年期，参加工作，获得劳动收入，生育子女，并对子女进行人力资本投资，进入老年期，继续工作一段时间，然后退休，直到身故。

假设在第 t 期，成年人的人力资本为$h_t$，单位有效劳动的工资率为$w_t$，则成年期的总收入为$w_t h_t$，总收入的一定比例（$\tau$）用于养老金缴费，其余部分用于消费$c_t$、储蓄$s_t$以及养育子女。养育子女的投入包括物质投入和人力资本投入两部分，假设父母对每个子女的物质投入为其工资的一定比例 v，对每个子女的人力资本投入为$e_t$。个人在成年期的预算约束为：

$$c_t = w_t h_t (1-\tau) - (v h_t w_t + e_t) n_t - s_t \tag{1}$$

其中，$n_t$代表生育子女的数量。

第 t 期，家庭对子女进行教育投入，用于累积子女的人力资本，假设人力资本累积函数为：

$$h_{t+1} = H e_t^{\theta} h_t^{1-\theta} \tag{2}$$

其中，$H>0, 0<\theta<1$是参数，令$\phi=1-\theta$，$\phi$可以理解为代际收入弹性。

在第 t 期处于成年期的人到了 t+1 期进入老年期，进入老年期后，个人会选择继续工作一段时间后退休，我们将个人在老年期的工作时间长度设定为 x，假设进入老年期后，个体的存活时间长度为 T（1>T>x），老年期的消费$d_{t+1}$来源于成年期的储蓄$R_{t+1}s_t$、老年期的工作收入$w_{t+1}h_t x$和养老金$P_t$，由此可以得到老年期

[④] 当然，养老金待遇还与单位工资、人力资本以及生育率等因素的相关。

的预算约束方程：

$$d_{t+1} = R_{t+1}s_t + w_{t+1}h_t x + (T-x)P_t \tag{3}$$

个人关心自己在成年期和老年期的消费水平以及子女的成长，我们将子女的数量和人力资本水平纳入个人的效用范畴，个人一生的效用函数为：

$$Log[c_t] + \gamma Log[n_t h_{t+1}] + \beta T Log[d_{t+1}/T] \tag{4}$$

其中，参数 $\gamma > 0$ 反映了父母对子女的偏好程度，$\beta > 0$ 反映了消费的时间偏好。

2. 生产技术

考虑在完全竞争市场，所有商品都是同质的，企业利用资本和劳动进行生产活动，假设生产函数服从柯布道格拉斯( Cobb－Douglas)形式：

$$Y_t = AK_t^{\alpha} H_t^{1-\alpha}, 0 < \alpha < 1 \tag{5}$$

其中，$Y_t$ 表示总产出，$A$ 是外生的技术进步水平，$K_t$ 是物质资本存量，$\alpha$ 是资本产出弹性，$H_t$ 为有效劳动供给。

厂商利润最大化的一阶条件为：

$$\begin{aligned} w_t &= A(1-\alpha)k_t^{\alpha} \\ R_t &= A\alpha k_t^{\alpha-1} \end{aligned} \tag{6}$$

其中，$k_t$ 为单位有效劳动的资本存量（下文简称单位资本存量）。

3. 政府

政府的主要责任是维持养老金收支的当期平衡，统筹账户的收支平衡条件为[⑤]：

$$L_t(T-x)P_t = \tau w_{t+1}h_{t+1}L_{t+1} + x\tau w_{t+1}h_t L_t \tag{7}$$

其中，等式左边代表第 t+1 期退休者领取的养老金总额 $L_t P_t$，$L_t$ 为第 t 期的成年人总数[⑥]，右边代表第 t+1 期养老金的缴费额，第 t+1 期的缴费额等于 t+1 期成年人的养老金缴费 $\tau w_{t+1}h_{t+1}L_{t+1}$ 加上仍然处于工作状态的老年人的缴费 $x\tau w_{t+1}h_t L_t$。

4. 市场出清与一般均衡

市场出清条件包括劳动力市场出清和资本市场出清。其中，劳动力市场的出清条件为第 t 期的有效劳动需求 $H_t$ 等于第 t 期的成年人的有效劳动供给 $L_t h_t$ 和老年人的有效劳动供给 $xL_{t-1}h_{t-1}$ 之和，即：

[⑤] 跟随康传坤（2014），本文此处只考虑统筹账户，将个人账户和私人储蓄合并处理。

[⑥] 第 t 期的成年人到 t+1 期成为老年人。

$$H_t = L_t h_t + xL_{t-1}h_{t-1} \tag{8}$$

成年人口的动态变动满足如下等式：

$$L_{t+1} = n_t L_t \tag{9}$$

资本市场的出清条件是第 t 期的储蓄转变为第 t+1 期的资本存量 $K_{t+1}$，即：

$$K_{t+1} = L_t s_t \tag{10}$$

其中，$K_{t+1} = H_{t+1}k_{t+1}$。

## 三、模型的分析

1. 一般均衡分析

将个人在成年期和老年期的预算约束条件（1）、（3）以及人力资本累积方程（2）代入效用函数（4），并将效用函数对生育率 $n_t$、人力资本投入 $e_t$ 以及储蓄 $s_t$ 求导，从而得到个人效用最大化一阶条件：

$$\frac{e_t + vh_t w_t}{c_t} = \frac{\gamma}{n_t} + \frac{T\beta\tau h_{t+1}w_{t+1}}{d_{t+1}} \tag{11}$$

$$\frac{n_t}{c_t} = \frac{\gamma\theta}{e_t} + \frac{T\beta\theta\tau n_t w_{t+1}h_{t+1}}{e_t d_{t+1}} \tag{12}$$

$$\frac{1}{c_t} = \frac{T\beta R_{t+1}}{d_{t+1}} \tag{13}$$

式（11）和式（12）的左右两边分别表示生育和教育的边际成本和边际收益，其中，边际成本包括物质投入和教育投入，边际收益包括父母从孩子数量和质量上得到的满足和年老后得到的养老金收入，式（13）为消费的欧拉方程。对上述一阶条件进行求解，并结合个人的预算约束方程，我们得到了人力资本投入 $e_t$、生育率 $n_t$ 以及储蓄 $s_t$ 的表达式：

$$\begin{cases} e_t = \dfrac{v\theta w_t h_t}{1-\theta} \\ n_t = \dfrac{\gamma\left[(1-\tau)R_{t+1}w_t h_t + xw_{t+1}h_t\right]}{(1+T\beta+\gamma)\left[R_{t+1}(e_t + vh_t w_t) - \tau w_{t+1}h_{t+1}\right]} \\ s_t = \dfrac{T\beta R_{t+1}\left[w_t h_t(1-\tau) - (vw_t h_t + e_t)n_t\right] - \tau h_{t+1}n_t w_{t+1} - xh_t w_{t+1}}{(1+T\beta)R_{t+1}} \end{cases} \tag{14}$$

由式（14）可知，父母对子女的教育投入 $e_t$ 为其收入的一定比例。家庭的生育率 $n_t$ 受到多方面因素的影响，父母对每个子女的总投入 $(e_t + vh_t w_t)$ 越大（包括物质投入和人力资本投入），生育率会越低，这体现了家庭生育选择数量和质量的替代关系，另外，下一代的养老金缴费 $\tau w_{t+1}h_{t+1}$ 越高，表明个人在退休后领取的养

老金越多，生育率也会越高，最后，生育率还与个人一生工资收入$(1-\tau)R_{t+1}w_th_t+xw_{t+1}h_t$以及家庭对子女的偏好程度$\gamma$正相关。由式（14）还可知，家庭的储蓄与成年期的工资收入水平$(1-\tau)w_th_t$正相关，与父母对子女的总投入$(vw_th_t+e_t)n_t$、个人在老年期的养老金$\tau h_{t+1}n_tw_{t+1}$以及老年期的工资收入$xh_tw_{t+1}$负相关。

成年期的储蓄率$sr_t$为储蓄$s_t$与净收入$w_th_t(1-\tau)$的比，即：

$$sr_t=\frac{s_t}{w_th_t(1-\tau)} \tag{15}$$

将满足效用最大化的人力资本投入$e_t$、生育率$n_t$以及储蓄$s_t$代入资本市场出清条件（10），并结合厂商利润最大化一阶条件，可以得到单位有效资本存量的动态方程：

$$k_{t+1}=\frac{(1-\alpha)(N_1+N_2)}{M} \tag{16}$$

其中，

$$\begin{aligned}
N_1&=H(1-\theta)\tau k_{t+1}\left[A\alpha(T\beta+\gamma)(\tau-1)k_t^{\alpha}+xk_{t+1}\right]\\
N_2&=Av\alpha k_t^{\alpha}\left[\frac{Av(1-\alpha)\theta k_t^{\alpha}}{1-\theta}\right]^{-\theta}\left[AT\alpha\beta(1-\tau)k_t^{\alpha}-x(1+\gamma)k_{t+1}\right]\\
M&=H\alpha\gamma(1-\theta)\left[A\alpha(1-\tau)k_t^{\alpha}+xk_{t+1}\right]
\end{aligned} \tag{17}$$

2. 社会福利函数

在均衡状态，单位资本存量保持不变，即$k_{t+1}=k_t=k$，在所有相关参数均给定的条件下，可以通过式（17）求解均衡的单位资本存量水平，进而可以得到消费、储蓄、生育率等其他变量的均衡解。如果其他参数保持不变，只有养老金缴费率变动，那么，可以通过不同的养老金费率计算得到上述变量的不同解，而不同的均衡解对应着不同的社会总福利水平，必定存在使社会总福利最大化的养老金缴费率水平。跟随 Blanchard & Fischer(1989)、张迎斌等（2013）以及康传坤和楚天舒（2014），我们将社会福利定义为从今往后的所有处于不同时代人群的效用贴现和，社会福利函数设定为：

$$\max V=\beta T\log\left(\frac{d_1}{T}\right)+\sum_{t=1}^{\infty}\rho^t\left[Log[c_t]+\gamma Log[n_th_{t+1}]+\beta TLog[d_{t+1}/T]\right] \tag{18}$$

其中，V 代表整个社会的福利水平，$\rho$为社会折现因子，反映了政府对不同时代群体的重视程度。社会的资源约束为：

$$F(K_t,H_t)+(1-\delta)K_t=C_t+D_t+K_{t+1} \tag{19}$$

其中，$F(K_t,H_t)$为第 t 期社会的总产出，$C_t$为第 t 期成年人的消费总量，即

$C_t = L_t c_t$， $D_t$为第 t 期老年人的消费总量，即 $D_t = L_{t-1} d_t$， $K_t$ 和 $K_{t+1}$ 分别为第 t 期和第 t+1 期的总资本存量，δ 为折旧率。由式（20）可知，第 t 期社会的总产出 $F(K_t, H_t)$ 加上扣除折旧之后的总资本存量 $(1-\delta)K_t$，然后减去成年人的消费总量 $C_t$ 和老年人的消费总量 $D_t$，等于第 t+1 期的总资本存量 $K_{t+1}$。第 t 期的总产出 $F(K_t, H_t)$ 与单位产出 $f(k_t)$ 以及总资本存量 $K_t$ 与单位资本存量 $H_t$ 存在如下关系：

$$f(k_t) = \frac{F(K_t, H_t)}{H_t}, \qquad k_t = \frac{K_t}{H_t} \tag{20}$$

社会福利最大化的一阶条件为：

$$\frac{\rho}{c_t} - \frac{T\beta L_t}{F[K_t, H_t] - C_t + K_t - \delta K_t - K_{1+t}} = 0 \tag{21}$$

结合式（13）（20），上述欧拉方程可简单表达为：

$$n_{t-1} - \frac{d_t \rho R_{t+1}}{d_{t+1}} = 0 \tag{22}$$

将式（14）（15）代入式（23），我们得到了均衡条件下使社会福利最大化的单位资本存量水平，即：

$$Ak^{-1+\alpha}\alpha\rho - \frac{\gamma(1-\theta)\left[kx + Ak^{\alpha}\alpha(1-\tau)\right]}{A(1+T\beta+\gamma)\left[k^{\alpha}v\alpha - k(1-\theta)\left(\frac{Ak^{\alpha}v(1-\alpha)\theta}{1-\theta}\right)^{\theta}\tau\right]} = 0 \tag{23}$$

将式（24）和满足均衡条件（即 $k_{t+1} = k_t = k$）的资本存量方程（17）联立，可以得到满足社会福利最大化的均衡资本存量水平和养老金最优缴费率。遗憾的是，上述方程组并没有解析解，也无法显示的考察延迟退休对最优缴费率的影响，因此，我们只能在下一节中求解数值解。

## 4. 数值计算

### 4.1 参数的选择与基准情景的设定

跨期迭代模型一般假定一期的时间跨度为 25-35 年之间，综合考虑，本文将一期的时间跨度设定为 30 年，另外，本文假设个人 20 岁进入成年期并开始工作。

林忠晶和龚六堂（2007）认为，若生产函数为 C-D 形式，那么一般物质资本收入份额在 0.3-0.8 之间，张军和施少华( 2003) 使用实证方法估计了我国 1952-1998 年之间的资本产出弹性，估计值为 0.6。赵志耘等（2006）计算了我国 1978—2004 年的资本产出弹性，结果为 0.56，白重恩等( 2008) 使用收入法测算了我国在 1978-2005 年的资本产出弹性，估计结果在 0.5 左右。郭凯明和颜色（2016）也将 α 设定为 0.5，综合上述文献，本文将基准情景下资本产出弹性设为 0.5，之后对参数值进行敏感性检验。

技术进步的估计值差异较大，李宾和曾志雄（2009）通过要素收入份额可变的增长核算法，重新测算了我国改革开放以来的全要素生产率（TFP）增长率，

文章估算的 1979-2007 年全要素生产率平均增长率为 3.588%。余泳泽（2015）从核算方法调整入手，采用检验后的超越对数生产函数的随机前沿模型，对我国省际全要素生产率进行了再估算。结果发现，两种资本存量核算方法下，中国 TFP 年均增幅分别仅为 1.68％和 1.63％。王海兵（2015）使用增长核算法测算的全要素生产率增长率的区间为 4.89%-5.13%，综合考虑，本文将全要素生产率年增长率设定为 4%，对应的 A 值为 3.25（1.04^30）。

主观贴现率 β 反映了个体对当期消费的偏好程度（相对于未来其消费）。现有多数文献将每年的时间偏好因子设定为 0.99 或 0.98，对应的每期的 β 值为 0.7397 和 0.5455，为此，本文首先将时间偏好设定为 0.7397，然后对其做敏感性分析。另外，跟随 d’Autume（2003）和康传坤等（2014），我们将社会折现因子 ρ 设定为 0.4845。根据 Deng et al.(2013)和 Qin et al.(2016)的研究，我国家庭的代际收入弹性基本处于 0.4-0.6 之间，基于此，本文将代际收入弹性ø设定为 0.5，同时，我们将参数 H 单位化为 1。综合考虑相关文献（严成樑，2018；郭凯明和颜色，2016），本文将 v 设定为 0.1。

据世界银行数据，1990 年中国人均预期寿命为 69.03 岁，2000 年增加到 71.73 岁，至 2016 年为 76.5 岁，从 1990 年到 2016 年的 26 年时间，中国国民的平均预期寿命增长了 7.47 岁，增幅超过 10%。根据《“健康中国 2030”规划纲要[⑦]》的预测，到 2030 年，我国的人均预期寿命将会达到 79.0 岁。因此，本文将基准情景下的预期寿命设定为 76.5 岁（即 $T=0.883$），然后分析寿命延长对养老金最优缴费率、生育率以及其他经济变量的影响。

按照我国目前的规定，男女的退休年龄并不相同,男性企业职工的退休年龄是 60 岁，女工人是 50 岁，女干部是 55 周岁。为了便于分析，我们将基准情景下的男女退休年龄统一设定为 60 岁（即 $x=0.33$），然后分析延迟退休对养老金最优缴费率、生育率以及其他经济变量的影响。

参数 γ（父母对子女的偏好程度）的设定较为困难，本文通过反推法得到 γ 的估计值。反推法的基本思路如下：首先，对基准情景下的生育率进行设定，并将该设定值代入式（22），结合其他参数值得到均衡条件下的单位资本存量 k；然后，将 k 代入式（16）和式（23）得到关于 τ 和 γ 的两个方程；最后，通过联立方程组求解得到参数 γ 和基准情景下的养老金最优费率 τ 的估计值。

为了得到参数 $\gamma$ 的估计值，首先需要对基准情景下人口的生育率进行设定。由于计划生育政策的实施，长期以来，我国人口总和生育率始终低于保持人口总量不变的世代更替水平。根据 2010 年第六次人口普查的数据，我国人口总和生育率仅为 1.18。随着“单独二孩”以及“全面二孩”政策的实施，我国人口的总和生育率有所回升，根据国家卫生计生委发布《2016 年我国卫生和计划生育事业发展统计公报》数据，2016 年的总和生育率提升至 1.7。但是，生育率短暂提高的主要原因是国民累积生育意愿的集中释放，育龄妇女的低生育现象在长期内仍然无法有效改善。因此，本文将总和生育率为 1.5，由于本文提及的生育率不分男女，我们将基准情景下的生育率设定为 0.75。通过上述的反推法得到基准情景下参数 τ 和 γ 的值分别为 0.0791 和 0.033[⑧]。基准情景下的所有参数值整理在表中 1。

[⑦] 由中共中央、国务院于 2016 年 10 月 25 日印发并实施。

[⑧] 本文通过消元法最终得到了关于 τ 的三次方程，三个解分别是 {–1.113, 1.388, 0.0791} ，显然，缴费率不可能为负，也不可能超过 1，因此，只有最后一个解（0.0791）合理，将该解代入式（16）可得到 γ。

表 1 基准情景下的参数值

| 参数 | $\alpha$ | $\beta$ | $\gamma$ | $\theta$ | $x$ | $T$ | $\rho$ | $A$ | v | H |
|---|---|---|---|---|---|---|---|---|---|---|
| 取值 | 0.5 | 0.7397 | 0.033 | 0.5 | 0.333 | 0.883 | 0.4845 | 3.25 | 0.1 | 1 |

## 4.2 数值计算结果分析

表 2 给出了不同退休年龄条件下，养老金统筹账户的最优缴费率。由表 2 可知，当退休年龄为 60 岁、预期寿命为 76.5 岁时，养老金最优缴费率为 7.91%，远低于现行标准（20%），当退休年龄从 60 岁延迟到 65 岁时，养老金最优缴费率从 7.91%提高到 14.09%。总体来看，在不同退休年龄方案下，养老金的最优缴费率均低于现行标准。

由表 2 还可以看出，最优缴费率与退休年龄为同方向变动关系，即延迟退休导致最优缴费率增加，这与景鹏和胡秋明（2016）的结论正好相反。一般认为，当退休被延迟后，老年期的收入会增加，若其他条件不变，老年时期的消费水平也会增加，为了保证消费的欧拉等式（式 13）成立，此时，可以适当降低养老金缴费率以增加成年期的消费水平。但是，由式（3）可知，老年期的消费不仅来源于养老金，还来源于成年期的储蓄以及老年期的工资收入，三者之间存在替代关系。延迟退休年龄导致老年期收入增加，为了提高成年期的消费水平，可以通过降低养老金缴费率或（和）降低成年期的储蓄率两种方式来实现。由表 2 可知，当退休年龄被延迟后，家庭的最优选择是降低储蓄率，政府的最优选择是提高养老金费率，因此，延迟退休导致社会储蓄替代私人储蓄。退休年龄从 60 岁提高到 65 岁时，储蓄率从 12.35%降低到了 0.67%，降幅为收入的 11.68%。养老金最优缴费率从 7.91%增加到 14.09%，增幅为收入的 6.18%。储蓄率的下降和养老金缴费率的提高虽然对成年期的消费水平影响相反，但是，私人储蓄率的下降起到了主导作用，两个相反的作用最终导致成年期的消费收入比增加 5.5%。我们还发现，缴费率的提高也导致养老金替代率上升，替代率从 60 岁的 28.76%提高到 55.97%。另外，家庭的储蓄率降低导致单位资本存量下降，而单位资本存量的下降不利于人力资本累积，此时，家庭生育的最优选择是数量对质量的替代，即生育的数量增加，子女的人力资本投入下降。退休年龄从 60 岁提高到 65 岁，生育率从 0.75 提高到 1.233。

由此可见，延迟退休政策有利于提高人口的生育率，改善人口年龄结构，在一定程度上缓解人口老龄化给我国社会经济发展带来的不利影响，这与严成樑（2016）的结论一致。但是，也应该看到，延迟退休抑制了私人储蓄和投资，对物质资本和人力资本的累积产生不利影响。

表 2 延迟退休对生育率和最优缴费率的影响

| 预期寿命 | 60 | 60.5 | 61 | 62 | 63 | 63.5 | 64 | 65 |
|---|---|---|---|---|---|---|---|---|
| 最优缴费率($\tau$) | 7.91% | 8.43% | 8.97% | 10.11% | 11.33% | 11.98% | 12.65% | 14.09% |
| 替代率 | 28.76% | 31.04% | 34.18% | 39.33% | 44.59% | 46.56% | 49.21% | 55.97% |
| 单位资本存量($k^*$) | 3.582 | 3.337 | 3.113 | 2.718 | 2.383 | 2.234 | 2.095 | 1.846 |
| 储蓄率($sr^*$) | 12.35% | 11.19% | 10.05% | 7.76% | 5.45% | 4.28% | 3.09% | 0.67% |
| 单位工资($w^*$) | 3.075 | 2.968 | 2.867 | 2.679 | 2.508 | 2.429 | 2.352 | 2.208 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 生育率($n^*$) | 0.750 | 0.791 | 0.833 | 0.922 | 1.018 | 1.068 | 1.121 | 1.233 |

### 4.3 参数的敏感性分析

本部分，我们分析在预期寿命（T）、资本产出弹性（α）、消费的时间偏好（β）以及代际收入弹性（∅）等相关参数发生变化时，养老保险的最优费率水平、总和生育率、储蓄率以及单位资本存量等变量的变化趋势。

表 3 给出了预期寿命延长对生育率和最优缴费率的影响。由表 3 可知，预期寿命与最优缴费率呈反方向变动关系，预期寿命延长导致社会最优养老金缴费率降低。当预期寿命延长后，为了满足消费的欧拉方程成立，老年期的消费需要增加，而成年期的消费要减少。由表 3 可知，预期寿命从 76.5 对提高到 80 岁，家庭的最优选择是提高储蓄率，储蓄率从 12.35%提高到了 15.80%，增幅为当期收入的 3.45%。而政府的最优选择是降低养老金费率，费率从 7.91%降低到 6.42%，降幅为收入 1.49%。降低储蓄率和提高养老金缴费率虽然对成年期的消费水平影响相反，但是，从表 3 的数值计算结果可知，家庭储蓄率的提高起到了主导作用，两种相反的作用最终导致成年期的消费收入比降低 1.96%。预期寿命的延长导致家庭的储蓄率上升，这与 Cocco & Gomes(2012)以及 De Nardi et al.(2009)的理论结论相一致，上述结论也得到了部分实证数据的支持（例如 Lee et al.,2000 和 Kinugasa and Mason,2007）。当然，也有学者认为，由于存在不确定性，因此，预期寿命的延长并不会导致储蓄率的上升（Post& Hanewald,2013）。

另外，储蓄率的上升使单位资本存量增加，父母对子女人力资本投入上升，子女人力资本的提高导致家庭生育选择数量对质量的替代，即生育子女的数量降低，子女的人力资本水平提高。由此可见，寿命延长有利于促进人力资本的提升，但是却抑制了人口数量的增加，这与 Zhang et al.(2001)的结论相一致。

表 3　　预期寿命延长对生育率和最优缴费率的影响

| 预期寿命 | 76.5 | 77 | 77.5 | 78 | 78.5 | 79 | 79.5 | 80 |
|---|---|---|---|---|---|---|---|---|
| 最优缴费率($\tau$) | 7.91% | 7.66% | 7.43% | 7.21% | 6.99% | 6.79% | 6.61% | 6.42% |
| 替代率 | 28.76% | 27.56% | 26.48% | 25.51% | 24.61% | 22.76% | 21.04% | 20.36% |
| 单位资本存量($k^*$) | 3.582 | 3.709 | 3.838 | 3.968 | 4.098 | 4.231 | 4.365 | 4.499 |
| 储蓄率($sr^*$) | 12.35% | 12.88% | 13.40% | 13.91% | 14.41% | 14.89% | 15.36% | 15.80% |
| 单位工资($w^*$) | 3.075 | 3.129 | 3.183 | 3.237 | 3.289 | 3.342 | 3.395 | 3.442 |
| 生育率($n^*$) | 0.750 | 0.731 | 0.712 | 0.694 | 0.678 | 0.662 | 0.648 | 0.632 |

表 4 给出了资本产出弹性$\alpha$的敏感性分析结果。由表 4 可知，$\alpha$与养老金最优费率呈反方向变动关系，$\alpha$增加，最优缴费率会降低。显然，$\alpha$的提高意味着资本回报率的上升，资本回报率的上升使家庭的储蓄率提高，而储蓄率的提高导致老年期的收入增加，为了平衡成年期和老年期的消费，此时，政府的最优决策是降低养老金缴费率，个人的最优决策是提高储蓄率，$\alpha$的提高导致私人储蓄替代社会储蓄。资本产出弹性从 0.3 提高到 0.7，私人储蓄率从 8.77%提高到 14.7%，增幅为收入的 5.93%，养老金缴费率从 11.22%降低到 6.53%，降幅为收入的 4.69%，两种相反的作用导致成年期的消费收入比增加 3.61%。另一方面，私人储蓄率的

提高导致单位资本存量增加，此时，家庭的最优生育的选择是质量替代数量，即生育子女的数量下降，对子女的人力资本投入增加。

表 4 资本产出弹性的敏感性

| 资本收入份额 | 0.3 | 0.4 | 0.45 | 0.5 | 0.55 | 0.6 | 0.7 |
|---|---|---|---|---|---|---|---|
| 最优缴费率($\tau$) | 11.22% | 9.06% | 8.41% | 7.91% | 7.51% | 7.15% | 6.53% |
| 替代率 | 33.87% | 31.66% | 31.01% | 28.76% | 27.18% | 24.91% | 22.91% |
| 单位资本存量($k^*$) | 1.635 | 2.451 | 2.969 | 3.582 | 4.303 | 5.136 | 7.013 |
| 储蓄率($sr^*$) | 8.77% | 10.43% | 11.37% | 12.35% | 13.30% | 14.14% | 14.7% |
| 单位工资($w^*$) | 2.637 | 2.791 | 2.917 | 3.075 | 3.264 | 3.470 | 3.812 |
| 生育率($n^*$) | 0.995 | 0.833 | 0.786 | 0.750 | 0.721 | 0.696 | 0.652 |

表 5 给出了时间偏好 β 的敏感性分析结果。由表 5 可知，β 与养老金最优费率呈反方向变动关系，β 增加导致费率降低，反之亦然。显然，β 的增加意味着个人对老年期消费的重视程度增加，这表明，在其他条件不变的情况下，成年期的消费会减少，而老年期的消费水平会增加。由表 5 可知，β 增加时，个人的最优决策是提高储蓄率，政府的最优决策是降低养老金缴费率，时间偏好的增加导致私人储蓄对社会储蓄的替代。β 从 0.6 提高到 0.9，储蓄率从 5.78%增加到了 17.77%，增幅为收入的 11.99%，缴费率从 11.33%降低到了 5.69%，降幅为收入的 5.64%，两种策略的实施最终导致成年期的消费收入比降低约 6.35%。

另外，储蓄率的提高使单位资本存量增加，此时，家庭生育的最优选择是子女质量对数量替代，即加大对子女的教育投入，同时降低生育率。β 时间偏好从 0.6 增加到 0.9，单位资本存量从 2.383 增加到了 5.117，生育率从 1.018 降低到 0.574。

表 5 时间偏好的敏感性分析

| 时间偏好 | 0.6 | 0.65 | 0.7 | 0.7397 | 0.8 | 0.85 | 0.9 |
|---|---|---|---|---|---|---|---|
| 最优缴费率($\tau$) | 11.33% | 9.86% | 8.69% | 7.91% | 6.93% | 6.26% | 5.69% |
| 替代率 | 35.88% | 32.86% | 30.10% | 28.76% | 25.95% | 13.12% | 22.64% |
| 单位资本存量($k^*$) | 2.383 | 2.796 | 3.228 | 3.582 | 4.141 | 4.622 | 5.117 |
| 储蓄率($sr^*$) | 5.78% | 8.43% | 10.71% | 12.35% | 14.57% | 16.23% | 17.77% |
| 单位工资($w^*$) | 2.509 | 2.717 | 2.919 | 3.075 | 3.307 | 3.493 | 3.676 |
| 生育率($n^*$) | 1.018 | 0.903 | 0.811 | 0.750 | 0.673 | 0.6196 | 0.574 |

最后，我们给出代际收入弹性ø的敏感性分析结果。由表 6 可知，ø与养老金最优费率同方向变动,与生育率反方向变动,即ø增加导致最优费率上升提高，生育率降低。分析原因，由式（14）可知，当ø提高时，父母对子女的教育投入增加，此时，家庭生育的最优选择是质量对数量的替代，即父母提高对子女的人力资本投入，降低生育率。人力资本的提高使工资收入增加，由于成年期的工作时间长于老年期，因此，与老年期相比，成年期的收入增幅更大，为了满足消费的欧拉方程成立，成年期的消费收入比需要下降。由表 6 可知，当ø提高时，家庭的最优选择是降低储蓄率，而政府的最优选择是提高养老金缴费率，ø的增加

导致社会储蓄对私人储蓄的替代。∅从 0.35 增加到 0.65，家庭的储蓄率从 15.66%降低到 10.30%，降幅为工资收入的 5.36%，而缴费率从 6.53%提高到 8.85%，增幅为工资收入的 2.32%，最终，成年期的消费收入比下降 3.04%。

表 6　　代际收入弹性敏感性分析

| 代际收入弹性 | 0.35 | 0.4 | 0.45 | 0.5 | 0.55 | 0.6 | 0.65 |
|---|---|---|---|---|---|---|---|
| 最优缴费率($\tau$) | 6.53% | 7.02% | 7.49% | 7.91% | 8.29% | 8.60% | 8.85% |
| 替代率 | 22.31% | 24.18% | 26.01% | 28.76% | 30.43% | 32.01% | 33.45% |
| 单位资本存量($k^*$) | 3.254 | 3.384 | 3.493 | 3.582 | 3.653 | 3.708 | 3.748 |
| 储蓄率($sr^*$) | 15.66% | 14.43% | 13.32% | 12.35% | 11.51% | 10.83% | 10.30% |
| 单位工资($w^*$) | 2.932 | 2.989 | 3.037 | 3.075 | 3.106 | 3.129 | 3.146 |
| 生育率($n^*$) | 0.833 | 0.816 | 0.788 | 0.750 | 0.702 | 0.643 | 0.577 |

## 4. 动态变化路径的分析

上面的研究结论均是基于静态或比较静态的分析，没有考虑到消费、储蓄等相关经济变量的动态变化过程。在我国经济处于动态转型的过程中，讨论相关经济变量的动态变动过程显得非常重要。下面我们分析在延迟退休年龄与寿命延长的条件下[⑨]，资本存量、生育率、储蓄率和单位工资等变量的动态变动情况。

图 1 给出了预期寿命为 76.5 岁，退休年龄从 60 岁分别被延迟到 61 岁、63 岁和 65 岁时，相关经济变量的动态变化过程。由图 1 可知，在退休被延迟后，单位资本存量、生育率、储蓄率和单位工资均从旧的均衡点向新的均衡点做动态调整，所有变量经过大约 6-7 期均调整到新的均衡点，这表明模型是稳定的。其中，最初一期的调整幅度最大，然后调整幅度逐渐放缓，以单位资本存量为例，若退休年龄被延迟到 65 岁，单位资本存量在第一期的降幅高达 31.69%，第二期的降幅仅为 14.88%。另外，从图 1 还可以发现，退休年龄延迟的幅度越大，上述变量在初期的变动幅度也会越大，还以单位资本存量为例，若退休年龄被延迟到 65 岁，单位资本存量在第一期的降幅为 31.69%，相比之下，若退休年龄被延迟到 61 岁，单位资本存量在第一期的降幅仅为 7.93%。

[⑨] 鉴于篇幅所限，本文这里不给出其他参数变化条件下，相关变量的动态变动过程。

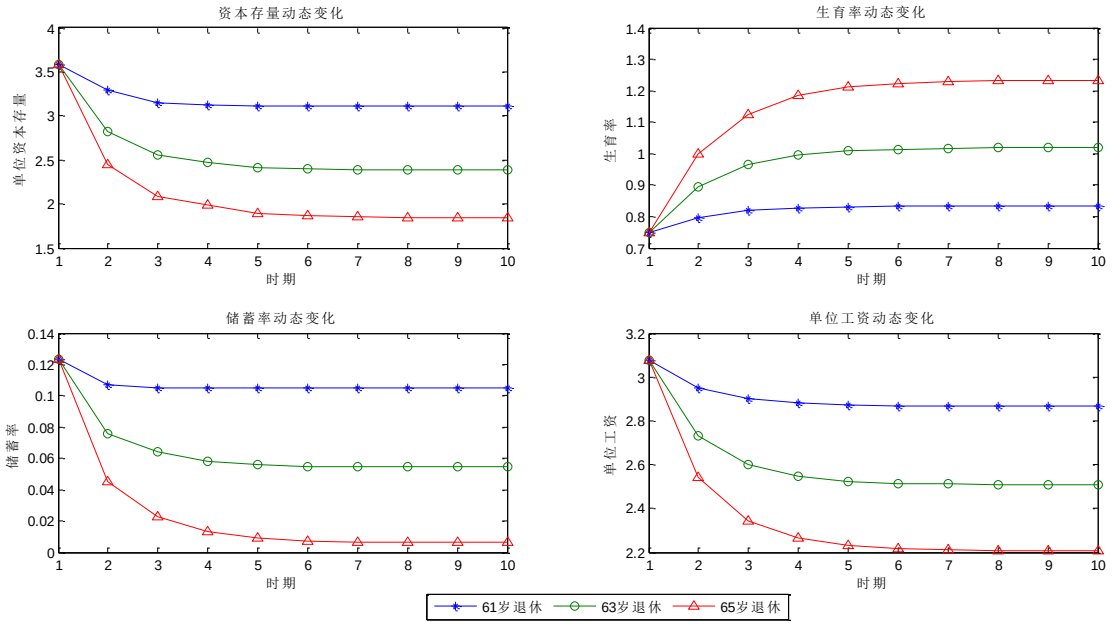


图 1：延迟退休对变量的动态影响

图 2 给出了退休年龄为 60 岁，预期寿命从 76.5 增加到 78 岁、79 岁和 80 岁时，相关经济变量的动态变化过程。由图 2 可知，与延迟退休的情况类似，当预期寿命增加时，相关经济变量均能够在有限的几期内从旧的均衡点调整到新均衡点上，而且在新均衡点，这些变量具有稳定性。

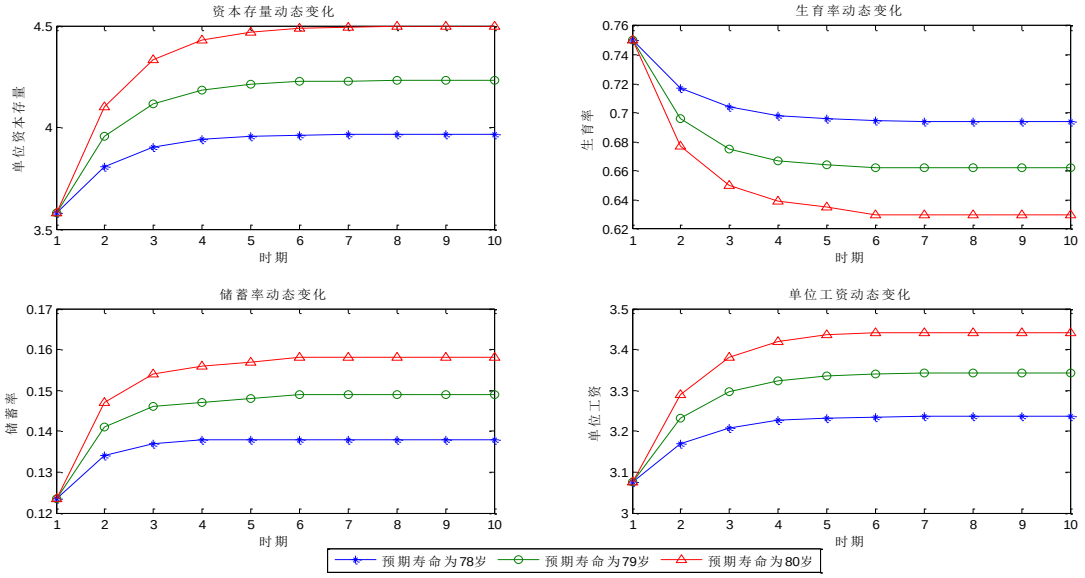


图 2：预期寿命延长对变量的动态影响

## 5. 结论

本文在统一增长理论的框架下，使用一般均衡 OLG 模型，通过效用最大化和社会福利最大化方法测算了我国养老保险统筹账户的最优缴费率，分析了延迟退休对家庭生育选择和最优缴费率的影响。测算结果显示，在不同的参数设定和

退休年龄假设下，养老金最优费率的变动区间为 5.69%-14.09%，明显低于目前20%的社会统筹缴费率。延迟退休导致社会储蓄对私人储蓄的替代，当退休年龄从 60 岁提高到 65 岁时，养老金最优缴费率从 7.91%上升到 14.09%，而私人储蓄率从12.35%下降到0.67%，延迟退休最终导致成年期的消费收入比增长6.73%。另外，延迟退休还导致家庭生育选择数量对质量的替代，当退休年龄被延迟后，生育率上升，父母对子女的人力资本投入下降。

根据理论模型分析与数值计算结果，本文得到的政策启示主要包括以下三点：首先，与养老金最优缴费率相比，现行的缴费率偏高，没有达到帕累托最优，存在进一步下降的空间。因此，适当的降低养老金缴费率不仅能够减轻企业的压力，还能够提高整个社会福利水平。其次，延迟退休有利于人口生育率的提高，与“全面二孩”政策并不矛盾。人口生育率的提高能够改善人口年龄结构，有利于缓解人口红利消失给社会经济发展带来的不利影响。最后，延迟退休不利于人力资本的累积。因此，应进一步增加财政对各层次公共教育的支持力度，积极鼓励和引导民间资本参与基本公共服务供给，弥补延迟退休对人力资本累积可能产生的负面效用。

本文研究仍有待于从以下两个方面进行拓展。第一，国际上，对养老金进行财政补助是各国政府的普遍做法，本文并没有将财政补助考虑到最优缴费率的问题之中，因此，考虑在财政补助条件下的最优缴费率是一个值得进一步研究的问题。第二，本文没有考虑到个人账户的最优缴费率问题，而是将个人账户与私人储蓄等同视之，由于我国个人账户存在“空账运行”的情况，而且其计息和给付模式与私人储蓄存在一定的区别，因此，后续的文章可以考虑研究个人账户的最优缴费率问题。

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# 延迟退休、生育选择与养老金最优费率

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**关键词:** 延迟退休年龄；生育率；养老金缴费率；OLG模型

**中文摘要.**本文在统一增长理论的框架下，通过一般均衡世代交叠模型测算了我国养老保险统筹账户的最优缴费率，并研究了延迟退休对家庭生育选择以及养老金最优缴费率的影响。研究结果表明：在不同的退休年龄方案下，统筹账户的最优费率变动区间为8.77%-14.09%，低于现行的标准，因此，适当降低统筹账户的缴费率有利于实现社会福利最大化。数值计算结果还显示，当退休年龄被延迟后，养老金最优缴费率和替代率均会提高，私人储蓄率降低；父母对子女人力资本的投入下降，生育率提高。总体来看，延迟退休导致社会储蓄对私人储蓄的替代，家庭生育选择数量对质量的替代。

# Does Deferred Incentive Promote Enterprise Innovation?—Empirical Evidence Based on Supplementary Pension Plan

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**Keywords:** The supplementary pension plan, Corporate innovation, Human resource management, Mediation Effect.

**Abstract.** Corporates' innovation ability is not only an important means to enhance the market competitiveness of enterprises, but also an important measure to accelerate the formation of a new development pattern. When Xi Jinping inspecting in Hunan province in September 2020, he pointed out that independent innovation is the life of corporates and the foundation for corporates to climb over the ridge. Innovation is not only the natural mission of scientific and technological personnel, but also the work crystallization of the grassroots staff. The supplementary pension plan, which benefits all employees, as the pension benefits provided by corporates for employees, plays an important long-term incentive role in corporate governance, and then affects corporate innovation. This paper takes the panel data of A-share listed companies from 2007 to 2019 as the research sample to explore whether the supplementary pension plan will have an impact on the corporates' innovation ability, and describes the corporate innovation ability from two dimensions of innovation quality and innovation quantity. It is found that the enterprise annuity plan has a significant impact on the total number and quality of innovation. In this paper, the enterprise innovation is further divided into invention innovation, utility model innovation and

appearance design innovation. The most significant impact is on the number and quality of invention innovation, followed by the appearance design innovation, The impact on design innovation is not significant; And the mediating effect research shows that the impact of enterprise annuity plan on innovation quality is mainly realized through the mechanism of attracting and retaining high-quality talents. Furthermore, the heterogeneity study shows that in the sub samples of low labor intensity, low average wage, high financing constraints and high equity concentration, the impact of enterprise annuity plan on the quality of enterprise innovation is more significant. In contrast, for the sub samples of high labor intensity, high average wage, high equity concentration, the impact of enterprise annuity plan on the quality of enterprise innovation is more significant The sub samples with low financing constraints and low equity concentration are not so obvious. In addition, the method of adjusting the sample interval and the analyzed variable is used for robustness test. It can be seen that in order to better promote the innovation ability of the company, the supplementary pension plan has become an important breakthrough. Therefore, the enterprise managements should reasonably set the supplementary pension plan according to actual situations, and the government should continue to increase the publicity of the supplementary pension plan, so as to guide the faster and better development of the supplementary pension plan of corporates, improve the corporate innovation ability and boost the nation's transformation from a big manufacturing to powerful manufacturing.

## 1. 引言

鉴于创新活动对企业核心竞争力(Porter,1992)以及国家长期经济增长(olow,1957)具有重要战略意义，如何促进企业积极开展创新活动、提高创新效率一直以来都是各国学者和政策制定者关注的焦点。而创新的技术往往蕴含在人力资本之中,使得人才成为创新的第一资源。正如习近平总书记《在参加十二届全国人大三次会议上海代表团审议时的讲话》中指出：“人才是创新的根基,创新驱动实质上是人才驱动，谁拥有一流的创新人才,谁就拥有了科技创新的优势和主导权。”激励作为人力资源管理中的重要部分，是激发员工工作积极性的必要手段，对人才创新及有效人力资源管理具有重要意义。因此，如何完善激励体系、激发员工的创新动力是促进企业创新的一大研究课题。现有研究围绕员工激励，分别从员工持股(Chang et al,2015；陈效东,2017)、员工劳动保护程度(倪骁然和朱玉杰，2016)及工会权力(Fang andGe.2012)等视角考察了其与企业创新的关系。值得注意的是，虽然我国员工的收入结构随着经济发展而呈现多样化特征，但在人口老龄化、老龄赡养率急剧提高，我国基本养老制度收支缺口不断加大等矛盾日益突出的背景下，人们越来越关注中国的第二大养老支柱企业年金在薪酬结构中占比。而企业年金是劳动关系中一种重要的激励手段，影响员工流动，工作努力程度及退休时间(Ippolito，1985)。作为一种长期的激励机制，企业年金在员工激励方面体现为持续的创新激励、高效率的工作状态、退休养老压力减轻、归属感增强、企业忠诚度提高等，能够进一步实现企业员工参与企业效益分配与管理，是企业鼓励创新、奖励忠诚和提高创

新及人才竞争力的有效手段。Ippolito(1985)指出企业年金计划是一种“隐性合同”，员工成为公司的长期债券持有人，他们有强烈的动机留在公司直到退休，因为他们在受雇初期(后期)的报酬低于(高于)边际产品。刘瑞莲(2014)指出，当企业建立企业年金计划后，可委托法人受托机构进行企业年金的基金资产托管，利用员工在退休之前不可领取、退休之后可领取企业年金的特征，实现企业年金基金长期投资回报增长，提高企业员工退休后的可支配收入，增加员工的安全感，能够减少人才流失程度。

本文的研究贡献主要体现在以下几方面。第一，从企业年金的视角丰富和拓展了企业创新绩效影响因素的相关研究。基于激励性薪酬视角的企业创新研究已有很多，但关注福利性薪酬对企业创新影响研究较少。与基本养老保险相比，企业年金属于非强制性的社会保障项目，企业可以选择降低缴费水平甚至不缴费，故企业年金不存在缴费不实的情况，该福利项目支出对企业创新的影响程度可以得到准确评估。第二，从企业创新的视角丰富了企业年金经济后果的相关研究。已有文献主要是从企业年金对宏观经济增长或员工行为的影响等方面研究企业年金的经济后果问题，而较少从企业的视角进行研究。作为年金计划的供给方，企业只有从年金计划的实施中获益，才能保证该项福利的持续性，进而完成建设多层次社会保障体系的任务。第三，人力资本作为创新的核心驱动力，研究其与企业创新之间的关系对我国企业创新突破具有意义。以往文献对创新研究的注意力多集中在员工持股这种少数管理人员才拥有的股权激励上面，而企业的持续创新能力不仅来源于管理层，还来自普通员工(陈效东，2017)。同样是延期激励，本文的关注点是全体员工的延期激励，而不只是关注少数人的利益对企业创新的影响。

## 2.文献综述

### 2.1 实施企业年金计划的经济后果

企业年金计划的主要经济功能就是为计划参与者退休后的收入提供保障。有学者认为企业年金会增加资本成本，企业年金缴款增加导致可用于投资正净现值项目的内部产生的现金流量减少。也就是说，公司的投资水平将下降，公司可能会选择筹集外部资金以减轻这种影响。如果由于信息不对称、代理成本、不完整的合同或税收制度，市场摩擦导致外部资金的成本超过内部产生的现金流的成本(Jensen 和 Meckling ,1976;Myers ,1977;Myers 和 Majluf,1984;Potterba 和 Summers,1984)，该公司在发行新的债务或股本证券时会招致无谓损失，其形式是更高的资本成本。对于那些面临更大外部融资约束的企业而言，这些市场摩擦以及由此对企业资本成本的影响可能最为明显(Almeida,Campello 和 Weisbach,2004;Rauh,2006; Franzoni,2009)。另一方面，有学者指出企业年金缴费不会导致企业资本成本的增加。Moody(2006)认为，企业年金缴款的增加是“信用中立”的事件，因为借钱来支付企业年金计划的公司正在将一种债务形式交换为另一种债务形式。Rauh(2006)指出，由于企业年金对内

部产生的现金流量产生了外源性冲击，得出了资本支出与企业年金的负相关关系，也发现企业年金缴费与较低的投资水平有关，表明企业年金缴费(更普遍地说是内部财务资源的减少)限制了公司投资于所需项目的能力。Franzoni(2009)发现企业年金与在随后的十二个月的股票收益之间存在负相关关系，对于融资约束的公司，这种关联会更强。

## 2.2 企业创新的影响因素

国内外学者对企业创新的研究相对较早，既有研究企业创新的文献大都从管理层异质性及能力、股权质押及企业内部薪酬差距、股权激励等角度进行探讨与分析。部分学者考察了高管个人特质对企业创新的影响。如宋建波和文雯(2016)指出董事的海外背景对企业创新具有正向促进作用；周建和李小青(2012)的研究表明董事会成员的教育程度对企业的创新战略具有积极的影响；权小锋等(2019)研究发现管从军经历具有正面的创新效应；何瑛等(2019)认为高管职业经历越丰富，企业创新水平越高；杨以文，郑江淮(2013)发现企业家精神是影响生产性服务业创新发展两个最关键的因素之一；另一部分学者从行为金融学的角度来予以分析，易靖韬等(2015)的实证表明高管过度自信会促进企业加大创新项目的投入和产出；Goel 和 Thakor(2006)认为过度自信的竞争者获取胜利的可能性较大，更容易获得晋升；SunderJetal.(2017)认为风险容忍度高及渴望新体验的高管在创新方面更容易成功；部分学者专注于管理层能力对企业创新的影响，如姚立杰等(2018)认为管理者能力能够有效地推动企业创新水平和创新效率；何威风等(2016)研究表明管理者能力强并不一定有利于企业创新。在股权质押对企业创新的影响中，目前学术界大部分学者都认为控股股东股权质押会抑制企业创新。国外学者 Bebchuketal.(1999)认为控股股东股权质押后，其现金流权下降，控制权和现金流权的分离度加大，控股股东开展高风险创新活动的意愿降低；Mengetal.(2019)研究发现控股股东的股权质押行为增加了发明专利的有效产出数量；国内学者李常青等(2018)，杨鸣京等(2019)，谷文林和孙静思(2020)，姜军等(2020)认为上市公司的创新投入与控股股东股权质押是呈负相关的，控股股东的股权质押对企业创新效率的抑制作用具有持续性；有关企业内部薪酬差距方面对企业创新影响的研究主要围绕高管与员工之间的薪酬差距以及高管之间的薪酬差距。在员工与高管的薪酬差距方面，Lazear 和 Sherwin(1981)，孔东民等(2017)认为拉大薪酬差距可以通过奖励有生产效率的员工，以达到提高企业经营绩效的目标，对创新产出存在正向影响；Akerlofetal.(1988)，Grolleauetal.(2006)认为较小的薪酬差距能够产生持续的凝聚力，增进员工满意度，过大的薪酬差距容易滋生员工的不满情绪，导致其工作消极；在高管与高管之间的薪酬差距对企业创新影响的研究中，牛建波等(2019)，曾春华和李开庆(2019)认为增加高管的薪酬差距有利于提高企业的创新效率；王晓燕和张册(2020)的却认为高管薪酬差距会与企业创新效率显著负相关。在股权激励对企业创新的影响中，许多研究都表明员工持股对企业创新有利，比如国外学者 Milleretal.(2002)，Hellmannetal.(2011)，Baranchuketal.(2014)提出长期激励改善了管理层的短视行为，他们放弃短期获利的行为动机而着眼于远期规划，从而增加企业的创新；Changatal.(2015)进一步指出尤其是期权的长期有效性能促进创新产出；Kim 和 Ouimet(2014)的

研究表明，小规模企业互相监督的动力更强，股权激励效果更好；另外，Manso(2011)认为创新的失败率较高，需要容忍早期失败的激励；Rajan 和 Zingales(1995)认为股权激励的凸性刚好有利于激励对象承担风险机制。在国内，同样有许多学者对股权激励对企业创新的影响进行深入的研究，如孟庆斌等(2019)提出实施员工持股计划促进了企业创新产出；周冬华等(2019)提出员工持股计划持有人数越多，资金规模越大，高管认购比例越高，锁定期越长，越能增加企业发明专利和实用新型专利申请数量；进一步地有研究表明，在员工持股计划中高管的持股比例越高，则企业创新动力越大，其创新产出也越好；对此，也有学者提出不一致的意见，例如朱德胜和周晓珮(2016)研究发现高管持股比例与企业创新效率之间具有显著的非线性关系；李韵和丁林峰(2020)实证表明员工持股计划对创新激励的效果呈现 “U”形的累积效应关系。张兴亮(2018)提出高管持股差距是最有效的创新激励安排，与高管持股相比，高管持股差距的创新激励效果更好。

## 3.理论分析与假设

企业年金对企业创新可能存在两方面的影响：一方面，企业年金属于企业对员工的一种延期性的薪酬待遇支付，是当前城镇职工基本养老保险制度的重要补充。它不仅具有调节工资收入分配和职工养老保障的作用，并且对于员工也有很强的激励作用，有助于增强企业对优秀人才的吸引力和对员工的凝聚力，提高员工工作热情，从而激发企业活力和创造力，促进企业创新行为，使其在激烈的市场竞争中占据优势。另一方面，企业参与企业年金，会使企业的劳动力成本增加，从而增加财务负担，这会使企业的经营杠杆增加，融资约束加大，影响企业对创新的研发投入，基于以上分析，本文提出两个假设：

假设 1：企业年金对企业创新具有积极影响

企业年金影响企业创新行为的渠道可能体现在：

(一)吸引高素质人才，优化人力资本结构

由于信息不对称，企业在劳动市场无法精准地了解应聘者的特征和能力，而企业年金的市场本质属性就决定其会优先筛选出劳动力市场中的优秀者。完善的保障制度体系既是企业实力的体现，同时也是“以人为本”企业文化的体现，有利于树立企业良好形象，增强对人才的吸引力。知识经济时代，人才资源的重要性日益突出，在市场经济不断完善的同时，与之相应的人才流动机制也已逐步形成，在更为开放的择业观念下，人才的合理流动已成为时代的潮流，福利待遇好的企业自然更容易吸引优秀人才的加入。首先，通过建立年金，企业能够在劳动力市场上传达出一种信号：公司经营绩效好，薪酬制度体系完善、待遇高等，因此，这类企业在劳动力市场中就更具备竞争优势。而高素质人才也往往更具备长远的眼光，不会产生“短视行为”，考虑退休之后的生活保障问题，他们会更倾向于加入覆盖了年金的企业，缓解养老压力以保障自己退休之后的生活。所以较没有建立年金的企业来说高素质人才更愿意向覆盖年金的企业抛出橄榄枝，因此企业更容易筛选到高素质人才，从而提高优质人才在企业劳动力构成中的比重，高素质的人才知识储备量往往更大，更具备新潮的思

维和创新意识，能够提出新想法和新见解，从基层推动企业创新发展；其次，建立年金制度还有利于塑造企业关怀职工、重视人才以及高福利、高待遇的良好形象，为企业赢得良好的社会评价和业界口碑，增强企业员工的自信心、荣誉感和对企业的归属感，进一步满足企业职工在精神方面的需求，增强企业在人才市场中的竞争力，从而吸引更多优秀人才的加盟。

(二)增加企业对人力资本的投入

从理论上讲，企业虽然可以通过在职培训等改善存量的人力资本，但在职培训等人力资本投资容易引发“敲竹杠”等问题(Wasmer，2006)。由于人力资本投资具有专用性，在契约不完备的情况下，在职培训可能会使企业被 “套牢”，进而导致企业人力资本投资不足(阳义南，2012)。企业年金的权益归属期限设定恰好可以解决人力资本投资不足的问题。企业年金相当于员工交 给企业的抵押物，员工并不能获得全部薪酬，其若在接受培训后提前离职，将会损失企业年金。因此，企业年金使得员工无法以“终止就业关系”威胁企业，这有利于企业增加人力资本投资，提升人力资本水平。

(三)减少离职率，稳定优秀员工

创新是一个持续输出的过程，职工的离职率会影响企业创新的成功率。现有研究表明，合理高效的年金制度有利于提高员工的劳动生产率和减少员工的流动，有利于为员工提供稳定的工作环境，提高劳动生产效率，影响企业创新。

企业希望留住人才，对创新型人才进行投资培养并与他们进行长期的合作，企业年金相当于一种隐形的“契约性合同”，其建立有助于维持这种长期的合作关系，起到预防企业创新型人才的流失，约束企业创新型人才跳槽的频率，吸引和留住创新型人才。

对于企业来说，人才的流失带来的损失是巨大的，因此对人力资本进行了专项投资的企业建立年金计划的意愿更高。对于从人力资本的培训中受益的员工来说，自身在人力培训中所承担的费用在今后的工作中需要承担很高的成本。在成本收回之前，若员工跳槽到同一行业的其他企业中，那么对于原先的企业来说，不仅造成了公司人力资本的损失，还会直接面临着同一行业的竞争压力。而企业年金计划的制定对于以上情况具有良好的抑制作用，有利于稳定员工队伍，留住创新型人才，促进企业创新。

合理有效的企业年金制度有利于激励员工提高责任感和归属感，从而增强企业的劳动生产率，推动企业创新发展。另外，企业年金实质是一种延期付款，分期付款返回转移机制，提高员工裸辞的成本，员工离职率降低表现为企业更加的稳定，熟练的员工更了解企业的运作方式和操作规则，能为企业节省部分培训和管理成本。最后，企业年金能够弥补企业对员工培训投资不足的问题，经实践证明，培训后的员工在本企业工作的时间越长，所带来的效益的增加量就越多，企业也可以收回人力培训的成本，反馈到人力资本上，又可以促进企业继续对人力资本进行更多的投资，进而形成良性的循环，不断提高企业员工的专业技能，促进企业创新。

(四)薪酬激励作用

激励作为人力资源管理中的重要部分，是激发员工工作积极性的必要手段，对人才创新及有效人力资源管理具有重要意义。大部分学者认为企业年金计划作为一种长期激励机制，在员工激励方面体现为持续的创新激励、高效率的工作状态、退休养老压力减轻、归属感增强、企业忠诚度提高等，能够进一步实现企业员工参与企业效益分配与管理，是企业鼓励创新、奖励忠诚和提高创新型人才竞争力的有效手段。

多数学者认为，企业年金的激励效应会提高企业员工的生产效率，员工高效率的工作状态是企业创新的基础前提。王海艳(2019)认为年金不仅能够从长远的角度吸引员工，也能在一定程度上对员工行为产生一定的激励作用，这是一种保健作用额激励因素，在一定程度上能够使员工认识到企业的文化，进而增强自己的归属感和认同感。张琼(2016)认为企业年金能够在很大程度上满足员工的养老需求并且企业年金的设立能够在一定程度上改善企业的绩效。此外，相关的企业在实行企业年金的时候将年金的数额与员工的绩效挂钩，员工在工作的时候会具有更大的积极性，员工对企业的忠诚度得到提升，员工与企业之间的劳资关系也能够得到有效改善，从而企业的生产效率得到了很大的提升，企业也就能够因此而得到更大的发展，因此企业更具备创新潜力。程远，于新亮等(2017)提出企业年金具有 “甄别效应”和“激励效应”。高生产率员工更可能选择加入企业年金，说明企业年金具有在信息不对称情况下甄别高生产率员工的“甄别效应”。参加企业年金令员工的生产效率更高，说明企业年金具有提高员工生产率的“激励效应”，且效果明显。刘祥林等(2006)认为企业年金制度有助于激励高层管理者的长期化行为，在解决代理问题，保护股东利益方面有重大的意义。企业年金既有薪酬的基本特点，也有社会养老保险的特点，单令彬(2017)认为企业年金具有后置性激励和税惠激励。企业年金的后置性权益归属特征能在一定程度上约束员工和管理者的行为，激励其为企业做出长期性、高质量的服务，提高企业投资和经营效率，降低投资者对投资风险的预期，降低资本成本。年金制度能够在一定程度上长期约束员工的行为，稳定员工与企业的长期关系，能够激励员工，尤其是工作年限较短的员工的长期良好表现。而税惠激励能进一步稳定职工队伍、降低不必要的人力资源转换成本，激励职工提高生产经营效率。

假设 2：企业年金对企业创新具有消极影响

(一)增加企业财务负担，影响企业创新投入

企业年金所导致的财务负担加重可能会直接影响研发投资。根据投资理论，投资项目的处置价值是企业投资决策的重要影响因素。用工成本越高，意味着投资项目的处置价值越低，企业也越有可能放弃投资 (Bai et al.，2020)。卢闯等(2015)发现，用工成本上升所带来的成本增加、盈利下降会导致企业投资不足。由于企业年金增加了用工成本，导致企业的研发投资收益降低，所以企业年金会对研发投资产生抑制作用。廖冠民和陈燕(2014)的研究显示，用工成本增加导致企业的经营杠杆率显著上升。可见，企业年金所带来的用工成本增加会抑制企业的研发投资。

(二)“短视行为”对企业创新的消极影响

| | |
|---|---|
| 总的创新数量(PAT) | 某企业当年申请的总专利数 |
| 发明型创新数量(INO) | 某企业当年申请的发明型专利数 |
| 实用新型创新数量(PRA) | 某企业当年申请的实用新型专利数 |
| 外观设计型创新数量(DES) | 某企业当年申请的外观设计型专利数 |
| 创新质量(PAT_) | 某企业实际授权的总专利数 |
| 发明型创新质量(INO_) | 某企业实际授权的发明型专利数 |
| 实用新型创新质量(PRA_) | 某企业实际授权的实用新型专利数 |
| 外观设计型创新质量(DES_) | 某企业实际授权的外观设计型专利数 |
| 企业年金虚拟变量(PENSION) | 若该公司覆盖有企业年金计划，则该变量取 1，否则取 0 |
| 人均税前薪酬(SALARY) | 人均税前薪酬的自然对数 |
| 分析师关注度(AF) | 分析师关注程度 AF，AF＝Ln(1+分析师跟踪人数) |
| 研发支出占比(R&D) | 研发支出占上年年末总资产比例与 100 的乘积 |
| 可抵押资产(FIX) | 固定资产净值与总资产之比 |
| 机构投资者持股(INS) | 机构投资者持股比例 |
| 托宾 q 值(TOBIN_Q) | 市值与资产总计之比 |
| 企业利润率(PROFIT) | 企业营业利润与主营业务收入之比 |
| 资产收益率(ROA) | 净利润与总资产之比 |
| 企业规模(SIZE) | 总资产的自然对数 |
| 是否国有(SOE) | 如果企业最终控制人为国有，则取值为 1，否则为 0 |
| 企业成立年限(AGE) | 上市年限的自然对数 AGE |
| 杠杆比率(LEV) | 总负债与总资产之比 |
| 人均 GDP(RJGDP) | 人均 GDP |

企业年金是员工工资的一部分，由于员工对企业年金的认识片面，存在利益短视行为。具有“短视行为”的员工会认为企业年金减少了其现时效用。因此对企业年金具有抵触心理，从而消极怠工，影响企业创新。其次，由于企业年金全员覆盖的特性，员工可能存在“躺平”心理，自己已经没有了养老的“后顾之忧”，即不用努力工作也有企业年金，退休后的生活也能得到保障。

## 4.研究方法

### 4.1 实证计量模型

为了检验上文所提出的企业年金对企业创新的影响假设，本文构建了如下计量模型：

$$\text{Innovation}_{it+1} = \propto_i + \beta_1 Pension_{it} + \sum \gamma_j Control_{it} + Indu_j + Year_t + province_x + \varepsilon_{it}$$

其中，为 INNOVATION 为 t+1 期公司 i 的总的专利数以及发明型专利数、实用新型和外观设计三种专利申请数量代表企业创新数量，其授权数量代表专利申请质量；PENSION 是企业年金虚拟变量，只要公司 i 某年度实施了企业年金，则认为该公司为实行企业年金的企业，只要公司 i 某年度实施了企业年金，变量则取 1，否则取 0。CONTROL 为控制变量，主要包括税前薪酬 SALARY、分析师关注人数 AF、研发支出占比 R&D、固定资产占比 FIX、机构投资者持股 INS、托宾 Q 值 TOBIN_Q、企业利润率 PROFIT、资产收益率 ROA、公司规模 SIZE、是否国有企业 SOE、企业成立年限 AGE、杠杆比率 LEV、人均 GDP 等变量。由于创新变量可能存在时间趋势，而且不同行业创新活跃程度不一样，因此本文在模型中加入了 indu、year、province 三组虚拟变量，来控制行业与时间相关的固定效应，本文采用 t+1 期的创新变量对 t 期的 PENSION 和 CONTROL 等解释变量进行回归。由于数据为明显的非平衡面板数据，因此本文采用面板回归方法来估计模型的系数。

## 4.2 变量及其解释

## 4.3 样本与数据

本文的样本期间为 2007——2019 年，样本包括了该期间所有能够获得完整数据的 A 股上市公司，共计 39709 个年度——公司观测值。没有考察 2007 年之前的样本是因为我国 2006 年颁布的《企业会计准则第 9 号——应付职工薪酬》要求企业在财务报表附注中披露企业年金的期初余额、本期发生额及期末余额，因而 2007 年是可获得企业年金数据的最早年份。

本文数据的来源于 Wind 和 CSMAR 数据库，对初始研究样本进行了如下处理：

(1)剔除金融类上市公司；

(2)剔除经营状况异常的 ST、*ST 上市公司；

(3)剔除相关变量缺失的观测值；

(4)为了消除异常值的影响，本文对所有连续变量在 1%和 99%分位数上进行了缩尾处理。

(5)剔除企业职工人数少于 100 的公司。

本文最终获得 39029 个样本观测值，涉及 3097 家 A 股上市公司，其中涉及 990 家覆盖企业年金的公司。

## 4.4 实证结果与分析

### 4.4.1 描述性统计

表 1 报告了主要变量的描述性统计结果。两组对比的结果显示，无论是创

新数量还是创新质量，覆盖了企业年金计划的企业(PENSION=1)的均值均高于没有覆盖企业年金计划的企业(PENSION=0)，这可能覆盖了企业年金的企业创新水平更高。覆盖企业年金计划的企业职工平均薪酬、可抵押资产、机构投资者持股比例、企业规模、企业年龄及资产负债率的均值均高于没有覆盖企业年金计划的企业；而在研发支出、企业利润率及资产收益率的均值却低于没有覆盖企业年金计划的企业。

4.4.2 回归结果

表 2 列示了多元回归分析结果。表 2 的结果分为两部分：首先，第(1)部分为创新数量，创新数量有四个指标，分别是总的创新数量及发明型创新数量、实用新型创新数量、外观设计型创新数量，回归分析中均加入了年度、行业及地区的固定效应作为控制变量，结果显示，PENSION 的回归系数显著为正；第(2)部分为创新质量，创新质量也有四个指标，分别是总的创新质量及发明型创新质量、实用新型创新质量、外观设计型创新质量，结果亦显示，在控制年度、行业、地区等层面的不变因素后，PENSION 的回归系数依然在 5% 的置信水平显著为正。因此，这就初步验证了假设 1，即实施年金计划能够促进企业的创新水平。

4.4.3 中介效应分析

接下来，本文进一步高素质人才是否在企业年金影响企业创新的过程中发挥中介作用。借鉴温忠麟等(2004)提出的中介效应检验程序，本文进行以下几步检验：第一步，检验解释变量创新数量和创新质量对被解释变量企业年金(PENSION)的回归系数，若显著则继续第二步，否则终止检验；第二步，检验企业年金(PENSION)对高素质人才(HIGH)的回归系数，若显著，则进行第三步；第三步，将高素质人才(HIGH)纳入第一步的模型中，如果企业年金(PENSION)和高素质人才(HIGH)的系数都显著，则说明存在部分中介效应，如果企业年金(PENSION)系数不显著而高素质人才(HIGH)系数显著，则是完全中介效应；此外，如果第二步的企业年金(PENSION)和第三步的高素质人才(HIGH)所得系数中有不显著的，则要做 Sobel 检验判断中介效应是否存在。

中介效应的检验结果见表 3-5。实证结果表明，第一步中，企业年金(PENSION)对总体创新数量(PAT)、发明型创新数量(INO)、实用新型创新数量(PRA)和总体创新质量(PAT_)、发明型创新质量(INO_)、实用新型创新质量(PRA_)回归系数均显著，与上文一致；第二步中，企业年金(PENSION)与高素质人才(HIGH)显著正相关，说明覆盖企业年金之后，公司的高素质人才数量显著上升，公司人力资源结构改善；第三步结果显示，高素质人才(HIGH)公司总的创新数量(PAT)、发明型创新数量(INO)及发明型创新质量(INO_)的系数显著为正，说明企业年金对发明型创新具有完全中介效应。进一步地，检验其 sobel 系数，未展示的结果表明，其 sobel 系数均显著。

表1 描述性统计结果

| PENSION=0 | | | | | | |
|---|---|---|---|---|---|---|
| 变量 | 观测值 | 均值 | 标准差 | 25%分位数 | 中位数 | 75%分位数 |
| PAT | 10440 | 43.20 | 83.55 | 7.00 | 18.00 | 45.00 |
| INO | 10440 | 17.44 | 35.64 | 2.00 | 6.00 | 17.00 |
| PRA | 10453 | 20.00 | 41.69 | 2.00 | 7.00 | 20.00 |
| DES | 10406 | 4.33 | 12.39 | 0.00 | 0.00 | 3.00 |
| PAT_ | 10445 | 31.67 | 63.53 | 4.00 | 13.00 | 32.00 |
| INO _ | 10447 | 5.82 | 13.97 | 0.00 | 1.00 | 5.00 |
| PRA_ | 10453 | 19.95 | 41.56 | 2.00 | 7.00 | 20.00 |
| DES _ | 10406 | 4.31 | 12.35 | 0.00 | 0.00 | 3.00 |
| SALARY | 13846 | 11.51 | 0.43 | 11.22 | 11.48 | 11.77 |
| AF | 12783 | 2.04 | 0.86 | 1.39 | 2.08 | 2.71 |
| RD | 20504 | 4.64 | 3.58 | 2.72 | 3.80 | 5.60 |
| FIX | 18136 | 0.21 | 0.14 | 0.10 | 0.18 | 0.29 |
| INS | 15834 | 32.16 | 22.83 | 11.35 | 29.84 | 49.85 |
| TOBIN Q | 15937 | 2.06 | 1.09 | 1.35 | 1.72 | 2.39 |
| PROFIT | 22446 | 13.22 | 12.32 | 6.00 | 11.83 | 19.25 |
| ROA | 22255 | 9.97 | 7.89 | 4.65 | 8.52 | 14.00 |
| SIZE | 21581 | 7.23 | 1.10 | 6.44 | 7.17 | 7.95 |
| SOE | 25950 | 0.17 | 0.37 | 0.00 | 0.00 | 0.00 |
| AGE | 26039 | 20.58 | 4.79 | 17.00 | 20.00 | 24.00 |
| LEV | 22367 | 39.34 | 18.55 | 24.41 | 38.56 | 53.24 |
| RJGDP | 26667 | 43827 | 15470 | 30808 | 43684 | 54139 |
| PENSION=1 | | | | | | |
| 变量 | 观测值 | 均值 | 标准差 | 25%分位数 | 中位数 | 75%分位数 |
| PAT | 5537 | 65.21 | 134.80 | 6.00 | 17.00 | 57.00 |
| INO | 5538 | 27.14 | 59.22 | 2.00 | 6.00 | 22.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| PRA | 5523 | 30.23 | 63.85 | 1.00 | 7.00 | 25.00 |
| DES | 5570 | 4.40 | 13.77 | 0.00 | 0.00 | 2.00 |
| PAT | 5531 | 47.22 | 97.32 | 4.00 | 13.00 | 41.00 |
| INO | 5529 | 9.74 | 22.34 | 0.00 | 2.00 | 8.00 |
| PRA | 5523 | 30.17 | 63.75 | 1.00 | 7.00 | 25.00 |
| DES | 5570 | 4.39 | 13.76 | 0.00 | 0.00 | 2.00 |
| SALARY | 7171 | 11.70 | 0.49 | 11.37 | 11.68 | 12.03 |
| AF | 7974 | 1.93 | 0.88 | 1.10 | 1.95 | 2.64 |
| RD | 6535 | 2.26 | 2.46 | 0.38 | 1.51 | 3.45 |
| FIX | 10845 | 0.25 | 0.18 | 0.10 | 0.22 | 0.38 |
| INS | 10879 | 43.40 | 22.11 | 27.02 | 44.74 | 60.93 |
| TOBIN Q | 10763 | 1.830 | 1.07 | 1.14 | 1.46 | 2.09 |
| PROFIT | 11352 | 9.41 | 13.26 | 2.62 | 6.83 | 14.49 |
| ROA | 11523 | 6.08 | 6.00 | 2.95 | 5.18 | 8.36 |
| SIZE | 11145 | 7.95 | 1.29 | 7.08 | 7.95 | 8.80 |
| SOE | 11747 | 0.75 | 0.43 | 0.00 | 1.00 | 1.00 |
| AGE | 11805 | 23.97 | 4.88 | 21.00 | 24.00 | 27.00 |
| LEV | 11411 | 51.82 | 19.13 | 37.98 | 52.79 | 66.60 |
| RJGDP | 12314 | 43783 | 15462 | 30808 | 43684 | 54139 |

表2 回归结果

| | 创新数量 | | | | 创新质量 | | | |
|---|---|---|---|---|---|---|---|---|
| | PAT | INO | PRA | DES | PAT_ | INO_ | PRA_ | DES_ |
| L.PENSION | 13.520** | 6.297** | 5.659* | 1.086 | 8.625* | 1.592** | 5.668* | 1.085 |
| | (-2.07) | (-2.12) | (-1.81) | (-1.25) | (-1.83) | (-2.37) | (-1.82) | (-1.25) |
| L.SALARY | 38.363*** | 16.508*** | 17.159*** | 1.874*** | 24.063*** | 4.859*** | 17.193*** | 1.854*** |
| | (-8.77) | (-7.78) | (-7.89) | (-3.1) | (-7.23) | (-7.25) | (-7.94) | (-3.07) |
| L.AF | 6.228*** | 2.067** | 2.960*** | 0.538** | 4.219*** | 1.191*** | 2.929*** | 0.544** |
| | (-3.66) | (-2.44) | (-3.45) | (-2.25) | (-3.19) | (-3.73) | (-3.43) | (-2.28) |
| L.RD | 2.450*** | 1.693*** | 0.837*** | 0.148** | 1.181*** | 0.609*** | 0.833*** | 0.149** |
| | (-4.56) | (-6.49) | (-3.13) | (-2) | (-2.88) | (-7.36) | (-3.13) | (-2) |
| L.FIX | -67.816*** | -29.797*** | -28.598*** | -7.707*** | -39.625*** | -10.223*** | -28.499*** | -7.644*** |
| | (-5.40) | (-4.90) | (-4.59) | (-4.45) | (-4.16) | (-5.49) | (-4.59) | (-4.42) |
| L.INS | 0.029 | -0.007 | -0.016 | 0.004 | -0.02 | 0.001 | -0.018 | 0.004 |
| | (-0.48) | (-0.22) | (-0.52) | (-0.49) | (-0.43) | (-0.08) | (-0.60) | (-0.49) |
| L.TOBIN_Q | -1.183 | 0.269 | -1.451** | 0.125 | 0.949 | 0.17 | -1.364** | 0.123 |
| | (-0.96) | (-0.44) | (-2.33) | (-0.72) | (-0.99) | (-0.7) | (-2.20) | (-0.71) |
| L.PROFIT | 0.431** | 0.181* | 0.318*** | -0.051* | 0.295* | 0.035 | 0.317*** | -0.052* |
| | (-2.13) | (-1.83) | (-3.15) | (-1.82) | (-1.9) | (-1.01) | (-3.15) | (-1.84) |
| L.ROA | -0.346 | -0.093 | -0.282 | 0.175*** | -0.043 | -0.091 | -0.282 | 0.174*** |
| | (-0.92) | (-0.51) | (-1.50) | (-3.33) | (-0.15) | (-1.401 | (-1.50) | (-3.32) |
| L.SIZE | 41.623*** | 17.743*** | 18.784*** | 3.376*** | 27.174*** | 4.503*** | 18.727*** | 3.370*** |
| | (-17.88) | (-16.24) | (-16.54) | (-10.71) | (-15.76) | (-15.09) | (-16.56) | (-10.7) |
| L.SOE | 2.768 | 2.655 | -0.694 | 0.202 | 0.101 | 0.785 | -0.658 | 0.209 |
| | (-0.48) | (-1.01) | (-0.25) | (-0.26) | (-0.02) | (-1.31) | (-0.24) | (-0.27) |
| L.AGE | -0.861* | -0.319 | -0.562** | -0.114* | -0.829** | -0.105** | -0.566** | -0.115* |
| | (-1.68) | (-1.37) | (-2.29) | (-1.68) | (-2.25) | (-1.99) | (-2.32) | (-1.69) |
| L.LEV | 0.245** | 0.192*** | 0.181*** | -0.026* | 0.252*** | 0.048*** | 0.180*** | -0.026* |
| | (-2.24) | (-3.63) | (-3.33) | (-1.70) | (-3.03) | (-2.89) | (-3.33) | (-1.70) |
| L.RJGDP | 0 | 0 | 0.000** | 0 | -0.001*** | -0.001*** | 0.000** | 0 |
| | (-1.26) | (-0.38) | (-2.33) | (-1.07) | (-4.09) | (-14.95) | (-2.11) | (-1.04) |
| 时间效应 | Y | Y | Y | Y | Y | Y | Y | Y |
| 行业效应 | Y | Y | Y | Y | Y | Y | Y | Y |
| 地区效应 | Y | Y | Y | Y | Y | Y | Y | Y |
| _cons | 796.353** | 338.806** | 361.655** | -48.644*** | 450.870** | -46.655*** | 359.816** | -48.302*** |
| | (-13.59) | (-12.09) | (-12.52) | (-6.07) | (-10.24) | (-5.33) | (-12.51) | (-6.04) |
| N | 4625 | 4616 | 4625 | 4615 | 4631 | 4629 | 4625 | 4615 |

第一步：

表 3

| | 创新数量 | | | | 创新质量 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | PAT | INO | PRA | DES | PAT | INO | PRA | DES |
| PENSION | 13.455** | 4.396* | 6.278** | 0.788 | 8.308* | 1.532** | 6.311** | 0.792 |
| | (2.28) | (1.67) | (2.16) | (0.98) | (1.90) | (2.31) | (2.18) | (0.98) |
| 控制变量 | Y | Y | Y | Y | Y | Y | Y | Y |
| 时间效应 | Y | Y | Y | Y | Y | Y | Y | Y |
| 行业效应 | Y | Y | Y | Y | Y | Y | Y | Y |
| 地区效应 | Y | Y | Y | Y | Y | Y | Y | Y |
| N | 6111 | 6103 | 6111 | 6092 | 6114 | 6106 | 6111 | 6092 |

第二步：

表 4

| | 中间变量 |
|---|---|
| | (9) |
| | HIGH |
| PENSION | 0.511** |
| | (2.89) |
| 控制变量 | Y |
| 时间效应 | Y |
| 行业效应 | Y |
| 地区效应 | Y |
| N | 8344 |

第三步：

表 5

| | 创新数量 | | | | 创新质量 | | | |
|---|---|---|---|---|---|---|---|---|
| | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) |
| | PAT | INO | PRA | DES | PAT | INO | PRA | DES |
| PENSION | 8.025 | 1.847 | 2.700 | 0.515 | 3.319 | 1.289* | 2.710 | 0.524 |
| | (1.09) | (0.58) | (0.77) | (0.57) | (0.63) | (1.65) | (0.78) | (0.58) |
| HIGH | 2.672*** | 1.642*** | 0.199 | 0.090 | 0.470 | 0.364*** | 0.195 | 0.090 |
| | (5.92) | (7.76) | (0.91) | (1.57) | (1.43) | (5.61) | (0.90) | (1.56) |
| 控制变量 | Y | Y | Y | Y | Y | Y | Y | Y |
| 时间效应 | Y | Y | Y | Y | Y | Y | Y | Y |
| 行业效应 | Y | Y | Y | Y | Y | Y | Y | Y |
| 地区效应 | Y | Y | Y | Y | Y | Y | Y | Y |
| N | 4493 | 4485 | 4493 | 4482 | 4496 | 4488 | 4493 | 4482 |

## 4.5 稳健性检验

4.5.1 缩短样本区间

由于我国在 2011 年人力资源社会保障部、银监会、证监会、保监会修订了《企业年金基金管理办法》，优化完善了监督管理机制并调整了企业年金的投资范围、投资比例，标志着我国企业年金开始逐步走向完善，因此本文选取 2011 年以后的企业年金数据区间重新进行面板回归，表 6 展示了其结果，结果表明，本文的结论依旧成立

表 6

| | PAT | INQ | PRA | DES | PAT | INQ | PRA | DES |
|---|---|---|---|---|---|---|---|---|
| L.PENSION | 13.580** | 5.744* | 5.177 | 1.048 | 8.184* | 1.693** | 5.186 | 1.048 |
| | (2.04) | (1.91) | (1.62) | (1.19) | (1.72) | (2.56) | (1.63) | (1.19) |
| L.SALARY | 39.705*** | 17.119*** | 17.445*** | 2.102*** | 24.113*** | 4.641*** | 17.482*** | 2.081*** |
| | (8.59) | (7.64) | (7.64) | (3.30) | (6.88) | (6.95) | (7.69) | (3.27) |
| L.AF | 6.344*** | 2.131** | 2.844*** | 0.591** | 4.127*** | 0.995*** | 2.812*** | 0.597** |
| | (3.56) | (2.40) | (3.19) | (2.37) | (2.99) | (3.12) | (3.17) | (2.39) |
| L.RD | 2.332*** | 1.724*** | 0.839*** | 0.135* | 1.182*** | 0.572*** | 0.835*** | 0.135* |
| | (4.15) | (6.35) | (3.03) | (1.74) | (2.78) | (7.02) | (3.03) | (1.75) |
| L.FIX | 69.505*** | 30.563*** | 28.791*** | -8.816*** | 40.788*** | -9.721*** | 28.692*** | -8.749*** |
| | (-5.32) | (-4.84) | (-4.47) | (-4.90) | (-4.12) | (-5.29) | (-4.47) | (-4.87) |
| L.INS | 0.031 | -0.014 | -0.015 | 0.003 | -0.015 | 0.002 | -0.017 | 0.003 |
| | (0.48) | (-0.43) | (-0.46) | (0.36) | (-0.30) | (0.19) | (-0.54) | (0.35) |
| L.TOBIN_Q | -0.581 | 0.309 | -1.334** | 0.157 | 1.028 | 0.183 | -1.243** | 0.155 |
| | (-0.46) | (0.49) | (-2.10) | (0.88) | (1.04) | (0.76) | (-1.97) | (0.87) |
| L.PROFIT | 0.397* | 0.166 | 0.318*** | -0.058** | 0.259 | 0.023 | 0.317*** | -0.058** |
| | (1.88) | (1.60) | (3.02) | (-1.96) | (1.60) | (0.69) | (3.03) | (-1.97) |
| L.ROA | -0.366 | -0.128 | -0.317 | 0.187*** | 0.023 | -0.061 | -0.317 | 0.186*** |
| | (-0.91) | (-0.65) | (-1.58) | (3.33) | (0.07) | (-0.93) | (-1.59) | (3.32) |
| L.SIZE | 42.552*** | 18.233*** | 19.294*** | 3.469*** | 27.705*** | 4.315*** | 19.235*** | 3.463*** |
| | (17.70) | (16.21) | (16.51) | (10.67) | (15.63) | (14.62) | (16.53) | (10.66) |
| L.SOE | 2.216 | 2.284 | -0.879 | 0.155 | -0.413 | 0.497 | -0.842 | 0.162 |
| | (0.38) | (0.86) | (-0.31) | (0.20) | (-0.10) | (0.85) | (-0.30) | (0.21) |
| L.AGE | -0.945* | -0.304 | -0.601** | -0.114 | -0.864** | -0.099* | -0.605** | -0.114* |
| | (-1.81) | (-1.29) | (-2.41) | (-1.64) | (-2.32) | (-1.91) | (-2.43) | (-1.65) |
| L.LEV | 0.196* | 0.180*** | 0.154*** | -0.030** | 0.215** | 0.045*** | 0.153*** | -0.029* |
| | (1.72) | (3.26) | (2.73) | (-1.88) | (2.49) | (2.76) | (2.72) | (-1.87) |
| L.RJGDP | 0.001* | -0.000 | 0.000*** | 0.000 | -0.001*** | -0.001*** | 0.000*** | 0.000 |
| | (1.76) | (-0.57) | (3.05) | (0.33) | (-5.51) | (-21.43) | (2.71) | (0.28) |
| 固定时间 | Y | Y | Y | Y | Y | Y | Y | Y |
| 固定行业 | Y | Y | Y | Y | Y | Y | Y | Y |
| 固定地区 | Y | Y | Y | Y | Y | Y | Y | Y |
| N | 4370 | 4361 | 4370 | 4361 | 4376 | 4377 | 4370 | 4361 |

## 5. 进一步分析

### 5.1 企业年金对企业创新的影响程度在不同企业间的差异

#### 5.1.1 劳动密集度与平均工资水平的影响

企业年金计划旨在提高职工退休后的生活水平，职工的工资越低，在同等条件下企业年金对其发挥的边际效用越大，而工资相对较低的职工大多处于需要大量劳动力的劳动密集型企业。企业年金计划的实施能够直接影响到这些低收入劳动者退休后的工资水平，使得劳动密集型企业受企业年金计划的影响也较其他企业严重。此外，虽然企业实施企业年金计划会使企业的总支出显著增加，但是对于平均工资水平较低的企业职工而言，企业年金相当于企业给职工

转移一笔“额外的财富”，企业年金计划对职工的影响程度显然更强，因此对企业创新的影响程度也较强。基于此，本文预期，企业年金对企业创新的影响，主要存在于劳动密集度较高或工资水平较低的企业。结果如表 7 和表 8 所示，与本文预期一致。

表 7　劳动密集度的影响

| | 劳动密集度低 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PAT | INO | PRA | DES | PAT_ | INO_ | PRA_ | DES_ |
| PENSION | 17.323* | 9.220 | 7.713* | 2.337** | 5.937 | 6.007 | 0.753 | 0.754 |
| | (-1.84) | (-1.38) | (-1.74) | (-2.41) | (-1.23) | (-1.26) | (-0.62) | (-0.63) |
| 控制变量 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 时间效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 行业效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 地区效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| N | 2112 | 2117 | 2110 | 2117 | 2114 | 2114 | 2116 | 2116 |
| | 劳动密集度高 | | | | | | | |
| | PAT | INO | PRA | DES | PAT_ | INO_ | PRA_ | DES_ |
| PENSION | 4.401 | 0.542 | 3.151 | 1.835 | 5.72 | -0.207 | 3.119 | 1.829 |
| | (0.54) | (0.16) | (0.84) | (1.64) | (0.96) | (-0.23) | (0.84) | (1.63) |
| 控制变量 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 时间效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 行业效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 地区效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| N | 2513 | 2506 | 2511 | 2499 | 2514 | 2512 | 2511 | 2499 |

表 8　平均工资水平的影响

| | 平均工资水平低 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PAT | INO | PRA | DES | PAT_ | INO_ | PRA_ | DES_ |
| PENSION | 15.162* | 7.452** | 4.17 | 1.539 | 10.760* | 3.243** | 4.198 | 1.548 |
| | (-1.9) | (-2.24) | (-1) | (-1.1) | (-1.69) | (-2.47) | (-1.01) | (-1.11) |
| 控制变量 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 时间效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 行业效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 地区效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| N | 1408 | 1408 | 1407 | 1403 | 1408 | 1410 | 1407 | 1403 |
| | 平均工资水平高 | | | | | | | |
| | PAT | INO | PRA | DES | PAT_ | INO_ | PRA_ | DES_ |
| PENSION | 10.527 | 3.701 | -4.990 | 0.87 | 4.437 | 4.468 | 0.285 | 0.303 |
| | (0.66) | (0.35) | (-0.78) | (0.47) | (0.65) | (0.65) | (0.16) | (0.18) |
| 控制变量 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 时间效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 行业效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 地区效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| N | 834 | 839 | 827 | 837 | 836 | 836 | 831 | 831 |

5.1.2 企业面临融资约束时的影响

在面临更为严重的融资约束环境时，企业年金的作用会更加显著。企业提供年金计划可以从以下三个方面增加企业财务宽松：一是中国的企业年金费用在工资总额一定比例或标准以内的部分可计入成本，免征企业所得税。由于企业边际所得税率递增，通过建立企业年金，企业不仅可以获得税收优惠，而且能够降低企业实际所得税率，获得一部分额外税收补贴(Black，1980)；二是企业的经营状况与是否建立企业年金的决策高度相关(Chen et al.，2013)，年金计划的建立可以作为企业生产经营状况良好的信号，进而得到信贷机构较高的信用评价，并以更大的可能性获得融资；三是中国的企业年金采取市场化运作。企业建立年金计划的资金须委托金融机构管理和投资，人力资源和社会保障部批准的 26 个年金管理机构资格中就有 12 家商业银行，这使得企业可以通过企业年金业务与金融机构建立长期合作关系。而银行与企业间的长期关系有助于企业获得关系型贷款，降低其贷款利率，减少抵押和担保要求(Berger and Gregory，1995；邓超等，2010)。余新亮等(2016)也指出企业年金能够增加财务宽松，降低企业融资约束，企业年金增加融资宽松得到国外实践和研究的证实(Friedman，1984；Bartram，2012)。因此，在同等条件下实施企业年金计划的公司有着更高的筹集资金的能力，更容易获得外部融资，帮助企业降低资本成本、缓解融资约束，促进企业创新更为显著。结果如表 9 所示，与本文预期一致。

表 9 企业面临融资约束时的影响

| | 融资约束低 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PAT | INO | PRA | DES | PAT_ | INO_ | PRA_ | DES_ |
| | (0.95) | (1.32) | (0.76) | (0.58) | (0.44) | (0.66) | (0.74) | (0.57) |
| PENSION | 8.122 | 4.697 | 2.811 | 0.654 | 2.445 | 0.553 | 2.738 | 0.647 |
| | (0.95) | (1.32) | (0.76) | (0.58) | (0.44) | (0.66) | (0.74) | (0.57) |
| 控制变量 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 时间效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 行业效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 地区效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| N | 2319 | 2315 | 2317 | 2310 | 2320 | 2321 | 2317 | 2310 |
| | 融资约束高 | | | | | | | |
| | PAT | INO | PRA | DES | PAT_ | INO_ | PRA_ | DES_ |
| PENSION | 18.467** | 7.217* | 7.055* | 1.268 | 12.314** | 2.275** | 7.125* | 1.281 |
| | (2.22) | (1.82) | (1.69) | (1.13) | (2.00) | (2.22) | (1.71) | (1.14) |
| 控制变量 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 时间效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 行业效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 地区效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| N | 2306 | 2301 | 2308 | 2305 | 2311 | 2308 | 2308 | 2305 |

5.1.3 股权集中度的影响

一般来说，在成长性的企业股权集中度较高，企业的用人需求标准更高，对创新的需求也更大。企业的成长性越高，企业维持高成长所需要的资源就越多，从而在遭遇负面冲击时企业继续投入大量资源的难度就越大；企业的规模越小，其所控制的资源就越少，可以用于抵押担保的资源也越少，从而小规模企业抵御风险的能力越差；企业经营活动产生的现金净流量越少，意味着企业单位利润所带来的现金流越少，从而企业在面临危机时陷入现金流短缺的可能性越高。因此，企业年金的边际价值在股权集中高的公司会发挥更大的作用。结果如表 10 所示，股权集中高的企业，其企业年金对企业创新产生显著影响。

表 10　股权集中度的影响

| | 股权集中度低 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PAT | INO | PRA | DES | PAT_ | INO_ | PRA_ | DES_ |
| PENSION | -7.377 | 5.622 | -3.456 | 1.611 | -1.250 | -0.653 | -3.483 | 1.611 |
| | (-0.60) | (0.89) | (-0.59) | (1.14) | (-0.17) | (-0.44) | (-0.60) | (1.14) |
| 控制变量 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 时间效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 行业效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 地区效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| N | 1174 | 1171 | 1176 | 1181 | 1175 | 1179 | 1176 | 1181 |
| | 股权集中度高 | | | | | | | |
| | PAT | INO | PRA | DES | PAT_ | INO_ | PRA_ | DES_ |
| PENSION | 30.199* | 13.808** | 14.671* | 2.140 | 25.427** | 5.492** | 14.789* | 2.143 |
| | (1.79) | (1.99) | (1.90) | (1.04) | (2.02) | (2.50) | (1.92) | (1.05) |
| 控制变量 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 时间效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 行业效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| 地区效应 | 是 | 是 | 是 | 是 | 是 | 是 | 是 | 是 |
| N | 1015 | 1018 | 1012 | 1005 | 1014 | 1014 | 1012 | 1005 |

## 6.结论及建议

### 6.1 结论

本文利用 2007-2019 年 A 股上市公司的企业年金缴费数据，实证检验了企业年金与企业创新水平的关系。研究结果显示：(1)企业年金有助于提升企业的创新水平；(2)企业年金通过吸引行业内高素质人才，优化企业人力资本结构来达到促进企业创新产出；(3)在具备平均工资水平低、劳动密集度低、融资约束大、股权集中度高等特征的企业，企业年金会显著增加企业的创新产出，且所导致的财务负担增加对企业创新绩效的影响较小，其带来的对企业创新投资的“挤出效应”较小。

### 6.2 政策建议

市场化主体应转变观念，推动企业年金的健康发展。党的十九大报告提出全面建成多层次社会保障体系的目标，而多层次社会保障体系中的企业年金发

展较为缓慢，影响到构建多层次社会保障体系这一目标的实现。本文的研究表明，企业年金的积极作用不仅体现在宏观层面，其对微观企业的人才队伍建设也有着积极的促进作用，有利于提高企业的核心竞争力。因此，作为市场化主体的企业年金管理机构应加强对企业年金的宣传工作，转变企业对年金计划的片面认识，从而推动更多的企业实施年金计划。

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# 延期激励促进了企业创新吗？——基于企业年金的经验证据

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**关键词：** 企业年金；企业创新；人力资源管理；中介效应模型

**中文摘要.** 企业创新能力既是增强企业市场竞争力的重要手段，又是加快形成新发展格局的重要举措。习近平总书记 2020 年 9 月在湖南考察时曾指出，自主创新是企业的生命，是企业爬坡过坎、发展壮大的根本。创新，不仅是科技人员的天然使命，而且是广大基层员工的工作结晶。惠及所有员工的企业年金计划，作为企业为员工提供的养老福利，在公司治理方面起着重要的长期激励作用，继而会影响到企业创新。本文以 2007 年至 2019 年 A 股上市公司的面板数据为研究样本，探究企业年金计划是否会对企业创新能力产生影响，并从创新质量和创新数量两个维度来刻画企业创新能力。研究发现，企业年金计划对企业总的创新数量及创新质量均产生显著影响，本文将企业创新进一步地细分为发明型创新、实用新型创新及外观设计型创新，其中对发明型创新数与质量量的影响最为显著，对外观设计型创新的影响其次，对外观设计型创新的影响不显著；而且中介效应研究表明，企业年金计划对创新质量的影响主要是通过吸引与留住高素质人才这一作用机制实现的。进一步地，异质性研究表明，在劳动密集度低、平均工资水平低、融资约束程度高及股权集中度高的子样本中，企业年金计划对企业创新质量的影响更为显著，而相比之下，对于劳动密集度高、平均工资水平高、融资约束程度低及股权集中度低的子样本则不那么明显。此外，选用调整样本区间与被解析变量的方式进行稳健性检验。可见，为更好地促进企业创新能力的提升，企业年金计划已成为一个重要的突破口，因此企业管理层应根据实际情况合理设定企业年金计划，而政府也应该不断加大企业年金的宣传力度，旨在引导企业年金更快、更好地发展的同时提升企业创新能力，助推国家从制造大国向制造强国的转变。

# An Empirical Analysis on the Impact of Urban and Rural Residents' Basic Endowment Insurance on the Labor Supply of Rural Population--Based on the CHARLS data

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**Keywords:** Basic Endowment Insurance for Urban and Rural Residents, Labor supply, Differences-in-Differences model, Poverty alleviation of insurance.

**Abstract.** This article is supplemented by theoretical models from an empirical point of view to explore whether the Basic Endowment Insurance for Urban and Rural Residents has a more significant policy effect on the reduction of labor supply for the rural poor. This paper firstly models the impact of the Basic Endowment Insurance for Urban and Rural Residents on the labor supply of the rural population in the payment stage and the benefit receiving stage, and compares and analyzes the utility optimization problem model of these two stages. In terms of empirical research, this article uses data from the China Health and Pension Tracking Survey (CHARLS) in 2011, adopts a double-difference model, and uses the national poverty line as the standard to identify the poor, and divides the labor into four types

according to whether it is agricultural labor and whether it is self-employed. Then we respectively carry out regression analysis on different sub-samples with differences-in-differences model. In the robust test, the parallel trend hypothesis test is passed, which shows the applicability of the DID model. In the end, the Basic Endowment Insurance for Urban and Rural Residents reduces the labor supply of the rural population, especially for the poor, with more significant policy effects. Finally, this paper puts forward policy suggestions from the three aspects of insurance premium payment, fund management and pension payment, hoping to provide some ideas for curbing the phenomenon of returning to poverty and achieving long-term poverty alleviation.

## 1.引言

根据 2020 年中国统计年鉴数据，2019 年我国 65 周岁及以上人口数达到 1.76 亿，占总人口的 12.6%，且老年人口比例仍在逐年增长，我国老龄化趋势日趋严重。预计到 2040 年，65 岁及以上老年人口占总人口的比例将超过 20%。此外更多的年轻人选择进城务工，农村人口比例逐渐下降，农村独居老人日渐增多。由于农村老年人缺乏充足的养老保障，他们不得已继续提供劳动以获取经济收入。养老金对于农村老年人来说，是一项非常重要的非劳动性收入。

2009 年，新型农村社会养老保险(以下简称“新农保”)在全国 10%的县（市、区）开展试点。作为一项惠及民生的重大举措，新农保对保障农村居民基本生活、改善城乡二元结构有重要意义。但是在具体实施中，新农保政策的参保是否真正能够给农村居民提供养老保障，缓解农村居民的劳动压力，这一问题需要进一步分析。2014 年，新型农村社会养老保险和城镇居民社会养老保险合并为城乡居民基本养老保险，“新农保”这一政策名词成为了过去式。故本文的研究对象为“城乡居保”。

目前已有很多文献对养老金的收入效应进行了实证检验，但基于收入的边际效用递减这一特点，本文认为养老金可能对不同收入群体产生的效应不同。城乡居保政策是否对老年贫困人口有更强的正面作用，是否能更大程度地减轻老年贫困人口的劳动负担，本文主要对此展开研究。本文在考虑新农保的滞后性的基础上，实证检验了城乡居保的扶贫效用，这也在一定程度上响应了我国 2021 年全面脱贫攻坚取得胜利后如何维持胜利果实，遏制返贫现象的出现，进而实现长效扶贫。

## 2.文献综述

### 2.1 国外研究综述

国外学者的研究大部分是针对非洲国家、越南等地的社会养老金项目的研究。Börsch-supan（2000）研究发现在包括德国在内的欧洲多国，养老金激励是老年人劳动参与率下降并维持在相当低水平的重要原因。美国学者 Bertrand 等

（2001）在南非做了养老金计划的实验，实验得到，当家庭中老年人领取到养老金之后，家中其他青壮年劳动力的工作时间会显著减少。尤其是当养老金领取人是女性时，劳动供给下降的幅度更大。Case A C（2001）从对南非养老金的分析中得到，养老金的发放有助于提高所有家庭成员的健康水平。Duflo 等（2003）基于 20 世纪 90 年代的南非养老金计划及儿童营养状况调查数据，发现女性领取的养老金对女孩的身体状况有显著影响，对男孩影响很小。而男性领取者没有类似的影响。Kakwani N 等（2007）以南非洲的 15 个低收入国家的老年人口为样本得到，尽管国家提供的社会养老金水平较低，但是对缓解贫困仍具有积极作用。Danzer（2013）运用双重差分 DID 和断点回归 RD 以及工具变量的方法研究了乌克兰 2004 年普遍提高养老保险给付对劳动供给的影响，结果表明这种未预期到的外生的养老待遇提高使法定领取养老金年龄退休的概率增加了 28%-33%。

## 2.2 国内研究综述

中国新型农村养老保险制度实施后对于劳动供给的影响，国内学者已经有过诸多的实证研究。张川川等（2014）的文章中系统地评估了新农保的政策效应，用 CHARLS2011-2012 年的数据，根据 RD 和 DID 模型的实证分析结果得出，新农保政策会减少老年人的劳动供给，提高收入水平，减少贫困，促进消费，提高主观福利。吴海清等（2020）采用倾向分值匹配基础上的差分内差分方法(PSMDD),发现考虑时滞效应时新农保对农村中老年人的劳动供给产生负向影响。刘远风和孙宇（2020）发现社会养老和家庭养老会降低老年人的农业劳动供给，但对非农劳动供给没有产生显著影响。但也有一些文献得出了与上述截然相反的结论。刘凌晨等（2016）发现参加新农保整体上会提高劳动参与率并增加劳动供给时间。解垩（2017）基于 CFPS 数据，利用消除内生性的模糊断点回归 2SLS 方法，结果得到新农保和城居保对减少老年人多维贫困和不平等没有明显作用。

在对现有文献的梳理中，我们发现目前针对“城乡居保（或新农保）对劳动供给的政策效应”的研究仍存在不足。针对这些不足，本文有以下三个创新点：

第一，现有文献忽略了城乡居保对不同收入的农村人口政策效应的异质性。基于收入边际效用递减的特点，养老金可能对不同收入群体产生不同的效应。因此，本文实证检验了城乡居保的扶贫效用，这也在一定程度上响应了我国全面脱贫攻坚取得胜利后如何维持胜利果实，遏制返贫现象的出现，进而实现长效扶贫。

第二，本文对劳动类型的划分更加细致。将劳动供给根据农业、非农业劳动以及自雇、受雇劳动划分为四类，并且考虑到了 60 岁以后非农受雇劳动减少的非自愿性。

第三，现有文献大多只关注了养老金的收入效应，而关于社会养老保险对处在缴费阶段的年轻人的劳动供给影响的研究并不多。城乡居保或者新农保等社会养老保险分为缴费阶段和待遇领取阶段。本文构建了理论框架，分别定性地探究在缴费阶段和待遇领取阶段下城乡居保对居民劳动供给的影响。由于本文重点关注城乡居保对老年人的政策效应在不同收入水平上的异质性，因此只对待遇领取阶段进行了实证检验。对缴费阶段的实证检验是我们接下来的研究

方向，也希望可以为之后的相关研究提供思路。

## 3.理论框架

城乡居保政策规定，参保人参保后需按时缴纳社保费，并在年满 60 周岁、累计缴费满 15 年后定期领取养老金。考虑居民的终身效用问题，本节基于缴费阶段和领取阶段分别构建理论优化问题来定性探讨城乡居保对居民的劳动供给的影响。

### 3.1 缴费阶段的最优化问题

对于已参保、正在缴费阶段的年轻人来说，他们希望在生命周期预算约束下最大化其效用。对于一位有代表性的年轻人，其效用函数为：

$$U(c^y, c^o, l^y, l^o) \tag{1}$$

其中，$c^y$表示此人在年轻时的消费，$c^o$表示此人在老年时的消费，$l^y$表示此人在年轻时的劳动时间，$l^o$表示此人在老年时的劳动时间。我们规定闲暇为正常品，即$\frac{\partial U}{\partial l^y} < 0$，$\frac{\partial U}{\partial l^o} < 0$。

他在年轻时期面临的预算约束为：

$$y^y(l^y) = c^y + T + S \tag{2}$$

其中，$y^y(l^y)$为年轻时期的收入[①]，与年轻时期的劳动时间有关。$T$为年轻时期缴纳的保险费，$S$为储蓄。

他在老年时期面临的预算约束为：

$$y^o(l^o) + B + S(1+r) = c^o \tag{3}$$

其中，$y^o(l^o)$为老年时期的收入，与老年时期的劳动时间有关。$B$为老年时期领取的养老金，$S(1+r)$为储蓄本金及利息，$r$为利率。

这个年轻人在生命周期整体面临的预算约束为：

$$y^y(l^y) + \frac{y^o(l^o)}{1+r} + \frac{B}{1+r} = c^y + \frac{c^o}{1+r} + T \tag{4}$$

对于已参保、正在缴费阶段的年轻人来说，社会养老保险对其劳动供给的影响有两个方向：第一，使$l^y$增加。社保费$T$对年轻人来说是一项成本，参保后的年轻人有动力为了增加的生活成本而增加自己的劳动时间$l^y$。第二，使$l^y$减小。年轻人知道在自己年老时会收到养老金$B$，自己的养老负担有所减轻，因此参加社会养老保险带来的养老保障使得年轻人选择减少劳动时间$l^y$，增加闲暇。最终，城乡居保对年轻人劳动供给的影响取决于这两方面影响的强弱关系。

### 3.2 领取阶段的最优化问题

对于已参保、正在领取养老金的老年人来说，要在老年时期的预算约束下

[①] 此收入包括农业劳动收入和非农劳动收入。因为农业自雇劳动没有“小时工资”一说，所以用工资率与劳动时间的乘积来表示收入是不准确的。因此，这里将收入表示为劳动时间的函数。

最大化其效用。一位有代表性的老年人的效用函数为：

$$U(c^o, l^o) \tag{5}$$

他在老年时期面临的预算约束为：

$$y^o(l^o) + B + S(1+r) = c^o \tag{6}$$

对于正在领取养老金的老年人来说，他会收到养老金作为非劳动收入。与未参保的老年人相比，参保的老年人每月领取的养老金$B$会使得预算约束线上移，增加最优的消费水平和闲暇时间，增加参保老年人的效用。因此，城乡居保会减少老年人的劳动供给时间，这也是本文重点关注的收入效应。

## 4.模型及变量

### 4.1 实证模型

本文使用双重差分模型（DID）来评估新农保（或城乡居保）在待遇给付阶段的政策效果。将所在社区进行了新农保试点的样本列入实验组，将所在社区没有实施新农保政策的样本列入对照组。观测 60 岁前后样本劳动时长的变化（第一次差分），并将这一变化在实验组和对照组之间进行比较（第二次差分），最终识别出新农保的政策效应。双重差分模型如下：

$$Y_{ij} = \beta_0 + \beta_1 T_i \times D_j + \beta_2 T_i + \beta_3 D_j + \beta_4 X_{ij} + S_j + \varepsilon_{ij} \tag{7}$$

其中，$Y_{ij}$为被解释变量，即在第 j 个社区、第 i 个样本的劳动供给时长。$T_i$是表示第 i 个样本年龄的虚拟变量，若样本 i 的年龄大于等于 60 岁，则$T_i$=1；若样本 i 的年龄小于 60 岁，则$T_i$=0。$D_j$是表示第 j 个社区是否实施了新农保政策试点的虚拟变量，若社区 j 实施了新农保政策，则$D_j$=1；反之，若社区 j 没有实施新农保，则$D_j$=0。$X_{ij}$表示社区 j、样本 i 的其他控制变量，$S_j$表示社区固定效应，$\varepsilon_{ij}$表示残差。

### 4.2 数据来源及处理

本文的数据来自中国健康与养老追踪调查（China Health and Retirement Longitudinal Study，简称 CHARLS）。CHARLS 是由北京大学社会科学调查中心负责设计实施的一项专门针对中老年人的全国性大型追踪调查。该调查采用了多阶段、概率与规模成比例的抽样方法，样本覆盖了全国 28 个省、市、自治区的中老年人口。

2011 年，新农保政策还未实现全国范围的覆盖，还处在政策的推行阶段，所以使用 2011 年的数据时实验组和对照组的样本数都会比较充足且均衡。若使用 2013、2015、2018 年的数据，由于新农保或者城乡居保的覆盖率已经非常高了，对照组的样本量会过少，估计结果会产生较大偏误。

拿到原始样本后，首先作如下数据处理：

（1）去掉没有资格参加新农保（或城乡居保）的样本，例如已经参加机关

事业单位养老保险和企业职工养老保险的样本。

（2）去掉城市户口样本。

## 4.3 变量选取

### 4.3.1 被解释变量

本文的被解释变量为劳动供给，用受访者过去一年的劳动时长来衡量，并且根据是否农业劳动和是否自雇将劳动分为四种类型。

表 1 劳动供给变量分类

| 劳动分类 | | | 劳动时长变量 | 解释 |
|---|---|---|---|---|
| 劳动 | 农业劳动 | 农业自雇 | 农业自雇劳动时长 | 为自家从事农业生产经营活动 |
| | | 农业受雇 | 农业受雇劳动时长 | 为其他农户打工 |
| | 非农劳动 | 非农自雇 | 非农自雇劳动时长 | 从事个体、私营经济活动或不拿工资为家庭经营活动帮工 |
| | | 非农受雇 | 非农受雇劳动时长 | 挣工资工作 |

上表是劳动供给相关变量，若受访者不进行此类劳动，则相应的劳动时长为 0。劳动时长为过去一年中进行此类劳动的总时长。在回归时，使用各类型劳动时长的自然对数值，若劳动时长为 0，定义其对数值为 0。

### 4.3.2 核心解释变量

本文使用双重差分模型探究新农保的政策效应，主要关注交乘项的显著性和估计系数。交乘项由两个 0-1 变量相乘，分别是“年龄是否大于等于 60 岁”和“所在社区是否实施新农保[①]”。

### 4.3.3 分组变量

“是否贫困”是本文进行分样本回归的分组依据，以探究新农保养老金对贫困人口和非贫困人口的效应的不同。2011 年的国家贫困线标准为家庭人均年纯收入 1196[②]元，将家庭人均年收入小于等于 1196 元的人口定义为贫困人口，大于 1196 元的人口为非贫困人口。

### 4.3.4 控制变量

控制变量的选择要包含除政策因素外其他影响劳动供给时长的重要因素，结合 CHARLS 问卷，选择反映受访者的人口学特征、身体健康状况和经济状况等特征的变量。本文的控制变量具体说明如下：

（1）年龄：连续型变量。在进行双重差分模型估计时，我们选取年龄在 55 岁（包含）至 64 岁（包含）的受访样本，以减少年龄趋势对劳动供给的影响，增大 60 岁前后样本的可比性。

（2）性别：0-1 变量，样本为男性时，定义值为 1；样本为女性时，值为 0。

（3）受教育程度：将受访者的最高学历由低到高分为未受过教育、未读完小学、私塾毕业、小学毕业、初中毕业、高中毕业、中专（包括中等师范、职

① 在 CHARLS2011 年的社区问卷中，有关于“此社区是否实施了新型农村社会养老保险”的问题。
② 2009 年国务院政府工作报告中提出，将扶贫标准提高到人均 1196 元，并且到 2011 年未改变。http://www.gov.cn/test/2009-03/16/content_1260221.htm

高）毕业、大专毕业、本科毕业、硕士毕业、博士毕业 11 个层次，分别生成 11 个 0-1 变量。

（4）婚姻状况：将受访者的婚姻状况分为已婚与配偶一同居住、已婚没有和配偶一同居住、分居（不再作为配偶共同生活）、离异、丧偶、从未结婚，分别生成 6 个 0-1 变量。在 CHARLS 问卷中，同居被认为已经有了事实上的婚姻关系，属于“已婚与配偶一同居住”的类型。

（5）自评健康：在 CHARLS2011 年的问卷中，受访者被分为两组来询问自评健康，一组的选项依次是：极好，很好，好，一般，不好，另一组的选项依次是：很好，好，一般，不好，很不好。根据受访者的回答依次赋值 5、4、3、2、1，也就是说，分值越高，自评身体健康越好。

（6）IADL 得分：将 CHARLS 问卷中 IADL 量表的做家务活、做饭、购物、管理财务、吃药这五项指标进行赋值加总。将回答中的“没有困难”赋值为 4，“有困难但可以完成”赋值为 3，“有困难，需要帮助”赋值为 2，“无法完成”赋值为 1，将这五项指标的得分进行加总得到 IADL 得分，分值越高，表示身体功能越好，更能无障碍地完成日常活动。

（7）个人收入：代表个人的经济状况的变量，包括上一年个人获得的所有收入。回归时取自然对数，数值为 0 的，定义取对数之后为 0。

（8）家户人均收入：反映家庭的经济状况，此变量包含了家户总收入和家户规模两个信息。“家户人均收入”是家庭成员中所有人上一年的工资收入、转移性收入、农业收入、个体经营以及以家户为单位获得的政府转移支付收入之和与家户成员人数的比值。回归时取自然对数，数值为 0 的，定义取对数之后为 0。

表 2　变量设置

| 变量类型 | 变量分类 | 变量名称 | 赋值 |
|---|---|---|---|
| 被解释变量 | 劳动供给 | 劳动 | 0-1 变量 |
| | | 劳动年时长（对数） | 连续型变量 |
| | 农业劳动供给 | 农业劳动 | 0-1 变量 |
| | | 农业劳动年时长（对数） | 连续型变量 |
| | | 农业受雇 | 0-1 变量 |
| | | 农业受雇年时长（对数） | 连续型变量 |
| | | 农业自雇 | 0-1 变量 |
| | | 农业自雇年时长（对数） | 连续型变量 |
| | 非农劳动供给 | 非农劳动 | 0-1 变量 |
| | | 非农劳动年时长（对数） | 连续型变量 |
| | | 非农受雇 | 0-1 变量 |
| | | 非农受雇年时长（对数） | 连续型变量 |
| | | 非农自雇 | 0-1 变量 |
| | | 非农自雇年时长（对数） | 连续型变量 |
| 核心解释变量 | $T_i$ | 年龄是否大于等于 60 岁 | 0-1 变量 |

| | | | |
|---|---|---|---|
| | $D_j$ | 社区是否实施“新农保” | 0-1 变量 |
| 分组变量 | 贫困人口 | 是否贫困人口 | 以家庭人均年纯收入 1196 元为标准 |
| 解释变量 | 人口学特征 | 年龄 | 取值为 55-64 的连续型变量 |
| | | 性别 | 0=女；1=男 |
| | | 受教育程度 | 未受过教育、未读完小学、私塾毕业、小学毕业、初中毕业、高中毕业、中专（包括中等师范、职高）毕业、大专毕业、本科毕业、硕士毕业、博士毕业，定义 11 个 0-1 变量 |
| | | 婚姻状况 | 已婚与配偶一同居住、已婚没有和配偶一同居住、分居（不再作为配偶共同生活）、离异、丧偶、从未结婚，定义 6 个 0-1 变量 |
| | 健康状况 | 自评健康 | 取值为 1-5 的连续型变量 |
| | | IADL 得分 | 取值为 5-20 的连续型变量 |
| | 收入情况 | 个人收入（对数） | 连续型变量 |
| | | 家庭人均收入（对数） | 连续型变量 |

## 4.4 变量描述

### 4.4.1 描述性统计

在本文的模型中，为了减少年龄趋势对劳动供给的影响，我们只选取了年龄在 55 岁到 64 岁年龄区间的样本。表 3 是对各变量观测量、平均值、标准差、最小值和最大值的统计。从表 3 可以得出，有 71.5%的样本还在进行劳动。样本中有 70.9%老年人还在进行农业劳动，其中大部分是为自家从事农业生产经营活动；只有 20.0%的样本参与了非农劳动，说明农业生产仍然是农村人口的主要劳动类型。有 45.3%的样本所在的社区开展了新农保试点。有 18.5%的样本属于贫困人口。从性别上看，女性人口略多于男性人口。在受教育程度方面，绝大多数样本的学历水平都在初中毕业及以下，没有学历为本硕博毕业的样本。样本中大部分老年人都已婚并且和配偶同住。从自评健康和 IADL 得分来看，样本总体的身体健康状况较好。可以发现，个人收入和家庭人均收入的方差较大。

表 3 变量的描述性统计

| 变量类型 | 变量分类 | 变量名称 | 观测量 | 平均值 | 标准差 | 最小值 | 最大值 |
|---|---|---|---|---|---|---|---|
| 被解释变量 | 劳动 | 劳动 | 4,859 | 0.715 | 0.452 | 0 | 1 |
| | | 劳动年时长（对数） | 4,859 | 5.014 | 3.297 | 0 | 9.036 |
| | 农业劳动 | 农业劳动 | 5,052 | 0.709 | 0.454 | 0 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 农业劳动年时长（对数） | 4,909 | 4.180 | 3.397 | 0 | 8.813 |
| | | 农业受雇 | 5,030 | 0.047 | 0.211 | 0 | 1 |
| | | 农业受雇年时长（对数） | 4,987 | 0.223 | 1.153 | 0 | 8.120 |
| | | 农业自雇 | 5,029 | 0.624 | 0.484 | 0 | 1 |
| | | 农业自雇年时长（对数） | 4,949 | 4.134 | 3.389 | 0 | 8.813 |
| | 非农劳动 | 非农劳动 | 5,043 | 0.200 | 0.400 | 0 | 1 |
| | | 非农劳动年时长（对数） | 4,989 | 1.287 | 2.797 | 0 | 8.995 |
| | | 非农受雇 | 5,036 | 0.138 | 0.345 | 0 | 1 |
| | | 非农受雇年时长（对数） | 5,000 | 0.871 | 2.377 | 0 | 8.995 |
| | | 非农自雇 | 5,036 | 0.061 | 0.240 | 0 | 1 |
| | | 非农自雇年时长（对数） | 5,025 | 0.411 | 1.693 | 0 | 8.590 |
| 核心解释变量 | 年龄是否大于等于 60 岁 | | 5,077 | 0.449 | 0.497 | 0 | 1 |
| | 社区是否实施新农保 | | 4,653 | 0.453 | 0.498 | 0 | 1 |
| 分组变量 | 贫困 | | 5,077 | 0.185 | 0.389 | 0 | 1 |
| 解释变量 | 年龄 | | 5,077 | 59.198 | 2.791 | 55 | 64 |
| | 性别 | | 5,071 | 0.487 | 0.500 | 0 | 1 |
| | 受教育程度 | 未受过教育 | 5,070 | 0.333 | 0.471 | 0 | 1 |
| | | 没读完小学 | 5,070 | 0.251 | 0.434 | 0 | 1 |
| | | 私塾 | 5,070 | 0.002 | 0.044 | 0 | 1 |
| | | 小学毕业 | 5,070 | 0.237 | 0.425 | 0 | 1 |
| | | 初中毕业 | 5,070 | 0.136 | 0.343 | 0 | 1 |
| | | 高中毕业 | 5,070 | 0.035 | 0.183 | 0 | 1 |
| | | 中专毕业 | 5,070 | 0.004 | 0.059 | 0 | 1 |
| | | 大专毕业 | 5,070 | 0.002 | 0.042 | 0 | 1 |
| | | 本科毕业 | 5,070 | 0.000 | 0.020 | 0 | 1 |
| | | 硕士毕业 | 5,070 | 0.000 | 0.000 | 0 | 0 |
| | | 博士毕业 | 5,070 | 0.000 | 0.000 | 0 | 0 |
| | 婚姻状况 | 已婚同住 | 5,077 | 0.832 | 0.374 | 0 | 1 |
| | | 已婚不同住 | 5,077 | 0.076 | 0.265 | 0 | 1 |
| | | 分居 | 5,077 | 0.004 | 0.064 | 0 | 1 |
| | | 离异 | 5,077 | 0.004 | 0.066 | 0 | 1 |
| | | 丧偶 | 5,077 | 0.070 | 0.256 | 0 | 1 |
| | | 从未结婚 | 5,077 | 0.013 | 0.112 | 0 | 1 |
| | 健康状况 | 自评健康 | 5,055 | 2.433 | 1.022 | 1 | 5 |
| | | IADL 得分 | 5,025 | 19.141 | 2.229 | 5 | 20 |
| | 收入情况 | 个人收入（对数） | 5,021 | 4.363 | 4.430 | 0 | 14.772 |
| | | 家户人均收入（对数） | 4,826 | 8.356 | 1.646 | 0 | 14.088 |

### 4.4.2 分年龄段新农保覆盖率

为了对 2011 年全国的新农保实施程度有总体的认识，下面对新农保覆盖率

分年龄段进行了统计。值得说明的是，CHARLS 的调查访问只针对年龄在 45 岁及以上的人口，但是年龄数据和社区数据都是可获得的，所以下表的统计结果也包括了 45 岁以下的样本。由表 4 可知，2011 年我国新农保覆盖率大致在 45%左右。

表 4 2011 年分年龄段新农保覆盖率统计

| 年龄分段 | 样本量 | 新农保覆盖率 |
|---|---|---|
| 44 岁及以下 | 274 | 43.066% |
| 45-49 | 2,512 | 46.497% |
| 50-54 | 1,889 | 46.321% |
| 55-59 | 2,555 | 44.618% |
| 60-64 | 2,098 | 46.092% |
| 65-69 | 1,332 | 46.772% |
| 70-74 | 943 | 42.842% |
| 75-79 | 620 | 46.935% |
| 80-84 | 321 | 47.975% |
| 85 岁及以上 | 145 | 51.724% |
| 总样本 | 12,689 | 45.827% |

### 4.4.3 实施新农保与未实施新农保社区样本的平均年劳动时长对比

由图 1 可知，在 60 岁之前，实施了新农保和未实施新农保政策社区的样本的平均劳动时长没有明显差距，两个组的劳动时长都是随着年龄的增长，在波动中逐渐下降的（除了在 58 岁的未实施新农保样本的时长异常过低外）。在 60 岁之后，实验组和对照组的平均劳动时长有明显不同，且未实施新农保的社区样本的劳动时长明显高于实施新农保的社区。由此可以大致猜想到新农保的政策效果，但要得到准确结论还需要进一步实证分析。

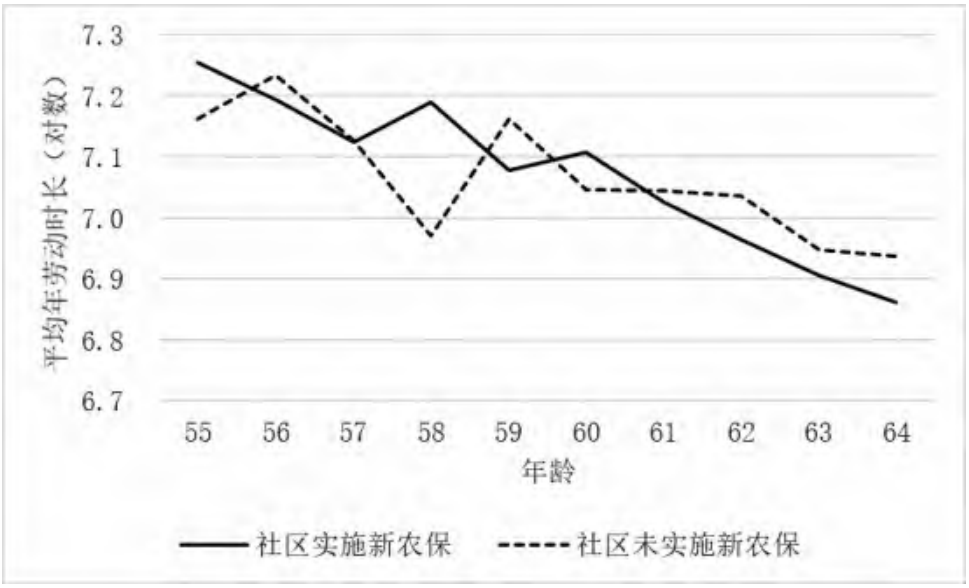


图 1　实施新农保与未实施新农保社区样本分年龄平均年劳动时长

4.4.4 贫困人口和非贫困人口的平均年劳动时长对比

图 2 是实验组中贫困人口与非贫困人口各年龄的平均劳动时长，可以发现，贫困人口的劳动时长普遍要少于非贫困人口的，而且在 60 岁前后，贫困人口劳动时长的减少幅度要大于非贫困人口的。由此可以大致猜想新农保对贫困人口劳动供给的减少可能有明显的作用，但要得到准确结论还需要进一步实证分析。

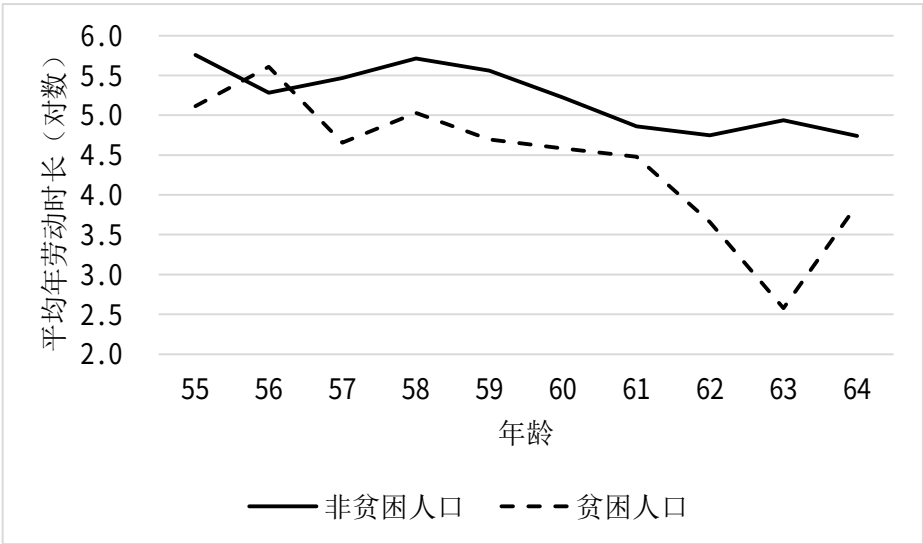


图 2　贫困人口与非贫困人口分年龄平均年劳动时长

## 5.实证模型及回归结果

对 4.1 中的双重差分模型进行估计，结果如表 5 所示：

表 5 双重差分模型估计结果[①]

| 变量名称 | 劳动年时长 | 农业劳动年时长 | 非农劳动年时长 |
|---|---|---|---|
| $T_i \times D_j$ | -0.499*** | -0.178 | -0.553*** |
| | (0.190) | (0.201) | (0.143) |
| $T_i$ | 0.229 | 0.253 | -0.005 |
| | (0.207) | (0.219) | (0.154) |
| $D_j$ | 0.021 | -0.162 | 0.257** |
| | (0.122) | (0.134) | (0.100) |
| 年龄 | -0.088*** | -0.048 | -0.065** |
| | (0.033) | (0.036) | (0.025) |
| 男 | 1.192*** | 0.852*** | 0.747*** |
| | (0.109) | (0.115) | (0.080) |
| 未受过教育 | -0.848** | 5.307*** | -4.829*** |
| | (0.388) | (0.412) | (0.281) |
| 没读完小学 | -1.054*** | 5.014*** | -4.800*** |
| | (0.378) | (0.402) | (0.280) |
| 私塾 | -1.292 | 4.451*** | -5.212*** |
| | (0.939) | (1.064) | (0.521) |
| 小学毕业 | -1.270*** | 4.719*** | -4.671*** |
| | (0.377) | (0.402) | (0.279) |
| 初中毕业 | -1.659*** | 4.435*** | -4.783*** |
| | (0.387) | (0.413) | (0.288) |
| 高中毕业 | -0.998** | 5.115*** | -4.603*** |
| | (0.431) | (0.472) | (0.366) |
| 中专毕业 | -1.399 | 3.582*** | -3.712*** |
| | (0.932) | (0.950) | (0.921) |
| 大专毕业 | -3.111*** | 1.288 | -4.162*** |
| | (1.175) | (0.872) | (1.286) |
| 已婚同住 | 1.402*** | 1.156*** | 0.707** |
| | (0.406) | (0.438) | (0.280) |
| 已婚不同住 | 1.187*** | -0.025 | 1.677*** |
| | (0.438) | (0.473) | (0.315) |
| 分居 | -0.896 | -0.405 | -0.143 |
| | (0.884) | (0.872) | (0.465) |
| 离异 | 0.540 | -0.028 | 0.956* |
| | (0.738) | (0.802) | (0.575) |
| 丧偶 | 0.439 | 0.309 | 0.512* |

① 括号里为稳健标准误。***表示 p<0.01，**表示 p<0.05，*表示 p<0.1。以下所有回归结果同。因为样本中硕士毕业、博士毕业全部取值为 0，且为避免多重共线性，去掉了本科毕业和从未结婚两个变量，所以这四个控制变量没有参与回归。

| | | | |
|---|---|---|---|
| | (0.450) | (0.480) | (0.304) |
| 自评健康 | 0.206*** | 0.084* | 0.186*** |
| | (0.048) | (0.0510) | (0.037) |
| IADL 得分 | 0.301*** | 0.276*** | 0.049*** |
| | (0.020) | (0.020) | (0.011) |
| 个人收入（对数） | 0.065*** | -0.099*** | 0.273*** |
| | (0.012) | (0.013) | (0.009) |
| 家户人均收入（对数） | 0.119*** | 0.065* | 0.051*** |
| | (0.036) | (0.038) | (0.018) |
| 常数项 | 2.306 | -4.574** | 6.006*** |
| | (2.010) | (2.151) | (1.523) |
| 样本量 | 4,227 | 4,268 | 4,340 |
| R-squared | 0.153 | 0.097 | 0.318 |

从上表的回归结果可以发现，新农保政策的实施显著降低了老年人的劳动供给，特别是非农劳动供给，而对农业劳动供给没有统计上的降低效果。这可能是因为农业生产是农村人口赖以生存和发展的产业，为了维持生计，农村人口依然会在拿到新农保养老金之后选择继续进行农业生产。

接下来分析控制变量对劳动供给的影响。年龄的估计系数为负，这和预想相同，年龄越大，劳动时长越短。男性比女性的劳动时间长，这说明我国农村的主要劳动力还是男性。在受教育程度对劳动年时长的回归中可以发现，随着受教育水平的提高，估计系数大致呈减少的趋势，可以得到，受教育程度越高，在 55 岁到 64 岁年龄段的农村人的劳动时长越少。这一结论同样适用于农业劳动供给，而在非农劳动上没有类似明显的规律。在婚姻状况的影响上，已婚人口相比其他人来说有着更高的劳动供给。自评健康和 IADL 得分都显著为正，身体状况对劳动供给有重要影响，身体状况越好，劳动时间越长。对于家庭和个人经济状况的控制变量这里不做讨论，因为收入和劳动时间存在相互影响，这里加入收入情况主要是为了控制经济因素。

在上述研究的基础上，我们评估新农保对贫困人口与非贫困人口的政策效果。这里只展示了关键变量的回归结果，完整的回归结果可参见附表 1。

表 6　贫困与非贫困人口的政策效果对比

| 变量名 | 劳动年时长对数 | | 农业劳动年时长对数 | | 非农劳动年时长对数 | |
|---|---|---|---|---|---|---|
| | 非贫困人口 | 贫困人口 | 非贫困人口 | 贫困人口 | 非贫困人口 | 贫困人口 |
| $T_i * D_j$ | -0.473** | -1.008* | -0.150 | -0.851 | -0.565*** | -0.221 |
| | (0.205) | (0.543) | (0.218) | (0.549) | (0.164) | (0.203) |
| $T_i$ | 0.078 | 1.105* | 0.084 | 1.154** | -0.022 | 0.033 |
| | (0.225) | (0.568) | (0.238) | (0.574) | (0.178) | (0.255) |
| $D_j$ | 0.023 | 0.405 | -0.179 | 0.352 | 0.288** | 0.086 |
| | (0.129) | (0.368) | (0.143) | (0.379) | (0.113) | (0.138) |
| 常数项 | 3.264 | 5.480 | -1.609 | 6.477 | 3.560** | -0.357 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (2.255) | (5.607) | (2.421) | (5.784) | (1.814) | (2.542) |
| 样本量 | 3,558 | 669 | 3,595 | 673 | 3,643 | 697 |
| R-squared | 0.151 | 0.227 | 0.107 | 0.211 | 0.323 | 0.163 |

从表中结果可以得到，新农保对贫困人口劳动供给的减少效果在数值上要大于对非贫困人口的政策效果，但是贫困人口估计的显著性较低。新农保对农业劳动供给的影响在贫困人口与非贫困人口的子样本中都不显著，这与全样本的估计结果相似。然而，在非农劳动供给上，新农保只对非贫困人口减少非农劳动时长有显著的效果，对贫困人口的非农劳动供给并没有明显的影响。

根据以上两个回归结果，我们发现新农保政策对非农劳动供给的影响效果明显。但是我们不得不考虑到，在非农受雇劳动中，当受雇人年龄达到 60 岁以上后，用工单位就会与受雇者解除劳动关系。此时，受访者劳动时间的减少并不是因为新农保政策，而是因为年龄限制被迫找不到雇主，因此无法进行非农受雇劳动。

为了解决这一问题，接下来本文将除去非农受雇劳动的劳动时长，但并不排除农业受雇劳动，因为农业受雇大多是私人性质的、就近的、非正规的，受雇者通常不会受到年龄限制。下表为被解释变量除去非农受雇劳动时长的回归结果，完整回归结果参见附表 2。

表 7 除去非农受雇劳动类型的回归结果

| 变量名 | 农业自雇+农业受雇+非农自雇劳动年时长（对数） | | |
|---|---|---|---|
| | 全样本 | 非贫困人口 | 贫困人口 |
| $T_i * D_j$ | -0.357* | -0.338 | -0.981* |
| | (0.200) | (0.217) | (0.548) |
| $T_i$ | 0.264 | 0.100 | 1.295** |
| | (0.218) | (0.238) | (0.576) |
| $D_j$ | -0.006 | -0.014 | 0.391 |
| | (0.133) | (0.142) | (0.373) |
| 常数项 | 3.167 | 4.928** | 7.672 |
| | (2.146) | (2.424) | (5.715) |
| 样本量 | 4,227 | 3,558 | 669 |
| R-squared | 0.101 | 0.104 | 0.220 |

在不考虑非农受雇劳动的情况下分析新农保对劳动供给的政策效应，我们发现新农保对减少贫困人口劳动时长的效应显著，并且对贫困人口减少劳动时长有正向作用，这也达到了政策实施的目的。

## 6.平行趋势检验

双重差分模型的前提假设为：实验组的样本，在没有受到政策影响的情况下，其因变量的变化趋势和对照组相同。然而我们无法同时观测到同一样本在受到政策影响和没有受到政策影响两种情况下的劳动供给情况。若实验组和对照组在没有受到政策影响时的劳动供给变化趋势相同，那么在未收到政策影响的时间段内，上述模型中的交乘项应该是不显著的。因此本文做以下有效性检验：以 55 岁为时间变量截点，样本大于等于 55 岁时，$T_i'$=1；样本小于 55 岁时，$T_i'$=0，其余都不变，对 50 岁到 59 岁的样本重新进行估计。若此样本符合 DID 的假定，即实验组和对照组在未受到政策影响时变化趋势相同，则交乘项的估计结果应当不显著。

表 8　对 50 岁到 59 岁样本回归结果

| 变量名 | 劳动年时长（对数） | | | 劳动时长除非农受雇（对数） | | |
|---|---|---|---|---|---|---|
| | 全样本 | 非贫困人口 | 贫困人口 | 全样本 | 非贫困人口 | 贫困人口 |
| $T_i' * D_j$ | 0.056 | 0.089 | -0.180 | 0.245 | 0.278 | -0.144 |
| | (0.187) | (0.197) | (0.603) | (0.210) | (0.223) | (0.615) |
| $T_i'$ | 0.171 | 0.076 | 0.324 | 0.148 | 0.037 | 0.351 |
| | (0.200) | (0.211) | (0.602) | (0.221) | (0.237) | (0.616) |
| $D_j$ | -0.031 | -0.067 | 0.542 | -0.221 | -0.262 | 0.471 |
| | (0.142) | (0.149) | (0.471) | (0.161) | (0.172) | (0.481) |
| 常数项 | -3.043 | -0.732 | -8.202 | -3.379 | -0.385 | -7.575 |
| | (2.188) | (2.423) | (5.599) | (2.244) | (2.503) | (5.697) |
| 样本量 | 3,994 | 3,476 | 518 | 3,994 | 3,476 | 518 |
| R-squared | 0.149 | 0.145 | 0.309 | 0.082 | 0.090 | 0.296 |

从上表中可以看到两组六个回归的交乘项都不显著，说明此模型符合 DID 假设，因此本文使用 DID 模型来估计新农保的政策效应是合理的。完整的回归结果可参见附表 3。

## 7.结论及政策建议

### 7.1　结论

#### 7.1.1 城乡居保政策的实施显著降低了农村人口的劳动供给

从表 5 的回归结果中可知，总劳动时长和非农劳动时长的交乘项的系数显著为负，说明领取新农保养老金有助于减少农村人口的劳动供给，减少农村人口的劳作负担。但是对农业劳动时长回归的交乘项不显著，这可能是因为农业生产是农村人口赖以生存和发展的产业，为了维持生计，农村人口在拿到新农保养老金之后依然选择继续进行农业劳作。此外，为避免因为用人单位不再雇佣 60 岁以上的人引起的劳动时长的减少，表 7 的回归中去掉了非农受雇的劳动时长，所得结果依然证明城乡居保养老金显著降低了农村人口的劳动时长。、

#### 7.1.2 城乡居保养老金对贫困人口减少劳动时长有更大的政策效应

从表 6 的回归结果中可以得到，贫困人口分样本的回归结果的交乘项的系数在数值上大于非贫困人口。在表 7 中除去非农受雇劳动时长之后，贫困人口分样本的交乘项显著，而非贫困人口的交乘项不显著。综合表 6、7 的结果，可以得到，城乡居保政策对减轻贫困人口的劳动负担有着更明显的效应。

## 7.2 政策建议

从本文的分析中易知，城乡居保（或新农保）养老金作为农村人口一项非劳动性收入，可以显著减少贫困人口的劳动时长，减轻贫困人口的劳动负担，可以说达到了政策实施的目的。这也在一定程度上响应了我国全面脱贫攻坚取得胜利后如何维持胜利果实，遏制返贫现象的出现，进而实现长效扶贫。为了进一步凸显、扩大城乡居保政策在长效扶贫方面的效应，本文提出以下政策建议：

### 7.2.1 提高对贫困人口缴纳城乡居保保险费的补助力度

城乡居民基本养老保险基金的筹集来源于个人缴纳、集体补助和政府补贴。由于城乡居保实行多缴多得的原则，贫困人口选择较低的缴费档次，达到年龄后收到的养老金也会较低。为了发挥城乡居保对低收入人群的帮扶作用，建议提高低收入人口的集体补助和政府补贴。国家对基础养老金的缴费分为 13 个档次，每提高一个档次只能多获得 5 元补贴，这一差别相对较小。在财政支出允许的前提下，地方政府对因贫不参加城乡居保或因贫选择较低缴费档次的人口给予适当的缴费补贴，避免贫困人口因为缴费负担不参保，提高贫困人口的可得养老金。

### 7.2.2 加大城乡居民基本养老保险基金的投资运营效率

养老保险基金的投资、运营直接关系到养老基金的安全性，对维持制度正常推进、缓解我国的养老压力有重要意义。提高养老保险基金的投资运营效率，保证其保值增值，提高个人账户的计息利率，增加参保人的到手养老金，对农村贫困人口改善生活有很大帮助。

### 7.2.3 根据通货膨胀水平和个人经济情况调整基础养老金发放水平

城乡居保养老金包括基础养老金和个人账户养老金。基础养老金水平由政府适时调整。建议政府根据物价变动及时、适当地调整基础养老金发放水平，对于低收入人口可以加发基础养老金，给予贫困群体更多的资金支持，缓解他们高强度的劳动压力。

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## 附录

附表 1　贫困与非贫困人口的政策效果对比

| 变量名 | 劳动年时长对数 | | 农业劳动年时长对数 | | 非农劳动年时长对数 | |
|---|---|---|---|---|---|---|
| | 非贫困人口 | 贫困人口 | 非贫困人口 | 贫困人口 | 非贫困人口 | 贫困人口 |
| $T_i * D_j$ | -0.473** | -1.008* | -0.150 | -0.851 | -0.565*** | -0.221 |
| | (0.205) | (0.543) | (0.218) | (0.549) | (0.164) | (0.203) |
| $T_i$ | 0.078 | 1.105* | 0.084 | 1.154** | -0.022 | 0.033 |
| | (0.225) | (0.568) | (0.238) | (0.574) | (0.178) | (0.255) |
| $D_j$ | 0.023 | 0.405 | -0.179 | 0.352 | 0.288** | 0.086 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.129) | (0.368) | (0.143) | (0.379) | (0.113) | (0.138) |
| 年龄 | -0.063* | -0.242** | -0.017 | -0.234** | -0.066** | -0.015 |
| | (0.036) | (0.098) | (0.039) | (0.100) | (0.029) | (0.043) |
| 男 | 1.118*** | 1.415*** | 0.670*** | 1.459*** | 0.926*** | -0.016 |
| | (0.119) | (0.295) | (0.126) | (0.298) | (0.094) | (0.116) |
| 未受过教育 | -1.289*** | 1.313 | 4.347*** | -0.368 | -4.301*** | 1.865** |
| | (0.430) | (0.948) | (0.465) | (1.100) | (0.350) | (0.803) |
| 没读完小学 | -1.472*** | 1.211 | 4.067*** | -0.457 | -4.285*** | 1.911** |
| | (0.421) | (0.890) | (0.456) | (1.055) | (0.350) | (0.801) |
| 私塾 | -1.759 | 0.921 | 3.375*** | -0.746 | -4.799*** | 1.580* |
| | (1.120) | (1.694) | (1.285) | (1.797) | (0.735) | (0.909) |
| 小学毕业 | -1.639*** | 0.853 | 3.865*** | -0.948 | -4.192*** | 1.987** |
| | (0.415) | (0.921) | (0.451) | (1.097) | (0.345) | (0.856) |
| 初中毕业 | -1.983*** | 0.270 | 3.635*** | -1.384 | -4.329*** | 1.958** |
| | (0.426) | (1.004) | (0.463) | (1.151) | (0.351) | (0.834) |
| 高中毕业 | -1.383*** | 1.123 | 4.239*** | -0.503 | -4.147*** | 2.229** |
| | (0.469) | (1.361) | (0.520) | (1.464) | (0.428) | (0.889) |
| 中专毕业 | -1.755* | | 2.637*** | | -3.085*** | |
| | (0.998) | | (0.964) | | (0.982) | |
| 大专毕业 | -3.217*** | | 1.023 | | -4.037*** | |
| | (1.212) | | (0.910) | | (1.266) | |
| 已婚同住 | 0.972** | 2.911*** | 0.787 | 2.835*** | 0.876*** | -0.171 |
| | (0.461) | (0.685) | (0.491) | (0.723) | (0.330) | (0.502) |
| 已婚不同住 | 1.014** | 1.148 | -0.234 | 1.240 | 1.964*** | -0.421 |
| | (0.491) | (0.862) | (0.526) | (0.901) | (0.367) | (0.503) |
| 分居 | -1.291 | 1.394 | -0.570 | 1.748 | -0.083 | -1.046 |
| | (1.019) | (1.704) | (0.991) | (1.879) | (0.545) | (0.749) |
| 离异 | -0.125 | 2.133* | -0.744 | 1.875 | 0.814 | 0.846 |
| | (0.814) | (1.270) | (0.866) | (1.287) | (0.713) | (1.108) |
| 丧偶 | 0.043 | 2.188*** | 0.025 | 2.309*** | 0.601* | -0.339 |
| | (0.511) | (0.815) | (0.540) | (0.848) | (0.364) | (0.496) |
| 自评健康 | 0.204*** | 0.279** | 0.081 | 0.236* | 0.194*** | 0.073 |
| | (0.051) | (0.132) | (0.055) | (0.135) | (0.043) | (0.047) |
| IADL 得分 | 0.306*** | 0.300*** | 0.275*** | 0.301*** | 0.059*** | 0.013 |
| | (0.023) | (0.041) | (0.023) | (0.042) | (0.014) | (0.015) |
| 个人收入对数 | 0.074*** | 0.102** | -0.084*** | 0.017 | 0.270*** | 0.118*** |
| | (0.013) | (0.051) | (0.014) | (0.055) | (0.010) | (0.034) |
| 家户人均 | -0.062 | 0.323*** | -0.301*** | 0.315*** | 0.213*** | 0.009 |
| 收入对数 | (0.063) | (0.076) | (0.066) | (0.076) | (0.050) | (0.020) |
| 常数项 | 3.264 | 5.480 | -1.609 | 6.477 | 3.560** | -0.357 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (2.255) | (5.607) | (2.421) | (5.784) | (1.814) | (2.542) |
| 样本量 | 3,558 | 669 | 3,595 | 673 | 3,643 | 697 |
| R-squared | 0.151 | 0.227 | 0.107 | 0.211 | 0.323 | 0.163 |

附表 2　除去非农受雇劳动类型的回归结果

| 变量名 | 农业自雇+农业受雇+非农自雇劳动年时长（对数） | | |
|---|---|---|---|
| | 全样本 | 非贫困人口 | 贫困人口 |
| $T_i * D_j$ | -0.357* | -0.338 | -0.981* |
| | (0.200) | (0.217) | (0.548) |
| $T_i$ | 0.264 | 0.100 | 1.295** |
| | (0.218) | (0.238) | (0.576) |
| $D_j$ | -0.006 | -0.014 | 0.391 |
| | (0.133) | (0.142) | (0.373) |
| 年龄 | -0.052 | -0.018 | -0.281*** |
| | (0.036) | (0.039) | (0.100) |
| 男 | 0.908*** | 0.768*** | 1.427*** |
| | (0.114) | (0.126) | (0.297) |
| 未受过教育 | -2.251*** | -2.939*** | 1.141 |
| | (0.408) | (0.459) | (0.944) |
| 没读完小学 | -2.492*** | -3.166*** | 1.024 |
| | (0.397) | (0.448) | (0.883) |
| 私塾 | -2.599*** | -3.243*** | 0.842 |
| | (0.964) | (1.202) | (1.633) |
| 小学毕业 | -2.803*** | -3.419*** | 0.650 |
| | (0.397) | (0.443) | (0.914) |
| 初中毕业 | -3.173*** | -3.736*** | 0.104 |
| | (0.408) | (0.455) | (0.998) |
| 高中毕业 | -2.384*** | -3.001*** | 0.948 |
| | (0.463) | (0.510) | (1.359) |
| 中专毕业 | -3.915*** | -4.607*** | |
| | (1.021) | (1.071) | |
| 大专毕业 | -5.782*** | -5.956*** | |
| | (1.207) | (1.259) | |
| 已婚同住 | 1.054** | 0.564 | 2.857*** |
| | (0.431) | (0.478) | (0.698) |
| 已婚不同住 | -0.253 | -0.610 | 1.170 |
| | (0.470) | (0.518) | (0.877) |
| 分居 | -0.929 | -1.305 | 1.596 |
| | (0.868) | (0.975) | (1.865) |

| | | | |
|---|---|---|---|
| 离异 | -0.376 | -1.311 | 1.777 |
| | (0.810) | (0.869) | (1.276) |
| 丧偶 | 0.019 | -0.447 | 2.243*** |
| | (0.474) | (0.528) | (0.827) |
| 自评健康 | 0.144*** | 0.144*** | 0.237* |
| | (0.051) | (0.055) | (0.135) |
| IADL 得分 | 0.277*** | 0.275*** | 0.299*** |
| | (0.020) | (0.023) | (0.041) |
| 个人收入对数 | -0.060*** | -0.050*** | 0.053 |
| | (0.013) | (0.014) | (0.054) |
| 家户人均收入对数 | 0.098*** | -0.166** | 0.324*** |
| | (0.037) | (0.066) | (0.076) |
| 常数项 | 3.167 | 4.928** | 7.672 |
| | (2.146) | (2.424) | (5.715) |
| 样本量 | 4,227 | 3,558 | 669 |
| R-squared | 0.101 | 0.104 | 0.220 |

附表 3　对 50 岁到 59 岁样本回归结果

| 变量名 | 劳动年时长（对数） | | | 劳动时长除非农受雇（对数） | | |
|---|---|---|---|---|---|---|
| | 全样本 | 非贫困人口 | 贫困人口 | 全样本 | 非贫困人口 | 贫困人口 |
| $T_i' * D_j$ | 0.056 | 0.089 | -0.180 | 0.245 | 0.278 | -0.144 |
| | (0.187) | (0.197) | (0.603) | (0.210) | (0.223) | (0.615) |
| $T_i'$ | 0.171 | 0.076 | 0.324 | 0.148 | 0.037 | 0.351 |
| | (0.200) | (0.211) | (0.602) | (0.221) | (0.237) | (0.616) |
| $D_j$ | -0.031 | -0.067 | 0.542 | -0.221 | -0.262 | 0.471 |
| | (0.142) | (0.149) | (0.471) | (0.161) | (0.172) | (0.481) |
| 年龄 | -0.069** | -0.061* | -0.127 | -0.048 | -0.033 | -0.142 |
| | (0.033) | (0.035) | (0.103) | (0.037) | (0.039) | (0.106) |
| 男 | 1.192*** | 1.166*** | 0.905*** | 0.887*** | 0.789*** | 0.954*** |
| | (0.110) | (0.118) | (0.328) | (0.118) | (0.127) | (0.332) |
| 未受过教育 | 3.487*** | 2.928** | 6.266*** | 4.455*** | 3.857*** | 6.329*** |
| | (1.095) | (1.206) | (1.078) | (0.899) | (1.015) | (1.089) |
| 没读完小学 | 3.306*** | 2.760** | 6.629*** | 4.186*** | 3.588*** | 6.568*** |
| | (1.093) | (1.205) | (1.077) | (0.898) | (1.014) | (1.086) |
| 私塾 | 4.197*** | 3.712*** | 4.330*** | 5.588*** | 5.369*** | 4.373*** |
| | (1.180) | (1.368) | (1.262) | (1.055) | (1.048) | (1.266) |
| 小学毕业 | 3.081*** | 2.557** | 6.262*** | 3.835*** | 3.261*** | 6.333*** |
| | (1.092) | (1.203) | (1.075) | (0.897) | (1.012) | (1.081) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 初中毕业 | 2.871*** | 2.377** | 5.611*** | 3.788*** | 3.274*** | 5.663*** |
| | (1.091) | (1.203) | (0.997) | (0.895) | (1.010) | (1.004) |
| 高中毕业 | 2.900*** | 2.365* | 5.788*** | 3.791*** | 3.230*** | 5.890*** |
| | (1.097) | (1.207) | (1.159) | (0.904) | (1.019) | (1.174) |
| 中专毕业 | 2.428* | 1.736 | 8.684*** | 3.559*** | 2.895** | 8.577*** |
| | (1.308) | (1.410) | (1.330) | (1.203) | (1.316) | (1.332) |
| 已婚同住 | 1.186** | 0.770 | 3.065*** | 1.087** | 0.792 | 2.978*** |
| | (0.461) | (0.511) | (0.857) | (0.491) | (0.554) | (0.887) |
| 已婚不同住 | 1.158** | 0.817 | 2.750*** | -0.068 | -0.375 | 2.559** |
| | (0.481) | (0.531) | (0.997) | (0.521) | (0.584) | (1.059) |
| 分居 | -1.176 | -2.135 | 1.892 | -1.156 | -2.100 | 2.223 |
| | (1.142) | (1.333) | (1.885) | (1.165) | (1.318) | (2.120) |
| 离异 | 0.534 | -0.0342 | 2.937* | -0.131 | -0.741 | 2.872* |
| | (0.873) | (1.002) | (1.545) | (0.925) | (1.101) | (1.561) |
| 丧偶 | 0.620 | 0.333 | 2.257** | 0.458 | 0.317 | 2.243** |
| | (0.514) | (0.570) | (1.011) | (0.547) | (0.615) | (1.041) |
| 自评健康 | 0.162*** | 0.166*** | 0.336** | 0.090* | 0.097* | 0.305** |
| | (0.047) | (0.050) | (0.151) | (0.052) | (0.056) | (0.152) |
| IADL 得分 | 0.291*** | 0.301*** | 0.310*** | 0.265*** | 0.271*** | 0.304*** |
| | (0.023) | (0.027) | (0.045) | (0.024) | (0.028) | (0.046) |
| 个人收入对数 | 0.098*** | 0.108*** | 0.165*** | -0.073*** | -0.060*** | 0.107 |
| | (0.012) | (0.013) | (0.062) | (0.013) | (0.014) | (0.070) |
| 家户人均 | 0.092** | -0.115* | 0.361*** | 0.047 | -0.266*** | 0.361*** |
| 收入对数 | (0.038) | (0.062) | (0.086) | (0.040) | (0.068) | (0.086) |
| 常数项 t | -3.043 | -0.732 | -8.202 | -3.379 | -0.385 | -7.575 |
| | (2.188) | (2.423) | (5.599) | (2.244) | (2.503) | (5.697) |
| 样本量 | 3,994 | 3,476 | 518 | 3,994 | 3,476 | 518 |
| R-squared | 0.149 | 0.145 | 0.309 | 0.082 | 0.090 | 0.296 |

# 城乡居民基本养老保险对农村人口劳动供给的影响
# ——基于CHARLS数据的实证分析

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**关键词：**城乡居民基本养老保险；劳动供给；双重差分模型；长效扶贫

**中文摘要．**本文从实证角度辅以理论模型，探究了城乡居民基本养老保险是否对农村贫困人口减少劳动供给有政策效果上的倾斜。本文首先对缴费阶段和待遇领取阶段的城乡居民基本养老保险对农村人口劳动供给的影响进行理论建模，对比分析两个阶段的最优化问题模型。在实证方面，本文使用中国健康与养老追踪调查（CHARLS）2011 年数据，采用双重差分模型，以国家贫困线为标准判别贫困人口，将劳动根据是否农业劳动、是否自雇劳动分为四种类型，分别对不同子样本进行了回归分析。在稳健性检验中，通过了平行趋势假设检验，表明了 DID 模型的适用性。最终得到，城乡居民基本养老保险降低了农村人口的劳动供给，尤其是对于贫困人口来说，有更显著的政策效果。最后，本文从城乡居保保险费的缴纳、基金管理、养老金发放三个环节上提出了政策建议，希望能为遏制返贫现象、实现长效扶贫提供一些思路。

# Research on the Balanced Premium Rate of Long-term Care Insurance Based on the Elderly's Health Transition Probability Matrix

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**Keywords:** Health transfer, Long-term care social insurance, Balanced premium rate, Pay-as-you-go system, Fully funded system.

**Abstract.** Combined with Markov process and generalized linear model(GLM) model, we uses micro tracking survey data to fit the transfer intensity of different genders, different urban and rural elderly individuals at different ages, and describe the health transfer probability matrix of the heterogeneous elderly population. Then, using social insurance actuarial theory, we separately inspected the different situations of urban employees and urban and rural residents, and predicted the balanced premium rate of

long-term care insurance (LTCI) under the pay-as-you-go system and the fully funded system. Finally, a sensitivity analysis is carried out on important parameters. The results show that from 2019 to 2039, the number of disabled persons will increase by about 3.5 times, and the horizontal balanced premium rate under the pay-as-you-go system will also increase by about 3.5 times, but the overall level is low, the maximum balanced premium rate does not exceed 0.10% and 0.50%. However, as the population structure ages, it may face the risk of increasing the balanced premium rate. In comparison, although the vertical balanced premium rate under the full funded system is relatively high, the fund remains stable for a long time. Taking the establishment of a fully funded system for LTCI in 2019 as an example, the vertical balanced premium rate for male urban employees, female urban employees, male urban and rural residents, and female urban and rural residents at the age of 40 are 0.16%, 0.18%, 0.87% and 1.50% respectively. The sensitivity results of different financing systems show that the government subsidy ratio parameter has the greatest impact. Therefore, in order to balance the pension pressure of individuals and the government and maintain the stability and sustainability of the fund, China should establish a LTCI financing model as soon as possible in which the pooled account is a pay-as-you-go system and the personal account is a full funded system.

## 1. 引言和文献综述

2020 年 9 月，中国医保局会同财政部印发了《关于扩大长期护理保险制度试点的指导意见》（医保发〔2020〕37 号，以下简称《意见》）。《意见》指出参保对象从职工基本医疗保险参保人群起步，探索建立以互助共济的方式筹资资金、为长期失能人员的基本生活照料和与之密切相关的医疗护理提供服务或资金保障的社会保险制度。在社会保险制度中，筹资模式是一个重要的部分，是影响社会保险基金的稳定性和可持续性的重要因素。社会保险基金的筹资模式主要包括现收现付制（pay-as-you-go）、完全基金制（full funded）和混合制三种。长期护理社会保险也有着三种模式。显然，不同筹资模式均需满足社会保险基金的收支平衡,将满足收支平衡的费率称为均衡费率。显然，作为社会保险制度的核心参数之一，均衡费率在长期护理社会保险中也是一个核心参数。均衡费率的高低直接影响了长期护理社会保险中筹资主体的缴费负担和长期护理社会保险基金的可持续性。

从保持平衡的方向而言，不同筹资模式需满足的收支平衡可以分为横向平衡和纵向平衡。现收现付制下，社会保险基金需满足某一时点上的横向平衡，即同一时期中年轻个体的缴费以补偿当期老年个体的长期护理支出，从而实现当期的收支平衡。现收现付制是一种代际再分配机制。现收现付制的优点是收支关系相对简单，容易实施，基金不存在保值增值的压力；缺点是可能会面临因人口老龄化而带来的支大于收的压力。我国目前长期护理社会保险试点地区主要采取的就是现收现付的筹资方式。完全基金制下，保险基金需满足的平衡原则是实现纵向平衡，每个人的缴费和未来的给付实现平衡；即参保个人或参保集体在所有年度内的缴费现值等于未来所得给付的现值。完全基金制的优点是能有效预防人口老龄化的冲击，基金的可持续性较强；缺点是管理较为复杂，而且需要对基金进行保值增值。何文炯等（2010）指出，很多地方都会出现“年轻时不参保，等年老多病时才参保”的现象，所以有必要研究不同年龄参保人的纵向均衡费率。混合

制是介于现收现付制和完全基金制之间的模式，是现收现付制与完全基金制的结合，又称为部分基金制。我国目前实施的社会医疗保险制度就是社会统筹与个人账户相结合的混合制模式；即社会统筹部分采用的是现收现付制，个人账户部分则采用完全基金制。

我国长期护理社会保险制度还处于试点阶段，发展尚不完善，对不同筹资模式的研究还较为缺乏。目前的研究主要单独对横向平衡和纵向平衡下的均衡费率进行测算，如陈璐（2013）、林宝（2016）和张盈华（2020）等均从横向平衡的角度测算；从纵向平衡角度测算均衡费率的研究分为两种，一是针对参保个人的精算平衡，一般应用在对长期护理商业保险的定价中，如胡晓宁等（2016）、张琳和汤薇（2020）等；另一种是对参保群体的精算平衡，常用于社会保险中个人账户均衡费率的研究，如医疗保险（何文炯等，2010）、长期护理保险（黄枫和吴纯杰，2018）。那么，在长期护理社会保险制度中，不同的筹资模式对长期护理社会保险基金的测算思路与计算方法究竟有何影响？不同筹资模式下应具体采用多大的均衡费率呢？

长期护理社会保险基金的支出主要取决于未来失能人口的规模和未来长期护理费用的支出。失能人口规模的预测方法主要分为宏观模拟法和微观模拟法两种。宏观模拟法多采用联合国分年龄段人口预测数据和静态失能率，从而预测每5年的失能人口规模（景跃军等，2017）。微观模拟法运行的理论基础是老年个体健康状态演变规律的 Markov 转移概率矩阵。其优点是允许老年人的身体状况在各种健康状态之间进行相互动态转化、对于失能的定义更为精确，且方便对异质性参保群体的健康状况进行分开建模（黄枫和吴纯杰，2012）。健康转移概率的估计方法包括直接估计法和间接估计法。直接估计法即直接对健康转移概率进行建模，如在转移概率与时间无关的 Markov 框架下（黄枫和吴纯杰，2012；胡宏伟等，2015；崔晓东，2017），或在转移概率与状态持续时间有关的 Semi-Markov 框架下（BIESSY，2015；Fuino 和 Wagner，2018）。由于微观数据的限制，中国目前的微观数据库缺乏有关失能老年个体失能持续时间的具体数据。间接估计法即将转移强度矩阵作为中间变量计算转移概率的方法。如 Hanewald 等（2019）和胡晓宁等（2016）、陈秉正和范宸（2020）。这种方法的实施前提是有个体的纵向跟踪调查数据库，包含个体的出生日期、调查日期、死亡日期以及状态转移日期。目前中国满足要求的数据库包括中国老年健康影响因素跟踪调查（CLHLS）和中国健康与养老追踪调查（CHARLS）。这两个数据库在调查对象、抽样方法和样本量之间存在较大差异。相比之下，CLHLS 对高龄老人健康分布的描述更加精确（陈秉正和范宸，2020）。由于本文主要的分析对象是 65 岁及以上的老年人，因此选用 CLHLS 数据计算健康转移概率矩阵。综合考虑健康转移概率矩阵估计方法的稳健性和数据的可得性，拟选用间接估计法估计个体的健康转移概率。

因此，本文将根据我国的宏观和微观数据，利用长期护理社会保险收支平衡精算模型，研究现收现付制和完全基金制两种不同筹资模式下长期护理社会保险的均衡费率，并就将来可能的变化进行敏感性分析，以期对我国正在推广的长期护理社会保险制度的试点提供理论和实践的借鉴。可能的贡献有：第一，考虑到男性和女性、城镇和农村以及不同年龄老年人健康状态演变趋势之间的差异，对不同性别、不同城乡和不同年龄进行分开建模，提高了未来失能人口规模预测的准确性。第二，测算了现收现付制下的横向均衡费率和完全基金制下的纵向均衡费率，丰富了长期护理社会保险筹资模式的研究。第三，对现收现付制和完全基

金制两种筹资模式下的制度参数进行了敏感性分析，洞察了在不同参数下长期护理社会保险均衡费率的水平和变动幅度。

## 2. 模型构建与方法

在中国长期护理社会保险试点的地区中，参保范围主要分为两类：一类是覆盖城镇职工的参保人员；另一类是覆盖城镇职工和城乡居民的参保人员。本文将分别基于这两类参保人群范围进行研究分析。城镇职工长期护理社会保险的缴费群体是小于等于 65 岁的在职参保职工，其均衡费率为工资水平的一定比例；受益群体则为 65 岁以上的退休职工。城乡居民长期护理社会保险的缴费群体则为小于等于 65 岁的居民，其均衡费率为收入水平的一定比例；受益群体的年龄同样限制为 65 岁以上。可以看到，无论是针对城镇职工还是城乡居民的长期护理社会保险，停止缴费和可能开始领取的年龄都是 65 岁。因此以 65 岁作为停止缴费和可能开始领取的时间。

### 2.1 健康转移概率矩阵的估计方法

在计算长期护理社会保险的均衡费率时，健康转移概率矩阵是需要解决的一个关键性问题。本文首先建立计算健康转移概率矩阵的模型。

#### 2.1.1 健康状态的划分

在设计长期护理保险的具体规则时，失能状态和失能等级的划分最终直接影响了老人获得给付的资格和给付水平。不同学者对失能状态等级的设计划分略微有所不同，主要包括三状态（健康、失能和死亡），如胡晓宁等（2016）和 Hanewald 等（2019）；四状态（健康、健康受损、功能障碍和死亡），如黄枫和吴纯杰（2012）；五状态（健康、轻度失能、中度失能、重度失能和死亡）。显然，失能状态的分类过多过细，会导致每个状态下的样本量过少，导致健康转移概率的估计精度降低（陈秉正和范宸，2020）。但倘若失能状态的分类过少，则难以刻画老人健康状态转移过程中的重要特征。

因此综合以上因素，最终采用四状态的失能状态分类：健康$h$（health）表示无任何功能障碍；受损$m$（mild）表示具有器具性日常活动障碍或 1-2 项日常活动障碍；失能$s$（severe）表示具有 3 项及以上日常活动的障碍；死亡$d$（death）表示身故。

#### 2.1.2 健康转移概率矩阵的估计

$D_x$表示不同年龄$x$下分性别、分城乡的年度健康转移概率矩阵，表示为：

$$\boldsymbol{D}_x = \begin{bmatrix} P_{hh}(x) & P_{hm}(x) & P_{hs}(x) & P_{hd}(x) \\ P_{mh}(x) & P_{mm}(x) & P_{ms}(x) & P_{md}(x) \\ P_{sh}(x) & P_{sm}(x) & P_{ss}(x) & P_{sd}(x) \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{1}$$

其中的$P_{ij}(x)$称为 $x$ 岁时的健康转移概率。假设各年龄下老年人健康状态的转移均服从时间齐性的 Markov 过程，即转移概率$P_{ij}(x)$只与时间间隔有关，而与所处的时间点无关。其中，$h$、$m$和$s$是过渡态，意味着各状态之间可以相互转移，即存在恢复的可能性。考虑到老人进入到$s$状态后再恢复到健康状态$h$的可能性较低，所以对这种情况不予以考虑。$d$是吸收态。身体各状态之间的转移概率与转移强度的公式分别表示为：

$$P_{ij}(x, x+t) = \Pr\{S(x+t) = j | S(x) = i\} \qquad t \geq 0, i, j \in \{h, m, s, d\}$$

(2)

$$\mu_{ij}(x) = \lim_{t\to 0^+} \frac{P_{ij}(x,x+t)}{t} \quad (3)$$

式中，$x$代表年龄，$t$代表时间，$S(x)$表示个体在年龄$x$时的随机健康状态，$P_{ij}(x,x+t)$表示在年龄$x$时处于状态$i$的个体经过时间$t$后转移到状态$j$的概率，$\mu_{ij}$表示从状态$i$转移到状态$j$的瞬时转移概率，又叫转移强度（transition intensity）。假设$\mu_{ij}(x)$是可积的，且仅依赖于年龄。参考 Fong 等（2015）、胡晓宁等（2016）、Hanewald 等（2019）的模型设定，运用广义线性模型（GLM）对健康状态转移强度进行估计。根据估计结果，可以预测出每个年龄下不同健康状态之间的转移强度，进一步通过 Kolmogorov 微分方程来求解相应的转移概率，具体表达式如下：

$$\frac{d}{dt}P_{ih}(x,t) = P_{im}(x,t)\mu_{mh}(t) - P_{ih}(x,t)[\mu_{hm}(t) + \mu_{hs}(t) + \mu_{hd}(t)] \quad i \in h,m \quad (4)$$

$$\frac{d}{dt}P_{im}(x,t) = P_{ih}(x,t)\mu_{hm}(t) - P_{im}(x,t)[\mu_{mh}(t) + \mu_{ms}(t) + \mu_{md}(t)] \quad i \in h,m \quad (5)$$

$$\frac{d}{dt}P_{is}(x,t) = P_{is}(x,t)\mu_{sd}(t) \quad i \in h,m,s \quad (6)$$

$$P_{id}(x,t) = 1 - P_{ih}(x,t) - P_{im}(x,t) - P_{is}(x,t) \quad (7)$$

根据式（4）~（7）和 Euler 方法，就可以求出不同性别、不同居住类型在不同年龄下的年度健康转移概率矩阵$\boldsymbol{D}_x$。

## 2.2 长期护理社会保险的均衡费率模型

再根据现收现付制和完全基金制两种不同筹资模式，分别建立长期护理社会保险的均衡费率模型。将均衡费率表示为工资水平或收入水平的一定比例。后文为了简化，均用工资水平代替工资或收入水平。

### 2.2.1 现收现付制

（1）横向均衡费率模型

根据现收现付制下基金收支的平衡原理，从收入端来看，长期护理保险基金未来的收入与缴费人数和均衡费率有关。社会保险具有一定的强制性，采取强制缴费的方式，因此假设所有的存活个体都参与并缴费。从支出端来看，长期护理保险基金未来的支出主要与未来的失能人数、不同护理方式的补贴比例以及失能个体在不同护理方式下的支出有关。假设失能状态的转变和缴费都发生在期初，则以 2019 年作为预测起点，横向平衡需要满足的等式为：

$$ER_t \sum_{x=a}^{65} M_{x,t}\, w_{2019}\,(1+g)^{t-2019} = \sum_{x=65}^{w} N_{x,t}^{3} \sum_{m=1}^{3}(1-\tau^m) f^m cost_{2019}^m\,(1+bt-2019 \quad (8)$$

其中，等式（8）左边表示基金收入，$ER_t$为第 $t$ 年的横向均衡费率，$a$为缴费开始年龄，$M_{x,t}$表示第 $t$ 年的缴费人数，$w_t$表示第$t$年的工资水平，$g$为工资增长率。式（8）右边表示基金未来的赔付支出，$w$为极限年龄，假定为 100 岁[1]，$N_{x,t}^3$表

[1] 由于第六次全国人口普查数据中仅包含 100 岁及以上的总人口信息，所以设定极限年龄为 100 岁。

示在 $t$ 年$x$岁群体中的失能老人数量，$\tau^m$表示政府对不同护理方式$m$的补贴比例，目前通常有护理院护理、养老院护理和居家护理三种护理方式，分别设定护理院护理$m=1$、养老院护理$m=2$、居家护理$m=3$。假定政府对居家护理的补贴比例始终比护理院护理或养老院护理的补贴比例高 5%。$f^m$为对不同护理方式$m$的偏好，$cost_t^m$为第 $t$ 年失能老人在护理方式$m$下的年度费用总支出，$b$为长期护理费用增长率。对（8）式移项得到第 $t$ 年参保个体的均衡费率$ER_t$，

$$ER_t = \frac{\sum_{x=65}^{w} N_{x,t}^3 \{\sum_{m=1}^3 (1-\tau^m) f^m cost_{2019}^m (1+b)^{t-2019}\}}{\sum_{x=a}^{65} M_{x,t}\, w_{2019} (1+g)^{t-2019}}$$
$$= \frac{\sum_{x=65}^{w} N_{x,t}^3}{\sum_{x=a}^{65} M_{x,t}} \times \sum_{m=1}^3 (1-\tau^m) f^m \times \frac{cost_{2019}^m}{w_{2019}} \left(\frac{1+b}{1+g}\right)^{t-2019} \quad (9)$$

从式（9）可以看出，在现收现付制的筹资模式下，个体的横向均衡费率取决于三个因素：一是失能人数与缴费人数的比例$\sum_{x=65}^{w} N_{x,t}^3 / \sum_{x=a}^{65} M_{x,t}$，如果比例越高，则横向均衡费率越高，这主要与失能状态的定义和人口结构有关；二是政府对不同护理方式提供的补贴比例$\tau^m$和失能老人对不同护理方式的偏好$f^m$。政府的护理补贴比例越高或失能老人更倾向于居家护理，则个体的横向均衡费率都会越低；三是长期护理费用增长率和工资增长率的比值$[(1+b)/(1+g)]^{t-2019}$。显然，如果工资增长率$g$快于长期护理费用增长率$b$，则随着时间$t$的增加，横向均衡费率会降低，反之亦反。当$g=b$时，即工资增长率等于长期护理费用增长率时，均衡费率实现工资中性，此时横向均衡费率的大小与$g$、$b$均无关。所以后文主要对政府补贴比例$\tau^m$和个体偏好$f^m$两个参数进行敏感性分析。

（2）失能人数的计算

用向量$N_{x,t} = [N_{x,t}^h, N_{x,t}^m, N_{x,t}^s, N_{x,t}^d]$表示$x$岁个体在第$t$年处于不同健康状态的老人数量分布，其中，上标$h$、$m$、$s$、$d$分别表示健康、受损、失能和死亡四种健康状态，即$N_{x,t}^s$表示处于失能状态的老人数量。

第$t$年的失能人口主要由两部分构成。一部分是$t-1$年已满 65 岁及以上年龄的老人，另一部分是在$t$年刚满 65 岁的失能老人。对于第一部分的老年人，按照年龄移算法$N_{x,t} = N_{x-1,t-1}\boldsymbol{D}_{x-1}$，可以得到年龄为$x$岁的个体在 $t$ 年的健康状态分布。$\boldsymbol{D}_x$表示不同年龄$x$下分性别、分城乡的年度健康转移概率矩阵。如 2020 年处于不同健康状态的老年人口分布比例，通过$N_{x,2019}$乘以$\boldsymbol{D}_x$得到。然后对所有年龄$x$求和，$x \in 66\sim100$，得到第一部分的失能老人总和，表示为$\sum_{x=66}^{100} N_{x,t}^s$。

另一部分就是在$t$年刚满 65 岁的失能老人，通过将年龄为$2019+65-t$岁个体在2019年初始的老年人数乘以对应年龄的生存率$p_x$得到。各年龄生存率可以从死亡率表得到，$p_x = 1-q_x$， $q_x$表示$x$岁的个体在一年内死亡的概率。因此，每一年新满 65 岁的老人数目$n_t$表示为：

$$n_t = l_{2019+65-t} \prod_{x=2019+65-t}^{64} p_x \qquad t = 2020\sim2039 \quad (10)$$

记$n_t$为第 $t$ 年刚满 65 岁的老人数量，$l_x$为年龄为 $x$ 岁个体在 2019 年的生存人数。将总人数$n_t$乘以 65 岁老人在不同健康状态的分布比例，得到第 $t$ 年新满 65 岁的失能老人数量。最后，将上述两个部分的失能人数加总，等于第 $t$ 年处于失能状态的老人总数。

2.2.2 完全基金制

假设从 2019 年开始建立长期护理社会保险制度，且筹资模式为完全基金制，即参保者可以从 40~65 周岁间的任意年龄开始长期护理社会保险的缴费，但在年满 65 岁之后停止缴费，同时政府会对符合失能条件的老人进行给付。根据完全

基金制下的基金收支平衡原理，假定缴费和给付都发生在期初，年龄为 $x$ 岁的人群一生所缴保险费的终值等于参保者可能获得的长期护理保险给付期望值的终值。

下面计算 40-65 岁个体的纵向均衡费率。假设存活个体都参与了缴费，每年需要缴纳的费用是工资或收入的一定比例，纵向平衡需要满足的平衡公式为：

$$ER_a \sum_{x=a}^{65} N_{x,2019+x-a} w_{2019} (1+g)^{x-a} (1+r)^{w-x+1} =$$

$$\sum_{x=65}^{w} N^3_{x,2019+x-a} \sum_{m=1}^{3} (1-\tau^m) f^m cost^m_{2019} (1+b)^{x-a} (1+r)^{w-x+1} \quad (11)$$

其中，式（11）左边表示未来缴费的终值，纵向均衡费率为$ER_a$，$a$表示初始缴费的年龄，$a \in 40{\sim}65$，年龄为$a$岁的参保者需要一直缴费直到 65 岁，即总共缴费 $65-a+1$年。 $N_{x,2019+x-a}$表示年龄为$x$岁在$2019+x-a$年时的参保群体，我们仅已知$x$年龄个体在 2019 年的初始人数$N_{x,2019}$，之后年份的参保人数由$N_{x,2019+x-a} = N_{x,2019} \prod_{x=a}^{65-a+1} p_x$得到。工资或收入水平的增长率为$g$，$w_{2019}$表示 2019 年的工资或收入水平，$(1+r)^{w-x+1}$表示终值因子。式（11）右边代表未来支出的终值，年龄为$a$岁的个体经过$2019+65-a$年后变为 65 岁，此时存活的人口总数用$N_{a,2019+65-a}$表示；乘以$h_{65}$，得到 65 岁时处于不同健康状态的老人数量分布，之后大于 65 岁的个体在年龄为$x$年份为$2019+x-a$时处于不同健康状态的人数分布由$N_{a,2019+65-a} h_{65} \prod_{65}^{x} D_x$得到，由此获得处于失能状态下的老人数量$N^3_{x,2019+x-a}$。同样，$D_x$表示年龄为$x$的年度健康转移概率矩阵。$w$表示极限年龄。$r$表示银行一年期定期存款利率，取 3.5%。对式（11）进行移项得到$a$岁参保个体对应的纵向均衡费率$ER_a$，

$$ER_a = \frac{\sum_{x=65}^{w} N^3_{x,2019+x-a} \{\sum_{m=1}^{3} (1-\tau^m) f^m cost^m_{2019} (1+b)^{x-a}\} (1+r)^{w-x+1}}{\sum_{x=a}^{65} N_{x,2019+x-a} w_{2019} (1+g)^{x-a} (1+r)^{w-x+1}}$$

$$= \frac{\sum_{x=65}^{w} N_{a,2019+65-a} h_{65} \prod_{65}^{x} D_x \{\sum_{m=1}^{3} (1-\tau^m) f^m cost^m_{2019} (1+b)^{x-a}\} (1+r)^{w-x+1}}{\sum_{x=a}^{65} N_{x,2019} \prod_{x=a}^{65-a+1} p_x w_{2019} (1+g)^{x-a} (1+r)^{w-x+1}} \quad (12)$$

根据式（12）可以计算出 40~65 岁缴费群体满足基金平衡原则时的纵向均衡费率。个体初始缴费年龄$a$越小，总缴费年数越长，实现纵向均衡条件所需的均衡费率越低。从式（12）可以大致看出，个体纵向均衡费率主要取决于三大类因素，一类是初始人口结构和健康水平，如初始人数$N_{x,2019}$、生存率$p_x$和健康转移概率矩阵$D_x$等，这些参数相对而言较为稳定；第二类是长期护理费用支出水平，影响因素包括政府对不同护理方式的补贴比例$\tau^m$、失能老人对不同护理方式的偏好$f^m$等。其中，$\tau^m$越高或居家护理偏好$f^m$越高，纵向均衡费率下降得越多，且不同缴费年龄个体下降的幅度相同；第三是其他参数，如利率水平$r$，利率水平的大小直接影响基金未来的现金价值，缴费年限越长的个体，受利率影响的程度越大。后文主要针对政府的补贴比例$\tau^m$和利率水平$r$两个代表性参数引起的纵向均衡费率的变化进行敏感性分析。

## 3. 数据及其描述性统计

本文所使用的数据主要来自两个方面：一是 CLHLS 四期追踪调查数据和 2010 年第六次人口普查数据。主要有三个用途，首先利用 Markov 状态转移假设和 GLM 估计方法来估算不同性别、不同居住类型在各个年龄的健康转移概率矩阵。其次在计算不同年龄初始健康状态的分布时，由于宏观人口调查数据对健康状态的分类较为主观和粗糙，所以本文按照 CLHLS 调查数据中关于不同年龄健康状态比例来进行近似模拟。CLHLS 数据良好的代表性保证了这一假设的合理性。第三则是利用 2010 年第六次人口普查数据和 2019 年人口抽样调查数据，预测我国未来失能老年人口的规模和演变趋势。第二个数据来源是有关个体对不同护理方式的偏好，以及不同护理方式下具体的护理费用等相关的参数信息。

## 3.1 计算健康转移概率矩阵所需的数据

### 3.1.1 数据来源

根据 CLHLS2008、2011、2014 和 2018 年的调查数据构建三次健康状态转移数据，并以 65 岁及以上老人为研究对象。其中，2008-2011 年、2011-2014 年、2014-2018 年的样本量分别为 16954、9765 和 7192 人。总体来说，样本量较大，基本满足对 65-105 岁之间的每个年龄进行精确建模的要求。且考虑到男性和女性、城镇和农村的失能率存在巨大差异（景跃军等，2017），故分为四个子样本分别进行估计。在界定健康状态时，采用国际上普遍认可的六项日常活动能力（ADLs）和八项器具性日常活动能力（IADLs）来进行评估。CLHLS 问卷中对每一个问题都进行了询问。倘若受访者在没有其他人持续提供帮助则无法完成某项日常活动时，则记为失去该项活动能力。有一项即记为 1，并以老人无法完成的活动数量来衡量失能的严重程度。

### 3.1.2 描述性统计

首先对数据进行清理，删掉健康、性别、居住类型等关键变量缺失的观测值，排除后续跟踪调查中丢失的样本。将合并所有样本并根据失能状态进行分类后，共计 27275 个样本。其中，来自 2008-2011 年、2011-2014 年和 2014-2018 年调查的样本分别占比为 50.51%、30.65%和 18.84%，具体如表 1 所示。对跟踪调查的数据进行对比分析发现，有 10577 名老人在后续跟踪调查中去世，占比约 38.78%。在剩余的老人中，41.69%老人为健康，无任何功能障碍；13.89%的老人为受损；5.64%的老人为失能，存在严重的功能障碍且需要护理。数据表明，受损的老人仍有较高的恢复率，占总样本的 2.11%。而失能的老人恢复到健康和受损状态的可能性较低，样本比例仅为 0.15%和 0.40%。所以下文不再考虑失能状态向健康和受损状态的恢复率，但还是有必要考虑从受损状态向健康状态的恢复率（*m-h*）。

把男性城镇、女性城镇、男性农村和女性农村分别记为 mc、fc、mv 和 fv。根据不同性别、不同居住类型得到分样本描述性统计。男性占比 44.2%，女性占比 55.8%，女性老人多于男性；城镇占比 41.0%，农村占比 59.0%，农村居民多于城镇。总体来说，分样本数据较为平衡，为划分成四个子样本估计提供了样本数量的支撑。

表1　数据的描述性统计

| trans | 2008-2011 | | | | 2011-2014 | | | | 2014-2018 | | | | 总计 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mc | fc | mv | fv | mc | fc | mv | fv | mc | fc | mv | fv | |
| H-H | 976 | 923 | 150<br>3 | 171<br>4 | 882 | 799 | 103<br>0 | 862 | 467 | 411 | 682 | 508 | 1075<br>7 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H-M | 178 | 260 | 454 | 262 | 138 | 177 | 126 | 230 | 84 | 131 | 100 | 155 | 2295 |
| H-S | 62 | 65 | 113 | 85 | 41 | 36 | 36 | 51 | 25 | 29 | 26 | 34 | 603 |
| H-D | 395 | 344 | 816 | 834 | 291 | 215 | 291 | 249 | 226 | 154 | 281 | 242 | 4338 |
| M-H | 38 | 56 | 121 | 61 | 48 | 47 | 36 | 100 | 11 | 20 | 15 | 22 | 575 |
| M-M | 83 | 191 | 345 | 109 | 70 | 160 | 54 | 196 | 20 | 48 | 25 | 84 | 1385 |
| M-S | 60 | 112 | 164 | 44 | 28 | 78 | 27 | 85 | 11 | 34 | 11 | 37 | 691 |
| M-D | 283 | 562 | 1111 | 458 | 188 | 347 | 193 | 387 | 112 | 195 | 167 | 317 | 4320 |
| S-H | 0 | 7 | 8 | 3 | 3 | 7 | 1 | 3 | 2 | 5 | 0 | 1 | 40 |
| S-M | 4 | 13 | 17 | 9 | 8 | 13 | 10 | 22 | 0 | 5 | 3 | 4 | 108 |
| S-S | 9 | 43 | 39 | 11 | 26 | 42 | 10 | 42 | 4 | 8 | 0 | 10 | 244 |
| S-D | 87 | 219 | 397 | 129 | 124 | 235 | 99 | 216 | 78 | 124 | 63 | 148 | 1919 |
| total | 217 5 | 279 5 | 508 8 | 371 9 | 184 7 | 215 6 | 191 3 | 244 3 | 104 0 | 116 4 | 137 3 | 156 2 | 2727 5 |

## 3.2 长期护理保险模型中的基本参数设置

其他可能用到的长期护理保险基本参数设置及依据详细如下：

1.长期护理社会保险参保人数：分为城乡居民参保人数和城镇职工参保人数。假定长期护理社会保险的参保人数与基本医疗保险的参保人数情况相似，总参加率为 100%。以 2019 年的数据为例[2]，城镇退休人员参保人数占城镇职工参保人数的比重大致为 26.43%，城镇职工参保人数占城镇总参保人数的比例约为 24.32%，城镇总参保人数减去城镇职工参保人数为城镇居民参保人数，即城镇居民参保人数占城镇总参保人数的比重为 75.68%。城乡居民由城镇居民和农村居民组成。假设之后预测年份的情况与 2019 年的比例相同，即城镇职工参保人数占比、城镇居民参保人数占比均不发生变化。

2.收入水平：城镇职工就业人员平均工资、城镇居民人均可支配收入为、农村居民人均可支配收入在 2019 年分别为 90501 元、42359 元和 16021 元，以上数据均来源于国家统计局。对于 2020 年及以后的工资数据，则通过假设工资收入按照年平均增长率$g$增长而得到，即$w_t = (1+g)w_{t-1}$，$g$取 6%。

3.不同护理方式的选择比例：长期护理支出主要由城乡地区中老人使用不同护理方式的比例以及不同护理方式的单位费用所决定。护理方式主要包括护理院、养老机构和居家护理三种。借鉴李佳（2020），设置城镇失能老人和农村失能老人选择护理院、养老机构和居家养老的比例。并假设城乡地区的老人对不同护理方式具有不同的偏好，但偏好并不随年龄而变化。在对参数进行敏感性分析时，无论是城镇职工还是城乡居民，都保持家庭对护理院偏好与养老院偏好之间的差值不变，且对居家护理的偏好$= 1 -$护理院偏好$-$养老院偏好。

4.不同护理方式的单位护理费用：参考陈璐（2013），得到 2009 年失能老年人在护理院、养老机构和居家护理三种护理方式下的单位护理费用。后续进一步根据城镇和农村居民的人均年收入增长率，推算出 2019 年在不同护理方式下的费用水平。为了简化参数，实现工资中性的目的，假设长期护理费用增长率和工资增长率相等，均为 6%。

5.政府补贴比例：政府对不同护理方式给付的补贴比例不同的。为了减少社

[2] 数据来源：中国统计局官网，https://data.stats.gov.cn/easyquery.htm?cn=C01

会照料的负担，充分发挥家庭照料的优势，政府对于不同的护理方式给予了不同的补贴比例。假定无论是城镇职工还是城乡居民的失能老人，同一护理方式下的补贴比例均相同。具体比例根据我国目前试点地区的实践经验数据选取确定。在对参数进行敏感性分析时，保持居家护理的补贴比例−0.05=护理院的补贴比例=养老院的补贴比例的等式不变。

本文所用的基础参数如表 2 所示。

表2 基础参数设置的汇总

| 符号 | 含义 | 取值 | 参考文献与依据 |
|---|---|---|---|
| $g$ | 工资增长率 | 6% | 黄枫和吴纯杰（2018） |
| $b$ | 护理费用增长率 | 6% | 同上 |
| $f^m$ | 失能老人对护理方式的偏好（preference） | 护理院、养老院、居家：城镇（19.2%、19.3%、61.5%）；农村（13.4%、24.2%、62.4%） | 李佳（2020） |
| $cost_t^m$ | 失能老人在护理方式$m$下的单位护理费用 | 城镇：5514、1944、2238 元/月<br>农村：1366、849、993 元/月 | 陈璐（2013） |
| $\tau^m$ | 政府对不同护理方式$m$的补贴比例（subsidy） | 护理院：养老院：居家=0.70：0.70：0.75 | 长期护理试点地区数据 |

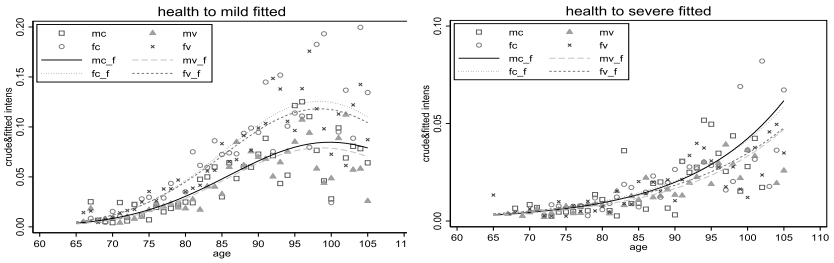
## 4. 模型估计过程与结果

### 4.1 健康转移概率矩阵的估计

#### 4.1.1 转移强度的计算

首先根据微观原始数据，利用风险暴露法得到原始转移强度，然后对分样本下的 7 个原始转移强度依次分别进行 GLM 拟合，利用 BIC 准则确定最优的模型形式，得到拟合后的转移强度曲线。图 1 展示了原始转移强度（mc\mv\fc\fv）的散点图和拟合后的转移强度曲线（mc_f\mv_f\fc_f\fv_f）。其中，横轴代表年龄从 65-105 岁，纵轴代表了转移强度的大小。

其中，原始转移强度等于转移次数除以期初相应健康状态的风险暴露数。风险暴露数可以根据每次调查的调查日期、出生日期以及死亡日期来确定，并可以精确到月度数据。若期末状态为死亡，则状态转移时间为确切的死亡日期；若期末状态不是死亡但健康状态发生了变化，则假设健康状态的转移时间为两次调查日期的中点。



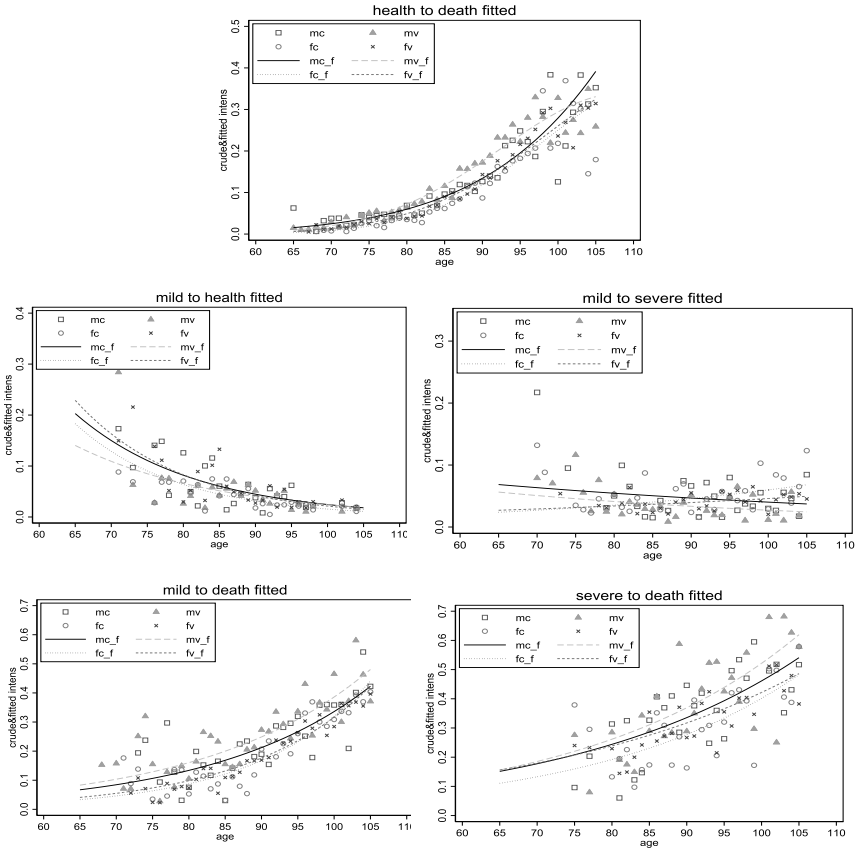



图1 转移强度的散点图和拟合曲线图

根据前文的分析，不再考虑失能转移到健康（*s-h*）和失能转移到受损（*s-m*）两种情况。从图 1 中拟合曲线的趋势可以看出，由受损状态恢复到健康状态（*m-h*）的转移强度随着年龄的增加而降低；除 *m-h* 外，其他健康状态拟合后的转移强度均随着年龄的增加而增加，且增加的幅度与初始健康状态紧密相连。另外，除从受损转移到失能（*m-s*）中转移强度是与年龄有关的一次函数之外，其余健康状态的转移强度均是年龄的二次函数。年龄的正二次效应意味着，年龄越大的个体，其健康转移强度的正向变化率越大，即失能和死亡的风险越高。从拟合后转移强度的大小来看，不同性别和不同城乡的老年个体在不同初始健康状态下的表现不同。初始为健康状态的老年个体中，女性城镇（fc_f）的转移强度最高；初始为受损状态的老年个体中，尤其是从受损转移到死亡（*m-d*）的情况下，男性农村（mv_f）的转移强度反而最高。

4.1.2 健康转移概率矩阵

根据图 1 拟合得到的转移强度，结合公式（4）~（7），可以求出不同性别、不同城乡下各年龄（65-105 岁）的单位年度健康转移概率矩阵，总共包括了 164 个矩阵，即 2*2*41 个矩阵。限于篇幅，下文仅列出在年龄为 65 岁和 75 岁的男性城镇、男性农村、女性城镇和女性农村的年度健康转移概率矩阵，如表 3 所示。

表3 65岁和75岁分性别、分城乡的年度健康转移概率矩阵

| | 期末 | H | M | S | D | H | M | S | D |
|---|---|---|---|---|---|---|---|---|---|
| 年龄 | 期初 | 男性城镇 | | | | 男性农村 | | | |
| 65 | H | 0.978 | 0.004 | 0.003 | 0.016 | 0.985 | 0.003 | 0.003 | 0.009 |
| | M | 0.203 | 0.661 | 0.069 | 0.067 | 0.140 | 0.720 | 0.056 | 0.083 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | S | 0 | 0 | 0.849 | 0.151 | 0 | 0 | 0.844 | 0.156 |
| | H | 0.938 | 0.017 | 0.006 | 0.039 | 0.939 | 0.015 | 0.006 | 0.040 |
| 75 | M | 0.111 | 0.724 | 0.059 | 0.106 | 0.085 | 0.740 | 0.046 | 0.129 |
| | S | 0 | 0 | 0.792 | 0.208 | 0 | 0 | 0.780 | 0.220 |
| | | 女性城镇 | | | | 女性农村 | | | |
| | H | 0.988 | 0.005 | 0.004 | 0.003 | 0.985 | 0.005 | 0.004 | 0.006 |
| 65 | M | 0.183 | 0.760 | 0.024 | 0.033 | 0.229 | 0.703 | 0.027 | 0.041 |
| | S | 0 | 0 | 0.890 | 0.110 | 0 | 0 | 0.844 | 0.156 |
| | H | 0.949 | 0.025 | 0.007 | 0.019 | 0.942 | 0.025 | 0.007 | 0.027 |
| 75 | M | 0.090 | 0.815 | 0.031 | 0.064 | 0.116 | 0.779 | 0.031 | 0.074 |
| | S | 0 | 0 | 0.840 | 0.160 | 0 | 0 | 0.793 | 0.207 |

从表 3 中可以看到：（1）对于不同年龄的老人，初始健康状态仍然是最为显著的失能和死亡风险因素。如对于不分性别和城乡类型的 65 岁老年个体，初始状态为健康时，下一年失能和死亡的平均概率分别为 0.004 和 0.009；初始状态为受损时，下一年失能和死亡的平均概率为 0.044 和 0.056；初始状态为失能时，下一年死亡的平均概率为 0.1433。表明随着初始健康状态的恶化，老年个体失能和死亡的概率均显著增加。（2）老人失能和死亡的风险随着年龄的增长显著增加。如 65 岁男性城镇的健康老人在下一年度中转移到受损和失能的概率分别为 0.004 和 0.003，一年内死亡的概率为 0.016。而 75 岁男性城镇的健康老人的这三个数据则依次为 0.017、0.006 和 0.039。（3）无论是不同性别之间、还是不同居住类型之间，老人的健康状态变化都存在着显著的异质性。女性老人具有明显的生存优势。女性老人在一年内生存（死亡）的概率总是比相同年龄、相同初始健康状况的男性老人高（低）；但男性老人具有更明显的健康优势。从居住地域来看，城乡地区老人的健康转移表现却具有不同的特征。居住在城镇的老人虽然具有更低的死亡率，但失能率相对较高，表现具有显著的生存优势和健康劣势。这可能是由于城乡之间的医疗服务设施的差异、收入不平等、生态环境和城乡差距造成的健康不平等所导致的（Wang 和 Yu，2016）。

## 4.2 现收现付制下的横向均衡费率

### 4.2.1 预测结果

根据公式（10），可以得到 2019-2039 年失能人数的大小，结果如图 2 所示。图 2 中，横轴为各年度，纵轴为失能人数。可以看到，随着年份的推移，未来的总失能人数持续增加，在 2019 年到 2039 年的 21 年间，总失能人数增长了大约 3.5 倍；在 2035 年时，总失能人数更是冲破了 1000 万人的大关。这充分意味着随着我国老龄化、失能化程度的加深，建立全国性的长期护理社会保险制度刻不容缓。从分性别、分城乡的失能人口大小来看，女性失能人口始终高于男性，城镇失能人口始终高于农村，具体为女性城镇>男性城镇>女性农村>男性农村。这种大小关系在任何年份都成立，且随着时间的推移，不同性别、不同城乡的失能人口差距进一步扩大。

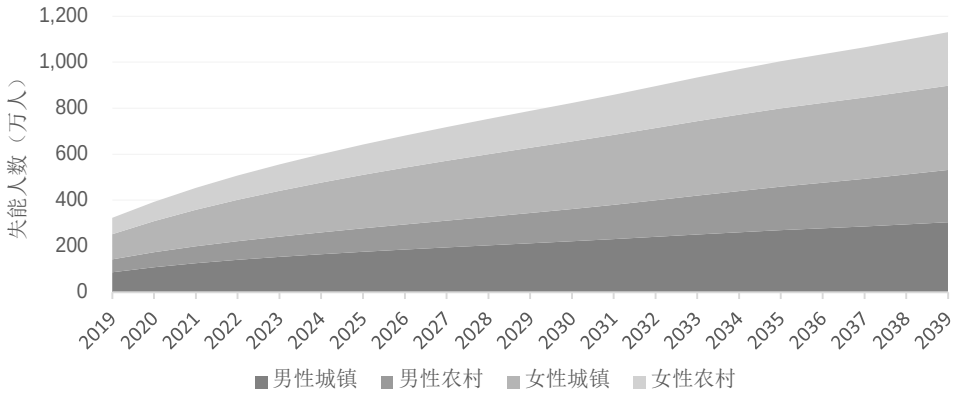



图2　2019~2039年失能人数的大小

进一步根据公式（9），可以得到 2019-2039 年横向均衡费率和缴费额（横向均衡费率乘工资或收入水平）的大小，结果如图 3 所示。

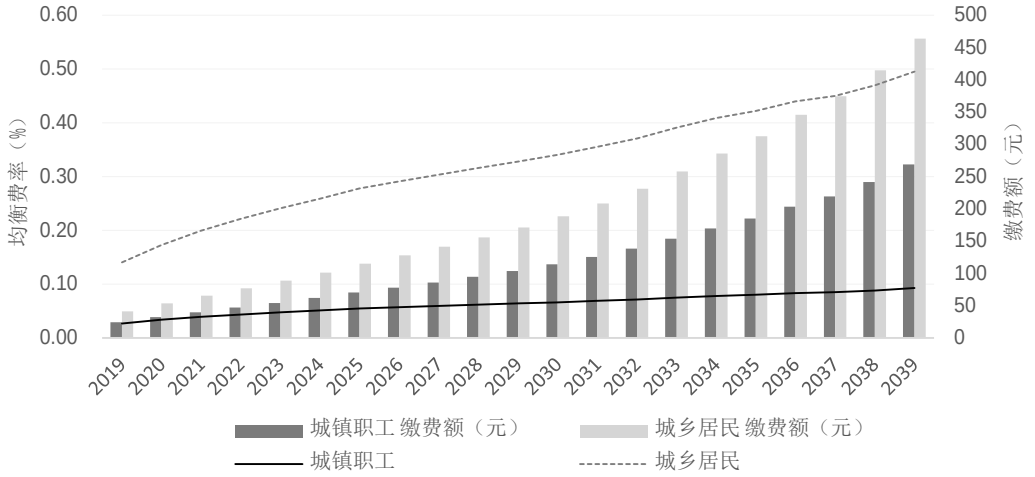



图3　现收现付制下2019~2039年横向均衡费率及缴费额

图 3 中，横轴为各年度，纵轴为横向均衡费率和缴费额。从 2019-2039 横向均衡费率的模拟结果可以看到，随着时间的推移，未来的均衡费率虽然会持续地稳步增加，但整体水平相对仍较低。到 2039 年，城镇职工和城乡居民最高均衡费率也未超过 0.1%和 0.5%。特别的是，城镇职工的均衡费率显著低于城乡居民所需的均衡费率，但两者的增长率相近，2019 年~2039 年这 21 年间均增长了 3.5%左右。从缴费额来看，在 2019 年，城镇职工和城乡居民的横向均衡缴费额分别为 24 元/人和 41 元/人。这与和我国目前试点地区的个体缴费额大小相近。但到 2039 年，城乡居民的缴费额增加至 464 元/人。这显然对于个体而言是一个较大的负担。

所以，在目前均衡费率还不是很高的背景下，我国应尽快建立起全国范围内的长期护理社会保险制度。横向均衡费率和缴费额的上升主要是由于未来我国人口结构老化，而现收现付制下基金的稳定性过度是依赖于人口结构而造成的。所以，未来需要进一步提高横向均衡费率才能实现基金的平衡。另外，由于现收现付制具有在不同群体之间的风险分担和收入再分配的功能，所以会带来公平性问题。比如，女性的失能率高于男性，但他们的横向均衡费率却是相同的。

4.2.2 敏感性分析

通过改变式（9）中长期护理社会保险横向均衡公式中的某些参数，可以考察参数在截面维度和时间维度上对城镇职工和城乡居民横向均衡费率的影响，主要参数有政府补贴比例$\tau^m$、失能老人对居家护理的偏好$f^m$，结果分别如图 4a 和图 4b 所示。

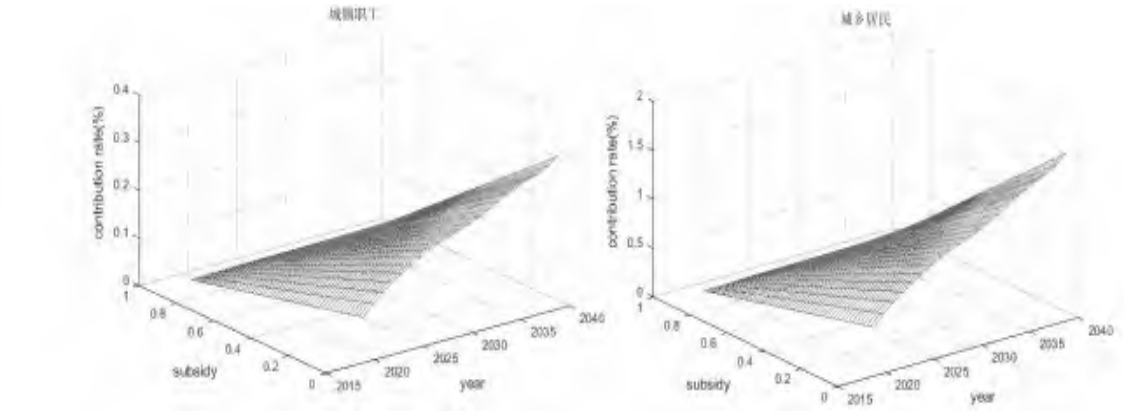



图4a 政府补贴比例对城镇职工（左）和城乡居民（右）横向均衡费率的影响

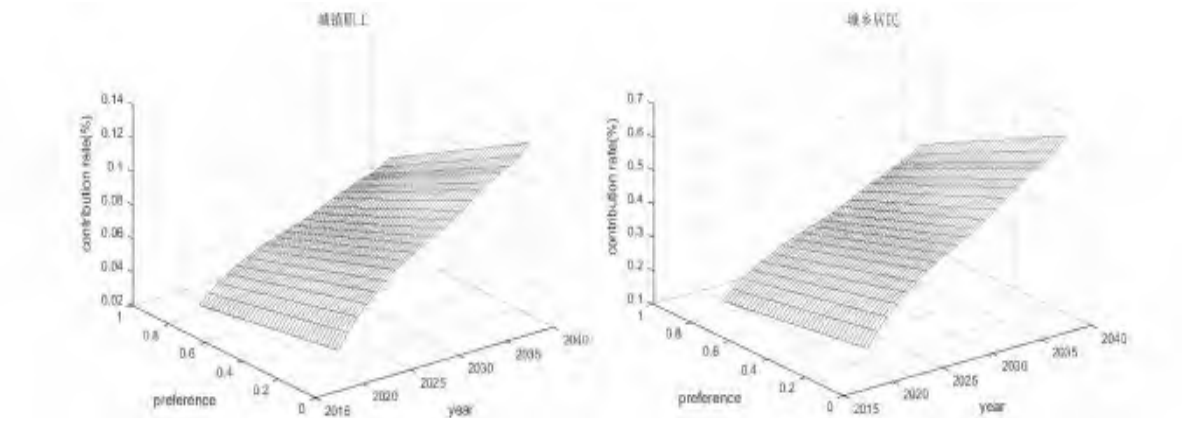



图4b 居家护理偏好对对城镇职工（左）和城乡居民（右）横向均衡费率的影响

图 4a 和图 4b 中，x 轴代表了预测的未来年度（2019~2039，时间维度），y 轴代表了不同参数的取值范围（截面维度），z 轴代表了横向均衡费率的大小。从图 4a 所示的截面维度来看，随着政府补贴$\tau^m$的增加，会显著减轻个体负担，降低个体横向均衡费率；从时间维度看，均衡费率具有显著增加的势头。若在时间的向后推移和补贴比例减少的双重作用下，即在 2039 年且政府对三种护理方式的补贴比例最低时（取 0%、0%和 5%），城镇职工和城乡居民的横向均衡费率达到最大值，分别为 0.32%和 1.71%。相较于基准补贴情形（70%、70%和 75%），横向均衡费率分别增加了约 3.45 倍。

从图 4b 的截面维度来看，个体对居家护理的偏好程度$f^m$越低，意味着失能老人更不愿意选择居家护理，而更愿意选择机构护理或养老院护理，此时横向均衡费率显著增加。从时间维度看，随着时间的推移，横向均衡费率也在不断增加，同样在 2039 年达到最大。此时若失能老人对居家护理的偏好分别为最小（城镇 0.12；农村 0.004）和最大（城镇 0.972；农村 0.864）时，相较于基准偏好情形（城镇 0.615；农村 0.624），城镇职工和城乡居民的横向均衡费率分别增加了 1.40 倍和 1.37 倍。

通过对比图 4a 和图 4b 中 z 轴的大小可以发现，相较于失能老人对居家护理偏好$f^m$改变带来的影响，政府补贴比例$\tau^m$的变动对个体横向均衡费率带来的影响明显更为显著。

## 4.3 完全基金制下的纵向均衡费率

### 4.3.1 预测结果

根据式（12），得到不同参保年龄下城镇职工男性、城镇职工女性、城乡居民男性和城乡居民女性的纵向均衡费率的大小，结果如图 5 所示。其中，横轴代表参保年龄，纵轴代表纵向均衡费率。

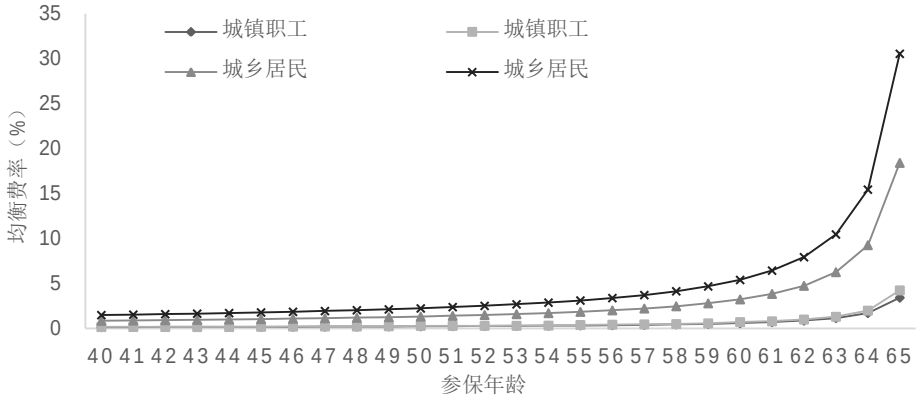



图5　不同参保年龄的纵向均衡费率

从图 5 可以看出，完全基金制下，不同年龄的纵向均衡费率不同。对于年龄越高的参保者，其缴费的年限较短，因此要实现基金平衡的纵向均衡费率越高。例如，男性城镇职工在 40 岁、50 岁和 60 岁下的纵向均衡费率分别为 0.1619%、0.2492%和 0.6044%。从不同的性别来看，无论在哪种情况下，女性的纵向均衡费率均显著高于男性。这与表 3 得到的转移概率矩阵结果相一致，即与相同年龄的男性个体相比，女性个体具有明显的生存优势和健康劣势。这在长期护理商业保险的定价中也得以体现，也与其他学者的研究结论保持了一致（黄枫和吴纯杰，2012；胡晓宁等，2016）。从不同的参保主体来看，仍然表现为城乡居民的纵向均衡费率显著高于城镇职工。

比较图 3 和图 5 可以发现，在相同的参保主体下，纵向均衡费率的大小显著高于横向均衡费率。但纵向均衡费率保证了不同年龄参保群体之间的公平性，且在 2019 年确定了纵向均衡费率后，不会因为年份的推移或人口年龄结构的老龄化而影响到基金的收支平衡，从而不需要调整未来纵向均衡费率的大小。

### 4.3.2 敏感性分析

通过改变式（13）中政府补贴比例$\tau^m$和利率$r$变动的大小来观察纵向均衡费率的变化，结果如图 6 所示。

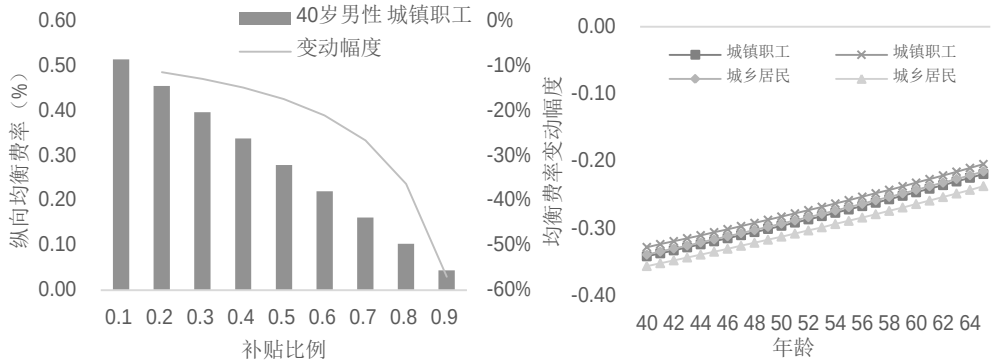



图6 补贴比例变动（左）和利率变动（右）对纵向均衡费率的影响

图6左图显示了在不同政府补贴比例$\tau^m$下，40岁男性城镇职工纵向均衡费率的大小；以及$\tau^m$按照每10%的幅度提高时，纵向均衡费率的变动幅度。从变动大小来看，随着政府补贴比例$\tau^m$的不断提高，纵向均衡费率显著降低；从变动幅度来看，随着政府补贴比例的提高，纵向均衡费率降低幅度的绝对值越大。如政府补贴比例为0.1和0.9时，40岁男性城镇职工的纵向均衡费率分别为0.5144%和0.0444%，降低了91%。此时虽然个体的缴费负担变轻，但政府的补贴负担变重。图6右图显示了银行利率$r$由3.5%上升为5%时对不同年龄个体纵向均衡费率带来的影响。结果显示，利率升高将导致纵向均衡费率下降，且不同性别和不同居住类型个体的下降幅度基本相同，但年龄越小的个体，由利率升高带来的纵向均衡费率下降的幅度越大。如对初始缴费年龄为40岁和60岁个体而言，利率升高1.5%带来的纵向均衡费率的下降幅度分别约为0.34%和0.22%。说明在完全基金制筹资模式下，基金的保值增值能力越强，个体的缴费负担越小。

## 5. 结论与政策建议

研究社会保险制度运行的理论基础是社会保险精算学，本文在建立了健康转移矩阵之后，研究了长期护理社会保险在不同筹资模式下的均衡费率。主要的研究思路是：利用 CLHLS 四次追踪调查数据对老年人健康状态的转移概率矩阵进行建模，得到我国不同性别、不同居住类型的 65 岁及以上老人的健康转移概率矩阵；然后结合社会保险精算理论，分城镇职工和城乡居民两种参保主体的情形，分别模拟测算了现收现付制和完全基金制两种长期护理社会保险筹资模式下 2019-2039 年的横向和纵向均衡费率。主要得到了如下的研究结论：

（1）从健康转移矩阵来看，初始健康状态的恶化和年龄的增长都将导致老人失能和死亡的概率显著增加。但健康状态具体的演变规律在不同性别、不同居住类型的老年人之间存在异质性。具体表现为女性老人具有明显的生存优势，即女性老人在一年内生存（死亡）的概率总是比相同年龄、相同初始健康状况的男性老人高（低）；但男性老人具有更明显的健康优势。从居住地域来看，居住在城镇的老人虽然具有更低的死亡率，但失能率相对较高，表现出显著的生存优势和健康劣势。

（2）现收现付制下，未来的失能人口数不断增加，从 2019 年到 2039 年，失能人数增长了约 3.5 倍，到 2035 年冲破 1000 万人大关。因此建立起全国性的长期护理社会保险制度迫在眉睫。从横向均衡费率来看，在 2019~2039 年预测期内，虽然城镇职工和城乡居民的横向均衡费率都在不断增加，但总体水平较低，

不会给个体造成较大的经济负担。到 2039 年，城镇职工和城乡居民的最高横向均衡费率也不超过 0.1%和 0.5%。总体来说，现收现付制的实施较为容易，且要求的横向均衡费率的水平较低，能够实现了长期护理费用的代际转移以及风险的共济，但随着人口未来结构的进一步老化可能会面临着需提高均衡费率的风险。参数敏感性结果显示，改变政府补贴比例相较于改变个体对居家护理的偏好程度对个体横向均衡费率带来的影响更大。

（3）完全基金制下，测算了 40~65 岁个体纵向均衡费率的大小。随着参保人年龄增加，个体纵向均衡费率显著增加。如男性城镇职工在 40 岁、50 岁和 60 岁下的纵向均衡费率分别为 0.1619%、0.2492%和 0.6044%，明显高于现收现付制下的横向均衡费率。而且年龄越大，纵向均衡费率越高，参保群体可能更难以接受。虽然纵向均衡费率相对较高，但在不同参保年龄的群体之间更加公平，且未来也不会面临由于人口结构老化而需要调高均衡费率的情况，长期护理社会保险基金具有相对更好的稳定性和持续性。敏感性分析显示政府补贴比例从 0.1 上升到 0.9 时，最多导致纵向均衡费率下降 91%；利率水平升高 1.5%，最多使 40 岁个体的纵向均衡费率下降约 0.34%。

目前，虽然我国大多数试点地区的长期护理社会保险采用的都是现收现付制，但随着未来人口结构的老龄化和失能程度的加深，完全基金制的建立也是非常有必要的。本文的研究结论比较倾向于参照社会医疗保险基金的筹资模式，为有效避免人口老龄化带来的缺口影响，并考虑到基金的稳定性和可持续性，建议建立长期护理社会保险独立运行的统筹账户和个人账户。其中，统筹账户按照现收现付制进行筹资，而个人账户按照完全基金制进行筹资。

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# 基于老年人健康转移概率矩阵的长期护理保险均衡费率研究

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**关键词:** 健康转移; 长期护理社会保险; 均衡费率; 现收现付制; 完全基金制

**中文摘要.**本文利用微观跟踪调查数据，结合Markov过程和GLM模型，拟合了不同性别、不同城乡老年个体在不同年龄下的转移强度，刻画了异质性老年群体的健康转移概率矩阵。进而运用社会保险精算学理论，分别考察参保主体为城镇职工和城乡居民的不同情况，预测了现收现付制和完全基金制下长期护理保险的均衡费率，最后就重要参数进行了敏感性分析。结果显示，从2019年到2039年，失能人数会增长约3.5倍，现收现付制下的横向均衡费率也翻了约3.5倍，但整体水平偏低，城镇职工和城乡居民的横向均衡费率最高也不超过0.10%和0.50%；但随人口结构老龄化可能会面临需提高均衡费率的风险。相较而言，虽然完全基金制下的纵向均衡费率较高，但基金保持长期稳定。以2019年建立长期护理保险完全基金制筹资模式为例，年龄为40岁的男性城镇职工、女性城镇职工、男性城乡居民和女性城乡居民的纵向均衡费率分别为0.16%、0.18%、0.87%和1.50%。不同筹资模式的敏感性结果显示，政府补贴比例参数的影响最大，所以为了平衡个体和政府的养老压力并维持基金的稳定性和可持续性，我国应该尽快建立起统筹账户为现收现付制、个人账户为完全基金制的长期护理保险筹资模式。

# How to Provide For the Elderly without Raising a Baby? --Innovative Plan Design of "Insurance + Old-Age Service" under the Background of Sterile Culture

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**Keywords:** Sterile culture; Longevity risk; Lee-Carter model; Internal rate of return; "Embedded" intelligent elderly care community; Moderate socialization

**Abstract.** At present, influenced by foreign culture and fertility policies in China, the infertility culture in the social environment of our country is developing rapidly, and the people's concept of marriage and fertility has undergone tremendous changes. Increasingly large groups of infertile people are facing the predicament of having no children to provide for the elderly, and their unique ideas and habits make their needs for various aspects of elderly life different from other groups.

This article first uses the Lee-Carter model combined with time series analysis to predict the mortality rate of the population of different ages in my country by gender. It is easy to know that the overall mortality rate is declining over time, but the male mortality rate is still higher, and it is expected that in 2030, the average life expectancy of men and women will increase to 82.20 years and 84.08 years respectively. Faced with increasingly severe risks of longevity, the pension problems of infertile people have become more prominent. Therefore, it is imperative to vigorously develop commercial endowment insurance and build a multi-level endowment insurance system to meet the pension requirements of different groups of people. Afterwards, we discussed individual commercial pension insurance products according to annuity and non-annuity types and found that the current commercial pension insurance market in China is imperfect. So we combine the special insurance needs of unmarried and infertile persons and analyze the feasibility of pension insurance products for unmarried and infertile persons from the three perspectives of the market, policies and commercial insurance institutions. Next, in the context of the diversified pension insurance product portfolio, this article innovatively designs a pension insurance which includes innovative combined commercial pension insurance products and life and death insurance + "embedded" smart pension community. The product uses the community as a carrier while embedding functions, resources and contacts, it also embeds smart technology methods based on the Internet and the Internet of Things and embeds a market-oriented elderly care method in the smart elderly care community through a competitive mechanism to integrate peripheral elderly care. Service resources to provide professional, personalized and convenient elderly care services for the elderly to provide elderly care for the elderly, and to create an all-age community covering industries such as elderly care, medical care, education, culture, etc. so as to realize the appropriate

socialization of the elderly and satisfy unmarried people. Infertile people have multiple physical and psychological needs, especially meeting their needs for dignity and self-realization in life. Finally, we conduct a risk analysis of the product, and give out the risks faced by the product and how to deal with the risks and prospects. It provides meaningful enlightenment and reference for insurance companies to develop such customer groups and design new insurance products.

## 1 Introduction

### 1.1 Research background

With the reform and opening up and the transformation of the economic system, influenced by foreign culture and childbirth policies, great changes have taken place in the concept of marriage and childbirth of our nationals, which has had a huge impact on the concept of marriage, family structure and relationships.

Influenced by the DINK culture abroad (DINK, that is couples with dual income and no children), t is precisely a family that is fertile but does not want to have children. From 1979 to 1989, a total of 1.1334 million couples registered marriage in Shanghai, of which about 164,800 couples did not have children. Except for those who remarried without children and those who were unable to have children for physical reasons, families who were able to bear children but did not want to have children accounted for 3 percent of the city's families[1]. After entering the 1990s, this proportion has also increased. A sample survey in Nanjing showed that 4 percent of couples volunteered to become DINK couples. A survey of newly married couples in some urban areas of Tianjin shows that the proportion of Dink couples is 6.4%[2]. It can be predicted that this proportion will continue to rise in the future. Since the idea of DINK has been widely spread, the people of DINK have mainly shown the following characteristics: First, DINK families are common in developed cities in developed and developing countries. Second, The education level of both spouses is higher. Third, higher income level; Fourth, Passionate about traveling; Fifth: People with high IQ.

The main reasons for the emergence of DINK families are as follows:
The pressure of job competition. With the rapid development of technology, invisible pressures such as the accelerated pace of life and fierce competition have made people unwilling to spend their energy on raising children. In order to develop their careers, they have to focus on career development and have no time to take care of future generations.

Economic factors. The high-end quality of life needs the support of stronger economic strength. In particular, people with high academic qualifications are more willing to make trade-offs in order to pursue a high-quality life. In addition to the financial expenses of raising children, there are also energy expenditures and accompanying time. The direct costs and opportunity costs of childbirth and raising

are quite high. In other words, the investment in childbirth is high risk and high cost. Faced with the complicated reality, they have to choose to postpone or even give up child-bearing.

Change of concept. In modern society, the main purpose of marriage and family is no longer to pass on the family line and economic factors, but to meet people's psychological needs-companionship and emotional sustenance. Under the domination of this concept, the development of DINK concept was promoted. The DINK family is built on the basis of marriage and contains only one kind of social relationship that is the relationship between husband and wife. In this "pure" relationship, the husband and wife are more concerned about emotions and quality of life.

The influence of infertility culture. Among the DINK families in our country, intellectuals account for 73.7%, among which 65.9% are men and 68.4% are women in families with a college degree or above[3]. In addition, for DINK families, which are mainly white-collar workers, because they are often well-educated and have higher cultural literacy, they can look at problems more rationally and objectively, and are more likely to accept the trendy life concepts and lifestyles of western countries.In traditional concepts, it is easy to ignore the feelings of oneself, and take certain responsibility (such as passing on the family line) as the basic purpose of life. DINK people pay more attention to themselves and always pay attention to the realization of their own value.

With the deepening of aging, although most DINK families will become well-off families after middle age, how to arrange their own life in their later years and solve the problem of elderly care is still a difficult problem they have to face. In addition, because DINK families have no children, and the basic social pension insurance paid cannot meet the diverse needs of “DINK” families, compared with non-DINK families, their options for pensions are limited. For DINK people, it is undoubtedly the best move to insure the appropriate commercial pension insurance.

### 1.2 Research significance

In April 2019, the "Opinions of the General Office of the State Council on Promoting the Development of Elderly Care Services" proposed to ensure that by 2022, on the basis of guaranteeing everyone's access to basic elder care services, the diversified and multi-level elder care needs of the elderly can be effectively met. Driven by relevant policies, the development prospects of the elderly care industry are promising.

Since the reform and opening up, China's economy has developed rapidly, the income level of residents has been continuously improved, and the scale of insurance industry has gradually expanded. Although China is the world's second largest insurance market, the insurance depth and insurance density are far lower than the

developed countries. At present, China has initially established a three-pillar system of old-age insurance, which is the first pillar of social old-age insurance, the second pillar of enterprise annuity and occupational annuity, and the third pillar of commercial old-age insurance. At present, China's first pillar is the main pillar. According to the statistics of the Ministry of Human Resources and Social Security, the number of people participating in the basic endowment insurance reached 942.93 million at the end of 2018, an increase of 27.45 million over the same period last year. By the end of 2018, 87,400 enterprises in China had established enterprise annuities, with 623.88 million employees participating [4]. According to the 2017 China Household Finance Survey (CHFS) survey, only 12.7% of households in China have commercial insurance[5]. It is easy to see that China's second and third pillars are underdeveloped, and the preliminarily established old-age security system cannot meet the needs of the elderly at this stage. It is urgent to develop commercial old-age insurance to meet the needs of different groups of people.

The contribution of this article is: in response to the phenomenon that unmarried and infertile people fail to meet the needs of all aspects of old-age life due to their unique ideas and behaviors, under the background of diversified pension insurance product portfolios. The design includes life and death insurance + "embedded" intelligent pension community insurance products to meet the physical and psychological needs of unmarried and infertile people, especially, it meets their needs for life dignity and self-realization and realizes the proper socialization of the elderly. It solves the problem of vacancies in the types of pension insurance for unmarried and infertile persons in the current market, provide ideas for insurance companies to develop such customer groups and design products.

## 2. Literature review

When Alan Budd and Nigel Campbell [6] studied the British pension system, they found that the introduction of SERPS (National Income-Linked Pension Plan) by the government would cause the national insurance contribution rate to rise by 2%. Francisco Cabo and Ana Garcia-Gonzalez[7] studied the impact of the labor market on the aging of the population and the decline in the birth rate. Abhijit Banerjee, Xin Meng, Tommaso Porzio, and Nacny Qian[8] analyzed the relationship between birth rate and household savings through the OLG model, and reached the conclusion that most families believe that children are the key to supporting the elderly. Yijia Lin and Martin F Grace[9] established financial vulnerability indicators to control family risks, found that life insurance is generally part of the family's investment portfolio, and the elderly prefer to use life insurance to protect a certain level of financial vulnerability. Andre P Liebenberg, James M Carson, and Randy E Dumm[10] studied commercial endowment insurance based on the dynamics of family living standards and financial changes, and concluded that the higher the unemployment rate, the more insured persons are willing to buy commercial life insurance. Melvin Stephens Jr and aTakashi Unayamab[11] used monthly household income data in Japan to study

the impact of pensions on consumption, and the results showed that low-income households prefer to consume food. Alan S Blinder[12] analyzed the government's role in public pension security and the degree of influence of social pensions on savings.

Zheng Bingwen[13] found through data analysis that China's three-pillar pension system relies too much on social pension insurance, and the coverage of corporate annuities and commercial pension insurance is too low, which leads to uncoordinated development of the pension security system. At the same time, it sums up the experience of the reform of the old-age system in developed countries such as the United States and Singapore, combined with the high proportion of household savings deposits and real estate in China, and proposed the construction of an "individual pension account" with the function of security and investment. Chen Yanglin, Zhang Changquan, and Jiang Shaohua[14] according to a 2003 Chinese general social survey data found that rates of less than 7% of China's commercial endowment insurance, from the macro, micro and four aspects of supply and demand to study the factors that influence the residents ginseng found income, insurance consciousness and less product variety of factors affect the residents to participate in the commercial endowment insurance. Su Xin and Guo Dandan[15] proceeded from the main social contradictions and pointed out that a sound social security system will affect the happiness index of residents. At the same time, it explained the government's role in commercial pension insurance, and pointed out that relevant laws and regulations should be improved to promote the integration of social pension insurance and commercial pension insurance. Li Jingping[16] studied the coordination degree of commercial endowment insurance and social endowment insurance in 31 provinces, cities and autonomous regions in China from 2006 to 2011, and found that the western region was obviously lagging behind the eastern region, and the integration and development of the two still had great potential. Qi Zipeng, Zhou Yunchen, and Xia Lei[17] used the data from the China Health and Pension Tracking Survey from 2013 to 2015 to conduct an empirical analysis on the performance of commercial health insurance for people aged 45 and over through the Probit model, and found that the number of insureds in urban and rural areas is generally, and the purchase of insurance has a positive effect on the physical and mental health of the insured at some point.

Generally speaking, the current research on pension insurance focuses on the establishment of a sound basic pension insurance system to maintain the healthy and orderly operation of the society, but for the necessity of how to develop commercial pension insurance, whether it has broad development prospects and specific development What kind of commercial pension insurance, etc., these important issues are rarely involved. To this end, this article starts from the infertile people, analyzes their unique ideas, behaviors, and insurance needs, designs insurance products that include both survival and death insurance + "embedded" intelligent pension community, and conducts feasibility analysis, provide reference for

commercial endowment insurance products for infertile persons that are vacant in the market.

## 3. Life is getting longer and longer, is it happy or bad?

### 3.1 From the perspective of reducing the mortality of both sexes

#### 3.1.1 Establishment of Lee-Carter model

The representation of the Lee-Carter model is:

$$ln(m_{x,t}) = \alpha_x + \beta_x k_t + \varepsilon_{x,t} \quad (3.1)$$

Among them, $m_{x,t}$ is the center mortality of people aged $x$ at time $t$, $\alpha_x$ is the average mortality of people aged $x$ in historical years, $\beta_x$ is the age factor, $k_t$ is the same time factor at any age, and $\alpha_x$ and $\beta_x$ have the same value in any year, $\varepsilon_{x,t}$ is a random error term with mean 0 and variance $\sigma_t^2$.

Choose the least square method to estimate $\partial_x$, $\beta_x$ and $k_t$. Since the model observation value has only one $m_{x,t}$ on the left side of the equation, the three parameters to be estimated are on the right side of the mode. Therefore, if you estimate the model parameters directly, you will get countless numbers and you cannot make the next prediction. In order to obtain the predicted value of mortality, Lee and Carter set standardized conditions to limit $\beta_x$ and $k_t$. The specific conditions are as follows: Lee and Carter set standardized conditions

$$\sum_x \beta_x = 1 \quad (3.2)$$

$$\sum_t k_t = 0 \quad (3.3)$$

So we get the least squares estimate of $\alpha_x$ as follows:

$$\hat{\alpha}_x = \frac{\sum_t \ln(m_{x,t})}{n} \quad (3.4)$$

Where $n$ is the total number of years in which mortality is considered.

We use constraints to get the estimated value of $k_t$:

$$\hat{k}_t = \sum_x (\ln(m_{x,t}) - \hat{\alpha}_x) \quad (3.5)$$

Establish the regression equation with the help of $\alpha_x$ and $k_t$:

$$\ln(m_{x,t}) - \hat{\alpha}_x = \beta_x \hat{k}_t + \varepsilon'_{x,t} \quad (3.6)$$

It can be known that the estimated value of $\beta_x$ is:

$$\hat{\beta}_x = \frac{\sum_t \hat{k}_t (\ln(m_{x,t}) - \hat{\alpha}_x)}{\sum_t \hat{k}_t^2} \quad (3.7)$$

### 3.1.2 Lee-Carter model effect test

We use my country's population mortality data by sex and age during the two decades from 1997 to 2016 as sample data. The data are derived from the <China Population and Employment Statistical Yearbook>[18]during these two decades .

In order to be able to accurately predict the future mortality level, we use the mortality data of the first nineteen years from 1997 to 2015 as the basic data, and use the predicted 2016 data as the comparative data. After obtaining the male and female mortality prediction model ARIMA(1,1,0) model and ARIMA(0,1,2) model, predict the mortality level in 2016 and compare it with real data to test the prediction effect of these two models.

First, use the ARIMA(1,1,0) model and the ARIMA(0,1,2) model to predict the male and female $k_t$ predicted values in 2016 [19]. The male predictive value is shown in Table 3-1

Table 3-1. The predicted value of $k_t$ for both genders in 2016

| 2016 | Male | Female |
|---|---|---|
| The value of $k_t$ | -26.3715 | -31.4485 |

Then we substitute the obtained predicted value $k_t$ and the above estimated $\alpha_x$ and $\beta_x$ values into the expression of the Lee-Carter model to obtain the central mortality rate of each age, and then convert it into the 2016 predicted value of male and female mortality, and then compare it with 2016 Comparing the actual value of mortality rate $q_x$ , the comparison between the predicted value of male and female mortality rate in 2016 and the actual value is shown in Figure 3-1 and Figure 3-2.

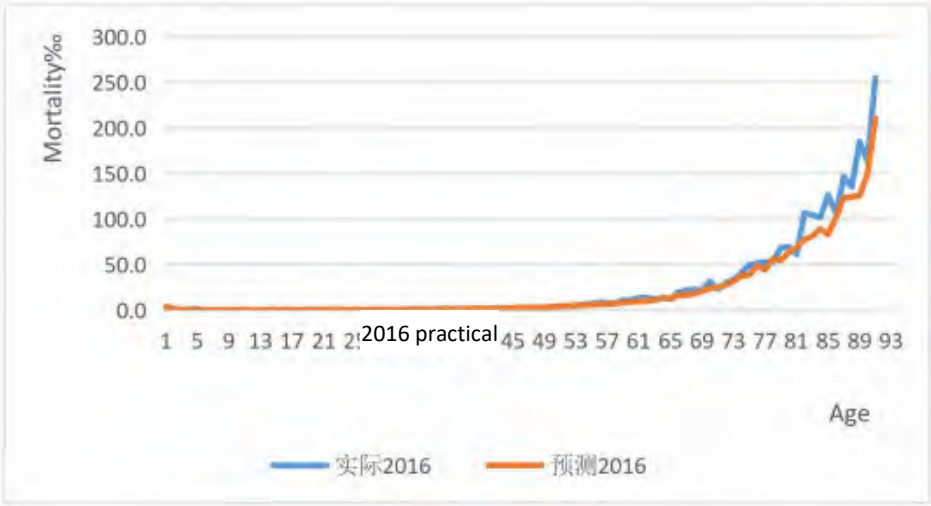


Fig. 3-1. Comparison of predicted and actual male mortality rate in 2016

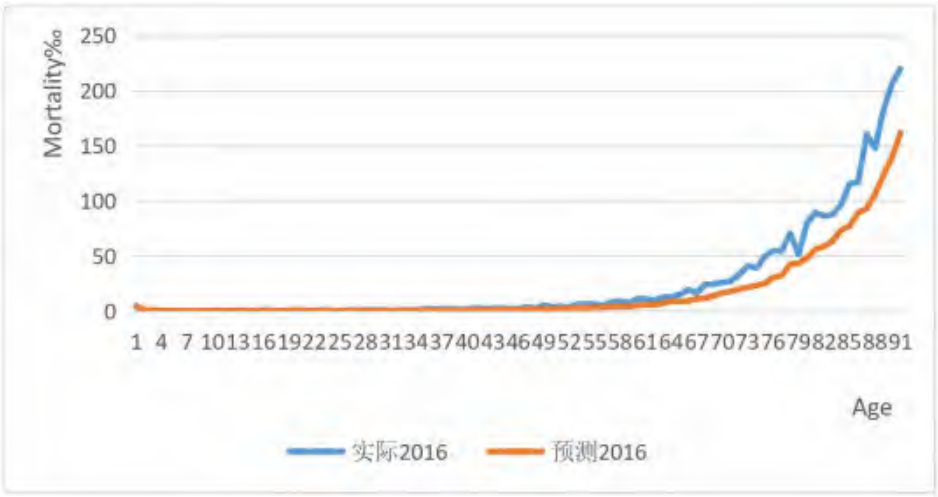


Fig. 3-2. Comparison of predicted and actual female mortality rate in 2016

Observing Figure 3-1 and Figure 3-2, it is not difficult to see that the ARIMA(1,1,0) model and the ARIMA(0,1,2) model fit the mortality rates of male and female at all ages. In particular, the ARIMA(0,1,2) model that predicts the level of female mortality also makes the mortality curve more smooth for people over 60 years of age. Therefore, we believe that the ARIMA(1,1,0) model and the ARIMA(0,1,2) model can be used to predict the mortality of men and women respectively.

### 3.1.3 Analysis of mortality prediction results

Above we have proved that the ARIMA(1,1,0) model and ARIMA(0,1,2) mod el can effectively predict male and female mortality. Next, we first predict the value of $k_t$ for male and female from 2017 to 2030, then apply the ARIMA(1, 1,0) model and the ARIMA(0,1,2) model to predict the mortality rate of men and women from 2017 to 2030. Among them, the predicted values $k_t$ of male s from 2017 to 2030 is shown in Table 3-2.

Table 3-2. The predicted values $k_t$ of males from 2017 to 2030

| Year | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|
| $k_t$ | -38.346 | -47.535 | -55.281 | -62.106 | -68.276 | -73.950 | -79.231 |
| Year | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| $k_t$ | -84.191 | -88.883 | -93.345 | -97.609 | -101.698 | -105.633 | -109.429 |

Through the predicted value of $k_t$, we can predict the future mortality level. The difference in the future mortality level is reflected in the comparison bet ween the future mortality level and the actual mortality level in my country. This difference essentially reflects the severity of the longevity risk in my co untry. Therefore, we choose the mortality data in 2020 and 2030 to compare the actual mortality data in 2010 with a ten-year cycle, and specifically analy ze the severity of the longevity risk that my country is currently facing, and obtain the gender in 2010, 2020 and 2030. The comparison of mortality $q_x$ is s hown in Figure 3-3.

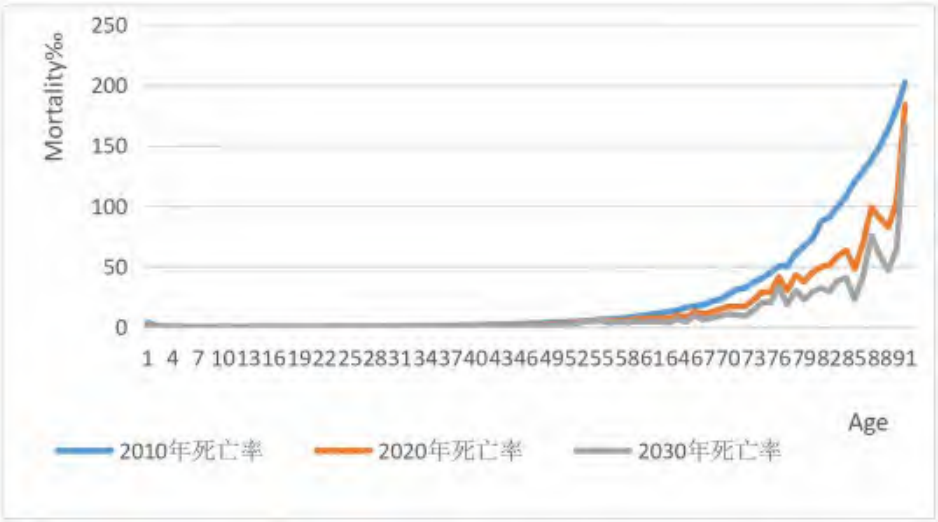


Fig. 3-3. Comparison of male mortality in 2010, 2020, and 2030

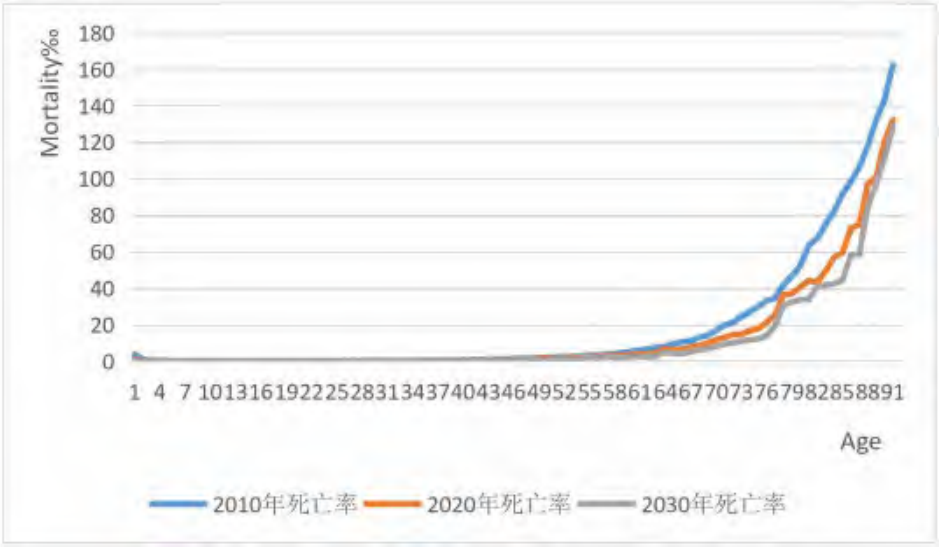


Fig. 3-4. Comparison of female mortality in 2010, 2020, and 2030

Observing Figures 3-3 and 3-4, we can easily see that the overall mortality rat e shows a downward trend over time, especially for the population over 60, th e decline is more obvious, and the decline in male mortality is greater than th at of females. but the overall mortality rate for men is still higher, and this sit uation becomes more pronounced after the age of 70.It can be concluded that the longevity risk pressure faced by our country is still severe in the future, a nd both sexes are facing an increasing trend of longevity risk pressure.

### 3.2 From the perspective of increased life expectancy of both sexes

To further understand the risk of longevity, we used the average life expectan cy derived from mortality data to quantitatively measure the risk of longevity. The calculation formula is shown in equation (3.8).

$$e_0 = \sum_{k=0}^{\omega} {}_{k+1}p_0 \tag{3.8}$$

Among them, $e_0$ is the average life expectancy, $k$ is the age, $\omega$ is the extreme age, and $p_0$ is the probability that the newborn will survive one year. We can calculate the average life expectancy of both sexes in 2020 and 2030 according to formula(3.8).Similarly, with a ten-year cycle, the average life expectancy comparison is shown in Table 3-3.

Table 3-3 Comparison table of average life expectancy

| Year | 2010 | 2020 | 2030 |
|---|---|---|---|
| Average male life expectancy/year | 72.38 | 78.97 | 82.20 |
| Average female life expectancy/year | 77.37 | 82.10 | 84.08 |

Source: The average life expectancy data for both sexes in 2010 was obtained by consulting the National Bureau of Statistics.

According to Table 3-3, the average life expectancy of both sexes in my cou ntry in 2020 is 78.97 years and 82.10 years, respectively, which have increase d by 6.6 years and 4.7 years respectively compared with 2010; It is expected that in 2030 this data will increase by 9.8 years and 6.7 years to reach 82.2

0 years and 84.08 years respectively. Combined with the analysis in this section, it can be seen that between 2010 and 2030, the average life expectancy of men and women has increased significantly, and the increase rate of men is greater than that of women, which can explain the longevity risks faced by our country are in the stage of accelerating development.

## 4. Social endowment insurance：not enough, commercial pension insurance supplement

### 4.1 Longevity risks are becoming increasingly serious

Longevity risk affects individual and commercial insurance companies and government pension institutions. For different objects, the definition of longevity risk is different. For individuals, longevity risk refers to the risk of retirees losing all or part of their economic income and living longer than expected, resulting in a decline in the quality of life and financial difficulties. The longevity risks faced by individuals can easily be avoided by purchasing commercial pension insurance and participating in social pension insurance.

For commercial insurance companies and government pension institutions, longevity risk refers to the increase in the annuity payments of insurance companies (and government pension institutions) due to the unexpected decline in the overall mortality rate of the society and the extension of life expectancy, and the n the normal Risk of serious threats to operations.As the life expectancy of our country's population is increasing year by year, and the trend of population aging is becoming more and more obvious, these two factors work together to cause our country to face a great risk of longevity in the future. For social pension insurance, the pension gap problem has become increasingly prominent. According to a McKinsey & Company research report: As of 2010, my country’s pension gap has reached 110 billion US dollars. If the pension gap problem for retirees cannot be properly resolved , It will definitely affect the stability of society and even become a huge obstacle to social development.

### 4.2 The necessity of developing commercial pension insurance

Our country's social pension security system covering all people has been basically completed in 2012, but due to factors such as my country's large population base, large regional economic development gap, and late start of the pension insurance system, it has appeared in the construction and development of the pension security system. Some issues that cannot be underestimated are mainly embodied in deep-seated issues such as social fairness, mobility adaptation, and the realization of sustainable development. Although the current social pension insurance coordinating model formulated by the State Council has been transformed from a pay-as-you-go system to a partial accumulation system, and the possibility of long-term payment risks has been delayed to a certain extent, the problem of long-term income insolvency still exists. In the pay-as-you-go part, when the number of pensioners in the future increases unexpectedly, it will still increase the payment burden of future employees. Although it is not a longevity risk in the theoretical sense, it is because of the risk caused by longevity.

According to data released by the National Bureau of Statistics, in 2018, my country's

population over the age of 60 accounted for approximately 17.9% of the total population, or 249.49 million people. It is expected that this figure will exceed 30% by 2050.It is conceivable that for a long period of time in the future, the proportion of the elderly population in my country will remain high and difficult to reverse, and the increase in the elderly population will bring about a further expansion of the expenditure scale of the basic pension insurance fund for employees. According to the data in the "my country Pension Actuarial Report 2018-2022"[20] released by the World Social Security Research Center of the Chinese Academy of Social Sciences,, the level of basic pension insurance for employees of urban enterprises in my country in 2018 was about two taxpayers corresponding to one retire. By 2022, there will be less than two taxpayers corresponding to one retire. This aging trend will only become more severe in the short term. When the number of pensioners in the future increases unexpectedly, it will still increase the contribution burden of future employees. When the number of pensioners in the future increases unexpectedly, it will still increase the tax burden of future employees. Although it is not a longevity risk in the theoretical sense, it is because of the risk caused by longevity. As the world's largest developing country, although my country's population aging problem is not as severe as most developed countries, however, it has the characteristics of a large absolute number of elderly people, a fast aging rate, a low level of economic development, and a relatively short period of opportunity to deal with population aging , which will have a great impact on the basic pension insurance system. Therefore, we believe that it is imperative to develop commercial pension insurance to make up for the insufficient protection of basic pensions, to alleviate the current domestic pension problems, to improve the pension system, and to meet the pension needs of the elderly.

At the same time, with the gradual decline of the aging problem in our society and the gradual decrease in the newborn rate of infants and young children, the pension gap has now been continuously expanded. After excluding financial subsidies, in 1997, there were only 5 cities in my country where the pension fund income was not enough. In 1998, the national pension insurance fund suffered a deficit for the first time. By 1999, the basic pension income and expenditure gap had reached 18.7 billion yuan. Subsequently, the social pension gap continued to increase. According to the "China Pension Development Report 2011", after excluding fiscal subsidies, In 2010, the current pension balance in my country was only 65.7 billion yuan, and the gap reached 67.9 billion yuan. In 2011, the pension income and expenditure gap in my country reached 76.7 billion yuan. It can be seen that my country's basic pension payment gap has shown a positive growth trend over time.

## 5. Deficiencies in commercial pension insurance products in China: for the infertile

Personal commercial pension insurance products can be divided into annuity pension insurance and non-annuity pension insurance. Annuity pension insurance has the function of guarantee and investment and financial management. Recently it has become a more popular pension insurance product. Non-annuity pension insurance products in recent years mainly with a tax deferral and housing reverse mortgage into people's vision. By comparing the commercial annuity pension insurance products on sale in the market, we find that although the product category is rich, but most of the structure is single, the phenomenon of product homogenization is very

serious, and fewer products are targeted at infertile people. At present, commercial pension insurance has failed to become a strong third pillar of the old-age security system and to meet the growing demand of consumers of all kinds.

## 5.1 Deficiencies in annuity-type pension insurance products

### 5.1.1 Commercial pension insurance products are single

From the perspective of insurance categories, China's commercial pension insurance is mainly divided into five types of insurance: traditional commercial pension insurance, dividend-type commercial pension insurance, universal life insurance, investment-linked insurance, innovative commercial pension insurance. Recently, insurance companies have been actively introducing new commercial pension insurance products to enrich the insurance product category. Table 5-1 shows some commercial pension insurance products currently on the market.

Table 5-1. Commercial Pension Insurance Products for Some Insurance Companies

| Some domestic insurance companies pension insurance products | | | | | | |
|---|---|---|---|---|---|---|
| Firm | Products | Insurance options | | | | |
| | | Age of Insurance | Payment Method | Pick-up Time | Method of Payment | Insurance Period |
| China Life Insurance | National Life Xinyao Oriental Annuity Insurance | 0-70 years old | Pay off once/3/5 years | 5th Policy Anniversary Day | insurance amount 20%/60%/100% | 10 years |
| | National Life Wishful Family Insurance | 50-70 years old | Pay off once/3/5/10 years | 5th Policy Anniversary Day | fixed amount | Lifelong |
| | Cornucopia Insurance Portfolio Plan | 30 days - 53 years old | 3/5/10 years | 6th/25th anniversary of the policy/65 years old | fixed amount | Lifelong |
| Ping An Insurance | Ping An Taurus Annuity Insurance | 18-59 years old | Pay off once | 5th Policy Anniversary Day | insurance amount 20% | Lifelong |
| HUA LIFE INSURANC | Jade Yuyi (ultimate) | 28 days - 70 years | Pay off once/5/10 | 6th/11th anniversary | fixed amount | Lifelong |

| | | | | | | |
|---|---|---|---|---|---|---|
| E | annuity insurance product plan | old | years | of the policy | | |
| CHINA PACIFIC INSURANCE | Old Tofu Annuity Insurance B（2018） | 50-70 years old | Pay off once/3/5/10 years | 5th Policy Anniversary Day | fixed amount | Lifelong |
| Taikang Life Insurance | Taikang Enjoy New Life Pension Insurance (Dividend Type) | 18-60 years old | Pay off once/3/5/10 years | 65/70 years old | fixed amount | Lifelong |
| | Yongfu Life Annuity Insurance | 0-60 years old | Pay off once/5/10 years | 15th/20th anniversary of the policy /55/60/65 years old | fixed amount | Lifelong |
| AIA Life Insurance | AIA Heng Win Jinsheng (2020) Annuity Insurance (Dividend Type) | 7 days - 70 years old | Pay off once/3/6/15/20 years | 5th Policy Anniversary Day | insurance amount 20%/40% | Up to 105 years old |
| Life Insurance Company | Forde Life Rich wins 99 years of gold insurance | 25 days – 55 years old | Pay off once/3/5/10 years | 10th Policy Anniversary Day | insurance amount 10% | Lifelong |

Source: Compiled according to the official websites of major insurance companies

From Table 5-1, it can be seen that the innovation of commercial pension insurance

products is simply to package multiple insurance products into a combination plan or introduce annuity insurance, still stucking on the surface, and that it does not start from the actual needs of customers. The number of infertility is increasing and their pension problems are gradually highlighted, but at present, insurance companies have not introduced the corresponding pension products for this person. Moreover, the current commercial pension insurance products rarely consider the actual needs of policyholders and lack the division of consumer groups, such as urban and rural areas, high-income and low-income groups, and so on, thus hindering the development of commercial pension insurance[21].

### 5.1.2 The return of China's commercial pension insurance products is low

IRR can be used to measure the rate of return on an investment. IRR is essentially a discount rate that makes net cash flow equal to zero, which means the total present value of capital inflows equals the total present value of capital outflows. The formula is as follows:

$$APV = \sum_{t=0}^{n} PV_t = \sum_{t=0}^{n} \frac{C_t}{(1+r)^t} \quad (5.1)$$

Wherein, APV refers to the sum of net cash flows of an investment project, r represents the discount rate, t represents the number of discount periods, $PV_t$ represents the present value of cash flows in the t-period, $C_t$ represents the cash flow of the t-period, when the APV is 0, the corresponding discount rate r is the project's return on investment IRR (Huang Jisheng, 2012)[22].

Below we take a product with better sales of Xinhua Life Insurance Co., Ltd., as an example, to measure the internal rate of return of commercial pension insurance products, the specific form of the product is shown in Table 5-2.

Table 5-2. Some product terms of Zunyi Life Pension Insurance

| Product | Zunyi life pension annuity insurance |
|---|---|
| Pricing rates | 3.5% |
| Payment period | Pay off once/3/5/10/20 years |
| Insurance period | Lifelong |
| Age of insurance | 30 days – 65 years old |

| | |
|---|---|
| Survival annuity | 10% basic coverage per year (20 years of coverage) |
| Dead/completely disabled | First time to receive the death of the day before: the premium paid and the cash value is greater |
| Premium waivers | Accidental death/total disability |

Source: Xinhua Life Insurance Co., Ltd. official website.

Assuming that Mr. Yi, 30 years old, buys the basic insurance amount of 300,000 yuan and pays the annual premium of 15900 yuan for 20 years. He can receive pension annuity as a supplement to the pension from the age of 60 to live more at ease in later life. Under the insurance contract, his returns from the age of 30 to the age of 85 are shown in Table 5-3.

Table 5-3. Statement of income from funds of the policy under maturity

| Age | Investment /Yuan | Age | Investment /Yuan | Age | Investment /Yuan | Age | Investment /Yuan |
|---|---|---|---|---|---|---|---|
| 30 | -15900 | 44 | -15900 | 58 | 0 | 72 | 30000 |
| 31 | -15900 | 45 | -15900 | 59 | 0 | 73 | 30000 |
| 32 | -15900 | 46 | -15900 | 60 | 30000 | 74 | 30000 |
| 33 | -15900 | 47 | -15900 | 61 | 30000 | 75 | 30000 |
| 34 | -15900 | 48 | -15900 | 62 | 30000 | 76 | 30000 |
| 35 | -15900 | 49 | -15900 | 63 | 30000 | 77 | 30000 |
| 36 | -15900 | 50 | 0 | 64 | 30000 | 78 | 30000 |
| 37 | -15900 | 51 | 0 | 65 | 30000 | 79 | 30000 |
| 38 | -15900 | 52 | 0 | 66 | 30000 | 80 | 30000 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 39 | -15900 | 53 | 0 | 67 | 30000 | 81 | 30000 |
| 40 | -15900 | 54 | 0 | 68 | 30000 | 82 | 30000 |
| 41 | -15900 | 55 | 0 | 69 | 30000 | 83 | 30000 |
| 42 | -15900 | 56 | 0 | 70 | 30000 | 84 | 30000 |
| 43 | -15900 | 57 | 0 | 71 | 30000 | 85 | 30000 |

Source: According to the premium and survival pension corresponding to the life pension insurance contract

According to the Excel formula, it can be calculated that the IRR of death during the guarantee period is 2.1388 percent by means of period delivery. After the period of guarantee, the IRR of the policy is 2.7830% by the age of 85. This case assumes that the life expectancy of the insured person is up to 85 years and that the period of receiving an annuity is more than 20 years, but the average life expectancy of our residents is currently 77 years, and the actual IRR value of most policyholders buying the product may be lower. In fact, the IRRs of commercial pension products on the market are below 3.5%. It can be seen that the yield of China's commercial pension insurance products is low.

### 5.2 Deficiencies in non-annuity commercial pension insurance products

#### 5.2.1 Tax Deferred Commercial Pension Products are unattractive

Taking the current deduction of 5000 yuan as an example, according to the current method of implementing individual tax deferred old-age insurance, when the monthly taxable income is 16666.67 yuan and above, the deduction can only be 1000 yuan/month, if the contributor reaches 25% of the marginal tax withholding rate, you can enjoy a tax benefit of 175 yuan/month, if the contributor reaches 30% of the marginal tax withholding rate, you can enjoy a tax benefit of 225 yuan/month, if the contributor reaches 45% of the marginal tax withholding rate, you can enjoy a tax benefit of 175 yuan/month, preferential tax amount of about 0.41% of the monthly wages. This is a very small discount for high-income groups, and because of the long duration of the business and the long span of the period, infertile people have little interest in the product, which not conducive to attracting the eyes of the infertile.

#### 5.2.2 Housing reverse mortgage pension products are in short supply, single products

At present, there are only "non-participatory products" in the market, if future house prices rise, insurance companies fail to enjoy the benefits of real estate appreciation, but bearing the risk of longevity or market fluctuations[23].

As of the end of June 2018, only one insurance company, Happy Life, had started the business with 139 elderly people from 98 households completing the underwriting procedures. As of the end of September 2019, a total of 129 valid policies with 191 elderly people insured for such products and their average age of 71 years old. Each household received an average monthly pension of more than 7,000 yuan, the highest monthly pension reached more than 30,000 yuan.

**5.2.3 Relevant laws, regulations and policies are not perfect**

Since the beginning of 2019, housing pension fraud cases frequently appear. Zhong'an Minsheng company alone suspected of housing pension fraud amounted to up to 1 billion yuan, and the number of elderly people deceived more than 600 people[24]. And China's small property rights, housing reform, rural private housing and other types of housing property rights, how to carry out reverse mortgage is one of the status quo that has not been solved; In addition, China's Inheritance Law, Security Law, Property Law and other laws are inconsistent and incongruous phenomenon, as well as some legal convergence gaps.

The insurance business process of "housing old-age pension" is more complex than other old-age products, the period of insurance cannot be determined, involving real estate, insurance, administration and many other fields. It is necessary to guarantee institutions, asset appraisal institutions, personal credit system participation and improvement. However, China's existing system and policies cannot meet this demand at present.

## 6. Feasibility Analysis on the Design and Application of Endowment Insurance Products for Infertile People

The purpose of designing infertile pension insurance products is to meet the needs of infertile pensioners. Based on the background of the accelerating rate of population aging in my country and the rapid development of infertility culture, this article analyzes the feasibility of family endowment insurance products for infertile persons from the three perspectives of market, policy and commercial insurance institutions.

### 6.1 Market feasibility analysis

First of all, infertile people have an inherent demand for commercial pension insurance products. With the development of society, there will be more and more infertile people, and their pension problems are worthy of our attention. For infertile people who are usually highly educated, high-income, and high-quality-of-life groups, it is obvious that the current social pension security system cannot meet their needs. Therefore, commercial insurance institutions need to adapt to the needs of the times and innovate new products, designing commercial pension insurance products suitable for infertile persons [25].

Secondly, infertile people have a potential demand for commercial pension insurance products. The characteristics of adaptability and flexibility make the commercial pension insurance not only able to meet the needs of popularization, but also to meet

the needs of individualization and specialization. The flexibility of commercial pension insurance enables it to meet the needs of people of different regions, different ages, and different income levels. For the infertile people, they especially need to meet their own endowment insurance needs, and therefore more need commercial endowment insurance products.

Finally, the market supply of commercial pension insurance products for the infertile is lacking. At present, there are almost no commercial endowment insurance products specifically for infertile persons on the market, which also provides ideas for the design of this article.
In summary, there is an imbalance in the supply of commercial pension insurance for the infertile, and there is market demand but no product supply. From a market perspective, the feasibility of the design of the infertile pension insurance product is analyzed.

### 6.2 Policy feasibility analysis

In order to meet the people's growing demand for pension insurance and accelerate the development of our country's social pension industry, the State Council issued the 《Opinions on Accelerating the Development of Commercial Pension Insurance》 on June 21, 2017. The release of several opinions shows that the government has put forward new requirements for our country's social pension security, and policy support has been given. The Nineteenth National Congress of the Communist Party of China clearly pointed out that the development direction of China's multi-level old-age security system is to cover the whole country, coordinate urban and rural areas, and have clear and sustainable government and market responsibilities.

Commercial endowment insurance is provided by commercial insurance institutions. It is a product and service that protects endowment risks and manages endowment funds. As our country's aging rate has been accelerating in recent years, the pressure on old-age security has increased day by day. However, commercial endowment insurance products that can provide protection for the elderly are relatively lagging, with few products and services, and insufficient coverage, which cannot meet people's objective needs to improve the level of endowment insurance. The issuance of the 《Several Opinions》 shows the state's attitude to accelerate the development of commercial pension insurance, to make full use of the advantages of commercial insurance institutions in risk protection and long-term capital management, expand the supply of commercial pension insurance products, and improve service quality. Broaden the scope of services to meet the needs of people at different levels and in different fields of work, and strive to enable commercial endowment insurance institutions to play a role in improving the endowment insurance system, effectively supplementing basic endowment insurance, and promoting stable social development. Increasing the support for commercial pension insurance in terms of policies and safeguard measures. It also provides institutional and policy support for the research and design of infertile pension insurance products for this article.

### 6.3 Technical feasibility analysis

First, for large commercial pension insurance companies, they have high-quality talents, sophisticated insurance actuarial technical teams, and rich experience in the design and pricing of various pension products, so they can accurately complete insurance clauses and pricing design. Second, large-scale commercial pension insurance companies have rich fundraising experience, which helps them to adopt more advanced payment methods to collect premiums for infertility family insurance products. At the same time, the agent system of commercial insurance companies can also enable residents to have extensive exposure to commercial endowment insurance products, increase their awareness of insurance products, and strengthen insurance awareness. In addition, the income of insurance agents depends on performance. Such institutional arrangements can fully mobilize the enthusiasm and initiative of insurance agents, and raise more premium funds while increasing the insurance participation rate. Third, commercial endowment insurance institutions are the trading entities of the market economy. At the same time, the policies and regulations also specifically point out that the management of commercial endowment insurance funds cannot be treated the same as other insurance businesses. Therefore, insurance institutions need to be responsible for their own business activities, and cannot simply invest funds in high-return and high-risk areas, and must bear the risk losses in insurance operations. And commercial endowment insurance institutions are profit-oriented enterprises, and they will inevitably invest endowment insurance funds in high-yield areas with security guarantees, so as to maintain and increase the value of endowment insurance funds.

### 6.4 Scientific and technological feasibility analysis

Block chain is essentially an Internet database technology. From a data perspective, it belongs to a distributed database that is almost impossible to be changed, that is, distributed shared ledger. It is distributed data storage, point-to-point transmission, consensus mechanism, encryption algorithm, etc. A new application model of computer technology.

The application of block chain in the scenario of "Insurance + Intelligent Elderly Care Community" has natural advantages. It can grasp the physical condition and physiological needs of the elderly in time, especially to provide help to the elderly who are unwell at the first time, and it is also convenient for insurance companies carry out the tracing of responsibilities.

In addition, through block chain technology to ensure the openness, transparency and traceability of information, and through intelligent contracts to control product insurance, operation, claims and other processes, pricing is more accurate, risks are more controllable. It also reduces the cost of operating claims and improves business efficiency.

## 7. Life and death insurance + "embedded" smart pension community insurance product design

In view of the current social pension insurance capacity is limited, commercial pension insurance is insufficient, and the basic needs of the elderly are not fully satisfied in quality and quantity, the design of this article includes dual insurance + "embedded" smart pension Commercial pension insurance products in the community. The commercial endowment insurance product uses the community as a carrier. While embedding functions, resources and contacts, it also embeds the Internet and the Internet of Things as the basis of intelligent technology to meet the physical and psychological needs of the elderly, and improve the quality of elderly care services. It is to meet the needs of the elderly for emotion, respect and self-realization.

### 7.1 Noun explanation

Intelligent pension: Through the sensor network system and information platform of the pension community, on this basis, we can provide real-time, fast, efficient, low-cost, Internet of Things, Internet and intelligent pension services. Through intelligent interconnection, it breaks through regional limitations and centralizes the elderly information, social resources and demand matching on the platform, then it uses various systems and products to provide comprehensive and personalized services to the elderly[27].

Pension community: The elderly living community provides different elderly care services according to the physical conditions of the clients. Pension community includes an integrated service of independent living, assisted living (including amnesia care) and professional nurse care (including rehabilitation care). The multi-function integrated service community not only retains the family affection and comfortable environment of home care, but also avoids the defect of the lack of professional services in the traditional home care, so that the elderly can enjoy the retirement life of "living at home, living in the community and serving the organization".

"Embedded" pension: "Embedding" is the organic integration of a system into another system, or an objective phenomenon of a thing born into other things and it also reflects a process of the socialization of the elderly. "Embedded" pension is still in its infancy, and scholars have analyzed its definition because of different points of focus and emphasis. In this paper, it is defined as: the supplement and integration of institutional care and community home care, that is, the community as the carrier, with the concept of resource embedding, function embedding and multiple operation mode embedding, through the competition mechanism to embed a market-oriented operation mode of pension in the intelligent pension community, and integrate the surrounding pension service resources to provide professional, personalized and convenient elderly care services for the elderly nearby.

"Embedded" intelligent pension community: According to the problems encountered in community home care and institutional care, a new type of pension service is

extended out. It is different from the traditional institutional pension, the elderly can live in the open elderly community, there will be no "information island". By embedding nursing homes, universities for the elderly, third-party businesses and other resources in the community, the psychological and emotional needs of the elderly can be met on the premise of the combination of medical care and care. It is a combination of "embedded" pension and intelligent pension, and on the basis of community as the carrier, it embeds intelligent technology, and at the same time embeds resources, functions, communication and diversified operation modes.

## 7.2 Product Features

### 7.2.1 Life and death insurance + "embedded" intelligent pension community

Life and death insurance refers to a type of insurance in which the insured can obtain insurance money if he dies or survives within the insurance period. Because it can be used as a means of saving to provide protection for the elderly, it is popular with consumers. There are many life-and-death insurances in the insurance market, but there are few innovative combinations combined with intelligent pension communities.There are very few types of commercial long-term care insurance in my country, and most of the payment methods are cash payments. The insured also needs to contact the care institution to meet his care needs. It will take a lot of time and effort to select the institution and confirm the eligibility for accommodation. Our product combines life and death insurance and the "embedded" intelligent pension community to provide pension protection for the 25 to 60 years old who are not disabled or demented, and scientifically manage the risk of disability and dementia of the elderly.

### 7.2.2 Premium determination: based on regional differences

Due to the different economic conditions in different regions, the local pension burden, residents' pension preferences, and disability/dementia assessment rules are different. Our product subdivides insured persons from different provinces based on local economic development indicators and to determine insurance premiums to determine insurance plans suitable for local residents to participate in, and to conduct risk management.

### 7.2.3 Insurance policies plus physical goods provide diversified endowment protection

This product is equivalent to the consumer's current premium investment in exchange for the right to live in the retirement community in the future. If the insured chooses to live in the retirement community after the expiration of the insurance period, the previous payment will be used to exchange the length of residence in the retirement community; If the customer waives the eligibility to stay, he can choose to receive the income form of the annuity. Through the
form of insurance policy + physical objects, the conversion of monetized income to physical income is realized, so that customers can enjoy the benefits of business value-added while enjoying insurance protection, resist possible future inflation risks, and enjoy continuous and deterministic tangible protection to double guarantee added to intangible value.

### 7.2.4 Intelligent technology embedded in elderly care services

The intelligent elderly care community embeds intelligent technology to provide intelligent elderly care services centered on the cloud platform, through intelligent product terminals, such as fall detection carpets, sleep monitors, mattress sensors, intelligent robots, health cabins, etc., with the help of mature Internet of things. The system is constructed to upload data in real time, and the App terminal and community service terminal receive and process the data to provide intelligent elderly care services for the elderly. And all the elderly are equipped with wireless emergency pagers, which are connected to the video robot through wireless signals. When they fall down, are in a sudden illness and cannot get up and other emergency situations, they can press the emergency call button and call for help immediately. In addition, each elderly person wears a positioning watch, and the system is connected through the network to view the position, historical trajectory, and heart rate pulse of the elderly in real time, and send signals when abnormalities occur.

**7.2.5 Realize the appropriate socialization of the elderly**

According to the embeddedness theory, the emergence of "embedded" old-age care was to ensure that the old-age life of the elderly will not be overly or under-socialized, so there is the emergence of embedding elderly care services in the community, where the embedders here are related elderly care industries and services, and the embedded ones are intelligent elderly care communities. This new type of "embedded" intelligent elderly care community not only satisfies the moderate socialization of the elderly, but also ensures that the elderly can enjoy elderly care services on the basis of fully adapting to their new roles.

**7.2.6 People-oriented, mutual benefit and win-win**

Insurance companies can expand the industrial chain or connect with pension institutions to provide in-kind pension plans for insured persons. Customers who purchase this product can get confirmed qualifications to stay in the retirement community in the future, and the intelligent retirement community can also lock in future rents in advance. Due to the difference in premiums, the corresponding length of time in the retirement community is different. If the customer dies unexpectedly or has a poor experience after moving into the retirement community and wants to terminate the occupancy contract, the settled rent can be deducted and the remaining cost will be returned. For policyholders, there is no "consumption kidnapping" problem, and everything is people-oriented.

## 7.3 Guarantee level and content

### 7.3.1 "Two-tiered" guarantee

This product combines life and death insurance and intelligent elderly care communities to provide endowment protection for people aged 25 to 60 who are not disabled or demented, and scientifically manage the risk of disability and dementia of the elderly.

During the insurance period after the end of the waiting period, the coverage of this insurance varies according to the status of the insured. For the deceased insured, the

insurance payment shall be settled according to the annuity table. After the expiry of the insurance period (65 years old), the insured person can either choose the traditional mode to receive the pension or choose to live in the old-age community. If you choose the latter, you can enjoy the right to live in the retirement community. For insured persons who apply for disability/dementia insurance, their disability/dementia level shall be determined in accordance with the disability/dementia assessment rules stipulated by the social security bureau of their place of residence, and the type of care they prefer (institutional care or professional on-site care), corresponding to provide care services for them.

The elderly care community provides different levels of elderly care services according to different physical conditions of customers. In the same elderly community, it includes integrated services of independent living, assisted living (including amnesia care) and professional nurse care (including rehabilitation care). Regardless of whether the occupants' physical condition or self-care ability changes beyond expectations, they can still receive different levels of care in the elderly community. The specific policy flowchart is shown in Figure 7-1:

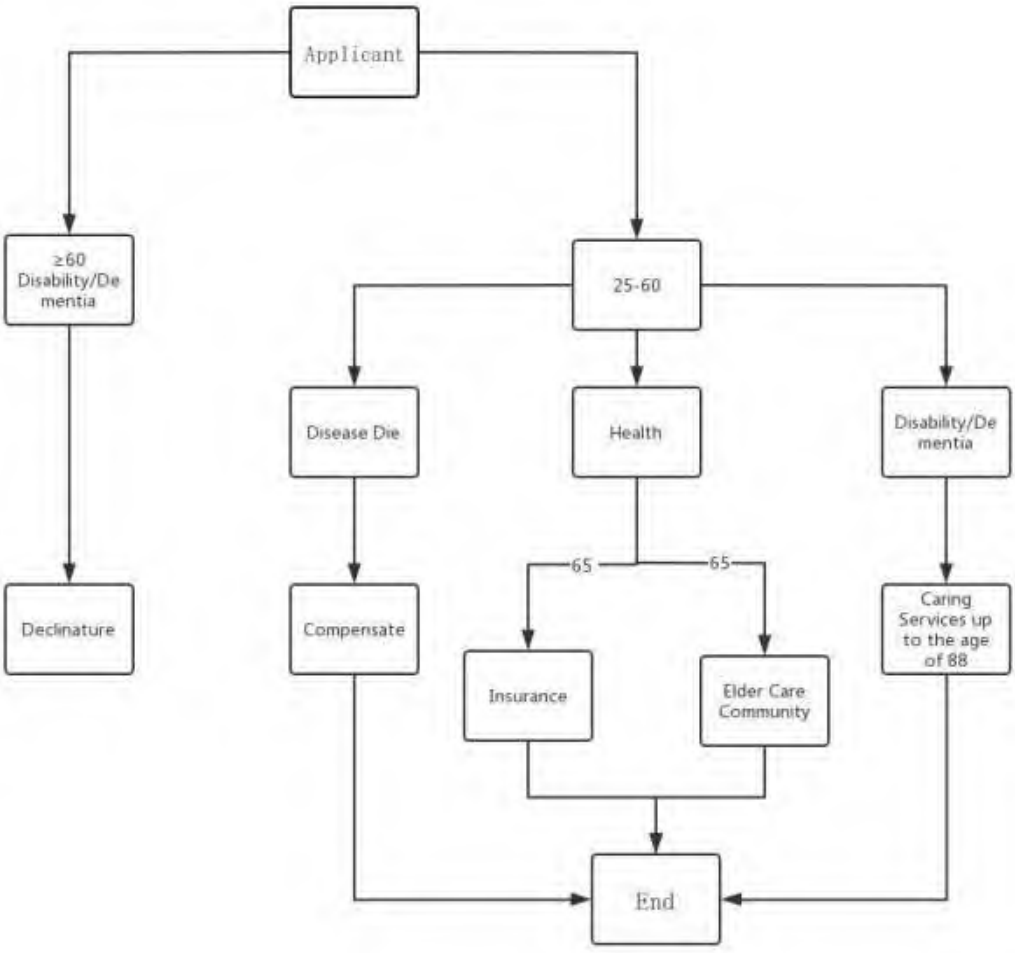


Figure 7-1. Policy flow chart

### 7.3.2 "Embedded" intelligent elderly care community: elderly care service complex

"Embedded" intelligent elderly care service is a combination of "embedded" elderly care and intelligent elderly care. Based on the community as the carrier, it embeds intelligent technology, while embedding resources, functions, communication and multiple operation methods, which is provide a higher quality of life for the elderly.

The "embedded" intelligent elderly care community discussed in this article is a new type of elderly care service based on the problems encountered in the community's home care and institutional care. In addition to providing services for the elderly who live in, it also radiates the elderly outside the intelligent elderly care community. After paying, they can equally enjoy the care, medical, entertainment and other elderly service resources provided by professional institutions. However, it is reserved for the insured person who purchases the commercial pension insurance.

Specifically, the "embedded" intelligent elderly care community embed the elderly care, medical care, education, culture and other industries into a full-age community. In the operation of the community, through the form of third-party leasing, merchants are introduced, such as all the shops in the comprehensive supporting building for external leasing. The settled merchants are fully open to the outside world and are responsible for their own profits and losses. Among them, there are supermarkets, senior travel agencies, kindergartens, coffee shops, banks, bakeries, pharmacies, health centers, gyms, etc., forming a small business circle centered on the intelligent elderly community. This kind of elderly care community embedded in market operation can keep the entire service system and content alive. The third-party rented businesses also ensure operational efficiency and service quality; the embedding of diversified elderly care functions and diversified elderly care resources greatly promotes the efficiency of resource integration, so that the elderly can enjoy professional, individualized, diversified and convenient elderly care services in an open community.

The "embedded" intelligent elderly care community can not only meet the needs of the elderly in life care, medical care, culture and entertainment, but also provide a comprehensive market body for employment for young and middle-aged laborers, establishing a "self-care apartment + nursing apartment + commercial facilities + medical facilities". As an integrated urban elderly care service complex, the specific community structure is shown in Figure 7-2.

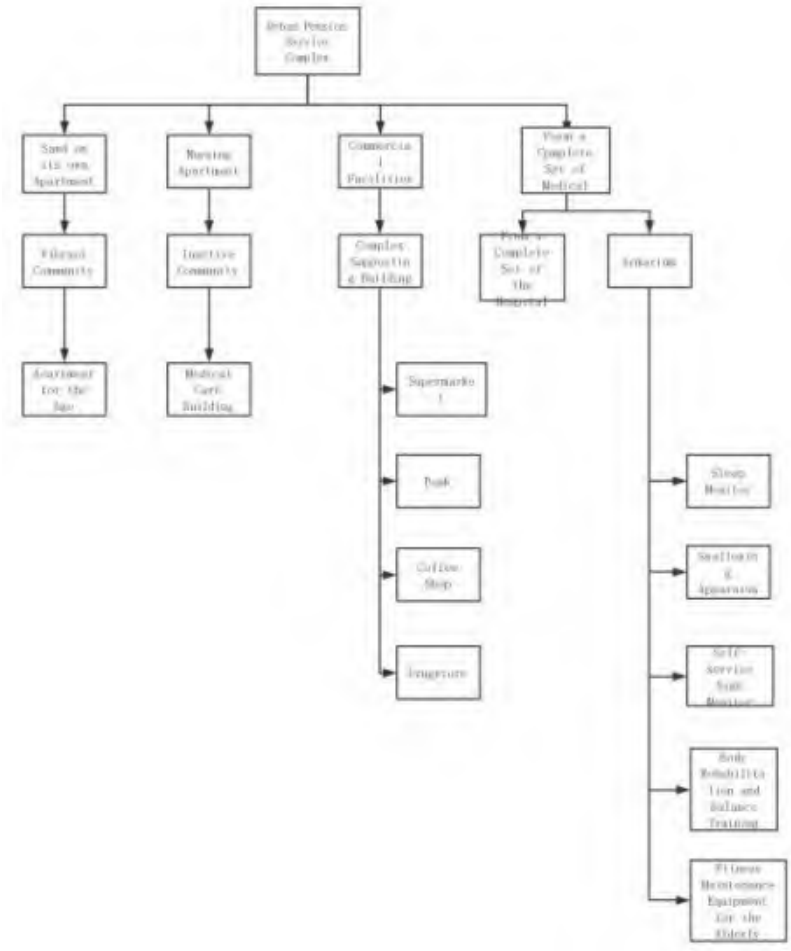

Figure 7-2. "Embedded" smart elderly care community structure

### 7.3.3 "Embedded" intelligent elderly care community service content

(1) Safe and convenient life

① The retirement community has a favorable natural environment, close to the prosperous urban life circle, only 30 minutes by car, close to children, relatives and friends. Layout in many cities across the country, migratory bird-style elderly care, select livable elderly care communities according to climate change and physical conditions. A variety of room types can be selected at will to meet the needs of different customers. You can choose small apartments such as standard rooms, or large apartments such as suites and apartments.

② Universal design suitable for aging, universal design suitable for aging facilities throughout the region, and thoughtful creation of refined and livable communities. For example: The high and low cat eyes are designed on the door to facilitate the elderly with inconvenient legs; all furniture adopts rounded corners to prevent the elderly from bumping; the bathroom is equipped with a full range of assisted handrails, and emergency buttons and pull rope alarm can be seen everywhere in the bed and toilet; the room is equipped with a 24-hour infrared detector, and if the occupant suffers a cardiac arrest or detects a health abnormality, he or she can be treated in time.

③ Public safety system settings. I. All areas are equipped with automatic fire alarms and linkage systems, in the event of a fire, to ensure that the elderly evacuate in time; II. Perimeter prevention technology adopts pulse-type electronic fences to provide the first level of prevention on the perimeter to prevent illegal intrusion from outsider; III. Video security monitoring to ensure that there are no blind spots in public parts monitoring, real-time monitoring 24 hours a day, and the video storage time is at least 30 days; IV. Pedestrian entrances are set up with access control, and single buildings are set up with visual intercom systems. Enter and exit through various methods such as face recognition, fingerprints, IC card, etc., non-community personnel are strictly prohibited to enter and exit; V. Through community positioning technology and community-wide cloud monitoring, when the elderly encounter a sudden fall in the community, they can provide timely rescue and reduce the degree of injury; VI. Set up road gates at the entrances and exits of the car to provide safety precautions for the elderly community. The security protection system of the elderly community adopts multi-layer protection design, fully enclosed management, multiple identity confirmation, and through the combination of the functions of each security protection subsystem, a comprehensive and three-dimensional cross-cutting security management is realized, so that civil defense and technical defense complement each other. Improving the comprehensive prevention capacity of the retirement area.

④ Intelligent home system design. In order to further improve the quality of community life, a intelligent home system is set up. For lighting control, curtain control, home appliance control, intelligent environment monitoring, intelligent drying racks, intelligent door locks, etc., the intelligent home system can be networked and intelligent by setting up intelligent panels, mobile APP clients, and wireless transmission. Providing a better life experience for the elderly in the community.

(2) Abundant medical resources

The community not only provides 24-hour medical rescue services, but also builds its own professional medical rehabilitation institutions, establishes connections with many top three hospitals, and cooperates with some foreign high-end hospitals to ensure that the elderly can get high-quality treatment in the first time. If residents need medical services, they can make an appointment with a doctor by dialing the phone, and they can use social security cards to pay for medical expenses. In terms of medical security, it also provides high-end medical services for such groups, so that they have coverage and services not covered by other insurance products, and add free value-added services, such as health consultation, expert appointment, rehabilitation assessment and consultation, etc. The details are as follows:

① A wide range of coverage, "everything can be insured", with an insured amount of more than 5 million, covering outpatient clinics, hospitalizations, critical illness clinics, emergency medical care, dentistry, ophthalmology, physical examinations, vaccines, and general medical insurance excluding liabilities.

② The coverage is wide, can be treated globally, and enjoy the best medical resources.
③ A wide range of medical treatment and excellent medical services (available in private hospitals, special needs, and national treatment).
④ Have a better service experience, convenient medical treatment process (direct payment for claims), professional service team.
⑤ Second diagnosis and treatment opinion. When a client is diagnosed with a serious illness, the insurance company provides employees with a second diagnosis and treatment opinion from other experts or even global experts in order to determine the accuracy of the diagnosis and treatment plan.

(3) Health and thoughtful care
In terms of health management, it is provided by qualified health stewards. From the date of purchase of the insurance policy, a permanent health record will be established, and services such as regular and personalized physical examination, health guidance, and psychological consultation will be provided to increase customers' attention to health. Wearable devices are used to detect the health of customers, and provide customers with certain amount of insurance discounts, so as to stimulate customers' health awareness and lay the foundation for health management in their later years.

The restaurants in the community are equipped with professional nutritionists to carefully match nutritious meals; food consultants are also equipped to select natural and healthy ingredients, and dozens of dishes are provided for each meal a day. Those with special eating habits can also choose private customization. At the same time, the big data backend formulates meals that meet the health requirements of the elderly, such as low-salt, low-fat, oil-free, vegetarian food, etc., based on the elderly's physical conditions and medical advice labels. Realize classified management of elderly care services to meet the diverse needs of the elderly.

At the medical care terminal, use intelligent devices, such as fall detection carpets, sleep monitors, mattress sensors, intelligent robots, health cabins, etc., to collect real-time health and safety data of the elderly; then, through wireless communication networks such as routers and WIFI, data is transmitted to the background monitoring platform; real-time monitoring pays attention to the dynamics of the elderly, and real-time alarms when danger occurs. All the elderly in the community are equipped with wireless emergency pagers. The device can be hung on the bathroom wall, bedside and other places where the elderly are prone to safety hazards, or placed on the chest of the elderly, and connected to the video robot through wireless signals. They can immediately call the system for help in emergencies such as falling down or being unable to get up. In addition, there are also escort terminals that rely on video functions in the community, which can provide intelligent elderly care services such as video consultations, medication reminders, and health lectures.

(4) Spiritual culture and entertainment

In addition to addressing the safety and physical needs of the elderly, elderly care institutions also need to pay attention to the leisure and entertainment of the elderly, and meet the emotional needs of the elderly by providing diversified entertainment and social activities.

All kinds of activity spaces are fully functional and distinguish between dynamic and static. Including swimming pools, SPA, supermarkets, restaurants, gyms, rehabilitation sports halls, senior colleges, multi-functional audio-visual halls, libraries, religious activity areas and other activity areas to meet residents' various aspects of life services, self-cultivation, health and rehabilitation, etc. If necessary, the elderly can directly participate in various activities in the community. At the same time, it has formed cooperation with local troupes to provide various types of performances for the elderly on a regular basis; the community also provides various types of courses, such as baking, flower arrangement or professional knowledge courses, to meet their spiritual and cultural needs. For the elderly who choose to take care of themselves at home, they can install voice-controlled learning software on their mobile phones, so that the elderly who are convenient for home care can also enjoy various types of performances and corresponding cultural courses to meet their spiritual and cultural needs.

## 8. Risk analysis and response and outlook

### 8.1 Risk analysis

(1)Legal supervision risk

With the advent of the new era, the intelligent pension model is also facing innovation. However, our country's intelligent pension model is still in its infancy and can only be regarded as starting. There are many problems that need to be solved urgently, and there are many problems that need to be continuously improved. Judging from the operating model of the "embedded" intelligent elderly care community, intelligent elderly care has certain legal risks, which are mainly reflected in the following aspects:

Lack of unified standards and effective supervision. At present, there are not many domestic policy documents related to elderly care service standards. The related documents and systems that have been issued are mostly constructive or guiding opinions. They are often based on verbal descriptions, and lack scientific explanations and operating standards. The guiding role of practice is not strong. For example, in practice in Hefei City, because of the incompatibility of the content, standards, and operation methods of the elderly care service information platform, information resources cannot be shared and service resources cannot be used mutually. The intelligent elderly care industry does not have systematic systems or norms to guide, lack of unified industry standards and effective industry supervision, resulting in uneven quality of intelligent elderly care services.

The information management of the elderly is not standardized. The "embedded" intelligent elderly care community monitors the elderly in real time through blockchain technology, and can obtain information about the elderly anytime and anywhere. However, the current domestic personal information management is extremely non-standard, there are situations such as inconsistent statistical data module standards and serious personal information leakage. Due to the lack of awareness of the importance of personal information and management methods of the elderly, the overall situation of personal information is very chaotic, resulting in insufficient data collection, effective analysis and scientific integration processing, and personal information leakage is not uncommon.

(2)Competitive risk

The large scale of insurance funds, low cost, long term, and the pursuit of long-term stable income determine the natural fit and good matching degree between insurance funds and the pension industry. With the development of the economy and the increase of national income, people are no longer satisfied with basic old-age insurance but have higher-end old-age needs. Therefore, the competition of high-end old-age insurance products has intensified.

Large-scale centralized high-end elderly care communities such as Taikang Home Yanyuan and Yanda Golden Age Health Care Center. It is located on the outskirts of Beijing and will be built as a large-scale retirement community of more than 100,000 square meters, equipped with relatively complete daily entertainment, nursing and rehabilitation and other necessary facilities for the elderly. The networked elderly care community takes Gongheyuan under Lecheng Pension as an example. The site is selected in the main urban area of Beijing. Each project covers an area of less than 10,000 square meters, and a total of 4 sites will be constructed, which are equipped with different facilities, such as different nodes of the network, to save investment, development and operating expenses for the community. According to the original China Insurance Regulatory Commission data, as of the end of June 2017, a total of 8 institutions including China Life Insurance, Taikang Life Insurance, and Taiping Life Insurance had invested in 29 senior care community projects, distributed in Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Hainan and other eastern coastal areas. It covers an area of more than 12 million square meters, a planned investment of 67.8 billion yuan, and more than 40,000 beds.

Due to the endless emergence of the same type of pension insurance products, competition among different pension communities is also fierce. Slight differences in the qualifications of insurance companies in pension, nursing, rehabilitation, and medical services, convenience of services, and flexibility of charges may lead to the loss of customers, thereby intensifying competition among insurance companies.

(3)Technical risk

Different from traditional old-age care methods, the core of intelligent old-age care is the use of technology to empower insurance products and services. But at present "artificial intelligence + old-age care" is still in the development stage, and the types of services involved include life care, medical care, spiritual comfort and emergency assistance, etc. The four categories cannot meet service needs. Products mainly include wearable devices, intelligent phones, intelligent home appliances, intelligent robots, etc. Although there are many types of products, there is a status quo that the functions are duplicated and the products are not connected to each other.

When using intelligent wearable devices to provide elderly care services, at least three subsystems are required, namely, real-time monitoring subsystem, elderly care service APP subsystem, and data processing subsystem. Every caregiver subject to real-time monitoring needs to submit a large amount of data to the health and elderly care platform. These massive amounts of data involving personal privacy must not only ensure effective data access control mechanisms and security, but also require desensitization and preprocessing of the data. The elderly care platform perceives the current status of the elderly through real-time monitoring and analysis of the wearable devices worn by each elderly person. When the number of online monitoring elderly persons is small, the platform pressure has not yet appeared. Once the monitoring population reaches a certain scale, the operation pressure of the platform will rise linearly.

Although intelligent devices can predict the behavior of the elderly, they cannot fully summarize the behavior of the elderly. At present, the intelligent elderly care industry has just started, and related technologies such as the Internet and the Internet of Things are still in the embryonic stage, and even technical research in some aspects is still blank. The problem of low intelligence is more obvious on intelligent terminals, and many terminal devices still have certain false alarms. False alarms caused by insufficient "intelligence" of products will not only increase the burden of management, but also greatly affect the quality of life of the elderly, causing them to be more reluctant to accept intelligent elderly care products and services.

In the context of "insurance + technology", the adoption of intelligent elderly service technology is an inevitable trend. However, at this stage, information technology and intelligent devices are in the initial stage of research, development, and application. In many respects, the service content that can be provided is single and the service quality is not high.

(4)Implementation risks

From the perspective of top-level supervision, the elderly care institutions are under the jurisdiction of the civil affairs department, while the medical institutions are under the jurisdiction of the health and family planning department. Matters related to participating in medical insurance and medical insurance expense reimbursement are in charge of the human resources and social department. Involved in capital protection and related to the financial department. The overlapping functions of the

competent departments and the unclear boundaries of responsibilities have caused certain obstacles to the practice of integrating medical care and nursing care. From the perspective of implementation, there is a big difference between the business model required by the combination of medical and elderly care and the goals and needs of traditional pension or medical institutions. For medical institutions, the first is that the pension industry is not profitable. Elderly care services have a charity attribute, a long investment return period, high operating costs, and less profitability than medical institutions. The second is the shortage of nursing personnel. The shortage of elderly care professionals is a common problem in the elderly care industry. Even if there are talents, professional capabilities may not be able to meet the demand. The talent bottleneck hinders the motivation to invest in elderly care services. The third is the high risk of the nursing process. Most elderly care recipients are disabled and demented elderly people. Even if the nursing service is fully compliant, there will be some unexpected factors that cannot be controlled. Compared with hospitals, the role of elderly care institutions when such problems occur is often weaker. In addition, from the perspective of medical insurance policies, with the exception of some elderly care institutions that cooperate with public hospitals, most elderly care institutions have their own medical supporting facilities, and it is difficult to apply for medical insurance.

### 8.2 Risk response

(1)Regarding legal supervision risks

Formulate regulatory guidelines to give the market clear expectations. With the continuous launch of innovative products based on block chain and the promotion of the development of mixed-industry business trends, the insurance industry will also usher in mixed-industry supervision, and it is an inevitable trend to unify regulatory standards based on business characteristics. Regulatory agencies should implement regulatory standards based on product functions and characteristics. In addition, regulators need to follow the example of overseas market regulators and establish comprehensive digital currency and financial blockchain supervision guidelines to meet the needs of the future development of the market and conduct research on intelligent supervision. The design and operation of the "Insurance + Intelligent Elderly Community" blockchain must be within the regulatory framework of the state and regulatory agencies. In the future, it is possible to directly embed the law into the code, identify illegal behaviors in the financial blockchain through artificial intelligence algorithms, and combat illegal decentralized autonomous organizations and criminal software.

(2)For competition risks

In the pricing of long-term care insurance products in the United States, the incidence rate (mainly focused on the probability of recovery from disability), the surrender rate, the mortality rate (the general life insurance life table was used in the setting, resulting in a certain degree of death loss), cost inflation (care cost inflation is higher than the general price), interest rate loss and other issues, in order to avoid repeating the same mistakes, we can consider establishing a certain rate adjustment

mechanism. It is recommended that supervision or industry associations take the lead and organize the insurance industry to coordinate the establishment of the incidence of long-term care, the changing trend of long-term care expenses, and a database of customer claims status to more accurately predict the future cash flow of long-term care products.

(3)For technical risks

For the block chain-based Internet of Things, data leakage is caused by the characteristics of the block chain itself, and all walks of life have been committed to the research and application of technology to protect transaction privacy. At present, it is recommended to adopt a variety of methods to make the risk controllable: The first is to use a two-layer data structure, a combination of multiple layers of the block chain and an internal data layer to process data. Most of the data that does not need to flow on the block chain is only placed in the internal database of the enterprise, and a small part of the data that needs to flow is connected to the block chain when needed. The second is to authorize and manage the nodes that apply for access to the block chain. The insurance public welfare application block chain is different from the public chain. It needs to perform identity authentication and authorization management for the connected nodes, and at the same time, it must sign related agreements to restrict the behavior of each node from a legal perspective. The third is to use advanced encryption algorithms to protect data technically. At present, the industry generally believes that the three directions of zero-knowledge proof, ring signature, and homomorphic encryption are the most likely to realize the privacy protection of transactions, and there are already public chains that have adopted zero-knowledge proof to achieve hidden related transactions. After the above technologies are mature, the problem can be solved fundamentally.

## 8.3 Prospects for the future

Insurance will integrate comprehensive financial services and extract intelligent contract models to form basic intelligent contract components. Convenient for more third parties to quickly access the "insurance + intelligent pension community" block chain management platform and support fast and simple realization of business functions, while providing customers with more open, complete, rich and high-quality integrated financial services, creating a stable and efficient pension insurance circle. Multi-party participation in cross-industry and jointly supported innovation alliances, including financial chains, administrative chains, and other industry chains that build blockchain applications. In the future, insurance will continue to devote itself to the research and application of insurance technology in serving the development of the real economy and social governance innovation, actively promote the development of cross-industry and cross-blockchain mutual trust and integration. Strengthen the application innovation of blockchain among the industry, the bank-insurance system, and the individual alliance, so as to better serve the elderly and benefit thousands of households.

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# Longevity Risk and the Basic Pension Insurance: A Review

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**Keywords:** Longevity Risk, Basic Pension Insurance, Financing gap, Analysis strategy.

**Abstract.** The longevity risk of basic pension insurance is a systemic risk that is caused by the average actual life of the population higher than the life expectancy, and cannot be dispersed by the law of large numbers. Longevity risk will bring serious "financing gap" to the basic pension insurance system of China. However, longevity risks have not received enough attention. This article starts with the definition and description of longevity risk, analysis and measurement strategies, its impact on basic pension insurance and countermeasures. It sorts out the research consensus and discussion points on longevity risk, and analyze "financing gap" on the basic pension insurance system from the perspective of longevity risk. We expect to arouse the interest of social security researchers, and expand the research on longevity risk from annuity insurance to the new research field of basic pension insurance.

## 1. 引言

随着我国基本养老保险制度的日益健全与覆盖面逐渐扩大，参加社会养老保险成为了人们抵御老龄风险的重要途径。同时，社会生产力的扩大和生活水平的提高使人口的死亡率逐渐降低，平均预期寿命不断延长，与之伴随而生的长寿风险问题成为了悬在我国基本养老保险制度上的"达摩克里斯之剑"。于是，了解长寿风险并探讨其与基本养老保险之间的关系成为了当前养老保险研究的当务之急。在过去的十余年中，国内外的学者就长寿风险及其影响撰写了大量的研究文献，但是这些研究往往将关注的焦点集中于年金保险的长寿风险，较少涉及社会养老保险；另一方面，在社会保险研究领域，已有一批学者关注到预期寿命的延长和不确定性给基本养老保险带来的潜在风险，但是这类研究并未在长寿风险的视域内展开讨论，存在问题界定不清晰和分析框架不完整等问题，因此很有必要进一步梳理当前的研究文献，在回顾商业寿险和年金保险长寿风险研究的基础

上，重新对基本养老保险的长寿风险进行界定和描述，并详细介绍近十年间我国学者在基本养老保险实证研究上的新发现，就长寿风险与基本养老保险之间的关系进行重点评述。本文将从以下几个部分展开，首先，重新回顾长寿风险的描述和理解，厘清当前研究中出现的认识谬误；其次，评述长寿风险研究中主要的分析与度量策略；最后，介绍长寿风险对基本养老保险制度的影响研究中的新发现，并对长寿风险的应对对策展开讨论。

## 2. 长寿风险的描述与理解

### 2.1 概念、特点与辨析

长寿风险（Longevity Risk）的概念界定早已成为了国内外学界的共识，虽然表述各有差别，但是大多数研究都认为长寿风险是指人口未来的平均实际寿命高于预期寿命而产生的风险（MacMinn et al, 2006; Stallard, 2006; 陈秉正，2008；郭金龙，2013）。由于长寿风险最早是由国外商业保险和养老金计划的学者提出，所以一直以来，长寿风险的危害都特指实际寿命高于预期寿命给个人或团体的养老保险造成的财务损失（Antolin, 2007）。

长寿风险的危害主要体现在个体和整体两个层次（MacMinn，2006），其在个体层次称为个体长寿风险（Individual Longevity Risk），在人口整体层次被称为聚合长寿风险（Aggregate Longevity Risk）。个体长寿风险是指由于实际寿命的延长，导致个人在生存年限内的花费超过了其积累的财富，而聚合长寿风险是指一个群体的平均生存年限超过了平均预期余寿（陈秉正等，2008）。现有研究通常认为个体长寿风险是可以转移的，如参加政府、企业和保险公司的各类养老保险和年金计划，而聚合长寿风险是不能通过大数法则进行分散的系统性的风险，最终会由各类养老保险计划的主办者承担（Milevsky et al, 2006; Cairns et al, 2006; 陈秉正，2008）。从本质上讲，在个人参加社会保险或商业保险的过程中，个体长寿风险已经从参保者转移给了保险的举办者，并最终聚合成为无法分散的系统性风险。这也说明了无论是商业保险公司，还是企业，抑或是政府，只要它们成为了一个养老金计划或者年金计划的举办者，它们就势必要面对长寿风险的控制和管理问题。

在对长寿风险的理解上，有一个问题尤其需要注意，那就是长寿风险和人口老龄化的辨析。陈秉正（2019）指出，现在很多的研究者和政策制定者对长寿风险和人口老龄化的认识是模糊的，将长寿风险解释成人口老龄化的加剧。在不少长寿风险研究中，都可以发现这两者的概念混淆问题，很多学者在描述长寿风险研究的必要性时，往往罗列大量我国人口老龄化或者“未富先老”的数据，但其实这些证据并不能证明长寿风险的严重性。人口老龄化是指在一个人口中 60 岁或者 65 岁以上老年人口比重逐渐增加的过程，人口的平均寿命延长只是导致人口老龄化的一个重要原因，后者还会受到生育率下降等原因的影响。在分析我国基本养老保险制度时，我们需要考察人口老龄化和长寿风险对制度的不同影响，如果将二者混为一谈，则会将导致人口老龄化和长寿风险带给统筹账户的效应无法区分，给基金精算分析带来麻烦。

### 2.2 长寿风险的来源与构成

#### 2.2.1 长寿风险的来源

自长寿风险产生之初，其就与养老保险紧密相连。在现代社会之前，人们无需关注于长寿风险，原因之一是由于人口的预期寿命较短，且存活年限和有劳作

能力的年限重合，人们没必要担心年老后的生活问题；另一个原因则是在传统社会中，代际支持和子代赡养极为普遍，人口的生育率较高，即使人们的寿命延长，也没有必要过度考虑整个生命周期的财富均衡问题。进入现代社会之后，人口的死亡率快速下降，生育率不断降低，家庭代际关系弱化，人们开始利用商业保险的方式实现生命周期内的财富均衡，同时参与政府构建的社会保险体系实现贫富居民之间的互济，长寿风险之虞也随之产生。综上所述，长寿风险不仅脱胎于个体老化风险，同时也是其重要的组成部分。

由于长寿风险会受到死亡率长期趋势的不确定性影响，也导致其需要区别于个体老化风险而进行单独分析。众所周知，风险源于不确定性，在长寿风险没有得到研究者的关注之前，人们认为养老保险只需要抵御财富在生命周期分配内的不确定性，以及社会整体中财富分配的不确定性，所以商业保险和社会保险分别使用年金方案和建立统筹账户来控制这两项风险。但是管理这两类风险都有一个假设前提，那就是保险的主办者可以精确的测量人口年龄别死亡率，且死亡率是稳定不变的。但是实际上，由于医疗卫生技术的进步和人们生活水平的日益提高，伴随着死亡率的下降，平均预期寿命仍在逐年提高，通过表 1 可以看出，我国平均预期寿命在 15 年间增长了 4.94 岁，这就导致长寿风险成为各类养老保险计划风险控制中的关键。

表 1 我国分性别平均预期寿命变化（2000 年—2015 年）

| 预期寿命指标（岁） | 2015 年 | 2010 年 | 2005 年 | 2000 年 |
|---|---|---|---|---|
| 平均预期寿命 | 76.34 | 74.83 | 72.95 | 71.40 |
| 男性平均预期寿命 | 73.63 | 72.38 | 70.83 | 69.63 |
| 女性平均预期寿命 | 79.43 | 77.37 | 75.25 | 73.33 |

数据来源：国家统计局官方网站 http://data.stats.gov.cn/index.htm。

### 2.2.2 长寿风险的构成

如果进一步探析死亡率不确定趋势的来源，则可以将长寿风险进一步分解，从而可知长寿风险的构成。CRO Forum（2010）的一项报告就指出，长寿风险可以分为三个不确定因素，分别为死亡率水平风险（Mortality Level Risk）、死亡率趋势风险（Mortality Trend Risk）和波动风险（Volatility Risk）。其中，死亡率水平风险指对于一个给定的人口错误估计当前死亡率水平的风险，死亡率趋势风险是指错误估计未来死亡率趋势的风险，波动风险则是指个人早于或晚于预期死亡的随机风险。虽然也有一些其他研究者（Blake et al, 2009）提出将长寿风险分为建模风险（Modeling Risk）、趋势风险（Trend Risk）和随机变化风险（Random Variation Risk），但是相较之下，CRO Forum 提出的长寿风险构成法思路更加清晰，可以帮助研究者更方便的了解长寿风险的来源，从而对其进行分析与度量。从图 1 可以看出，长寿风险来源于以下三个环节中犯错的风险，即通过人口死亡率数据对当前死亡率水平进行估计，通过当前死亡率预测未来死亡率和通过死亡率推断个人的预期寿命。

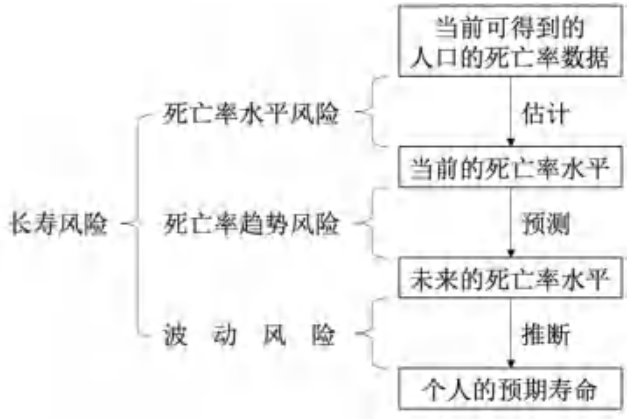


图 1 长寿风险的来源与构成示意图

CRO Forum（2010）认为在这三个部分中，死亡率水平风险和波动风险是可以通过多样化转移和大数法则控制的，而死亡率趋势风险则是无法避免的系统性风险。因为即使具备了准确的死亡数据，得到了当前真实的死亡率水平，当研究者对未来的死亡率水平进行预测时，现在的预测方法往往由于种种原因产生低估。例如 Shaw（2007）就报告了过去三十年对英国人口数据进行寿命预测时，对预期寿命的预测一直被实际的预期寿命所超过，这说明死亡率趋势风险需要在长寿风险管理中重点应对。

## 3. 长寿风险的分析与度量策略

### 3.1 年金保险的长寿风险分析策略

在所有的保险种类中，一共有三类保险计划会遭受长寿风险冲击，分别为商业寿险公司建立的商业人寿保险，企业建立的员工年金保险和政府建立的社会养老保险。由于前两者是完全积累的年金型保险，制度设计较为简洁清晰，而且国外研究者已经对其进行了大量的分析研究，所以对这两种保险存在的的长寿风险分析已经相对成熟。国内就商业寿险和年金保险开展的长寿风险研究往往按照“死亡率预测—长寿风险度量”的分析策略展开研究，形成了大量基于我国人口死亡率数据的实证研究，检验了许多西方学者提出的死亡率预测模型和长寿风险计算指标，为长寿风险的分析与度量提供了实证工具上的参考。

#### 3.1.1 未来死亡率的预测

在死亡率的预测上，大多数研究都选择以 Lee-Carter 模型（1992）为代表的动态死亡率模型进行建模，使用 ARIMA 模型对前者的模型参数进行估计，都取得了比较稳健的预测结果（韩猛和王晓军，2010；李志生和刘恒甲，2010；祝伟和陈秉正，2012；赵明和王晓军，2015b；王镇和刘丽文，2016）。在死亡率外推模型上，除了最经典的 Lee-Carter 模型外，也有研究使用了更新颖的 Currie 模型；在参数估计上，除了经典的 ARIMA 模型，也有学者使用贝叶斯方法通过 MCMC 抽样进行了参数估计（金博轶，2012）。另外，一些非参数估计方法也在死亡率预测中得到了尝试，如段白鸽和陆婧文（2015）通过重叠区块 Bootstrap 再抽样（1992）的方法对死亡率进行了预测。综合来看，国内的这些实证研究基本顺应了国外死亡率预测模型发展的趋势，逐渐从只考虑单一年龄变量的静态死亡率模

型，转变用采用考虑了年龄-时期双变量的动态死亡率模型，同时一些的参数估计或非参数估计方法也在死亡率预测中得到了尝试。

### 3.1.2 长寿风险的度量

长寿风险的度量需要选择合适的度量策略、度量指标和度量方法。首先，在度量策略上，赵明和王晓军（2015b）以欧盟 Solvency 为理论框架，将保险公司承担的长寿风险分为两类长寿风险，第一类是死亡率降低导致保险公司偿付能力不足的长寿风险，第二类是死亡率被低估引发的长寿风险。其次，长寿风险的度量指标有绝对指标和相对指标两种，前者为生存年金的精算现值（Richards, 2011），后者为偿付能力资本要求（LCR），其中，相对指标应用更加广泛（赵明，王晓军；2015b）。最后，在长寿风险的度量方法上，赵明和王晓军（2015b）探讨了三种长寿风险的度量方法，分别为压力趋势法，标准公式法和随机模拟法，其中，被国内现有实证研究广泛采用的是基于在险价值（VaR）和条件尾部期望（CTE，或与之相似的 TVaR 或 CVaR）的随机模拟法，前者是欧盟第二代偿付能力（Solvency Ⅱ）标准度量方法，后者是瑞士偿付能力测试（Swiss Solvency Test, SST）标准风险度量方法，国内学者金博轶（2012）、王志刚和王晓军（2014）以及姜增明和单戈（2016）都用该方法对我国年金保险的长寿风险进行了测度。除此之外，赵明和王晓军（2015a）还对这两种方法进行了比较，并引入了更灵活的 GlueVaR 风险度量方法，但后者在实证研究中的使用还较少。

总体来说，我国学者针对年金型保险的分析和度量策略的研究成果较为丰富，在研究进展上大幅领先于基本养老保险的长寿风险研究。造成这一的情况的原因有两个，第一是由于年金型保险在设计上较为简洁，只存在完全积累的个人账户，对其进行长寿风险的分析和度量都较为容易，第二则是由于国外对长寿风险的谈谈起步且集中于年金型保险的长寿风险研究，国内学者可参照和模仿的经验较多，例如在长寿风险的度量上，国内学者就大量使用了欧盟和瑞士较为成熟的风险度量方法，这也给中国情境下的实证研究提供了许多便利。

## 3.2 基本养老保险的分析和度量策略

### 3.2.1 经典的长寿风险分析策略无法适用的原因

当前我国的基本养老保险体系主要由两个部分组成，分别是城镇职工基本养老保险和城乡居民基本养老保险，这两者相较于年金型保险来说，制度设计更为复杂，参与主体更加多元，风险转移和聚合的路径也需要进一步的分析，这都使得针对年金型保险的“死亡率预测—长寿风险度量”分析策略不再直接适用于基本养老保险的长寿风险分析。

从制度设计上来说，基本养老保险都按照“统账结合”的原则，设立了统筹账户和个人账户，统筹账户的功能是收入再分配，注重公平，带有“待遇确定型”（DB）的性质，而个人账户的功能是激励，注重效率，更多带有“缴费确定型”（DC）的性质（何文炯等，2016）。其中，在统筹账户设计上，城镇职工基本养老保险和城乡居民基本养老保险的思路不同，前者是通过富者和贫者的收入统筹实现互济，后者则是通过财政发挥再分配功能；在个人账户设计上，两种基本养老保险的个人账户都不是纯粹的年金型保险账户。一方面，个人账户的资金完全属于个人财富，可以继承，体现了年金型保险的特点，但是另一方面，当个人账户的资金被领取完之后，参保人仍旧可以按照原标准领取养老金，不比以个人账

户储蓄额为限（王增文，2017），这一点则完全悖于年金型保险的设计理念。制度设计的复杂性也导致原本针对于年金型保险的分析策略无法适用，研究者需要对风险源进行提前识别。

从保险参与主体来看，年金型保险往往由个人参加，保险公司承保，由于参与主体较少，所以权责也明确清晰，但是基本养老保险往往涉及个人、企业、养老保险管理部门和政府财政部门等，这就给研究者判断长寿风险的风险主体带来了麻烦。从长寿风险转移和聚合的路径上看，年金型保险长寿风险的转移路径较为简单，即从参保者个人转移给了保险公司，并在保险公司处聚合成了无法转移的系统性风险，但是对于基本养老保险而言，这一路径则要更为复杂。由于城镇职工基本养老保险长期“混账”运行（何文炯等，2016），基金模式实际上变成了“现收现付”制，导致原本应该由保险的举办者——政府承担的长寿风险实际上一部分转移给了未来养老金的领取者，即在职职工；而且由于城镇职工基本养老保险未能实现全国范围内的统收统支，所以长寿风险也会在地区间形成转移，造成省际的不均衡。

### 3.2.2 基本养老保险的长寿风险分析策略

以上诸多原因导致在分析年金型保险的长寿风险时效果很好的“死亡率预测—长寿风险度量”分析策略不能很好的适应基本养老保险的长寿风险研究，需要在进行死亡率预测的环节前进行长寿风险的识别与机理分析。封铁英和罗天恒（2017）在分析农村社会养老保险时提出了一种“风险识别—风险分析—风险评价—风险控制”的长寿风险分析策略，即是这一思路下很好的尝试。首先，他们认为应在风险识别这一环节中判断风险源和影响范围，根据现行制度中的参保范围、基金筹集和待遇给付等关键环节识别其中蕴含的长寿风险；随后，在风险分析环节中寻找长寿风险的产生和影响机理；最后，在风险评价环节中进行死亡率的预测和长寿风险的测度，并给出长寿风险的控制策略。另外，还有研究者在分析城镇职工养老保险的超额支出问题时，就在测算之前先将个人账户风险进行了识别，将其支出缺口分为“遗产差”和“寿命差”，“长寿差”即为长寿风险带来的基金超额支出，研究最终测度了基金缺口及“寿命差”的比重（王增文，2017）。虽然这一研究无意于预测和度量未来的死亡率和长寿风险，但是其仍旧为基本养老保险的长寿风险研究提供了风险识别和政策分析上的参考。

结合以上研究不难发现，当前的研究者在分析基本养老保险的长寿风险时已经意识到了基本养老保险制度的复杂性，并且在“死亡率预测—长寿风险度量”环节前就对制度中的长寿风险进行了识别和机理分析。但是从总体上来看现有研究仍存在着以下不足：第一，仍有部分研究直接套用年金型保险的分析策略来研究基本养老保险的长寿风险，缺乏对制度设计本身的政策分析，未能意识到识别风险源和影响范围的重要性，致使其提出的一些精算假设偏离实际情况，导致进一步的死亡率预测和长寿风险测度结果不可靠；第二，现有研究往往存在着“风险识别—机理分析”与“死亡率预测—长寿风险度量”前后衔接不紧密，实证链条不吻合的情况。例如一些研究在政策分析中探讨了基本养老保险的参保人群和总人口的区别，但是在死亡率预测环节却又直接套用总人口的死亡率数据进行测算，未对参保人群当前的死亡率进行重新估计，这也会极大的降低后续分析和度量的准确性。

### 3.2.3 基本养老保险的长寿风险度量策略

在基本养老保险的长寿风险度量策略上，现有研究中大致采取了资产度量和时间度量两种策略，前者是以超额支出金额等资产指标为度量衡对长寿风险的影响进行测算，后者则以超额支出月数等时间指标为度量衡进行测度，其中，资产度量策略得到较多研究者的采用。在资产度量策略的使用上，姜增明和单戈（2016）就利用基于在险价值（VaR）的测度模型对未来 50 年长寿风险影响进行了度量，发现 2015 年长寿风险对基本养老保险的影响仅为 148.22 亿，而在 2050 年，这一数字为 7.47 万亿，占 GDP 比重从 0.02%上升至 2.09%；刘醒和刘昌平（2019）利用城乡居保的个人账户现值模型计算了长寿风险影响下的个人账户超额支出至 2097 年将高达 10.2 万亿。在时间度量策略的使用上，封铁英等人（2017）在对农村社会养老保险的长寿风险测度后认为到 2040 年农村养老金个人账户的超支月数将达 131.3 个月，并且其提出了基于超支月数占政策规定养老金给付时长的比例的风险等级判定标准，即将比例在 30%以下、30%-50%、50%-70%和 70%以上分别定义为低风险、中度风险、高风险和重度风险。将两种度量策略比较来看，资产度量是一种绝对指标，可以和当年的 GDP、养老金收入和结余等指标进行对比，适用的场景更多，但是测算所需的假设条件也更多，失真的风险也更大；时间指标是相对指标，使用时较为简洁，但是其不能精准的测算基本养老保险制度遭受长寿风险冲击时的损失额，适用的场景较为有限。

## 4. 长寿风险对基本养老保险的影响

长寿风险的危害通常被定义为预期寿命的延长给养老保险带来的损失，对于基本养老保险来说，这种损失就是基本养老保险的支出超过预期的部分，换句话说，就是其实现精算平衡的资金缺口。王晓军等人（2016）借助国际上金融机构偿付能力资本需求 VaR 的思想将长寿风险对基本养老保险的冲击效应定义为“在一定概率下（通常为 95%的上限）长寿风险的上界对应的养老金支出与预期的平均养老金支出之差”，这一定义在之后得到了较多研究者的采用。在我国的基本养老保险体系内，无论是城镇职工基本养老保险，还是城乡居民基本养老保险，其都由社会统筹账户和个人账户构成。其中，统筹账户的基金管理模式为“待遇确定”型（DB），筹资模式为现收现付式，其依赖社会互济和代际赡养实现横向平衡；个人账户则是“缴费确定”型账户（DC），筹资模式为完全积累式，其依赖投资运营实现纵向平衡，正因为这两种账户在基金管理模式、筹资模式和精算平衡策略都完全不同，所以也导致长寿风险对其的影响效应大相径庭。

### 4.1 长寿风险对养老金个人账户的影响

当前国内研究者在探讨长寿风险对基本养老保险制度的影响时往往集中于长寿风险对个人账户的影响上，其原因在于个人账户在制度设计上存在可继承性和无限延续性的不合理之处，导致其先天就存在资金缺口问题（陆安等，2010）。个人账户在制度上规定个人的缴费余额可以继承，体现了其私有性质，但是其又规定当个人账户中的资金领取完毕后仍旧可以领取相同养老金至参保人死亡，这一规定就与其缴费确定的原则相违背。这种制度设计上的矛盾就导致自个人账户运行之初就饱受批判，但是至今为止，这一制度设计并未有改头换面的调整。有学者对这一情况进行了解释，例如汪泽英和曾湘泉（2004）从参保者的视角解释了个人账户先天不足，但是可以有效运行的合理性，他们认为参保者领取的养老金收入大于缴费储蓄的部分其实是一种对于参保者的“收益激励”。这种看法也得到了一些学者的认同，例如刘万等人（2010）就认为现行个人账户的给付政策有利于提高人们的参保缴费积极性，在过去的基本养老保险扩面中发挥了很大的

作用，这些解释逻辑的合理性基础在于个人账户原本应具备的投资增值的激励性丧失。如果按照“缴费确定”型的基金管理模式，个人账户属于个人的私有财富，个人参保的激励性应来源于集中投资运营带来的财富增值，但是实际上，我国的个人账户从未做实过，账户资金被大量挪用至统筹账户，集中的投资增值自然无从谈起。因此，想要革除个人账户的先天不足，必须对现行的基本养老保险基金管理大力改革，显然这在短期内是难以实现的。

既然个人账户的超额支出将会长期存在，那么在其资金平衡的缺口中有多少是长寿风险所致的呢？杨俊（2015）在对个人账户超额支出的因素进行分析后给出了一种思路。杨俊认为我国的个人账户制度不能实现养老金精算平衡是由于“寿命差”、“遗产差”和“增长差”三种因素存在，其中，“寿命差”即我国个人账户的计发月数小于参保者退休时实际的预期余寿的差值。从计发规则上看，计发月数越小，则参保者每月领取的养老金就越多，带给个人账户基金的超额支出也就越多。如果将计发月数理解成制度设计时认定的参保者预期余寿，那么“寿命差”即为长寿风险给基本养老保险个人账户带来的影响。“遗产差”和“增长差”则分别指参保者死亡时个人账户可以继承导致的个人账户超额支出和养老金增长率高于个人账户记账利率带来的超额支出。随后杨俊采取超额支出率指标对上述三种因素进行了边际分解发现，当参保者退休年龄为 50 岁时，同一队列的总的超额支出率为其缴费总积累的 177%，其中寿命差贡献因素最大，占到了一半以上。后续的研究者对“寿命差”的绝对数进行了进一步的测算，王增文（2017）在计算了 1997-2015 年缴费参加城镇职工基本养老保险的“标准人”在远期退休后预计产生的“遗产差”和“寿命差”后发现，其超额支出总额约为 140.34 万亿，其中，“寿命差”约 133.56 万亿，占个人账户超额支出的 95%，远远大于遗产差的比重。这些研究结论进一步佐证了长寿风险是造成当前基本养老保险个人账户超额支出的主要原因。

除了上述对当下长寿风险对个人账户的影响测算外，一部分研究者利用死亡率估计和预测的手段，对未来长寿风险影响的变化也进行了描述。封铁英等人（2017）就在控制了其余影响个人账户超额支出的因素后，基于 2012-2041 年农村居民平均预期寿命的预测结果，测算了未来三十年长寿风险造成的城居保个人账户的养老金超支月数发现，随着 2012 年至 2040 年平均预期寿命的增长，个人账户超支月份不断增加，超支月份比例从 18.93%上升至 85.48%。这一研究结果说明如果个人账户养老金的计发月数不随预测的预期寿命进行调整，长寿风险带给其的超额支出影响只会越来越大，并最终将导致基本养老保险制度难以为继。

### 4.2 长寿风险对养老金统筹账户的影响

一个值得注意的情况是，在现有的长寿风险研究中，关于个人账户超额支出的文章汗牛充栋，但专门谈论长寿风险对统筹账户影响的文章则凤毛麟角，其中很重要的原因就是学者们普遍认为统筹账户的本质是代际赡养，是工作一代人和退休一代人的代际均衡，其会遭受人口老龄化的冲击，但是不存在预期寿命延迟导致的养老金缺口问题（封铁英等，2017）。的确，人口老龄化带来的代际不均衡会对统筹账户形成巨大的冲击，并这并非意味着长寿风险对其影响为零。实际上，长寿风险是一种无法被转移的系统性风险，“系统性”即意味着其无法通过大数法则分散，长寿风险的冲击效应可能已经隐性的传递给了制度本身，并进一步的转移给了下一代的参保者，而这部分效应在现有的研究中往往被错误的归因到了人口老龄化身上。因此，在未来的长寿风险研究中，很有必要就长寿风险对

基本养老保险统筹账户的影响展开探讨，并在进一步的分析和测算中将长寿风险的影响与人口老龄化的效应剥离。由于人口老龄化和人口平均预期寿命的变化并不是完全同步的，因此也有必要结合人口预测结果对未来两种因素效应的变化进行动态图景上的描述。

## 5. 长寿风险应对之讨论

在讨论长寿风险管理对策的国内研究中，大部分仍集中于年金保险的长寿风险对策研究，管理方法通常是为了帮助保险公司降低风险，主要有以下几种：第一，风险自留，通过死亡险和年金险业务实现长寿风险的自然对冲（陈秉正和祝伟，2008；魏华林等，2014），其原理是长寿风险会同时给死亡险业务带来死差益和死差损，可以实现一部分长寿风险的对冲（胡仕强，2019），同时也有研究探讨了自然对冲方案的使用条件和有效性（金博轶，2013）；第二，再保险，将部分长寿风险转移给国际性的再保险公司（刘安泽，2007；陈秉正和祝伟，2008）；第三，限制养老保险的投保年龄，参保人的投保年龄越大，长寿风险的不确定性也就越低（陈秉正和祝伟，2008）；第四，建立年金方案，以分红年金代替非分红年金，实现保险套期保值（陈秉正和祝伟，2008；单戈和王晓军，2017），开发 buy-ins 和 buy-outs 年金产品（陈翠霞等，2018）；第五，利用资本市场中的各类金融工具实现长寿风险证券化（刘安泽，2007；谢世清，2014），如发行生存债券、生存互换、生存期货和生存期权等（陈秉正和祝伟，2008），政府则应提供配套政策保证提高其可行性，如提供死亡率数据支持、搭建长寿债券运行的技术平台、发展资本市场与完善政策规定等（陈翠霞等，2017）。虽然上述提出的一些措施受国内诸多条件的制约无法直接适用于基本养老保险的长寿风险应对，但是仍可以为后续政策设计和调整提供参考，例如基本养老保险的个人账户年金化之后，这些长寿风险的应对策略则可以大展拳脚。

在探讨我国基本养老保险的长寿风险对策的研究中，除了专门探讨长寿风险的文献外，一些政策分析的研究也为制定长寿风险对策提供了建议，主要有以下几个方面。首先，大量研究探讨了个人账户长寿风险管理对策，一类观点较为激进，其认为应实现个人账户的强制年金化，使其回归“缴费确定”型设计的初衷，以一次性的解决其超额支出问题（刘昌平，2007；刘醒和刘昌平，2019）；另外一些学者的观点则较为中庸，他们认为应该改变现有制度中个人账户设计不合理支出，如按照预期寿命变化调整计发月数（潘孝珍，2014；杨俊，2015；封铁英等，2017；王增文，2017），刘醒等（2019）根据测算结果认为如果按照实际预期寿命动态调整计发月数，个人账户超额支出将减少约 5 倍，建议取消个人账户支付终身的规定；最后一种观点则较为保守，他们认为个人账户如果强制年金化会引起“逆向再分配”，而现行的计发办法有利于扩大基本养老保险的覆盖面，长寿风险带来的缺口问题可以通过有效的投资管理加以遏制（刘万等，2010）。其次，一些研究从基本养老保险计发的视角提出通过延迟退休（刘安泽，2007；金博轶，2013；潘孝珍，2014；姜增明和单戈，2016；陈秉正，2019）和动态调整养老金给付标准（刘安泽，2007；陈秉正，2019）的办法降低长寿风险带来的资金缺口；另一些学者则从资金筹集的视角提出建议，认为应通过增加养老保险财政投入力度（王增文，2017）和建立应对风险的长期准备金（陈秉正，2019）来防控风险。最后，仍有学者建议政府应借鉴保险公司的对策，通过设计和发行长寿证券将长寿风险转移给资本市场（侯立平，2011；姜增明和单戈，2016；陈秉正，2019）。

## 6. 小结

通过对长寿风险的描述和理解、分析和度量策略、影响和后果以及对策与建议几个部分的研究回顾与梳理，基本可以得到以下几点认识：

第一，在概念定义上，长寿风险指人口未来的平均实际寿命高于预期寿命而产生的风险，危害是会给个人或团体的养老保险造成的财务损失；在人口整体层次上，聚合长寿风险是一种无法被转移的系统性风险；长寿风险虽然和人口老龄化的成因有相同之处，但是两者是成因不一、影响不同、管理对策区别很大的两种情况。在性质上，长寿风险是人们老化风险的一部分，其来源于死亡率长期趋势的不确定性，其由死亡率水平风险、死亡率趋势风险和波动风险三部分组成。

第二，长寿风险的分析与度量策略因年金保险和基本养老保险的种类不同而存在区别，前者往往基于“死亡率预测—长寿风险度量”的分析策略，后者则需要在这一分析策略上补充长寿风险的识别和机理分析等前置环节，前者在研究进展上大幅领先于后者。

“死亡率预测—长寿风险度量”分析策略的重点在于对未来死亡率的预测和对长寿风险的度量，当前的国内研究已经形成了大量基于我国人口死亡率数据的实证研究，检验了许多西方学者提出的死亡率预测模型和长寿风险计算指标。但是这种分析和度量策略由于基本养老保险制度设计、参与主体和风险转移和聚合的复杂性而不能直接适用，国内的研究者逐渐认识到这一点并增加了对基本养老保险的风险识别和机理分析，但是这些研究仍存在着前后分析环节衔接不紧密，实证链条不吻合的情况。

第三，长寿风险对基本养老保险的危害是前者会导致后者的支出超出预期，给精算平衡带来资金缺口。目前国内对这一危害的研究集中在长寿风险对个人账户的影响上，已有研究认为导致个人账户超额支出的“寿命差”是由于个人账户设计时认定的参保者平均预期余寿即计发月数，远低于实际平均预期寿命所引发的长寿风险所致，一些实证研究结果证明长寿风险是造成个人账户超额支出的最主要原因，且这种影响还会在未来逐渐扩大。在长寿风险对统筹账户的影响上，一些学者认为统筹账户的本质是代际赡养，其会遭受人口老龄化的冲击，但是不存在预期寿命延迟导致的养老金缺口问题。实际上这一观点仍有待商榷，因为长寿风险是一种无法被转移的系统性风险，其影响不会被大数法则分散，而是隐性的传导给了下一代的缴费者，本文认为应该在进一步的实证研究中将长寿风险的影响与人口老龄化的效应剥离。

第四，现有研究中对基本养老保险长寿风险的对策研究主要集中在以下几点，首先，探讨了个人账户长寿风险管理的对策，并形成了强制年金化、改变现有制度设计中的不合理部分，如调整计发月数，取消终身给付等，以及保持现有政策不变，将个人账户资金投资运营等从激进到保守的不同观点。其次，一些研究分别从资金给付和筹集的时间出发，提出通过延迟退休、动态调整养老金给付标准、增加财政投入力度和建立风险应对长期准备金等对策。最后，仍有学者建议借鉴保险公司应对长寿风险的策略，利用再保险、年金方案和风险证券化等手段将风险转移给资本市场，但是目前来讲，这一对策仍有诸多的限制条件。

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# 长寿风险与基本养老保险：一个研究综述

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**关键词：**长寿风险；基本养老保险；资金缺口；分析策略

**中文摘要.** 基本养老保险的长寿风险（Longevity Risk）是一种由人口未来的平均实际寿命高于预期寿命导致，且无法通过大数法则分散的系统性风险，长寿风险将会给我国的基本养老保险制度带来严重的资金缺口问题。但是在我国养老金研究领域中，长寿风险并未得到足够的重视。本文从长寿风险的界定和描述、分析度量策略、其对基本养老保险的影响及对策四个方面入手，梳理了国内外关于长寿风险的研究共识和讨论要点，并在长寿风险视域下考察了基本养老保险的资金缺口问题，以期引发社会保障研究者的兴趣，使长寿风险研究从年金保险进一步拓展到基本养老保险研究领域。

# Research on the Supplementary Effect of Xianmen Individual Tax Deferred Endowment Insurance on the Basic Endowment Insurance

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**Keywords:** Tax Deferral, Basic Endowment Insurance, Replacement Rate, Supplement

**Abstract.** In this paper, Xiamen City is selected as the research object to study the supplementary role of the tax deferred endowment insurance. This paper is divided into four parts. The first chapter elaborate on the background of population aging, pension system under pressure and low replacement rate of urban workers. Chapter two Empirical analysis of the replacement rate by simulating the case of Xianmen City staff basic endowment insurance, it highlights that China's current basic old-age insurance can not meet the needs of the total replacement rate, the second and third pillars have great room for growth and so on. The third chapter first calculates the replacement rate of individual tax deferred endowment insurance under the current system, and draws the conclusion that the replacement rate of China's current individual tax deferred endowment insurance has little effect, and the low-income group cannot enjoy preferential treatment. In addition, we optimize the tax preferential amount, pension investment rate of return and the actual tax rate paid at the receiving stage, and make a variety of combinations. It is found that when the tax deferred preferential amount is 10000 yuan, the pension investment rate of return is 8%, and the actual tax rate paid at the receiving stage is 4%, the total replacement rate of pension insurance reaches 80.12%. The fourth chapter puts forward some policy suggestions, such as moderately expanding the amount of tax deferred tax preference, appropriately increasing the pension investment yield, appropriately reducing the individual income tax rate in the receiving stage, and combining tax deferred tax preference with the subsidy of low-income groups.

## 1. 引言

随着人口老龄化的加剧以及抚养比的攀升，当代年轻人的养老压力越来越大。目前，我国推行多层次的养老体系。2018年5月，税延养老险试点工作启动，三支柱框架建立。目前，我国已有9.7亿人参加基本养老保险，中共十八大报告提出：“要坚持全覆盖、保基本、多层次可持续的方针，全面建成覆盖城乡居民的社会保障体系。”我国实行的是“广覆盖、保基本”的方针，随着人数的不断增加，我国养老保险的保障水平难以做到满足老年人退休后的生活品质要求。养老金替代率是衡量养老金是否充足的一个很重要的指标，依照世界劳工组织发布的《社会保障最低标准公约》显示，55%是养老金替代率的警戒线，若养老金替代率低于这个数据，那么退休者的生活水平将严重下降。而综合世界各国经历来看，只有替代率超过70%，退休后才能保持现有生活水平。而我国的养老金替代率却不高于警戒线水平。通过表1.1中数据发现，从2001年到2019年, 我国城镇离退休人员的数量和城镇退休人员的人均养老金支出均不断增加。从2001年到2014年，我国城镇职工养老金的平均替代率呈逐年下降的趋势，由2001年时的73.29%，下降至2014年的48.33%，在2015年时平均替代率水平有所提高，到2017年突破50%，但近三年又呈下降趋势，随着人口老龄化的进一步加剧，这一数字只能是进一步下降。

表1　城镇职工基本养老保险替代率水平

| | 城镇基本养老金支出（亿元） | 离退休人员（万人） | 退休人员人均养老金（元） | 城镇在职职工平均工资（元） | 平均替代率(%) |
|---|---|---|---|---|---|
| 2001 | 2321.3 | 3380 | 6867.75 | 10870 | 73.29 |
| 2002 | 2842.9 | 3607.8 | 7879.87 | 12422 | 72.49 |
| 2003 | 3122.1 | 3860.2 | 8087.92 | 14040 | 65.11 |
| 2004 | 3502.1 | 4102.6 | 8536.29 | 16024 | 60.80 |
| 2005 | 4040.3 | 4367.5 | 9250.83 | 18364 | 57.73 |
| 2006 | 4896.7 | 4635.4 | 10563.71 | 21001 | 57.52 |
| 2007 | 5964.9 | 4953.7 | 12041.30 | 24932 | 57.34 |
| 2008 | 7389.6 | 5303.6 | 13933.18 | 20229 | 55.88 |
| 2009 | 8894.4 | 5806.9 | 15316.95 | 32736 | 52.40 |
| 2010 | 10554.9 | 6305 | 16740.52 | 37147 | 51.14 |
| 2011 | 12764.9 | 6826 | 18700.41 | 42452 | 50.34 |
| 2012 | 15562 | 7446 | 20899.81 | 47593 | 49.23 |
| 2013 | 18470 | 8041 | 22969.78 | 52388 | 48.26 |
| 2014 | 21755 | 8593 | 25317.12 | 57361 | 48.33 |
| 2015 | 25813 | 9142 | 28235.62 | 63241 | 49.22 |
| 2016 | 31854 | 10103 | 31529.25 | 68993 | 49.86 |
| 2017 | 38052 | 11026 | 34511.16 | 76121 | 50.02 |
| 2018 | 44645 | 11798 | 37841.16 | 84744 | 49.71 |
| 2019 | 49228 | 12310 | 39990.25 | - | 47.19 |

数据来源:城镇在职职工平均工资来源于国家统计局；2012-2019年城镇基本养老金支出和离退休人员数据来源于《人力资源和社会保障事业发展统计公报》，2012-2019；2001-2011年城镇基本养老金支出和离退休人员数据来源于《中国统计年鉴2012》

随着第一支柱养老金替代率水平逐渐下降，为了不断完善基本养老保险制度，在2004年正式颁布了企业年金制度，企业年金作为基本养老保险的补充。经过20年的发展，企业金的覆盖率始终很低。数据显示，目前仅有不过2000多万的员工享有企业年金，可见，第二支柱企业养老金也不能满足退休人员的实际需求。

在第一支柱和第二支柱都难以保障退休人员的实际需求情况下，2006年，中国保监会发展改革部、清华大学经济管理学院联合课题组《保险业对改革中长期社会经济发展环境的作用研究》提出：利用税收杠杆，鼓励个人和团体购买养老、医疗保险。2018年4月，财政部等五部门联合发布了《关于开展个人税收递延型商业养老保险试点的通知》，为推动我国个人税收递延型商业养老保险(以下简称税延养老险)试点工作提供理论指引和制度保障。从此，我国在苏州工业园区，上海市以及福建省（含厦门）进行了试点工作。进行了一年的试点工作以后，发现结果并不是很乐观。所以，如何推进个税递延型养老保险的试点，以及今后的发展是丞待解决的问题。

## 2．厦门市基本养老保险替代率测算

### 2.1 基本养老保险替代率模型构建

一般情况下，养老保险替代率通过目标替代率这一指标进行测算。目标替代率是职工退休后领取的养老金收入与当职工退休前一年工资收入之比。由于数据获得的有限性，目标替代率通常是当年的退休职工领取的平均养老金收入与上一年城镇职工的平均工资收入之比。根据国发〔1997〕26号文件，1997年在全国范围实施养老保险制度改革，通常将统账结合之前已经退休的人称为“老人”，将统账结合之前参加工作，之后到龄办理退休的人称为“中人”，将统账结合之后参加工作的人称为“新人”。由于“老人”在1997年已经退休，无需再缴纳养老保险，所以本文暂不考虑。由于“新人”群体和“中人”群体在计算上有差别，所以对“新人”和“中人”进行分类讨论。

#### 2.1.1 “新人”群体

参考国发〔2015〕2号文件中城镇职工养老金的计算内容，城镇职工养老金领取者工养老金收入包括社会统筹养老金和个人退休账户养老金。

社会统筹养老金收入=退休时上一年度在职职工月平均工资×（1＋个人平均缴费指数）/2×年限×1%

个人账户养老金收入=退休时本人基本养老保险个人账户累计余额/计发月数，其中计发月数见下表2。

表 2 40岁—70岁退休人员计发月数

| 退休年龄 | 计发月数 | 退休年龄 | 计发月数 | 退休年龄 | 计发月数 |
|---|---|---|---|---|---|
| 40 | 233 | 51 | 190 | 61 | 132 |
| 41 | 230 | 52 | 185 | 62 | 125 |
| 42 | 226 | 53 | 180 | 63 | 117 |
| 43 | 223 | 54 | 175 | 64 | 109 |
| 44 | 220 | 55 | 170 | 65 | 101 |
| 45 | 216 | 56 | 164 | 66 | 93 |

| | | | | | |
|---|---|---|---|---|---|
| 46 | 212 | 57 | 158 | 67 | 84 |
| 47 | 208 | 58 | 152 | 68 | 75 |
| 48 | 204 | 59 | 145 | 69 | 65 |
| 49 | 199 | 60 | 139 | 70 | 56 |
| 50 | 195 | | | | |

数据来源：国务院关于完善企业职工基本养老保险制度的决定 国发〔2005〕38号

社会统筹养老金收入为：

$$R_1 = S \times \frac{1+\alpha}{2} \times N\% \tag{2.1}$$

其中R1是社会统筹养老金收入，α是个人平均缴费指数，S是个人工资（社会职工月平均工资），N是缴费年限。

个人账户养老金收入为：

$$R_2 = \frac{\sum_{i=1}^{N} S_0\alpha(1+g)^i\beta(1+r)^{N-i+1}}{n} \tag{2.2}$$

其中R2是个人账户养老金收入，β是个人缴费率，r是个人账户记账利率，S0是工作最初工资，n是计发月数/12。

社会统筹账户养老金替代率为：

$$\lambda_1 = \frac{R_1}{S_0\alpha(1+g)^N} = \frac{S \times \frac{1+\alpha}{2} \times N\%}{S_0\alpha(1+g)^N} = \frac{S_0(1+g)^{N+1}(1+\alpha) \times N\%}{2S_0\alpha(1+g)^N} = \frac{(1+\alpha)(1+g)}{2\alpha} \times N\% \tag{2.3}$$

其中λ1是社会统筹账户养老金替代率，g是工资增长率。

个人账户养老金替代率为：

$$\lambda_2 = \frac{R_2}{S_0\alpha(1+g)^N} = \frac{\sum_{i=1}^{N} S_0\alpha(1+g)^i\beta(1+r)^{N-i+1}}{n \times S_0\alpha(1+g)^N} = \frac{\beta(1+g)\sum_{i=1}^{N}\left(\frac{1+r}{1+g}\right)^{N-i+1}}{n} \tag{2.4}$$

其中λ2是个人账户养老金替代率。

城镇职工基本养老金替代率为：

$$\lambda = \lambda_1 + \lambda_2 \tag{2.5}$$

其中λ是城镇职工基本养老金替代率。

由公式2.4和2.5可知，在工资增长率g，个人平均缴费指数α，个人缴费率β，个人账户记账利率r，缴费年限N，计发月数n确定的情况下，可测算我国的“新人”群体城镇职工养老金替代率。

2.1.2 “中人”群体

参考国发〔2005〕38号文件中的内容，1997年后退休且缴费年限累计满15年的人员，在发给基础养老金和个人账户养老金的基础上，再发给过渡性养老金。

过渡性养老金=退休时上一年度在职职工月平均工资×个人平均缴费指数×缴费年限（过去）×过渡系数

过渡性养老金的收入为：

$$R_3 = S \times \alpha \times M \times \gamma \tag{2.6}$$

其中M是到1997年之前缴费年限，$\gamma$ 是过渡系数。

过渡性养老金替代率为：

$$\lambda_3 = \frac{R_3}{S_0\alpha(1+\mathrm{g})^{\mathrm{N}}} = \frac{S_0(1+\mathrm{g})^{\mathrm{N}} \times M \times \gamma}{S_0(1+\mathrm{g})^{\mathrm{N}}} = M \times \gamma \tag{2.7}$$

城镇职工基本养老金替代率为：

$$\lambda = \lambda_1 + \lambda_2 + \lambda_3 \tag{2.8}$$

由公式2.7和2.8可知，在缴费年限（过去）M，过渡系数 $\gamma$ 已知的情况下，可测算我国的“中人”群体城镇职工养老金替代率。

## 2.2 参数选取

根据厦门市统计年鉴数据显示，厦门市近10年城镇职工的平均工资增长率是10%，所以本文的工资增长率g用10%来进行测算。

根据（国发〔2015〕2号）文件1中的养老保险的规定，单位需按照工资总额20%缴费，个人需按照个人工资的8%缴费，所以本文的β的取值是8%。

通过人社部办公厅、财政部办公厅印发的关于个人账户记账利率的通知，2018年和2019年城镇职工基本养老保险个人账户记账利率分别是8.29%，7.71%，取其平均值8.0%，所以本文的r用8%进行测算。为了下文的个税递延养老险的补充作用测算方便，个人账户利率分别用3.5%和8%进行测算。

根据厦门市统计局数据资料显示，2019年厦门市城镇职工年人均工资是97779元。将缴费基数的下限设置为将社会平均工资的60%，缴费基数上限设置为社会平均工资的300%。本文根据这一指标划分低、中、高收入群体，分别是 0.6倍、1倍、3倍的社会平均工资。

根据厦门政府〔2006〕408号文件，厦门市的过渡系数是1.3%，所以本文 $\gamma$ 的取值是1.3%。

我国规定法定退休年龄为男性年满60周岁，女性职工年满50周岁，女性干部年满55周岁，由于我国延迟退休已商议多年，虽然还未落实，本文取60岁进行测算。在目前普遍的情况下，一般是6岁上小学，9年义务教育，15岁上高中，18岁上大学，大学毕业是21岁。对于新人群体，最年轻的是21岁，最年长的是44岁（1997年缴纳社保），取其平均值32岁作为“新人”的测算值，其退休年龄是60岁，缴费年限是39年（21岁开始缴费）。对于中人群体中，最年轻的是45岁（1996年缴纳社保），目前在职时间最长的（2020年退休）60岁，取其平均值52岁作为“中人”的测算值。 “中人”群体在1989年21岁时参加工作，到1997年29岁时开始加入基本养老保险制度并拥有个人账户，预计其60岁退休，那么其缴费年限是31年。

## 2.3 基本养老保险替代率模拟结果分析

[1] 国务院关于机关事业单位工作人员养老保险制度改革的决定

在假设条件确定的情况下，得出个税递延养老保险的替代率测算表，如下表3和4，从测算结果可以得出以下结论：

2.3.1　城镇职工基本养老保险替代率偏低

以中收入群体作为目前普遍大众的工资收入水平，其养老水准作为未来大众的基本养老金给付标准。可以发现，以8%作为投资收益率，“新人”“中人”的基本养老金替代率分别是53.34%和54.76%，低于警戒线水平。所以，无论是“新人”群体还是“中人”群体的基本养老金替代率都是偏低的。对于高收入群体的“新人”“中人”，其基本养老金的替代率分别为39.04%和43.39%，此结果表明高收入群体的基本养老金替代率与国际警戒线相差甚远，如果投资收益率降为3.5%，那么“新人”和“中人”的基本养老金替代率只有29.68%和34.78%，这说明该群体步入老年生活后，生活水平可能会大幅降低。低收入群体的基本养老金替代率相对较高，“新人”“中人”分别是68.04%和66.13%，略高于世界警戒线水平，前文提到，只有退休人员的养老金替代率超过70%，退休人员才能保持退休前的生活水平。所以，无论是中收入群体、高收入群体还是低收入群体，在目前的基本养老保险替代率下，都无法满足退休后保持现有生活水平，因此，养老金体系仍需完善。

2.3.2　养老保险基金的投资收益率有待提高

根据本文的测算结果，投资收益率用8%进行测算，我国的基本养老金替代率都无法达到国际标准。由公式2.3和2.4可知，养老金替代率与投资收益率呈现正相关的关系，所以，在目前市场低利率的情况下，养老金的保值升值需要“稳中求进”，既需要稳健投资，更需要在稳健投资的方式中选择利率相对较高的产品。

表3　“新人”替代率测算表

| 替代率（%） | | 低收入（α=0.6） | 中收入（α=1） | 高收入（α=3） |
|---|---|---|---|---|
| 社会统筹养老金替代率 | r=3.5% | 57.6 | 42.9 | 28.6 |
| | r=8% | 57.6 | 42.9 | 28.6 |
| 个人账户养老金替代率 | r=3.5% | 1.08 | 1.08 | 1.08 |
| | r=8% | 10.44 | 10.44 | 10.44 |
| 基本养老金替代率 | r=3.5% | 58.68 | 43.98 | 29.68 |
| | r=8% | 68.04 | 53.34 | 39.04 |

表4　“中人”替代率测算表

| 替代率（%） | | 低收入（α=0.6） | 中收入（α=1） | 高收入（α=3） |
|---|---|---|---|---|
| 社会统筹养老金替代率 | r=3.5% | 45.47 | 34.1 | 22.73 |

| | | | | |
|---|---|---|---|---|
| | r=8% | 45.47 | 34.1 | 22.73 |
| 个人账户养老金替代率 | r=3.5% | 1.65 | 1.65 | 1.65 |
| | r=8% | 10.26 | 10.26 | 10.26 |
| 过渡性养老金替代料率 | r=3.5% | 10.4 | 10.4 | 10.4 |
| | r=8% | 10.4 | 10.4 | 10.4 |
| 基本养老金替代率 | r=3.5% | 57.52 | 46.15 | 34.78 |
| | r=8% | 66.13 | 54.76 | 43.39 |

## 3．厦门市个税递延养老保险补充作用测算

### 3.1 现行个税递延养老保险的补充作用测算

#### 3.1.1 个税递延养老保险替代率模型构建

因本文需要故只讨论在职职工的情况，在缴费环节，个人缴费允许税前扣除，月缴费扣除限额按照当月工资薪金、连续性劳务报酬收入的6%和1000元孰低者确定限额。在领取环节，领取额在扣除25%的免税额后按10%的比例税率计征个人所得税，税递延型养老年金的领取方式为保证返还账户价值终身月领或年领的方式、固定期限为15年或者20年，月领或年领的方式，根据厦门经济特区统计年鉴，厦门市的平均预期寿命是80.89岁，为便于测算，本文采取20年年领的方式进行测算。

目前我国对个人所得采取的是超额累进税制，根据《全国人民代表大会常务委员会关于修改“中华人民共和国个人所得税法”的决定》文件的指示，2019年1月1日起，个税起征点由原来的3500提升至5000，并施行新的税率政策。根据我国个人所得税法，个人所得税=应纳所得税×税率－速算扣除数，其中应纳所得税=个人收入－专项扣除－专项附加扣除－起征点，其中专项扣除一般是社保缴费和公积金缴费率。具体税率表如下表5。

表5 2020年个人所得税税率表

| 级数 | 全月应纳税所得额 | 税率 | 速算扣除数 |
|---|---|---|---|
| 1 | 不超过3000元的 | 3% | 0 |
| 2 | 超过3000元至12000元的部分 | 10% | 210 |
| 3 | 超过12000元至25000元的部分 | 20% | 1410 |
| 4 | 超过25000元至35000元的部分 | 25% | 2660 |
| 5 | 超过35000元至55000元的部分 | 30% | 4410 |
| 6 | 超过55000元至80000元的部分 | 35% | 7160 |
| 7 | 超过80000元的部分 | 45% | 15160 |

由于缴费环节采取个人工资6%和1000元孰低来确定，本文根据需要，采取其临界点16667元进行分类构建替代率模型。

3.1.1.1　月收入低于16667元的情况

投保后个人所得税额为：

$$T=\left[\frac{(1-\theta-6\%)S_0}{12}-5000\right]\mathrm{t}-\mathrm{Y} \tag{3.1}$$

其中T是个人所得税额，Y是速算扣除数，t是税率，S0是年个人工资收入，θ是社保和公积金缴费率。

投保人退休前保费积累值为：

$$V(\mathrm{n})=6\%\mathrm{S}_0\frac{(1+r)^n-1}{r} \tag{3.2}$$

其中r是养老金的年收益率，$V(\mathrm{n})$是n时刻的积累值

投保人退休后，年金享领额为：

$$P=\frac{V(\mathrm{n})-V(\mathrm{n})\times75\%\times10\%}{a_{\overline{20}|}}=\frac{92.5\%\times V(\mathrm{n})\times r}{1-\frac{1}{(1+r)^{20}}} \tag{3.3}$$

综合公式3.1，公式3.2，公式3.3可得，月收入低于16667元时的替代率为：

$$\lambda=\frac{P}{S_0(1+g)^{n-1}\times(1-\theta-6\%)-T\times12} \tag{3.4}$$

3.1.1.2　月收入高于16667（含）元的情况

投保后个人所得税额为：

$$T=\left[\frac{(1-\theta)S_0}{12}-6000\right]\mathrm{t}-\mathrm{Y} \tag{3.5}$$

投保人退休前保费积累值为：

$$V(\mathrm{n})=12000\frac{(1+r)^n-1}{r} \tag{3.6}$$

投保人退休后，年金享领额为：

$$P=\frac{V(\mathrm{n})-V(\mathrm{n})\times75\%\times10\%}{a_{\overline{20}|}}=\frac{92.5\%\times V(\mathrm{n})\times r}{1-\frac{1}{(1+r)^{20}}} \tag{3.7}$$

综合公式3.5，公式3.6，公式3.7可得，月收入高于16667（含）元时的个税递延养老保险替代率为：

$$\lambda=\frac{P}{S_0(1+g)^{n-1}\times(1-\theta)-T\times12-12000} \tag{3.8}$$

由公式3.4和公式3.8可知，在工资增长率g，养老金的年收益率r，缴费年限n，社保和公积金缴费率$\theta$已知的情况下，可测算个税递延养老保险的替代率。

3.1.2　参数选取

根据本文第三章的内容，将人群划分为“新人”和“中人”，分别从低收入、中收入、高收入三个方面进行测算。本章同样采取第三章的方式进行测算。按照前

文的假设，“新人”群体中投保年龄32岁，退休年龄是60岁。“中人”群体中投保年龄是52岁，退休年龄是60岁。根据文章第三章的内容，厦门市的在职职工工资增长率g按照10%来进行测算。

根据我国年度企业年金基金业务数据摘要显示，2016年到2019年，我国企业年金投资收益率分别为 3.03%，5%，3.01%，8.29%。2019年8月30日《关于完善人身保险业责任准备金评估利率形成机制及调整责任准备金评估利率有关事项的通知（〔2019〕182号）》表明4.025%预定利率年金产品将成为绝唱。未来保证收益产品利率将大幅下降为3.5%。所以，本文的养老金收益率为3.5%进行测算。

根据厦门市五险一金的缴费比例，其中需要个人缴费的有养老保险8%，医疗保险2%，失业保险1%，住房公积金8%，所以本文的θ用19%来测算。

根据《厦门经济特区统计年鉴2020》数据显示，2019年厦门市在岗职工的年平均工资是97779元，参保人月平均工资取值8148元。2020年，厦门市社保缴费基数的上限是24444元，下限是4888.8元。

### 3.1.3 个税递延养老保险的补充测算结果分析

个税递延型养老保险的补充测算结果见表6和表7。从表中可以得出以下结论：

#### 3.1.3.1 补充效果微弱

个税递延养老保险对基本养老保险的补充作用效果甚微。通过测算结果我们可以发现，对于“新人”群体和“中人”群体，无论是中收入还是高收入的人群，个税递延养老险的替代率都是非常低的，只能维持在1%-2.5%。总和替代率也大致维持在温饱水平，无法保障老年人退休后的需求。相比较于第一支柱养老保险的替代率，个税递延养老保险的替代率占比非常低，对养老保险的贡献大多不到5%，只有“中人”群体中中收入的人群达到了5%，出现此现象表明个税递延养老保险未能发挥有效价值、补充作用太过微弱，导致我国的基本养老保险还是处于主要的位置，长此以往下去，我国的基本养老保险基金可持续性令人堪忧。因此，我国养老保险的发展需要商业养老保险作为补充，通过养老支柱多样化提高养老金的充足性。

#### 3.1.3.2 低收入群体无法受益

税收优惠政策的人群覆盖面有限，效果未达到预期水平。2019年起，新的个税政策实施以后，个税起征点提高到5000元，以厦门市为例，2019年的月平均工资是8148元，按照月平均工资为基数乘以系数0.6，即月收入4889的低收入群体是免征个人所得税的，税延政策对于这部分群体没有任何优惠作用，所以，税延政策难以调动低收入群体的投保积极性。只有所有的高收入群体，才能真正的享受到税延优惠政策，然对于部分中收入群体，如果扣除五险一金后剩余的金额也不足以缴纳个人所得谁的情况下，依然享受不到税延优惠政策，所以只有部分中收入群体才能受益。

#### 3.1.3.3 对养老金的投资收益率有一定的要求

本节按照3.5%的利率进行的测算结果中，个税递延养老保险的替代率也是非常低的。在目前低利率市场环境下，利率还有可能继续降低。根据公式不难发现利率与个税递延养老保险的替代率呈现正相关关系，所以个税递延养老保险的替

代率可能进一步降低。所以，如上文所说，养老金的保值升值需要“稳中求进”，既需要稳健投资，更需要保证养老金的投资收益率。

表6 “新人”个税递延养老险补充作用测算表

| 替代率（%） | 低收入（4889） | 中收入（8148） | 高收入（24444） |
|---|---|---|---|
| 个税递延养老金替代率 | - | 1.84 | 1.17 |
| 基本养老金替代率 | 58.68 | 43.98 | 29.68 |
| 总和养老金替代率 | 58.68 | 45.82 | 30.85 |
| 补充占比 | 0 | 4.02 | 3.79 |

表7 “中人”个税递延养老险补充作用测算表

| 替代率（%） | 低收入（4889） | 中收入（8148） | 高收入（24444） |
|---|---|---|---|
| 个税递延养老金替代率 | - | 2.43 | 1.63 |
| 基本养老金替代率 | 57.52 | 46.15 | 34.78 |
| 总和养老金替代率 | 57.52 | 48.58 | 36.41 |
| 补充占比 | 0 | 5.00 | 4.48 |

## 3.2 现行个税递延养老保险优化后的补充作用测算

### 3.2.1 提高个税递延限额

#### 3.2.1.1 个税递延养老保险替代率模型构建

假设税延优惠额度为X,其他假设同文章4.1.1部分。

投保后个人所得税额为：

$$T=\left[\frac{(1-\theta)S_0}{12}-5000-\mathrm{X}\right]\mathrm{t}-\mathrm{Y} \tag{3.9}$$

投保人退休前保费积累值为：

$$V_{(\mathrm{n})}=12\mathrm{X}\frac{(1+r)^n-1}{r} \tag{3.10}$$

投保人退休后，年金享领额为：

$$P=\frac{V(\text{n})-V(\text{n})\times 75\%\times 10\%}{a_{\overline{20}|}}=\frac{92.5\%\times V(\text{n})\times r}{1-\frac{1}{(1+r)^{20}}} \tag{3.11}$$

综合公式3.9，公式3.10，公式3.11可得，个税递延养老保险替代率为：

$$\lambda=\frac{P}{S_0(1+g)^{n-1}\times(1-\theta)-T\times 12-12\mathrm{X}} \tag{3.12}$$

由公式3.12可知，在工资增长率g，养老金的年收益率r，缴费年限n，社保和公积金缴费率$\theta$已知的情况下，可测算个税递延养老保险的替代率。

3.2.1.2 参数的选取

因本小节要研究税延优惠额度提高之后的个税养老保险的补充作用，现假设税收优惠额度分别提升至1500元、5000元、10000元，因此X的取值分别1500、5000、10000。其他参数的选取同文章3.1.2部分。

3.2.1.3 个税递延养老保险的补充测算结果分析

个税递延型养老保险的补充测算结果见表8和表9。从表中可以得出以下结论：

（1）个税递延优惠额度提升使得补充作用大大增强

综合表3.4、表3.5的测算结果，我们可以发现，当税收优惠额度提升时，对于不同收入的人群，无论“新人”群体还是“中人”群体，个税递延养老保险的补充作用大幅提升，由原来的不到2.5%提升至最高20.81%。随着税延优惠额度的增加，补充作用效果更加明显。例如表3.5中的高收入群体，税收优惠额度是1500元时，税延养老险替代率是2.47%，当税延优惠额度提升至5000元，税延养老险替代率提升至8.98%，当税延优惠额度提升至10000元，税延养老险替代率提升至20.81%。中收入群体也是类似的情况，但税收优惠额度增加到5000元与10000元时，由于中收入群体收入有限，因此无法试用税延5000元、10000元的政策。所以，增加税收优惠的额度，是改善个税递延养老保险补充作用效果的重要途经之一，但也不可一味地增加。

（2）个税递延优惠额度提升对不同群体的补充作用存在差异

“中人”群体的补充作用相较于“新人”群体提升幅度更为明显。由表3.4可知，对于“新人”群体来说，若税延优惠额度提升至1500元，中收入群体的税延养老险替代率是5.32%，提升了189.13%。高收入群体的替代率是1.76%，提升了50.42%。而对于“中人”群体来说，若税收优惠额度提升至1500，中收入群体的税延养老险替代率是7.78%，提升了220.16%。高收入群体的税延养老险替代率是2.47%，提升了51.53%。按照中收入群体和高收入群体来划分，中收入群体更加受益。究其原因，本文是基于税延优惠额度直接抵扣1500元的标准作为假设来进行研究，若考虑按照当月工资薪金的6%和1500元较低者确定限额，那么临界值变成25000元，而本文将平均工资的3倍作为高收入群体的代表，远低于临界值25000元，而此时只能用平均工资的6%进行抵扣，所以无论优惠额度是1500、5000还是10000元，都只能按照平均工资的6%进行抵扣，替代率不会改变。本文为了研究增加税收优惠抵扣额度对个税递延养老保险补充作用的影响，特假设直接将税延优惠额度进行抵扣。所以，高收入群体和中收入群体抵扣的额度是一样的，高收入群体的收入基数大，所以高收入群体税延养老险的替代率比中收入群体低。按照“新人”“中人”划分，“中人”群体更加受益。这是因为本文假设的工资增长率是

10%，虽然“新人”群体积累的养老金较多，但由于工资增长率的作用，使得“新人”退休前一年的工资水平也相对较高，扣除相对应的保费在其工资收入中所占的比重不大，而“中人”群体恰恰相反，扣除的保费在其工资收入中占的比重很大，使得“中人”养老金替代率的分子相对较小，所以“中人”比“新人”更加受益。

表8 “新人”个税递延养老险补充作用测算表

| 替代率（%） | 低收入（4889） | | | 中收入（8148） | | | 高收入（24444） | | |
|---|---|---|---|---|---|---|---|---|---|
| 税收优惠额度 | 1500 | 5000 | 10000 | 1500 | 5000 | 10000 | 1500 | 5000 | 10000 |
| 个税递延养老金替率 | - | - | - | 5.32 | - | - | 1.76 | 5.94 | 12.08 |
| 基本养老金替代率 | 58.68 | 58.68 | 58.68 | 43.98 | 43.98 | 43.98 | 29.68 | 29.68 | 29.68 |
| 总和养老金替代率 | 58.68 | 58.68 | 58.68 | 49.30 | 43.98 | 43.98 | 31.44 | 35.62 | 41.76 |
| 补充占比 | 0 | 0 | 0 | 10.79 | 0 | 0 | 5.60 | 16.68 | 28.93 |

表9 “中人”个税递延养老险补充作用测算表

| 替代率（%） | 低收入（4889） | | | 中收入（8148） | | | 高收入（24444） | | |
|---|---|---|---|---|---|---|---|---|---|
| 税收优惠额度 | 1500 | 5000 | 10000 | 1500 | 5000 | 10000 | 1500 | 5000 | 10000 |
| 个税递延养老金替率 | - | - | - | 7.78 | - | - | 2.47 | 8.98 | 20.81 |
| 基本养老金替代率 | 57.52 | 57.52 | 57.52 | 46.15 | 46.15 | 46.15 | 34.78 | 34.78 | 34.78 |
| 总和养老金替代率 | 57.52 | 57.52 | 57.52 | 53.93 | 46.15 | 46.15 | 37.25 | 43.76 | 55.59 |
| 补充占比 | 0 | 0 | 0 | 14.43 | 0 | 0 | 6.63 | 20.52 | 37.43 |

### 3.2.2 提高养老金收益率

#### 3.2.2.1 个税递延养老保险替代率模型构建和参数选取

因本小节主要研究的内容是税延养老险的投资收益率r提升至8 %后，厦门市个税递延型养老保险补充作用研究，由于是建立在文章3.1的基础上，且此小节的模型同以上4.1.1的内容，所以模型构建即公式3.4，3.8。

3.2.2.2 参数的选取

根据本小节的研究内容，假设养老金年收益率r是8%，其他参数的选取同文章3.1.2部分。

3.2.2.3 个税递延养老保险的补充测算结果分析

个税递延型养老保险的补充测算结果见表3.6和表3.7。从表中可以得出以下结论：

（1）投资收益上升使得补充作用有所增强

综合表10、表11的测算结果，我们可以发现，当养老金的投资收益率提升时，无论是“新人”群体还是“中人”群体，对于不同收入的人群，个税递延养老保险的补充作用都有小幅的提升。从表4.6中我们可以发现，在“新人”群体中，对于高收入群体，当养老金投资收益率提升至8%时，个税递延养老保险的补充作用由1.17%提升至3.49%，略有提升；对于中收入群体，当养老金投资收益率提升至8%时，个税递延养老保险的补充作用由1.84%提升至5.48%，有明显的较大幅度的提升。从表3.7中我们可以发现，对于中收入群体和高收入群体，税延养老险的补充作用效果略有提升，但效果不是非常明显。我们可以发现，当养老金投资收益率提升至8%时，虽然个税递延养老保险的补充作用有所提升，但提升幅度较小，相比较于文章上文提到的提高税收优惠额度所带来的增加效果，显然是微弱的，而且养老保险的投资原则就是建立在稳定的基础上，不可能冒很大风险去追求更高的投资收益。所以，要提高个税递延养老保险的替代率，增大其对基本养老保险的补充作用，仅仅靠提升养老保险金的投资收益率是不够的，还需要与增加税收优惠额度的政策共同作用。

（2）投资收益率上升对“新人”补充作用优于“中人”

通过表3.6和3.7我们可以发现，不论是中收入群体还是高收入群体，养老金投资收益率上升对“新人”群体的补充作用优于“中人”群体。这是因为养老金投资收益率主要影响的是养老金的积累值从而影响养老金的年金享领值，且呈现出正相关的关系，因为本文中“新人”比“中人”多缴费20年，所以最后得出“新人”的税延养老险替代率高于“中人”群体。

表10 “新人”个税递延养老险补充作用测算表

| 替代率（%） | 低收入（4889） | | 中收入（8148） | | 高收入（24444） | |
|---|---|---|---|---|---|---|
| | r=3.5% | r=8% | r=3.5% | r=8% | r=3.5% | r=8% |
| 个税递延养老金替代率 | - | - | 1.84 | 5.48 | 1.17 | 3.49 |
| 基本养老金替代率 | 58.68 | 68.04 | 43.98 | 53.34 | 29.68 | 39.04 |
| 总和养老金替代率 | 58.68 | 68.04 | 45.82 | 58.82 | 30.85 | 42.53 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 补充占比 | 0 | 0 | 4.02 | 9.32 | 3.79 | 8.21 |

表11 “中人”个税递延养老险补充作用测算表

| 替代率（%） | 低收入（4889） | | 中收入（8148） | | 高收入（24444） | |
|---|---|---|---|---|---|---|
| | r=3.5% | r=8% | r=3.5% | r=8% | r=3.5% | r=8% |
| 个税递延养老金替代率 | - | - | 2.43 | 4.13 | 1.63 | 2.77 |
| 基本养老金替代率 | 57.52 | 66.13 | 46.15 | 54.76 | 34.78 | 43.39 |
| 总和养老金替代率 | 57.52 | 66.13 | 48.58 | 58.89 | 36.41 | 46.16 |
| 补充占比 | 0 | 0 | 5.00 | 7.01 | 4.48 | 6.00 |

### 3.2.3 降低领取期个人所得税税率

#### 3.2.3.1 个税递延养老保险替代率模型构建

因本小节主要研究的内容是领取阶段降低税费，50%予以免税，其他部分按照10%、8%的税率征收个人所得税，那么个人领取时实际缴纳的税费是5%，4%，厦门市个税递延养老保险的补充作用效果研究，所以本小节的模型同文章4.1.1的内容，只是公式在4.3和4.7上有所改变，其他公式没有变化。新的公式如下：

$$P=\frac{V_{(n)}-V_{(n)}\times M}{a_{\overline{20|}}}=\frac{(1-M)\times V_{(n)}\times r}{1-\frac{1}{(1+r)^{20}}} \tag{3.13}$$

其中M是领取阶段实际缴纳的个人所得税税率。

#### 3.2.3.2 参数的选取

根据本小节的研究内容，M分别假设为5%，4%，其他参数的假设同文章3.1.2部分。

#### 3.2.3.3 个税递延养老保险的补充测算结果分析

个税递延型养老保险的补充测算结果见表3.8和表3.9。从表中可以得出以下结论：

根据测算结果，我们可以发现，领取阶段税率改变时，个税递延养老保险的替代率并没有发生巨大的变化。从表3.8中可以发现，对于高收入群体，领取阶段50%予以免税的情况下，剩余部分按照10%和8%的税率纳税，并没有大幅改变税延养老险的替代率，仅从1.17%提升至1.21%。而中收入群体中，变化也仅仅从1.84%提升到1.91%。表3.9也是类似的情况。所以得出结论，改变领取阶段的

税率，养老金替代率虽有提升效果，但作用效果微弱。仅仅靠改变领取阶段的领取税率是行不通的，还需结合其他政策共同作用。

表12 “新人”个税递延养老险补充作用测算表

| 替代率（%） | 低收入（4889） | | | 中收入（8148） | | | 高收入（24444） | | |
|---|---|---|---|---|---|---|---|---|---|
| 领取阶段实际税率（%） | 7.5 | 5.0 | 4.0 | 7.5 | 5.0 | 4.0 | 7.5 | 5.0 | 4.0 |
| 个税递延养老金替代率 | - | - | - | 1.84 | 1.89 | 1.91 | 1.17 | 1.20 | 1.21 |
| 基本养老金替代率 | 58.68 | 58.68 | 58.68 | 43.98 | 43.98 | 43.98 | 29.68 | 29.68 | 29.68 |
| 总和养老金替代率 | 58.68 | 58.68 | 58.68 | 45.82 | 45.87 | 45.89 | 30.85 | 30.88 | 30.89 |
| 补充占比 | 0 | 0 | 0 | 4.02 | 4.12 | 4.16 | 3.79 | 3.89 | 3.93 |

表13 “中人”个税递延养老险补充作用测算表

| 替代率（%） | 低收入（4889） | | | 中收入（8148） | | | 高收入（24444） | | |
|---|---|---|---|---|---|---|---|---|---|
| 领取阶段实际税率（%） | 7.5 | 5.0 | 4.0 | 7.5 | 5.0 | 4.0 | 7.5 | 5.0 | 4.0 |
| 个税递延养老金替代率 | - | - | - | 2.43 | 2.50 | 2.52 | 1.63 | 1.67 | 1.69 |
| 基本养老金替代率 | 47.12 | 47.12 | 47.12 | 46.15 | 35.75 | 35.75 | 34.78 | 24.38 | 24.38 |
| 总和养老金替代率 | 47.12 | 47.12 | 47.12 | 48.58 | 38.25 | 38.27 | 36.41 | 26.05 | 26.07 |
| 补充占比 | 0 | 0 | 0 | 5.00 | 6.53 | 6.59 | 4.48 | 6.43 | 6.49 |

3.2.4 多种因素综合作用

上文3.2.1、3.2.2、3.2.3分别研究了单一因素作用下，税延养老险的作用效果变化。为了研究将以上三种效果共同作用，税延养老险的作用效果变化。本节内容分别提高个税递延限额至1500、5000、10000元，提高养老金的投资收益率至8%，降低领取阶段的税率，使得实际缴纳税率为5%、4%，综合得出个税递延养老保险的优化效果测算结果。

根据下表14、15中的测算结果，我们可以发现：

（1）补充作用效果大幅提升

三种方式共同作用下，税延养老险的补充作用效果有明显提升，个税递延养老保险的替代率从之前的不足2.5%，最高提升至37.39%，补充占比高达48.92，此时的总和替代率已经高达76.43%。对于高收入群体，不管“中人”还是“新人”群体，可以发现，当税延优惠额度是1500元时，其他值不变，个税递延养老金的替代率是偏低的，只有5%左右，那么总和养老金替代率也不足55%，在警戒线以下，说明此时的税延优惠额度不足以满足高收入群体的需要，还需提高额度。而此时的中收入群体的总和替代率已接近70%，大致能维持退休前的生活水平，所以在制定政策时，可以按照不同收入群体进行差别优惠额度抵扣。

从表3.10可以发现，对于不同收入群体，个税递延养老金的替代率与税延优惠额度、养老金收益率呈正比的关系，税延优惠额度越高、养老金的收益率越高，个税递延养老金替代率越高；个税递延养老金替代率与领取阶段实际税率呈反比的关系。由于中收入群体以厦门市平均工资8148元作为测算值，税延优惠额度提升至5000元和10000元时由于收入有限就不再考虑。表3.11也呈现出类似的情况，本文就不再一一赘述。

（2）补充效果对中收入群体优于高收入群体

通过测算结果可以发现，在税延优惠额度、养老金收益率、领取阶段实际税率保持一致时，中收入群体的补充作用效果优与高收入群体。如表3.10中的税延优惠额度为1500，养老金收益率为8%，领取阶段的实际税率为5%时，中收入群体的税延养老金替代率提高14.44%，高收入群体的税延养老金替代率提高4.22%，补充作用效果相对较弱。之所以会产生此现象，是由于税延优惠额度在三种方式中处于主导地位，当税收优惠额度是1500元时，在中收入群体和高收入群体中的收入占比是不同的，在中收入群体中的收入占比较高，相当于缴费的比例更高，多缴多得，所以税延养老金的替代率更高，反之较低。所以如上文所说，在政策实施时，税收优惠额度要进行差别抵扣。

表14 “新人”个税递延养老险补充作用测算表

| 替代率（%） | 中收入（8148） | | | | | | |
|---|---|---|---|---|---|---|---|
| 税延优惠额度 | 488.88 | 1500 | 5000 | 10000 | 1500 | 5000 | 10000 |
| 养老金收益率（%） | 3.50 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 |
| 领取阶段实际税率（%） | 7.5 | 5.0 | 5.0 | 5.0 | 4.0 | 4.0 | 4.0 |
| 个税递延养老金替代率 | 1.84 | 16.28 | - | - | 16.45 | - | - |
| 基本养老金替代率 | 43.98 | 53.34 | 53.34 | 53.34 | 53.34 | 53.34 | 53.34 |
| 总和养老金替代率 | 45.82 | 69.62 | 53.34 | 53.34 | 69.79 | 53.34 | 53.34 |
| 补充占比 | 4.02 | 23.38 | 0 | 0 | 23.57 | 0 | 0 |
| 替代率（%） | 高收入（24444） | | | | | | |
| 税延优惠额度 | 1000 | 1500 | 5000 | 10000 | 1500 | 5000 | 10000 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 养老金收益率（%） | 3.50 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 |
| 领取阶段实际税率（%） | 7.5 | 5.0 | 5.0 | 5.0 | 4.0 | 4.0 | 4.0 |
| 个税递延养老金替代率 | 1.17 | 5.39 | 18.17 | 37.00 | 5.45 | 18.36 | 37.39 |
| 基本养老金替代率 | 29.68 | 39.04 | 39.04 | 39.04 | 39.04 | 39.04 | 39.04 |
| 总和养老金替代率 | 30.85 | 44.43 | 57.21 | 76.04 | 44.49 | 57.40 | 76.43 |
| 补充占比 | 3.79 | 12.13 | 31.76 | 48.66 | 12.24 | 31.99 | 48.92 |

表15 “中人”个税递延养老险补充作用测算表

| 替代率（%） | 中收入（8148） | | | | | | |
|---|---|---|---|---|---|---|---|
| 税延优惠额度 | 488.88 | 1500 | 5000 | 10000 | 1500 | 5000 | 10000 |
| 养老金收益率（%） | 3.50 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 |
| 领取阶段实际税率（%） | 7.5 | 5.0 | 5.0 | 5.0 | 4.0 | 4.0 | 4.0 |
| 个税递延养老金替代率 | 2.43 | 13.59 | - | - | 13.73 | - | - |
| 基本养老金替代率 | 46.15 | 54.76 | 54.76 | 54.76 | 54.76 | 54.76 | 54.76 |
| 总和养老金替代率 | 48.58 | 68.35 | 54.76 | 54.76 | 68.49 | 54.76 | 54.76 |
| 补充占比 | 5.00 | 19.88 | 0 | 0 | 20.05 | 0 | 0 |
| 替代率（%） | 高收入（24444） | | | | | | |
| 税延优惠额度 | 1000 | 1500 | 5000 | 10000 | 1500 | 5000 | 10000 |
| 养老金收益率（%） | 3.50 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 |
| 领取阶段实际税率（%） | 7.5 | 5.0 | 5.0 | 5.0 | 4.0 | 4.0 | 4.0 |
| 个税递延养老金替代率 | 1.63 | 4.31 | 15.68 | 36.35 | 4.36 | 15.85 | 36.73 |
| 基本养老金替代率 | 34.78 | 43.39 | 43.39 | 43.39 | 43.39 | 43.39 | 43.39 |
| 总和养老金替代率 | 36.41 | 47.70 | 59.07 | 79.74 | 47.75 | 59.24 | 80.12 |
| 补充占比 | 4.48 | 9.04 | 26.54 | 45.59 | 9.12 | 26.75 | 45.85 |

## 4．发展个税递延养老保险的政策建议

### 4.1 适度扩大个税递延税收优惠额度

目前我国个税递延养老保险的试点情况并不乐观，其中主要原因就是税收优惠抵扣额度较低，民众投保的积极性不高。试点期间，对于个人而言，月缴费扣除限额按照当月工资的6%和1000元孰低者确定扣除限额。通过测算结果可以发现，目前情况下的个税递延养老保险的补充作用是很微弱的，所以，建议提高免税限额标准，加大优惠力度，对1000元的上限进行上调。文章也对增加税收优惠额度进行了测算，当税收优惠额度提升至1500、5000、10000元时，个税递延养老保险的补充作用效果有明显的提升。但也不可一味的增加，通过测算结果我们可以发现，当税收优惠额度提升至10000元时，中收入群体也无法享受10000元的税收优惠额度。所以，应考虑采取“阶梯性免税限额”，按照个人收入水平划分档次，确定不同收入人群投保的最高限额，确保中等收入群体和无固定收入群体能获得更大的税优幅度；此外，在确保免税限额梯度区间相对公平的前提下，允许高收入群体有更高的扣除上限，兼顾效率与公平，进一步调动不同收入水平消费者投保或续保的积极性。

### 4.2 提高养老金投资收益率

本文通过测算，当养老金投资收益率为8%时,个税递延养老保险的替代作用效果略微有所提升，但没有增加税收优惠额度所带来的效果明显，而且我国目前处于低利率的时代，未来利率有可能进一步降低，所以养老金的保值升值需要“稳中求进”，既需要稳健投资，更需要保证养老金的投资收益率。除此之外，仅仅靠提高养老金投资收益率是不足以改善个税递延养老保险的补充作用效果，还需要搭配其他的政策共同实施。

### 4.3 适当降低领取阶段个人所得税税率

通过测算，发现降低领取阶段的税率对税延养老险的替代率作用效果甚微，但我们可以通过适当降低税率，增加投保人的积极性。尤其是对于被保险人出现重疾、身故或全残情况，建议领取时免征个人所得税。除此之外，建议结合其他政策比如增加税收优惠额度共同作用，以提高税延养老险的替代率。

试点期间，税延养老险的领取方式限制还是较多的。建议采取较为灵活的领取方式，例如在投保人有需求时，可依照自己需求领取账户内的额度。从而发挥商业养老保险个人账户的优势，提升税延养老险的吸引力。

### 4.4 税收递延优惠应与低收入群体补贴相结合

国民收入的多样化决定了税收优惠政策的多样化。通过实证分析我们可以发现，无论是提高税延优惠额度还是增加养老金投资收益率，对于低收入群体来说，都没有享受到优惠。低收入群体的月平均收入不足以当月扣除个人所得税，而我国目前的试点地区是较为发达地区，相对于其他欠发达地区，低收入群体是相对较少的，也就是说如果进一步扩大试点地区，将有更多的人无法享受税优政策。所以，为了提高政策的普惠性，应采用税收递延优惠与低收入群体补贴相结合的形式，通过对特定低收入人群进行资助，缩小不同收入群体由于养老金不同而带来的差距，一定程度上也促进了社会和谐。维护社会稳定。以德国为例，“李斯特养老金”采取直接补贴与税收优惠相结合的方式，这一政策兼顾效率与公平，对低收入群体非常友好，极大的激发了民众的投保热情。推行5年的时间，其覆盖范围已超过企业年金，成为养老保险中的重要支柱。2019年，我国的个税起征点进一步上调，导致更多的低收入群体享受不到税延政策，所以，我国可以借鉴

德国的“李斯特养老金”模式，对低收入群体给与一定的直接补贴，让低收入群体受益，从而提高政策的普惠性，促进社会公平。

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# 厦门市个税递延养老保险对基本养老保险补充作用研究

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**关键词：**税收递延；基本养老保险；替代率；补充

**中文摘要.** 本文选取了厦门市作为研究对象，对个税递延养老保险的补充作用进行研究。本文共分四个部分。第一章对人口老龄化、养老体系面临压力以及城镇职工的替代率水平低大背景作出阐述。第二章通过模拟厦门市城镇职工基本养老保险案例进行替代率测算，凸显出我国现行基本养老保险无法满足总和替代率需求、第二三支柱有巨大增长空间等问题，引出第四章的补充作用测算。第三章首先对现行制度下个税递延养老保险的替代率进行测算，得出了我国现行的个税递延养老保险的补充作用微小、低收入群体无法享受优惠的结论。此外，对税收优惠额度、养老金投资收益率和领取阶段实际缴纳税率进行了优化，并进行了多种组合，发现税延优惠额度在10000元、养老金投资收益率是8%、领取阶段实际缴纳税率为4%时，总和养老保险的替代率达到80.12%。第五章在此基础上提出了建议，一是适度扩大个税递延税收优惠额度；二是尽量提高养老金投资收益率；三是适当降低领取阶段个人所得税税率；四是税收递延优惠应与低收入群体补贴相结合。

# A Study on the Impact of Delayed Retirement on the Employees' and Residents' Pension Wealth

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**Keywords:** Aging Population, Delay Retirement, Pension WealthBasic, Retirement Insurance.

**Abstract.** In the context of increasing social aging, declining birth rate, increasing average life expectancy, and imbalance in the income and expenditure of the basic social pension insurance fund, adjusting the pension age is an inevitable choice to

maintain the sustainable operation of the social public safety. Therefore, the establishment of a pension wealth model and a pension wealth impact rate model for employees and residents using numerical simulation methods, assess the impact of the delayed pension age on personal pension wealth.The results show that postponing retirement age will reduce the pension income of male workers, but not the pension income of female workers, and that delaying the pension age will cause the loss of the pension wealth of male residents, rather than the loss of female residents' pension wealth. It is suggested to improve the basic pension scheme, take the contributory years into account in the adjustment of the basic pension, adjust the interest rate of personal account bookkeeping, and set the flexible retirement age range.

## 1. Introduction

In order to adapt to the changes in the demographic structure of China and reduce the financial pressure on pension expenditures, delaying the retirement age has been put on the agenda as an important measure in the reform of the pension system. *The lawmakers also approved the Outline of the 14th Five-Year Plan (2021-2025) for National Economic and Social Development and the Long-Range Objectives Through the Year 2035,* clearly propose to implement a gradual delay in the statutory retirement age. Given that the problem of China's population aging is serious, it is inevitable to delay the pension age of urban and rural residents in the future[①]. Therefore, this paper constructs a pension wealth model and a pension wealth impact model for the "New Urban and Rural Residents" and "Middle Employees" to study this question. Taking into account the income growth rate, the average life expectancy of the population, the basic pension calculation standard and other factors, this paper study the impact of the implementation of the delayed pension policy on the pension wealth of urban workers and urban and rural residents, so as to provide theoretical support for the setting of the delayed age and the modification of the basic pension calculation parameters. It is of great practical significance to promote the formulation of China's "gradual delay in retirement" policy and further consolidate the social basic pension insurance system.

The following arrangements are as follows: the second part is a review of domestic and foreign literature; the third part is the research on the impact of delayed retirement on the pension wealth of employees; the fourth part is the research on the impact of delayed retirement on the pension wealth of residents; the fifth part is the research conclusion and recommendations.

## 2. Literature review at home and abroad

Domestic and foreign scholars' research on delayed retirement mainly focuses on three aspects: the study of delayed retirement plan, the study of delayed retirement on pension balance and the study on the impact of delayed retirement on pension wealth.

The problem of deepening social aging was the first to appear in developed countries, and foreign scholars have had rich research results on delayed retirement plans. Friedberg and Webb believe that different pension plans will affect employees' choice of retirement age[1]. Kalemli-Ozcan and Weil construct an employee selection model in which employees make choices about their labor and leisure in their lives when the age of death is uncertain. The results show that the reduction in mortality can affect the transformation of labor supply patterns during the life cycle of individuals[2]. Díaz-Giménez and Díaz-Saavedra construct a general equilibrium intergenerational overlap model to quantitatively analyze the reform effects of the

① *5 major changes set for pension insurance system*
http://english.www.gov.cn/policies/policy_watch/2018/04/02/content_281476099079092.htm

Spanish public pension system. They find that the reform measures to postpone the statutory retirement age by three years in 2010 are sufficient to solve the sustainability issues that plagued Spain's public pension system[3]. Lacomba and Lagos believe that postponing the statutory retirement age is a powerful reform measure to solve the financing problem of the public pension system[4].

Since the 21st century, whether China should implement a delayed retirement plan, how to formulate a delayed retirement plan, and the impact of delayed retirement on personal pension wealth have attracted the attention of domestic and foreign scholars. James Estelle points out that China should use actuarial methods to scientifically and rigorously calculate the delayed retirement age in line with China's national conditions[5]. Yang Yinan establishes an actuarial model of personal basic pension wealth and finds that the space for postponing the retirement age of male and female employees is limited. Compared with male employees, the postponement space of female employees is relatively large[6]. Li Xiaohe and Yin Jun analyze the difference between personal choice and government choice through a model. They argue that the implementation of the delayed retirement policy cannot attend to trifles and neglect the essentials, and blindly rely on retirement reform to solve the social pension gap problem. The formulation and promotion of the policy should take into account the wishes of the people and social reality[7]. Lin Xi and Lin Yi believe that under the current pension system, both male and female workers will cause personal wealth loss due to delayed retirement, and the personal wealth loss of male workers is more obvious[8]. Feng Jin attempts to use a large sample of micro data from the perspectives of total pension wealth, total wealth of workers, and individual welfare to calculate the impact of delayed retirement policies on different types of workers[9].

From an overall point of view, when domestic scholars discuss the impact of postponement of employees' retirement age on their personal wealth, they mainly focus on the "New Urban and Rural Residents" in the employee system, while there is relatively little research on the pension wealth of the "Middle Employees", and lack of consideration of gender differences. Besides, there is little literature to explore the impact of urban and rural residents' delaying pension age on their personal pension benefits.

## 3. Study on the impact of delayed retirement on the pension wealth of employees

### 3.1 Basic assumptions and descriptions of the model

This chapter takes into account the development history of basic old-age insurance for enterprise employees, in conjunction with No. 26 Document of The State Council〔1997〕, *Decision of the State Council on the Establishment of a Unified Basic Pension Insurance System for Enterprise Employees*, and No. 38 document of The State Council〔2005〕, *The State Council's decision on improving the basic old-age insurance system for enterprise workers*, make the following

assumptions[①]:

(1) The research object of this chapter is "Middle Employees" of the employee system[②], which means that the total number of years of contribution of basic old-age insurance for employees of an enterprise has reached 15 years and that the time that the employee has been working in the work of the employee is before the promulgation and implementation of No. 26 document of The State Council（1997）, and the time of retirement is after the promulgation and implementation of document No. 38 document of The State Council（2005）.

(2) The pension wealth model of "Middle Employees" pension established in this section does not take into account the pension wealth of individual accounts[10、11].

(3) Assuming that employees start to pay basic endowment insurance after they are officially employed, there is no case of withholding basic endowment insurance.

(4) It is assumed that the rate of increase in the salary of employees is the same as that of the average salary of the employees in the previous year at the place where they work.

(5) This section uses data on the average life expectancy of the population.

(6)The actuarial value of pension wealth is discounted to the current statutory retirement age for male and female workers.

(7) The basic pension influence factors of male and female workers after retirement are not taken into account.

(8) It is assumed that the worker will be able to survive normal death after the average life expectancy of the population.

### 3.2 The "Middle Employees" wealth model and the wealth influence rate model

Men and women start to pay insurance premiums at the age of $a_{zg}$ and retire at the age of $r_{zg}$. The average life expectancy of the population is $e$. The adjustment proportion of social basic pension is $d$ proportion of the average annual salary growth rate of the previous year in the place where the employee works, $g_{zg}$ is the salary growth rate of the employee, and $\overline{\omega}_{r_{zg}-1}$ is the average social salary growth rate of the last year in the place where the employee retires.

The average contributory wage index $\overline{\delta}$ is calculated by the following formula:

$$\overline{\delta} = \left(R_1/\overline{R}_0 + R_2/\overline{R}_1 + \cdots + R_n/\overline{R}_{n-1}\right)/n. \tag{1}$$

In Eg. 1, $R_1, R_2, \cdots R_n$ is the average annual wage paid by employees after they participate in the basic endowment insurance; $n$ is the number of years for male and female employees to pay the basic endowment insurance; $\overline{R_0}, \overline{R_1}, \cdots \overline{R_{n-1}}$ is the annual standard of average social wage of on-duty employees in the previous year.

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① Chinese government website .The State Council's decision on improving the basic old-age insurance system for enterprise workers. [EB/0L].[2005-12-03]. http://www.gov.cn/zhengce/content/2008-03/28/content_7376.htm

② Individual industrialists and freelancers are not considered

Let $R_1 = \delta\overline{R_0}$, $\delta$ is the wage index of workers' contribution, and $\delta > 0$. According to Hypothesis (4) of the model in this chapter, the wage growth rate of employees and the average wage growth rate of employees in the previous year are both $g_{zg}$. According to Eg. 1, we can get:

$$\bar{\delta} = \left[\delta + \frac{1+g_{zg}}{1+g_{zg}}\cdot\delta + \cdots + \frac{\left(1+g_{zg}\right)^{n-1}}{\left(1+g_{zg}\right)^{n-1}}\right]\cdot\delta \Big/ n = \delta. \tag{2}$$

（1）Bridging pension$(P_t)_{r_{zg}}$

The employee system "Middle Employees" shall be regarded as the expends the fixed number of year for $Y_{1998} - a_{zg}$, β is the coefficient of planning and sending of transitional pension, refer to the No. 38 document of The State Council（2005）, the $(P_t)_{r_{zg}}$ obtained when the employee retires at the age of $r_{zg}$:

$$\left(P_t\right)_{r_{zg}} = \delta\overline{\omega}_{r_{zg}-1}\beta\left(Y_{1998}-a_{zg}\right)\sum_{k=0}^{e-r_{zg}-1} v^k. \tag{3}$$

When the retirement age is pushed back by n years, $(P_t)_{r_{zg}+n}$ is:

$$\left(P_t\right)_{r_{zg}+n} = \delta\overline{\omega}_{r_{zg}-1}\left(1+g_{zg}\right)^n\beta\left(Y_{1998}-a_{zg}\right)\sum_{k=0}^{e-r_{zg}-n-1} v^{k+n}. \tag{4}$$

（2）Basic pension$(P_b)_{r_{zg}}$

Referring to No. 38 document of The State Council（2005）, the $(P_b)_{r_{zg}}$ obtained by the employee when he retires at the age of $r_{zg}$:

$$\left(P_b\right)_{r_{zg}} = \frac{1}{2}\overline{\omega}_{r_{zg}-1}(1+\delta)\left(r_{zg}-a_{zg}\right)\sum_{k=0}^{e-r_{zg}-1}\left(1+dg_{zg}\right)^k v^k. \tag{5}$$

Where, $v = (1+r_2)^{-1}$, and $r_2$ is the discount rate.

When the retirement age is delayed by $n$ years, $(P_b)_{r_{zg}+n}$ is

$$\left(P_b\right)_{r_{zg}+n} = \frac{1}{2}\overline{\omega}_{r_{zg}-1}\left(1+g_{zg}\right)^n(1+\delta)\left(r_{zg}+n-a_{zg}\right)\%\sum_{k=0}^{e-r_{zg}-n-1}\left(1+dg_{zg}\right)^k v^{k+n}. \tag{6}$$

（3）Pension wealth$(PW)_{r_{zg}}$

Will $(P_b)_{r_{zg}}$ and sum $(P_t)_{r_{zg}}$, can be the worker system of pension wealth "Middle Employees" actuarial model $(PW)_{r_{zg}}$ :

$$(PW)_{r_{zg}} = \frac{1}{2}\bar{\omega}_{r_{zg}\text{-}1}(1+\delta)(r_{zg}-a_{zg})\% \sum_{k=0}^{e-r_{zg}-1}(1+dg_{zg})^{k} v^{k} + \delta\bar{\omega}_{r_{zg}-1}\beta(Y_{1998}-a_{zg})\sum_{k=0}^{e-r_{zg}-1} v^{k}. \tag{7}$$

Similarly, when the retirement age is pushed back by $n$ years,$(PW)_{r_{zg}+n}$ is:

$$\begin{aligned}(PW)_{r_{zg}+n} &= \frac{1}{2}\bar{\omega}_{r_{zg}\text{-}1}(1+g_{zg})^{n}(1+\delta)(r_{zg}+n-a_{zg})\% \sum_{k=0}^{e-r_{zg}-n-1}(1+dg_{zg})^{k} v^{k+n} \\ &+\delta\bar{\omega}_{r_{zg}\text{-}1}(1+g_{zg})^{n}\beta(Y_{1998}-a_{zg})\sum_{k=0}^{e-r_{zg}-n-1} v^{k+n}.\end{aligned} \tag{8}$$

The personal pension wealth of the "Middle Employees" under the present pensionable age is $(PW)_{r_{zg}}$, and the personal pension wealth after the pensionable age is delayed by $n$ years is $(PW)_{r_{zg}+n}$, and the wealth influence rate $\phi(n)_1$ is:

$$\phi(n)_1 = \frac{(PW)_{r_{zg}+n} - (PW)_{r_{zg}}}{(PW)_{r_{zg}}} \times 100\%. \tag{9}$$

### 3.3 Model The selection and setting of the Baseline parameter

(1) Samples selected 54-year-old female workers and 59-year-old male workers in 2020.

(2) Assuming that both male and female employees are 22 years old to participate in the work, the "retirement" age for male and female workers is 60 years and 5 years for female workers, respectively.

(3) The discount rate is 3%.

(4) Set by reference to No.21 document issued by the Ministry of Labour and Social Welfare（2006）. $d = 70\%$. The average contribution wage index for male and female workers is set at 1.

(5) Consider that China's entry into the new normal, future wages will not continue to grow at a high rate, assuming a future wage growth rate of 7 %.

(6) Assuming that the life expectancy of an employee is equivalent to the average life expectancy of the population, the age at which a female or male worker ends his or her life cycle is set is 80 years and 74 weeks, respectively.

(7) With reference to the relevant documents issued by the provinces and cities of the country, this section selects the transitional pension accounting factor of 1.2%.

### 3.4 Numerical simulation results and analysis

#### *3.4.1 Impact of delayed retirement on employee pension wealth under baseline conditions*

This section quantitatively studies changes in the personal pension wealth of male and female workers at different deferred ages. Bringing the baseline parameters

into the Eg. 9, the impact rate of pension wealth for individual workers and men is simulated, as shown in Table 1 and Fig. 1.

Table 1. Personal Pension Wealth Impact Rate for Male and Female Workers (benchmark) (units:%)

| Delay refund age | Male | Female |
|---|---|---|
| | 74 | 80 |
| 56 | - | 1.62 |
| 57 | - | 3.01 |
| 58 | - | 4.16 |
| 59 | - | 5.04 |
| 60 | - | 5.63 |
| 61 | -2.01 | 5.91 |
| 62 | -4.58 | 5.83 |
| 63 | -7.78 | 5.38 |
| 64 | -11.63 | 4.52 |
| 65 | -16.21 | 3.22 |
| 66 | -21.55 | 1.44 |
| 67 | -27.73 | -0.86 |
| 68 | -34.80 | -3.71 |
| 69 | -42.83 | -7.16 |
| 70 | -50.87 | -11.24 |
| 71 | -62.04 | -16.16 |
| 72 | -73.44 | -20.60 |
| 73 | -86.02 | -27.93 |
| 74 | - | -32.49 |

Table 1. Personal Pension Wealth Impact Rate for Male and Female Workers (benchmark) (units:%) (continued Table)

| Delay refund age | Male | Female |
|---|---|---|
| | 74 | 80 |
| 75 | - | -45.24 |
| 76 | - | -55.34 |
| 77 | - | -62.49 |
| 78 | - | -75.41 |
| 79 | - | -85.12 |

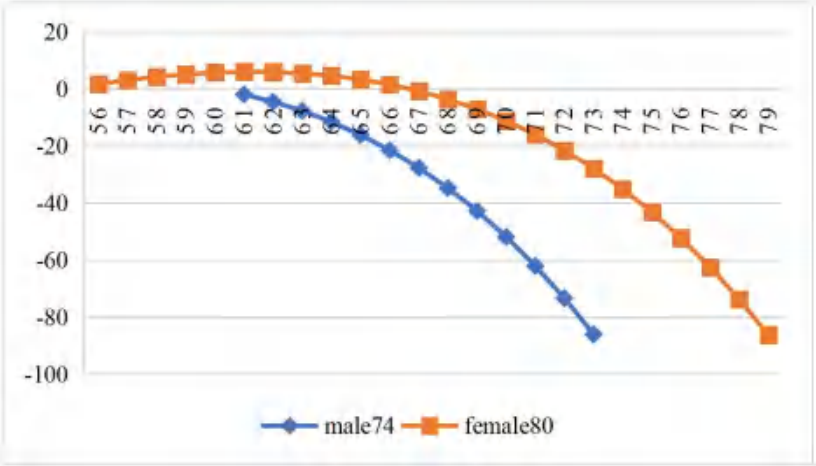


Fig. 1 Impact rate on pension wealth for individual workers and men(benchmark)

Observations of Table 1 and Fig.1 show that, under the baseline, when a male worker's retirement age is delayed by one year, the impact rate of pension wealth obtained as a result of the delay is -2.01%; the retirement age is delayed by 3 years with an impact rate of -7.78%; for male workers who have a delayed age of less than 6 years, the average loss rate of personal pension wealth due to the delay is approximately 3.55% for every 1 year of retirement age that is deferred.

Under the benchmark situation, different from the trend of change of personal pension wealth of male workers, with the increase of delayed age, the personal pension wealth of female workers increases first and then decreases, and the trend of change is parabolic. According to the chart, female workers within a certain range of deferred age, delayed retirement age will increase their personal pension wealth, delay 6 years of age, wealth impact rate reached a maximum of 5.91%. Since then, the impact rate of wealth has diminished as the age of delay has increased. When the retirement age for female workers is pushed back to 67 years, personal pension wealth is lost, with a loss rate of 0.86%. Based on the benchmark model, a delay in the retirement age of female workers by 4-6 years would help increase their personal pension wealth.

*3.4.2 Sensitivity analysis of influence parameters*

This section analyzes the trend of individual pension income of male and female workers with the delay of retirement age under different parameters development levels from the changes of the four influencing parameters.

(1) The impact of different life expectancy on the pension wealth of workers who delay retirement

Change the life expectancy of workers regularly, keep the remaining baseline hypothesis parameters unchanged, simulate the measurement of different life expectancy of male and female workers under the impact rate of personal pension wealth, the specific results can be seen in Table 2 and Fig. 2.

Table 2 Influence rate of personal pension wealth of male and female workers with different life expectancy (unit: %)

| Delay refund age | Male | | | Female | | |
|---|---|---|---|---|---|---|
| | 74 | 77 | 80 | 80 | 83 | 86 |
| 56 | - | - | - | 1.62 | 2.07 | 2.43 |
| 57 | - | - | - | 3.01 | 3.96 | 4.73 |
| 58 | - | - | - | 4.16 | 5.67 | 6.88 |
| 59 | - | - | - | 5.04 | 7.17 | 8.87 |
| 60 | - | - | - | 5.63 | 8.43 | 10.69 |
| 61 | -2.01 | -0.09 | 0.98 | 5.91 | 9.45 | 12.30 |
| 62 | -4.58 | -1.79 | 0.15 | 5.83 | 10.19 | 13.70 |
| 63 | -8.87 | -3.36 | -0.28 | 5.38 | 10.64 | 14.86 |
| 64 | -11.63 | -5.43 | -1.10 | 4.52 | 10.75 | 15.67 |
| 65 | -16.21 | -7.04 | -2.34 | 3.22 | 10.51 | 16.73 |
| 66 | -21.55 | -12.32 | -4.20 | 1.44 | 9.98 | 16.86 |
| 67 | -27.73 | -16.06 | -6.91 | -0.86 | 8.58 | 16.64 |
| 68 | -34.80 | -20.35 | -8.98 | -3.71 | 7.25 | 16.24 |
| 69 | -42.83 | -25.57 | -12.41 | -7.16 | 5.67 | 15.44 |
| 70 | -50.87 | -31.46 | -17.05 | -11.24 | 2.66 | 13.20 |
| 71 | -62.04 | -36.98 | -21.53 | -16.16 | -0.24 | 12.31 |
| 72 | -73.44 | -46.23 | -24.95 | -20.60 | -3.82 | 11.30 |
| 73 | -86.02 | -53.10 | -30.20 | -27.93 | -7.32 | 7.74 |
| 74 | - | -62.67 | -39.43 | -32.49 | -15.28 | 3.67 |
| 75 | - | -77.62 | -43.51 | -45.24 | -20.08 | 0.29 |
| 76 | - | -89.86 | -57.31 | -55.34 | -25.62 | -5.23 |
| 77 | - | - | -63.89 | -62.49 | -33.81 | -9.67 |
| 78 | - | - | -78.32 | -75.41 | -46.26 | -16.37 |
| 79 | - | - | -86.94 | -86.24 | -50.99 | -22.76 |
| 80 | - | - | - | - | -61.46 | -30.57 |
| 81 | - | - | - | - | -73.07 | -39.36 |
| 82 | - | - | - | - | -85.89 | -49.16 |
| 83 | - | - | - | - | - | -60.05 |
| 84 | - | - | - | - | - | -72.10 |
| 85 | - | - | - | - | - | -85.39 |

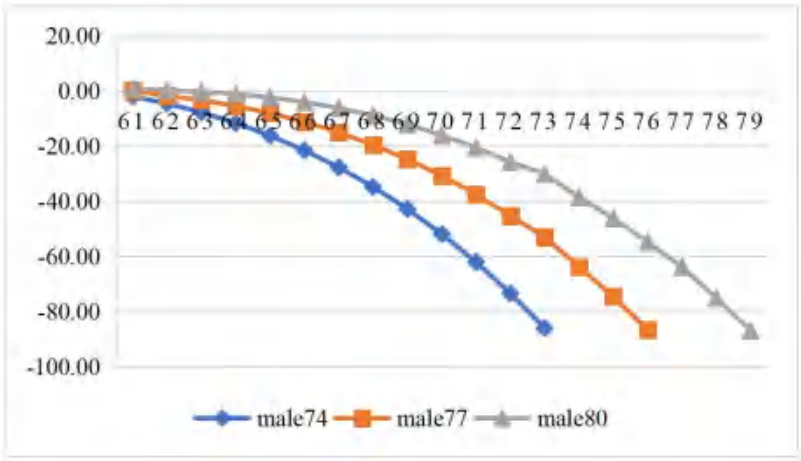


Fig. 2(a) Impact rates of personal pension wealth for male workers with different life expectancies

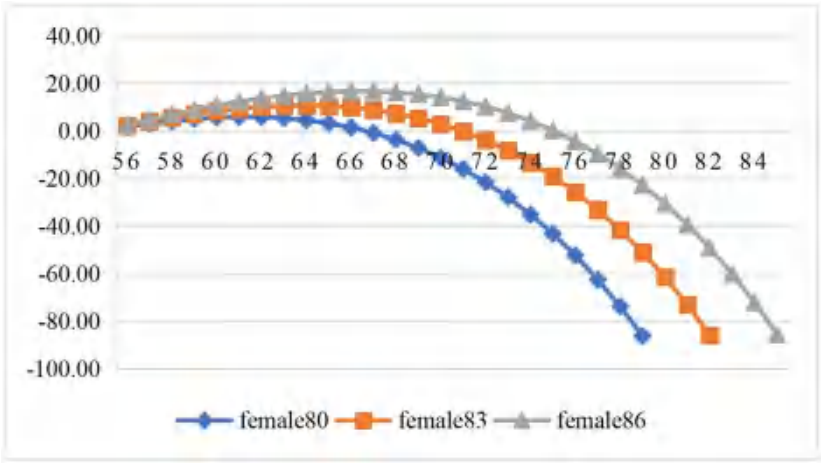


Fig. 2(b) Influence rate of personal pension wealth of female workers with different life expectancies

As can be seen from Table 2 and Fig. 2, as life expectancy of both male and female workers increases and the remaining baseline assumptions remain unchanged, the impact of late retirement on the pension wealth of individual male and female workers has increased and the loss rate has decreased.

For male workers, when life expectancy is 74 years and 77 years, regardless of the number of years of retirement delay, delay in retirement is bound to result in a reduction in the pension wealth of male workers. Delayedretirement does not necessarily reduce the total pension income of male workers when their life expectancy reaches80 years and the deferred age is within a certain range.

As the delayed age of female workers increases, the trend of changes in their personal pension wealth remains parabolic. The higher the life expectancy of female workers, the higher the impact of their personal pension wealth and the more conducive it is to increasing their personal pension income in retirement. When the life expectancy of a female worker is higher than 80 years, the retirement age for female workers can be delayed by at least 10 years.

(2) Impact of different salary growth rates on pension wealth of workers who delay retirement

The salary growth rate of employees is divided into four grades, namely, low-grade salary growth rate of 5%, the benchmark situation is the medium-grade salary growth rate of 7%, the middle-high-grade salary growth rate of 10%, high-grade salary growth rate of 12%, and further measures and analyzes the impact rate of personal pension wealth of male and female workers under different salary growth rates, the results are shown in Table 3 and Fig. 3.

Table 3 Influence rate of personal pension wealth of male and female employees under different wage growth rates (unit: %)

| Delay refund age | Male | | | | Female | | | |
|---|---|---|---|---|---|---|---|---|
| | 5% | 7% | 10% | 12% | 5% | 7% | 10% | 12% |
| 56 | - | - | - | - | 0.28 | 1.62 | 3.41 | 4.48 |
| 57 | - | - | - | - | 0.32 | 3.01 | 6.69 | 8.91 |
| 58 | - | - | - | - | 0.11 | 4.16 | 9.80 | 13.25 |
| 59 | - | - | - | - | -0.36 | 5.04 | 12.71 | 17.48 |
| 60 | - | - | - | - | -1.11 | 5.63 | 14.27 | 24.32 |
| 61 | -3.26 | -2.01 | -0.29 | 1.21 | -2.35 | 5.91 | 18.32 | 26.54 |
| 62 | -7.10 | -4.58 | -0.72 | 1.49 | -3.79 | 5.83 | 20.78 | 29.60 |
| 63 | -12.54 | -7.78 | -2.35 | 1.43 | -5.06 | 5.38 | 21.45 | 33.11 |
| 64 | -16.32 | -11.63 | -5.32 | 0.22 | -7.16 | 4.52 | 22.49 | 34.76 |
| 65 | -23.12 | -16.21 | -8.92 | -2.88 | -10.52 | 3.22 | 23.32 | 38.61 |
| 66 | -29.23 | -21.55 | -13.81 | -6.24 | -13.32 | 1.44 | 23.52 | 36.78 |
| 67 | -36.43 | -27.73 | -18.13 | -9.74 | -15.34 | -0.86 | 22.74 | 39.71 |
| 68 | -40.66 | -34.80 | -25.94 | -17.88 | -19.85 | -3.71 | 20.52 | 40.67 |
| 69 | -50.55 | -42.83 | -33.78 | -23.89 | -23.79 | -7.16 | 17.24 | 37.65 |
| 70 | -58.23 | -50.87 | -46.43 | -36.72 | -28.06 | -11.24 | 16.21 | 36.57 |
| 71 | -68.34 | -62.04 | -54.86 | -45.96 | -32.00 | -16.16 | 11.99 | 32.07 |
| 72 | -79.40 | -73.44 | -69.28 | -63.84 | -38.21 | -20.60 | 5.59 | 26.42 |
| 73 | -89.33 | -86.02 | -81.92 | -77.72 | -44.14 | -27.93 | -0.17 | 21.73 |
| 74 | - | - | - | - | -49.49 | -32.49 | -8.61 | 12.01 |
| 75 | - | - | - | - | -57.39 | -45.24 | -19.34 | 3.01 |
| 76 | - | - | - | - | -63.87 | -55.34 | -30.11 | -10.61 |
| 77 | - | - | - | - | -71.94 | -62.49 | -42.92 | -28.20 |
| 78 | - | - | - | - | -80.35 | -75.41 | -60.01 | -48.16 |
| 79 | - | - | - | - | -89.98 | -85.12 | -79.62 | -72.93 |

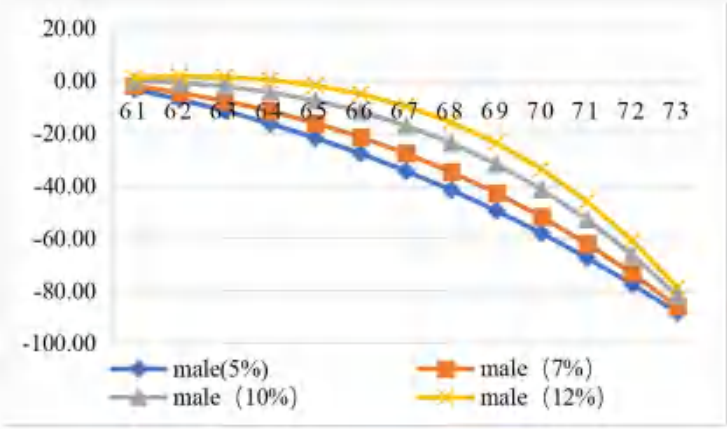


Fig. 3(a) Influence rates of male employees' personal pension wealth under different wage growth rates

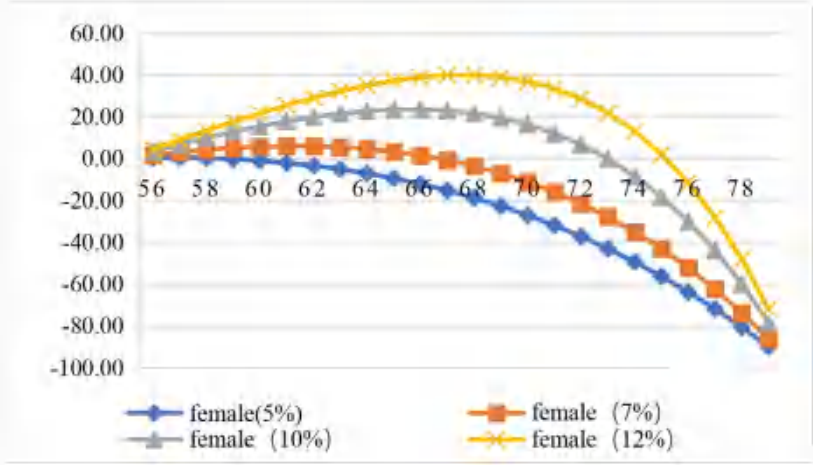


Fig. 3(b) Influence rates of female employees' personal pension wealth under different wage growth rates

As can be seen from Table 3 and Fig. 3, the impact rate of personal pension wealth of male and female workers increases gradually with the increase of the salary growth rate of workers, mainly because the increase in the salary income of workers increases the pension distribution base, thus raising the level of personal wealth during the retirement of male and female workers remaining baseline assumptions remain unchanged.

For male workers, under the low, medium and high salary growth rate, delayed retirement will inevitably bring losses to the pension wealth of male workers. But with the age of delay, higher wage growth rates could reduce the loss of pension wealth for male workers.

For female workers, with a 5% pay increase, retirement at any age of 59 and beyond will result in a loss of personal pension wealth. When the salary growth rate is 10%, the maximum impact of postponing retirement age on the personal pension wealth of female workers is 23.52%, the optimal retirement age is 66 years, the salary growth rate is 12%, the maximum wealth impact rate of female workers is 40.67% and the optimal retirement age is 68 years.

(3) Effect of different discount rates on pension wealth of workers who delay retirement

Change the discount rate regularly, keep the remaining baseline assumptions unchanged, and further analyze the changes in the impact rate of personal pension wealth of male and female workers at the discount rate of 3%, 5% and 7%, as shown in Table 4 and Fig. 4.

Table 4 Influence rates of male and female employees' personal pension wealth under different discount rates (unit: %)

| Delay | Male | | | Female | | |
|---|---|---|---|---|---|---|
| refund age | $r_2 = 3\%$ | $r_2 = 5\%$ | $r_2 = 7\%$ | $r_2 = 3\%$ | $r_2 = 5\%$ | $r_2 = 7\%$ |
| 56 | - | - | - | 1.62 | 0.64 | -0.46 |
| 57 | - | - | - | 3.01 | 1.04 | -1.15 |
| 58 | - | - | - | 4.16 | 1.18 | -2.07 |
| 59 | - | - | - | 5.04 | 1.06 | -3.24 |
| 60 | - | - | - | 5.63 | 0.65 | -4.65 |
| 61 | -2.01 | -2.96 | -3.97 | 5.91 | -0.05 | -6.32 |
| 62 | -4.58 | -6.44 | -8.36 | 5.83 | -1.08 | -8.26 |
| 63 | -7.78 | -10.45 | -13.19 | 5.38 | -2.45 | -10.46 |
| 64 | -11.63 | -14.03 | -18.46 | 4.52 | -5.17 | -12.96 |

Table 4 Influence rates of male and female employees' personal pension wealth under different discount rates (unit: %) (continued Table)

| Delay refund | Male | | | Female | | |
|---|---|---|---|---|---|---|
| age | $r_2 = 3\%$ | $r_2 = 5\%$ | $r_2 = 7\%$ | $r_2 = 3\%$ | $r_2 = 5\%$ | $r_2 = 7\%$ |
| 65 | -16.21 | -21.21 | -25.21 | 3.22 | -6.63 | -15.64 |
| 66 | -21.55 | -27.01 | -33.54 | 1.44 | -9.75 | -19.83 |
| 67 | -27.73 | -32.50 | -37.16 | -0.86 | -11.68 | -22.22 |
| 68 | -34.80 | -40.60 | -45.24 | -3.71 | -16.14 | -27.74 |
| 69 | -42.83 | -48.23 | -53.12 | -7.16 | -19.32 | -28.89 |
| 70 | -50.87 | -57.25 | -61.55 | -11.24 | -24.21 | -35.49 |
| 71 | -62.04 | -66.71 | -71.48 | -16.16 | -30.24 | -41.54 |
| 72 | -73.44 | -78.52 | -80.32 | -20.60 | -35.55 | -46.25 |
| 73 | -86.02 | -89.86 | -90.81 | -27.93 | -40.40 | -49.95 |
| 74 | - | - | - | -32.49 | -45.97 | -55.64 |
| 75 | - | - | - | -45.24 | -53.48 | -60.93 |
| 76 | - | - | - | -55.34 | -62.07 | -69.64 |
| 77 | - | - | - | -62.49 | -70.65 | -74.79 |
| 78 | - | - | - | -75.41 | -79.89 | -84.39 |
| 79 | - | - | - | -85.12 | -88.28 | -90.35 |

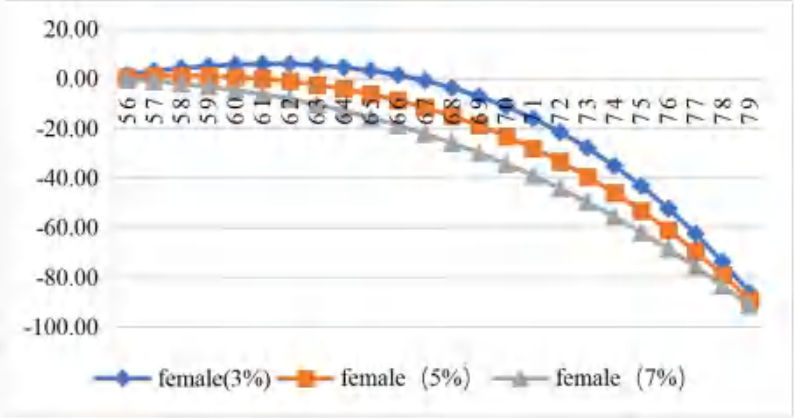


Fig. 4(a) Influence rates of male workers' personal pension wealth under different discount rates

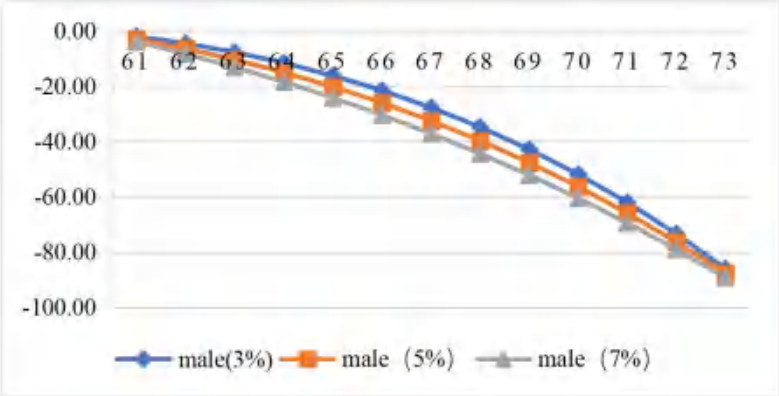


Fig. 4(b) Influence rates of female employees' personal pension wealth under different discount rates

As can be seen from Table 4 and Fig. 4, there is a negative correlation between the discount rate and the impact rate of personal pension wealth for male and female workers while the remaining baseline assumptions remain unchanged. At the same age of postponement, the impact rate of personal pension wealth of male and female workers decreases gradually with the increase of discount rate, and the higher the discount rate, the greater the loss rate of personal pension wealth of employees.

(4) The effect of different pension adjustment ratios on the pension wealth of workers after delayed retirement

The effect of changes in pension adjustment ratio on the personal pension wealth of male and female workers is further analyzed, with the pension adjustment ratio being adjusted from 70% of the baseline to 50% and 100% respectively,and the effect of the change in the pension adjustment ratio on the personal pension wealth of male and female workers is furtheranalyzed, as shown in Table 5 and Fig. 5.

Table 5 Individual Pension Wealth Impact Rates of Male and Female Employees under Different Pension Adjustment Rates (Unit: %)

| Delay refund | Male | | | Female | | |
|---|---|---|---|---|---|---|
| age | 50% | 70% | 100% | 50% | 70% | 100% |
| 56 | - | - | - | 2.19 | 1.62 | 0.59 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 57 | - | - | - | 4.18 | 3.01 | 0.95 |
| 58 | - | - | - | 5.94 | 4.16 | 1.06 |
| 59 | - | - | - | 7.45 | 5.04 | 0.91 |
| 60 | - | - | - | 8.67 | 5.63 | 0.47 |
| 61 | -1.52 | -2.01 | -2.82 | 9.58 | 5.91 | -0.26 |
| 62 | -3.63 | -4.58 | -6.15 | 10.13 | 5.83 | -1.30 |
| 63 | -6.39 | -7.78 | -10.03 | 10.29 | 5.38 | -2.67 |
| 64 | -9.86 | -11.63 | -14.64 | 10.02 | 4.52 | -4.38 |
| 65 | -13.31 | -16.21 | -20.57 | 9.28 | 3.22 | -7.47 |
| 66 | -20.12 | -21.55 | -26.29 | 8.01 | 1.44 | -9.95 |
| 67 | -26.17 | -27.73 | -33.71 | 6.17 | -0.86 | -12.92 |
| 68 | -34.15 | -34.80 | -41.72 | 2.61 | -3.71 | -16.22 |
| 69 | -42.51 | -42.83 | -50.01 | 0.72 | -7.16 | -19.23 |
| 70 | -50.67 | -50.87 | -57.36 | -4.95 | -11.24 | -24.72 |
| 71 | -60.33 | -62.04 | -68.81 | -9.03 | -16.16 | -30.01 |
| 72 | -73.78 | -73.44 | -78.31 | -14.59 | -20.60 | -35.42 |
| 73 | -87.11 | -86.02 | -89.02 | -23.66 | -27.93 | -41.35 |
| 74 | - | - | - | -29.79 | -32.49 | -50.81 |
| 75 | - | - | - | -40.40 | -45.24 | -53.03 |
| 76 | - | - | - | -52.03 | -55.34 | -62.31 |
| 77 | - | - | - | -59.46 | -62.49 | -73.12 |
| 78 | - | - | - | -74.22 | -75.41 | -80.09 |
| 79 | - | - | - | -83.51 | -85.12 | -90.38 |

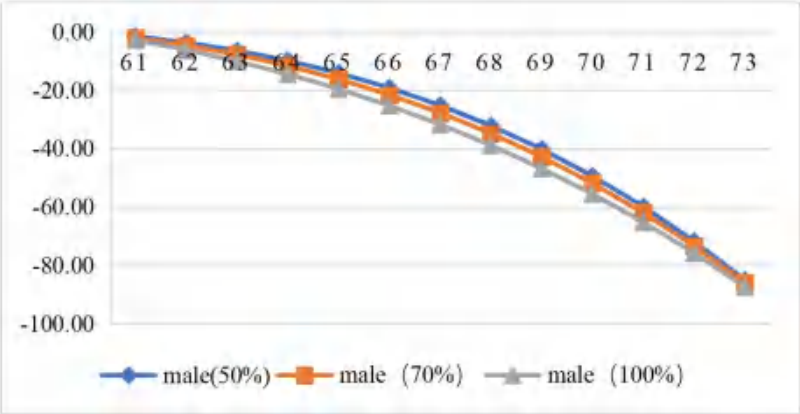


Fig. 5(a) Influence rates of male employees' personal pension wealth under different pension adjustment ratios

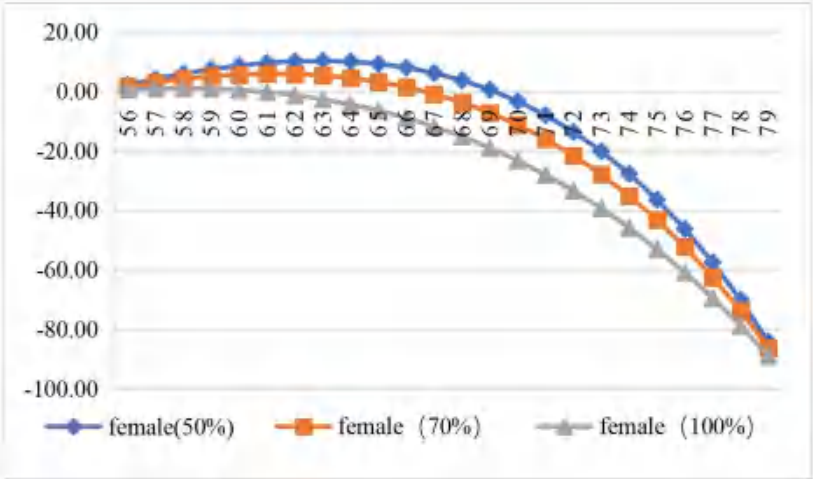


Fig. 5(b) Influence rates of female employees' personal pension wealth under different pension adjustment ratios

As can be seen from Table 5 and Fig. 5, there is a negative correlation between the pension adjustment ratio and the impact rate of personal pension wealth of male and female workers, subject to the remaining baseline assumptions. In the case of the same age of postponement, the impact rate of personal pension wealth of male and female workers decreases gradually with the increase of the proportion of pension adjustment, the higher the adjustment ratio, the greater the loss rate of personal pension wealth of employees, the less conducive to increasing personal pension income.

For male workers, changing the proportion of pension adjustments and postponing the retirement age reduces their personal pension income and undermines their pension wealth. In the case of the delay of age consistency, the higher the proportion of pension adjustment, the greater the damage to the personal pension wealth of male workers.

Similar to the trend of changes in the level of personal pension wealth of male workers, the personal pension income of female workers decreases with the adjustment ratio, in the same way as the deferred age. However, within a certain deferred age range, the impact rate of female workers' personal wealth is still positive, and the optimal retirement age still exists.

## 4. Research on the impact of delayed "retirement" on residents' pension wealth

### 4.1 Basic assumptions and explanations of the model

This chapter makes the following assumptions in accordance with the requirements of No. 32 Document of The State Council（2009）, *the implementation of a new type of rural social old-age insurance on the pilot of the state council*[①] and No. 8 document of The State Council（2014）, *on the establishment of a unified*

[①] Chinese government website. *The implementation of a new type of rural social old-age insurance on the pilot of the state council*. [EB/0L]. [2009-09-04].http://www.gov.cn/zhengce/content/2009-09/04/content_7280.htm

*basic old-age insurance system for urban and rural residents*[①]:

(1) For urban and rural residents, delayed "retirement" means the postponement of the pension age.

(2) Set 2009 as the initial measurement point for the pension wealth of urban and rural residents.

(3) It is assumed that the standard of government contribution subsidy for individual pension accounts of urban and rural residents remains unchanged.

(4) It is assumed that the insured residents do not receive any financial support from socio-economic organizations, charitable organizations or individuals, nor do they receive subsidies from rural collectives.

(5) Assume thatthe future growth rate of per capita income of urban and rural residents is equal to the rate of economic growth.

(6) This section sets theuse of average life expectancy data in the actuarial model.

(7) Assuming that the insured urban and rural residents pay their contributions at the beginning of each year, the payment grade cannot be changed once selected, and there is no case of the withdrawal of basic endowment insurance.

(8) It is assumed that the population will be able to survive normal death after the average life expectancy of the population.

(9) The actuarial values of wealth that will appear in this section are discounted to the current statutory pension age for residents.

## 4.2 "New Urban and Rural Residents" pension wealth model and wealth impact rate model

Assuming that a resident who starts to pay the urban housing security at the age of $a_{jm}$ starts to receive the pension at the age of $r_{jm}$, the average life expectancy of the population is $e$, and the contributory years are $r_{jm} - a_{jm}$, the basic pension planning and payment standard of the urban housing security in 2009 is $P_{jm0}$, and the adjustment ratio of the basic pension of the urban housing security is $f$, then:

(1) Basic pension $(P_b)_{r_{jm}}$

The total actuarial present value $(P_b)_{r_{jm}}$ of the annual basic pension received by urban and rural residents in the year of $r_{jm}$ is:

$$(P_b)_{r_{jm}} = P_{jm0}(1+f)^{r_{jm}-a_{jm}} \sum_{k=0}^{e-r_{jm}-1}(1+f)^k v^k. \tag{10}$$

Where, $v = (1+r_2)^{-1}$, and $r_2$ is the discount rate.

When the pension age is delayed by $n$ years, $(P_b)_{r_{jm+n}}$ is:

[①] Chinese government website. On the establishment of a unified basic old-age insurance system for urban and rural residents.[EB/OL].[2014-02-26].http://www.gov.cn/zhengce/content/2014-02/26/content_8656.htm

$$\left(P_b\right)_{r_{jm}+n} = P_{jm0}\left(1+f\right)^{n+r_{jm}-a_{jm}} \sum_{k=0}^{e-r_{jm}-n-1}\left(1+f\right)^{k} v^{k+n}. \tag{11}$$

(2) Private pension account$(P_i)_{r_{jm}}$

$C$ represents the initial contribution standard of insured residents; $r_1$ represents the return rate of individual account fund; $S$ represents the annual contribution subsidy amount of local government; $M$ represents the number of months for individual account pension payment; $r_2$ represents the discount rate; and $g_{jm}$ represents the growth rate of per capita income of urban and rural residents. Then, the total actuarial present value $(P_i)_{r_{jm}}$ of the individual account pension received by residents every year in the year of $r_{jm}$ is:

$$\left(P_i\right)_{r_{jm}} = \frac{C\sum_{i=1}^{r_{jm}-a_{jm}}\left(1+g_{jm}\right)^{r_{jm}-a_{jm}-i}\left(1+r_1\right)^{i} + S\sum_{j=1}^{r_{jm}-a_{jm}}\left(1+r_1\right)^{j}}{M/12}\sum_{l=0}^{e-r_{jm}-1} v^{l}. \tag{12}$$

When the pension age is pushed back by n years, $(P_i)_{r_{jm}+n}$ is:

$$\left(P_i\right)_{r_{jm}+n} = \frac{C\sum_{i=1}^{n+r_{jm}-a_{jm}}\left(1+g_{jm}\right)^{n+r_{jm}-a_{jm}-i}\left(1+r_1\right)^{i} + S\sum_{j=1}^{n+r_{jm}-a_{jm}}\left(1+r_1\right)^{j}}{M/12}\times\sum_{l=0}^{e-r_{jm}-n-1} v^{l+n}. \tag{13}$$

（3）Residents pay for basic endowment insurance$D_{r_{jm}}$

Taking individual basic endowment insurance contribution as the cost, the total cost $D_{r_{jm}}$ of the basic endowment insurance that residents pay for their whole life in the year when they start to receive pension is

$$D_{r_{jm}} = C\sum_{t=0}^{r_{jm}-a_{jm}-1}\left(1+g_{jm}\right)^{t}. \tag{14}$$

When the pension age is delayed by n years, $D_{r_{jm}+n}$ is:

$$D_{r_{jm}+n} = C\sum_{t=0}^{n+r_{jm}-a_{jm}-1}\left(1+g_{jm}\right)^{t}. \tag{15}$$

（4）Pension wealth$(PW)_{r_{jm}}$

By summation of the actuarial present value $(P_b)_{r_{jm}}$ of the total basic pension and the actuarial present value $(P_i)_{r_{jm}}$ of the total personal account pension, and

subtracted the total contribution $D_{r_{jm}}$, we can get the actuarial model $(PW)_{r_{jm}}$ of the pension wealth for residents " New Urban and Rural Residents" under the current planning and payment standard as follows:

$$(PW)_{r_{jm}} = (P_b)_{r_{jm}} + (P_i)_{r_{jm}} - D_{r_{jm}}. \tag{16}$$

Similarly, when the pension age is pushed up by n years,$(PW)_{r_{jm+n}}$ is：

$$(PW)_{r_{jm+n}} = (P_b)_{r_{jm+n}} + (P_i)_{r_{jm+n}} - D_{r_{jm+n}}. \tag{17}$$

The personal pension wealth of the "New Urban and Rural Residents" in the resident system is $(PW)_{r_{jm}}$ under the present pension age, and the personal pension wealth after the pension age is delayed by n years is $(PW)_{r_{jm}+n}$, and the wealth influence rate is $\phi(n)_2$:

$$\phi(n)_2 = \frac{(PW)_{r_{jm}+n} - (PW)_{r_{jm}}}{(PW)_{r_{jm}}} \times 100\%. \tag{18}$$

### 4.3 Selection and setting of model benchmark parameters

(1) Study subjects: 60-year-old male residents and 60-year-old female residents in 2040

(2) Assume that the age of 25 is the age at which a male or female resident begins to pay city residence insurance.

(3) According to No.8 Document of The State Council（2014）,the current legal pension age for both male and female residents is 60 years. The base fee level is 100 yuan per person per year. The local people's government contribution subsidy standard is: the payment grade of 500 yuan or less is not less than 30 yuan per person per year;

(4) According to document No.32 Document of The State Council（2009）, the basic pension standard set by the central government is 55 yuan per person per month. Therefore, the initial base pension is set at 660 yuan per person per year.

(5) Assume a discount rate of 3%.

(6) Assume that the adjustment ratio of the basic pension for urban housing insurance is 4.1%.

(7) According to the Statistics of china Statistical Yearbook (2020)[①], the annual growth rates of per capita disposable income of rural residents in China in 2009-2014 and 2014-2019 are 14% and 8.8%, respectively, which is not much different from the

[①] National Bureau of Statistics. *China Statistical Yearbook (2020)*. http://www.stats.gov.cn/tjsj/ndsj/2020/indexch.htm [EB/OL] [2020-9]

annual growth rate of average wages of non-private sector workers in urban areas. Therefore, it is assumed that the per capita income growth rate of urban and rural residents in China will be 7% in the future.

(8) Set the age of death for female and male residents at 80 years and 74 weeks respectively.

(9) Combined with the data released by the Monetary Policy Division of the Chinese Bank of China and document No.48 Document of The State Council （2015）[①]and taking into account the actual situation, assume that the personal account yield is 6 %.

## 4.4 Numerical simulation results and analysis

### *4.4.1 Impact of delayed "retirement" on residents' pension wealth under the baseline conditions*

Bring the baseline parameters into the Resident Wealth Impact Rate Model, i.e. Eg. 18, to simulate the impact rate of pension wealth for male and female residents under different deferred ages, with results shown in Table 6 and Fig. 6.

Table 6 Impact Rate of Personal Pension Wealth Impact of Male and Female Residents (benchmark)

(units:%)

| Payment grade | Delay refund age | Male | Female |
|---|---|---|---|
| | | 74 | 80 |
| 100 | 61 | -3.09 | 0.24 |
| | 62 | -6.43 | 0.34 |
| | 63 | -9.54 | 0.45 |
| | 64 | -12.95 | 1.18 |
| | 65 | -16.77 | 2.50 |
| | 66 | -21.18 | 4.30 |
| | 67 | -25.46 | 7.72 |
| | 68 | -30.63 | 12.35 |
| | 69 | -35.88 | 20.33 |
| | 70 | -18.82 | 112.23 |

[①] Chinese government website. *Notice of the State Council on the issue of investment management measures for basic pension insurance funds*.[EB/OL].[2014-08-23].http://www.gov.cn/zhengce/content/2015-08/23/content_10115.htm

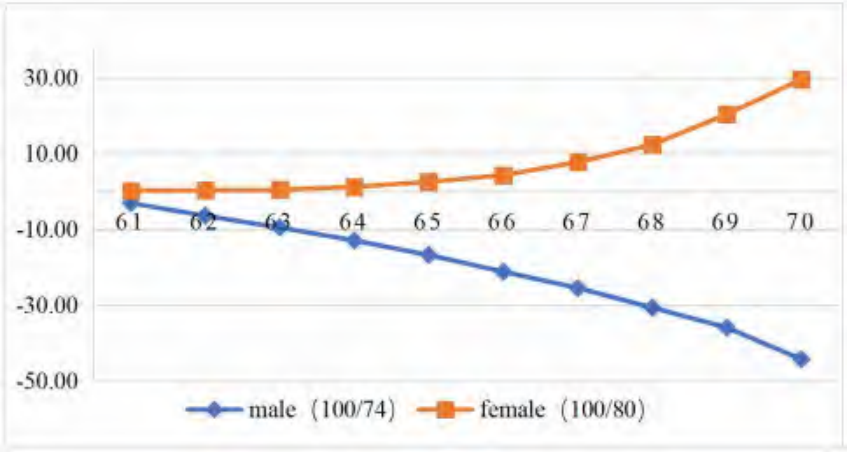


Fig. 6 Personal pension wealth impact rate for male and female residents (benchmark)

Look at the data related to Table 6 and Fig. 6, in the case of a benchmark, When a male resident's "retirement" age is delayed by one year, the impact rate of pension wealth received by the male resident is -3.09%; the "retirement" age is delayed by 5 years with an impact rate of -16.77%; for every one year of delay in retirement age for male residents who have a delay of less than 6 years, the average loss rate of their personal pension wealth due to delay is approximately 3.42%.

Under the benchmark, the personal pension wealth of female residents has been growing as the age of delay has increased, which is different from the change of the personal pension wealth of male residents. In other words, after the age of 60, female residents receive more pension income at any age than they do when they "retire" at the age of 60. Female residents have a longer life expectancy than male residents, and there is more room to delay the "retirement" age. From this point of view, the delayed "retirement" scheme design of urban and rural residents in the future may also consider the strategy of "women before men".

*4.4.2 Sensitivity analysis of the impact parameter*

This section analyzes the impact of delaying the "retirement" age of male and female residents on their personal pension wealth at different levels of development.

(1) The impact of different contribution grades on the pension wealth of residents after delaying "retirement"

In the case of controlling the remaining baseline assumptions, By reference to the 12 payment grades set in No. 8 document of The State Council (2014), choose 100 yuan (benchmark), 500 yuan, 1000 yuan and 2000 yuan, 4 payment grades per person per year. The changes in the impact rate of personal pension wealth for male and female residents at different contribution levels are measured, as shown in Table 7 and Fig. 7.

Table 7 Impact Rate of Personal Pension Wealth of Male and Female Residents in Different Contribution Grades (units: %)

| Payment grade | Delay refund age | Male | Female |
|---|---|---|---|
| | | 74 | 80 |
| 100 | 61 | -3.09 | 0.24 |
| | 62 | -6.43 | 0.34 |
| | 63 | -9.54 | 0.45 |
| | 64 | -12.95 | 1.18 |
| | 65 | -16.77 | 2.50 |
| | 66 | -21.18 | 4.30 |
| | 67 | -25.46 | 7.72 |
| | 68 | -30.63 | 12.35 |
| | 69 | -35.88 | 20.33 |
| | 70 | -44.27 | 29.53 |
| 500 | 61 | 0.63 | 4.25 |
| | 62 | 0.82 | 8.87 |
| | 63 | 1.57 | 14.98 |
| | 64 | 1.76 | 21.85 |
| | 65 | 1.13 | 29.60 |
| | 66 | -0.65 | 38.41 |
| | 67 | -2.12 | 50.70 |
| | 68 | -5.41 | 65.59 |
| | 69 | -8.79 | 87.58 |
| | 70 | -18.82 | 112.23 |

Table 7 Impact Rate of Personal Pension Wealth of Male and Female Residents in Different Contribution Grades (units: %) (continued Table)

| Payment grade | Delay refund age | Male | Female |
|---|---|---|---|
| | | 74 | 80 |
| 1000 | 61 | 1.86 | 5.72 |
| | 62 | 3.19 | 11.88 |
| | 63 | 5.22 | 19.80 |
| | 64 | 6.58 | 28.63 |
| | 65 | 6.99 | 38.51 |
| | 66 | 6.03 | 49.64 |
| | 67 | 5.45 | 64.88 |
| | 68 | 2.72 | 83.18 |
| | 69 | -0.11 | 109.86 |
| | 70 | -10.84 | 139.71 |
| 2000 | 61 | 2.69 | 6.70 |
| | 62 | 4.80 | 13.88 |
| | 63 | 7.68 | 23.01 |
| | 64 | 8.21 | 33.13 |
| | 65 | 9.83 | 44.42 |
| | 66 | 10.56 | 57.09 |
| | 67 | 11.33 | 74.29 |
| | 68 | 11.94 | 94.86 |
| | 69 | 5.74 | 124.66 |
| | 70 | -5.45 | 157.96 |

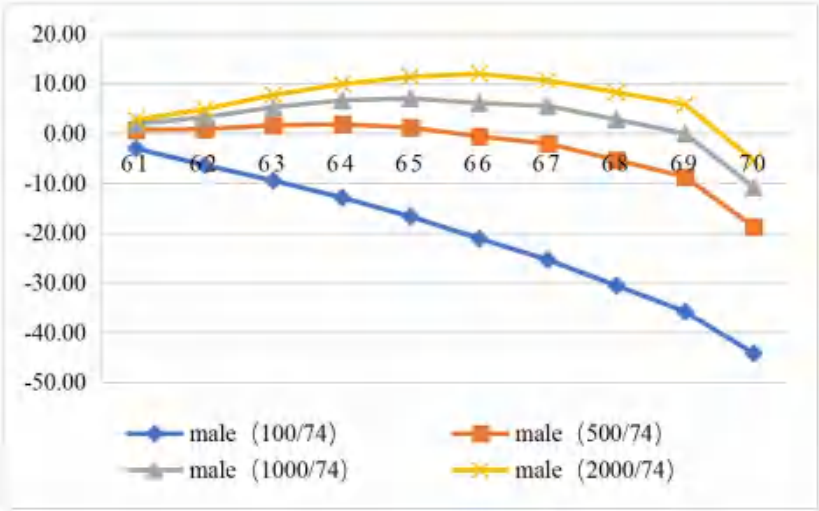


Fig. 7(a) Impact Rate of Personal Pension Wealth For Male Residents in Different Contribution Grades

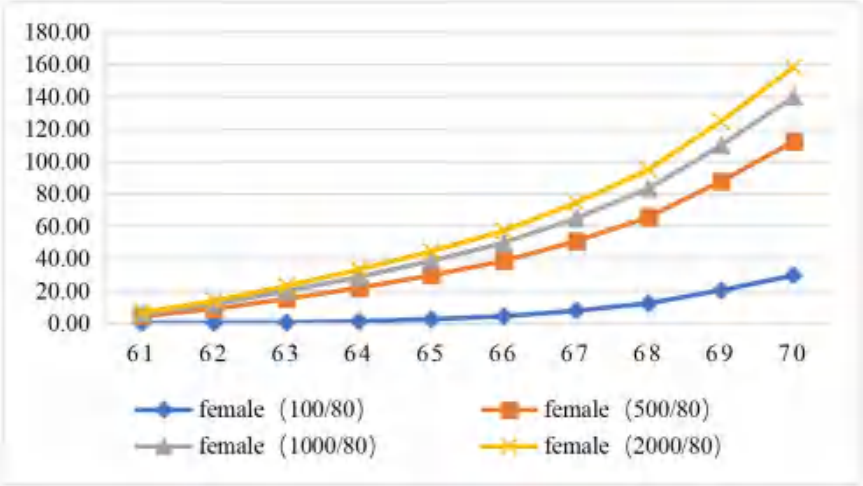


Fig. 7(b) The impact rate of the wealth of female residents in different payment grades

This can be observed in Table 4-2 related data and Fig. 4-2, there is a positive correlation between contribution grade and the personal pension wealth of male and female residents. With the same number of years of contribution, a higher level of contribution will lead to more pension income. The reason for this is that higher contribution grades lead to greater personal account accumulation and investment returns. Residents to improve their own payment level of insurance will increase pension income, improve the level of personal pension wealth.

For male residents, when the payment grade is higher, it is 500 yuan, 1,000 yuan and 2,000 yuan per person per year, As the pension age of male residents is delayed, the trend of changes in their personal pension wealth is parabolic.Therefore, there is the optimal "retirement" age for male residents, and the optimal "retirement" age for male residents will gradually increase with the increase of contribution grade. Male residents can have their pension age delayed by at least 5 years when their contribution level is 500 yuan or more.

For female residents, the increase in contribution grades will increase the impact of delayed "retirement" on their pension wealth at the same "retirement" age. When the contribution grade is raised to 2,000 yuan, the "retirement" age is delayed by 1 year and the impact rate of the deferred "retirement" is 6.70%, which is 0.98 percentage points higher than when the contribution grade is 1,000 yuan; delayed "retirement" has an impact rate of 13.88 percentfor delayed 2 years, which is 2% higher than when the contribution grade is 1,000 yuan.

(2) Impact of different life expectancy on residents' pension wealth after delayed "retirement"

Control the remaining benchmark assumption parameters unchanged, change the life expectancy of residents regularly, simulate the impact rate of personal pension wealth of male and female residents under different life expectancy, and take into account the difference in the impact of the base contribution grade and higher contribution grade on the residents' pension wealth after delayed "retirement", the results are shown in Table 8 and Fig. 8.

Table 8 Impact Rate of Personal Pension Wealth for Male and Female Residents under Different Life Expectancy (units:%)

| Payment Grade | Delay refund age | Male | | | Female | | |
|---|---|---|---|---|---|---|---|
| | | 74 | 77 | 80 | 80 | 83 | 86 |
| 100 | 61 | -3.09 | -1.34 | 0.24 | 0.24 | 0.48 | 0.98 |
| | 62 | -6.43 | -2.68 | 0.34 | 0.34 | 1.20 | 2.26 |
| | 63 | -9.54 | -3.50 | 0.45 | 0.45 | 2.72 | 4.40 |
| | 64 | -12.95 | -4.22 | 1.18 | 1.18 | 4.73 | 7.13 |
| | 65 | -16.77 | -4.86 | 2.50 | 2.50 | 7.32 | 10.59 |
| | 66 | -21.18 | -5.43 | 4.30 | 4.30 | 10.65 | 14.95 |
| | 67 | -25.46 | -4.93 | 7.72 | 7.72 | 15.97 | 21.52 |
| | 68 | -30.63 | -4.03 | 12.35 | 12.35 | 23.00 | 30.14 |
| | 69 | -35.88 | -1.06 | 20.33 | 20.33 | 34.19 | 43.44 |
| | 70 | -44.27 | 1.48 | 29.53 | 29.53 | 47.69 | 59.78 |
| 1000 | 61 | 1.86 | 4.29 | 5.72 | 5.72 | 6.65 | 7.28 |
| | 62 | 3.19 | 8.66 | 11.88 | 11.88 | 13.96 | 15.39 |
| | 63 | 5.22 | 14.39 | 19.80 | 19.80 | 23.31 | 25.70 |
| | 64 | 6.58 | 20.44 | 28.63 | 28.63 | 33.93 | 37.55 |
| | 65 | 6.99 | 26.80 | 38.51 | 38.51 | 46.09 | 51.28 |
| | 66 | 6.03 | 33.44 | 49.64 | 49.64 | 60.15 | 67.35 |
| | 67 | 5.45 | 42.79 | 64.88 | 64.88 | 79.21 | 89.05 |
| | 68 | 2.72 | 53.27 | 83.18 | 83.18 | 102.60 | 115.94 |
| | 69 | -0.11 | 68.97 | 109.86 | 109.86 | 136.42 | 154.68 |
| | 70 | -10.84 | 83.71 | 139.71 | 139.71 | 176.11 | 201.17 |

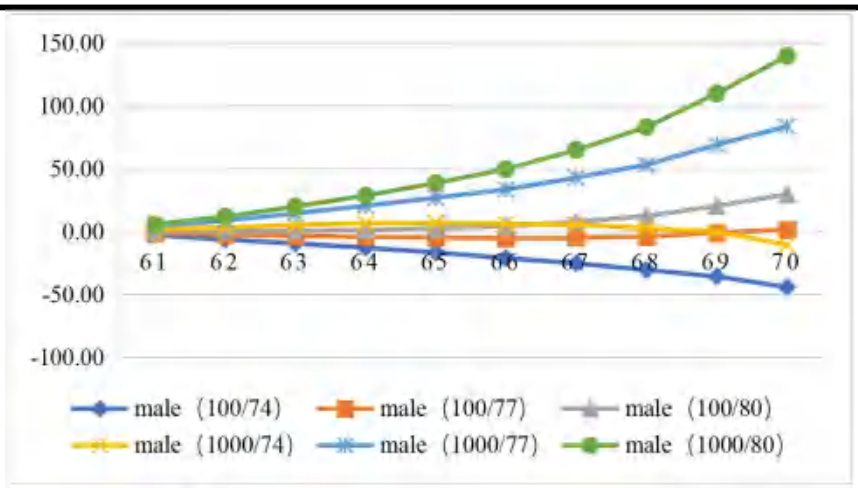


Fig. 8(a) Impact rate of personal old-age wealth for male residents under different life expectancy

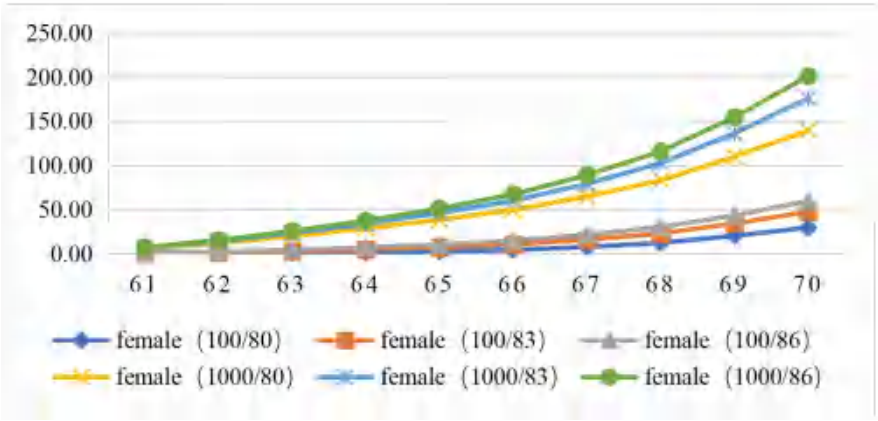


Fig. 8(b) The impact rate of personal pension wealth for female residents under different life expectancy

As can be seen from Table 8 and Fig. 8, the impact of deferred pension age on the personal pension wealth of both male and female residents has increased and the loss rate has decreased as life expectancy has increased, while the remaining benchmark assumptions remain unchanged.

For male residents, delaying the pension age will inevitably result in a reduction in the personal pension income of male residents when the contribution level is 100 yuan per person per year (benchmark) and life expectancy is 74 years and 77 years of age. When a male resident's life expectancy reaches 80 years, delaying the age of payment can increase the personal pension income of male residents. When the contribution level is 1,000 yuan per person per year, an increase in the life expectancy of male residents increases the impact rate on their personal pension wealth.

For female residents, when the contribution grade is 100 yuan per person per year, the increase in life expectancy will increase the impact rate of female residents' pension wealth. When a female resident's life expectancy is higher than 80, the "retirement" age for a female resident can be delayed by at least 10 years.

(3) The impact of different discount rates on residents' pension wealth after delaying "retirement"

Change the discount rate regularly, keep the remaining baseline assumptions unchanged, and further analyze the changes in the impact rate of personal pension wealth of male and female residents at the discount rate of 3%, 5% and 7%, as shown in Table 9 and Fig. 9.

Table 9 Impact rate of personal pension wealth for male and female residents at different discount rates (units: %)

| Payment Grade | Delay refund age | Male | | | Famle | | |
|---|---|---|---|---|---|---|---|
| | | 3% | 5% | 7% | 3% | 5% | 7% |
| 100 | 61 | -3.09 | -4.65 | -6.39 | 0.24 | -1.65 | -3.28 |
| | 62 | -6.43 | -9.54 | -12.96 | 0.34 | -3.20 | -6.45 |
| | 63 | -9.54 | -14.17 | -19.22 | 0.45 | -4.08 | -8.96 |
| | 64 | -12.95 | -19.09 | -25.73 | 1.18 | -4.69 | -11.23 |
| | 65 | -16.77 | -24.41 | -32.58 | 2.50 | -4.98 | -13.23 |
| | 66 | -21.18 | -30.27 | -39.92 | 4.30 | -4.90 | -14.91 |
| | 67 | -25.46 | -36.01 | -47.10 | 7.72 | -3.33 | -15.23 |
| | 68 | -30.63 | -42.57 | -55.03 | 12.35 | -0.75 | -14.70 |
| | 69 | -35.88 | -49.19 | -62.98 | 20.33 | 4.82 | -11.48 |
| | 70 | -44.27 | -58.72 | -73.60 | 29.53 | 11.31 | -7.61 |

Table 9 Impact rate of personal pension wealth for male and female residents at different discount rates (units: %) (continued Table)

| Payment Grade | Delay refund age | Male | | | Famle | | |
|---|---|---|---|---|---|---|---|
| | | 3% | 5% | 7% | 3% | 5% | 7% |
| 1000 | 61 | 1.86 | -0.58 | -3.56 | 5.72 | 3.76 | 1.34 |
| | 62 | 3.19 | -1.88 | -8.03 | 11.88 | 7.75 | 2.69 |
| | 63 | 5.22 | -2.63 | -12.04 | 19.80 | 13.33 | 5.48 |
| | 64 | 6.58 | -4.26 | -17.14 | 28.63 | 19.53 | 8.65 |
| | 65 | 6.99 | -7.06 | -23.60 | 38.51 | 26.48 | 12.28 |
| | 66 | 6.03 | -11.43 | -31.80 | 49.64 | 34.34 | 16.50 |
| | 67 | 5.45 | -15.59 | -39.93 | 64.88 | 45.90 | 24.06 |
| | 68 | 2.72 | -22.07 | -50.55 | 83.18 | 59.98 | 33.65 |
| | 69 | -0.11 | -28.84 | -61.59 | 109.86 | 81.65 | 50.14 |
| | 70 | -10.84 | -43.46 | -80.46 | 139.71 | 105.64 | 68.17 |

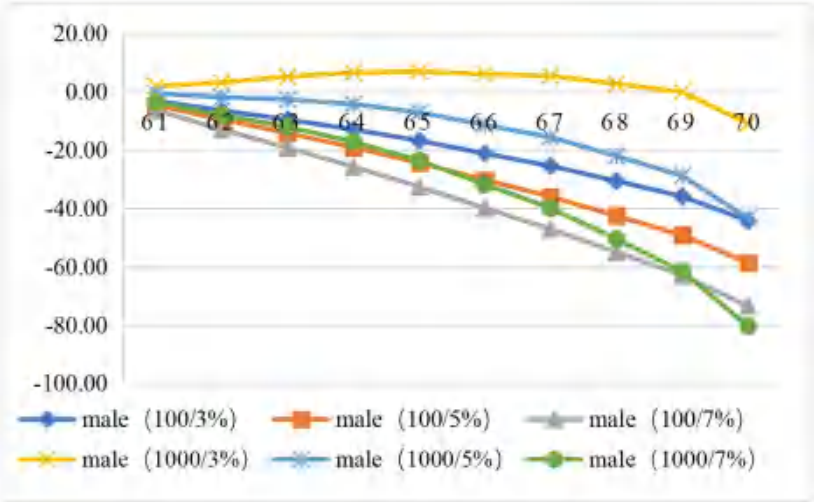


Fig. 9(a) The impact rate of personal pension wealth for male residents at different discount rates

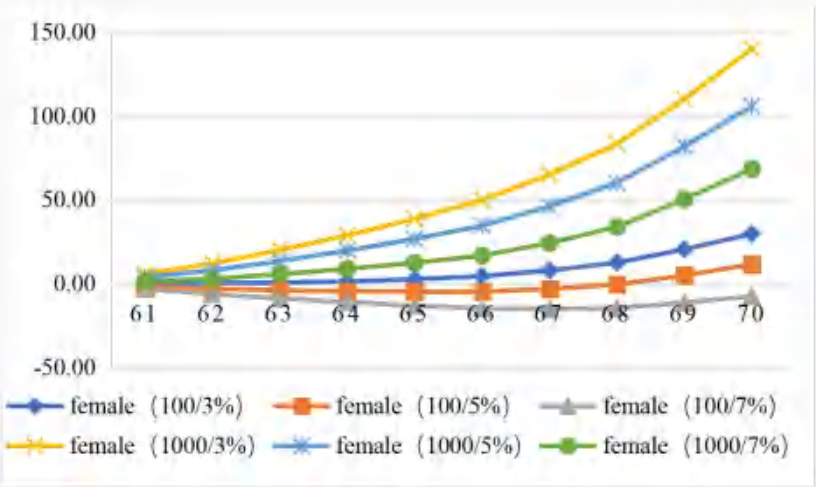


Fig. 9(b) The impact rate of the wealth of female residents on their personal pension at different discount rates

As can be seen from Table 9 and Fig. 9, there is a negative correlation between the discount rate and the impact rate of personal pension wealth for male and female residents, subject to the control of the remaining baseline assumptions. At the same age of delay, the impact rate of personal pension wealth of male and female residents decreases gradually with the increase of discount rate, and the higher the discount rate, the greater the loss rate of personal pension wealth of residents.

For male residents, when the contribution grade is the benchmark, at 100 yuan per person per year, a delay in the pension age at a discount rate of 3%, 5% or 7% will damage the personal pension wealth of male residents after "retirement". At the same age of deferment, the higher the discount rate, the greater the damage to the personal pension wealth of male residents.

For female residents, when the contribution grade is the benchmark, at 100 yuan per person per year and a discount rate of 3%, the impact of deferred age of 1-3 on the pension wealth of female residents is 0.24%, 0.34%, and 0.45%, respectively. When

the discount rate is 5% and 7%, delays in "retirement" are bound to result in a reduction in their pension wealth, regardless of delaying retirement age. Delayed "retirement" does not result in damage to the personal pension wealth of female residents when the contribution level is 1,000 yuan per person per year.

(4) Impact of different resident income growth rates on residents' pension wealth after delayed "retirement"

The income growth rate of urban and rural residents is divided into four categories, namely, low-grade income growth rate of 5%, medium-grade income growth rate of 7% as the benchmark, high-grade income growth rate of 1%, mand high-grade income growth rate of 12%, respectively, to estimate the impact rate of personal pension wealth of male and female residents under different income growth rates, the results are shown in Table 10 and Fig. 10.

Table 10 Impact Rate of Personal Pension Wealth of Male and Female Residents at Different Income Growth Rates (units: %)

| Payment Grade | Delay refund age | Male | | | | Female | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 5% | 7% | 10% | 12% | 5% | 7% | 10% | 12% |
| 100 | 61 | -3.63 | -3.09 | -1.99 | -1.03 | 0.07 | 0.24 | 1.58 | 3.26 |
| | 62 | -7.46 | -6.43 | -4.35 | -2.56 | 0.16 | 0.34 | 3.47 | 7.02 |
| | 63 | -11.11 | -9.54 | -6.37 | -3.68 | 0.53 | 0.45 | 6.48 | 12.33 |
| | 64 | -14.99 | -12.95 | -8.88 | -5.47 | 0.77 | 1.18 | 10.13 | 18.62 |
| | 65 | -19.20 | -16.77 | -12.07 | -8.27 | 0.86 | 2.50 | 14.53 | 26.09 |
| | 66 | -23.83 | -21.18 | -16.25 | -12.56 | 1.42 | 4.30 | 19.85 | 34.97 |
| | 67 | -28.35 | -25.46 | -20.38 | -16.93 | 2.90 | 7.72 | 27.93 | 47.89 |
| | 68 | -33.52 | -30.63 | -26.09 | -23.75 | 4.46 | 12.35 | 38.24 | 64.22 |
| | 69 | -38.71 | -35.88 | -32.14 | -29.35 | 6.25 | 20.33 | 54.40 | 89.21 |
| | 70 | -46.17 | -44.27 | -40.76 | -37.46 | 11.81 | 29.53 | 73.18 | 118.61 |

Table 10 Impact Rate of Personal Pension Wealth of Male and Female Residents at Different Income Growth Rates (units: %) (continued Table)

| Payment Grade | Delay refund age | Male | | | | Female | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 5% | 7% | 10% | 12% | 5% | 7% | 10% | 12% |
| 1000 | 61 | 1.24 | 1.86 | 2.88 | 3.62 | 4.62 | 5.72 | 7.69 | 9.19 |
| | 62 | 2.04 | 3.19 | 5.06 | 6.36 | 9.57 | 11.88 | 16.07 | 19.32 |
| | 63 | 3.47 | 5.22 | 8.01 | 9.92 | 16.01 | 19.80 | 26.78 | 32.26 |
| | 64 | 4.36 | 6.58 | 10.02 | 12.26 | 23.15 | 28.63 | 38.85 | 47.01 |
| | 65 | 4.49 | 6.99 | 10.61 | 13.63 | 31.11 | 38.51 | 52.53 | 63.91 |
| | 66 | 3.55 | 6.03 | 9.15 | 11.64 | 40.03 | 49.64 | 68.15 | 83.42 |
| | 67 | 3.01 | 5.45 | 7.86 | 10.02 | 52.31 | 64.88 | 89.51 | 110.19 |
| | 68 | 0.81 | 2.72 | 5.23 | 7.19 | 66.99 | 83.18 | 115.50 | 143.17 |
| | 69 | -2.34 | -0.11 | 1.92 | 3.88 | 88.42 | 109.86 | 153.55 | 191.77 |
| | 70 | -13.70 | -10.84 | -7.36 | -4.20 | 112.13 | 139.71 | 197.11 | 248.39 |

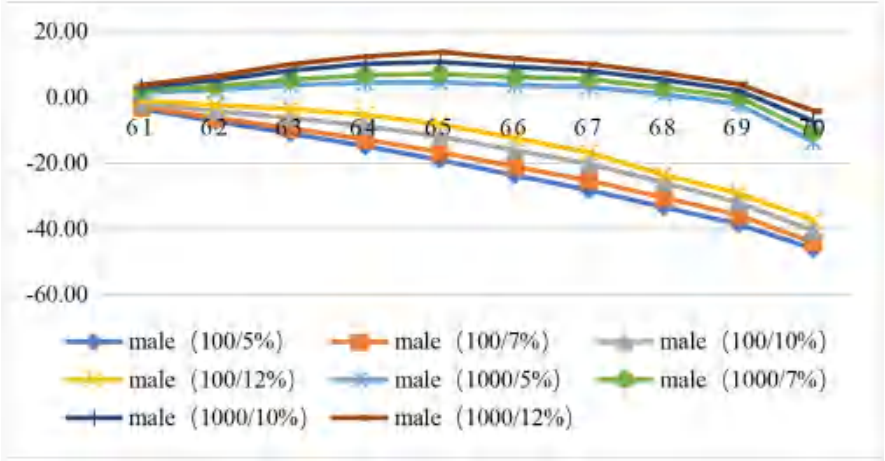


Fig. 10 The impact rate of personal pension wealth for male residents at different income growth rates

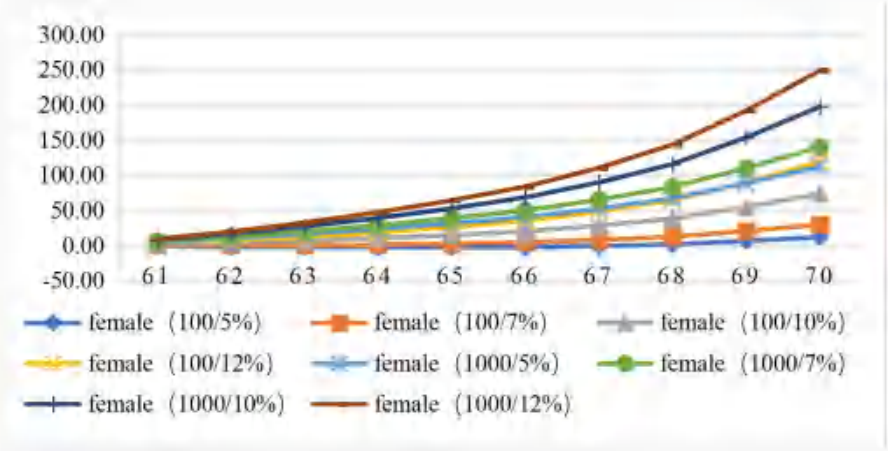


Fig. 10(b) Impact rate of personal pension wealth for female residents at different income growth rates

As can be seen from Table 10 and Fig. 10, under the 2 payment grades, the impact rate of personal pension wealth of male and female residents increases gradually with the increase of the income growth rate of urban and rural residents, under the condition that the remaining baseline assumption parameters remain unchanged and the age is delayed in the same way. The reason for this is that the increase in per capita income has led to an increase in the cumulative amount of pension in individual accounts, which in turn has increased the level of pension entitlements during the "retirement" period and increased the pension income of residents.

For male residents, when the contribution grade is 100 yuan per person per year, delayed "retirement" at four income growth rates is bound to result in a loss of personal pension wealth for male residents, and the loss rate increases gradually as the "retirement" age increases. But in the case of delaying age consistency, higher income growth rates can reduce the loss of pension wealth for male residents.

## 5. Research conclusions and policy recommendations

### 5.1 Research conclusions

#### *5.1.1 The conclusion of the study on "Middle Employees" in the system of urban workers*

(1) The level of personal pension wealth of male and female workers is affected by the delayed retirement age

Under the benchmark conditions, delaying retirement age for male workers reduces personal pension income, and delaying retirement for female workers within a certain deferred age range does not reduce personal pension income.

(2) Postponing the retirement age may increase or decrease the personal pension wealth of male and female workers

The change of employee's pension wealth is closely related to its salary growth rate, life expectancy, gender difference and other influencing parameters. Among them, there is a positive correlation between the salary growth rate and life expectancy and the impact rate of pension wealth. There is a negative correlation between pension adjustment ratio, discount rate and pension wealth impact rate.

#### *5.1.2 Conclusions of the study on "New Urban and Rural Residents" in the urban and rural residents system*

(1) The level of personal pension wealth of male and female residents is affected differently by the deferred age

Under the benchmark assumption parameters, the delay in the pension age of male residents will reduce the personal pension income, and the delay of female residents from receiving the pension age will not reduce the personal pension income.

(2) Postponing the pension age may increase or decrease the personal pension wealth of residents

The change of resident's pension wealth is closely related to the influencing parameters such as life expectancy, contribution grade, discount rate and resident

income growth rate. Among them, there is a positive correlation between contribution grade, life expectancy, income growth rate of urban and rural residents and the impact rate of residents' pension wealth. There is a negative correlation between the discount rate and the impact rate of residents' pension wealth.

## 5.2 Policy recommendations

### *5.2.1 Improve the basic pension scheme*

For those insured whose contribution time exceeds a certain number of years, the basic pension income shall be increased by a certain proportion or amount, i.e. the pension for the contributory years shall be increased, and the basic pension payment standard shall be further improved. In addition, it is proposed to increase the amount of pension payments for the contributory years in stages, in accordance with the principle of more and more, less and less.

### *5.2.2 Adjust the personal account book rate*

A higher interest rate is given to the insured whose contribution time exceeds a certain number of years. This will help to increase the pension income of individual accounts, and encourage the insured to make long-term contributions, non-stop payment, non-payment.

### *5.2.3 Implement flexible, targeted deferred retirement programs*

The pension payment standards of urban workers and urban and rural residents are not consistent with the current statutory pension age, therefore, the delay in the pension age should not be one-size-fits-all, different groups should be flexible, targeted design of delayed retirement programs, accurate policy. It is recommended to set the retirement age elastic interval, in which employees and residents can freely choose the retirement age.

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# Operational Efficiency Evaluation of Urban and Rural Residents' Basic Pension Insurance System and Influencing Factors —Based on DEA-Tobit Analysis

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**Key words:** Basic pension insurance for urban and rural residents; operating efficiency; DEA-Tobit analysis

**Abstract：** With the rapid development of China's economy and the intensified transformation of social structure, the trend of population aging and family structure miniaturization is becoming more and more obvious, and the problem of old-age care for urban and rural residents is becoming more and more prominent. In 2014, China began to implement a unified basic pension insurance system for urban and rural residents, aimed at further guaranteeing the basic life of the elderly. The basic old-age insurance for urban and rural residents is an indispensable part of China ’s social security system, and its operational efficiency is directly related to the level of welfare benefits that the elderly group can receive. Based on the panel data of 31 provinces (autonomous regions and municipalities directly under the Central Government) from 2013 to 2018, this paper uses the DEA-Malmquist and Tobit models to analyze the operational efficiency evaluation and influencing factors of China's urban and rural residents' basic pension insurance system. The results of the DEA model show that in 2018, 19 provinces did not reach DEA effectiveness, of which 8 provinces had a pure technical efficiency of less than 1; non-DEA effective regions had scale efficiency of less than 1, of which 18 provinces were in diminishing returns to scale. Only NeiMengGu is in increasing returns to scale; from the perspective of the overall efficiency value, the efficiency in the east of China is the most advanced, followed by the west, the lowest in the middle, and there are significant differences between regions. The Malmquist index calculation shows that in the past five years, China's urban and rural housing insurance efficiency has declined, mainly restricted by technological progress; 15 provinces with positive total factor productivity growth have all benefited from the contribution of scale efficiency; total factor productivity has negative growth All 16 provinces are constrained by technological progress. The results of the Tobit model show that the level of urbanization has a significant positive impact on the efficiency of the urban and rural residents ’basic pension insurance system, and the regional GDP growth rate and the number of years of education per capita have a significant negative impact. Based on this, it is proposed that various regions should implement differentiated efficiency improvement strategies according to their own problems, further improve system innovation, and promote new urbanization construction policy suggestions.

## 1.引言

数据显示，截至 2019 年年底，我国 60 周岁及以上人口达 2.54 亿人，占全国总人口的 18.1%；其中，65 周岁及以上人口为 1.66 亿人，占总人口的 11.9%，人口老龄化较为严重。20 世纪 70 年代末由于政治经济等因素的影响，计划生育工作力度空前强大，这直接影响到 2040 年左右我国人口老龄化的进程。对于已成为“老年型社会”的中国社会来说，养老问题成为影响经济健康发展、社会和谐稳定的关键所在。为了应对严峻的养老风险挑战，我国先后建立了新型农村社会养老保险制度和城镇居民社会养老保险制度，并于 2014 年 2 月将其组合为城乡居民基本养老保险制度（以下简称为“城乡居保”）。经过多年的运行发展，我国城乡居保制度已初具规模，据人社部数据显示，2019 年城乡居保参保人数达到 5.33 亿人，占全国总人口的 38.1%，实际领取待遇人数 1.60 亿人；同时全年城乡居保基金收入 4107 亿元，支出 3114 亿元，年末基金累计结存达 8249 亿元。面对如此庞大的基金规模和覆盖人数，保持城乡居保制度的稳定高效运行已成为工作重心之一。2019 年我国基本养老保险基金收益率为 9.03%，养老金待遇增长却高达 10%，待遇增长率超过了投资回报率，这将加剧养老金缺口，故提高养老金运行效率很有意义。那么，我国城乡居保的运行效率如何？哪些因素影响了我国养老保险基金的运行效率？其影响结果是怎样的以及如何改善效率？因此，及时对我国城乡居保运行效率进行评估分析，了解其运行状况并发现潜在问题，对于提高城乡居保体系运行能力，保障城乡居保制度平稳可持续发展有着重大现实意义。

## 2.文献综述

对于养老保险制度的运行效率问题，国外学者更早关注并对其展开相应研究。早在 1958 年，Samuelson[1]就首次提出了世代交替模型，自此奠定了养老保险效率研究的理论基础。之后，Diamond (1965)[2]、Feldstein (1974)[3]等学者就在此基础上，分别就养老保险的现收现付制与完全累积制对改进经济效率问题进行了深入的探讨和研究。Kotlikoff(1987)[4]在之前研究基础上，创立了动态生命周期模型对两种制度进行了进一步研究。Hebbel (1999)[5]针对拉美国家养老保险制度改革进行了深入研究。Holzman(2001)[6]则通过对全球 35 个国家数据进行分析，提出养老保险制度改革的效率评价标准和基本目标。Bikker (2008)[7]研究了荷兰人寿保险行业的竞争和效率问题。Wanke(2016)[8]利用两阶段 DEA 模型对巴西保险业进行分析，认为保险公司异质性会对效率产生影响。

在研究我国社会养老保险制度效率时，我国学者也采取了不同类型的研究方法。寇国明等（2007）[9]借鉴 Samuelson 的世代交替模型构建出中国基本养老保险效率模型，并提出中国基本养老保险制度不仅可以实现帕累托效率改进，还将会促进经济长期均衡增长。张怡恬（2013）[10]从社会效率、经济效率、政治效率、文化效率和中观效率等五个角度对社会养老保险制度进行分析与评价，进而分别提出提高制度效率的措施。吴永求等（2014）[11]提出了养老保险效率公平权衡理论，对不同养老保险制度的效率与公平进行定量评价，以养老金待遇的标准差系数度量公平，用养老金替代率的标准差系数来度量效率，从而为养老保险制度设计提供参考。汪然（2016）[12]认为需要从财务、安全、公平和信任四个维度去分

析我国的养老保险运行情况，通过人口平衡发展让养老金平衡发展。马海超等（2017）[13]采用 Malmquist 模型，对中国各区域养老保险效率的年际动态变化进行了分析，得出中、西部地区的综合效率增长相对较快的结论。李婷婷（2018）[14]则先后通过基尼系数和加权变异系数对我国社保基金收支差异进行测量，结果显示我国各省社会保险基金基本呈“W”发展趋势，我国各省份间社保基金收支差异有所扩大。

学界对我国养老保险制度效率的评价也有所差异。杨秀玲等（2014）[15]利用 PCA－DEA 模型综合评估了 24 个省市基本养老保险制度的运行效果，认为 2012 年这些省市养老保险制度整体运作处于较好水平，同时彼此间存在着明显的差异；郭曦等（2016）[16]认为我国现行的“统账结合”的养老保险制度造成不公平现象，在养老保险基金运用效率方面也表现不佳，应通过对现行的养老保险制度调整来缩小不同群体、不同地区之间养老保险水平的差距；于宁（2017）[17]从经济性、效率性、有效性角度构建了我国基本养老保险基金支出绩效评价指标体系，通过对 2003-2015 年数据分析后，认为财政补助力度不足、女性法定退休年龄过低、基本养老金替代率水平偏低、多支柱养老体系匮乏等原因拉低了综合得分。伊茹等（2019）[18]则选取养老保险制度经济性、效率性、有效性视角建立养老保险制度绩效评价指标体系，再通过广义 DEA 方法构建基本养老保险制度绩效评价模型，最终结果显示我国各省份城镇职工基本养老保险制度绩效整体处于偏低水平，与其经济发展水平不协调；

综上所述，运用数据包络分析法（DEA）来分析我国城乡居保制度运行效率已经比较成熟，然而目前的研究主要仍存在以下两个问题：一是传统 DEA 模型仅可分析某一年份截面数据，出于前沿面异质性问题不能用于分析跨年度面板数据；Wheelock P（1999）[19]就在其文章中指出 BCC 模型只能水平式分析同一期间的资料，不能探究不同时期的效率变动，而 Malmquist 指数则在运用面板数据基础上，引入距离函数的概念，从而求出可作为垂直比较分析的生产率指数即 Malmquist 指数，这样就弥补了 BCC 模型不能分析不同时期效率变动的缺点。二是学者们在检测了城乡居保运行效率值后，对其影响因素的探讨并不全面，如胡扬名等（2019）[20]在分析影响因素时忽略了居民收入和人口素质等因素。因此，本文在用 DEA 模型分析 2019 年城乡居保效率的基础上，引入 Malmquist 指数来探讨 2013-2019 年全要素生产率变动原因，再通过 Tobit 模型来分析影响我国城乡居保运行效率的宏观因素，最后根据实证分析结果提出相应政策建议。

## 3.研究方法与模型构建

数据包络分析（Data Envelopment Analysis， DEA）方法是一种对被评价对象进行相对比较的非参数技术效率分析方法，是一种可以评价具有多投入产出的决策单元（DMU）相对效率的评价工具，由美国的 Charnes、Cooper 和 Rhodes（1978）[21]三人于 1978 年首次提出。这种方法无需对指标数据无量纲化处理，不需要人为预先限定参数，从而可以避免确定权重而带来的主观性，做到“一视同仁”，近年来广泛用于评价制度投入产出效率。栾文敬等（2013）[22]认为通过包络分析法估算出的投入产出效率是一组取值介于 0 到 1 之间的连续数值，若采用最小二乘法进行估计的话，因其并不满足正态分布假设，可能得不到一致估计，所以对于 DEA 的运算结果一般选用截断数据的 Tobit 模型进行进一步研究分析。

### 3.1 构建 DEA 模型分析截面数据

本文采取产出导向型 BCC 模型（Banker 等（1984）[23]），BCC 模型基于规模收益可变（Variable Returns to Scale，VRS），得出的技术效率可以排除规模的影响。模型规划式为：

$$\min_{\theta,\ \lambda}\theta \tag{1}$$

$$\sum_{i=1}^{n}\lambda_i X_i \le \text{s.t.}\,\theta \mathrm{X}_{i_0} \tag{2}$$

$$\sum_{i=1}^{n}\lambda_i X_i \ge Y_{i_0} \tag{3}$$

$$\sum_{i=1}^{n}\lambda_i = 1 \tag{4}$$

$$\lambda \ge 0，\ i = 1,2,3，\ldots，n$$

其中，$X_{i_0}$ 表示第 $\mathrm{i}_0$ 个省份的投入向量，$Y_{i_0}$ 表示第 $\mathrm{i}_0$ 个省份的产出向量，$\lambda_i$ 表示权重系数，所求得的 $\theta$ 表示各省份的城乡居保运行效率值。当 $\theta=1$ 时，表示该地区位于前沿面上，该省份 DEA 有效；当 $\theta<1$ 时，表示该地区不位于前沿面上，该省份 DEA 无效。

### 3.2 引入 Malmquist 指数分析面板数据

由于引入时间因素的话，会改变生产前沿面，因此传统 BCC 模型适用于截面数据，而 Malmquist 指数适用于面板数据，可衡量不同时期效率水平。Malmquist 生产力变动指数模型是一种比较经典的非参数效率测度方法，能够用来衡量各决策单元（DMU）的综合效率变动和技术进步变化情况（Malmquist（1953）[24]）。Malmquist 指数模型的基本运算思路是，首先定义 s 期以及 s+ 1 期的产出项、投入项，通过 DEA 法构建决策单元的效率前沿面，再引入距离函数计算各 DMU 到效率前沿面的距离，同时基于 s 期和 s+1 期的的距离函数值，得到 Malmquist 指数。

根据 Fare 等（1994）[25]对 Malmquist 指数的定义，可将 Malmquist 指数分解为技术效率进步指数（TP）和技术效率变化指数（TEC），其中技术效率变化指数（TEC）又可分解为规模效率变动指数（SEC）和纯技术效率变化指数（PTEC）。其中，技术效率变化指数（TEC）表示不同时期实际产出水平与各自最优产出水平距离之比，技术效率进步指数（TP）表示相同投入在不同时期的最优产出水平之比，规模效率变动指数（SEC）是通过比较不同时期的规模效率来反应其规模报酬变动，纯技术效率变化指数（PTEC）是可变动规模报酬假定下的技术效率变化。综上，全要素生产率可以表示为：

$$M(X^{t+1},\ Y^{t+1};\ X^{t},\ Y^{t}) = TEC * TP = SEC * PTEC * TP \tag{5}$$

Malmquist 指数小于 1 表示城乡居保运行效率降低，大于 1 表示运行效率有

所提高，等于 1 表示城乡居保运行效率情况没有变化。当构成 Malmquist 生产率指数的某一分解指数大于 1 时，则表明该指数是导致生产率整体水平提高的原因，反之则是引起生产率整体水平降低的原因。

### 3.3 构建受限因变量（Tobit）模型探究城乡居保运行效率影响因素

韩华为等（2010）[26]认为 Tobit 模型属于受限因变量模型，适用于研究分析因变量在一定约束条件下取值的回归情况。由于本文因变量选择的是 DEA 模型测得的城乡居保综合效率值是一组取值在 0 到 1 之间的连续数值，即为双侧受限，因此选用 Tobit 回归模型来分析城乡居保运行效率与其影响因素之间的关系。构建的 Tobit 模型公式如下：

$$Y_i=\beta_i X_i+\varepsilon_i+C \tag{6}$$

其中 $Y_i$ 表示第 $i$ 省份城乡居民基本养老保险制度运行效率，$X_i$ 表示影响城乡居保运行效率的各个因素，$\beta_i$ 为系数向量，$C$ 为常数项，误差项 $\varepsilon_i$ 独立且服从正态分布：$\varepsilon_i \sim N(0,\sigma^2)$。

## 4.指标选取及数据来源

### 4.1 DEA 模型投入产出指标选取

综合刘晓玲等（2017）[24]、朱梅等（2019）[25]、李涛（2018）[26]和强国民（2020）[32]等人研究，同时基于数据的可得性，本文共选取了八项指标。其中基金收入、参保人数、基金支出、实际领取待遇人数和累计结余这五项指标因其可以直接在地区国民经济和社会发展统计公报中找到，因而学者均选择了这五项指标。覆盖率、替代率和领取率这三项指标分别根据上述诸位学者的研究综合考量后选取。

本文城乡居民基本养老保险投入指标选择基金收入和参保人数；产出指标选取基金支出、实际领取待遇人数、累计结余、覆盖率、替代率和领取率。基金支出和实际领取待遇人数是直接产出。基金累计结余是衡量养老保险基金持续支付能力的关键指标。覆盖率用来衡量城乡居保覆盖程度，一般采用参保人数/应参保人数来计算，基于数据的可选择性和严谨性，应参保人数计算方法为该省份 15 周岁以上总人口数减去城镇职工基本养老保险参保人数。养老金替代率是用来衡量参保者退休前后生活水平差异的指标，以人均养老金领取额/农村居民人均可支配收入计算，其中人均养老金领取额计算方式为基金支出/实际领取待遇人数。领取率是实际领取待遇人数占参保人数的比率，直接影响到养老金收支及支付能力。

表 1 城乡居运行效率 DEA 模型的投入、产出指标设置

| 指标分类 | 具体指标 | 指标单位 | 指标定义 |
|---|---|---|---|
| 投入指标 | 基金收入 | 亿元 | 城乡居保基金年度收入金额 |
| | 参保人数 | 万人 | 城乡居保基金年度参保人数 |
| | 基金支出 | 亿元 | 城乡居保基金年度支出金额 |
| | 实际领取待遇人数 | 万人 | 城乡居保基金年度实际领取待遇人数 |
| 产出指标 | 累计结余 | 亿元 | 年末城乡居保基金累计结余金额 |
| | 覆盖率 | % | 参保人数/应参保人数 |
| | 替代率 | % | 养老金人均领取额/农村居民人均可支配收入 |
| | 领取率 | % | 实际领取待遇人数/参保人数 |

## 4.2 影响因素指标

本文基于 DEA 模型测算得出城乡居民基本养老保险运行效率后，综合李胜会等（2016）[27]、王翠琴等（2020）[28]、薛兴利等（2020）[29]、彭媛媛（2018）[30]、王祥明（2013）[31]、强国民（2020）[32]、吕文广（2010）[33]等研究成果及我国城乡居保发展实际，地区经济发展水平、老年人口抚养比、农村居民人均可支配收入增速、地方财政社保支出水平、受教育水平和城镇化率可能对各省份间城乡居保运行效率产生影响。

4.2.1 地方经济发展水平

以地区国民生产总值（GDP）同比增长率来衡量地区经济发展水平。地区经济发展水平是影响一个地区基本养老保险效率的重要因素。一般情况下，一个地区经济发展水平越高，政府就有更多财政预算用于社保支出，该地区的社会保障水平也就越高，其中的养老保障水平也就越高。但从另一方面来讲，地区经济实力越强，投入越多，造成冗余和浪费的风险也越大，反而会造成城乡居保制度运行效率的下降。所以经济发展水平对城乡居保效率的影响方向和程度需要实证检验。

4.2.2 老龄化程度

以老年人口抚养比来衡量地区老龄化程度。人口结构是对养老保险制度运行效率的重要影响因素，伴随我国人口老龄化水平的不断提升，老年人口抚养比也随即提高，老年人口对城乡居保基金的需求就越大，养老金领取率会不断升高，需要更多的资金来保障，城乡居保制度的运行效率将难以保证。

4.2.3 居民收入水平

以农村居民人均可支配收入增速来衡量一个地区农村居民收入水平。居民收入水平会对城乡居保制度的运行效率产生重要影响，人均可支配收入增速越高，居民就有更多闲置资金来参投城乡居保，养老保障水平越高，但同时造成冗余浪费的风险也越大，因此居民收入水平对城乡居保效率的影响方向和程度需要实证检验。

4.2.4 地方财政社保支出水平

以地方财政社会保障支出占地方财政总支出的比例来衡量地方财政社保支出水平。地方财政补贴是城乡居民基本养老保险基金收入的重要来源之一，地方财政补贴越高，基金总额越高，也会带动更多居民投保，城乡居保运行效率就越

高。但是，由于中国各地区政府公共服务能力差异性较大，对养老保险效率的影响可能也存在一定差异性。

4.2.5 受教育水平

以地区居民平均受教育年限来衡量受教育水平。居民受教育水平对城乡居保制度的运行效率会有一定的影响。一方面，居民受教育水平越高，参保的思想意识也就越高，预计会有更多人参投城乡居保，将提升运行效率；另一方面，受教育程度较高的居民可能会通过投保商业养老保险的方式来规避养老风险，反而不愿意投保“回报低”的城乡居保。因而受教育水平对城乡居保效率的影响方向和程度需要实证检验。

4.2.6 城镇化率

以地区城镇人口占地区总人口的比值来衡量城镇化率。城镇化率对城乡居保制度的运行效率会有一定的影响，城镇化有利于资本和劳动力的集聚，“集聚”效应会提高居民收入水平，地方财政和居民也将有更多资金投入到基金中，对提升运行效率很有利。

表 2　城乡居保运行效率 Tobit 模型的变量设置

| 变量属性 | 变量名称 | 变量单位 | 变量符号 | 变量定义 |
|---|---|---|---|---|
| 被解释变量 | 城乡居保运行效率 | - | $Y^*$ | 制度运行效率的综合效率值 |
| 解释变量 | 地区经济发展水平 | % | $X_1$ | （本年度 GDP-上年度 GDP）/上年度 GDP |
| | 老龄化程度 | % | $X_2$ | 65 岁以上人口数/劳动年龄人口数 |
| | 居民收入水平 | % | $X_3$ | （本年度人均收入-上年度人均收入）/上年度人均收入 |
| | 地方财政社保支出水平 | % | $X_4$ | 地方财政社会保障支出/地方财政支出 |
| | 受教育水平 | % | $X_5$ | 平均受教育年限 |
| | 城镇化率 | % | $X_6$ | 地区城镇人口/地区总人口 |

## 4.3　数据来源

城乡居民基本养老保险制度自 2014 年 2 月合并实施，但其数据统计口径可以上溯到 2012 年，考虑到指标选取和变量选择时数据可得性，本文采取 2013-2019 年我国 31 个省（直辖市、自治区）城乡居民基本养老保险数据，具体来源为各年度的《中国统计年鉴》、各省份每年的统计年鉴和各省份每年的国民经济和社会发展统计公报。同时根据国家统计局相关规划，将我国大陆 31 个省级单位分划为东部、中部、及西部地区。

# 5. 实证结果与分析

## 5.1　城乡居保运行效率静态分析

本文运用 DEAP2.1 软件结合 DEA 模型对 2019 年我国 31 个省级单位的城乡

居保运行效率进行了测算，结果如表 3 所示。

表 3 2019 年我国 31 省份城乡居保运行效率值

| 地区 | | 综合效率 | 纯技术效率 | 规模效率 | 规模报酬 |
|---|---|---|---|---|---|
| 东部地区 | 北京 | 1.000 | 1.000 | 1.000 | — |
| | 天津 | 1.000 | 1.000 | 1.000 | — |
| | 河北 | 0.932 | 1.000 | 0.932 | drs |
| | 上海 | 1.000 | 1.000 | 1.000 | — |
| | 江苏 | 1.000 | 1.000 | 1.000 | — |
| | 浙江 | 1.000 | 1.000 | 1.000 | — |
| | 山东 | 0.859 | 1.000 | 0.859 | drs |
| | 广东 | 1.000 | 1.000 | 1.000 | — |
| | 海南 | 0.862 | 0.890 | 0.968 | drs |
| | 福建 | 0.904 | 0.957 | 0.945 | drs |
| | 辽宁 | 0.986 | 1.000 | 0.986 | — |
| | 平均值 | 0.958 | 0.986 | 0.972 | |
| 中部地区 | 山西 | 0.951 | 1.000 | 0.951 | drs |
| | 吉林 | 0.947 | 0.959 | 0.986 | — |
| | 黑龙江 | 0.956 | 0.959 | 0.997 | drs |
| | 安徽 | 0.836 | 1.000 | 0.836 | drs |
| | 江西 | 0.860 | 0.920 | 0.935 | drs |
| | 河南 | 0.916 | 1.000 | 0.916 | drs |
| | 湖北 | 0.830 | 0.937 | 0.885 | drs |
| | 湖南 | 0.943 | 1.000 | 0.943 | drs |
| | 平均值 | 0.905 | 0.972 | 0.931 | |
| 西部地区 | 内蒙古 | 0.995 | 0.997 | 0.997 | irs |
| | 广西 | 0.955 | 0.998 | 0.957 | drs |
| | 重庆 | 0.941 | 1.000 | 0.941 | drs |
| | 四川 | 0.971 | 1.000 | 0.971 | drs |
| | 贵州 | 1.000 | 1.000 | 1.000 | — |
| | 云南 | 0.917 | 0.984 | 0.932 | — |
| | 西藏 | 1.000 | 1.000 | 1.000 | — |
| | 陕西 | 0.902 | 1.000 | 0.902 | drs |
| | 甘肃 | 0.899 | 1.000 | 0.899 | drs |
| | 青海 | 0.996 | 1.000 | 0.996 | drs |
| | 宁夏 | 1.000 | 1.000 | 1.000 | — |
| | 新疆 | 0.844 | 0.844 | 1.000 | — |
| | 平均值 | 0.952 | 0.985 | 0.966 | |
| 全国均值 | | 0.942 | 0.982 | 0.959 | |

注：“—”为规模报酬不变，drs 为规模报酬递减，irs 为规模报酬递增。

从全国来看，2019 年全国城乡居保运行效率处于较高水平，综合效率值为 0.942，纯技术效率值达到 0.982，而规模效率值为 0.959。因综合效率＝纯技术

效率×规模效率，可以得出各省份纯技术效率对城乡居保运行综合效率影响不大，影响综合效率的原因主要在规模效率上，说明各地区在城乡居保基金规模上有着一定差距。

从地区来看，2019 年我国西部、中部与东部地区城乡居保的综合效率均值分别为 0.958、0.905 和 0.952，在综合效率上整体呈现出东部＞西部＞中部的格局，其中中部地区的综合效率、纯技术效率和规模效率均低于全国平均水平。东部地区 11 省份中有 6 省份达到 DEA 有效，西部地区 12 省份中有 3 省份达到 DEA 有效，而中部 8 省均未达到 DEA 有效，差距较明显。

从各省份来看，2019 年全国共有北京等 9 省份达到 DEA 有效，综合效率值为 1，反映出这些省份城乡居保运行效率很高，在纯技术效率和规模效率上都领先其他省份。河北、山东、四川、辽宁、山西、河南、湖南、陕西、重庆、安徽、甘肃和青海这 12 个省份纯技术效率为 1，而规模效率值小于 1，表明这些省份在制度管理运作上已经很成熟，但受到基金规模的制约从而未达到前沿状态。新疆则是规模效率值为 1，但纯技术效率全国最低，说明新疆自治区的基金规模效率已经达到极高状态，但是在城乡居保的运作管理上效率较低。而福建、江西和湖北三省份在纯技术效率和规模效率上都低于全国平均水平，说明这些地区的城乡居保运行效率较低，有较大提升空间。

从规模报酬来看，2019 年全国共有北京等 13 省份处于规模报酬不变的状态，综合运行效率较好，投入与产出能做到同比例变动。内蒙古自治区则处于规模报酬递增状态，说明内蒙古地区提高城乡居保运行效率可以采用继续增加投入这一方法。而河北等 17 省份处于规模报酬递减状态，这些省份继续增加投入并不能提高综合运行效率。

## 5.2 城乡居保运行效率动态分析

将 DEA 模型与 Malmquist 指数结合，运用 DEAP2.1 软件对 2013-2019 年我国总体城乡居保运行效率的平均 Malmquist 指数变动进行测算，结果如表 4 所示。

表 4　2013—2019 年我国城乡居保运行效率 Malmquist 指数变化及其分解

| 年份 | 效率变化（TEC） | 技术进步（TP） | 纯技术效率（PTEC） | 规模效率（SEC） | 全要素生产率（TFP） |
|---|---|---|---|---|---|
| 2014 | 1.072 | 0.910 | 1.024 | 1.047 | 0.976 |
| 2015 | 0.983 | 0.977 | 0.989 | 0.993 | 0.960 |
| 2016 | 0.977 | 1.057 | 1.001 | 0.976 | 1.033 |
| 2017 | 1.091 | 0.893 | 0.999 | 1.092 | 0.974 |
| 2018 | 0.977 | 1.029 | 1.000 | 0.977 | 1.006 |
| 2019 | 0.988 | 1.056 | 1.012 | 0.976 | 1.043 |
| 平均值 | 1.019 | 0.981 | 1.003 | 1.016 | 0.999 |

全要素生产率（TFP）变动可分解为效率变化（TEC）与技术进步（TP），效率变化（TEC）又可分解为纯技术效率（PTEC）变动与规模效率（SEC）变动，因而：

$$TFP = TEC \times TP = PTEC \times SEC \times TP \tag{7}$$

从全要素生产率（TFP）来看，近五年间平均下降 0.1%，反映近五年我国城乡居保效率有些许下滑。在 2014 年、2015 年、2017 年全要素生产率（TFP）均为负增长，在 2016 年、2018 年和 2019 年为正增长。这与技术进步（TP）的变动趋势相似，而纯技术效率（PTEC）变动趋势除 2014 年外均与全要素生产率（TFP）变动趋势相似。而除 2015 年外，规模效率（SEC）变动与效率变化（TEC）的趋势均与全要素生产率（TFP）变动趋势相反。这说明，2016 年、2018 年和 2019 年全要素生产率上升主要源于技术进步和纯技术效率的提升，可能的原因是有更多的新技术和更先进的管理制度运用于城乡居保的运行中，削弱了规模效率下降带来的制约作用，最终提升了城乡居保运行效率。在 2014 年、2015 年和 2017 年全要素生产率的下降主要源于技术进步的滞缓和规模效率的下降。

进一步考察 2013-2019 年我国 31 省份城乡居民基本养老保险运行效率 Malmquist 指数变化，结果如表 5 所示。

表 5　2013—2019 年我国各省城乡居保运行效率 Malmquist 指数变化及其分解

| 地区 | | 效率变化（TEC） | 技术进步（TP） | 纯技术效率（PTEC） | 规模效率（SEC） | 全要素生产率（TFP） |
|---|---|---|---|---|---|---|
| 东部地区 | 北京 | 1.000 | 1.068 | 1.000 | 1.000 | 1.068 |
| | 天津 | 1.000 | 1.028 | 1.000 | 1.000 | 1.028 |
| | 河北 | 1.044 | 0.945 | 1.006 | 1.038 | 0.987 |
| | 上海 | 1.000 | 1.072 | 1.000 | 1.000 | 1.072 |
| | 江苏 | 1.000 | 1.053 | 1.000 | 1.000 | 1.053 |
| | 浙江 | 1.000 | 0.999 | 1.000 | 1.000 | 0.999 |
| | 山东 | 1.001 | 1.000 | 1.000 | 1.001 | 1.001 |
| | 广东 | 1.021 | 1.001 | 1.019 | 1.001 | 1.021 |
| | 福建 | 1.031 | 0.985 | 0.998 | 1.033 | 1.015 |
| | 海南 | 0.985 | 0.968 | 0.977 | 1.008 | 0.954 |
| | 辽宁 | 1.005 | 0.996 | 1.004 | 1.001 | 1.001 |
| | 平均值 | 1.008 | 1.010 | 1.000 | 1.007 | 1.018 |
| 中部地区 | 山西 | 1.061 | 0.974 | 1.007 | 1.053 | 1.033 |
| | 吉林 | 1.000 | 0.984 | 1.000 | 1.000 | 0.984 |
| | 黑龙江 | 1.014 | 0.967 | 1.015 | 1.000 | 0.981 |
| | 安徽 | 1.023 | 0.961 | 1.000 | 1.023 | 0.983 |
| | 江西 | 0.985 | 0.932 | 0.999 | 0.986 | 0.918 |
| | 河南 | 1.037 | 0.947 | 1.000 | 1.037 | 0.982 |
| | 湖北 | 1.007 | 0.980 | 0.998 | 1.009 | 0.987 |
| | 湖南 | 1.037 | 0.940 | 1.000 | 1.037 | 0.975 |
| | 平均值 | 1.021 | 0.961 | 1.002 | 1.018 | 0.980 |
| 西部地区 | 内蒙古 | 1.062 | 0.987 | 1.025 | 1.036 | 1.049 |
| | 广西 | 0.991 | 0.802 | 1.000 | 0.991 | 0.795 |
| | 重庆 | 1.007 | 0.992 | 1.000 | 1.007 | 0.999 |
| | 四川 | 0.994 | 0.991 | 1.000 | 0.994 | 0.985 |
| | 贵州 | 1.033 | 0.935 | 1.000 | 1.033 | 0.966 |
| | 云南 | 1.081 | 0.973 | 1.014 | 1.066 | 1.052 |

| | | | | | |
|---|---|---|---|---|---|
| 西藏 | 1.000 | 1.106 | 1.000 | 1.000 | 1.106 |
| 陕西 | 1.047 | 0.977 | 1.000 | 1.047 | 1.023 |
| 甘肃 | 1.043 | 0.966 | 1.000 | 1.043 | 1.007 |
| 青海 | 1.029 | 0.955 | 1.005 | 1.024 | 0.982 |
| 宁夏 | 1.017 | 0.947 | 1.014 | 1.003 | 0.963 |
| 新疆 | 1.039 | 0.967 | 1.019 | 1.020 | 1.004 |
| 平均值 | 1.029 | 0.959 | 1.006 | 1.022 | 0.987 |
| 全国均值 | 1.019 | 0.981 | 1.003 | 1.016 | 0.999 |

从全要素生产率变动来看，北京、山西、内蒙古等 15 省份为正增长，增长率最高的是西藏自治区 10.6%；河北、吉林、贵州等 16 省份均有不同程度的下降，下降幅度最大的是广西 20.5%。东部地区近 6 年间全要素生产率平均增长 1.8%，而中部与西部地区则分别平均下降了 2%和 1.3%。从各分解因素来看，各省份全要素生产率变动受不同因素影响。对于全要素生产率正增长的 15 省份，他们的规模效率均为正增长或不变，而除福建省外纯技术效率也为正增长，因此可得这些省份城乡居保效率提升的可能原因为组织管理更加完善和运行成本下降。对于全要素生产率负增长的 16 省份，他们的技术进步均为负增长，这说明技术创新已成为制约城乡居保运行效率提升的重要因素。

从效率变化来看，全国仅有海南、江西、广西、四川四省为负增长，说明在 2013-2019 年七年间，他们的资源配置效率有所下降。从技术进步来看，全国有北京、天津、上海、江苏、山东、广东和西藏七省呈现出技术水平的提升，西藏地区提升的可能原因是中央对口支援力度加大，其他地区则可能因为经济发达带来的技术发展。从纯技术效率变动来看，仅有福建、海南、江西、湖北四省为负增长，组织管理水平下降。从规模效率变动来看，仅有江西、广西、四川三省呈现负增长态势，可能原因是三省调整投入规模和结构导致运行成本的提升，带动规模效率下降。

## 5.3 城乡居保运行效率影响因素分析

本文运用 Eviews10 软件结合 Tobit 模型对 2019 年影响我国 31 个省级单位城乡居保运行效率的外部环境因素进行了回归分析，结果如表 6 所示。

表 6　城乡居保影响因素的 Tobit 模型回归结果

| 变量 | 相关系数 | 标准误差 |
|---|---|---|
| C | 0.974293*** | 0.182875 |
| 地区经济发展水平（X1） | -0.010486** | 0.004952 |
| 老龄化程度（X2） | -0.011372 | 0.007103 |
| 居民收入水平（X3） | 0.024732 | 0.026597 |
| 地方财政社保支出水平（X4） | 0.003649 | 0.004762 |
| 受教育水平（X5） | -0.056259* | 0.035966 |
| 城镇化率（X6） | 0.006472** | 0.003076 |

注：*表示在 10%水平下显著，**表示在 5%水平下显著，***表示在 1%水平下显著

如表 6 所示，地区经济发展水平（X1）的相关系数为-0.010486，且与城乡居保运行效率在 5%水平下显著负相关，表明经济发展速度越快的地区，其城乡居保的运行效率越低。如安徽、湖北、陕西等省份其 GDP 增长率均超过 11%，但其综合效率值反而未达到 DEA 有效；而 GDP 增长率较低的宁夏、吉林、上海等地综合效率值反而较高。可能的原因是地区经济增速较低的地区其城乡居民基本养老保险基金累计结余较低，如宁夏、吉林、上海等地累计结余分别为 32.4 亿元、62.3 亿元、81.5 亿元，远低于全国平均值 233.9 亿元，因此可能因其基金累计结余的投入冗余率较低而拉升综合运行效率，同时这些地区财政补贴水平较低，基金管理部门为了维持基金收支平衡只能尽力提高运行效率。而地区经济增速较高的地区其城乡居民基本养老保险基金累计结余也都相对较高，安徽、湖北、陕西等地基金累计结余分别为 398 亿元、305.6 亿元、222.6 亿元，可能因其基金累计结余的投入冗余率较高而拉低综合运行效率。

受教育水平（X5）的相关系数为-0.056259，且与城乡居保运行效率在 10%水平下显著负相关，表明人均受教育年限越高的地区，其城乡居保的运行效率越低。如山西、广东、海南等地区受教育年限分别为 8.9 年、8.7 年、8.9 年，高于全国均值 8.4 年，但其城乡居保综合效率反而较低；而贵州、云南、西藏等地受教育年限分别为 7.3 年、7.4 年、5.4 年，低于全国均值，但其综合效率反而较高。可能的原因是受教育年限越高的地区，在城市就业的居民就越多，大部分人参投城镇职工基本养老保险，剩下的小部分受教育年限较低的居民参投城乡居民基本养老保险，基金投入会减少，从而降低综合效率。

城镇化率（X6）的相关系数为 0.004380，且与城乡居保运行效率在 5%水平下显著正相关，表明城镇化率越高的地区，其城乡居保的运行效率越高。如北京、天津、上海等地区城镇化率分别达到 86.5%、83.1%、88.1%，远高于全国均值 60%，其城乡居保运行综合效率都较高；而河南、广西、新疆等地区城镇化率分别为 51.7%、50.2%、50.9%，低于全国均值，综合效率较低。可能的原因是随着城镇化率的提高，生产要素集聚于城镇地区，推动该地区经济迅速发展，进而对地方财政补贴城乡居保的压力进行了有效缓解。同时农民思想意识向市民靠拢，对养老保险渴求增加，推动提高城乡居保覆盖率的提高。

老龄化程度（X2）未通过显著性检验，结合现有数据可以发现，地区人口老龄化程度与城乡居保效率并无直接联系。以 DEA 有效的 9 省份为例，宁夏、西藏、广东、北京及天津五省老龄化程度均低于全国均值 15.69%，而贵州、江苏、浙江和上海四省人口老龄化程度近乎 20%，但其仍能达到 DEA 有效，因而人口老龄化程度与城乡居保效率并无联系。

居民收入水平（X3）未通过显著性检验。2019 年我国农村居民人均可支配收入平均增速为 8.84%，低于这一均值的共有 10 个省份，然而其中天津、江苏及广东三省市能够达到 DEA 有效，其余辽宁等七省则未达到 DEA 有效，所以居民收入水平与城乡居保运行效率并无直接联系。

地方财政社保支出水平（X4）未通过显著性检验，2019 年达到 DEA 有效的 9 省份中，除西藏和天津外其余七省的地方财政社保支出水平均在 11%左右，西藏的地方财政社保支出水平为 5.5%，远低于全国平均水平 13.98%；而天津为 16.3%，又高于全国平均水平，因此地方财政社保支出水平与城乡居保运行效率并无直接联系。

## 6.研究结论与政策建议

## 6.1 研究结论

本文采用我国 31 个省（直辖市、自治区）2013-2019 年数据为样本，应用 DEA-Malmquist 模型实证分析了我国城乡居民基本养老保险制度运行效率的地区差异，运用 Tobit 模型分析了效率的影响因素，得到以下基本结论：

1、整体来看 2019 年我国城乡居民基本养老保险制度运行效率较为平稳高效，纯技术效率和规模效率均处在高位；从各地区来看，我国东部地区效率最为领先，地区之间有着显著差异；从各省份来看，有 9 个省份达到 DEA 有效，省份之间差距明显。

2、全国城乡居保制度全要素生产率近五年间平均下降 0.1%，反映近五年我国城乡居保效率有些许下滑，主要受技术进步因素下滑的制约（技术进步下降 1.9%）。从地区角度来看，东部地区近 7 年间全要素生产率平均增长 1.8%，而中部与西部地区则分别平均下降了 2%和 1.3%。从省份角度来看，15 个全要素生产率为正增长的省域，均受益于规模效率的贡献；全要素生产率为负增长的 16 个省域中，均受到技术进步的制约。

3、城乡居民基本养老保险运行效率主要受城镇化水平、地区经济发展水平和受教育水平等因素影响。其中，城镇化水平对城乡居保制度运行效率具有显著正向影响；受教育水平和地区经济发展水平对其具有显著负向影响。老龄化程度、居民收入水平和地方财政社保支出水平影响不显著。

## 6.2 政策建议

基于上文研究分析，本文提议从以下几个角度来考虑如何提升我国城乡居民基本养老保险运行效率的策略：

### 6.2.1 因地制宜，制定差异化策略

不同地区、不同省份间的城乡居保运行效率有着极大差异。各省份要联系自身实际投入产出情况来采取措施提升制度效率，东部地区可以利用科技、技术等综合优势，利用新技术新知识推动技术进步，提高城乡居保运行效率；中部西部可以狠抓城乡居保基金组织管理水平，尽力拉升基金运营收益率，提高城乡居保运行效率。

### 6.2.2 制度创新，试行弹性费率制

不同地区的城乡居保运行效率所差异，如若实行费率“一刀切”政策，容易造成部分地区基金冗余浪费。在全国大规模降税降费的背景下，推进制度创新，试行有限度的弹性费率制。处于规模报酬递增状态表的内蒙古自治区可以减缓降费速率，通过缓慢增加基金收入来提高运行效率，而处于规模报酬递减状态的河北等 17 省份可以加快降费速度，在减轻居民负担的同时提高运行效率，一举两得。规模报酬不变的省份城乡居保运行效率均处在较高水平，各省可根据当年经济发展情况自行决定缴费费率。

### 6.2.3 推进新型城镇化建设，实现城乡公共服务均等化

强化服务导向和创新导向，激发城市发展的自身潜力和发展的原动力，优化公共产品和服务，努力实现城乡公共服务均等化目标，提供高质量的就业保障，缩小地区间的经济发展差距，保护环境，建设生态宜居的新型城镇，通过新型城镇化建设来推动提高城乡居保制度的平稳运行。

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# 城乡居民基本养老保险制度运行效率评估及其影响因素
# ——基于 DEA-Tobit 分析法

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**关键词**：城乡居民基本养老保险；运行效率；DEA-Tobit 分析法

**中文摘要：**伴随着我国经济的快速发展和社会结构的加剧转型，人口老龄化和家庭结构小型化趋势愈加明显，城乡居民的养老问题越来越突出。2014 年，我国开始实行统一的城乡居民基本养老保险制度，旨在进一步保障老年群体的基本生活。城乡居民基本养老保险是我国社会保障制度不可或缺的重要部分，其运行效率直接关系到老年群体所能接受到的福利待遇水平。本文基于 2013-2018 年 31 个省（自治区、直辖市）的面板数据，应用 DEA-Malmquist 和 Tobit 模型对我国城乡居民基本养老保险制度运行效率评估及其影响因素进行分析。DEA 模型结果显示：2018 年有 19 个省域未达到 DEA 有效，其中 8 个省域区纯技术效率小于 1；非 DEA 有效地区的规模效率都小于 1，其中 18 个省域处于规模报酬递减，仅内蒙古处于规模报酬递增；从整体效率值来看，我国东部地区效率最为领先，西部次之，中部最低，地区之间有着显著差异。Malmquist 指数运算显示：近五年我国城乡居保效率有所下滑，主要受技术进步的制约；15 个全要素生产率为正增长的省域，均受益于规模效率的贡献；全要素生产率为负增长的 16 个省域中，均受到技术进步的制约。Tobit 模型结果显示：城镇化水平对城乡居民基本养老保险制度运行效率具有显著正影响，地区生产总值增长率、人均受教育年限具有显著负影响。基于此，提出各地区应根据自身问题实施差异化的效率提升策略，进一步提高制度创新、推进新型城镇化建设的政策建议。

# A study on the Preference of Annuity Insurance for Family -- based on the Education of Children

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**Keywords:** Expenditure on education, annuity insurance, Economic development

**Abstract.** Under the guidance of the policy of strengthening the country of talents and education, the expenditure on family education is increasing gradually. This study starts with children's education, which is one of the main economic burdens of modern families, and analyzes the purchase preference of family annuity insurance and the underlying reasons, then puts forward relevant suggestions for industry development. This study mainly uses the methods of statistical analysis and empirical analysis, on the basis of relevant theoretical analysis, through the analysis of China Family Panel Studies (CFPS) data, to find the real choice preference of personal annuity insurance for family . Further exploring the factors that affect the preference of families to purchase annuity insurance, through the Logit model, this paper studies the influence of children's education stage on the choice preference of family annuity insurance, and finally puts forward some suggestions for the future layout of the industry. Through systematic analysis, I found that: first of all, families have a stronger preference for non-pension insurance when their children are young. Secondly, there are differences in the influence of different stages of education on the choice of annuity insurance . Finally, it is proposed that annuity insurance should be continuously optimized from the aspects of underwriting period and payment flexibility, and share the family financial burden in all directions and in many periods, so as to provide economic guarantee for the development of the next generation , to improve the labor efficiency of young people and promote economic development, in the face of the increasingly serious problem of aging in the country.

## 1.引言

社会转型和人口结构改变将对我国家庭资本配置产生深远影响。科技发展对人力资本需求的凸显会进一步提升家庭对教育投入的重视程度，促使教育投资逐步成为家庭主要支出之一。据第七次人口普查结果显示，我国 14 岁以下人口占总人口 17.97%，比 2010 年上升 1.35 个百分点，60 岁以上人口占比为 18.70%，比 2010 年上升 5.44 个百分点，其中 65 岁以上人口占比达 13.50%，相比 2010 年上升 4.63%。三个人口阶段中，仅 15-59 岁群体占比下降 6.79 个百分点，表明中年家庭决策者面临的经济压力日趋严峻。

社会发展推动家庭结构日益小型化，但出于社会保障制度建设情况和传统家庭观念，我国家庭的主要经济模式仍以“三代式”为主。人均寿命延长和家庭教育负担增加，势必会对家庭支出结构产生影响； 当“独生子女政策”实施下出生的主要群体作为中年家庭决策者时，其将对家庭资产配置的合理性提出更高要求。如何通过保险产品分担中年群体的家庭压力，提升家庭资金利用效率，推动实现适度生育水平，为实现中华民族伟大复兴的中国梦提供坚实基础和持久劳动力，是保险行业需要思考的重要命题。

因此，面对新的人口结构和家庭经济压力，要平缓总和生育率下降趋势，保持人力资源禀赋优势，社会各界需共同努力，帮助家庭缓解生育面临的经济压力和精神压力，年金保险应充分发挥其长期性优势，为家庭提供合理的资产配置方案、保障家庭各阶段收支平衡。鉴于此，本文提出三点研究目的，一、运用统计分析得出家庭商业年金保险投保意愿与家庭和个人特征间的关系；二、探究子女受教育阶段对家庭年金保险选择偏好的具体影响情况；三、从家庭生命周期角度分析商业年金保险如何满足消费者不同阶段的需求，为家庭提供全面保障，减轻家庭生育的后顾之忧，对行业未来布局和消费者引导提出合理建议。

## 2.文献综述

### 2.1 个人年金保险相关论述

依据年金保险所承保的风险，可将其分为养老年金保险和非养老年金保险，养老年金保险主要针对年老期间的生存风险，用于保障个人老年生活；非养老年金保险主要针对青少年群体，用于分担教育风险。现有研究主要针对个人养老年金，从人口老龄化入手分析年金保险如何为家庭及个人提供保障，丁珊（2019）认为个人年金保险对退休资金规划具有重大意义，目前呈现需求不足的原因在于个人认知不足、产品缺乏吸引力。Beck,webb(2003)认为个人财富状况和市场通胀率是影响寿险需求的主要因素，Inkmann 等(2011)通过对英国市场分析发现，个人财富年金化的意愿与个人财富、预期寿命和受教育程度呈现正向关系，与未来可得的养老金收入和对配偶的遗赠意愿呈反向关系，可见社会养老保障程度越高的个体购买商业年金险的动机越小。Brugiavini(1993)提出如果未来收入水平是确定的在年轻时购买年金保险的个体在整个生命周期内不会选择再次购买年金保险；如果未来收入是不确定的，消费者的决策行为将存在不确定性，因此没有稳定收入来源的个体对年金保险的潜在需求更高。

## 2.2 人口结构变化对我国家庭支出的影响

依据国家统计局统计指标，我国家庭支出主要包括七大类，其中教育文化娱乐支出与青少年群体相关，医疗费用支出与老年人口密切相关。目前的“三明治”家庭模式，对家庭支出结构具有较大影响，李宜航（2019）在关于老龄化和子女抚养负担对家庭人力资本影响的研究中运用世代交叠模型和 Tobit 计量模型发现家庭养老负担的减轻有利于提高家庭教育支出，而老龄化以及子女数量增加都会对家庭中每个子女的教育投入产生负面影响。李昊（2021）通过面板固定效应模型和中介效应模型发现老年群体的增加会引起家庭医疗负担加重，最终导致人力资本投资减少，对于如何提升家庭人力资本支出，有学者提出应当完善社会养老保障体制（李宜航、赵静等）。

通过相关文献分析，可见老年群体和儿童群体的占比增加，对家庭人力资本投资具有显著影响，需要通过提前规划对家庭经济负担进行分散，当前研究主要针对健康保险或者年金保险中的养老保险，很少有研究从家庭全周期入手分析不同时期家庭需求的变换。因此本文从家庭生命周期入手探究其实际偏好，分析引起该偏好的主要因素，为分散家庭压力提升资金运用效率提出合理建议。

## 3.理论分析及研究假设

### 3.1 生命周期假说

生命周期假说认为消费者是理性的，其进行各种行为的唯一目的是实现自身效用最大化。理性的消费者会将劳动期间获得的收入，分配到人生各个阶段，使一生的消费等于收入。依据这一理论，随着子女教育支出的增加，中年消费者在养老资金储备和子女教育资金支出间矛盾将越发凸显，如何在中年时期良好的平衡家庭支出，是中年群体面临的主要问题之一。

### 3.2 家庭生命周期理论

家庭生命周期将家庭划分为形成期、成长期、成熟期、衰老期，依据这一理论家庭在不同时期的风险承担能力、资金获取能力、资金投入方向具有较大差距。通常处于成长期的家庭（子女出生到大学毕业）经济负担较为繁重，家庭主要支出包括生活费用、教育费用和医疗费用，处于成熟期的家庭（子女参加工作到自身退休）教育负担较轻，其主要投资方向为养老资金储备。

鉴于以上两种理论，本文提出：

假设 1：子女年幼时家庭更偏向于投保非养老年金保险。

假设 2：不同受教育阶段对家庭年金保险投保意愿的影响存在差异。

## 4.家庭基本特征和保险购买偏好分析

本文的主要数据来源是中国家庭追踪调查（China Family Panel Studies，CFPS），该调查由北京大学和国家自然科学基金共同资助，北京大学中国社会科学研究中心(ISSS)实施，包括家庭成员、家庭经济、个人和儿童问卷四部分。本文主要分析子女处于 0-16 岁阶段家庭年金保险购买偏好及引起该偏好的主要原因，家庭经济、个人、儿童数据库为研究提供了详实可靠的数据。经筛选，

本文最终保留 7171 个 0-16 岁之间的儿童，对其进行分析。

### 4.1 家庭商业年金保险投保意愿

个人年金保险可以分为个人养老年金和个人非养老年金，投保意愿主要通过投保人或被保险人是否自愿投保体现。虽然问卷缺乏非养老年金调研数据，但为子女购买年金的主要意义在于教育准备，且具有教育储备意愿的家庭平均教育储蓄金额为 13672 元，因此，本文以是否专门进行教育储蓄衡量家庭非养老年金保险投保意愿；以是否投保商业养老保险衡量家庭养老年金保险投保意愿。

对样本进行统计分析发现，具有个人养老年金投保意愿的父母共有 363 位，占比为 5.06%；具有个人非养老年金投保意愿的父母共 1006 位，占比 14.03%。证明假设 1 成立，在中国传统观念的影响下，家庭个人年金保险投保意愿在子女未成年时期，呈现出个人养老年金投保意愿弱于非养老年金投保意愿的现象。

表 1 商业年金保险选择偏好

| | 投保意愿 | 数量 | 占比 |
|---|---|---|---|
| 筛选后总样本 | 养老年金 | 363 | 5.06% |
| | 非养老年金 | 1006 | 14.03% |
| 城镇样本 | 养老年金 | 246 | 7.65% |
| | 非养老年金 | 564 | 17.55% |
| 乡村样本 | 养老年金 | 117 | 2.96% |
| | 非养老年金 | 442 | 11.17% |

其中城镇样本的个人养老年金和非养老年金投保比例均上升近 3 个百分点，乡村样本的个人养老年金和非养老年金投保比例均下降约 2 个百分点，表明相较于农村，城镇家庭的投保意识和投保能力更强，城镇居民对保险的接受程度优于农村居民。

### 4.2 家庭总收入状况

家庭收入对家庭年金保险选择具有显著影响，孙瑞婷和熊学萍、张朝华等人发现收入水平和收入不确定性与个人养老资金投资意愿呈正相关关系，但鲜有学者基于家庭收入分析不同收入等级家庭在养老年金和非养老年金之间的选择倾向。

依据家庭收入等级表，本文将家庭划分为贫困、低收入、较低收入、小康、中产、高产和富裕七个等级，从最低收入的贫困户逐级上升到最高收入群体，对不同收入阶段家庭的个人养老年金和非养老年金投保意愿进行统计。统计结果见表 3 和图 1，由于富裕阶段统计结果的绝对值较小、缺乏代表性，因此未呈该阶段的统计结果。

表 2 收入等级划分表

| 收入等级 | 收入区间（单位：万元） |
|---|---|
| 贫困 | 0-1 |
| 低收入 | 1-3 |
| 较低收入 | 3-8 |
| 小康 | 8-15 |
| 中产 | 15-30 |
| 高产 | 30-100 |
| 富裕 | >100 |

表 3 不同收入阶层家庭年金保险投保意愿

| 收入水平 | 贫困 | 低收入 | 较低收入 | 小康 | 中产 | 高产 |
|---|---|---|---|---|---|---|
| 非养老年金投保意愿 | 5.32% | 8.10% | 13.54% | 19.46% | 24.56% | 25.38% |
| 养老年金投保意愿 | 0.64% | 1.59% | 3.73% | 8.35% | 13.16% | 26.15% |
| 非养老年金投保意愿增速 | | 2.78% | 5.43% | 5.93% | 5.10% | 0.83% |
| 养老年金投保意增速 | | 0.96% | 2.13% | 4.62% | 4.81% | 12.99% |

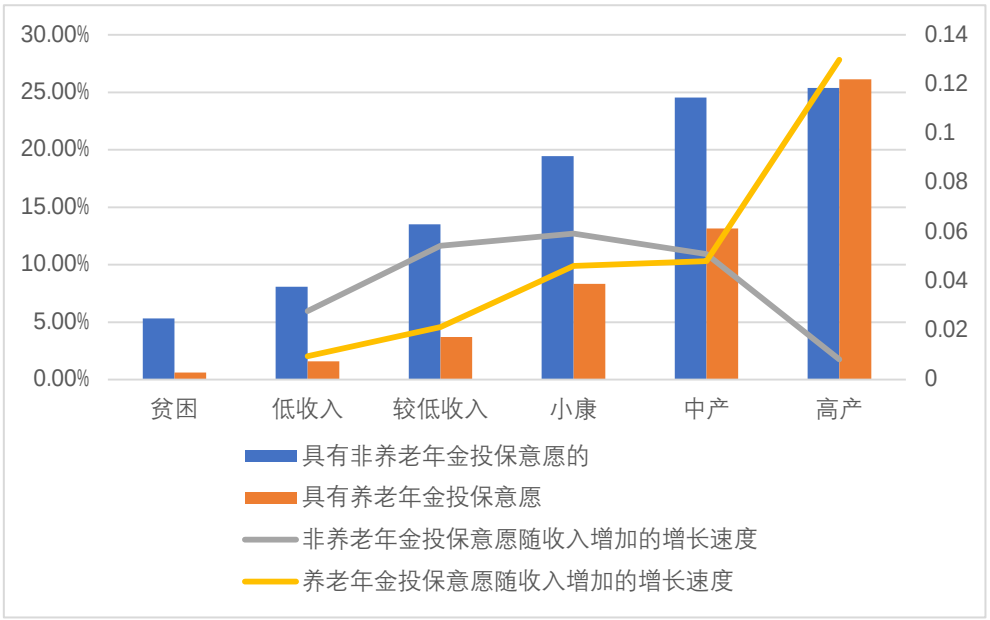


图 1 不同收入等级家庭年金保险投保意愿

由表 3 和图 1 可以看出：

随着收入的提升，家庭个人养老年金和非养老年金的投保意愿也随之增强，各阶层非养老年金投保偏好基本强于养老年金。充分表明资金有限时家庭往往更偏向于投保非养老年金保险。从收入变化对年金保险选择意愿的影响来看，收入对家庭养老年金需求的影响程度强于非养老年金，当家庭进入小康水平后随着收入的增加，家庭非养老年金投保意愿的增速有所下降，但养老年金呈现

高速增长的态势。

呈现这一现象原因在于，收入增加一方面会提升家庭年金保险的消费能力，另一方面也会对消费者预期产生影响。目前，多数家庭在子女受教育期间，具有稳定的收入来源或充足的劳动能力，因此当收入上升至一定程度，家庭预期未来现金流入足以有效负担子女教育支出，会在一定程度上抵消收入增加对年金保险需求的促进作用。依据经济学家杜森贝利提出的消费习惯取决于相对收入的假说，家庭消费具有“棘轮效应”及消费者的消费习惯难以随着收入减少而向下调整，因此在收入足以支撑日常生活及子女教育等开支时，家庭从现有收入中提取部分资金进行养老规划的意愿将逐步强于子女教育资金规划意愿。

### 4.3 家庭对子女受教育期望

随着家庭收入水平的提升，其对家庭非养老年金投保意愿的边际效应在递减，但家庭对子女的受教育水平的期望对家庭非养老年金投保意愿的影响则越来越强，吴强、赵静等都认为家庭对子女教育期望与教育资金投入呈正相关。一方面，家庭期望存在差异引起资金投向不同领域的效用有所偏差，在预算约束下家庭会将有限的资金投入到效用最高的领域；另一方面，未来预期不同也会给家庭带来不同的选择偏好。

由图 2 可以看出：

随着对子女受教育期望程度的提升，家庭非养老年金的投保意愿也持续上升。对子女受教育程度期望极低的家庭，非养老年金的投保意愿为 0；当父母对子女最高学历期望优于初中时家庭非养老年金的投保意愿优于养老年金，且非养老年金投保意愿随着受教育期望提升的速度较快。

表 4 不同教育期望的家庭年金保险投保意愿

| 受教育期望 | 无 | 小学 | 初中 | 高中 | 大专 | 大学 | 研究生 | 博士 |
|---|---|---|---|---|---|---|---|---|
| 具有养老年金投保意愿 | 0.00% | 7.14% | 1.57% | 3.18% | 3.70% | 5.18% | 8.04% | 6.47% |
| 具有非养老年金投保意愿 | 0.00% | 0.00% | 4.72% | 9.80% | 14.20% | 13.88% | 19.84% | 21.09% |

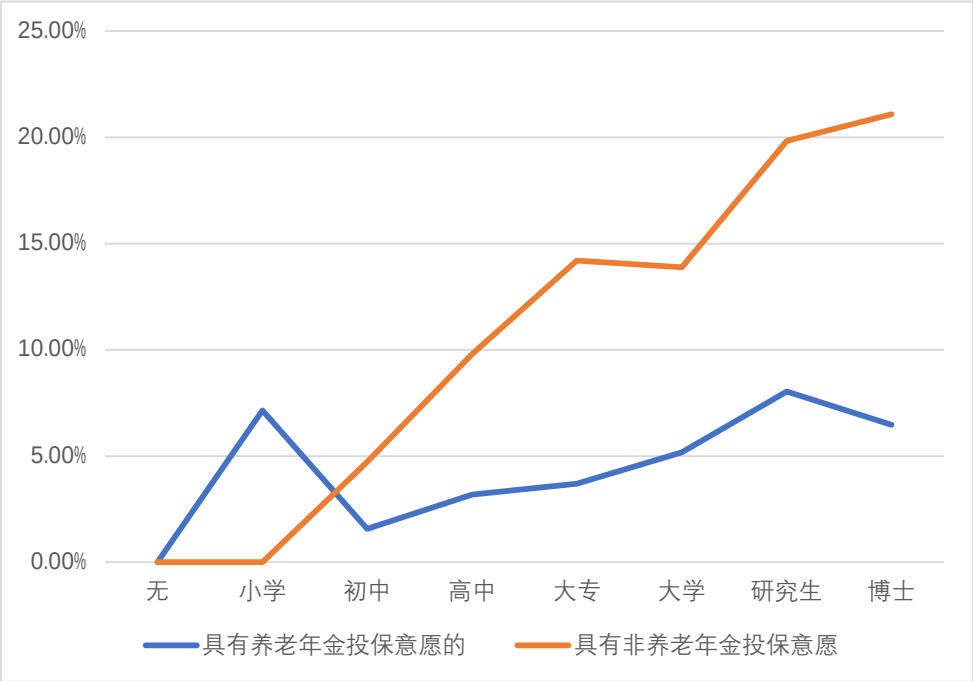


图 2 不同教育期望家庭对商业年金的购买偏好

呈现上述趋势的根源在于预算约束及家庭预期差异。首先，对子女教育期望较高的家庭认为目前资金投入子女教育带来的效用优于进行养老储备，因此在有限的预算约束下，家庭会优先考虑子女教育。其次，基于中国传统文化，父母多认为子女生活条件与自身未来养老状态联系较为密切，过去的“独生子女政策”实施促使这一联系更加紧密，因此在该预期的影响下，子女受教育期望的提升在一定程度上会抑制家庭养老年金投保意愿。

### 4.4 家庭子女所处教育阶段

依据选取群体的年龄以及 CFPS 的调研分类，本文将 0-16 岁子女分为未入学、学前教育、小学、初中和高中五个阶段，从整体看，非义务教育阶段家庭非养老年金投保意愿更强，随着子女年龄的增长，家庭养老年金投保意愿也在不断增强。

由图 3 可以看出：

当子女处于学前教育阶段时家庭非养老年金投保意愿较高，随着子女进入义务教育阶段这一投保意愿有所下降，在高中时期又达到新的高峰。这是由于学前教育、高中阶段及其之后的本科、研究生教育所需的支出水平较高，家庭需要有充足的资金储备为子女教育提供保障；小学、初中阶段，国家实行九年义务教育，极大程度上减轻了家庭的经济负担。表明家庭非养老年金投保意愿与当前或近期教育支出水平密切相关，家庭资金规划存在短视性问题。

家庭教育储蓄绝对额的均值为 13672 元，这一水平足以满足市场现存年金类保险的交费起点。表明：如果市场可以给予正向引导，积极开发符合消费者需求的保险产品，家庭非养老年金投保意愿可以充分转化为非养老年金的实际需求。

表 5 不同受教育阶段家庭年金保险投保偏好

| 受教育阶段 | 无 | 学前教育 | 小学 | 初中 | 高中 |
|---|---|---|---|---|---|
| 具有养老年金投保意愿的 | 4.81% | 4.98% | 4.60% | 6.31% | 16.07% |
| 具有非养老年金投保意愿 | 11.45% | 14.83% | 14.69% | 14.58% | 28.57% |

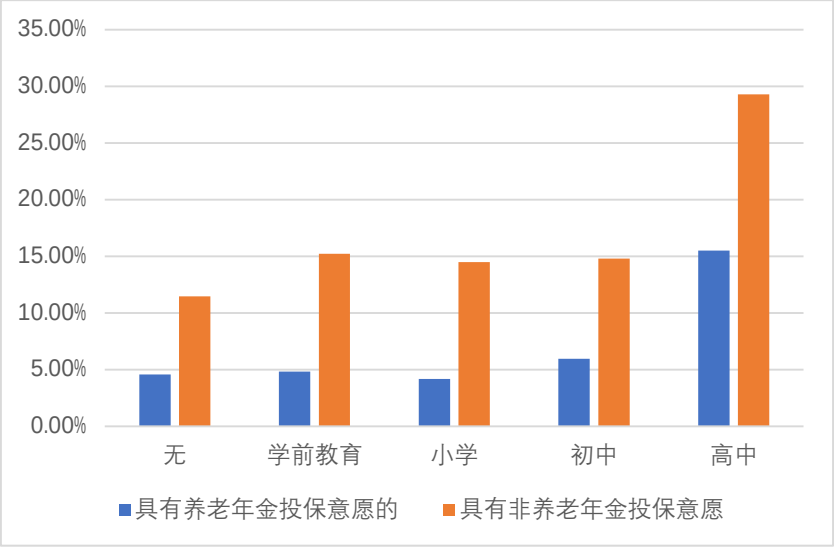


图 3 不同教育阶段家庭对商业年金的购买偏好

通过以上分析可见，影响家庭年金保险选择的原因呈现多样性，本文主要从子女受教育阶段入手，选取子女所处教育阶段为主要被解释变量，将其余变量作为控制变量，探究不同受教育阶段对家庭年金购买偏好的影响。

## 5.影响家庭保险购买偏好的实证分析

### 5.1 模型设定

为检验家庭子女受教育阶段对家庭年金保险投保意愿的影响，本文建立两个二值选择模型，通过比较运用 logit 模型进行回归产生的结果对影响情况进行分析。回归模型的具体形式如式（1）和式（2）所示：

$$edu_ins_i = \alpha_0 + \alpha_1 edu_i + \alpha_2 Z_i + u_i \quad (1)$$

$$pen_ylnj_ok_i = \beta_0 + \beta_1 edu_i + \beta_2 Z_i + \varepsilon_i \quad (2)$$

其中，$edu_ins_i$和$pen_ylnj_ok_i$分别代表第 i 个儿童父母的非养老年金投保意愿和养老年金投保意愿；$edu_i$表示子女所处受教育阶段；$Z_i$包括家庭特征和个人特征在内的控制变量；$\alpha_0$和$\beta_0$表示截距项；$\alpha_1$和$\beta_1$为本文需要估计的参数，$u_i$ 和$\varepsilon_i$表示随机误差项。

## 5.2 变量选取

被解释变量。本文的被解释变量为家庭个人年金保险投保意愿，采用 CFPS 问卷中个人库的“商业年金投保状况”和少儿父母代答问卷中的“是否为教育存钱”分别代表家庭个人养老年金（pen_ylnj_ok）和非养老年金（edu_ins）投保意愿，若家庭无投保意愿则取值为 0，若家庭有投保意愿则取值为 1。

核心解释变量。本文主要研究家庭年金保险投保意愿与子女所处受教育阶段间的关系，通过探寻受教育阶段对家庭年金投保意愿的影响，帮助保险行业开发符合消费者真实需求的年金产品。因此，本文的核心解释变量为子女受教育阶段（edu），共分为未入学、学前教育、小学、初中、高中五个阶段，回归将选取未入学阶段作为基准组，分析其余受教育时期与未入学间的差距。

控制变量。本文对家庭特征和个体特征进行控制。家庭特征包括家庭收入（lnfin）、家庭老人占比（old_r）、家庭子女占比(child_r)、家庭总人数(familysize18)、家庭所处地域(urban)，个体特征包括父母对子女受教育程度的期望(exp_edu)、母亲受教育程度(m_edu)。为平滑收入数据，本文对家庭收入变量取对数回归。

表 6 变量定义

| 变量类型 | 变量名 | 描述 |
|---|---|---|
| 被解释变量 | edu_ins | 非养老年金投保意愿，0=否，1=是 |
| | pen_ylnj_ok | 养老年金投保意愿，0=否，1=是 |
| 解释变量 | edu | 子女受教育阶段，0=未入学，1=学前教育，2=小学， 3=初中， 4=高中/中专 |
| | exp_edu | 父母对子女的受教育期望，0=未入学，7=博士 |
| | m_edu | 母亲受教育水平，0=文盲，7=博士 |
| 控制变量 | lnfin | 家庭年收入的对数 |
| | child_r | 需要家庭提供教育支持的子女占比 |
| | old_r | 与家庭有经济联系的老年人占比 |
| | familysize18 | 家庭总人数 |
| | urban | 城乡分布，0=乡村，1=城镇 |

表 7 统计描述

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| edu_ins | 7171 | .14 | .347 | 0 | 1 |
| pen_ylnj_ok | 7171 | .051 | .219 | 0 | 1 |
| edu | 7171 | 1.42 | 1.023 | 0 | 4 |
| exp_edu | 7171 | 4.853 | 1.005 | 0 | 7 |
| lnfin | 7171 | 10.808 | 1.169 | 0 | 14.509 |
| edu_m | 7171 | 1.98 | 1.377 | 0 | 6 |
| child_r | 7171 | .387 | .122 | .077 | .8 |
| old_r | 7171 | .17 | .166 | 0 | 1 |
| urban | 7171 | .448 | .497 | 0 | 1 |
| familysize18 | 7171 | 5.551 | 2.114 | 2 | 21 |

## 5.3 回归结果及分析

为验证假设 1 是否成立，本文采用养老年金投保意愿和非养老年金投保意愿作为被解释变量，子女受教育阶段作为解释变量进行 2 个 Logit 回归，研究受教育阶段对家庭年金保险投保意愿的影响情况，回归结果如表 8 所示。为便于系数解读，本文将 Logit 回归系数转化为平均边际效应。

表 8 年金保险投保意愿的 Logit 回归结果

| VARIABLES | edu_ins | pen_ylnj_ok |
|---|---|---|
| edu | 0.022*** | 0.010*** |
| | (5.550) | (3.440) |
| lnfin | 0.042*** | 0.036*** |
| | (7.250) | (7.730) |
| old_r | 0.041 | -0.005 |
| | (1.480) | (-0.300) |
| child_r | -0.216*** | -0.032 |
| | (-5.240) | ( -1.200) |
| familysize18 | -0.008*** | 0.003*** |
| | (-3.670) | (2.620) |
| urban | 0.013 | 0.023*** |
| | (1.490) | (3.790) |
| exp_edu | 0.019*** | 0.005 |
| | (4.110) | (1.550) |
| edu_m | 0.013*** | 0.006*** |
| | (3.820) | (2.690) |

*** p<0.01, ** p<0.05, * p<0.1 Robust z-statistics in parentheses

非养老年金投保意愿的回归中子女受教育阶段变量的系数为 0.022，养老年金投保意愿的回归中子女受教育阶段变量的系数为 0.010。对两个回归进行比较，可以发现子女进入受教育阶段后对家庭非养老年金投保意愿的促进作用强于养老年金，可以进一步验证假设 1 子女受教育时期家庭更偏向于为子女教育进行资金准备，非养老年金投保意愿更强。

进而为验证假设 2 是否成立，寻求各受教育阶段家庭年金保险投保意愿的具体变化情况，本文采用养老年金投保意愿和非养老年金投保意愿作为被解释变量，将以子女受教育阶段为基础的虚拟变量作为解释变量进行 Logit 回归，研究不同受教育阶段对父母年金保险选择的影响情况，回归结果如表 9 和表 10 所示。本文采用逐步回归的方法，模型（1）分析核心解释变量对被解释变量的

影响，模型（2）在模型（1）的基础上加入了家庭特征有关变量，模型（3）进一步控制了个人特征，随着控制变量的加入，各变量对被解释变量的影响方向和显著性水平并未发生显著变化。为便于系数解读，本文将 Logit 回归系数转化为平均边际效应。

从表 9 的模型（3）可以看出，子女处于上学阶段家庭非养老年金的投保意愿均有所增强，且该趋势在 1%的水平上显著，子女进入高中阶段后家庭非养老年金投保意愿比子女未上学阶段提升了 0.175 个单位。从表 10 的模型（3）可以看出，子女处于不同的上学阶段，家庭养老年金投保意愿影响存在差异，子女进入初中后才会对家庭养老年金投保意愿产生显著影响，证明了本文的假设 2 成立。

表 9 非养老年金的 Logit 回归结果

| VARIABLES | (1) | (2) | (3) |
|---|---|---|---|
| | edu_ins | edu_ins | edu_ins |
| 1.edu | 0.034*** | 0.028*** | 0.030*** |
| | (2.947) | (2.579) | (2.838) |
| 2.edu | 0.032*** | 0.046*** | 0.055*** |
| | (3.085) | (4.333) | (5.140) |
| 3.edu | 0.031** | 0.038*** | 0.051*** |
| | (2.353) | (2.907) | (3.802) |
| 4.edu | 0.171*** | 0.162*** | 0.175*** |
| | (3.700) | (3.754) | (4.107) |
| lnfin | | 0.052*** | 0.042*** |
| | | (9.298) | (7.224) |
| old_r | | 0.038 | 0.039 |
| | | (1.366) | (1.408) |
| child_r | | -0.263*** | -0.217*** |
| | | (-6.441) | (-5.249) |
| familysize18 | | -0.011*** | -0.009*** |
| | | (-4.685) | (-3.806) |
| urban | | 0.023*** | 0.012 |
| | | (2.662) | (1.418) |
| exp_edu | | | 0.019*** |
| | | | (4.088) |
| edu_m | | | 0.013*** |
| | | | (3.798) |
| Observations | 7,171 | 7,171 | 7,171 |

*** p<0.01, ** p<0.05, * p<0.1 Robust z-statistics in parentheses

与家庭特征相关的控制变量中，非养老年金的回归结果显示，儿童占比的系数为-0.217、家庭成员数量的系数为-0.009，且 p 值小于 0.01，说明儿童占比和家庭成员数量对家庭非养老年金投保意愿具有显著的抑制作用，可能是家庭儿童数量增加给家庭带来经济负担，减少其为子女教育提前准备资金的意愿；家庭收入的系数显著为正，说明家庭收入越高其投保非养老年金的意愿越强。

养老年金的回归结果显示，儿童占比的系数为-0.03、老年人占比系数为-0.003，但该系数的 p 值大于 0.05，说明儿童占比和老年人占比对家庭养老年金投保意愿并无显著影响；家庭收入和城乡分布的系数显著为正，说明收入较高的家庭养老年金投保意愿更强，与乡村相比城镇家庭的养老年金投保意愿更高，原因在于城镇地区保险的发展水平优于乡村，现阶段我国城乡二元差异较为显著。

与个人特征相关的控制变量中，非养老年年金的回归结果显示，父母对子女受教育程度的期望和母亲的受教育水平变量的系数显著为正，说明父母的期望会对家庭资金分配方式产生较大影响，母亲的受教育程度对子女受教育资金的储备具有明显的促进作用。养老年金回归结果显示，对子女受教育程度期望变量的系数并不显著、母亲受教育水平变量的系数显著为正，表明子女未来受教育水平对家庭养老年金投保意愿没有显著影响，但家庭女主人的受教育程度越高该家庭提前进行资金规划的意识越强。

表 10 养老年金的 Logit 模型回归结果

| VARIABLES | (1) | (2) | (3) |
|---|---|---|---|
| | pen_ylnj_ok | pen_ylnj_ok | pen_ylnj_ok |
| 1.edu | 0.002 | -0.002 | -0.001 |
| | (0.235) | (-0.133) | (-0.093) |
| 2.edu | -0.002 | 0.004 | 0.007 |
| | (-0.325) | (1.046) | (1.082) |
| 3.edu | 0.015* | 0.024*** | 0.030*** |
| | (1.659) | (3.103) | (3.152) |
| 4.edu | 0.113*** | 0.113*** | 0.121*** |
| | (3.501) | (3.737) | (3.721) |
| lnfin | | 0.040*** | 0.036*** |
| | | (7.936) | (7.874) |
| child_r | | -0.046* | -0.030 |
| | | (-1.271) | (-1.126) |
| old_r | | -0.003 | -0.003 |
| | | (-0.205) | (-0.175) |
| urban | | 0.027*** | 0.023*** |
| | | (3.816) | (3.819) |
| familysize18 | | 0.002** | 0.003*** |
| | | (2.787) | (2.831) |
| exp_edu | | | 0.005 |
| | | | (1.518) |
| edu_m | | | 0.006*** |
| | | | (2.642) |
| Observations | 7,171 | 7,171 | 7,171 |

*** p<0.01, ** p<0.05, * p<0.1 Robust z-statistics in parentheses

## 6．异质性分析

首先，结合之前学者的研究，受到中国传统观念的影响，家庭仍然存在重男轻女的现象，因此本文以性别为标准，将子女分为男性和女性分别进行分析。其次，鉴于我国呈现城乡二元体制，城乡间投保意识、对教育的重视程度、家庭经济收入存在较大差异，因此将两者分别进行考察，以便深入探究子女受教

育阶段对不同。由于异质性分析主要关心核心解释变量 edu 的系数大小和显著性，因此表 12 和表 14 主要列出了核心解释变量的平均边际效应和 z 统计量的值，表 11 和表 13 为不同分类下的描述性统计结果。

表 11 以性别为依据的异质性描述统计

| Variable | 女性（gender=0） | | | | 男性（gender=1） | | | |
|---|---|---|---|---|---|---|---|---|
| | Obs | Mean | Min | Max | Obs | Mean | Min | Max |
| edu ins | 3344 | .13 | 0 | 1 | 3827 | .149 | 0 | 1 |
| pen ylnj ok | 3344 | .053 | 0 | 1 | 3827 | .049 | 0 | 1 |
| edu | 3344 | 1.416 | 0 | 4 | 3827 | 1.423 | 0 | 4 |
| lnfin | 3344 | 10.78 | 0 | 14.078 | 3827 | 10.833 | 0 | 14.509 |
| child r | 3344 | .394 | .077 | .8 | 3827 | .382 | .077 | .8 |
| old r | 3344 | .17 | 0 | .667 | 3827 | .171 | 0 | 1 |
| familysize18 | 3344 | 5.677 | 2 | 21 | 3827 | 5.441 | 2 | 21 |
| exp edu | 3344 | 4.845 | 0 | 7 | 3827 | 4.859 | 0 | 7 |
| edu m | 3344 | 1.987 | 0 | 6 | 3827 | 1.974 | 0 | 6 |
| urban | 3344 | .443 | 0 | 1 | 3827 | .453 | 0 | 1 |

表 12 表明，男性子女进入受教育阶段对家庭年金保险投保意愿提升总体来看比女性子女更强烈，除学前教育时期，男性子女的对家庭非养老年金投保意愿的促进作用均优于女性子女；对于养老年金，子女进入初中、高中阶段后，其对家庭养老年金投保意愿的影响才趋于显著，且女性子女受教育阶段提升对家庭养老年金投保意愿的促进作用几乎未男性的 2 倍。说明现阶段，我国家庭对男性子女受教育水平的重视程度和支出水平依然高于女性子女，重男轻女的传统观念依旧存在；不少家庭依然认为，未来养老的主要依赖对象还是儿子而非女儿。

表 12 以性别为依据的异质性结果分析

| VARIABLES | 男性 | | 女性 | |
|---|---|---|---|---|
| | edu_ins | pen_ylnj_ok | edu_ins | pen_ylnj_ok |
| 1.edu | 0.028* | 0.004 | 0.031** | -0.006 |
| | (1.934) | (0.463) | (2.062) | (-0.616) |
| 2.edu | 0.062*** | 0.009 | 0.046*** | 0.005 |
| | (4.168) | (1.006) | (3.064) | (0.477) |
| 3.edu | 0.061*** | 0.033*** | 0.039** | 0.026* |
| | (3.218) | (2.656) | (2.059) | (1.792) |
| 4.edu | 0.244*** | 0.088** | 0.093 | 0.156*** |
| | (3.848) | (2.240) | (1.508) | (3.115) |
| Observations | 3,827 | 3,827 | 3,344 | 3,344 |

*** p<0.01, ** p<0.05, * p<0.1 z-statistics in parentheses

从表 13 可以看出，城镇年金保险投保意愿总体强于乡村。从表 14 现实的

回归结果可以看出，子女受教育阶段对城镇家庭非养老年金投保意愿的影响更为显著，随着子女受教育程度的增加，城镇家庭非养老年金投保意愿逐步增强，这是由于随着收教育程度的提升、家庭教育支出的压力在不断增加，且这一现象在城镇尤为显著。

表 13 以地域为依据的异质性描述统计

| Variable | 城镇(urban=1) | | | | 乡村(urban=0) | | | |
|---|---|---|---|---|---|---|---|---|
| | Obs | Mean | Min | Max | Obs | Mean | Min | Max |
| edu_ins | 3214 | .175 | 0 | 1 | 3957 | .112 | 0 | 1 |
| pen_ylnj_ok | 3214 | .077 | 0 | 1 | 3957 | .03 | 0 | 1 |
| edu | 3214 | 1.402 | 0 | 4 | 3957 | 1.434 | 0 | 4 |
| lnfin | 3214 | 11.108 | 0 | 14.078 | 3957 | 10.564 | 0 | 14.509 |
| child_r | 3214 | .373 | .111 | .75 | 3957 | .399 | .077 | .8 |
| old_ r | 3214 | .158 | 0 | 1 | 3957 | .18 | 0 | .75 |
| familysize18 | 3214 | 5.152 | 2 | 14 | 3957 | 5.876 | 2 | 21 |
| exp_edu | 3214 | 4.947 | 0 | 7 | 3957 | 4.776 | 0 | 7 |
| edu_m | 3214 | 2.544 | 0 | 6 | 3957 | 1.522 | 0 | 6 |

表 14 以地域为依据的异质性结果分析

| VARIABLES | 城镇 | | 乡村 | |
|---|---|---|---|---|
| | edu_ins | pen_ylnj_ok | edu_ins | pen_ylnj_ok |
| 1.edu | 0.048*** | 0.011 | 0.014 | -0.010 |
| | (2.814) | (0.942) | (1.036) | (-1.568) |
| 2.edu | 0.067*** | 0.004 | 0.043*** | 0.010 |
| | (3.883) | (0.336) | (3.261) | (1.364) |
| 3.edu | 0.072*** | 0.044*** | 0.032* | 0.020** |
| | (3.280) | (2.602) | (1.935) | (1.969) |
| 4.edu | 0.263*** | 0.173*** | 0.063 | 0.094** |
| | (4.087) | (3.398) | (0.979) | (2.175) |
| Observations | 3,214 | 3,214 | 3,957 | 3,957 |

*** p<0.01, ** p<0.05, * p<0.1 z-statistics in parentheses

从表 14 中进一步可以看出，乡村和城镇均呈现出子女进入初中阶段后，才会对养老年金投保意愿产生显著的促进作用，在此之前没有显著影响的现象。但从系数看，城镇的促进作用是乡村的二倍，这说明城乡差异不会对促进的趋势产生影响，但会对促进效果产生显著影响。

## 7.结论及建议

年金保险是家庭资金储蓄的重要手段之一，其长期性和强制性的特点可以帮助家庭合理规划长期资金的运用，但从我国实际保险购买情况，可以发现商业年金保险的市场占比远低于发达国家，2020 年我国年金险新单保费为 2788 亿元，占人身险保费收入的近 9%，占寿险保费收入的近 11.6%。本文利用 2018

年 CFPS 中的有关数据，通过两个 Logit 模型研究子女受教育阶段对家庭年金保险需求偏好的影响。运用教育储备意愿代表非养老年金投保偏好，商业养老年金保险代表养老年金投保偏好，通过统计分析和实证研究得出四点结论：第一，在子女年幼时期，家庭非养老年金投保意愿更强；第二，相比于未入学阶段，子女接受教育后，家庭对各年金的投保偏好均有提升；第三，不同受教育阶段，家庭对年金保险的投保意愿存在波动性，学前教育阶段和高中教育阶段是家庭非养老年金投保意愿较强的两个时期，初中阶段后，子女受教育情况对养老年金投保意愿才会产生显著影响。第四，基于性别和城乡的异质性分析可知，相比女性子女，男性子女受教育阶段对家庭非养老年金投保意愿的促进作用更突出，女性子女受教育阶段对家庭养老年金投保意愿的促进作用更突出。

探寻消费者的真实需求，对于保险业产品供给具有重要意义，家庭发展是具有周期性，每一时期具有不同的保障需求，因此作为长期资金规划的主要工具之一，年金保险的设计也应呈现长期性的特征，拉长保障期限和保障的灵活性，让一张年金险保单能够对家庭进行全周期保障，充分发挥年金保险对家庭的保障作用，提升家庭资金规划的合理性、减轻家庭的后顾之忧。另一方面，通过对家庭收入进行分类，我们发现收入水平达到小康以上的家庭对年金保险的投保意愿较强，从中产群体到高产群体养老年金的投保意愿产生较大飞跃，因此在进行产品设计时，需针对家庭缴费能力，资金需求设计合理的产品，以满足消费者的实际需求。但由于 CFPS 缺乏对 16 周岁以上家庭教育储蓄意愿的调查，本文对子女成年后家庭年金保险投保偏好研究不足。未来随着数据的增加，可进行进一步深入研究。

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# 家庭商业年金投保偏好研究——基于子女教育

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**关键词：**教育支出；年金保险；经济发展

**中文摘要．**在人才强国和教育强国的政策引领下，家庭教育支出逐步增加，本研究从现代家庭主要经济负担之一——子女教育入手进行研究，分析家庭年金保险购买偏好及背后深层原因，为行业发展提出相关建议。本文主要采用统计分析、实证分析的方法，在相关理论分析的基础上，通过对中国家庭追踪调查（CFPS）数据分析，得出各受教育阶段家庭个人年金保险真实的选择偏好。进一步探讨影响家庭年金保险投保偏好的因素，通过 Logit 模型研究子女所处受教育阶段对家庭年金保险选择偏好的影响，最后对行业未来布局提出建议。通过系统分析发现：首先，子女年幼时家庭非养老年金保险投保偏好更强。其次，子女在不同受教育阶段对家庭年金保险选择的影响程度存在差异。最后，提出年金保险应当从承保期限、给付灵活性等方面不断优化，全方位、多时段分担家庭经济负担，为下一代发展提供经济保障，在国家老龄化问题日益严峻的情况下提升年轻群体的劳动效率、推动经济发展。

# Study of Basic Pension Insurance on Financial Risk Asset Allocation of Urban Households

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**Keywords:** Pension Insurance, Differences-in-Differences, Household Finance, Risky Asset Allocation.

**Abstract.** In recent years, the household financial asset allocation of Chinese residents has shown the phenomenon of single structure and insufficient allocation of risky financial assets. Along with the intensification of aging and urbanization in China, urban residents' sense of security and happiness in their old age has increasingly become an important factor affecting the household financial asset allocation. As an important component of the social security system, social pension insurance protects residents' income in their old age, gives them a sense of security and well-being, and helps them improve their later life, therefore, social pension insurance for residents is of great significance for studying the allocation of risky financial assets of households. Based on the 2015 and 2017 data from the China Household Financial Survey and Research Center (CHFS), this paper uses the Differences-in-Differences method to assess the impact of urban social pension insurance on urban households' asset choices. The study shows that the effect of urban social pension insurance on the financial risky asset allocation of urban households differs and is relatively small when taking into account the difference in the type of urban social pension insurance participation, the age of insurance, and the risk preference of the insured.

## 1. 引言

党的十九大报告中明确指出要“拓宽居民劳动收入和财产性收入渠道。”家庭金融资产作为拓宽居民财产性收入的重要渠道，它的配置方向既关乎家庭资产的保值和增值，又会对资本、金融市场和经济长期增长产生重要影响。根据西南财经大学中国家庭金融调查（CHFS）课题组最新发布的中国家庭金融资产调查报告显示，现阶段城镇家庭仍倾向于配置房屋类固定资产，家庭金融资产持有比例偏低。可见，当前研究我国家庭金融资产配置问题有重要的意义，一方面有利于剖析家庭对风险金融市场参与程度低的原因从而寻求优化家庭资产组合的方法，另一方面也有利于从需求的角度促进金融市场发展壮大与不断创新。

理论研究表明，我国城镇居民现阶段金融风险资产占比低的原因之一是未来面临的不确定性较大，其中，老龄化或长寿风险是最大的不确定性之一。基本养老保险在一定程度上能够消除或减弱这类不确定性，保障居民晚年的生活水平，使居民无需为晚年生活保障耗费过多财力，变相增加了居民的可支配收入，而这部分收入将为居民进行金融风险资产配置创造可能。基于此，为促进城镇家庭进行金融风险资产配置，进一步完善我国金融市场参与主体，深化金融市场参与水平，研究养老保险对家庭金融风险资产配置行为的影响将十分必要。

## 2. 文献综述

家庭金融是金融学的新兴研究领域，它关注的是家庭（决策者）如何使用金融工具来实现自身目标。具体而言，家庭需要选择股票、基金、债券等投资工具来实现资源跨期优化配置，以达到家庭长期消费效用最大化的目标。基本养老保险是重要的社会保障项目，理论上它对家庭金融资产配置的影响主要有两方面：首先，一部分家庭参加了社会养老保险，会加大对风险性金融资产的投资。考虑到参加社会养老保险能够降低家庭风险和不确定性，这种情况下，居民的晚年生活得到保障，居民有更多的时间和积蓄参与金融投资，家庭对金融市场的参与度将会提高。宗庆庆等（2015）基于2011年CHFS数据的研究发现，拥有社会养老保险会提高家庭对风险性金融资产的投资比重，并且这种影响在城乡之间存在差异，家庭参加社会养老保险对家庭金融资产选择的影响在农村样本中并不显著。其次，家庭参加养老保险部分会对金融资产产生挤出效应。家庭资金有限，既要满足自身生活的各种开支，又要拿出部分资金投资保险资产，参加社会养老保险分散了部分家庭资金，使得可支配资金减少，这种情况大概率会抑制家庭对其他类金融资产的投资。周寒等（2019）将保险资产按照职能分为社会保险和商业保险两大类，基于Tobit模型分析发现，与参加商业保险不同的是，参与社会保险则会在一定程度上抑制风险性金融资产的比重，但参加保险的家庭比未参加保险的家庭在金融市场的投资比重更高。

在养老保险影响家庭金融资产配置这个问题上，国内外学者取得许多研究成果，为本文的研究提供了基础。Rosen & Wu（2004）发现健康状况会影响金融资产持有的种类和比例。在家庭风险性金融资产和家庭投资组合方面，学术界也取得了丰富的研究成果，前者会受到收入风险、借贷约束预期、交易成本（Guiso et al.，1996）、背景风险（Gollier和Pratt，1996）的影响，后者则会受到年龄、财产、收入风险、信息成本（Bertaut和Starr－Mc Cluer，2002）、家庭参加社会养老保险情况（宗庆庆等2015）、社会养老保险改革（Gomes和Michaelides，2008）等的影响。对于无风险的金融资产，也有学者进行研究。Cocco等（2005）

研究发现，未来劳动收入流对无风险资产具有一定的替代作用。蹇滨徽、徐婷婷（2019）认为养老保险能够对家庭金融资产产生收入效应和替代效应。吴洪、徐斌、李洁（2017）认为家庭参加社会养老保险会增加家庭风险性金融资产的持有量，提高家庭投资风险性金融资产的概率。并且，这种正向影响在净资产较低的家庭中表现得更为明显。林靖、周铭山、董志勇（2017）发现社会保险不仅能够提高家庭在风险资产中的投资广度和深度，而且对于不确定性更大、风险承受更强家庭的影响更为显著。李昂、廖俊平（2016）研究发现参加社会养老保险提高了家庭参与金融市场的积极性，尤其是对风险性金融资产的投资，临近退休家庭的风险金融资产配置行为主要取决于财富规模和收入风险，对是否参保并不敏感。

在家庭金融资产配置领域，国内外学者研究成果颇多。从家庭金融学的提出、构建到从理论和实证两个方面分析家庭金融资产配置的影响因素，这些研究成果给本文的研究提供了很多启发。本文运用二重差分模型，分别从参保类型、风险态度和年龄三个角度对城镇家庭金融资产配置进行研究实，以是否参保基本养老保险将样本分为实验组和对照组，避免了已有研究中采用传统OLS，Probit等计量经济模型后，可能存在遗漏重要解释变量而导致的内生性问题，使研究结果更具有说服力。

## 3. 实证分析

### 3.1 研究模型

在完全随机化的实验中可以用最小二乘法估计一项政策的实施对结果变量的影响。但是在处理实际问题时，理想化的随机试验很难满足，此时传统的回归方法无法解决经验研究中最为关心的“内生性”问题。在本文的分析中，城镇家庭参与养老保险可能会对其资产配置产生重要影响，同时家庭现阶段的财产状况也很有可能会对个人的参保决策产生影响，存在明显的反向因果关系。

在进行政策评估时通常使用双重差分模型（DID）来消除潜在趋势所产生的影响，识别出因果效应。在本文分析中，将2015年未参保社会养老保险、2017年参保社会养老保险的受访居民群体做为实验组，将2015年和2017年均未参保社会养老保险的受访居民群体做为对照组，并以此构建本文的二重差分模型。参考Duflo（2001），本文设定如下经验方程：

$$Y_{\mathrm{it}} = \alpha + \beta_1 D_{\mathrm{ij}} * T_i + \beta_2 * D_{\mathrm{ij}} + \beta_3 * T_i + \delta X_{\mathrm{ij}} + \varepsilon_{\mathrm{ij}}$$

其中，$Y_{\mathrm{it}}$为被解释变量，即家庭是否参与风险金融资产配置和风险金融资产配置比例。$D_{\mathrm{ij}}$和$T_i$均为虚拟变量，其中$D_{\mathrm{ij}}$代表个体是否参保基本养老保险，$T_i$代表年份哑变量，2015年赋值为0，2017年赋值为1。$\beta_1$即为本文关注的双重差分估计量，它代表了基本养老保险的干预效果。$X_{\mathrm{ij}}$为控制变量。

### 3.2 数据来源

本文数据均来源于中国家庭金融调查( China Household Finance Survey，CHFS) 项目。中国家庭金融调查是西南财经大学中国家庭金融调查与研究中心进行的一项全国性的调查，调查样本分布在全国29个省(市、区)，363个县，1439个村(居)委会。本文选取了CHFS数据库中2015年及2017年的数据，在进行分析之前，通过对数据的筛选和清洗，在剔除了农村家庭数据以及一些明显异常的数据

以及未持有任何金融资产家庭的数据后，最终选择了CHFS数据库中2250个城镇家庭数据进行实证分析。

## 3.3 变量设置

### 3.3.1 被解释变量

本文的研究目的在于分析参保养老保险对家庭金融资产决策及程度的影响，因此，本文的被解释变量为家庭是否进行风险性金融资产的配置以及家庭风险性金融资产占家庭总资产的比例。结合 CHFS 调查问卷，本文的被解释变量要考虑的金融资产分为两大类，即：无风险金融资产和风险性金融资产，前者主要包括存款和现金，后者包括股票、基金、债券、贵金属、非人民币资产、金融理财产品等，金融理财产品既包括银行理财产品，也包括互联网理财产品和其他理财产品等。此外，对于前者的取值以家庭是否拥有风险性金融资产为标准，若家庭持有风险性金融资产，则变量取值为1，反之为0。

### 3.3.2 解释变量与控制变量

本文的解释变量为家庭拥有的养老保险类型，以此为基础勾践DID模型的基本解释变量。考虑到本文探讨的是城镇家庭的金融资产选择，而新型农村社会养老保险主要针对农村家庭，因此，对于家庭是否拥有养老保险的标准是家庭成员中有一方拥有政府和事业单位退休金、城镇职工基本养老保险金、城镇居民社会养老保险金、城乡统一居民社会养老保险金其中的一类。

控制变量的选取应遵循外生的准则，本文选取了教育水平、性别、婚姻状况、健康状况、家庭人口规模及家庭收入水平作为控制变量，以排除这些变量对所研究问题的影响。本文选取“是否有日常活动能力障碍”来代表健康状况，而不是采用自评健康这一更为常用的健康度量指标，是因为自评健康状况的主观性太强，容易产生内生性问题；据此将健康状况分为健康（无日常活动能力障碍）与不健康（具有日常活动能力障碍）两类。一个家庭的婚姻状况会影响一个人的消费，因此本文将婚姻状况划分为未婚，已婚，离异（或配偶死亡）三类，虽然未婚和离异都是一个人生活，但是离异发生了婚姻状况的变化，未婚未发生变化，所以
两者在消费上也会因婚姻状态的不同而产生区别，因此将其分开。居民的教育水平普遍不是很高，因此本文将教育水平分为中学以下，中学（初中、高中）及中学以上三类。

表1 变量定义及赋值表

| | 变量名 | 赋值 |
|---|---|---|
| 解释变量 | 组别 | 实验组=1，对照组=0 |
| | 年份 | 2015年=0，2017年=1 |
| | 双重差分项 | 组别*年份 |
| 控制变量 | 性别 | 男=0，女=1 |
| | 健康状况 | 健康=1，不健康（一般、差）=0 |
| | 婚姻状况 | 已婚=2，离异（配偶死亡）=1，未婚=0 |
| | 教育水平 | 中学以下=1，中学（初、高中）=2，中学以上=3 |
| | 家庭人口规模 | 家庭人口数量 |

| | | |
|---|---|---|
| | 家庭收入水平 | 收入总和的对数 |
| 被解释变量 | 家庭是否持有风险金融资产 | 是=1，否=0 |
| | 风险金融资产占比 | 风险资产价值/（风险资产价值+无风险资产价值） |

## 3.4 变量的描述性统计

为了更直观地观察各变量样本数据间的差异，本文对样本进行描述性统计分析，以下为解释变量，控制变量及被解释变量的描述性统计结果。

表2 解释变量的描述性统计结果

| 变量 | 样本数 | 均值 | 标准差 | 最小值 | 最大值 |
|---|---|---|---|---|---|
| 组别 | 2250 | 0.241333 | 0.461113 | 0 | 1 |
| 年份 | 2250 | 0.5 | 0.500047 | 0 | 1 |
| 组别*年份 | 2250 | 0.120667 | 0.487076 | 0 | 1 |

组别分为实验组与对照组，实验组为2015年未参保社会养老保险、2017年参保社会养老保险的受访城镇居民群体；对照组是2015年和2017年均未参保社会养老保险的受访居民群体。组别的均值表示在样本中所有2015年未投保的人群中，2017年新参保的概率为0.241333，这表明了2015年至2017年，城镇基本养老保险的覆盖面在不断扩大。年份表示居民参保行为发生的时点，当年份=0时，即各变量在2015年时的数据；当年份=1时，表示各变量在2017年时的数据。在模型中，解释变量是组别与年份的交叉项（即组别*年份），当组别为实验组且年份为2017年时，解释变量为1。

表3 控制变量的描述性统计结果

| 变量 | 样本数 | 2015年 | | 2017年 | |
|---|---|---|---|---|---|
| | | 均值 | 标准差 | 均值 | 标准差 |
| 性别 | 2250 | 0.5822 | 0.4144 | 0.5822 | 0.4144 |
| 教育状况 | 2250 | 1.6624 | 0.5722 | 1.6624 | 0.5722 |
| 健康状况 | 2250 | 0.6750 | 0.5144 | 0.6616 | 0.4851 |
| 婚姻状况 | 2250 | 1.3685 | 0.5912 | 1.2949 | 0.5546 |
| 家庭人口数 | 2250 | 1.9284 | 0.6409 | 1.9324 | 0.5228 |
| 家庭收入 | 2250 | 20263.48 | 1307.16 | 20528.49 | 1615.62 |

从控制变量的描述性统计结果可以看出，样本中性别一栏的均值为0.5822，表示选取的样本中男女比例相差不大，选取的个体是家庭的主要受访者或者是主要财务管理者，表示在家庭中男女的地位还是比较均等的。教育的均值为1.6624，表明样本中居民的教育水平还是集中在中学附近，教育水平较低。2015年的健康状况为0.6750，2017年的健康状况为0.6616，表示随着时间推移，调查样本中居民的健康状况有所下降。婚姻状况的均值有所下降，可能是由部分样本的配偶去世、离异等引起。家庭人口数2015年的均值为1.9284，2017年为1.9324；家庭人口数变动不大。家庭收入2015年的均值与2017年的均值相差不大；但是两年的标准差都较大，这表明城镇家庭的收入差距较大；因此在将收入引入作控制变量时应取家庭收入的对数。

表4 被解释变量的描述性统计结果

| 变量 | 样本数 | 2015年 | | 2017年 | |
|---|---|---|---|---|---|
| | | 均值 | 标准差 | 均值 | 标准差 |
| 是否参与金融风险资产配置 | 2250 | 0.2009 | 0.1166 | 0.2233 | 0.1218 |
| 金融风险资产占家庭总资产比重 | 2250 | 0.1026 | 0.0544 | 0.1188 | 0.0610 |

通过被解释变量的描述性统计不难发现，城镇家庭对风险金融资产的参与度分别为2015年的0.2009和2017年的0.2233，整体参与比例较低，且在持有风险金融资产的样本中，2015年持有比例仅为0.1026，2017年也只有0.1188，说明城镇居民对风险金融资产普遍持有谨慎态度，整体参与程度较低。

## 3.5 实证结果

### 3.5.1 基准回归结果

表5 基准回归结果

| | （1）<br>是否持有风险金融资产 | （2）<br>风险金融资产占比 |
|---|---|---|
| 组别*年份 | 0.0049*<br>（1.77） | 0.1723<br>（1.16） |
| 是否参保 | -0.0044<br>（-1.63） | -0.036**<br>（-2.91） |
| 参保年份 | 0.0077***<br>（3.53） | 0.4948***<br>（5.53） |
| 收入水平 | 0.0013<br>（0.37） | 0.1403<br>（0.84） |
| 家庭规模 | 0.0002<br>（0.48） | 0.0029<br>（1.14） |
| 婚姻状况 | -0.0007<br>（-0.91） | 0.0001<br>（0.04） |
| 健康状况 | 0.0039***<br>（4.11） | 0.0183***<br>（4.79） |
| 教育水平 | 0.0052***<br>（5.52） | 0.0345***<br>（8.24） |
| 性别 | 0.0011<br>（0.42） | 0.0051<br>（0.48） |
| 常数项 | -0.0070<br>（-0.19） | -0.1449<br>（-0.86） |

注：括号中数值为t值，* p < 0.1， ** p < 0.05，*** p < 0.01。

基准回归的结果由表5所示，结果（1）反映参与基本养老保险对于家庭是否持有风险金融资产的影响，结果（2）反映参与基本养老保险对于家庭金融风险资产占比的影响。

根据回归结果（1），基本养老保险对城镇居民是否持有风险金融资产的影响的交叉项系数为0.0049，在10%的水平上显著，说明参加养老保险对于家庭是否配置风险金融资产有正向影响，这从整体上反映出基本养老保险通过降低投保人晚年生活的不确定性，促进了其参与金融风险资产的配置。此外，户主的健康状况和教育水平也显著影响着家庭对于风险金融资产的配置决策。健康状况较好的户主收入来源较广，赚取收入的能力较强，故此有较强的承担风险能力，因而倾向于更多地配置风险金融资产，而教育水平越高的户主由于金融素养较高，财富管理的理念较强，也倾向于更多地配置风险金融资产。

根据回归结果（2），基本养老保险对家庭金融风险资产的持有占比并未表现出显著性，这可能是由于我国现阶段基本养老保险的总体保障水平还比较低，投保的广度和深度远落后于发达国家，对于已持有金融风险资产的城镇居民来说，因拥有基本养老保险的保障而变动的金融风险资产金额相较于家庭持有的总资产金额来说占比过小，此外，居民在参保基本养老保险后，由于居民个体风险偏好的不同，还可能或多或少地配置其他无风险资产，减弱基本养老保险对家庭金融风险资产持有占比的影响。

考虑到不同类型的城镇居民保险的保障力度有所区别，且参保居民个人年龄的增长及风险态度的不同均有可能影响其是否进行金融风险资产配置及配置比重，本文将从样本家庭户主的年龄、参保类型和风险态度三个方面分别进行研究。

### 3.5.2 不同年龄组的回归结果

我国的基本养老保险制度规定，对于60周岁以上的参保城镇居民来说，其不需要再缴纳保费，且可按月领取养老金，而60周岁以下的城镇居民，需要缴满15年才能领取保险金。可见，基本养老保险对60周岁以上及以下的居民会有不同的影响，一方面，对于60周岁以下的居民来说，虽然参保基本养老保险的保费支出减少了其短期内的可支配收入，但同时缓解了其对晚年生活状况的忧虑；另一方面，对于60周岁以上的参保城镇居民，由于基本养老保险金的给付，其晚年的收入水平将有所提高，故此本文将家庭户主年龄在60周岁以下的分为一组，这类家庭现阶段只能参保缴费，另一组是家庭户主在60周岁以上的家庭，这类已参保家庭无需再缴费，可按月领取养老金。

表6 不同年龄组的回归结果

| | 60周岁以下 | | 60周岁以上 | |
|---|---|---|---|---|
| | （1）<br>是否持有风险金融资产 | （2）<br>风险金融资产占比 | （3）<br>是否持有风险金融资产 | （4）<br>风险金融资产占比 |
| 组别*年份 | 0.0504**<br>（1.99） | 0.0157**<br>（2.14） | -0.0249*<br>（-1.73） | -0.0031*<br>（-1.65） |
| 是否参保 | -0.0366**<br>（-2.32） | -0.0077*<br>（-1.75） | -0.0007<br>（-0.06） | -0.0002<br>（-0.06） |
| 参保年份 | 0.0474***<br>（4.28） | 0.0070**<br>（2.40） | 0.0471***<br>（3.72） | 0.0077***<br>（2.65） |
| 收入水平 | -0.002**<br>（-2.23） | 0.0042*<br>（1.91） | 0.0036*<br>（1.94） | 0.0008*<br>（1.86） |

| | | | | |
|---|---|---|---|---|
| 家庭规模 | 0.0019<br>（0.58） | -0.0003<br>（-0.40） | 0.0032<br>（0.84） | 0.0012<br>（1.18） |
| 婚姻状况 | -0.0014<br>（-0.25） | -0.0004<br>（-0.28） | 0.0039<br>（0.87） | 0.0004<br>（0.39） |
| 健康状况 | -0.0241***<br>（-4.73） | -0.0052***<br>（-4.08） | -0.0001<br>（-0.01） | -0.0004<br>（-0.04） |
| 教育水平 | 0.0419***<br>（7.38） | 0.0097***<br>（6.41） | 0.0134***<br>（2.58） | 0.0024**<br>（2.45） |
| 性别 | -0.0025<br>（-0.18） | 0.0032<br>（0.87） | 0.0036<br>（0.24） | 0.0017<br>（0.44） |
| 常数项 | 0.0163<br>（0.55） | -0.0007<br>（0.08） | -0.0425*<br>（-1.92） | -0.0089*<br>（-1.8） |

注：括号中数值为t值，* p < 0.1， ** p < 0.05, *** p < 0.01。

表6为城镇基本养老保险影响不同年龄组的家庭户主风险金融资产投资决策以及风险金融资产资产占比的研究结果。其中，第2列和第3列分别反映城镇基本养老保险对16至60周岁家庭户主是否持有风险金融资产和风险金融资产占比具有正向影响，第4列和第5列分别反映城镇基本养老保险对60周岁以上的家庭户主是否持有风险金融资产和风险金融资产占比具有消极影响。

根据回归结果（1）和结果（2），基本养老保险对16至60周岁家庭户主是否持有风险金融资产和风险金融资产占比的影响的交叉项系数分别为0.0504和0.0157，且均在5%的显著性水平上显著。这说明参保养老保险对于家庭进行风险金融资产投资配置以及提高现有风险金融资产占比具有正向作用。从这一结果来看，这一年龄组的家庭，其家庭成员大多尚未退出劳动力市场，有着较为广泛的收入来源，基本养老保险的缴费压力相对较小，而参保基本养老保险相当于对未来的储蓄，保障其未来的生活质量，这使其当前的生活有较高的容错度，降低了其投资失败时产生的心理负担，因而表现出参保者更愿意进行风险金融资产的投资或者提高现有风险金融资产的投资占比，以谋求更高的生活水平。

回归结果（3）和结果（4）中，基本养老保险对60岁以上家庭户主是否持有风险金融资产和风险金融资产占比的影响的交叉项系数分别为-0.0249和-0.0002，且在10%的显著水平上显著。这说明参保基本养老保险对家庭持有风险金融资产以及提高现有风险金融资产占比产生了消极影响，显著性较16至60周岁组的样本有所下降，但依然能够反映对于户主年龄在60周岁以上的城镇家庭，相较于未参保的居民，参保居民具有更强的保险意识，这使其对风险有较强的认知，在面对晚年生活的不确定性时，由于其大多已退出劳动力市场，收入能力减弱，风险承受能力下降，其对风险投资的策略更趋于保守，在拥有基本养老保险这一额外收入补充，参保居民的基本生活水平得以保障，因而对于风险金融资产的配置欲望下降。反观未参保城镇居民，由于失去基本养老保险这一保障，其不得不采取其他的财务安排以扩充晚年收入，保障其晚年生活水平，这就使其具有较强的资产增值需求，从而促使其进行一部分风险金融资产的配置。

### 3.5.3 参保不同养老保险的回归结果

在参保类型方面，由于政府和事业单位退休金和城镇职工基本养老保险金与城镇职工的工薪水平相联系，保费较高，相应地，保障程度也相对较高，可将其归纳为一类，以下统一称为城镇职工保险（简称“城职保”）类；而城镇居民社会养老保险、城乡统一居民社会养老保险主要是保障城镇居民的基本生活水平，保费较低的同时保障程度也较低，可将其归为另一类，以下统一称为城镇居民养老保险（简称“城居保”）类。

表7 参保不同基本养老保险的回归结果

| | 城职保 | | 城居保 | |
|---|---|---|---|---|
| | （1）<br>是否持有风险金融资产 | （2）<br>风险金融资产占比 | （3）<br>是否持有风险金融资产 | （4）<br>风险金融资产占比 |
| 组别*年份 | 0.0688**<br>（1.98） | -0.0093*<br>（-1.76） | 0.0038<br>（0.15） | -0.0056<br>（-0.82） |
| 是否参保 | -0.0676***<br>（-3.46） | -0.3287<br>（-1.25） | -0.0040<br>（-0.26） | -0.0016<br>（-0.45） |
| 参保年份 | 0.0490***<br>（4.22） | 0.0087***<br>（2.98） | 0.0479***<br>（5.25） | 0.0072***<br>（3.22） |
| 收入水平 | 0.0059<br>（0.16） | -0.0048<br>（-1.29） | 0.0013<br>（0.03） | -0.0039<br>（-0.52） |
| 家庭规模 | 0.0012<br>（0.35） | -0.0111<br>（-0.70） | 0.0030<br>（1.11） | 0.0005<br>（0.76） |
| 婚姻状况 | -0.0033<br>（-0.55） | -0.0388<br>（-1.14） | -0.0024<br>（-0.67） | -0.0008<br>（-0.96） |
| 健康状况 | -0.0241***<br>（-4.61） | -0.0381***<br>（-3.34） | -0.0205***<br>（-4.95） | -0.0046***<br>（-4.40） |
| 教育水平 | 0.0438***<br>（7.38） | 0.0223***<br>（5.03） | 0.0373***<br>（7.50） | 0.0055***<br>（5.01） |
| 性别 | 0.0079<br>（0.54） | 0.0073<br>（-1.01） | 0.0119<br>（1.02） | 0.0017<br>（0.60） |
| 常数项 | -0.0058<br>（-0.19） | 1.0483<br>（1.20） | -0.0107<br>（-0.46） | 0.0070<br>（1.28） |

注：括号中数值为t值，* p < 0.1， ** p < 0.05，*** p < 0.01。

表7的研究结果反映了参加城职保与城居保对家庭户主风险金融资产投资决策以及风险金融资产资产占比的影响。其中，第2列和第3列分别反映城职保对家庭户主是否持有风险金融资产和风险金融资产占比具有消极影响，第4列和第5列分别反映城居保对家庭户主是否持有风险金融资产和风险金融资产占比并无显著影响。

根据回归结果（1）和结果（2），城职保对城镇居民是否持有风险金融资产和风险金融资产占比的影响的交叉项系数分别为0.0688和-0.0093，前者在5%的

显著性水平上显著，这说明参加城职保对家庭参与风险金融资产配置有积极影响，而后者在10%的显著水平上显著，显著性有所下降，但仍能够说明参加城职保对家庭提高风险金融资产的占比产生了消极影响。这样的结果表明，参加城职保能够使得人们老有所养，保障人们的晚年生活，降低人们晚年生活的不确定性，人们在参保后乐于进行一些风险金融资产的配置以改善其现有生活质量，但由于我国目前的发展尚处在不发达的初级阶段，人们的工资水平普遍较低，这使得现行城职保制度的个人缴费比例相对较高，家庭成员在参加城职保并如期缴纳保险费后，其短期内可支配收入水平产生了较为明显的降低，最终导致参保的城镇家庭尽管有意愿进行风险金融资产投资，但受到收入减少的影响，只能进行较低水平的投资甚至减少已持有的风险金融配置，同时，由于收入减少，短期内应对突发事件风险的能力下降，这使得参保者对风险投资的偏好降低，转而更加愿意进行如银行保本理财之类的无风险投资，从而增加家庭的无风险资产比重，间接降低了风险金融资产占比。

回归结果（3）和结果（4）显示，城居保对城镇居民是否持有风险金融资产和风险金融资产占比的影响的交叉项系数均不显著，这说明参加城居保对于城镇家庭是否持有风险金融资产和风险金融资产持有比例未产生明显影响。之所以产生这样的结果，是由于城居保尽管缴纳的保费较低，但其相应的晚年保障力度也较低，如按照最低标准参保，仅能保障投保人最基本的晚年生活需求，无法改善投保人对未来晚年风险的预期，那么其也就很难对城镇家庭是否进行风险金融资产投资和风险资产持有占比产生影响。此外，城居保参保者往往是我国的低收入群体，其日常开销占据了收入的绝大部分，风险承受能力较差，对风险金融资产的配置意愿和能力较弱，而城居保只有在其晚年时才可以领取保险金，无法改善其当前收入状况，因而也就无法对其是否配置风险金融资产和风险金融资产的配置比例产生显著影响。

### 3.5.4 不同风险态度的回归结果

关于风险态度变量的设置，主要根据受访者在CHFS中的问卷回答进行衡量。在CHFS问卷中，有关于风险态度的问题是“如果您有一笔资金用于投资，您愿意选择哪种投资项目？”回答选项为“①高风险高回报的项目②略高风险略高回报的项目③平均风险平均回报的项目④略低风险略低回报的项目⑤不愿意承担任何风险⑥不知道”。本文认为选择①②为风险偏好，选择③为风险中性，选择④⑤为风险厌恶，由于选择③的受访者数量较少，为研究方便，本文将选择①②的受访者归为风险偏好型，将选择③④⑤的受访者归为非风险偏好型。

表8 不同风险态度的回归结果

| | 风险偏好 | | 非风险偏好 | |
|---|---|---|---|---|
| | （1）<br>是否持有风险金融资产 | （2）<br>风险金融资产占比 | （3）<br>是否持有风险金融资产 | （4）<br>风险金融资产占比 |
| 组别*年份 | 0.2179***<br>（2.94） | 0.0705***<br>（2.74） | -0.0082<br>（-0.23） | -0.0002<br>（-0.03） |
| 是否参保 | -0.1110**<br>（-2.10） | -0.0229**<br>（-2.55） | -0.0183<br>（-0.82） | 0.0003<br>（0.05） |

| | | | | |
|---|---|---|---|---|
| 参保年份 | -0.0180<br>（0.44） | -0.0113<br>（-1.30） | 0.0487***<br>（2.81） | 0.0077**<br>（2.00） |
| 收入水平 | -0.0027<br>（-0.72） | -0.0001<br>（-0.09） | 0.0001<br>（0.05） | -0.0001<br>（-0.03） |
| 家庭规模 | 0.0201*<br>（1.66） | 0.0041<br>（1.37） | -0.0027<br>（-0.62） | -0.0013<br>（-1.33） |
| 婚姻状况 | -0.0005<br>（-0.03） | 0.0016<br>（0.47） | -0.0072<br>（-1.19） | -0.0029**<br>（-2.30） |
| 健康状况 | -0.0286*<br>（-1.85） | -0.0044*<br>（-1.88） | -0.0309***<br>（-4.40） | -0.0056***<br>（-3.71） |
| 教育水平 | 0.0377**<br>（2.30） | 0.0034*<br>（1.91） | 0.0483***<br>（6.08） | 0.0070***<br>（4.56） |
| 性别 | -0.0235<br>（-0.47） | -0.0129<br>（-1.26） | 0.0216<br>（1.00） | 0.0079<br>（1.43） |
| 常数项 | 0.0747<br>（0.71） | 0.0275<br>（0.85） | 0.0010<br>（0.03） | 0.0057<br>（0.60） |

注：括号中数值为t值，* p < 0.1， ** p < 0.05，*** p < 0.01。

表8的研究结果反映了家庭户主的不同风险态度对家庭金融风险资产投资决策以及风险金融资产资产占比的影响。其中，第2列和第3列分别反映基本养老保险对风险偏好的家庭户主是否持有风险金融资产和风险金融资产占比具有显著的正向影响，第4列和第5列分别反映基本养老保险对非风险偏好的家庭户主对家庭是否持有风险金融资产和风险金融资产占比的影响并不显著。

根据回归结果（1）和结果（2），基本养老保险对风险偏好的家庭户主是否持有风险金融资产和风险金融资产占比的影响的交叉项系数分别为0.2179和0.0705，系数较大，且均在1%的显著性水平上显著，表现出较强的正相关关系。这样的结果表明，参加城镇基本养老保险对于城镇风险偏好型的家庭是否进行风险金融资产投资和风险金融资产配置比例有显著的正向影响，这主要是由于参加基本养老保险能够降低投保人未来面对的养老风险，使其未来的人生有了保障，间接降低了风险偏好者在进行风险金融投资时面临的风险，这就促使其更加有意愿去进行风险金融资产配置或提高已有风险金融资产的持有比例。

回归结果（3）和结果（4）显示，基本养老保险对非风险偏好的家庭户主是否持有风险金融资产和风险金融资产占比的交叉项系数均不显著，这意味着是否参加基本养老保险对风险厌恶的户主来说无法影响其是否参与风险金融资产配置和风险金融资产配置占比。之所以产生这样的结果，是由于尽管基本养老保险能在一定程度上保障未来的晚年生活水平，进而提升投保人家庭配置风险金融资产的意愿，但对于风险厌恶者来说，其更倾向于稳健的银行保本理财和银行存款，而非风险较高的风险金融投资，加之我国目前的基本养老保险制度下的养老金给付金额较发达国家而言相对较少，对于风险厌恶的投资者吸引力不足，对其未来风险预期的影响较小，因而难以对风险厌恶的户主是否进行家庭金融风险资产配置以及风险金融资产配置占比产生显著影响。

## 4. 结论与建议

经过对样本总体及从户主年龄、参保类型、风险偏好三个角度的二重差分实证研究，本文的出如下结论：

第一，城镇居民参保基本养老保险后，总体上看，其参与家庭金融风险资产配置意愿有所提升，但对于已持有风险金融资产的家庭来说，是否参加基本养老保险对该类资产占家庭总资产得到占比并无显著影响。

第二，60周岁以下的城镇居民投保基本养老保险后，对风险金融资产配置意愿有显著的正向影响，同时能够参保者更倾向于提高已有的风险金融资产占比，以获取更高收益，从而提高生活水平。60周岁以上的城镇居民投保基本养老保险后，对风险金融资产配置意愿有显著的负向影响，同时参保者倾向于减少风险金融资产占比，表明了高龄组对于风险更加厌恶。

第三，参保城职保的户主对于家庭金融风险资产的配置意愿显著增强，同时更倾向于增加已有的风险金融资产占比，而是否参保城居保的户主在家庭金融风险资产配置与风险金融资产占比方面并未产生显著差异。这表明基本养老保险的保障水平越高越有利于提升居民配置风险金融资产的意愿和风险金融资产占家庭总资产的比重。

第四，参保城镇基本养老保险对风险偏好的户主参与家庭金融风险资产配置和提升该类资产比重有较强的促进作用，而对于风险厌恶的户主则无明显影响。这可能与我国基本养老保险的保障水平总体较低有关，无法对风险厌恶的投保人参与风险金融资产配置或提高现有风险金融资产比重产生显著影响。

基于上述结论，为提高我国城镇居民金融市场参与度，完善我国金融市场参与主体，本文提出以下几点建议：

第一，本文发现社会养老保险对家庭参与风险金融市场和提高风险资产配置比例具有显著的激励作用，这为通过完善养老保险制度、健全国民养老保障体系的途径来改变家庭的微观经济活动提供了直接的证据。因此，政府部门有必要重视养老保险制度的深化改革，以切实提高实际参保率为首要目标，从而激励家庭合理地配置风险金融资产，提高市场参与的广度与深度，实现家庭财富增长和金融市场发展的良性循环。

第二，养老保险对我国家庭金融风险资产配置决策的影响受到领取保险金年龄的影响，当家庭临近退休年龄时，家庭的风险偏好会发生一定的转变，风险金融资产配置决策很大程度上已经不再是是否拥有养老保险，而是更加关注养老金的给付水平。因此，除了提高基本养老保险的实际覆盖率，还应该加强制度参数的设计和调整，优化养老金待遇增长机制，从而提高家庭的预期养老金水平，激励家庭进行积极的风险金融资产配置。

第三，在我国多轨制的基本养老保险体系下，有一部分城镇家庭未进入正规就业市场而只能被城乡居民社会养老保险制度覆盖，其制度运行模式和保障水平都与城镇企业职工基本养老保险和机关事业单位养老保险等针对正规就业者的保障项目存在非常大的差距，进而造成风险金融资产配置的群体间失衡。因此，政府及社会保障部门在养老保险体系改革过程中，应适当向弱势群体倾斜，缩小制度差异，提高城居保养老金待遇；同时，加强对居民就业培训与收入补贴力度，引导居民积极参与正规就业市场，降低其他风险对金融风险的挤出效应，促进金融市场繁荣发展。

第四，我国应努力探索、创新全国社保基金的运作方式，在以中央财政预算拨款、基金投资收益等方式确保基金规模和实现保值增值的同时，积极探索能够

进一步提高养老金给付水准的可行办法，从而更加广泛地激励我国居民参与风险金融市场，促进金融市场繁荣，进而反哺社保基金运作，形成良性循环。

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# 基本养老保险对城镇家庭金融风险资产配置的研究

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**关键词:** 养老保险；二重差分；家庭金融；风险资产配置

**摘要：**近年来，我国居民的家庭金融资产配置表现出结构单一、风险金融资产配置不足的现象，伴随着我国老龄化的加剧和城镇化的推进，城镇居民对于晚年生活的安全感和幸福感日渐成为了影响家庭金融资产配置的重要因素。社会养老保险做为社会保障体系的重要组成，保障了居民的晚年收入，使其老有所养，有助于其改善晚年生活，增加其安全感和幸福感，因此，居民社会养老保险对于研究家庭的风险金融资产配置具有重要意义。本文基于中国家庭金融调查研究中心（CHFS）2015年度和2017年度数据，运用双重差分法评估城镇社会养老保险对城镇家庭资产选择的影响。研究表明，在考虑到城镇社会养老保险的参保类型、投保年龄、和投保人风险偏好差异后，城镇社会养老保险对城镇家庭的金融风险资产配置影响有所差异，且影响程度相对较小。

# Analysis of the Effect of Basic Endowment Insurance on Delayed Retirement Intention Based on Population Differences

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**Keywords:** Population aging; Delayed retirement; Endowment insurance; population differences.

**Abstract.** The aging of population in China is becoming more and more serious. It is imperative to formulate a scientific and reasonable policy to delay the retirement age. Social endowment insurance is the main source of income for the elderly after retirement in China. But at the same time, two basic endowment insurance of our country's existing due to the differences in the security degree, and considering the differences between groups, so will have different influence on individuals' willingness to delay retirement, based on 2015 China Health and Retirement Longitudinal Survey, combined with related theory, analysis of social endowment insurance of our country older the specific effect of group delay retirement intend, Furthermore, it analyzes the influence of different pension insurance levels on delayed

retirement intention based on group differences. Furthermore, it provides some ideas for delaying retirement policy formulation.

# 1 绪论

## 1.1 研究背景及意义

### 1.1.1 研究背景

近年来，随着我国老龄化程度的不断加深，养老保险基金的支付压力逐渐增大，延迟退休政策得到了全社会的广泛讨论和关注。在 2017 年“两会”上，国家人力资源和社会保障部申明将于当年出台延迟退休方案，并预计于五年后正式实施。而这几年，延迟退休也屡屡被提及，在今年 2021 年人社部发布的《人力资源和社会保障事业发展“十四五”规划》中也提到按照小步调整、弹性实施、分类推进、统筹兼顾等原则，稳妥实施渐进式延迟法定退休年龄。延迟退休已势在必行。面对养老基金支付压力不断增大直至基金枯竭的风险，国际上通常的做法有两种，一是将养老基金制度改为积累制，二是延迟退休。我国当前的养老保险制度虽然是统账结合的，但实际上个人账户常年处于空账运转，考虑到当前经济形势以及我国国情，第一种方法较难实施。但同时，我国现行的男职工 60 周岁、女干部 55 周岁以及女工人 50 周岁的退休年龄在国际上都算是年轻的，加上预期寿命的不断延长，确有推行延迟退休政策的空间。

社会养老保险保障的是个体的老年与退休生活，当其达到法定退休年龄退休或者因年老丧失劳动能力后，社会养老保险可以对其基本生活进行保障；社会养老保险对个体的退休决策会产生两种方向相反的影响效应。一种是正向影响退休意愿的收入效应，养老保险计划将增加预期收入，减少不确定性，进而人们会增加闲暇时间而减少工作时间。另一种是负向影响退休意愿的替代效应，养老保险减少了个体的现时收入，通过放松主体预算约束而增加人力资本投资，使得人们增加劳动供给，降低退休意愿。再进一步，因为人群之间存在差异，导致社会养老保险对退休意愿或退休决策的影响也存在差异，例如具有较高养老金给付的个体会比具有较低养老金给付的个体倾向于更早离开劳动力市场。因此，要研究社会养老保险对退休决策的具体影响以及影响之间的差异，就必须要对其进行进一步的实证分析。

### 1.1.2 研究意义

第一，在我国人口老龄化严重、法定退休年龄与人口现状不相适配、社会养老保险制度不足问题突出的背景下，个体劳动参与率与社会养老保险制度的完善就成为了重点问题，研究社会养老保险对个体退休决策的影响，可以为该制度的改革、完善提供借鉴与思路，有利于社会养老保险制度的良好发展，也能为我国退休制度的改革提供建议，促进两种制度的协调发展，使得制度发展更切合我国现实。

第二，研究基本养老保险对个体退休意愿的影响以及探讨基本养老保险对个体退休决策影响的群体和地区间差异，有助于政策制定者正确了解基本养老保险对不同群体、地区个体延迟退休意愿的具体影响，为延迟退休政策的制定提供思路和方向，进而有助于相关部门科学制定延迟退休政策，以消解公众的对立情绪，缓和各利益群体的矛盾和冲突，减少政策推行过程中的阻力。

### 1.2 本文可能的创新点

1．一般而言，基本养老保险保障程度不同可能会对延迟退休意愿产生不同的影响，所以不同于已有的文献，本文将基本养老保险保障程度分为高保障和低保障两种类型，进而分别研究分析对延迟退休意愿的影响。

2．在不同人群中，由于区域、健康状况等等个体特征差异，也会导致基本养老保险对延迟退休意愿影响的差异，因此本文在前述基础上加上人群差异因素，重点研究分析基于人群差异的不同保障程度养老保险对延迟退休意愿的影响。

## 2 文献综述

### 2.1 社会养老保险对退休意愿的影响

从理论上说，社会养老保险对退休意愿的影响会产生三种情况：促使个体提前退休、无影响、促使个体延迟退休。而在实际研究分析中，经过无数学者论证，社会养老保险对个体退休意愿的影响绝大多数都是表现为促使个体提前退休和无影响两种情况，因此，在文献综述中，本文只列举社会养老保险促使个体提前退休和对延迟退休意愿无影响两种情况的研究文献。

#### 2.1.1 社会养老保险促使个体提前退休

Feldstein（1974）的扩展生命周期理论开辟了国外研究社会养老保险与退休行为关系的先河，他认为社会养老保险金会促使人们提前退休，增强人们的退休意愿。随后有无数学者在生命周期理论的基础上不断扩展，以此来研究社会养老保险与居民退休意愿的关系。Sheshinski（1977）在生命周期模型的基础上加入非零利率、时间折现等因素展开静态分析，研究发现如果随着退休年龄的推迟提高社会养老保险金的待遇，社会养老保险金对退休意愿的正影响就会减弱，降低人口增长率则正影响就会加强。Mitchell and Fields（1984）运用生命周期模型研究职工退休决策的影响因素，发现养老金缴费和养老金水平会对职工各个时期的劳动力供给和退休决策产生影响，会促使居民提前退休。Sueyoshi（1989）运用多重风险模型，将经济变量与非经济变量作为解释变量，退休决策作为被解释变量，发现经济因素与非经济因素都对退休决策产生影响，其中经济变量主要包括工资、财产、养老金和其他社会福利，其中养老金收入会对提前退休行为产生正向的影响。Gruber and Wise（1999）运用社会养老保险激励模型探索比利时、德国、法国、荷兰等国家 1960-1995 年间老年男性劳动参与率下降的原因，发现领取养老金收入会对劳动者达到法定年龄后退出劳动力市场起到正向激励作用。Diamond and Hausman（2006）利用美国 1965-1975 年的调查数据对退休行为的影响因素进行研究，研究结果发现提高社会保障的收益水平会激励居民的提前退休行为。Danzer（2010）对乌克兰国家的研究也有类似的发现，养老金收入与劳动参与率和劳动供给时间呈负相关，增大了老年人退出劳动力市场的概率。

国内关于这方面的研究有：汪泽英和曾湘泉（2004）使用 2000 年我国 42 个城市企业参保职工抽样调查的截面数据，运用社会养老保险收益激烈模型来研究社会养老保险对职工退休选择的影响，研究结果表明，当时存在的企业养老保险制度对职工按法定年龄退休起到激励的作用，职工更倾向于提前退休。肖金萍（2006）论证了公共养老金对劳动力市场的影响主要是通过养老金费用的缴纳和

收入的领取来对劳动力市场的供需产生影响的，养老金在一定程度上加剧了提前退休现象。张川川（2014）运用中国健康与养老追踪 2011 年的相关数据，使用断点回归法研究社会新农保对劳动决策的影响，发现养老金收入减少了农村老年人的劳动参与率，降低了农村老年人的劳动参与时间。王军、王广州（2016）使用 2014 年中国劳动力动态调查数据研究发现养老保险可以在一定程度上促进居民提前退休。林熙、林义（2017）运用生存分析法，通过 Cox 比例风险模型对 CHARLS 数据库的相关样本进行实证分析，研究结果表明拥有社会养老保险的人退休概率更高。

2.1.2　社会养老保险对退休意愿无影响

国外关于社会养老保险对个体退休意愿没有影响的研究主要有如下代表：Hu（1979）指出公共退休计划与退休行为之间无明显关系。Blinder (1980)通过研究发现社会养老保险并不会对老年人的劳动供给行为产生太大的影响，他认为现实生活中之所以会有提前退休的现象，是由于为人们对社会养老保险测算制度不够了解，人们并不清楚自己退休之后具体能得到多少补偿。Butless（1985）指出公共养老金计划水平的提高并不能成为美国劳动参与率急剧下降的原因。Krueger and Pischke(1992)采用群组分析法来研究养老金财富在近似自然实验的外部冲击下对劳动供给的影响，结果表明养老金财富及其增长并不会对老年劳动参与产生显著影响。Juarez（2010）在研究墨西哥养老保障对劳动供给行为的影响时，发现墨西哥的社会养老保险金收入与劳动者的供给行为没有关系。

国内学者解垩（2015）基于 2008 年和 2012 年两轮中国健康与养老追踪调查面板数据，采用差分-断点方法来评估“新农保”对农村老年人劳动力供给的影响，研究结果表明 “新农保”这种补助强度不大的外部干预政策并没有在短期内对老年人劳动供给和福利产生影响。

## 2.2　延迟退休意愿的人群差异研究文献

Becker（1965）对企业职工的退休决策展开研究，研究结果表明，家庭因素变量会对企业职工的退休决策和退休行为产生影响，企业职工会根据所在家庭的实际情况作出相应的决策和判断，进而影响到企业职工的退休态度和对退休行为的选择。Coile C（2000）的研究表明，预期养老金收入的提高对女性劳动者的退休意愿并无影响，但会使男性劳动者更倾向于提前退休。Doris Weichselbaumer（2013）认为性别会影响劳动者延迟退休意愿，其研究结果表明相对女性来说，男性更愿意延迟退休。Werner K（2013）研究结果表明，受教育水平越高的劳动者越不愿意延迟退休。Sauré，Philip 和 Zoabi（2011）利用美国的数据对个体平均退休年龄进行测算，并利用其他国家的职业构成对其个人平均退休年龄进行测算，对比测算结果后发现，不同国家的职业构成能在一定程度上解释各个国家的退休年龄差距，其研究结果说明，职业不仅是个体退休年龄的重要影响因素，也是各国退休年龄差异的重要影响因素。在婚姻状况方面，Shoven（2012）研究结果表明，已婚夫妻相对于单身男女，双职工夫妻相对于单职工夫妻而言，已婚夫妻和双职工夫妻更愿意延长退休年龄，更晚地开始领取养老金。在健康状况方面，Gustman A L（2014）研究发现，身体健康状况对美国劳动者的退休年龄有显著影响，健康状况较差是美国劳动者选择提前退休的重要原因。

车翼（2006）等人，利用青岛市大样本调查数据，对已退休劳动者的再就业行为进行研究，发现影响已退休劳动者再就业行为的各个因素中，性别的影响程度最大，在进一步分析后发现男性退休劳动者再就业的概率更高。黄阳涛（2013）

研究发现，与脑力劳动者相比，体力劳动者更不愿意延迟退休。李琴、彭浩然（2015）基于 2011 年的中国健康与养老追踪调查数据对 45-60 岁城镇人口的延迟退休意愿展开研究，通过构建 probit 模型进行实证分析，分析结果表明，女性的延迟退休意愿要高于男性。王军、王广州（2016）基于 2014 年中国劳动力动态调查数据对城镇劳动力的退休意愿及其影响因素展开实证研究，研究结果发现，婚姻状况与其延迟退休意愿显著相关，已婚劳动者的延迟退休意愿发生的概率要比单身者低 2.8%。田宋、席恒（2017）基于全国 10 个省市的调查，通过定量分析方法研究职工退休意愿和影响因素，其分析结果表明，身体健康状况与职工延迟退休意愿为显著正相关。路征（2018）等人，基于中国家庭收入调查数据库（CHIP），通过建立三期 OLG 模型，对劳动者的人力资本和退休决策的相关度展开实证分析，其分析结果表明，受教育程度与劳动者延迟退休决策显著相关，当劳动者文化程度为初中及以下时，文化程度负向影响劳动者延迟退休意愿，当劳动者文化程度超过初中时，文化程度与其延迟退休意愿正向相关。

### 2.3 文献述评

从上文对文献的梳理可知，国外关于社会养老保险对个体退休意愿的研究开始的较早且较为丰富。同时，尽管不同国家的社会养老保险制度各有不同，且各国经济社会背景也各有差异，但绝大多数学者都得出了社会养老保险会对退休意愿产生正影响的结论。可以发现，目前关于社会养老保险对老年人退休决策影响的理论研究已经有了较为完善的体系，但仍存在继续拓展的空间，比如加入不同人群之间的差异性以及个体非理性等因素等。在实证研究方面，应更关注具有中国特色的改革数据，以及与现有改革联系最为紧密的劳动力群体，比如城镇职工、农村居民等，并由此发现在中国市场和制度下，社会养老保险与个体退休决策的关系具有什么样的个性化特征。

## 3 相关理论基础及分析

### 3.1 生命周期消费理论

生命周期消费理论由美国经济学家弗朗科·莫迪利安尼提出，这一理论强调了消费与个人生命周期阶段的关系。生命周期消费理论认为，人们是理性的，他们会在较长时间范围内计划他们的生活消费开支，以达到在整个生命周期内消费的最佳配置，进而实现个人的效用最大化。具体来说，假定人的一生分为三个阶段：年青时期、中年时期和老年时期。前两个阶段是工作时期，后面的一个是非工作时期。一般来讲，人们在年青时期赚钱能力较弱从而收入偏低，消费可能会超过收入，需要借款进行消费。但随着时间的推移，他们的未来收入会增加。进入中年，人们赚钱能力增强，收入日益增加，这时的收入大于消费，人们一方面要偿还年轻时的负债，另一方面也会把一部分收入储蓄起来用于防老。当进入老年期，收入开始下降甚至基本没有收入，消费又会超过收入，此时的消费主要是靠过去两个阶段积累的财产，而不是收入。这样，个人可支配收入和财富的边际消费倾向便取决于该消费者的年龄。它表明当收入相对于一生平均收入高时，储蓄是高的。

养老其实就是一种跨期消费的行为，国家通过建立养老保险制度征收养老金来作为收入转移的手段，并将征收到的养老金用于自身未来财富的积累和转移给退休者。因此，可以发现，根据生命周期消费理论，养老保险通过影响收入会对

居民的退休决策产生两种影响，一种是缴纳养老保险费减少了居民的现时收入，使得他们会增加劳动供给；一种是居民可以领取养老金，增加了居民的未来收入进而增强居民的退休意愿，社会养老保险对退休决策的影响要看两种影响的综合效果。比较具有代表性的Feldstein（1974）的扩展生命周期理论认为拥有养老金会促使人们提前退休，增强人们的退休意愿。随后也有无数学者在扩展生命周期理论的基础上不断完善生命周期模型来研究社会养老保险对退休决策的影响，且大多数研究结果都显示社会养老保险能够促进个体提前退休。

### 3.2 持久收入理论

持久收入理论是由美国著名经济学家弗里德曼提出来的。持久收入理论认为居民的消费不取决于现期收入，也不取决于现期收入和以前最高收入的关系，而是取决于居民的持久收入。持久收入是稳定的，消费也是稳定的。也就是说，消费取决于收入，但是消费者不会对所有的收入变化做出相同的反应。具体而言，如果收入的变动是永久性的（比如晋升到一个可以提供更稳定的更高的收入岗位上），那么人们就可能会消费所增加的大部分收入。另一方面，如果收入的变动具有明显的暂时性（比如意外获得的奖金等），那么所增加的收入的相当大部分就会被储蓄起来。因此，收入应该分为持久收入与暂时收入。持久收入是指长期的，有规律的预期内能得到的稳定收入，一般应持续三年以上，例如，固定的工资收入。暂时收入是一时的，非连续性的偶然收入。人们希望消费是稳定的，因此，人们只会根据持久收入来安排消费，而不是根据暂时性收入来安排消费。

与持久收入能够影响消费的途径类似，对于个体的退休意愿，临时变动的政策并不会对个体退休意愿产生影响，而只有永久性的政策变动才能够产生影响。那么根据持久收入理论，养老金制度作为一项永久性的政策，养老金收入可以被看作是持久性收入，因此会对个体的储蓄以及退休决策产生影响。具体而言，养老金收入这项持久性收入增加了个体未来能够预期到的收入，进而增强了其退休意愿，影响个体的退休决策。

### 3.3 收入再分配理论

收入再分配是国民收入继初次分配之后在整个社会范围内进行的分配，是指在不改变资源总和的情况下，国家的各级政府以社会管理者的身份进行资源的分配，将资源从一部分人手里调节到另一部分人手里。收入的再分配实质上是一项能够有效对市场运行机制进行调节和补充的公共政策。

收入再分配从其实现形式来看，主要有个人收入再分配、代内收入分配与代际间收入分配。社会养老保险制度的代际间收入分配主要体现在财富资源在年轻一代与退休一代之间的再分配，也就是收入的代际间转移。我国目前的养老保险制度是现收现付制，即以劳动者在职期间的缴费加上同期用人单位或雇主缴费和政府补贴组成的养老保险基金来支付退休者养老金，实行年度收支平衡预算。通俗来讲就是用年轻一代的钱去养活退休一代，这样也就实现了社会养老保险的代际间收入分配。根据收入再分配理论，我们可以得知完善的社会养老保险体系能够缩小边际消费倾向在收入较高与收入较低的居民之间的差距，调节多代的代际收入，提高整个社会的边际消费倾向，进而改变居民的退休决策。

而社会养老保险的代内收入分配主要体现在社会养老保险对富裕阶层与贫困阶层、富裕地区与贫困地区之间的收入再分配。社会养老保险中共同的缴费比例使得收入较低的人群缴费要低于富有者，而领取的养老金来自于所有缴费者共同缴纳的养老金，从原则上来讲缴费越多能够领取的养老金就越多，但作为社会

管理者的政府出于社会公平和稳定的考虑会对社会养老保险制度合理化设计，使得社会养老保险能够在一定程度上缩小不同阶层与地区的收入差距，对市场机制进行调节和补充。社会养老保险的代内转移为贫困人群的基本养老生活水平提供了有效的保障，从而提高了居民的退休意愿。

### 3.4 个体差异理论

个体差异，也称个别差异，近代对个体差异的重视和研究源于生理学家和心理学家对个体差异的实验室认定。个体差异具体是指由于人的心理构成是千差万别的，人的先天条件和后天知识形成了个人兴趣、爱好等的差异，同时又由于所处社会环境和经历等等各不相同，各自的性格特点也不相同，从而导致个人在认识、情感、意志等心理活动过程中表现出来的相对稳定而又不同于他人的心理、生理特点。它表现在“质和量两个方面”，质的差异指心理生理特点的不同及行为方式上的不同，量的差异指发展速度的快慢和发展水平的高低。因此，由于个体差异的存在，导致个体的退休决策和退休意愿也会存在差异。

## 4 数据与变量

### 4.1 数据来源及说明

本文使用 2015 年中国健康与养老追踪调查数据（CHARLS）。本次调查是在 2013 年调查基础上的追踪调查。CHARLS 是针对中国 45 岁及以上中老年人家庭和个人进行的调查，主要涉及了居民健康状况，工作情况，退休情况，认知能力，工作、退休和养老金，家庭消费情况、家庭收入情况、社会人口学特征等方面的信息。样本遍布了全国城乡各地，调查了一万多户家庭，对我国中老年群体具有非常好的代表性。2015 年共调查了 28 个省（自治区、直辖市），覆盖了 150 个县区，包括了 450 个社区，成功随访了 1.24 万户家庭，共 2.3 万人完成了问卷调查。CHARLS 问卷的全面性，尤其是其中的工作退休与养老金模块与本文的研究对象和研究目标有很好的契合性，同时其覆盖的大规模受访群体为本文的研究提供了大样本。

### 4.2 变量处理

由于本文研究的是基于人群差异的基本养老保险对个体延迟退休意愿的影响，结合本文研究的需要，并在整合社会养老保险、心理因素、社会人口学特征等相关变量后，同时，在现实情况中，有许多人在达到退休年龄之后仍然存在工作意愿和具有相应的工作能力，愿意继续留在劳动力市场，然而又考虑到 75 岁以上的老人即使有工作意愿，但在一般情况下，也很难有实际工作的能力。因此，我们剔除了年龄大于 75 岁的数据、空缺值以及回答“不知道”、“记不清”等无效样本后，最终获得了 4149 个有效样本。如表 1 变量赋值表。

#### 4.2.1 因变量处理

本文的研究对象为我国中老年群体的延迟退休意愿，而在 CHARLS 问卷的工作退休与养老金模块中，有四个变量分别对应四类不同就业状态和职业（务农、受雇、自雇、失业）的受访者同一个问题的答案，即“您计划在多大年龄停止工作？即停止从事一切以挣钱为目的的活动以及不再为家庭经营活动帮工，将来也不打算从事比消遣性工作更劳累的工作？”。如果受访者觉得只要身体健康允许就会一直工作下去则回答为“0”。基于此，我们构造二元工作意愿变量，对于计

划退休年龄取值为 0 的样本，其工作意愿变量取值为 1（强工作意愿），其余样本取值为 0（弱工作意愿）。同时，为了保证因变量的取值是样本个体基于现实情况作出的理性预期，我们将回答计划退休年龄大于零且小于当时年龄的样本予以了剔除。

4.2.2 自变量处理

本文将是否参与基本养老保险以及参与养老保险(高保障/低保障养老保险)的情况作为解释变量，同时，对样本的受教育状况、年龄、性别、区域、婚姻状况、健康状况进行控制。

1）基本养老保险

本文将考察我国基本养老保险对个体延迟退休意愿的影响，基本养老保险包括城镇职工基本养老保险以及城乡居民基本养老保险。我们将首先构造养老金变量，如果个体没有参加以上任何一种养老保险，则取值为 0，否则取值为 1，从总体上考察是否参与养老保险对个体退休意愿的影响。

进而，我们根据基本养老保险的保障程度将其分为高、低保障养老保险两类，城镇职工基本养老保险归于高保障养老保险，城乡居民基本养老保险归于低保障养老保险，以考察不同保障程度养老金的分别影响。

2）控制变量

年龄会对个体的思想和行为产生影响，进而对个体的退休决策产生影响。在此，将受访者的年龄作为控制变量。

关于受教育状况，一般认为受教育状况越好、受教育程度越高，在劳动力市场上会具有更强的竞争力和更好的机会，会更谨慎考虑退休决策。在此，我们仅将原变量中关于最高学历的 11 种情况简单分为三种，分别是小学学历及以下、中学学历以及大学学历及以上三个层次（小学学历及以下=0、中学学历=1，大学学历及以上=2)，并将小学学历及以下者作为对照组。

性别差异理论认为男女不平等不仅是由生理上的差异导致，而是由包括社会阶级、文化教育等社会文化因素综合决定的，而男性通常是家庭主要的经济来源，因此更会长久留在劳动力市场。在此，我们构造性别虚拟变量(男性=1，女性=0)，将女性作为对照组。

区域变量是指示受访者所居住的地区是城镇还是农村的二元变量（城镇=1，农村=0）。根据受访者居住地区的客观属性能够准确直观地将区域变量仅分为城镇和农村两类。在此，我们将农村居民作为对照组。

良好的健康状况为个体留在劳动力市场提供了生理上的可行性，因此本文亦将健康状况作为控制变量。本文使用的健康状况采用受访者的自评情况，健康状况赋值为 0 或 1，1=健康，0=一般或不健康，以一般或不健康作为对照组。

关于婚姻状况，CHARLS 数据中将该变量分为已婚并与配偶同住、已婚不与配偶同住、分居等 6 种情况，在此，我们将婚姻状况仅区分为已婚或同居与未婚、离异或丧偶两种情况(已婚或同居=1，未婚、离异或丧偶=0)，并将未婚、离异或丧偶组作为对照组。

表1 变量赋值表

| 变量名称 | 变量赋值 |
|---|---|
| 延迟退休意愿 | 强工作意愿=1，弱工作意愿=0 |
| 基本养老保险 | 有基本养老保险=1，无基本养老保险=0 |
| 高保障养老保险 | 有高保障养老保险=1，无高保障养老保险=0 |

| | |
|---|---|
| 低保障养老保险 | 有低保障养老保险=1，无低保障养老保险=0 |
| 年龄 | 受访者年龄 |
| 教育状况 | 小学学历及以下=0，中学学历=1，大学学历及以上=2 |
| 健康状况 | 健康=1，一般或不健康=0 |
| 区域 | 城镇=1，农村=0 |
| 性别 | 男性=1，女性=0 |
| 婚姻状况 | 已婚或同居=1，未婚、离异或丧偶=0 |

## 5 实证结果与分析

### 5.1 模型选择

本文的因变量—个体的延迟退休意愿是一个离散型的二元虚拟变量，要么取值为 0，要么取值为 1，服从两点分布。1 表示个体强工作意愿，0 表示弱工作意愿。同时，其余变量数值皆为离散型变量，切合 Logit 模型的要求和优点，因此本文使用 Logistic 模型来研究基于不同人群差异的社会养老保险对延迟退休意愿影响分析。

具体模型设定形式如下：

$$Y_i=\alpha_0+\alpha_1*\text{social security}+\alpha_i X_i+\varepsilon \quad (5.1)$$

$$Y_i=\beta_0+\beta_1*\text{high social security}+\beta_i X_i+\zeta \quad (5.2)$$

$$Y_i=\gamma_0+\gamma_1*\text{low social security}+\gamma_i X_i+\eta \quad (5.3)$$

上述模型中， $Y_i$ 表示个体的工作意愿，social security、high social security 以及 low social security 为本文重点关注的基本养老保险情况，$X_i$ 为本文列举的控制变量，包括受访者的年龄、受教育状况、性别、区域等个体特征信息。ε、ζ、η为独立同分布的随机误差项，代表不可观测的因素的汇总。模型（5.1）是研究基本养老保险总体情况对延迟退休意愿的影响，模型（5.2）和模型（5.3）将基本养老保险划分为高保障和低保障两类，研究不同保障程度的基本养老保险对延迟退休意愿的影响。最后，在上述基础上，考虑到人群之间存在差异，本文结合上述三个模型进一步研究基于人群差异的不同保障程度的基本养老保险对延迟退休意愿的影响。

### 5.2 全样本

#### 5.2.1 全样本的变量描述性统计

本文结合所述理论，首先研究在全样本下，基本养老保险情况对个体延迟退休意愿的影响。整理全样本数据，得到如表 2 所示描述性统计。

表2 全样本的变量描述性统计

| 变量 | 样本数量 | 最小值 | 最大值 | 平均值 | 标准差 |
|---|---|---|---|---|---|
| 延迟退休意愿 | 4149 | 0 | 1 | 0.5339 | 0.49891 |
| 基本养老保险 | 4149 | 0 | 1 | 0.6982 | 0.45908 |
| 高保障养老保险 | 4149 | 0 | 1 | 0.1796 | 0.38387 |

| | | | | | |
|---|---|---|---|---|---|
| 低保障养老保险 | 4149 | 0 | 1 | 0.5276 | 0.49930 |
| 年龄 | 4149 | 18 | 75 | 58.6898 | 8.31179 |
| 受教育状况 | 4149 | 0 | 2 | 0.3943 | 0.54075 |
| 性别 | 4149 | 0 | 1 | 0.4782 | 0.49958 |
| 区域 | 4149 | 0 | 1 | 0.2931 | 0.45523 |
| 健康状况 | 4149 | 0 | 1 | 0.2596 | 0.43846 |
| 婚姻状况 | 4149 | 0 | 1 | 0.9005 | 0.29942 |

从全样本的变量描述性统计来看，有 53.39%的个体倾向于延迟退休。基本养老保险情况中，有 69.82%的个体都购买了基本养老保险，说明基本养老保险的覆盖率较高、覆盖面较广。当把基本养老保险划分为高低保障养老保险之后，只有 17.96%的个体购买了高保障养老保险，参保率较低；而有半数以上的个体购买了低保障基本养老保险。样本平均年龄为 58.6898 岁，同时性别均值为 0.4782，说明男女样本比例接近一半，样本具有可信度。另外，可以看出样本的受教育程度较低，农村样本的比例更大，且只有近 30%的个体认为自身健康状况好，其他个体都认为自身身体状态不太好。关于婚姻状况，则有 90%的个体已婚或同居。

### 5.2.2 全样本的实证结果与分析

表3 全样本变量对退休意愿影响的实证结果

| | 全样本 | | |
|---|---|---|---|
| 变量 | 边际效应 | 边际效应 | 边际效应 |
| 基本养老保险 | -0.058***<br>（-3.46） | | |
| 高保障养老保险 | | -0.324***<br>（-16.62） | |
| 低保障养老保险 | | | 0.130***<br>（8.57） |
| 年龄 | 0.001<br>（0.66） | 0.000<br>（0.21） | 0.001<br>（0.76） |
| 性别 | -0.032**<br>（-1.98） | -0.029*<br>（-1.88） | -0.032**<br>（-2.04） |
| 区域 | -0.070***<br>（-3.87） | -0.045**<br>（-2.55） | -0.056***<br>（-3.15） |
| 健康状况 | 0.026<br>（1.50） | 0.039**<br>（2.24） | 0.032*<br>（1.82） |
| 受教育状况 | 0.002<br>（0.12） | 0.006<br>（0.38） | 0.004<br>（0.23） |
| 婚姻状况 | -0.025<br>（-0.94） | -0.023<br>（-0.91） | -0.026<br>（-1.00） |

注:***，**，*分别表示在 1%，5%，10%的水平上显著。

从上述实证结果表 3 来看，基本养老保险总体情况对个体的退休意愿有显著的正影响，即有基本养老保险能显著促进个体提前退休，边际效应显示，相较于没有基本养老保险的个体，有基本养老保险的个体的工作意愿平均下降约 5.8%。当进一步将基本养老保险划分为高保障和低保障两类之后，得到了两种方向相反的结果。具体而言，高保障养老保险能够显著促进个体提前退休，边际效应显示，

相较于没有高保障养老保险的个体，有高保障养老保险的个体的工作意愿平均下降约 32.4%；然而，低保障养老保险对延迟退休意愿影响的边际效应显著且为正数，即参加低保障养老保险个体比没有低保障养老保险个体更倾向于延迟退休，工作意愿平均上升约 13%。其原因可能为，低保障养老保险的待遇水平过低，无法覆盖生活需要，对参与者的生活没有起到实际的保障作用，参与者需要通过延长劳动时间，获得更多收入。

其余控制变量，如性别、区域变量能够显著促进个体提前退休；健康状况变量在基本养老保险总体情况下对延迟退休意愿无显著影响，但划分为高低保障养老保险之后，健康状况变量能够显著促进个体延迟退休，即身体健康状况好的个体会倾向于更晚离开劳动力市场。而年龄、受教育状况以及婚姻状况对个体的延迟退休意愿没有显著的影响，但年龄和受教育状况的边际效应显示为正值，婚姻状况的边际效应为负值。

## 5.3 婚姻状况分类样本

### 5.3.1 婚姻状况分类样本的变量描述性统计

婚姻作为一种非常重要的社会关系，有着独特的经济作用和社会作用。家庭是一个基本的经济单位，婚姻的形成会增加家庭财富，但同时也让家庭所面对的风险相对增大，因此导致已婚个体和未婚个体在面对不同风险时的退休意愿是有差异的。与此同时，家庭还是一个基本的情感单位，婚姻的形成不论是让女性还是男性都需要背负起更多的责任，即相对于未婚或离婚等个体，已婚个体需要承担更多责任，因此导致这些个体之间的退休意愿和退休决策会存在差异。因此，本文选择根据婚姻状况将样本数据划分为已婚或同居个体和其他个体两类，以此研究基本养老保险总体情况、不同保障程度基本养老保险对延迟退休意愿的婚姻状况差异。整理婚姻状况分类样本数据，得到如表 4 所示描述性统计。

表4 婚姻状况分类的变量描述性统计

| | 已婚或同居个体（样本数：3736 个） | | | | 未婚、离异和丧偶个体（样本数：413 个） | | | |
|---|---|---|---|---|---|---|---|---|
| 变量 | 最小值 | 最大值 | 平均值 | 标准差 | 最小值 | 最大值 | 平均值 | 标准差 |
| 延迟退休意愿 | 0 | 1 | 0.5305 | 0.49913 | 0 | 1 | 0.5642 | 0.49647 |
| 基本养老保险 | 0 | 1 | 0.7002 | 0.45823 | 0 | 1 | 0.6804 | 0.46689 |
| 高保障养老保险 | 0 | 1 | 0.1817 | 0.38569 | 0 | 1 | 0.1598 | 0.36687 |
| 低保障养老保险 | 0 | 1 | 0.5276 | 0.49931 | 0 | 1 | 0.5278 | 0.49983 |
| 年龄 | 18 | 75 | 58.1692 | 8.18346 | 40 | 75 | 63.3995 | 7.98437 |
| 性别 | 0 | 1 | 0.4917 | 0.50000 | 0 | 1 | 0.3559 | 0.47938 |
| 区域 | 0 | 1 | 0.2955 | 0.45633 | 0 | 1 | 0.2712 | 0.44511 |
| 健康状况 | 0 | 1 | 0.2642 | 0.44096 | 0 | 1 | 0.2179 | 0.41333 |
| 教育状况 | 0 | 2 | 0.4119 | 0.54589 | 0 | 2 | 0.2349 | 0.46273 |

如表 4 的婚姻状况分类变量描述性统计所示，未婚、离异和丧偶个体中的延迟退休意愿较已婚或同居个体更高。基本养老保险参保率以及高、低保障养老保险参保率在已婚或同居个体和未婚、离异和丧偶个体并无显著差异，均值相差不大。同时，这两类个体中，城镇个体与农村个体的比例相近，且绝大多数的个体认为自身身体状况不太好。另外，已婚或同居个体中的受教育程度较未婚、离异和丧偶个体显著更高。

### 5.3.2 婚姻状况分类样本的实证结果与分析

表5 婚姻状况分类样本变量对退休意愿影响的实证结果

| | 已婚或同居个体 | | | 未婚、离异和丧偶个体 | | |
|---|---|---|---|---|---|---|
| 变量 | 边际效应 | 边际效应 | 边际效应 | 边际效应 | 边际效应 | 边际效应 |
| 基本养老保险 | -0.060***<br>（-3.39） | | | -0.052<br>（-1.02） | | |
| 高保障养老保险 | | -0.334***<br>（-16.30） | | | -0.218***<br>（-3.44） | |
| 低保障养老保险 | | | 0.136***<br>（8.51） | | | 0.060<br>（1.25） |
| 年龄 | 0.001<br>（0.45） | -0.000<br>（-0.04） | 0.001<br>（0.53） | -0.000<br>（-0.00） | 0.000<br>（0.06） | 0.000<br>（0.09） |
| 性别 | -0.012<br>（-0.74） | -0.011<br>（-0.69） | -0.014<br>（-0.86） | -0.204***<br>（-4.15） | -0.192***<br>（-3.96） | -0.197***<br>（-4.01） |
| 区域 | -0.071***<br>（-3.74） | -0.046**<br>（-2.46） | -0.057***<br>（-3.03） | -0.065<br>（-1.14） | -0.047<br>（-0.83） | -0.058<br>（-1.01） |
| 健康 | 0.021<br>（1.15） | 0.035*<br>（1.92） | 0.028<br>（1.54） | 0.083<br>（1.42） | 0.085<br>（1.46） | 0.078<br>（1.32） |
| 教育 | -0.004<br>（-0.23） | 0.001<br>（0.09） | -0.002<br>（-0.12） | 0.044<br>（0.78） | 0.038<br>（0.69） | 0.047<br>（0.83） |
| 婚姻 | / | / | / | / | / | / |

注:***，**，*分别表示在 1%，5%，10%的水平上显著。

从表 5 实证结果来看，基本养老保险在已婚或同居群体中能够显著促进个体提前退休，边际效应显示，相较于没有基本养老保险的个体，参加基本养老保险的个体的工作意愿平均下降约 6%；而在未婚、离异和丧偶个体中，基本养老保险对个体的退休意愿影响的边际效应虽然也为负数，但是并不显著。由此表明，基本养老保险总体情况对延迟退休意愿的影响具有婚姻状况的差异。之后，将基本养老保险划分为高低保障养老保险后，能够发现，尽管高保障养老保险在两类群体中都能够显著促进个体提前退休，但影响效果之间存在较大差异：已婚或同居样本中的高保障养老保险边际效应为 33.4%，未婚、离异和丧偶样本中为 21.8%，即高保障养老保险对延迟退休意愿的影响中，已婚或同居个体的工作意愿比未婚、离异和丧偶个体的工作意愿平均下降约 11.6%。这可能是因为已婚或同居的个体，在有高保障养老保险的情况下，未来的退休生活能够得到一定的保

障，能有相对较好的生活水平，因此期望更早离开劳动力市场，希望多花时间陪陪家人。然而，低保障养老保险在已婚或同居个体中能够显著促进个体延迟退休，其边际效应为 13.6%。但是在未婚、离异和丧偶个体中对延迟退休意愿的影响却不显著，我们认为在低保障养老保险对延迟退休意愿的影响中，相对于已婚或同居的个体来说，未婚、离异和丧偶个体所需要承担的家庭压力很小或者根本没有，他们只需过好自己的生活即可，再加上低保障养老保险的保障水平过低，不能充分保证退休人员的退休生活，导致未婚、离异和丧偶个体在低保障养老保险下缺少延迟退休的动力。因此，这一影响并不显著。综上，可以发现，不管是养老保险整体情况还是划分为高低保障之后的基本养老保险，对延迟退休意愿的影响都存在较大的婚姻状况上的差异。

关于控制变量，在已婚或同居样本中，年龄、性别和教育状况变量对延迟退休意愿的影响并不显著；健康状况变量在高保障养老保险下能够显著促进个体延迟退休；而区域变量在三种模型下都能够显著促进个体延迟退休。在未婚、离异和丧偶样本中，年龄和教育状况变量对延迟退休意愿的影响依旧不显著，但性别变量对延迟退休意愿的影响变得显著以及区域变量变得不显著，由此可见性别和区域变量对延迟退休意愿的影响也存在婚姻状况的差异。

## 5.4 健康状况分类样本

### 5.4.1 婚姻状况分类样本的变量描述性统计

从健康状况来看，一方面，健康状况决定了个体的工作效率，相对于健康状况好的个体，身体健康状况越差，工作效率越低，进而越倾向于提前退休；另一方面，健康状况决定了人们对寿命的预期，影响其对未来的规划，进而也会影响其退休决策。由此可见，不同的健康状况会对延迟退休意愿产生不同的影响。因此，本文选择根据健康状况将样本数据划分为健康状况好与健康状况一般和差两类，以此研究基本养老保险、不同保障程度基本养老保险对延迟退休意愿的健康状况差异。整理分类样本数据，得到如表 6 所示描述性统计。

表6 健康状况分类的变量描述性统计

| | 健康状况好的个体（样本数：1077 个） | | | | 健康状况一般和差的个体（样本数：3072 个） | | | |
|---|---|---|---|---|---|---|---|---|
| 变量 | 最小值 | 最大值 | 平均值 | 标准差 | 最小值 | 最大值 | 平均值 | 标准差 |
| 延迟退休意愿 | 0 | 1 | 0.5534 | 0.49737 | 0 | 1 | 0.5270 | 0.49935 |
| 基本养老保险 | 0 | 1 | 0.6955 | 0.46043 | 0 | 1 | 0.6992 | 0.45867 |
| 高保障养老保险 | 0 | 1 | 0.2061 | 0.40471 | 0 | 1 | 0.1702 | 0.37591 |
| 低保障养老保险 | 0 | 1 | 0.4995 | 0.50023 | 0 | 1 | 0.5374 | 0.49868 |
| 年龄 | 26 | 75 | 58.4466 | 8.21856 | 19 | 75 | 58.7551 | 8.34387 |
| 性别 | 0 | 1 | 0.4875 | 0.50008 | 0 | 1 | 0.4749 | 0.49945 |
| 区域 | 0 | 1 | 0.2841 | 0.45121 | 0 | 1 | 0.2962 | 0.45667 |
| 教育状况 | 0 | 2 | 0.4058 | 0.54678 | 0 | 2 | 0.3903 | 0.53865 |
| 婚姻状况 | 0 | 1 | 0.9164 | 0.27686 | 0 | 1 | 0.8949 | 0.30679 |

如表 6 健康状况分类变量描述性统计所示，健康状况好的个体中的延迟退休意愿比例较健康状况一般和差的个体更高，达到 55.34%。基本养老保险参保率

在这两类个体中相差不大，高保障养老保险参保率在健康状况好的个体中更高，而低保障养老保险在健康状况一般和差的个体中更高。年龄、性别、区域、教育状况以及婚姻状况在这两类个体中的比例相近，没有太大差异。

### 5.4.2 健康分类样本的实证结果与分析

表7 健康状况分类样本变量对退休意愿影响的实证结果

| | 健康状况好的个体 | | | 健康状况一般和差的个体 | | |
|---|---|---|---|---|---|---|
| 变量 | 边际效应 | 边际效应 | 边际效应 | 边际效应 | 边际效应 | 边际效应 |
| 基本养老保险 | -0.100***<br>（-3.03） | | | -0.045**<br>（-2.28） | | |
| 高保障养老保险 | | -0.299***<br>（-8.54） | | | -0.336***<br>（-14.29） | |
| 低保障养老保险 | | | 0.106***<br>（3.55） | | | 0.138***<br>（7.83） |
| 年龄 | 0.001<br>（0.61） | 0.001<br>（0.59） | 0.002<br>（0.87） | 0.000<br>（0.38） | -0.000<br>（-0.08） | 0.000<br>（0.36） |
| 性别 | -0.056*<br>（-1.83） | -0.060**<br>（-1.99） | -0.053*<br>（-1.71） | -0.024<br>（-1.27） | -0.018<br>（-1.01） | -0.025<br>（-1.38） |
| 区域 | -0.098***<br>（-2.78） | -0.067*<br>（-1.94） | -0.084**<br>（-2.37） | -0.060***<br>（-2.85） | -0.037*<br>（-1.82） | -0.047**<br>（-2.27） |
| 健康 | / | / | / | / | / | / |
| 教育 | 0.005<br>（0.16） | -0.000<br>（-0.00） | 0.007<br>（0.22） | 0.000<br>（0.01） | 0.008<br>（0.45） | 0.003<br>（0.15） |
| 婚姻 | -0.066<br>（-1.17） | -0.052<br>（-0.94） | -0.054<br>（-0.95） | -0.015<br>（-0.49） | -0.016<br>（-0.55） | -0.020<br>（-0.66） |

注:***，**，*分别表示在 1%，5%，10%的水平上显著。

如表 7 实证结果所示，基本养老保险能够显著促进个体提前退休，但基本养老保险对延迟退休意愿影响的边际效应在健康状况好的个体中为 10%，而在健康状况一般和差的个体中为 4.5%，由此表明基本养老保险对延迟退休意愿的影响存在较大健康状况的差异。同样的，将基本养老保险划分为高低保障养老保险之后，能够发现不同保障程度的基本养老保险对延迟退休意愿的影响也存在着健康状况的差异。具体而言：高保障养老保险能够显著促进个体提前退休，其在健康状况好的个体中的边际效应为 29.9%，而在健康状况一般和差的个体中边际效应为 33.6%，能够发现存在较大差异。其原因可能是在具有高保障养老保险条件下，健康状况一般和差的个体考虑到自身身体状态不太好的原因，同时又拥有高保障养老保险，在未来生活中能有一定保障，故而相较于健康状况好的个体更倾向于更早离开劳动力市场。低保障养老保险对延迟退休意愿的影响结果中，健康状况好的个体的边际效应为 10.6%，健康状况一般和差的个体的边际效应为 13.8%。这说明在低保障养老保险条件下，健康状况一般和差的个体比健康状况好的个体具有更强的工作意愿。我们认为这主要是因为健康状况一般和差的个体认为自己

未来面临的健康风险比健康状况好个体未来面临的健康风险要大，而且低保障养老保险保障待遇较低，不能很好保障退休者的退休生活，故而他们期望通过继续留在劳动力市场上来增加收入，进而提高自己未来抵御风险的能力。综上，不难发现基本养老保险总体情况以及不同保障程度的养老保险对延迟退休意愿的影响存在健康状况差异。

其余控制变量，在健康状况分类样本中，年龄、教育状况以及婚姻状况变量对延迟退休意愿的影响并不显著。三种模型中，性别变量在健康状况好的个体样本中都能够显著促进个体提前退休，而在健康状况一般和差的个体中却没有这种显著的影响；而区域变量却始终能够促进个体提前退休。

## 5.5 区域分类样本

### 5.5.1 区域分类样本的变量描述性统计

一般而言，城镇地区的经济发展状况较农村地区更好，城镇地区拥有较为便利的交通以及较为丰富的就业、教育以及医疗等资源，城镇个体在退休之后能享受到更多资源。与此同时，城镇地区的社会养老保险机制相较于农村地区也更加健全。由此可见，城镇地区和农村地区个体的退休意愿和决策也会存在差异。因此，本文继续根据区域将样本数据划分为城镇个体和农村个体两类，以此研究基本养老保险、不同保障程度基本养老保险对延迟退休意愿的区域差异。整理分类样本数据，得到如表 8 所示描述性统计。

表8 区域分类的变量描述性统计

| | 城镇个体（样本数：1216 个） | | | | 农村个体（样本数：2933 个） | | | |
|---|---|---|---|---|---|---|---|---|
| 变量 | 最小值 | 最大值 | 平均值 | 标准差 | 最小值 | 最大值 | 平均值 | 标准差 |
| 延迟退休意愿 | 0 | 1 | 0.4844 | 0.49996 | 0 | 1 | 0.5544 | 0.49712 |
| 基本养老保险 | 0 | 1 | 0.6859 | 0.46437 | 0 | 1 | 0.7034 | 0.45685 |
| 高保障养老保险 | 0 | 1 | 0.2360 | 0.42481 | 0 | 1 | 0.1562 | 0.36306 |
| 低保障养老保险 | 0 | 1 | 0.4589 | 0.49851 | 0 | 1 | 0.5561 | 0.49693 |
| 年龄 | 38 | 75 | 57.9638 | 8.31541 | 18 | 75 | 58.9908 | 8.29308 |
| 性别 | 0 | 1 | 0.4901 | 0.50011 | 0 | 1 | 0.4732 | 0.49937 |
| 健康状况 | 0 | 1 | 0.2516 | 0.43414 | 0 | 1 | 0.2629 | 0.44027 |
| 教育状况 | 0 | 2 | 0.6850 | 0.61689 | 0 | 2 | 0.2738 | 0.45431 |
| 婚姻状况 | 0 | 1 | 0.9079 | 0.28929 | 0 | 1 | 0.8974 | 0.30352 |

如表 8 区域分类变量描述性统计所示，农村个体中延迟退休意愿的比例比城镇个体的延迟退休意愿比例显著更高，达到 55.44%，而城镇个体只有 48.44%。基本养老保险参保率在两类个体中相差不大，但高保障养老保险在城镇个体中的参保率比在农村个体中显著更高，而低保障养老保险在农村个体中的参保率比在城镇个体中显著更高，即城镇个体更多人参与高保障养老保险，农村个体中更多人参与低保障养老保险。年龄、性别、健康状况以及婚姻状况在这两类个体中比例相差不大。但是，明显发现，在受教育状况中，城镇个体的受教育程度显著比农村个体更高。

### 5.5.2 区域分类样本的实证结果与分析

表9 区域分类样本变量对退休意愿影响的实证结果

| | 城镇个体 | | | 农村个体 | | |
|---|---|---|---|---|---|---|
| 变量 | 边际效应 | 边际效应 | 边际效应 | 边际效应 | 边际效应 | 边际效应 |
| 基本养老保险 | -0.083***<br>（-2.71） | | | -0.048**<br>（-2.38） | | |
| 高保障养老保险 | | -0.341***<br>（-10.41） | | | -0.314***<br>（-12.95） | |
| 低保障养老保险 | | | 0.162***<br>（5.80） | | | 0.117***<br>（6.42） |
| 年龄 | -0.000<br>（-0.11） | -0.001<br>（-0.31） | -0.000<br>（-0.04） | 0.001<br>（0.93） | 0.001<br>（0.50） | 0.001<br>（0.97） |
| 性别 | -0.023<br>（-0.78） | -0.026<br>（-0.94） | -0.027<br>（-0.93） | -0.037*<br>（-1.92） | -0.031*<br>（-1.67） | -0.036*<br>（-1.87） |
| 区域 | / | / | / | / | / | / |
| 健康 | -0.000<br>（-0.01） | 0.014<br>（0.45） | 0.009<br>（0.28） | 0.037*<br>（1.78） | 0.048**<br>（2.36） | 0.041**<br>（1.98） |
| 教育 | -0.011<br>（-0.48） | -0.000<br>（-0.00） | 0.000<br>（0.01） | 0.013<br>（0.61） | 0.012<br>（0.57） | 0.009<br>（0.44） |
| 婚姻 | -0.049<br>（-0.96） | -0.043<br>（-0.89） | -0.053<br>（-1.06） | -0.016<br>（-0.51） | -0.016<br>（-0.51） | -0.016<br>（-0.53） |

注:***，**，*分别表示在 1%，5%，10%的水平上显著。

如上述实证结果表 9 所示，基本养老保险能够显著促进个体提前退休，而且这种影响具有城乡差异：城镇个体中，基本养老保险对延迟退休意愿影响的边际效应为 8.3%，而在农村个体中，边际效应为 4.8%，即在基本养老保险条件下，城镇个体较之农村个体倾向于更早离开劳动力市场。将基本养老保险划分为高低保障养老保险之后，可以发现，城镇样本中高保障养老保险对延迟退休意愿影响的边际效应值大于农村样本，表明高保障养老保险对城镇个体退休意愿的影响更为明显，原因可能为城镇个体退休后能够享受到比农村个体更为丰富的资源，同时在高保障养老保险条件下，城镇个体的退休生活能够得到一定保障，在一定程度上维持生活水平，故而城镇个体会比农村个体更早离开劳动力市场。而在低保障养老保险对延迟退休意愿的影响中，城镇个体的边际效应为 16.2%，农村个体的边际效应为 11.7%，表明在低保障养老保险条件下，城镇个体相较于农村个体更晚离开劳动力市场，我们认为，这主要是因为虽然城镇地区居民相较于农村地区居民能够依靠城镇便利的交通以及丰富的就业资源取得更高水平的收入，但与此同时，城镇地区居民也面临着比农村地区居民更大的支出，承担着更大的压力。同时，低保障养老保险待遇水平较低，不能实际保障个体的退休生活。因此，在低保障养老保险条件下，城镇居民比农村居民更愿意留在劳动力市场，延长工作时间获得更多收入。综上，亦能得出，基本养老保险总体情况以及不同保障程度

的养老保险对延迟退休意愿的影响存在城乡差异。

关于其余控制变量，在城乡分类样本中，年龄、教育状况和婚姻状况变量对个体延迟退休意愿的影响仍旧不显著。然而，在三个模型中，虽然性别和健康状况变量在城镇个体中对延迟退休意愿没有显著影响，但是在农村个体中对延迟退休意愿却有着显著影响。表明性别和健康状况变量对延迟退休意愿的影响也存在城乡差异。

## 6 结论与建议

### 6.1 结论

在延迟退休政策即将推行的大背景下，本文利用 CHARLS 2015 年全国追踪调查数据实证分析了社会养老保险对个体退休意愿的影响，主要得出以下几点研究结论：

6.1.1 基本养老保险能够显著促进个体提前退休。

本文发现，基本养老保险对个体的退休意愿的回归效应为负数，且在 1%的显著性水平下显著，这说明基本养老保险提高了个体的提前退休意愿，促使个体提前退休。

基本养老保险会显著促进个体提前退休。拥有基本养老保险的人较之无基本养老保险的倾向于更早离开劳动力市场，享受闲暇，安享晚年。这一结果与国内外大多数学者的研究结果相一致。生命周期消费理论显示，劳动者退休之后，没有工作报酬收入，生活消费来源于前两阶段的储蓄以及所缴纳的社会养老保险，对于家庭资产和个人财富积累较少的劳动者更是如此。而基本养老保险在一定程度上能对劳动者退休后的基本生活进行保障，在一定程度上维持了劳动者退休后的生活质量和水平。基本养老保险对个体退休意愿的影响，实质上也反映出基本养老保险为我国居民提供了一定程度的福利保障，发挥出了基本养老保险的本质作用。

6.1.2 不同保障程度的养老保险对个体退休意愿的影响具有婚姻状况、健康状况以及城乡差异。

本文在上述基础上，将基本养老保险划分为高保障和低保障养老保险。从上述实证结果中能够发现，在所有模型中，基本养老保险总体情况能够显著促进个体提前退休；高保障养老保险也都能够显著促进个体提前退休；而低保障养老保险能够显著促进个体延迟退休。当把样本数据根据婚姻状况、健康状况以及城乡进行分类后，明显看出，基本养老保险总体情况和不同保障程度的养老保险对个体延迟退休意愿的影响存在婚姻状况、健康状况和城乡的差异。

### 6.2 建议

6.2.1 继续扩大社会养老保险覆盖率。

目前社会养老保险为老年人，特别是农村老年人的养老提供了重要保障。国家需要继续加大社会养老保险的覆盖率，使得社会养老保险能够为更多老年人的养老提供保障。同时，政府可以对缴费困难的城乡居民加大财政补贴的力度，帮助这些居民参保，以此保障这些居民能够在退休后维持基本生活。另外，这几年国家都在上调养老金水平，因此，国家应该在经济稳定的情况下继续科学合理的上调养老金，对老年人的福利制度进行完善，为老年人的养老提供全方位的保障；此外应注重同步发展其他保障措施，例如医疗保险制度，减少老年人的医疗支出

负担，降低老年人的养老成本。

6.2.2　缩小养老待遇差距，出台更公平合理的养老保险政策。

社会养老保险制度虽然在不断完善，但仍然存在着不足。在今后的改革中，不仅要统筹确定好各项基本养老保险的待遇标准，科学合理的逐步提高城乡居民基本养老保险的待遇水平和标准，使得该保险对参保人员的退休生活能够起到实际的保障。还需要逐步缩小社会养老保险在不同群体之间的待遇差距，实现社会养老保险公平正义的价值目标。

6.2.3　社会养老保险制度与延迟退休制度改革相结合。

目前我国的法定退休年龄偏低，养老金支付压力也不断增大，延迟退休政策也是势在必行、形式所趋。在本文中研究发现，基本养老保险能够显著促进个体提前退休，因此，未来退休制度的改革和养老金保险制度的改革同样要考虑此作用，适度消除基本养老保险对个体提前退休的正激励作用。同时，本文研究还发现，基本养老保险总体情况以及不同保障程度的养老保险对个体的延迟退休意愿存在婚姻状况、健康状况和城乡差异，因此，在延迟退休政策的制定中，制定者要考虑此类差异化影响，采用差别化退休政策，消解公众的对立情绪，缓和各利益群体的矛盾和冲突，减少政策推行过程中的阻力。

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# 基于人群差异的基本养老保险对延迟退休意愿影响分析

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**关键词：**人口老龄化；延迟退休；养老保险；人群差异

**中文摘要。**我国人口老龄化形式日益严峻，制定科学合理的延迟退休年龄政策已经是势在必行。社会养老保险是我国老年人退休后的主要收入来源。但同时，我国现存的两种基本养老保险由于在保障程度上存在差异，且考虑到人群间差异，因此会对个体的延迟退休意愿产生不同影响，本文利用2015年中国健康与养老追踪调查数据，结合相关理论，分析社会养老保险对我国中老年群体延迟退休意愿的具体效应，并进一步分析基于群体差异的不同保障程度养老保险对延迟退休意愿的影响，进而为延迟退休政策制定提供思路。

# Delayed Retirement Intention, Retirement-Medical Service and Health Benefits

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**Keywords:** Delayed Retirement Intention, Retirement-Medical Service, Health Benefits, Fuzzy Regression Discontinuity, Instrumental Variable.

**Abstract.** Since entering the aging society in 2000, the scale of China's elderly population has continued to expand, and the growth rate and proportion in the total population are also increasing. Considering the large population base, the deepening of aging makes more and more people retire， which not only causes the change of labor structure, but also has a profound impact on China's social economy, which outstanding performance is that the gap of medical security fund continues to widen, resulting in increasing pressure on the medical security system. Meanwhile, the intertemporal mismatch of medical service utilization caused by retirement will not only worsen individual health status, lead to excessive growth of medical consumption and waste of medical resources, but also further widen the gap of medical security fund, increase the burden of fund, and harm health benefits. Furthermore, China's legal retirement age is at a low level in the world. Under the background of the deepening aging degree and the gradual extension of the expected life expectancy, the lower legal retirement age not only accelerates the growth rate of

the retired population, but also further increases the burden of the medical security system. Therefore, it is urgent to delay retirement.

Based on the above background, the "14th five year plan" formally proposes to implement the policy of delaying retirement, following the implementation principle of "step-by-step adjustment, flexible implementation, classified promotion and overall consideration", which means employees have the space to independently choose the time point of retirement, and the importance of retirement intention is highlighted. Based on this, this paper uses four mixed cross-sectional data of CHARLS to establish a Fuzzy Regression Discontinuity model and a instrumental variable model to test the systematic influence of the delayed retirement intention on the labor behavior characteristics at life cycle stages, and uses a deformed Difference-in-difference model to measure the net effect of the delayed retirement intention on the utilization of medical services and the change of health benefits.

The main conclusions are as follows: there are differences in the utilization of medical services among male employees with different delayed retirement intention. In order to make the retirement life unaffected, employees without delayed retirement intention tend to restrain the utilization of medical services before retirement, work harder to get higher performance pay and pension benefits, and make health compensation after retirement. On the contrary, employees with the delayed retirement intention expect to work longer hours, and the time cost is relatively low during the working period, so there will be no intertemporal mismatch of medical service utilization, and the medical consumption will change smoothly. Moreover, smooth consumption is not the result of delayed treatment, but the effect of health investment in advance: After eliminating the endogeneity, the medical expenditure and times of employees with delayed retirement intention were significantly higher than those without delayed retirement intention before retirement, and were significantly lower than those without delayed retirement intention after retirement. After offsetting the increased medical expenditure and times before retirement, the extra decreased medical expenditure and times were 8665.0350 yuan and 4.026 times respectively. Furthermore, in the whole life cycle of employees, delayed retirement intention has obvious effect on medical cost control, and increases individual health benefits.

The following policy suggestions are put forward in this paper. Firstly, we need to establish a perfect elastic retirement system, change the rigid implementation into step-by-step adjustment, fully consider the differences of group and gender, and reserve enough space for individuals to choose retirement time points independently. Secondly, the delayed retirement intention plays an obvious role in saving medical resources, and also conforms to the "Value-Based Health Care". We should further stimulate the delayed retirement intention of employees by further adjusting the relevant social policies such as employment policy, retirement policy, social security policy, adhering to the system concept, strengthening top-level design, clarifying the functions of departments, and improving the system the labor market, which aims at improving the whole life cycle incentive of labor efficiency.

The marginal contributions and innovation of this paper may be reflected in three aspects. Firstly, the difference of retirement-medical service of employees with different delayed retirement intention enriches the content that there are different changes of medical service in the life cycle. Secondly, based on the changes of medical service and health benefits of employees in the whole life cycle, this paper makes an effective explanation for the medical behavior decision-making of

employees with different delayed retirement intention. Thirdly, this paper also has some enrichment and supplement to some local research fields.

## 1．引言

自 2000 年进入老龄化社会以来，我国老年人口规模持续扩大，且增长速度和占总人口比重也在不断提高（图 1）。据预测，“十四五”期间，我国老年人口数量将突破 3 亿，[①]从轻度老龄化迈入中度老龄化。[②]考虑到庞大的人口基数，老龄化程度的加深使得越来越多的人即将步入退休生活，在造成劳动力结构变动的同时，还会对我国社会经济造成深刻影响（李琴、彭浩然，2015），尤其是医保基金账户缺口持续增大（何庆红等，2019），医疗保障体系面临的压力与日俱增。

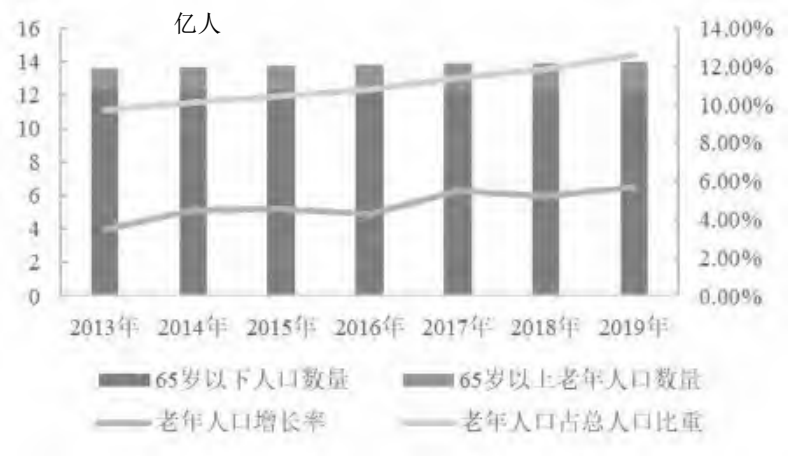


图1　2013-2019年中国老龄化情况

资料来源：《中国统计年鉴》

众多研究显示，退休会带来个体医疗服务利用的突然增加，即存在“退休-医疗服务利用”之谜（雷晓燕等，2010；李宏斌等，2014；邹红、喻开志，2015；赵建国、刘子琼，2020）。针对其背后的影响机制，有研究认为，退休通过降低个体健康水平和时间成本、提高医保报销比例来增加个体医疗服务利用率（雷晓燕等，2010；Zhang et al.，2018）。进一步地，退休后医疗服务利用增加是个体在生命周期内进行收入和健康（包括医疗消费）配置的结果，而某些政策性和制度性因素会诱导个体做出在退休前用健康换取收入、而在退休后再用收入换取健康的行为决策（Zhang et al.，2018）。这种医疗服务利用的跨期错配不仅会恶化个体健康状况，导致医疗消费的过度增长，造成医疗资源的浪费，还会进一步拉大医保基金账户缺口，加重账户负担，最终使得社会整体福利并不一定增加。与此同时，我国实行强制退休制度，男性 60 岁、女性 50 岁或 55 岁的法定退休年龄在世界范围内处于较低水平（Zhang et al.，2018），在老龄化程度不断加深以及预期余命逐渐延长背景下，较低的法定退休年龄不仅加快了退休人口增长速度，也进一步加重了医疗保障体系的负担。

为降低医疗保障体系负担，近年来我国开始研究延长退休年龄。2012 年 6

[①] 数据来源：《民政部举行二〇二〇年第四季度例行新闻发布会》，http://www.mca.gov.cn/article/xw/mtbd/202010/20201000030017.shtml。

[②] 根据联合国划分标准，“老龄化”社会表现为一国60岁及以上人口比例超过10%或者65岁及以上人口比例超过7%，“老龄”社会（“中度老龄化”社会）表现为60岁及以上人口比例超过20%或65岁及以上人口比例超过14%。

月 14 日，人力资源和社会保障部、发展改革委、民政部、财政部、原卫生部以及社保基金会等部门联合制定《社会保障“十二五”规划纲要》，明确提出要“立足当前，着眼长远，继续做实企业职工基本养老保险个人账户，研究弹性延迟领取养老金年龄的政策”，延迟退休开始受到广泛关注。至此，员工开始对政府即将实行延迟退休政策形成预期（刘璨等，2019）。进一步地，2020 年 10 月 29 日，中共十九届五中全会审议通过《中共中央关于制定国民经济和社会发展第十四个五年规划和二〇三五年远景目标的建议》，明确提出实施渐进式延迟法定退休年龄。2021 年 3 月 12 日公布的《中华人民共和国国民经济和社会发展第十四个五年规划和 2035 年远景目标纲要》则提出延迟退休政策实行“小步调整、弹性实施、分类推进、统筹兼顾”的实施原则，员工有自主选择退休时点的空间。虽然目前延迟退休政策尚未正式出台，但是政策消息或宣告不经应验也能造成实际的经济后果，员工会通过预期自发调整行为（Kitao，2018）。具体而言，延迟退休政策宣告后员工可以弹性选择退休时点，进而形成了不同的延迟退休意愿，可能会影响员工的医疗服务利用决策。那么，针对广泛存在的“退休-医疗服务利用”之谜，不同延迟退休意愿个体决策是否存在差异，其内在影响机制是否一致，学术界尚未广泛关注。而退休政策改革作为一项重大的公共政策调整，不仅需要综合考虑社保体系和劳动力市场等经济因素，还依赖于个体预期退休行为（延迟退休意愿）及其影响因素和影响后果（李琴、彭浩然，2015）。因此，在延迟退休政策更加注重个体自主选择的背景下，研究个体的延迟退休意愿，以及延迟退休意愿对医疗服务利用的影响，具有十分重要的现实意义。

基于此，本文利用中国健康与养老追踪调查（CHARLS）2011 年、2013 年、2015 年和 2018 年四期混合横截面数据，以我国强制退休制度作为外生政策冲击，建立模糊断点回归模型，系统检验退休前后不同延迟退休意愿下个体的医疗服务利用差异，同时建立工具变量模型探究其中的影响机制，并利用一个变形的双重差分模型测算延迟退休意愿对退休前后医疗服务利用的净效应及健康福利变动。结果表明，不同延迟退休意愿下男性个体医疗服务利用情况存在差异，无延迟退休意愿个体由于预期按时退休，有限工作期内时间成本相对较高，因此为使退休生活不受影响，倾向于退休前抑制医疗服务利用，转而更加努力工作以获得更高的绩效工资和养老金待遇，并在退休后进行健康补偿。而有延迟退休意愿个体由于预期更长的工作时间，工作期内时间成本相对较低，从而不会发生医疗服务利用的跨期错配，医疗服务利用平滑变动。并且，平滑消费不是延后就诊的结果，而是提前进行健康投资的作用：消除内生性后，有延迟退休意愿个体在退休前医疗消费支出和次数均显著高于无延迟退休意愿个体，而在退休后均显著低于无延迟退休意愿个体，抵消掉退休前增加的医疗消费支出和次数后，额外减少的医疗消费支出和次数分别为 8665.0350 元和 4.026 次，同时这种医疗控费行为并未损害个体健康福利，反而提高了个体健康福利。

本文的主要贡献如下：首先，本文察觉的不同延迟退休意愿下的退休-医疗服务利用差异丰富了医疗服务利用在生命周期不同阶段存在不同变化的特征事实。以往关注退休-医疗服务利用的研究，只侧重于分析退休行为对医疗消费的影响，而忽视了退休意愿的作用，并缺乏相关异质性分析，无法准确分离不同退休意愿个体退休-医疗服务利用决策的净效应。本文在进行相关理论分析后，利用大样本数据实证检验延迟退休意愿对员工生命周期退休-医疗服务利用决策的影响以及带来的健康福利变化。

其次，基于整个生命周期内员工医疗服务利用变动和健康福利变化为不同延

迟退休意愿群体的医疗行为决策做出了有效的解释，同时也丰富了健康经济学的相关文献，为有效配置医疗服务资源提供了经验证据，也为评估延迟退休政策效果提供微观数据和方法的实证证据，对于我国完善退休制度，构建相匹配的社会保障体系，激发员工延迟退休积极性，促进劳动力高质量供给提供了理论借鉴。

最后，本文对所涉及到若干局部研究领域也有一定的丰富和补充。例如，检验不同延迟退休意愿个体生命周期退休决策和医疗服务利用，以及测算延迟退休意愿对个体医疗服务利用情况的净效应都可能存在一定的内生性。本文利用当前中国男性员工在 60 岁前后退休概率外生变化这一准自然实验，采用模糊断点回归方法，考察退休概率外生变化时不同延迟退休意愿个体的医疗服务利用决策，进一步选择本区域内养老保险平均参保率作为工具变量，建立一个变形的双重差分模型，考察延迟退休意愿对个体退休前后医疗服务利用的净效应，有效克服了内生性问题。

本文剩余内容安排如下：第二部分回顾制度背景以及相关研究文献；第三部分建立计量模型，介绍相关数据；第四部分定量分析不同延迟退休意愿个体的退休-医疗服务利用差异；第五部分进行影响机制分析；第六部分实证测算延迟退休意愿对医疗服务利用的净效应及健康福利变动；第七部分为结论和政策启示。

## 2．制度背景与文献综述

### 2.1 制度背景

中国的退休制度最早可追溯到 1953 年《劳动保险条例》和 1958 年《关于工人、职员退休处理的暂行规定（草案）》。此后，针对不同单位职工采取了不同政策，[③]退休年龄得到进一步细化。总体而言，在中国，男性职工法定退休年龄为 60 岁；女性职工法定退休年龄为 55 岁或 50 岁，取决于具体职务。另外，个人可能因特殊原因提前退休。

中国法定退休年龄在世界范围内处于较低水平（Zhang et al.，2018）。随着老龄化程度不断加深、生育率持续下降以及预期余命逐渐延长，较低的法定退休年龄规定使得退休人口规模进一步扩大，社保体系面临的压力日益加重。延迟退休通常被认为一方面可以增加缴费年限，充实社保基金池；另一方面降低社保领取年限，减轻支付压力，能够在一定程度上缓解社保基金危机（李琴、彭浩然，2015）。而早在 2010 年 9 月，国务院新闻办公室于《中国的人力资源状况》白皮书发布会上就已提出“是否应该推迟退休年龄”这一议题。2011 年 5 月，上海市出台《关于本市企业各类人才柔性延迟办理申领基本养老金手续的试行意见》，规定自 2011 年 10 月 1 日起，上海市实行柔性延迟办理申请基本养老金手续:“参加本市城镇养老保险的企业中具有专业技术职务资格人员，具有技师、高级技师证书的技能人员和企业需要的其他人员均可柔性延迟退休”，已经体现了退休年龄弹性选择的思想，但是文件并未对柔性退休期间的其他社保待遇做出详细解释。2012 年 6 月 14 日，人力资源和社会保障部、发展改革委、民政部、财政部、原卫生部以及社保基金会等部门联合制定《社会保障“十二五”规划纲要》，明确提出要“立足当前，着眼长远，继续做实企业职工基本养老保险个人账户，研究弹性延迟领取养老金年龄的政策”。至此，延迟退休逐步受到广泛关注，民众

[③] 关于政府机关或公共部门职工的退休年龄规定主要来源于1955年《国家机关工作人员退休处理暂行办法》、1978年《关于工人退休、退职的暂行办法》和2018年《中华人民共和国公务员法》；关于国企职工退休年龄规定主要来源于1994年《关于在若干城市试行国有企业破产有关问题的通知》。

开始对“弹性延迟退休”形成预期（刘璨等，2019）。2020 年 10 月 29 日，中共十九届五中全会审议通过《中共中央关于制定国民经济和社会发展第十四个五年规划和二〇三五年远景目标的建议》，提出实施渐进式延迟法定退休年龄。《党的十九届五中全会〈建议〉学习辅导百问》进一步提出渐进式延迟法定退休年龄要“小步慢走、弹性实施、强化激励”。2021 年 3 月 12 日公布的《中华人民共和国国民经济和社会发展第十四个五年规划和 2035 年远景目标纲要》完善了延迟退休政策实行原则，要“小步调整、弹性实施、分类推进、统筹兼顾”，员工有自主选择退休时点的空间。

尽管延迟退休政策的具体方案内容仍未出台，但是尚未确定的政策也会影响员工预期，进而影响其行为（Kitao，2018）。特别地，员工可弹性选择退休时点的政策实行原则也进一步凸显了退休意愿的重要性。因此，作为一项重大公共政策调整，延迟退休政策制定和实行不仅需要考虑社保基金运行情况以及劳动力市场变动等经济因素，还依赖于个体预期退休行为（延迟退休意愿）及其影响因素和影响后果（李琴、彭浩然，2015），不同延迟退休意愿下个体的医疗服务利用行为以及健康福利差异是其重要表现。

## 2.2 文献综述

医疗服务利用一直是健康经济学的重点研究内容之一。Becker（1964）提出的家庭生产函数将医疗服务需求作为消费者对健康需求的引申需求。Grossman（1972）进一步建立了多期效用的动态健康需求模型，理论分析了医疗服务利用的影响因素。在此基础上，根据国内外文献，影响医疗服务利用的主要因素包括：（1）健康因素。涵盖疾病的严重程度、是否患慢性病以及自评健康等，是影响医疗服务利用最直接的因素。具体而言，当个体感觉身体不适或病情加重时，其医疗消费支出和就诊次数会显著增加（Qian et al.，2009；蒋露露等，2012；胡宏伟等，2012；马爱霞、许扬扬，2015）。（2）经济因素。个体的经济收入代表着其对医疗服务利用的支付能力，收入高的个体在患病时倾向于释放自身的医疗服务利用需求（Gerdtham et al.，1992；Schoen and DesRoches，2000；封进、秦蓓，2006；罗楚亮，2008）。另外，医疗保障也关乎个体医疗服务利用情况（Qian et al.，2009；刘国恩等，2011；赖国毅，2012；王新军、郑超，2014）。（3）人口学因素。影响医疗服务利用的人口学因素主要包括年龄、性别、受教育程度、户口性质以及是否退休等（Roos and Shapiro，1981；Gertler and Gaag，1990；Makinen et al.，2000；申志伟、蒋远胜，2008；叶春辉等，2008；孙健等，2009；马爱霞、许扬扬，2015；封进等，2015）。其中，退休对医疗服务利用影响较大，个体在退休后更易发生医疗服务利用行为（雷晓燕等，2010；李宏斌等，2014；Zhang et al.，2018）。

退休对医疗服务利用的影响主要存在以下中间传导机制：（1）健康水平。退休可能会对健康产生或正面（有时间加强锻炼、合理膳食）或负面（体力活动或社交活动的减少）的影响，进而影响退休后人们对于医疗服务的需求（雷晓燕等，2010；Zhang et al.，2018）。（2）时间成本。职工在退休之前请假看病可能会对其工资、奖金以及晋升等产生不利影响，因此，在职职工请假的机会成本较高，导致职工没有时间看病。退休后，空闲时间大幅增多，看病的机会成本相对降低，因此，退休可能会使人们增加医疗服务利用，提高医疗消费（Zhang et al.，2018）。（3）收入水平。职工退休后的主要收入来源于养老金（于新亮等，2019），相比工作时期收入减少，较低的收入可能会使人们控制开支，减少医疗消费（叶春辉

等，2008）。但是，收入降低也可能会降低人们的幸福感，对健康产生不利影响（Graham，2005；田国强、杨立岩，2006），从而增加人们的医疗消费。（4）医保报销比例。根据《中华人民共和国社会保险法》，目前，中国大部分地区医保报销标准向退休人员倾斜，即退休后人们的医保报销比例会相对提高。而医保报销比例的提高可能会释放人们受抑制的医疗需求，增加医疗消费（谢明明等，2016）。

综上所述，退休是个体医疗服务利用发生变化的重要影响因素，而目前针对退休-医疗服务利用的研究侧重于整体人群退休行为对医疗消费影响及其传导机制的分析，却忽视了个体间退休意愿异质性差异造成的医疗服务利用决策变化。由于中国老龄化程度的加深，社保体系面临的压力日益加重，延迟退休势在必行，个体间退休意愿的异质性在一定程度上可以体现为延迟退休意愿的差异。

延迟退休意愿受到多种因素的影响。Dwyer 和 Mitchell（1999）利用健康和退休调查数据（HRS），建立工具变量模型分析了预期退休年龄的影响因素，结果发现，相对于经济问题，健康状况更能影响职工的退休预期，具体而言，自评健康不佳或者身体功能受到限制的职工，延迟退休意愿大大降低，其预期退休年龄会比平均水平提前一到两年。Bottazzi 等（2006）评估了养老金改革对家庭内成员退休预期的影响，发现职工会按照改革建议的方向修正预期，而职工是否愿意延迟退休取决于是否能够准确预期养老金的变动。此外，外部环境、实际年龄、个人认知以及心理状态等都会对延迟退休意愿产生影响（李琴、彭浩然，2015）。

不同的延迟退休意愿代表着个体间不同的退休预期（李琴、彭浩然，2015），生命周期理论认为，理性消费者行为的唯一目标是实现效用最大化，其当前消费取决于自身全部的预期收入，而预期收入是个体在掌握各类信息情况下所形成的生命周期内总收入的期望值（Modigliani，1986）。退休预期则是各类信息的一种表现，在影响退休行为的同时，也会对预期收入产生作用，进而影响个体医疗消费。而相关研究将不同延迟退休意愿人群作为整体进行研究，分析其医疗服务利用的变动，可能会使实证结果产生偏误。

就本文研究内容而言，相较于有延迟退休意愿个体，无延迟退休意愿个体由于预期按时退休使得工作期相对更短，而随着预期寿命的延长，退休后时间增多，为使退休后生活不受影响，对财富积累要求相应提高（巩勋洲、尹振涛，2008），这意味着员工工作期内时间成本的上涨，即将促使员工在退休前相对较短的工作期内抑制医疗服务利用，转而更加努力工作以获得更高的绩效工资和养老金待遇，而在退休后进行健康补偿，具体表现为退休前后医疗消费的断点提升。而有延迟退休意愿个体在退休前会更加照料自身健康以应对预期工作期的延长（张车伟，2003），工作期延长带来的收入上涨也进一步提高了员工照料自身健康的动机（刘国恩等，2004），而这种健康投资也会提高员工健康水平，使其在退休后不必进行健康补偿，具体表现为退休前后医疗消费的平滑变动。进一步地，无延迟退休意愿个体的医疗服务利用跨期错配会造成医疗资源的过度使用（Zhang et al.，2018），而退休前的医疗消费抑制行为则会恶化健康（雷晓燕等，2010），造成整个生命周期内健康福利的损失。

综上所述，对延迟退休意愿的研究大多集中在影响延迟退休意愿的因素上，缺乏对延迟退休意愿影响后果的分析。本文在以往研究基础上，分析了退休前后不同延迟退休意愿人群的医疗服务利用情况，并测算了延迟退休意愿对医疗服务利用的净效应和健康福利变动。

## 3．实证模型

### 3.1 模型设定

中国的强制退休政策使得男性职工退休概率在 60 岁左右会有急剧变化：

$$retire_i = \begin{cases} 1, & age_i \geq 60 \\ 0, & age_i < 60 \end{cases} \quad (1)$$

其中，$retire_i$ 表示个体 $i$ 是否退休的虚拟变量，个体已经退休表示为 1，尚未退休表示为 0；$age_i$ 表示个体 $i$ 的年龄。在理想的状态下，即男性个体在 60 岁之后均为退休状态、60 岁之前均为工作状态，可以用 OLS 对（2）式进行估计，从而确定是否退休对医疗服务利用的因果性影响：

$$U_i = \alpha + \beta retire_i + \varepsilon_i (i = 1, \cdots, n) \quad (2)$$

其中，$U_i$ 为个体 $i$ 医疗服务利用情况，$\varepsilon_i$ 为随机扰动项。但是，个体 $i$ 的退休决策往往不只依赖于法定退休年龄的规定，并且医疗服务利用情况也并非随机，还受到个体特征、地区特征等因素的影响。因此，若能控制住所有影响个体退休决策以及医疗服务利用的因素 $X_i^k$，则是否退休对医疗服务利用的因果性影响仍能通过（3）式来有效评估：

$$U_i = \alpha + \beta retire_i + \sum_k \psi_k X_i^k + \varepsilon_i (i = 1, \cdots, n) \quad (3)$$

其中，$X_i^k$ 为同时影响个体退休决策以及医疗服务利用的前定变量组。但是，（3）式仍存在一定的内生性：首先，数据所限，本文无法观测到所有同时影响个体退休决策和医疗服务利用的前定变量，如个体的医疗消费偏好；其次，个体的退休决策往往也会受到医疗服务利用决策的影响，即是否退休和医疗服务利用之间存在互为因果的关系。因此，（3）式的估计结果存在偏误。基于此，结合以往研究（雷晓燕等，2010；李宏斌等，2014），本文采用模糊断点方法（FRD）检验不同延迟退休意愿人群的退休-医疗服务利用情况。

根据前文分析，不同延迟退休意愿人群的实际退休年龄不仅受到强制退休政策的影响，还会因健康状况、家庭情况等提前退休或者延迟退休，此时，$retire_i$ 不再是临界值的确定型函数。不过，在 $age = 60$ 处个体被处理的概率还是会有一个跳跃：

$$P[retire_i = 1 | age_i] = \begin{cases} g_1(age_i) & if \ age_i \geq 60 \\ g_0(age_i) & if \ age_i < 60 \end{cases}, \quad 其中 g_1(age_i) \neq g_0(age_i) \quad (4)$$

此时，

$$\rho = \lim_{\Delta \to 0} \frac{E[U_i | 60 \leq age_i < 60 + \Delta] - E[U_i | 60 - \Delta < age_i \leq 60]}{E[retire_i | 60 \leq age_i < 60 + \Delta] - E[retire_i | 60 - \Delta < age_i \leq 60]} \quad (5)$$

（5）式中分子为精确断点回归的估计值，即 60 岁前后医疗服务利用差异，分母为 60 岁前后个体进入处理组的概率，$\rho$ 为 wald 估计值，这个估计值是在 60 岁的 $\Delta$ 邻域中使用 $age_i$ 做 $retire_i$ 的工具变量而得。但是，此处得到的估计值为局部平均处理效应。具体而言，（4）式中的 $\rho$ 捕捉到的是相应工具变量的个体（顺

从者）表现出的因果效应，即当*age*的取值恰好由小于 60 岁变化到大于 60 岁时，被处理状态发生变化—由工作进入退休状态的个体所表现出的因果效应（Hahn et al.，2001）。因此，根据断点回归是局部随机试验设定要求，原则上只应选择断点附近的观测值，因此本文继续限定$age_i$的取值范围为$(60\text{-}h, 60+h)$，其中，$h$代表带宽。本文进一步使用非参数回归的方法，通过最小化均方误差（MSE）来选择最优带宽$h$。

根据前文分析，本文预期（5）式分母大于 0，而分子的符号则依据延迟退休意愿的异质性而不同，具体结果需要进一步地实证分析。

进一步地，为进行影响机制分析，本文以延迟退休意愿作为核心解释变量，分析延迟退休意愿对个体在工作期和退休期医疗服务利用的作用效果，建立如下模型：

$$U_i = \beta_0 + \beta_1 desire_i l(retire=1) + \beta_2 desire_i l(retire=0) + \sum_k \beta_k X_{ik} + \xi_i \quad (6)$$

（6）式中，$desire_i$为个体$i$的延迟退休意愿，$\beta_1$和$\beta_2$分别为$retire=1$和$retire=0$两种状态下解释变量$desire_i$对被解释变量$U_i$的影响系数。$l(\bullet)$为示性函数，括号中的表达式为真取值为 1，反之为 0。$X_{ik}$为控制变量组，$\beta_k$为相应估计系数。$\xi_i$为随机扰动项。

然而，延迟退休意愿受到多种因素的影响，数据所限，本文很难观测到所有同时影响延迟退休意愿和医疗服务利用的控制变量，那么回归结果就具有很强的内生性。基于以上分析，为克服遗漏变量等导致的内生性问题，本文建立了工具变量模型，即在（6）式基础上补充建立另一个模型：

$$desire_i = \gamma_0 + \gamma_1 z_i + \sum_k \gamma_k X_{ik} + \sigma_i \quad (7)$$

其中，$z_i$是工具变量，本文将其设定为社区内养老保险平均参保率，理论上它与个体延迟退休意愿有关（李琴、彭浩然，2015），与个体医疗服务利用无关，因此对于整体模型而言，工具变量的效果是良好的。$\sigma_i$为随机扰动项，并且与$\xi_i$相关，即$cov(\xi_i, \sigma_i) \neq 0$。

### 3.2 数据选取及变量设定

本文使用中国健康与养老追踪调查（CHARLS）2011 年、2013 年、2015 年和 2018 年四期混合横截面数据。选用该数据进行实证分析的原因，一是样本为专门针对 45 岁及以上中老年家庭及个人进行调查，主要调查内容涉及人口学情况、健康状况、医疗服务利用情况、工作退休状态等五个方面；二是样本具有代表性，数据覆盖 150 个县级单位，约 1 万户家庭，四期样本量超过 8 万，可满足最优带宽内断点回归对样本量的要求；三是成果丰富，该数据广泛应用于卫生经济和医疗保障领域研究；四是适用于本文所研究主题，问卷中预期退休年龄的设置也为本文有效构造延迟退休意愿变量创造了条件，另外，本文所需要的个体工作退休状态以及医疗服务利用情况等都是该数据的重点调查内容。

根据实证模型设计，本文进行如下变量设定：*retire*为退休变量，本文将退休定义为正式办理了退休手续，如果受访者回答“已经办理了退休手续，包括提前退休或内退”则该变量设置为 1，否则为 0；$U$为医疗服务利用变量，包括三类：一是医疗消费支出，本文设置为门诊费用和住院费用之和。二是医疗消费次数，本文设置为门诊治疗和住院治疗次数之和。三是自我治疗支出，本文设置为

问卷中“自己买药的花费”金额；*age* 为年龄变量，根据参保人员出生年月和调查年月构造，通过精确到月份的年龄，能够更好地划分退休概率发生显著变化前后的人群。本文选取受教育水平、婚姻状况、是否抽烟、是否喝酒、患病情况、是否患慢性病、自评健康、家庭成员数量等作为其它控制变量。受教育水平变量为依据个人学历设置的取值为 1-5 的等级变量，依次表示从未上过学、小学、中学、本科、研究生及以上；自评健康变量为等级变量，取值分别为 1-5，等级越大代表自评健康水平越低；其它均按常规方法设定，在此不再赘述。

### 3.3 描述性统计

本文共获得 CHARLS 数据四期共 74140 个样本。参照以往研究（李宏斌等，2014；邹红、喻开志，2015），由于断点回归、双重差分等模型要求实证数据中关键变量不能为缺失值，本文在删除了关键变量缺失的个体后，进一步保留了 40-80 岁的男性样本。经过处理后本文共选取了 17906 个有效观测样本，各变量的具体数据描述见表 1。

表 1 的描述性统计结果显示，总样本中，平均医疗消费支出为 1.6623 万元，平均医疗消费次数为 17.40，平均自我治疗支出为 0.2587 万元。无延迟退休意愿子样本中，退休后个体的医疗消费支出和医疗消费次数都高于退休前，而自我治疗支出低于退休前；有延迟退休意愿子样本中，退休后个体的医疗消费支出和次数均低于退休前，而自我治疗支出高于退休前，统计特征与无延迟退休意愿子样本相反；组间差异方面，退休前有延迟退休意愿子样本的医疗消费支出和次数均显著高于无延迟退休意愿子样本，差额分别为 0.4552 万元和 0.18 次，而退休后有延迟退休意愿子样本的医疗消费支出和次数均显著低于无延迟退休意愿子样本，差额分别为-0.5515 万元和-1.91 次。另外，无论是退休前还是退休后，有延迟退休意愿子样本的自我治疗支出均显著高于无延迟退休意愿子样本，差额分别为 0.0420 万元和 0.2650 万元。

表 1 描述性统计

| | 总样本 | 无延迟退休意愿子样本 | | 有延迟退休意愿子样本 | | 组间差异 | |
|---|---|---|---|---|---|---|---|
| | （1） | （2）<br>退休前 | （3）<br>退休后 | （4）<br>退休前 | （5）<br>退休后 | （6）<br>（4）-（2） | （7）<br>（5）-（3） |
| 医疗消费支出（万元） | 1.6623<br>（0.1990） | 1.4260<br>（0.4498） | 2.0547<br>（0.2177） | 1.8813<br>（0.1253） | 1.5032<br>（0.1541） | 0.4552*<br>（0.2461） | -0.5515**<br>（0.1723） |
| 医疗消费次数 | 17.40<br>（27.28） | 18.31<br>（25.83） | 18.55<br>（31.12） | 18.49<br>（26.68） | 16.64<br>（31.99） | 0.18*<br>（0.09） | -1.91*<br>（1.13） |
| 自我治疗支出（万元） | 0.2587<br>（0.67） | 0.2165<br>（0.6768） | 0.1787<br>（0.2530） | 0.2585<br>（0.9372） | 0.4437<br>（1.0893） | 0.0420***<br>（0.0167） | 0.2650***<br>（0.0656） |
| 年龄 | 59.00<br>（9.09） | 56.66<br>（7.97） | 63.46<br>（7.26） | 58.94<br>（8.89） | 66.85<br>（6.46） | 2.28***<br>（0.12） | 3.39***<br>（0.56） |
| 受教育水平 | 2.3572<br>（1.13） | 2.26<br>（1.10） | 2.65<br>（1.12） | 2.27<br>（1.10） | 2.91<br>（1.19） | 0.01<br>（0.02） | 0.26***<br>（0.03） |
| 婚姻状况 | 0.92<br>（0.27） | 0.93<br>（0.25） | 0.98<br>（0.14） | 0.91<br>（0.29） | 0.93<br>（0.25） | -0.02***<br>（0.003） | -0.05***<br>（0.01） |
| 是否抽烟 | 0.64<br>（0.48） | 0.66<br>（0.47） | 0.61<br>（0.49） | 0.65<br>（0.48） | 0.56<br>（0.50） | -0.01<br>（0.01） | -0.05**<br>（0.01） |
| 是否喝酒 | 0.57 | 0.61 | 0.60 | 0.57 | 0.53 | -0.04*** | -0.07*** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | （0.49） | （0.49） | （0.21） | （0.49） | （0.50） | （0.01） | （0.01） |
| 患病情况 | 0.62<br>（0.48） | 0.62<br>（0.48） | 0.70<br>（0.46） | 0.61<br>（0.49） | 0.68<br>（0.46） | -0.01<br>（0.01） | -0.02***<br>（0.01） |
| 是否患慢性病 | 0.56<br>（0.50） | 0.56<br>（0.50） | 0.65<br>（0.48） | 0.55<br>（0.50） | 0.63<br>（0.47） | -0.02**<br>（0.01） | -0.02<br>（0.01） |
| 自评健康 | 2.35<br>（0.62） | 2.36<br>（0.61） | 2.32<br>（0.63） | 2.34<br>（0.62） | 2.30<br>（0.63） | -0.03**<br>（0.01） | -0.02<br>（0.02） |
| 家庭成员数量 | 3.89<br>（0.31） | 3.91<br>（0.28） | 3.95<br>（0.21） | 3.88<br>（0.31） | 3.89<br>（0.30） | -0.03***<br>（0.004） | -0.06***<br>（0.01） |

注：括号内为标准差；第（6）列和第（7）列用 t 统计量检验样本差异的显著性；***、**、*分别表示 1%、5%、10%的显著水平下显著；由于组间样本表现出了非平衡特征，不同变量的有效样本不同，篇幅所限，本文未汇报各变量具体的样本量。

## 4．实证结果

### 4.1 前期检验

4.1.1 年龄与退休概率

图 2 描述了年龄与退休概率的关系。X 轴为实际年龄与 60 岁的差距，Y 轴表示退休人员占比，图中的散点即为每一年龄点上的平均退休率。60 岁两侧的曲线是通过局部函数拟合得到。可以发现，60 岁之前已有部分个体开始退休，退休概率一直随年龄平滑上升，直到在 60 岁左右两侧，退休概率有一个明显的向上跳跃。

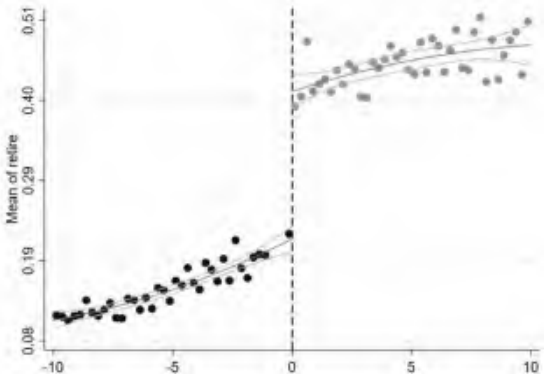


图 2　年龄与退休率

表 2 验证了图 2 的结果。表 2 中的被解释变量为每个年龄点的平均退休率，解释变量为是否大于 60 岁的虚拟变量，回归同时控制了地区固定效应和年龄的多项式（相对于 60 岁），并且（1）—（4）列年龄多项式的阶数分别从 2 增加到 5。结果显示，是否大于 60 岁变量系数均在 1%检验水平下显著为正，结合系数大小，说明 61 岁比 59 岁退休的概率依年龄多项式的不同提高了 23.9%—26.4%。表 2 最后一行显示了“是否大于 60 岁这一虚拟变量的系数为 0”原假设的 F 值，均远大于 10，强烈拒绝原假设，即是否大于 60 岁这一虚拟变量的系数不为 0，说明是否大于 60 岁这个虚拟变量能够很好地预测退休概率在 60 岁左右的变化情况，进而支持了本文将其作为工具变量的做法。

表 2 大于 60 岁对退休的影响

| | 因变量：平均退休率 | | | |
|---|---|---|---|---|
| | （1） | （2） | （3） | （4） |
| 是否大于 60 岁 | 0.2390***<br>（34.66） | 0.2460***<br>（37.14） | 0.2550***<br>（40.54） | 0.2640***<br>（44.44） |
| 年龄多项式 | 控制 | 控制 | 控制 | 控制 |
| 地区固定效应 | 控制 | 控制 | 控制 | 控制 |
| 常数项 | -0.0003<br>（-0.35） | 0.0600***<br>（11.37） | 0.0910***<br>（24.24） | 0.1070***<br>（35.27） |
| 样本数 | 17906 | 17906 | 17906 | 17906 |
| R2 | 0.2087 | 0.2084 | 0.2081 | 0.2076 |
| 检验 F 值：H0：是否大于 60 岁这一虚拟变量的系数为 0 | 4307.89 | 4301.25 | 4291.16 | 4280.11 |

注：括号内为回归系数所对应的 t 值；***、**、*分别表示 1%、5%、10%的显著水平下显著。下同。

4.1.2 内生分组检验

若年龄变量在断点处不连续，即存在内生分组，则会导致分组变量的密度函数在断点两侧有显著差异，最终导致断点回归的结果失去意义。理论上，年龄是随时间平滑变化的，很难出现个体通过年龄选择来完全控制分组变量，进而自由决定进入处理组时间的情况，换言之，年龄应该是随机分布的。为进一步验证理论分析，本文借鉴 McCrary（2008）提出的方法进行如下统计检验：

$$H_0:\rho \equiv ln\lim_{age\downarrow 60} f\left(age\right)-ln\lim_{age\uparrow 60} f\left(age\right)\equiv lnf^{+}-lnf^{-}=0 \tag{8}$$

其中，$\lim_{age\downarrow 60}$ 表示 $age$=60 的右极限，$\lim_{age\uparrow 60}$ 表示左极限，$f\left(age\right)$ 为年龄密度函数。$\hat{\rho}$ 即为年龄密度函数在 $age$=60 左右极限对数的差值，通过计算 $\hat{\rho}$ 及其标准误，即可检验年龄密度函数在 $age=60$ 处是否连续。结果显示，$\hat{\rho}=0.0106$，$se\left(\hat{\rho}\right)=0.0687$，对应 $t$ 值为 0.1543，在 10%检验水平下不显著，故可接受密度函数 $f\left(age\right)$ 在 $age=60$ 处连续的原假设。另外，从图 3 的 McCrary 检验结果也可验证上述结论，年龄密度函数的置信区间在断点 $age=60$ 两侧几乎完全重合，故可推定断点两侧年龄密度函数不存在显著差异，进而可接受密度函数 $f\left(age\right)$ 在 $age=60$ 处连续的原假设。因此，本文认为分组变量不存在个人通过自身努力而完全控制的问题。

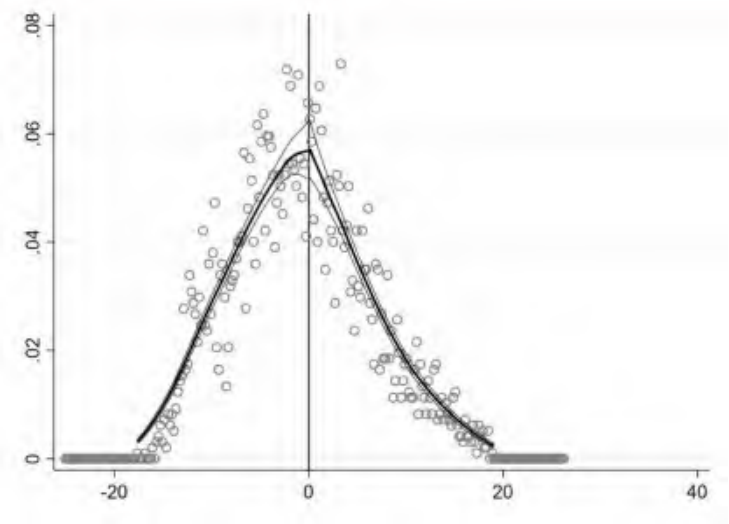


图 3　内生分组检验

4.1.3 前定变量平衡性检验

断点回归一个隐含的假设是：各个前定变量在断点处是连续的，否则断点的回归结果可能包含了前定变量的作用，进而造成实证结果的偏误（于新亮等，2020）。通过比较处于 60 岁两侧个体在前定变量上的差异，可以检验各前定变量在断点处是否连续。

图 4 显示了各前定变量随年龄的变化趋势。其中，X 轴为实际年龄与 60 岁的差距，Y 轴为各前定变量均值。断点两侧的曲线分别由局部线性函数拟合而得。结果显示，各前定变量均在断点两侧平滑过渡，未出现明显跳跃。

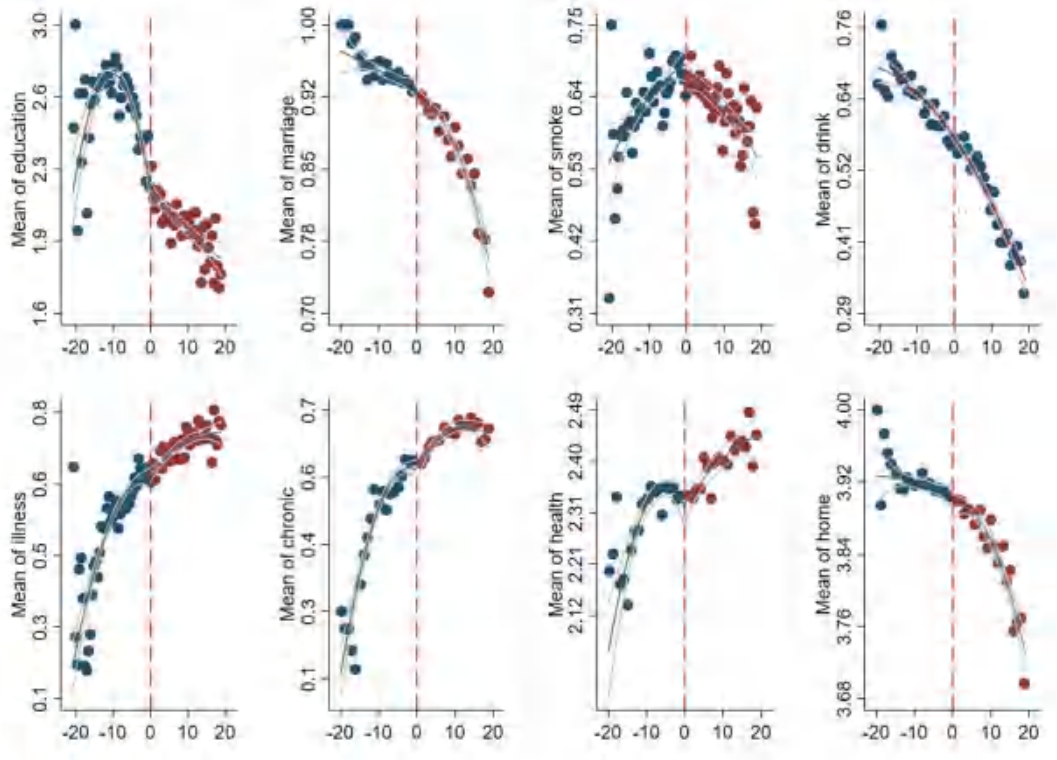


图 4　前定变量平衡性

图 4 虽然能直观表现前定变量在断点两侧的分布情况以及随年龄变化趋势，却无法精确表达前定变量在断点两侧是否平衡。为此，本文进一步实证检验了前定变量的平衡性。首先是对各前定变量平衡性的单独检验，即将各前定变量分别作为被解释变量加入回归模型，结果见表 3。结果显示，除自评健康外，其余各前定变量系数均不具有统计意义上的显著性，即在断点两侧是平衡的。而自评健康在 5%检验水平下存在显著的向上跳跃，说明当个体退休后，对自身健康水平的评价会显著降低，自评健康状况在断点两侧并不平衡。

表 3 前定变量平衡性检验

| 变量名称 | 回归系数 | 标准差 | t 值 | p 值 |
|---|---|---|---|---|
| 受教育水平 | -0.1525 | 1.8157 | -0.0840 | 0.9330 |
| 婚姻状况 | 0.5928 | 0.4938 | 1.2001 | 0.2300 |
| 是否抽烟 | -0.2005 | 0.5176 | -0.3874 | 0.6980 |
| 是否喝酒 | -0.3899 | 0.5924 | -0.6582 | 0.5100 |
| 患病情况 | -0.6462 | 1.2274 | -0.5265 | 0.5990 |
| 是否患慢性病 | -1.3732 | 1.6367 | -0.8390 | 0.4010 |
| 自评健康 | -1.7966 | 0.8357 | -2.1499 | 0.0320** |
| 家庭成员数量 | 0.2636 | 0.4924 | 0.5353 | 0.5920 |

注：表中数据采用三角核函数、选择 CCT 确定最优带宽并使用最优带宽进行平衡性检验。

已有研究表明受时间成本等因素影响，个体在退休后对自身健康状况的评价会降低（雷晓燕等，2010），但这为本文进行断点回归创造了困难。针对前定变量过多，单一前定变量出现断点等问题，可通过检验所有前定变量的联合平衡性，以保证在断点附近个体的可比性（Kim and Lim，2015）。本文据此采用广泛应用于断点回归中的似不相关回归检验前定变量在断点附近的联合平衡性（Lee，2010；Kim and Lim，2015）。检验结果显示，$\chi^2$ 统计量的值为 3.70，对应 P 值为 0.5940，接受处理变量回归系数均为零的原假设，证明本文选定的前定变量在断点两侧联合平衡，即前定变量在断点附近是可比的。

4.1.4 初步检验

已有文献表明男性个体在退休后会增加医疗消费支出和医疗消费次数（Zhang et al.，2018；何庆红等，2019），本文研究可为此提供一定的数据支持。在上文分析基础上，本文检验了总样本中退休与医疗服务利用的关系，结果如图 5 所示。可以发现，退休后个体的医疗消费支出和医疗消费次数都存在显著的向上跳跃，说明退休后个体的医疗消费支出和消费次数都大幅增加，这与相关文献结果一致。而自我治疗支出存在显著的向下跳跃，说明退休后个体的自我治疗支出显著减少，可能是随着退休后时间成本的下降以及医疗机构就诊报销比例的提高（Bíró，2016；Zhang et al.，2018；何庆红等，2019），以及养老金收入保证了退休人员收入的稳定性，老年人患病后更倾向于使用正规的医疗服务，从而挤占了部分自我诊断和治疗费用（焦娜，2016）。

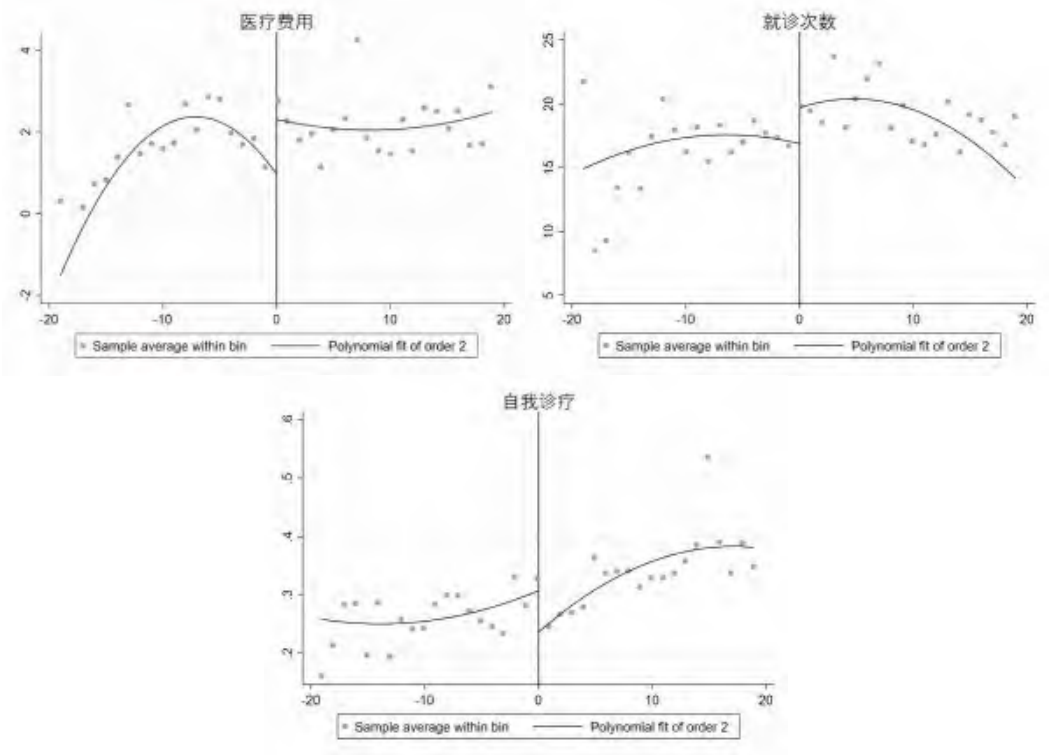


图 5　初步检验

## 4.2　正式检验

表 4 第（1）列和第（2）列为总样本退休-医疗服务利用关系的断点回归结果。结果表明，与初步检验结果一致，门诊和住院构成的总医疗消费支出和次数都在退休后发生了显著的向上跳跃。对就诊方式进一步细分，可以发现，门诊医疗消费支出和次数发生了显著向上跳跃，而住院医疗消费支出和次数的局部处理效应虽然为正，但是不显著，说明对于总样本而言，总体医疗消费支出和次数在退休后的显著跳跃，是通过退休对门诊医疗服务利用的作用带来的。另外，在自我治疗支出中，局部处理效应显著为负，与初步检验结果也具有一致性。

根据前文分析，本文进一步将总样本划分为无延迟退休意愿子样本与有延迟退休意愿子样本，分别检验不同延迟退休意愿群体在退休前后的医疗服务利用行为差异。第（3）列和第（4）列为无延迟退休意愿子样本的断点回归结果。无论是门诊还是住院，亦或是门诊住院加总的医疗消费支出和次数，在退休后都发生了显著的向上跳跃，而自我治疗支出则发生了显著的向下跳跃，这与总样本结果基本一致；第（5）列和第（6）列则是有延迟退休意愿子样本的断点回归结果。可以发现，回归结果均不具有统计意义上的显著性，说明有延迟退休意愿的个体在退休前后的医疗服务利用未出现骤升或骤降的现象，具有平滑消费的特征。进而可以推断，总样本退休后医疗消费支出和次数的显著提升，以及自我治疗支出的显著下降，主要是由无延迟退休意愿个体带来的。

表 4 退休-医疗服务利用回归结果

| 类别 | 总样本 | | 无延迟退休意愿子样本 | | 有延迟退休意愿子样本 | |
|---|---|---|---|---|---|---|
| | 支出（1） | 次数（2） | 支出（3） | 次数（4） | 支出（5） | 次数（6） |
| 门诊 | 26.0570***<br>（2.8019） | 87.7440**<br>（2.3942） | 14.6480***<br>（3.6891） | 91.3200*<br>（1.6524） | 7.5408<br>（0.5032） | 42.9150<br>（0.9954） |
| 住院 | 20.2180<br>（1.6003） | 2.9174<br>（0.6334） | 13.4840*<br>（1.8018） | 65.3400*<br>（1.6883） | 1.7261<br>（0.6129） | 1.4013<br>（0.9779） |
| 门诊+住院 | 37.2550***<br>（2.9960） | 102.4000***<br>（2.2448） | 18.5020***<br>（3.8339） | 107.3800***<br>（3.6912） | -47.9510<br>（-0.4256） | -17.4040<br>（-0.0397） |
| 自我治疗 | -192.5600**<br>（2.4332） | | -6.0979***<br>（-2.6606） | | -5.1348<br>（-1.1772） | |

## 4.3 稳健性检验

### 4.3.1 更换带宽以及核密度函数

断点回归是对断点周围的局部样本进行处理，此时若样本量足够大，则可产生随机试验的效果，通过局部线性函数即可拟合。但是数据所限，本文无法在断点两侧获得足够的样本量，在有限样本的条件下，可以通过改变不同的带宽以及选择不同的核密度函数来检验实证结果的稳健性（任明丽、孙琦，2020）。本文以总体医疗消费支出为例，分别采用 0.5 倍带宽和 2 倍带宽，以及三角核和二次核等核密度函数进行检验。结果显示，局部处理效应的符号以及显著性水平均未发生改变。此外，本文将门诊和住院的医疗消费支出和次数，以及自我治疗支出等作为被解释变量，分别代入断点回归模型，未汇报的结果显示，回归系数符号以及显著性水平也未发生明显变化，本文回归结果具有稳健性。

表 5 更换带宽及核密度函数

| | 总样本 | | 无延迟退休意愿子样本 | | 有延迟退休意愿子样本 | |
|---|---|---|---|---|---|---|
| | 0.5 倍带宽 | 2 倍带宽 | 0.5 倍带宽 | 2 倍带宽 | 0.5 倍带宽 | 2 倍带宽 |
| 三角核 | 22.2710*<br>（1.7910） | 11.2960***<br>（9.5718） | 6.0380*<br>（1.7779） | 60.61***<br>（11.3277） | 5.5160<br>（1.3512） | -47.4130<br>（-0.5596） |
| 二次核 | 18.0880**<br>（1.9839） | 417.2600***<br>（12.6470） | 6.8861*<br>（1.7838） | 47.9480***<br>（6.8974） | -3.4818<br>（-0.2205） | 25.4260<br>（0.3539） |

### 4.3.2 选择不同断点

进一步地，本文依然以总体医疗消费支出为例，选择 50 岁、55 岁和 65 岁作为新的断点进行安慰剂检验，结果如表 6 所示。结果表明，无论是总样本，还是子样本，断点回归的回归系数均不具有统计意义上的显著性，这在说明总样本和无延迟退休意愿子样本中，医疗服务利用的变化确是来自退休这一外生变量影响的同时，也进一步验证了有延迟退休意愿个体平滑地进行医疗服务利用的特征。

表 6 选择 50、55 和 65 作为断点

| | 总样本 | 无延迟退休意愿子样本 | 有延迟退休意愿子样本 |
|---|---|---|---|
| 50 岁为断点 | 9.0109<br>（0.1472） | -1.5344<br>（-0.1245） | -218.2300<br>（-1.2295） |
| 55 岁为断点 | -5.2119<br>（1.6003） | 10.1180<br>（0.0546） | 4.8260<br>（0.1305） |
| 65 岁为断点 | -32.1660<br>（-0.6735） | 4.5836<br>（0.6142） | -31.1660<br>（-0.7346） |

4.3.3 重新定义退休

参照雷晓燕等（2010）和何庆红等（2019）的研究，本文将退休定义为永久性退出劳动力市场，具体设置如下：若问卷中受访者回答“除去务农，上周至少工作一小时”或者“有工作但是目前正处在临时放假、休病假，或其他假期中，或者正在在职培训”，则将退休变量调整为 0，否则退休变量仍为原结果。将重新设置的退休变量加入回归，结果见表 7。与表 4 正式检验回归结果相比，结论基本一致。

表 7　重新定义退休

| 就诊方式 | 总样本 | | 无延迟退休意愿子样本 | | 有延迟退休意愿子样本 | |
|---|---|---|---|---|---|---|
| | 支出 | 次数 | 支出 | 次数 | 支出 | 次数 |
| 门诊 | 26.0410***<br>（2.7956） | 90.6652*<br>（1.7815） | 16.6089***<br>（4.2316） | 95.6848*<br>（1.6732） | 12.7340<br>（0.2556） | 30.8821<br>（1.4890） |
| 住院 | 15.3450<br>（1.1419） | 3.2431*<br>（1.7023） | 3.1083*<br>（1.7812） | 59.5554*<br>（1.6987） | 1.7862<br>（0.2658） | 1.6793<br>（1.2445） |
| 门诊+住院 | 40.6675***<br>（3.2218） | 95.2618***<br>（3.6479） | 16.7920*<br>（1.8071） | 50.2318*<br>（1.7053） | -45.2314<br>（-0.6875） | 10.4590<br>（0.3541） |
| 自我治疗 | -154.2873*<br>（1.7349） | | -10.2314***<br>（-2.7819） | | -4.3360<br>（-1.4082） | |

4.3.4 工具变量模型

以上断点回归方法为非参估计，本文同时采用工具变量模型进行参数估计。建立如下模型：

$$R_i = \varsigma_1 + \varsigma_2 e_i + \sum_k \varsigma_k X_{ik} + o_i \tag{9}$$

其中，$e_i$ 为工具变量，本文设定为是否大于 60 岁的虚拟变量。$R_i$ 为带有内生性的退休变量，式（9）为第一阶段模型，主要检验工具变量和退休变量之间的关系。将拟合值 $D_i$ 代入第二阶段模型，即可得到退休对医疗服务利用作用的一致估计量 $\theta_2$：

$$U_i = \theta_1 + \theta_2 D_i + \sum_k \theta_k X_{ik} + \kappa_i \tag{10}$$

第一阶段回归结果显示，年龄大于 60 岁使得退休概率显著上升了 22.60%。同时，F 值为 3924.04，远超过 10，因此不存在弱工具变量问题。综上表明，采用是否大于 60 岁作为工具变量是可靠的。第二阶段回归结果如表 8 所示。结果显示，退休与医疗服务利用的关系与上文相比均未发生显著变化，本文实证结果具有稳健性。

表 8　工具变量模型回归结果

| | 无延迟退休意愿子样本 | | | 有延迟退休意愿子样本 | | |
|---|---|---|---|---|---|---|
| | 支出 | 次数 | 自我治疗 | 支出 | 次数 | 自我治疗 |
| 是否退休 | 6.7950*<br>（1.8200） | 15.3828*<br>（1.7000） | -0.4190**<br>（-2.1800） | -1.7130<br>（-0.3500） | -17.2620<br>（-0.8700） | 0.1320<br>（1.3200） |
| 控制变量 | 控制 | 控制 | 控制 | 控制 | 控制 | 控制 |
| 常数项 | 7.5070*<br>（1.7200） | 175.3680<br>（1.6100） | 0.1770**<br>（2.1800） | 5.3720**<br>（2.0800） | -72.8910<br>（-1.2800） | 0.0620<br>（0.5300） |
| 观测值 | 1128 | 1128 | 2867 | 2065 | 2065 | 3879 |

## 5．影响机制分析

通过上文分析，本文发现退休与医疗服务利用的关系因延迟退休意愿的不同而存在显著差异，尤其是有延迟退休意愿个体在退休前后会平滑地进行医疗服务利用。对此，本文进一步探讨其中的影响机制。

### 5.1 择期治疗

以往文献表明，考虑到退休后时间成本下降，人们有可能在退休前一段时间推迟去医疗机构就诊。同时考虑到若等待时间较长，则会加重病情，治病成本随之进一步上升，因此择期治疗可能主要发生在退休前后一年（何庆红等，2019）。基于此，本文删除了退休前后一年的样本，同时考虑到删除样本后断点回归模型可能无法确定最优带宽，本文采取上文中的工具变量模型进行择期治疗的检验。回归结果如表 9 所示。结果显示，在去医疗机构就诊方面，无延迟退休意愿个体存在择期治疗行为，有延迟退休意愿个体不存在此行为：①在无延迟退休意愿子样本中，医疗消费支出和次数均不显著；②在有延迟退休医疗子样本中，无论是医疗消费支出和次数，还是自我治疗支出，回归结果依然不显著，退休依然未对医疗服务利用产生影响。验证了本文理论分析的合理性。

另外，在无延迟退休意愿子样本中，自我治疗支出的回归系数依然在 10%检验水平下显著为负，考虑到个体可能大多针对细微疾病进行自我治疗，本文推测个体可能会延长拖延治疗的时间，同时为进一步检验有延迟退休意愿子样本是否是因延长拖延治疗时间而造成的回归结果不显著，本文进一步删除了退休前后两年样本。结果显示，在无延迟退休意愿子样本中，自我治疗支出的回归系数不再显著，说明此子样本中的个体确是在自我治疗方面延长了拖延治疗的时间。而在有延迟退休意愿子样本中，回归结果依然不显著，说明此子样本确是未出现择期治疗、拖延治疗行为。

表 9　择期治疗检验

| | | 无延迟退休意愿子样本 | | | 有延迟退休意愿子样本 | | |
|---|---|---|---|---|---|---|---|
| | | 支出 | 次数 | 自我治疗 | 支出 | 次数 | 自我治疗 |
| 删除退休前后各一年样本 | 是否退休 | -2.4350<br>（-0.3200） | 123.2690<br>（0.1550） | -0.3390*<br>（-1.8400） | 4.3430<br>（1.4300） | -9.8550<br>（-0.4500） | 0.0410<br>（0.2100） |
| | 控制变量 | 控制 | 控制 | 控制 | 控制 | 控制 | 控制 |
| | 常数项 | 5.6980**<br>（2.0700） | 196.7440*<br>（1.7400） | 0.1810**<br>（2.1300） | 4.5530<br>（1.3700） | -58.1360<br>（-0.9900） | -0.2540<br>（-0.9400） |
| 删除退休前后各两 | 是否退休 | -6.0320<br>（-0.6000） | 82.7840<br>（0.1620） | 1.8900<br>（1.1300） | -2.0600<br>（-0.3200） | -4.7530<br>（-0.2000） | 0.2650<br>（1.4800） |
| | 控制变量 | 控制 | 控制 | 控制 | 控制 | 控制 | 控制 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 年样本 | 常数项 | 6.3910*<br>（1.7100） | 64.4230<br>（2.2700） | 0.9760<br>（1.4000） | 5.8140<br>（1.9800） | -53.6540<br>（-0.9000） | -0.4740<br>（-0.9600） |

## 5.2 提前进行健康投资

根据相关理论分析，有延迟退休意愿个体不会拖延治疗，可能不会发生医疗服务利用的错配，并且在退休前更加注意身体保健、以期获得更长久工作时间的动机可能会使有延迟退休意愿个体提前进行健康投资—在退休前的医疗消费相对更多，而在退休后相对更少，即延迟退休意愿在退休前对医疗服务利用产生正向作用，在退休后产生负向作用。为验证相关理论分析，按照（6）式，本文以延迟退休意愿作为核心解释变量，分析延迟退休意愿对个体在工作期和退休期医疗服务利用的作用效果。同时，为精确分析作用效果，本文将支出金额重新设定为以元为单位。

回归结果如表 10 所示。结果表明，无论是退休前还是退休后，延迟退休意愿都显著提高了个体的医疗消费支出和自我治疗支出，而对医疗消费次数的影响不显著，这与本文的理论分析严重不符，分析其原因，延迟退休意愿受到多种因素的影响，数据所限，本文很难观测到所有同时影响延迟退休意愿和医疗服务利用的控制变量，那么回归结果就具有很强的内生性。基于以上分析，为克服遗漏变量等导致的内生性问题，本文建立了工具变量模型，即以社区养老保险平均参保率作为工具变量，在（6）式基础上加入（7）式，重新进行回归。

表 10　延迟退休意愿对医疗服务利用的作用

| | 支出 | | 次数 | | 自我治疗支出 | |
|---|---|---|---|---|---|---|
| | 退休前 | 退休后 | 退休前 | 退休后 | 退休前 | 退休后 |
| 延迟退休意愿 | 4618.7000* | 23949.9*** | -0.804 | 0.408 | 462.6*** | 1819.8*** |
| | (1.7400) | (3.99) | (-0.26) | (0.39) | (3.42) | (4.76) |
| 年龄 | 1669.2060 | 3337.3 | 2.749 | 1.270 | 126.9 | -107.1 |
| | (1.2400) | (0.86) | (0.83) | (1.60) | (1.36) | (-0.30) |
| 年龄二次项 | -15.1460 | -33.72 | -0.0224 | -0.0102 | -0.979 | 0.712 |
| | (-1.4300) | (-1.09) | (-0.90) | (-1.57) | (-1.32) | (0.27) |
| 受教育水平 | 1744.8900 | -2312.9 | -0.892 | -0.649 | 252.7*** | 630.7*** |
| | (0.9100) | (-1.01) | (-0.69) | (-1.44) | (3.42) | (3.30) |
| 婚姻状况 | 48513.8230 | 25891.3 | -2.847 | -0.520 | 1077.8** | 805.6 |
| | (0.9800) | (1.06) | (-0.47) | (-0.15) | (2.42) | (0.76) |
| 是否抽烟 | -1807.3840 | -7102.1 | 0.632 | 0.445 | -507.2*** | -622.5 |
| | (-1.0100) | (-1.58) | (0.23) | (0.46) | (-3.47) | (-1.30) |
| 是否喝酒 | -9539.82*** | 4456.5 | -1.407 | 0.261 | -551.8*** | -1881.2*** |
| | (-3.0700) | (0.88) | (-0.54) | (0.27) | (-3.70) | (-3.63) |
| 患病情况 | -49.2500 | 11213.6 | 0.110 | 1.983 | 293.9 | 343.4 |
| | (-0.0200) | (0.69) | (0.01) | (0.77) | (0.64) | (0.22) |
| 是否患慢性病 | 3017.8790 | -16407.2 | -3.476 | -0.950 | -7.216 | -282.0 |
| | (1.3800) | (-1.06) | (-0.27) | (-0.37) | (-0.02) | (-0.17) |
| 自评健康 | -189.4170 | 9801.5*** | 3.246*** | 2.617*** | 480.3*** | 824.3*** |
| | (-0.2000) | (3.43) | (2.59) | (5.57) | (7.91) | (2.80) |
| 家庭成员数量 | -46117.7000 | -28783.3 | -1.231 | 0.789 | -650.9 | 487.2 |
| | (-0.9100) | (-1.16) | (-0.27) | (0.26) | (-1.51) | (0.47) |
| 常数项 | 6230.1330 | -67584.5 | -67.02 | -31.47 | -3970.6 | 552.1 |
| | (0.1300) | (-0.59) | (-0.60) | (-1.28) | (-1.35) | (0.05) |
| 样本量 | 1742 | 1451 | 1742 | 1451 | 5400 | 1346 |

为解决延迟退休意愿内生性而建立的工具变量模型回归结果如表 11 所示。在汇报回归结果前，本文分析了工具变量选取的有效性，即进行相关性、可识别性和弱工具变量检验。结果显示，首先，延迟退休意愿决策方程中社区养老保险平均参保率系数在 1%检验水平下显著为负，说明社区养老保险平均参保率显著影响个人延迟退休意愿，进而通过了工具变量的相关性检验。其次，用以检验工具变量不可识别的 Kleibergen-Paap rk LM 统计量数值对应 P 值均为 0，强烈拒绝不可识别的原假设，由此通过了工具变量的可识别性检验。最后，用以检验弱工具变量的 Cragg-Donald Wald F 统计量数值，对应 15%水平上 Stock-Yogo 弱工具变量检验临界值为 8.96，拒绝了其为弱工具变量的原假设。上述检验表明，本文选取社区养老保险平均参保率作为工具变量是有效的。

回归结果表明，同预期一致，退休前延迟退休意愿分别使医疗消费支出和次数显著增加了 10333.9610 元和 10.2870 次，而在退休后显著减少了 17410 元和 17.7950 次，退休后减少的医疗消费支出和次数要高于退休前增加的。自我诊疗方面，退休前和退休后延迟退休意愿都显著提高了自我治疗支出，并且退休后的提高程度要高于退休前，结合前文分析，退休后无延迟退休意愿人群自我治疗支出呈现显著的向下跳跃，而有延迟退休意愿人群消费依然平滑，这进一步加大了自我治疗支出差额，造成延迟退休意愿对退休后的提高作用大于退休前的现象。

表 11　工具变量模型回归结果

| | 支出 | | 次数 | | 自我治疗 | |
|---|---|---|---|---|---|---|
| | 退休前 | 退休后 | 退休前 | 退休后 | 退休前 | 退休后 |
| 延迟退休意愿 | 10333.9610*** | -17410.0000*** | 10.2870* | -17.7950* | 298.7580** | 524.0790** |
| | （2.6300） | （-1.8800） | （1.9300） | （1.6800） | （2.18） | （1.9800） |
| 控制变量 | 控制 | 控制 | 控制 | 控制 | 控制 | 控制 |
| 常数项 | -3534.3600** | 21300.000*** | -64.9350 | 29.1260*** | -37.8460 | -201.5820 |
| | （2.01） | （3.47） | （-1.22） | （3.9300） | （-0.48） | （-1.06） |
| Kleibergen-Paap rk LM statistic | 24.9550 | 66.9310 | 92.6030 | 34.4190 | 28.5870 | 21.1170 |
| Cragg-Donald Wald F statistic | 25.0440 | 68.0030 | 93.3530 | 33.0800 | 29.9200 | 21.9870 |
| 样本量 | 1742 | 1451 | 1742 | 1451 | 5400 | 1346 |

## 6．进一步分析

理论上，拖延治疗会带来健康水平的恶化，进而造成医疗费用的上升。同时，退休后无延迟退休意愿人群的医疗消费支出和次数呈现显著的向上跳跃。根据前文分析，无延迟退休意愿个体因为预期按时退休，会在有限的工作时间内抑制医疗服务利用来换取更高的收入，仅就退休前阶段而言，这种决策时完全有利的，但是扩展到整个生命周期内，有无延迟退休意愿对医疗服务利用的净效应到底是如何的？研究这一议题无论是对个人退休-医疗服务利用决策，还是对退休制度的完善都是十分必要的。

本文首先将有延迟退休意愿的人群作为处理组，无延迟退休意愿人群作为对照组；其次将 60 岁前作为基期，60 岁后作为处理期，估计退休前后延迟退休意愿对医疗服务利用的净效应。由于基期差异预期为正，处理期差异预期为负，本文所求净效应即为二者之和。

由于延迟退休意愿具有一定的内生性，在进行估计前，首先利用（7）式得出消除内生性的延迟退休意愿拟合值 $F_i$，其次将拟合值代入如下模型：

$$U_i = \eta_1 + \eta_2 treat_i \cdot post_i + \eta_3 treat_i + \eta_4 post_i + \sum_k \eta_k X_{ik} + \zeta_i \quad (11)$$

其中，$treat_i$ 为处理组虚拟变量，在此处为延迟退休意愿拟合值 $F_i$，$\eta_3$ 为相应的估计系数；$post_i$ 为处理期虚拟变量，本文设置为是否大于 60 岁，$\eta_4$ 为相应的估计系数；$treat_i \cdot post_i$ 为处理组虚拟变量和处理期虚拟变量的交互项，由于本文所求净效应为基期和处理期差异之和，而不是二者之差，因此本文进一步将基期的处理组和对照组互换，此时 $\eta_2$ 即为待估计的净效应，而（11）式就相当于一个变形的双重差分模型。

## 6.1 回归结果

利用（11）式计算的延迟退休意愿对医疗服务利用的净效应见表 12。为检验结果稳健性，表 12 分别展示了未加入控制变量和地区固定效应、加入控制变量、加入控制变量和地区固定效应的回归结果。结果显示，从同时加入控制变量和固定效应的完整回归来看，医疗消费支出方面，净效应回归系数为-8665.0350，且在 5%检验水平下显著，说明在退休后，与没有延迟退休意愿的人群相比，有延迟退休意愿人群医疗消费更少，在抵消掉退休前多花的费用之后，额外节省的医疗消费支出达到 8665.0350 元。在医疗消费次数方面，有延迟退休意愿人群额外少去医疗机构就诊的次数为 4.0260。而在自我治疗支出方面，有延迟退休意愿的人群额外增加了 521.8890 元支出。为进一步估算延迟退休意愿对个体在所有医疗服务利用方面的净效应，本文将医疗消费支出和自我治疗支出加和，重新加入回归模型，结果显示，在抵消掉自我治疗额外增加的费用后，延迟退休意愿依然在生命周期内降低了个体 6065.8840 元的费用支出。

表 12　延迟退休意愿对医疗服务利用净效应

| | 支出 | | | 次数 | | |
|---|---|---|---|---|---|---|
| 净效应 | -8046.7930*<br>（-1.87） | -6879.6380*<br>（-1.85） | -8665.0350**<br>（-1.99） | -6.1030***<br>（-5.37） | -3.7850**<br>（-2.30） | -4.0260*<br>（-1.95） |
| 处理组虚拟变量 | 9056.6960***<br>（3.09） | 4342.8150**<br>（2.00） | 9354.442.***<br>（3.68） | 4.5830***<br>（6.96） | 0.6310<br>（0.55） | 2.0460<br>（1.05） |
| 处理期虚拟变量 | 8501.6800**<br>（2.55） | 6038.7610**<br>（2.14） | 8292.9040**<br>（2.41） | 6.0300***<br>（5.77） | 2.8550**<br>（2.26） | 3.2790**<br>（2.09） |
| 控制变量 | | 控制 | 控制 | | 控制 | 控制 |
| 地区固定效应 | | | 控制 | | | 控制 |
| 常数项 | -7543.6640***<br>（-3.13） | 2334.4000***<br>（-5.05） | -3632.3070<br>（-0.94） | -3.8230<br>（-7.14） | -20.1630***<br>（-7.21） | -22.8940***<br>（-5.92） |

表 12　延迟退休意愿对医疗服务利用净效应（续）

| | 自我治疗 | | | 支出+自我治疗 | | |
|---|---|---|---|---|---|---|
| 净效应 | 750.9480***<br>（4.91） | 571.8460***<br>（3.34） | 521.8890***<br>（3.43） | -5973.5860*<br>（-1.71） | -5579.0860*<br>（-1.84） | -6065.8840*<br>（-1.77） |
| 处理组虚拟变量 | 233.6590**<br>（2.35） | 1.8060<br>（0.01） | -1049.3090***<br>（-7.26） | 7061.8340***<br>（2.97） | 3752.7140**<br>（2.10） | 5921.9400***<br>（2.90） |
| 处理期虚 | -639.7770** | -456.0450*** | -411.4770*** | 6226.1880** | 4812.3950** | 5192.4860* |

| | | | | | | |
|---|---|---|---|---|---|---|
| 拟变量 | （-5.20） | （-3.22） | （-3.25） | （2.30） | （2.09） | （1.92） |
| 控制变量 | | 控制 | 控制 | | 控制 | 控制 |
| 地区固定效应 | | | 控制 | | | 控制 |
| 常数项 | -402.4650*** （-5.13） | 275.0790 （1.37） | 1276.1180*** （4.99） | -5870.574** （-3.00） | -17604*** （-4.64） | 17804*** （-3.58） |

## 6.2 平行趋势检验

双重差分模型一个隐含的假设是：处理组和对照组在基期具有相同的时间趋势。图 6 为对照组和处理组医疗服务利用情况趋势图，X 轴为实际年龄与 60 岁的差距，Y 轴为医疗服务利用情况。可以发现，在 60 岁前，对照组和处理组医疗服务利用随年龄的变化情况基本保持平行，即具有相同的时间趋势。并且，处理组的医疗服务利用在整个生命周期内基本保持平稳。进一步地，本文将退休前各年龄虚拟变量与处理组虚拟变量分别相乘所形成的交互项代入变形双重差分模型，如果新加入交互项的系数不显著，则说明对照组和处理组在接受处理前医疗服务利用情况的变化趋势不具有显著差异。限于篇幅，本文不再对回归结果进行展示。本文对所形成的交互项进行零假设检验，得到 F 统计量为 1.12，对应 P 值为 0.2911，故可接受交互项系数为 0 的原假设。此时，退休对医疗消费支出净效应回归系数为-6955.3630，且在 10%检验水平下显著，另一方面验证了本文结论的稳定性。

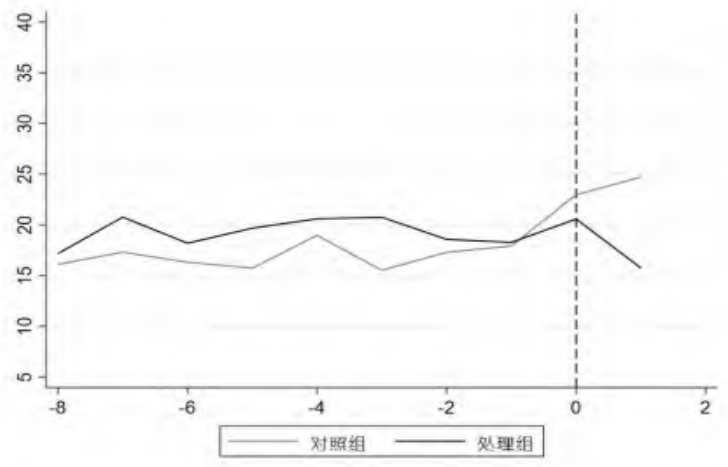


图 6 平行趋势检验

## 6.3 异质性分析

本文进一步将医疗消费划分为门诊消费和住院消费，分别检验延迟退休意愿在退休前后对门诊消费、住院消费的费用支出和次数，以及自付费用支出的净效应，结果见表 13。结果显示，相比于住院消费的费用支出和次数，延迟退休意愿对门诊消费费用支出和次数的净效应更大，分别显著降低了 4350.3380 元和 3.1140 次。另外，延迟退休意愿对门诊和住院自付费用的净效应分别为 4244.5440 元和 1224.6320 元。

表 13　异质性分析

| 就诊方式 | 医疗消费支出 | 就诊次数 | 自付费用 |
|---|---|---|---|
| 门诊 | -4350.3380*<br>（-1.66） | -3.1140**<br>（-2.18） | -4244.5440*<br>（-1.69） |
| 住院 | -2706.8160***<br>（-1.67） | -0.8930<br>（-0.88） | -1224.6320**<br>（-2.15） |

## 6.4　对价值医疗的讨论

前文结论显示，整个生命周期内，有延迟退休意愿人群更能平滑医疗消费，进而达到医疗控费目的。但是，如果这种医疗控费损害了个体在生命周期内的健康，那么控费是没有意义的。只有在不损害个体健康的的同时有效减少不必要的医疗开支，才符合“价值医疗”的精神（马超等，2019）。因此，本文分别以自评健康和慢性病患病情况作为因变量，加入表 11 的工具变量模型进行回归，考察延迟退休意愿对个体健康福利的影响。表 14 结果显示，虽然自评健康和慢性病患病情况对延迟退休意愿的回归系数存在显著性水平上的差异，但符号均为负，在一定程度上说明无论退休前后，延迟退休意愿都减少了个体自评健康差的概率，也降低了慢性病患病概率。综上，具有延迟退休意愿人群在控制医疗费用的同时，总体上对个体健康水平具有促进作用，即具有延迟退休意愿人群具有健康福利优势，更易进行“价值医疗”。

表 14　延迟退休意愿对健康的影响

| | 自评健康 | 慢性病患病情况 |
|---|---|---|
| 退休前 | -0.8670**<br>（-2.08） | -0.1620<br>（-0.95） |
| 退休后 | -1.5180*<br>（-1.88） | -0.3400<br>（-1.10） |

## 7．结论与政策启示

老龄化程度不断加深、预期余命逐渐延长以及退休年龄相对较低使得我国社保体系面临的压力日益加重，延迟退休迫在眉睫。2021 年 3 月 12 日公布的《中华人民共和国国民经济和社会发展第十四个五年规划和 2035 年远景目标纲要》正式提出实行延迟退休政策，遵循“小步调整、弹性实施、分类推进、统筹兼顾”的实施原则，员工有自主选择退休时点的空间，退休意愿重要性凸显。作为一项重大的公共社会政策调整，延迟退休政策制定不仅需要考虑社保基金运行情况以及劳动力市场变动等经济因素，还依赖于个体预期退休行为（延迟退休意愿）及其影响因素和影响后果，不同延迟退休意愿下个体的医疗服务利用行为是其重要表现。基于此，本文利用 CHARLS2011 年、2013 年、2015 年和 2018 年混合截面数据，建立模糊断点回归和工具变量模型检验延迟退休意愿对劳动力生命周期的阶段性及其行为特征所具有的系统性影响，并利用一个变形的双重差分模型实证测算了延迟退休意愿对医疗服务利用的净效应和健康福利变动。

本文的主要结论为：不同延迟退休意愿下男性个体医疗服务利用情况存在差异，无延迟退休意愿个体由于预期按时退休，有限工作期内时间成本相对较高，因此为使退休生活不受影响，倾向于退休前抑制医疗服务利用，转而更加努力工

作以获得更高的绩效工资和养老金待遇，并在退休后进行健康补偿。而有延迟退休意愿个体由于预期更长的工作时间，工作期内时间成本相对较低，从而不会发生医疗服务利用的跨期错配，医疗消费平滑变动。并且，这种平滑消费不是延后就诊的结果，而是提前进行健康投资的作用：消除内生性后，有延迟退休意愿个体在退休前医疗消费支出和次数均显著高于无延迟退休意愿个体，而在退休后均显著低于无延迟退休意愿个体，抵消掉退休前增加的医疗消费支出和次数后，额外减少的医疗消费支出和次数分别为 8665.0350 元和 4.026 次，同时这种医疗控费行为并未损害个体健康福利，反而提高了个体健康福利。

本文的结论为合理激发员工延迟退休意愿提供了经验证据，主要政策涵义在于：第一，需要建立完善的弹性退休制度，变“一刀切”的刚性实行为“软着陆”式小步调整，充分考虑不同群体不同性别差异，留足个人自主选择退休时点的空间。即延迟退休不代表让所有员工在同一时间点强制退出劳动力市场，而是基于员工根据自身意愿在一定区间内进行的退休决策。

第二，建立健全就业援助制度，对就业困难人员实行优先扶持和重点帮助。延迟退休势必会对教育水平偏低、主要从事体力劳动的员工产生挤出，应对此继续强化就业形势监测预警，为有需要的员工提供精准服务，贯彻落实职业技能培训制度，提升员工职业竞争力和满足感。

第三，加强工资和养老金待遇激发激励机制。延迟退休带来的工作期延长意味着个人工作期内工资水平的提高。此外，缴费时间的增多，也将会增加参保人员退休后的基本养老金水平。因此，需要进一步激发工资和养老金待遇激励机制，增强员工延迟退休接受度。

第四，坚持系统观念，加强顶层设计，厘清部门职能，以提高劳动效率的全生命周期激励为目标，完善劳动力市场内外部和外市场间相互联系的制度体系，建立起延迟退休的配套政策体系，尤其是加强对大龄劳动者的保护，建立录用大龄员工的激励机制，同时出台就业年龄歧视判定标准，加强监管的可操作性。

此外，退休前后医疗保障水平的阶跃式上涨也是造成不同延迟退休意愿下退休-医疗服务利用差异的诱因之一，因此实现医疗保障水平在退休前后的柔性过渡也十分重要。具体而言，可设置随年龄和退休时间动态变动的保障机制，依工龄和缴费年限设置不同区间，实现生命周期内纵向的精算平衡。同时，厘清延迟退休意愿的影响后果，科学有效地激发个体的延迟退休意愿，以顺利推行延迟退休政策，也是本文下一步研究的方向。

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# 延迟退休意愿、退休——医疗服务利用与健康福利

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**关键词：**延迟退休意愿；医疗服务利用；健康福利；模糊断点回归；工具变量

**中文摘要.** 老龄化程度不断加深、预期余命逐渐延长以及退休年龄相对较低使得我国社保体系面临的压力日益加重，延迟退休迫在眉睫。“十四五”规划正式提出实行延迟退休政策，遵循“小步调整、弹性实施、分类推进、统筹兼顾”的实施原则，员工有自主选择退休时点的空间，退休意愿重要性凸显。基于此，本文利用CHARLS四期混合截面数据，建立模糊断点回归和工具变量模型检验延迟退休意愿对劳动力生命周期的阶段性及其行为特征所具有的系统性影响，并利用一个变形的双重差分模型实证测算了延迟退休意愿对医疗服务利用的净效应和健康福利变动。

本文的主要结论为：不同延迟退休意愿下男性员工医疗服务利用情况存在差异，无延迟退休意愿个体由于预期按时退休，有限工作期内时间成本相对较高，为使退休生活不受影响，倾向于退休前抑制医疗服务利用，转而更加努力工作以获得更高的绩效工资和养老金待遇，并在退休后进行健康补偿。而有延迟退休意愿个体预期更长的工作时间，工作期内时间成本相对较低，从而不会发生医疗服务利用的跨期错配，医疗消费平滑变动。并且，平滑消费不是延后就诊的结果，而是提前进行健康投资的作用。进而，员工整个生命周期内，延迟退休意愿有着明显的医疗控费效果，且增加了个体健康福利。

本文随之提出如下政策建议：首先，需要建立完善的弹性退休制度，变“一刀切”的刚性实行为“软着陆”式小步调整，充分考虑不同群体不同性别差异，留足个人自主选择退休时点的空间；其次，延迟退休意愿在节约医疗资源方面起到了明显的作用，也符合“价值医疗”的精神。应该进一步调整相关就业政策、退休政策、社保政策等社会政策，坚持系统观念，加强顶层设计，厘清部门职能，以提高劳动效率的全生命周期激励为目标，完善劳动力市场内外部和外市场间相互联系的制度体系，以进一步激发劳动者的延迟退休积极性。

本文的边际贡献和创新点可能体现在三个方面：第一，本文察觉的不同延迟退休意愿下的退休-医疗服务利用差异丰富了医疗服务利用在生命周期不同阶段存在不同变化的特征事实；第二，基于整个生命周期内员工医疗服务利用变动和健康福利变化为不同延迟退休意愿群体的医疗行为决策做出了有效的解释；第三，本文对所涉及到若干局部研究领域也有一定的丰富和补充。

# Chapter 6. Insurance Economics

# Research on Design and Pricing of Shaanxi Winter Wheat Remote Sensing Index Insurance on Kilometer Grid

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**Keywords:** Remote sensing index insurance, winter wheat, rate determination, risk zoning, EVI.

**Abstract.** With the development of remote sensing technology, crop planting area estimation and yield estimation using remote sensing data have achieved higher and higher accuracy, and there have been some applications in crop insurance survey and damage assessment, but in the determination of crop insurance premium rates however, the application of this method is very limited, and only a few documents have explored this. This study believes that the use of remote sensing yield estimation methods can well make up for problems such as the lack of annual crop yield data and insufficient spatial accuracy, making the risk zoning of crop insurance more precise and reasonable, improving the accuracy of rate determination, reducing the adverse selection problem due to the "one rate one province" system, increasing the enthusiasm of farmers and agricultural enterprises to participate in insurance, and promoting the sustainable operation and high-quality development of agricultural insurance business.

The satellite remote sensing data used in this study to estimate the yield loss is the enhanced vegetation index (EVI) data in the MOD13A3 product. The data year is 2001-2018, with a spatial resolution of 1,000 meters and a time resolution of 1 month. The satellite remote sensing data used in determining the winter wheat planting area is the cereal crop map in the MCD12Q1 product. Based on the relationship between the Enhanced Vegetation Index (EVI) of the winter wheat planting area in Shaanxi and the actual yield of winter wheat in the county, the 60-61th EVI data of the whole year was selected to estimate the yield loss rate, and the winter wheat remote sensing index insurance product was designed. Using the kilometer grid as the scale, through detrending of EVI data, non-parametric kernel density estimation and Monte Carlo simulation, the claim threshold value and actuarial pure rate of winter wheat remote sensing index insurance were calculated, and the pure rate map was drawn. This insurance product can provide protection for the yield loss of winter wheat from sowing to greening, designing differentiated rates for different yield risks between plots, reducing adverse selection, and improving the spatial accuracy of winter wheat yield insurance premium rate determination.

In order to ensure the robustness of the rate determination, this study has repeatedly compared and verified the pure rate map generated. The verification methods include: (1) Compare with the average yield and yield variation coefficient of the county; (2) Compare with the rate map in the existing literature; (3) Perform principal component analysis and analysis based on multiple factors such as geography, climatic conditions, and irrigation facilities. Cluster analysis, compare the risk value of each category with the above rate map; (4) Consult a number of wheat experts in our school and the personnel responsible for agricultural insurance survey and loss assessment of the insurance company, and check the wheat production risk status reflected in the map Whether the regional difference is consistent with their experience; a variety of verification results show that the rate map has high rationality and reliability.

## 1. 引言

冬小麦是陕西省种植的主要粮食作物之一，主要在关中地区种植，如渭南、宝鸡、咸阳、西安等市。2019 年冬小麦种植面积 96.59 万公顷，占夏收粮食播种总面积的 87.5%；冬小麦年产量 382.04 万吨，占夏收粮食总产量的 90.9%。冬小麦是关系粮食安全的重要主粮作物，然而由于种植区域地处西部干旱半干旱地区，陕西冬小麦的种植受到自然灾害的较大影响。

陕西冬小麦每年 10 月播种，第二年 6 月初收割，生长周期较长，生产过程中面临的自然灾害种类繁多。10 月播种阶段可能面临干旱少雨，整地、播种后影响到出苗率。11 月到第二年 3 月可能面临低温冻害和干旱，造成幼苗干枯死亡。3 月的返青拔节到 5 月的扬花灌浆阶段可能面临倒春寒、干旱及病虫害，导致分蘖数不够、穗粒数不足或千粒重偏低。5 月初到 6 月初可能面临病虫害、冰雹和连阴雨等灾害，导致穗发芽等问题，影响产量。这些灾害的存在给陕西冬小麦的生产带来很大的不确定性。

农业保险是分散农业风险，提高农民小麦生产积极性的有效手段，也是政府支持保护农业的重要政策工具。陕西省自 2007 年开展政策性农业保险以来，在提高小麦等大宗农作物保险的覆盖率方面取得了快速发展，然而在费率厘定的空间精确度方面发展较为缓慢，至今仍然按照全省统一费率进行承保。这种“粗放”的费率模式导致风险低的区域农户投保积极性不高，而风险高的区域保险公司面临较大的亏损可能性，从而影响公司开展业务的积极性，整体上制约了农业保险向高质量发展。如何提高小麦产量损失保险费率的空间精确度，让农户缴纳的保费能够与其面临的风险相匹配，减少逆选择，提高农户投保积极性，促进农业保险高质量发展，成为迫切需要解决的问题。

本文利用 2001-2018 年卫星遥感数据，基于陕西冬小麦种植区域的增强植被指数（EVI）与冬小麦实际单产的关系，构建能够反映冬小麦单产损失率的遥感指数。以公里网格为尺度，测算了冬小麦遥感指数保险的理赔门槛值和精算纯费率。通过卫星遥感数据的应用，能够在一定程度上弥补农作物单产数据的缺失和不准确，更好地评估不同区域农作物生产风险差异，提高农作物保险费率厘定的空间精确度，减少单一费率带来的逆向选择问题。

## 2. 农作物遥感指数保险的国内外研究动态

产量损失风险的评估是农作物种植保险定价的核心，也是国内外农作物种植保险定价模型研究的重点。农作物保险的费率厘定通常采用对产量分布进行参数或非参数拟合以及在此基础上的蒙特卡洛模拟方法，但是由于用于分布拟合的产量数据通常是区域平均数据，而农作物种植保险的赔付是基于单个农场损失的，因此在农作物种植保险的定价模型中还必须考虑产量分布在空间上的异质性。

庹国柱和丁少群（1994）最早以陕西泾阳的棉花为例，证明了不同空间位置不同环境条件下，同一种农作物面临的风险不同，甚至在很小范围内也有很大差异。Popp et al.（2005）、Claassen and Just（2011）使用农场层面数据证明了，县域内的系统变异异常强烈，县域汇总数据的使用大大低估了地块水平的产量损失风险。张峭（2013）提出，在大空间尺度下，农户之间的产量波动会因统计加总而相互抵消或平滑，导致风险水平低估，并且空间尺度越大，低估程度也越严重。然而农作物微观产量数据的缺失给费率厘定的精细化带来很大困难。

随着遥感技术的发展，多级尺度的作物种植面积估计和产量估计已经获得越来越高的精度。这种基于遥感数据的估产模型可以为我们提供更小空间尺度上的产量信息，从而为建立地理网格尺度的产量损失风险模型提供了可能。

利用遥感观测数据实现不同地理网格上的农作物产量识别，其原理是利用植被反射率光谱特征反演关键植被参数，通过植被参数的变化趋势来分析农作物的长势信息（赵虎等，2011）。Kumhálová and Matějková（2017）的研究显示，标准化植被指数（NDVI）和小麦产量有高达 0.8 左右的显著相关性。Palakuru et al.（2018）利用增强植被指数（EVI）和土壤湿度主动被动探测指数（SMAP）估计水稻产量，其中使用 EVI 的二项式估产可决系数达到 0.74。刘新杰等（2019）使用中高分辨率多源卫星遥感数据，构建了冬小麦叶绿素密度、叶面积指数（LAI）的遥感反演模型，并基于此绘制了 2017 年安徽龙亢农场冬小麦产量遥感估算地图，产量分布与实际种植情况吻合良好，最高可决系数达到 0.74。郭铌等（2019）利用长时序 NDVI 建立了冬小麦受旱指数 WWDI，经检验，该指数与冬小麦产量存在极显著的相关关系（$p<0.001$）。Dou et al.（2020）利用中分辨率成像光谱辐射计（MODIS）的地表温度（LST）产品和植被指数（VI）产品估计了 2013 年长江流域水稻遭受高温灾害的受损面积，省级尺度的误差不超过 8.7%。这些研究建立的种植面积和产量估计模型，达到较高的精确度，可以满足应用需求，说明使用遥感估测产量进行地理网格尺度的农作物种植保险定价已经具有可行性。

基于卫星图像的遥感指数，近年来已在美国、加拿大和西班牙等国用于受损牧场和牧草保险，这种保险被称为卫星指数保险或遥感指数保险（Juan José Martín-Sotoca, et al，2019）。这种保险以卫星遥感观测图像为基础，能够大大提高农作物保险费率厘定可用的数据量和空间精度，弥补因农场级产量数据不足导致的传统精算方法的缺陷，具有广阔的应用前景。在我国，虽然遥感技术已在农业保险的查勘定损中开展了一定程度的应用，但在费率厘定方面的应用研究还很有限。目前仅看到以下两篇文献。李懿珈等（2018）基于遥感植被指数设计了西藏那曲地区畜牧业旱灾指数保险。叶涛等（2021），使用遥感数据和作物生长模型还原了 1991—2016 年全国 10km 栅格水平的单产损失率，厘定了保险纯风险损失率和大灾风险附加费率。本文的研究将以陕西冬小麦为例，采用公里网格尺度的增强植被指数（EVI）设计小麦遥感指数保险，为遥感数据在农作物保险费率厘定中的应用研究做出新的贡献。

## 3．冬小麦遥感指数选择和保险产品设计

为了真实反映冬小麦遭受自然灾害带来的产量损失，首先要建立一个与冬小麦产量显著相关的遥感指数。目前，已有不少卫星可以提供不同空间分辨率的光谱信息，例如来自 Terra 和 Aqua 卫星上的 MODIS 传感器数据。这两颗卫星分别于 1999 年 12 月 18 日和 2002 年 5 月 4 日发射成功。Terra 为上午星，从北向南于地方时 10:30 左右通过赤道，Aqua 为下午星，于地方时 13：30 左右通过赤道。两颗星相互配合每 1-2 天重复观测整个地球表面，得到 36 个波段的观测数据，其最大空间分辨率 250 米。

本文使用的是美国国家航空航天局（NASA）提供的 MOD13A3 产品中的增强植被指数（EVI）数据。MOD13A3 数据提供每月 1km 分辨率的 3 级正弦曲线投影网格产品。月产品加工过程中，算法吸收全部 16 天覆盖全月的 1km 产品，

若大气中无云，采用时间加权平均方法，或者采用最小值以防云影响。EVI 指数，能够最小化表观背景的变异和保持植被条件密度的稳定性。EVI 也用到蓝色波段去除烟雾和子像元薄云残留的大气污染，计算前经过表面的双向反射率大气校正，去除水、云、重气溶胶和云影的影响。

根据文献研究，冬小麦三月初开始返青，在我国北方地区，这个时间段里其他植物还没有大面积生长，因此植被指数受其他植物的干扰较少，能够比较准确地反映冬小麦的种植区域和长势。四月至五月初时，冬小麦开始逐渐成熟，随之植被指数在达到峰值后开始下降，直到五月底六月初收获前降至最低值。为了确定哪个时段的植被指数与冬小麦产量相关性最大，本文分别提取了 2001-2018 年各年 3 月初、4 月初、5 月初的 EVI 数据，使用对应年份 MCD12Q1 产品中的谷物分类地图作为掩膜进行裁剪。图 1 以 2018 年为例，展示了陕西省的谷物分类地图。谷物分类地图由 MODIS 数据分析加工得到，其中显示的种植区域包含小麦种植区域，由于小麦是陕西尤其是关中地区种植的主要谷物，因此本文采用该地图近似表达小麦种植区域。为了验证该分类地图的准确性，本文对 2001-2018 年各年的县域谷物分类地图面积和县域小麦播种面积进行了比照，相关系数大于 0.7。

图 2 以 2018 年为例展示了裁剪后的三月初 EVI 指数地图。裁剪后的数据以县域为单位计算平均 EVI 指数，计算其与当年冬小麦产量的 Pearson 相关系数，得到如下相关系数表（表 1）。从表 1 中可以看出，这三个时间段的 EVI 指数均

图1 2018年谷物种植区域图

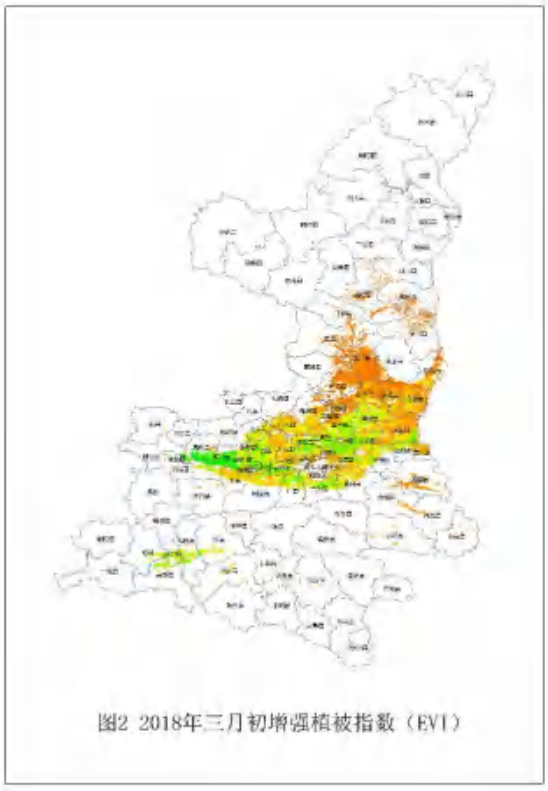

图2 2018年三月初增强植被指数（EVI）

与冬小麦产量有较强的相关性，相关系数都在 0.5 以上，p 值均小于 0.01。

本文选用相关系数最高的三月初 EVI 指数来设计遥感指数保险产品。当承保年度三月初观测到的 EVI 指数低于理赔门槛值时，投保农户可以按照损失百分比获得相应赔偿。农户按照各自种植小麦的地块所在的栅格，确定 EVI 指数

的理赔门槛值，以及应当缴纳的保费。这些理赔门槛和保费根据双方共同认可的EVI 数据来源计算得出并在保险公司的网站上公示，由农户在线查看。不能在线查看的农户可到保险公司查看，或由工作人员提供上门服务。如果所在地块跨越两个或两个以上栅格，农户可以选择其中一个栅格的理赔门槛和保费进行投保。保险金额根据该地块正常年份小麦产值，由投保人和保险公司协商确定。理赔时，仍然按照双方共同认可的 EVI 数据来源公布的 EVI 指数计算损失百分比。该保险产品能够为冬小麦从播种到返青期间遭受的各种灾害提供综合保障。由于减少了查勘定损的工作量，管理费用和保费率会比传统的产量保险更低。同时，由于采用客观指数，该保险产品能够提高理赔的公平性。

需要注意的是，植被指数的降低并不排除人为弃耕、改种其他作物或者地块被征收的情况，这些情况应该作为该保险产品的除外责任。另外，也可以同样的方法设计四月初指数和五月初指数的相应产品，产品的设计和费率厘定方法一致，优点在于能够保障更长时段的自然灾害风险，但存在的基差风险也可能更大。

**表 1 EVI 指数与冬小麦产量的相关系数**

| 年份 | 三月初<br>（全年第 60-61 天） | 四月初<br>（全年第 91-92 天） | 五月初<br>（全年第 121-122 天） |
|---|---|---|---|
| 2001 | 0.807315 | 0.794783 | 0.717720 |
| 2002 | 0.609283 | 0.631594 | 0.690457 |
| 2003 | 0.705692 | 0.722711 | 0.812367 |
| 2004 | 0.755919 | 0.628190 | 0.575840 |
| 2005 | 0.770225 | 0.781453 | 0.676510 |
| 2006 | 0.784136 | 0.779284 | 0.611246 |
| 2007 | 0.674232 | 0.630641 | 0.483429 |
| 2008 | 0.787696 | 0.671458 | 0.592330 |
| 2009 | 0.673765 | 0.623026 | 0.603001 |
| 2010 | 0.569302 | 0.545354 | 0.507030 |
| 2011 | 0.518157 | 0.566526 | 0.402355 |
| 2012 | 0.620465 | 0.543239 | 0.094765 |
| 2013 | 0.550985 | 0.446810 | 0.334906 |
| 2014 | 0.445783 | 0.367861 | 0.268645 |
| 2015 | 0.566554 | 0.428172 | 0.320838 |
| 2016 | 0.420428 | 0.337393 | 0.166421 |
| 2017 | 0.469298 | 0.403642 | 0.547568 |
| 2018 | 0.566818 | 0.520487 | 0.634716 |
| Pooled | 0.609157 | 0.589859 | 0.559117 |
| p-value | 0.000000 | 0.000000 | 0.000000 |

## 4．冬小麦遥感指数保险费率厘定方法

观察不同年份的 EVI 指数栅格地图能够看出 EVI 指数存在时间和空间上的异质性。即使相邻不远的地方，EVI 指数也会存在较大的差异，可能的原因是不同栅格之间海拔、地形、气候、土壤等各方面条件存在差异，从而影响冬小麦在返青时节的长势。在三月初之前发生的自然灾害也会在一定程度上影响冬小麦返青，从而降低灾害发生地块的 EVI 指数。植被指数在不同年份间也会有所差异，排除技术水平、品种采用以及地区城市化进程等影响之后，不同年份之间的 EVI 指数差异能够反映出冬小麦在不同年份中产量的综合损失率。

为了反映地块之间的风险差异，本文将陕西省行政地图划分为 1km*1km 的

栅格，共计 208314 个栅格。用谷物分类地图进行裁剪后，剩余栅格即种植谷物的栅格共 35468 个。为了减少城市化进程和农村产业规划对产量分析的影响，本文进一步剔除有些年份 EVI 指数为空值的栅格，因为这些地块可能由于城市开发或产业规划而不再种植小麦。最后进入费率厘定环节的栅格共有 25138 个。

遥感指数保险所收取的精算纯保费应当足以覆盖损失赔偿，因此需要对历年的损失率（EVI 指数低于理赔门槛值的百分比）进行分析。为了剔除技术和品种因素导致的变化，本文首先对各栅格各年的 EVI 指数进行去趋势。常用的去趋势方法有线性拟合法、指数平滑法、hp 滤波法、ARIMA 时间序列建模法等。考虑到 EVI 指数可能存在的序列自回归现象，本文选用 ARIMA 模型进行去趋势。去趋势过程采用 Python 的 pmdarima 程序包和 statsmodels 程序包完成。将 $\max\left(\left(\widehat{EVI}-EVI\right),0\right)/\widehat{EVI}$得到的比率作为损失百分率，其中 $EVI$ 是各栅格各年实际 EVI 指数，$\widehat{EVI}$为各栅格对应年份的样本内 EVI 指数预测值。理赔门槛值为向后一期的样本外预测值。对去趋势后的损失百分率进行非参数核密度拟合，在分布拟合模型的基础进行每个栅格 5000 次的蒙特卡洛模拟以得到较为稳定的损失率均值。该均值即为各栅格的精算纯费率。

## 5. 陕西冬小麦遥感指数保险费率厘定结果

经过以上分析和计算，我们得到两个表格，分别是各栅格下年度理赔门槛值表和各栅格下年度精算纯费率表。由于基础数据年份是 2001-2018 年，所以这里所说的下年度是指 2019 年。表格数据量较大，我们以地图形式比较直观地呈现，见图 3 和图 4。为了更清楚地看到区域间的差异，图 5 和图 6 分别把图 3、图 4 中小麦种植比较集中的关中地区放大呈现。

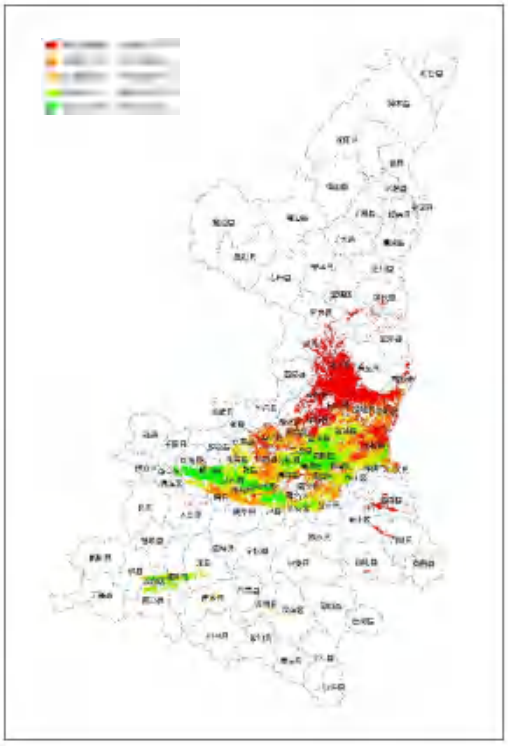

图 3 冬小麦遥感指数理赔门槛

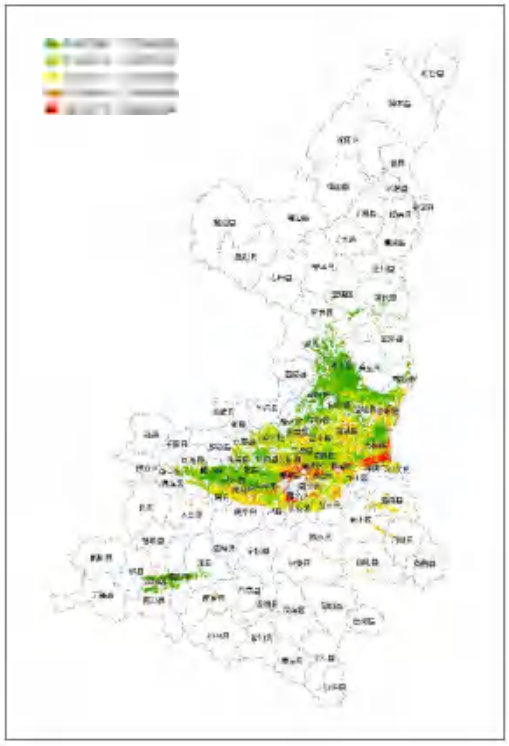

图 4 冬小麦遥感指数精算纯费率

理赔门槛由历年 EVI 指数 ARIMA 模型向右预测一期得到，体现的是各栅格三月初的正常 EVI 指数水平。精算纯费率则体现了各栅格实际 EVI 指数低于正常 EVI 指数的概率和程度，即理赔发生的概率和赔付强度。从图中可以看出，陕北地区、渭南东北部地区和咸阳北部地区预期理赔门槛较低，反映出这些地区冬小麦平均产量较低；渭南大部分地区精算纯费率较高，尤其以合阳、蒲城、华阴等地较为明显，反映出这些地区冬小麦种植风险较大。岐山、扶风、武功、乾县、阎良等县区预期理赔门槛较高且精算纯费率较低，反映出这些地区冬小麦产量较高且种植风险较低，是最适合种植冬小麦的地区。这些结论与这些地区的地理、气候条件是一致的。

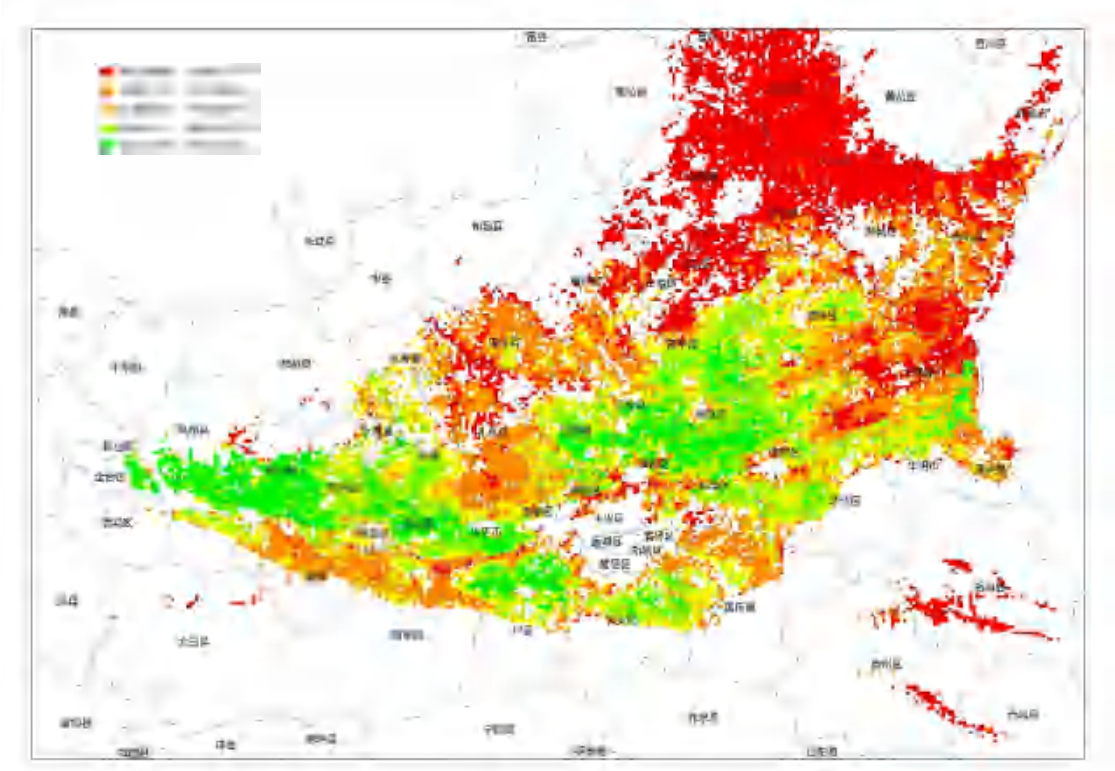

图 5 冬小麦遥感指数保险理赔门槛（关中地区）

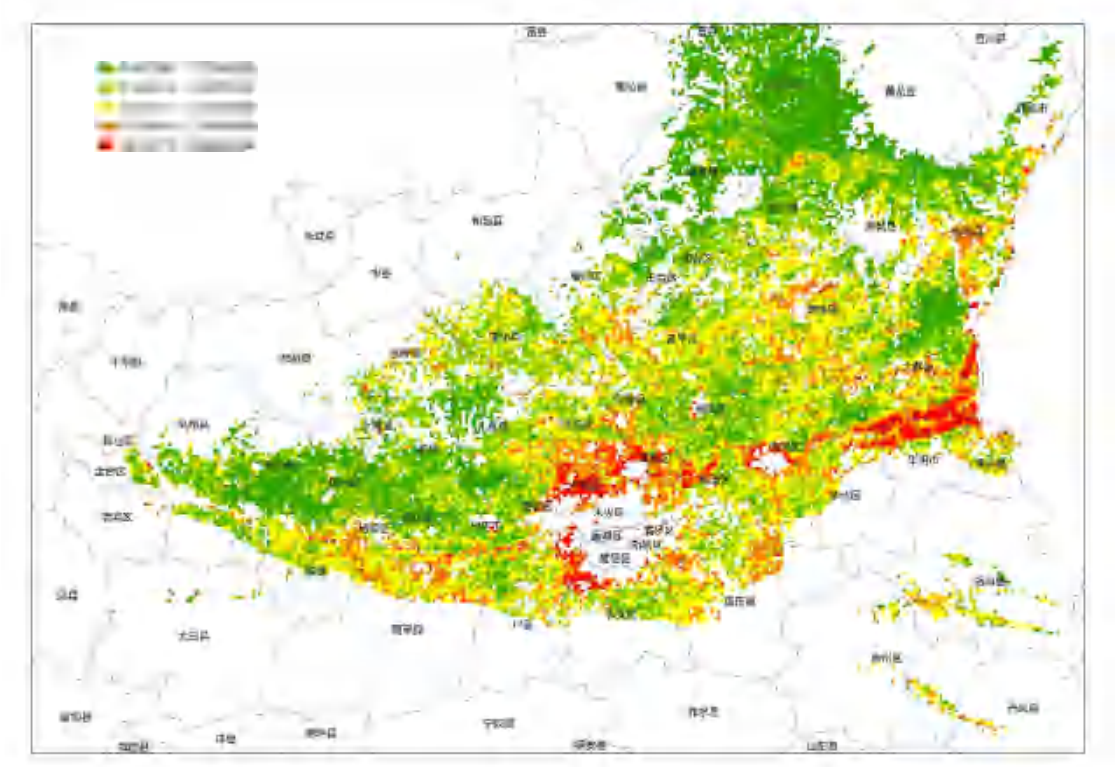

图 6 冬小麦遥感指数保险精算纯保费（关中地区）

## 6. 费率厘定结果验证

为了进一步验证根据冬小麦遥感指数保险理赔门槛和精算纯费率的可靠性，我们对得到的费率和理赔门槛地图进行了以下几方面的比对和校验。

### 6.1 与县域冬小麦平均产量和产量变异系数比对

表 2 中是根据陕西省各县域冬小麦产量数据整理计算的冬小麦理念平均产量和产量变异系数，数据来源于陕西省各地级市历年统计年鉴。通过比对，我们发现，平均产量较高的地区与正常 EVI 指数较高的地区是基本一致的，而变异系数较高的地区和精算纯费率较高的地区是基本一致的。说明 EVI 指数能够较好地反映冬小麦产量的平均水平和波动程度，基于 EVI 指数的遥感指数保险能够为冬小麦产量损失提供较好的保障。而相比传统产量保险，基于公里网格的遥感指数保险能够更好地体现小地块之间的风险差异。

表 2 县域冬小麦均值和变异系数排序

| 冬小麦产量均值排序 | | | 冬小麦产量变异系数排序 | | |
|---|---|---|---|---|---|
| 地名 | 经济区域 | 均值 | 地名 | 经济区域 | 变异系数 |
| 高陵区 | 关中 | 408.0617 | 永寿县 | 关中 | 0.220204 |
| 杨陵区 | 关中 | 392.4889 | 洛南县 | 陕南 | 0.189053 |
| 岐山县 | 关中 | 388.5636 | 淳化县 | 关中 | 0.177911 |
| 阎良区 | 关中 | 374.1457 | 长安区 | 关中 | 0.164101 |
| 扶风县 | 关中 | 371.7022 | 灞桥区 | 关中 | 0.158333 |
| 眉县 | 关中 | 333.7311 | 蓝田县 | 关中 | 0.143265 |
| 户县 | 关中 | 319.0123 | 洛川县 | 陕北 | 0.142093 |

| | | | | | |
|---|---|---|---|---|---|
| 武功县 | 关中 | 311.3767 | 白水县 | 关中 | 0.135748 |
| 凤翔县 | 关中 | 304.6938 | 杨陵区 | 关中 | 0.135618 |
| 兴平市 | 关中 | 302.3517 | 宜君县 | 关中 | 0.130717 |
| 泾阳县 | 关中 | 297.5550 | 金台区 | 关中 | 0.129428 |
| 三原县 | 关中 | 290.7383 | 户县 | 关中 | 0.129348 |
| 乾县 | 关中 | 287.5083 | 澄城县 | 关中 | 0.127907 |
| 富平县 | 关中 | 282.2556 | 周至县 | 关中 | 0.125119 |
| 临潼区 | 关中 | 280.6715 | 三原县 | 关中 | 0.122528 |
| 周至县 | 关中 | 271.7174 | 临潼区 | 关中 | 0.118369 |
| 长安区 | 关中 | 269.9383 | 礼泉县 | 关中 | 0.113457 |
| 礼泉县 | 关中 | 269.1983 | 王益区 | 关中 | 0.106625 |
| 大荔县 | 关中 | 262.8278 | 阎良区 | 关中 | 0.105616 |
| 灞桥区 | 关中 | 259.8279 | 蒲城县 | 关中 | 0.103587 |
| 华阴市 | 关中 | 252.2167 | 合阳县 | 关中 | 0.099378 |
| 华州区 | 关中 | 250.9389 | 华阴市 | 关中 | 0.098084 |
| 蒲城县 | 关中 | 245.1278 | 潼关县 | 关中 | 0.096294 |
| 蓝田县 | 关中 | 242.6515 | 乾县 | 关中 | 0.096196 |
| 淳化县 | 关中 | 236.0867 | 韩城市 | 关中 | 0.094666 |
| 潼关县 | 关中 | 227.4944 | 武功县 | 关中 | 0.089833 |
| 永寿县 | 关中 | 220.1617 | 耀州区 | 关中 | 0.087885 |
| 金台区 | 关中 | 213.8090 | 华州区 | 关中 | 0.082324 |
| 耀州区 | 关中 | 201.4667 | 泾阳县 | 关中 | 0.081087 |
| 白水县 | 关中 | 194.5833 | 兴平市 | 关中 | 0.079095 |
| 合阳县 | 关中 | 191.1778 | 高陵区 | 关中 | 0.074068 |
| 澄城县 | 关中 | 190.8611 | 印台区 | 关中 | 0.073451 |
| 韩城市 | 关中 | 189.0889 | 眉县 | 关中 | 0.071998 |
| 洛川县 | 陕北 | 188.9273 | 大荔县 | 关中 | 0.071671 |
| 宜君县 | 关中 | 168.2436 | 富平县 | 关中 | 0.068210 |
| 王益区 | 关中 | 162.2866 | 凤翔县 | 关中 | 0.063573 |
| 印台区 | 关中 | 161.6924 | 岐山县 | 关中 | 0.063546 |
| 洛南县 | 陕南 | 132.7709 | 扶风县 | 关中 | 0.057933 |

数据来源：根据陕西省各地级市历年统计年鉴数据整理计算。

## 6.2 与其他文献中的风险区划结果比对

本文对近年来相关研究中对陕西冬小麦风险区划的结果进行了整理和比对。

2020 年 11 月 10 日，中国精算师协会发布《稻谷、小麦、玉米成本保险行业基准纯风险损失率表（2020 版）》，其中陕西省小麦基准纯风险损失率如表 3。可以看出渭南市和榆林市的纯风险损失率较高，与本文研究结论基本一致。其中榆林市不是冬小麦的主产区，种植面积和产量都非常少。

表 3 小麦成本保险行业基准纯风险损失率

| 地名 | 纯风险损失率 |
|---|---|
| 西安市 | 2.4% |
| 铜川市 | 2.5% |
| 宝鸡市 | 2.4% |
| 咸阳市 | 2.4% |
| 渭南市 | 3.1% |
| 延安市 | 2.9% |
| 汉中市 | 2.4% |
| 榆林市 | 4.8% |
| 安康市 | 2.9% |
| 商洛市 | 2.9% |

数据来源：中国精算师协会

2020 年 6 月 28 日，在第十期中国农业保险论坛（CAIF）上，中国农业科学院农业信息研究所研究员、农业风险管理研究中心主任、首席科学家张峭，代表研究创新团队发布了《中国农业生产风险区划地图册（全国篇及省域篇）》。其中陕西省分县小麦生产风险区划地图中，陕北地区、商洛地区、渭南东部地区、咸阳北部地区小麦生产风险较高，与图 6 显示的结果基本一致。

叶涛、陈说、刘苇航等在 2021 年第 2 期《保险研究》上发表的《全国主粮作物减产风险评估与保险费率厘定研究》一文，利用作物模型集合模拟器、配合县级历史单产统计数据，使用单产时空融合方法还原了 1991—2016 年全国 10km 栅格水平的单产损失率，厘定了保险纯风险损失率和大灾风险附加费率。其中小麦纯风险损失率地图中显示，榆林东部地区、商洛东部地区风险最高，纯风险损失率高达 12%以上，咸阳北部和渭南大部分地区风险较高，与本文研究结论基本一致。

### 6.3 与多因素风险区划结果比对

考虑影响小麦产量的因素，从孕灾环境、致灾因子危险性、承灾体脆弱性、承灾体暴露度和防灾减灾能力五个维度选取指标，采用主成分分析的方法对影响冬小麦种植的各种因素进行了分类，使用层次分析法（AHP）对各主成分赋予权重，在此基础上计算各县域冬小麦种植风险值。风险值越高冬小麦种植风险越大。具体选用指标如下。孕灾环境因子指标包括：地形起伏度、地理经纬度、气温距平值、降水距平值、主要月份各月气温均值、各月降水均值、气温以及降水变异系数。承灾体脆弱性指标包括：小麦平均单产和产量变异系数。承灾体暴露度指标包括：小麦种植面积占比、人口密度、农业产值占比。致灾因子危险性指标包括：承灾面积、受灾面积、绝收面积。防灾减损能力指标包括：有效灌溉面积、农用水泵数、节水灌溉机械数、农民纯收入。风险区划结果如图 7，从图中可以看出榆林地区风险最高，延安、汉中、商洛、渭南等地风险较高，关中地区风险较低。与上文使用遥感指数得到的结果基本一致。

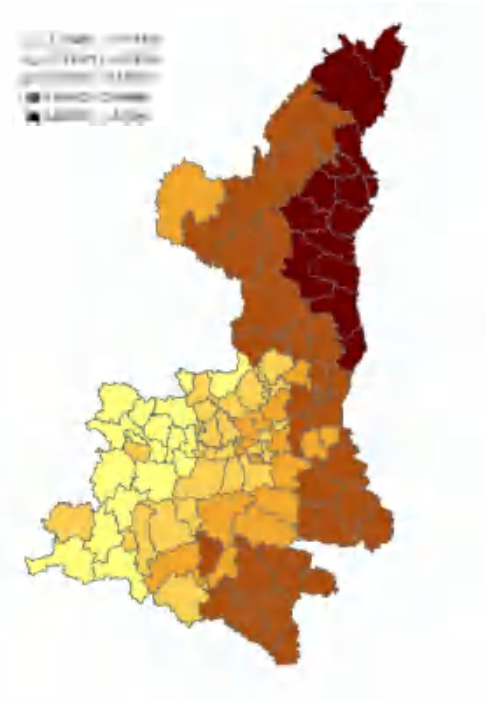

图 7 陕西省冬小麦风险区划图

### 6.4 针对个别地区风险特殊原因的专家咨询

如上所述，本文采用遥感指数评估小麦产量风险的研究方法，得出的结论与其他研究方法和其他文献中的结论基本一致，针对个别不一致的地方，我们向西北农林科技大学小麦育种专家和部分保险公司农业保险理赔人员进行了咨询。一是陕北洛川地区，从统计年鉴反映的产量波动率来看，并不是很低，但是从遥感指数评估出的纯费率来看，属于风险最低的区域之一。小麦育种专家认为，可能的原因是与关中地区相比，洛川地区种植小麦的面积和产量都较少，历史平均产量长期位于较低的水平，因此体现出的波动并不大，从本文的理赔门槛地图也可以看出，洛川地区的预期理赔门槛是很低的。第二个引起我们注意的是华阴地区，从历史产量波动率来看，华阴和大荔并不是风险最高的地区，但是在纯费率地图上显示出华阴与大荔交界的地区精算纯费率很高。从保险公司农险理赔人员那里得知，华阴与大荔交界地区位于渭河两岸，这一区域多次受到洪水侵袭，造成农作物大规模减产。以上实践观察对这两处地区风险特殊的原因做出了合理解释。

## 7. 结论与讨论

本文设计了一种基于 MODIS 增强植被指数（EVI）的陕西冬小麦遥感指数保险并测算了公里网格尺度上的理赔门槛值和精算纯费率。该保险产品能够为冬小麦从播种到返青期间的产量损失提供保障，并能较好地体现不同地块之间的产量风险差异，弥补传统产量保险因区域产量数据缺乏而导致的准确度和空间精度不足的缺陷。

研究结论与其他研究方法和其他文献中的结论基本一致，说明采用遥感数据研究产量风险和厘定小麦种植保险费率具有一定的可靠性，同时，基于遥感数据的研究方法能够比其他研究方法获得更好的风险区划精度，对特殊地区的风险给出更精准的评估。

目前存在的问题和计划今后改进的方向包括：（1）构建包含不同月份遥感影响数据的模型以使遥感指数保险能够更全面地反映冬小麦整个生长期的产量损失；（2）通过实地调研核实冬小麦种植区域以及不同地块冬小麦产量及其波动性差异。

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# 基于公里网格尺度的陕西冬小麦遥感指数保险产品设计与定价研究

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**关键词:** 遥感指数保险；冬小麦；费率厘定；公里网格；EVI

**中文摘要.** 随着遥感技术的发展，利用遥感数据进行的作物种植面积估计和产量估计已经获得越来越高的精度，并且在农作物保险的查勘定损中也已有一些应用，然而在农作物保险费率厘定中的应用却很有限，国内仅有极少文献对此进行了探索。本研究认为，遥感估产方法的采用能够很好地弥补农作物产量数据年度缺失和空间精度不足等问题，使农作物保险的风险区划更加精细合理，提高费率厘定

的精准度，减少全省统一费率导致的空间上的逆选择问题，提高农户和农业企业的参保积极性，促进农业保险业务的可持续经营和高质量发展。

本研究在估计产量损失时采用的卫星遥感数据是MOD13A3产品中的增强植被指数（EVI）数据，数据年度为2001—2018年，空间分辨率为1000米，时间分辨率为1个月。在确定冬小麦种植区域时采用的卫星遥感数据是MCD12Q1产品中的谷类作物地图。基于陕西冬小麦种植区域的增强植被指数（EVI）与县域冬小麦实际单产的关系，选择了全年第60-61的EVI数据估算产量损失率，设计冬小麦遥感指数保险产品。以公里网格为尺度，通过对EVI数据的去趋势、非参数核密度估计以及蒙特卡洛模拟，测算了冬小麦遥感指数保险的理赔门槛值和精算纯费率，并绘制了纯费率地图。该保险产品能够为冬小麦从播种到返青期间的产量损失提供保障，针对地块间不同的产量风险大小设计差异化费率，减少逆向选择，提高冬小麦产量保险费率厘定的空间精度。

为确保费率厘定结果的稳健性，本研究对生成的纯费率地图进行了反复比对和验证。验证方法包括：（1）向我校多名小麦专家以及保险公司负责农业保险查勘定损的人员进行咨询，查看地图反映出的小麦生产风险状况区域差异与他们经验中的是否一致；（2）对于地图中反映出的极高风险区和极低风险区进行实地调研，确认风险状况存在的原因；（3）和已有文献中的费率地图进行比对；（4）和县域平均产量及产量变异系数进行比较；（5）基于地理、气候条件、灌溉设施等多种因素进行主成分分析和聚类分析，将各类别风险值与上述费率地图进行比较。多种验证结果均显示出费率地图具有较高的合理性和可靠性。

# Individual Optimal Consumption and Investment Decision under Longevity Risk

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**Keywords:** Longevity risk, Life cycle model, Mortality prediction, Asset allocation.

**Abstract.** According to the government report in 2021, during the 13th Five-Year Plan period, the average life expectancy in China has increased from 76.3 years to 77.3 years, and the risk of pension insolvency caused by the aging of China's population has gradually increased. Therefore, longevity risk management has gradually become a hot topic of academic research and one of the key topics of decision makers. If we discuss how to manage longevity risk from the perspective of micro subjects, reasonable consumption and risk asset allocation are crucial.On the one hand, reasonable asset allocation can improve the ability of individuals to resist longevity risk. On the other hand, it can promote the perfection of China's pension system and promote the long-term stability of the society.

Most of the domestic and foreign researches on the theoretical model of asset allocation aim at maximizing the consumption utility, and introduce different conditions or assumptions into the model according to the needs of the research. However, there is little literature that introduces longevity risk as a condition in the model. In addition, previous literatures paid more attention to how the government,

insurance companies or enterprises manage longevity risk, and few literatures considered it from the perspective of micro subjects.This paper will embed actuarial modeling and modern financial measurement methods into the traditional life cycle theory framework. Based on the life cycle theory, this paper studies the influence of longevity risk on individual optimal consumption and optimal risk asset investment proportion decision. In this paper, the maximization of end-of-term consumption utility is selected as the control goal, and the stochastic differential equation of personal account accumulation is established, and the accumulation stage and payment stage of pension are studied under a unified framework. Meanwhile, human capital is introduced into the life cycle model. Next, consumption ratio and risk asset ratio are selected according to current financial wealth, future returns of assets and labor income. This paper solves the problem of optimal consumption and optimal risk asset investment proportion by continuous time finance method, and obtains the analytical solution.

At the same time, this paper used Winbugs software to carry out Bayesian Markov Chain Monte Carlo operation, and predicted the mortality data of 2020-2030 based on the historical mortality data of the national population from 1998 to 2019. Next, Python is used to carry out numerical simulation on the data results, and at the same time, the software is used to draw a three-dimensional diagram with better visibility.The results show that the optimal asset allocation strategy tends to be conservative as the time from the end of accumulation period becomes shorter, but from a horizontal perspective, the proportion of risky assets presents an upward trend, that is, the longer the subjective life expectancy, the higher the proportion of risky assets. The existence of human capital also has a wealth effect on asset selection. In addition, the extension of life expectancy has a negative impact on the proportion of individual consumption, but human capital is conducive to stimulating consumption.

This study has the following three implications. First, for investors with pension needs, investment based on the strategy of life cycle theory can not only effectively control asset risks, but also realize pension appreciation. Second, we should give play to the role of human capital to stabilize adverse shocks and accumulate human wealth as much as possible. Third, the government should grasp the impact of longevity risk on people's consumption, clarify macro-policy guidance, and promote the development of elderly consumption.

## 1.引言

2021年政府工作报告显示，“十三五”期间，中国人均预期寿命从76.3岁提高到了77.3岁。长寿风险成为社会的研究热点，MacMinn(2006)提出长寿风险指死亡率长期趋势的不确定造成的风险。当前，我国面临着严重的长寿风险已经成为学界不可争议的事实。骆正清(2010)对职工基本养老保险的财政收支情况进行了剖析，并通过构建养老金收支模型和人口迭代模型，发现基础养老金的缴纳和领取都显现出不断提升的趋势，但是领取的增加速度明显高于缴纳的速度，收不抵支的情况将出现且收支缺口也会逐步加大；当人们退休后领取退体金超过155个月，个人账户将呈现收不抵支的情况，基础养老金缺口进一步加大。王晓辉(2015)认为推进社会全体成员实现有效预防长寿风险是目前我国社会养老金体制改革的重要方向。完善个人养老金积累制账户与建立多支柱的养老保障可以有效抵御长寿风险。

在人口老龄化背景下，人口预期寿命不断增加的趋势将会对居民消费与风险资产配置决策带来深刻的影响。Hurd(1998)通过对生命周期消费模型进行扩展，发现消费路径对死亡率的变化是敏感的，随着死亡率的增长而下降。蔡兴(2015)利用生命周期理论，构建代际交叠模型，最终发现预期寿命的延长直接影响着居民消费率的下降。范叙春(2016)分析了不同历史时期内消费分布的不同特征，其中在2007年之后，消费随着年龄的增长呈现出几乎单调式下降的特征，主要原因是人们退休后，用于生活的财富大大缩水，理性个人必然会对生命周期行为进行调整，以保证自己的生活水准不至降低。对于风险资产配置行为，Spaenjer&Spira(2015)从微观视角对长寿风险与居民资产配置之间的影响进行了实证检验，利用美国消费者的金融调查数据构造了预期寿命指标，发现预期寿命会对居民资产选择产生显著影响。主观预期寿命越长，资产组合中投资于风险资产的比重越高。叶燕程和高随祥(2007)等人分别在连续时间和离散时间框架下，研究了长寿风险下养老金积累期的最优资产配置问题，并得到了最优资产配置策略随距离积累期结束时间变短且趋于保守的结论。同时Cocco（2005），Coile（2009）通过建立最优资产配置模型、研究老年资产配置情况，都发现随着年龄的不断增长，居民会减少股票等风险资产的投资。

对于如何通过模型构建得出消费与投资的最优资产配置，国内外学者大体使用两种优化目标函数，一种是将期末效用最大化作为目标函数，另外一种则是将最小化实际积累额与预期积累额二次偏差作为目标函数。Giacinto(2011)以最大化基金财富的预期效用为目标，研究了具有最小保证的定额供款养老基金的最优配置的连续时间随机模型。Andrewetal(2000)等人假设，在养老金积累期，投资收益和当期缴费是影响养老金变动的主要原因，并据此建立了随机方程。其中，无风险资产和风险资产的配置比例由参保人动态地进行控制。该模型的优化目标为最小化积累期各阶段实际积累额与期望积累额的二次偏差。本文则将选择期末消费效用最大化作为目标函数。

对于效用函数的选择，学者们常用的效用函数有： 幂效用函数（power utility)、指数效用函数（exponential utility)、对数效用函数（logarithmic utility)、二次效用函数（quadratic utility)，本文将选择常相对风险厌恶(Constant Relative Risk Aversion)效用函数，即财富越大，风险承受能力越强。

Battocchio(2003)等人考虑了风险资产和无风险资产以及养老金受益人的随机死亡时间，求解 CRRA 效用函数最大化时的养老金资产配置，研究考虑了养老金的累积阶段和发放阶段，得出累积阶段中风险资产的投资权重越来越小，在发放阶段的投资权重则会越来越大。

至于本文的架构，第二部分在传统的生命周期理论框架中嵌入精算建模和现代金融计量方法，在生命周期理论的基础上研究长寿风险对个人最优消费与最优风险资产投资比重决策的影响。本文选取期末消费效用最大化作为控制与优化目标，并建立个人账户积累额变动的随机微分方程，将养老金的积累阶段和发放阶段放在一个统一的框架下研究，同时将人力资本引入到生命周期模型中，根据现期金融财富、资产未来的回报和劳动收入来选择消费比率、风险资产比率，通过连续时间金融方法解决最优消费与最优风险资产投资比重问题，并得出解析解。第三部分根据1998-2019年全国人口死亡率历史数据预测2020-2030年死亡率数据，使用WinBUGS软件编程，进行贝叶斯Markov Chain Monte Carlo运算，并将数据结果利用Python进行数值模拟，画出可视性较好的三维立体图。最后在第四部分中，进行总结与启示并提出针对性的建议。

## 2．模型建立与求解

在养老金配置策略的模型构建文献中，经常采用的方法有随机控制理论、Legendre方法、对偶理论和鞅方法。近些年来，随机控制理论逐渐在养老金的资产管理领域被广泛应用，是解决连续时间最优资产配置问题的主要方法，Samuelson(1969)在连续时间金融理论的基础上，将阿罗德布鲁范式的不确定性情况和实际情况联系起来。并在马克维茨均值—方差理论的基础上，通过动态随机编程方法，构建了从长期视角角度考虑的多期投资模型，得出了一生消费和投资的最优选择。Bodie、Merton 和 Samuelson(1992)在生命周期投资模型中加入劳动收入和人力资本。分析了这些因素对资产配置与消费选择的影响。投资者在现实生活中有支配自身劳动与闲暇时间的权利，此时投资者需要在消费、金融资产投资、劳动或闲暇之间进行最优选择。

接下来，本部分研究养老金在消费效用最大化时的最优消费决策和风险资产的最优投资配置决策。首先假设个人的退休时间为 T，最大预期寿命为 D，死亡时间不确定，个人账户养老金体制中个人缴费比例为 τ 且保持不变，但本文假定 DC 型养老金中发放期的每期支付额不确定，受其当期价值和投保人的生存率的影响，且本文不考虑遗赠需求。

对于生存概率，设 s 岁的投保人在未来 t 年的存活率为$_tP_x = e^{-ht}$,其中 h 为死力。

假定退休后养老金的支付按照年金形式发放，设$a_x$为 x 岁的投保人购买单位年金的现值，则用于支付的养老金比例为每期 1/$a_x$。其中$a_x$满足，

$$a_x = \int_0^D e^{-rt}({}_tP_x)\,dt = \int_0^D e^{-rt}e^{-ht}\,dt = \frac{1}{h+r} \tag{1}$$

所以在发放阶段每期用于支付的养老金比例为 h+r。

本文假设养老金账户主要投资与风险资产与无风险资产，其中风险资产的价格服从一般的伊藤过程。

$$dS_0(t) = S_0(t)rdt \tag{2}$$

$$dS_1(t) = S_1(t)(\mu_t dt + \sigma_t dz) \tag{3}$$

$S_0$和$S_1$分别表示 t 时刻无风险资产和风险资产的价格，r 为无风险利率，本文假设其为常数，μ(t)为时变参数，σ>0 且为常数，是风险资产价格过程的扩散项，Z 是完备概率空间(Ω,F,P)上的一维布朗运动。其中 F 表示到时刻 t 为止所获信息总和，P 是概率测度且假设金融市场是无套利摩擦的完全竞争金融市场，其中在这个无套利无摩擦的完全竞争市场中，存在一个正的随机变数$M_t$，这里我们定义其为定价核。

$$M_t = M(t) = exp\left[-\int_0^t \theta dz - rt - \frac{1}{2}\theta^2 t\right] \tag{4}$$

其中 θ 为风险的市场价值，即夏普比。假设个人的金融财富为 F(t)，投资于风险资产的比例为 π，无风险资产的比例为 1-π，由于个人金融财富服从伊藤过程，根据伊藤定理，个人金融财富的收益率 dlnF(t)满足：

$$dlnF(t) = \left[\pi_s\mu_s + (1-\pi_s)r - \frac{1}{2}\pi_s{}^2\sigma_s{}^2\right]dt + \pi_s\sigma_s dz \tag{5}$$

设折现率为r，上文中每期支付额P(t)满足如下微分方程：

$$\frac{dp(t)}{p(t)} = \left(\pi_s(\mu_s - r) - \frac{1}{2}\pi_s^2\sigma_s^2\right)dt + \pi_s\sigma_s dz \tag{6}$$

## 2.1 个人最优消费决策模型

接下来求个人最优消费决策，以最大化消费期望效用为目标函数，假定死亡率风险与金融风险不相关，个人在 t 时刻的剩余终身效用函数如下：

$$V = max\int_t^D e^{-\rho s}e^{-hs}(u(c) - \chi D(s))ds \tag{7}$$

U(c)是从消费中获得的即时效用，D(s)是 s 时的劳动负效用，ρ 是常数的时间偏好，χ 在工作期取值为 1，在退休期取值为 0，即

$$\chi = \begin{cases} 1, 0 < t < T \\ 0, T < t < D \end{cases} \tag{8}$$

个人在工作期间的劳动报酬率为 w(t)，并向个人养老金账户缴费，我们把个人的总财富$G_t$的约束方程写成如下形式：

$$dG = G_S\pi_S(\mu dt + \sigma dz) + G_S(1-\pi_S)rdt + \chi(1-\tau)w_s G_S dt + G_S(1-\chi)(h+r)\frac{dpt}{pt} \tag{9}$$

$$dG = [G_S\pi_S(\mu - r)(1 + (1-\chi)(h+r)) - G_S\pi_S^2(1-\chi)(h+r)\frac{\sigma^2}{2} + G_S r + \chi(1-\tau)w_s G_S - C_S]dt + G_S\pi_S\sigma[1 + (1-\chi)(h+r)]dz \tag{10}$$

接下来将动态预算约束方程转变为静态跨期预算约束，对 Mt,Gt 的乘积应用伊藤定理并积分和取期望，

$$G_t = E_t[\int_t^D \frac{M_S}{M_T}(C_S - \chi(1-\tau)w_s G_S - (1-\chi)(h+r)G_S\pi_S(\mu - r - \frac{\pi_S\sigma^2}{2}))ds] \tag{11}$$

将个人的优化问题写成下面的拉格朗日乘子问题：

$$E_t[\int_t^D e^{-\rho s}e^{-hs}(u(c) - \chi D(s))ds] + \lambda(M_t G_t - E_t[\int_t^D M_s(C_s - \chi(1-\tau)w_s G_S - (1-\chi)(h+r)G_S\pi_S(\mu - r - \frac{\pi_S\sigma^2}{2}))ds] = 0 \tag{12}$$

效用函数的形式选取最为常见的CRRA效用函数，即$U(c) = c^\gamma/\gamma$, γ <1，$C_s$的最优化一阶条件则为：

$$C_s = exp(\frac{-(\rho+h)s}{1-\gamma})(\lambda M_s)^{\frac{1}{\gamma-1}} \tag{13}$$

将$C_S$代入$G_t$中得到当期财富和消费的关系式如下：

$$G_t = E_t[\int_t^D \frac{M_s}{M_t}(exp(\frac{-(\rho+h)s}{\gamma-1})(\lambda M_s)^{\frac{1}{\gamma-1}})ds - E_t[\int_t^D \frac{M_s}{M_t}\chi(1-\tau)w_s G_S - (1-\chi)(h+r)G_S\pi_S(\mu - r - \frac{\pi_S\sigma^2}{2}))ds] \tag{14}$$

$$G_t = E_t\left[\int_t^D \frac{M_s}{M_t}\left[e^{\frac{-(\rho+h)s}{\gamma-1}}(\lambda M_s)^{\frac{1}{\gamma-1}}\right]ds\right] - W_t \tag{15}$$

上文中提到的金融随机折现因子为公式(14)，则，

$$\frac{M_s}{M_t} = exp\left(\int_s^t \theta dz - r(s-t) - \frac{1}{2}\theta^2(s-t)\right) \tag{16}$$

由于个人财富的当期值等于个人计划期红利流的折现值加上终期折现值的

期望，且本文假定没有遗赠动机，所以$W_t$最优化终期财富为0，即，

$$G_t = E_t\left[\int_t^D \frac{M_s}{M_t}\left[e^{\frac{(\rho+h)s}{\gamma-1}}(\lambda Ms)^{\frac{1}{\gamma-1}}\right]ds\right]$$

$$= \lambda^{\frac{1}{\gamma-1}} M_t^{-1} \int_t^D (exp(\frac{-(\rho+h)s}{1-\gamma}) E_t(Ms)^{\frac{\gamma}{\gamma-1}})ds$$

$$= exp(\frac{(\rho+h)t}{\gamma-1})(\lambda Mt)^{\frac{1}{\gamma-1}} \int_t^D (exp\left(\frac{(\rho+h)(s-t)}{\gamma-1}\right) E_t\left(\frac{Ms}{Mt}\right)^{\frac{\gamma}{\gamma-1}})dt$$

$$= C_t \int_t^D (exp\left(\frac{(\rho+h)(s-t)}{\gamma-1}\right) E_t\left(\frac{Ms}{Mt}\right)^{\frac{\gamma}{\gamma-1}})dt \quad (17)$$

通过测度变换，可以求得

$$E_t(M_{t,s})^{\frac{\gamma}{\gamma-1}} = exp((r\frac{\gamma}{\gamma-1} + \frac{1}{2}\theta^2\frac{\gamma}{(\gamma-1)^2})(s-t)) \quad (18)$$

最后Ct可以简化为

$$C_t = \frac{G_t}{\int_t^D e^{\Delta(s-t)}ds} \quad (19)$$

$$\Delta = \frac{1}{\gamma-1}[\rho + h - ry + \frac{1}{2}\theta^2\frac{\gamma}{\gamma-1}] \quad (20)$$

由式(19)和式(20)也可求得

$$\frac{\partial(C_t/G_t)}{\partial D} < 0 \quad (21)$$

$$\frac{\partial(C_t)}{\partial W_t} > 0 \quad (22)$$

式(21)表示了预期寿命D与消费财富比$C_t/G_t$的关系，可见预期寿命增加时，消费-财富比将减小，即长寿风险增加后，所得财富将在更长的期间内分摊，从而使得消费率减少。从式(22)也可以看出，个人的消费水平不仅仅取决于金融财富，也受到人力财富的影响，若想提高消费水平，要尽可能提高将来的工作收入，积累人力资本。

## 2.2 个人最优风险投资配置比重模型

接下来，计算最优风险投资配置比重的解析解，将人力资本引入到生命周期模型当中，同样在消费效用最大化的条件下解决最优资产配置问题，模型推导过程入下：

首先定义效用方程：

$$J(G,t) = MAX\{e^{-\rho s}e^{-hs}(u(c) - \chi D(s))\} \quad (23)$$

式(23)的约束条件为总财富 G(t)，根据 Bellman 最优化条件，J 必须满足

$$MAX\{e^{-\rho s}e^{-hs}(u(c) - \chi D(s)) + J_G\left[G_S\pi_S(\mu - r)(1 + (1-\chi)(h+r)) - G_S\pi_S{}^2(1-\chi)(h+r)\frac{\sigma^2}{2} + G_S r + \chi(1-\tau)w_s G_S - C_S\right] + J_t + J_w gG + \frac{1}{2}\pi_S{}^2\sigma^2 G^2 J_{GG}(1 + (1-\chi)(h+r))^2\} = 0 \quad (24)$$

从式(23)可以得到效用最大化的一阶条件为：

$$u(c^*(t))e^{-(\rho+h)t} - J_G = 0 \tag{25}$$

$$J_G\left((\mu - r)(1 + (1-\chi)(h+r)) - \pi_s\sigma^2(1-\chi)(h+r)\right) + \pi_s\sigma^2 G J_{GG}(1 + (1-\chi)(h+r))^2 = 0 \tag{26}$$

$$J_G(\mu - r)(1 + (1-\chi)(h+r)) = J_G\pi_s\sigma^2(1-\chi)(h+r) - \sigma^2 G J_{GG}(1 + (1-\chi)(h+r))^2 \tag{27}$$

为简化计算，设：

$$m = (1-\chi)(h+r) \tag{28}$$

则个人的最优风险资产配置比重为

$$\pi_S = \frac{J_G(\mu - r)(1+m)}{J_G\sigma^2 m - \sigma^2 G J_{GG}(1+m)^2} \tag{29}$$

因为效用函数满足$U(C) = \frac{C^\gamma}{\gamma}$，则可以很容易证明

$$\frac{J_G}{J_{GG}} = \frac{G}{\gamma} \tag{30}$$

将式(30)带入式(29)中，则可以得到投资于金融资产的最优风险资产比例为：

$$\frac{\pi_S \cdot G}{F} = \frac{(\mu - r)(1+h+r)}{\sigma^2(h+r) - \sigma^2\gamma(1+h+r)^2}\left[1 + \frac{H}{F}\right] \tag{31}$$

## 3 死亡率预测与数值模拟

### 3.1 MCMC死亡率预测

Stallard（2006）提出死亡率预测的必要条件是现有人口的数据与死亡率模型，长寿风险因而可以量化。因此长寿风险度量的关键是要准确估测出未来人口死亡率或生存率，这也是长寿风险管理的基础。目前死亡率预测中广泛应用的方法是利用相关模型估测死亡率及其变动趋势，大致有静态死亡率预测模型、随机动态死亡率预测模型和由利率模型、市场模型等衍生出的模型。Lee Carter在1992年首次运用随机离散模型预测预期寿命。此模型不仅简单，且较容易得出相对准确的死亡率预测数据，但由于它是一个单因素模型，对于未来死亡率的不确定性及死亡率变化率之间的相互影响无法消除。之后大量的学者扩展与完善了Lee-Carter 模型，胡仕强(2015)采用贝叶斯统计推断技术处理了死亡率历史数据，使用贝叶斯 MCMC（Markov Chain Monte Carlo）算法生成来自预测分布的随机样本，充分利用了模型与样本信息，且融合了模型总体分布中多个未知参数的信息，全面地考虑和解决了传统方法样本不足与质量的问题，同时这种方法还可以一次性地在一体化的框架中完成参数的估计和预测，有效地避免了两阶段方法的误差累积等过程风险。

所以接下来本部分利用 MCMC 模型来进行死亡率预测，其中将用到三个参数序列：$a_x$，$b_x$，和$k_t$来描述 t 岁的人在观察时的中心死亡率$m_{xt}$的自然对数，公式为：

$$\ln(m_{xt}) = a_x + b_x k_t + \varepsilon_{xt} \tag{32}$$

这里的$k_t$是一个随时间而变化的参数，它表示一种时间效应，且对所有年龄段都相同。其次，与年龄相关的参数$b_x$代表了各个不同年龄对参数的敏感性，最后，参数$a_x$表示对每个年龄 x 来说的独立于参数$k_t$的年龄效应，可以将它看作各年龄对数死亡率的平均水平。

通过查阅《中国人口统计年鉴》和《中国人口与就业统计年鉴》，并整理 1998 至 2019 年的数据，然后选择 1997 年到 2018 年的全国人口死亡率历史数据，共采用 0 到 90+共 91 个数据组。使用 WinBUGS 软件编程，进行贝叶斯 Markov Chain Monte Carlo 运算，通过建立一个平稳分布的 Markov 链，对其进行抽样，然后基于这些样本做各种统计推断。得到参数后验分布的均数、标准差、95%置信区间和中位数等信息。本文进行了 12000 次的抽样，舍弃前 2000 次结果，以后 10000 次样本计算参数估计值。共给出（91 个）、（91 个）、（42 个）和未来死亡率（91×20=1820 个）共 2044 个监测参数的估计值，每个参数给出了均值、方差、MC 误差、2.5%分位点、中值和 97.5%分位点等相应的计算结果。下表给出了其中四个参数的计算结果示例，其中 a 和 b 分别 60 岁年龄的年龄效应和 60 岁的参数敏感性，k[26]表示在 22 年观察数据基础上得到的预测第 4 年的年龄效应值，即 2022 年的年龄效应值，m[60,4]表示第 60 年龄组和预测第 2 年，即 2022 年的死亡率预测值。

表 1 计算结果示例表

| node | mean | sd | MC error | 2.50% | median | 97.50% | start | sample |
|---|---|---|---|---|---|---|---|---|
| a[60] | -4.692 | 0.1431 | 0.001347 | -4.972 | -4.691 | -4.406 | 2001 | 10000 |
| b[60] | 0.00949 | 0.00413 | 5.317E-5 | 0.00121 | 0.00958 | 0.01749 | 2001 | 10000 |
| k[26] | -52.93 | 3.312 | 0.03632 | -59.43 | -52.97 | -46.44 | 2001 | 10000 |
| m[60,4] | 0.00574 | 0.00153 | 1.734E-5 | 0.00331 | 0.00556 | 0.00931 | 2001 | 10000 |

接下来进行参数收敛性分析。模型的收敛性是其预测结果可靠的前提，一般地，参数估计的 MC 误差小于其标准差的 3%就表示已经收敛，再结合参数的时间序列和自相关图就能做出确切的判断。对上表示例中的四个参数，MC 误差项都接近其标准差的 1%，其时间序列、核密度和自相关图如下：

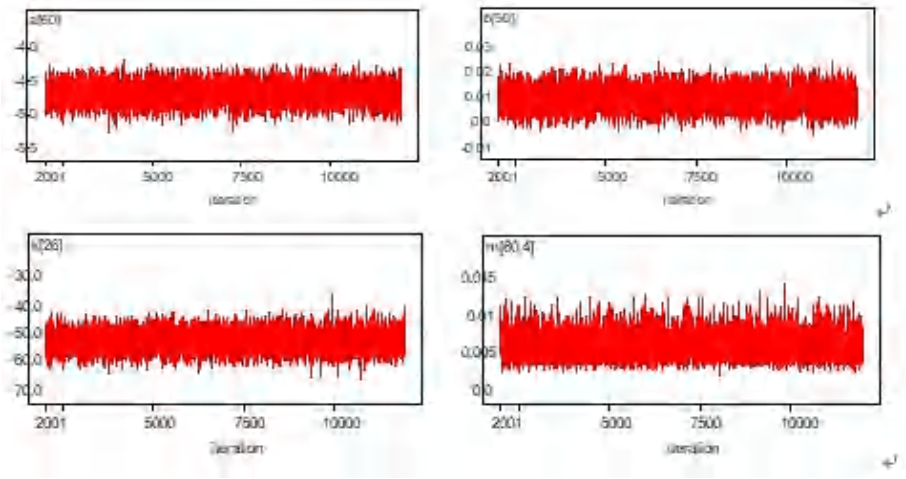

图 1 参数时序图

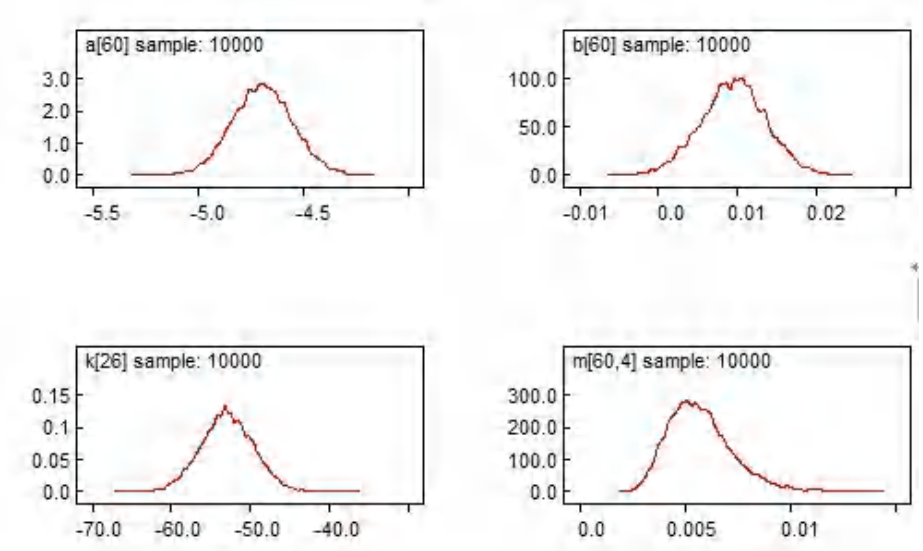


图 2 参数核密度图

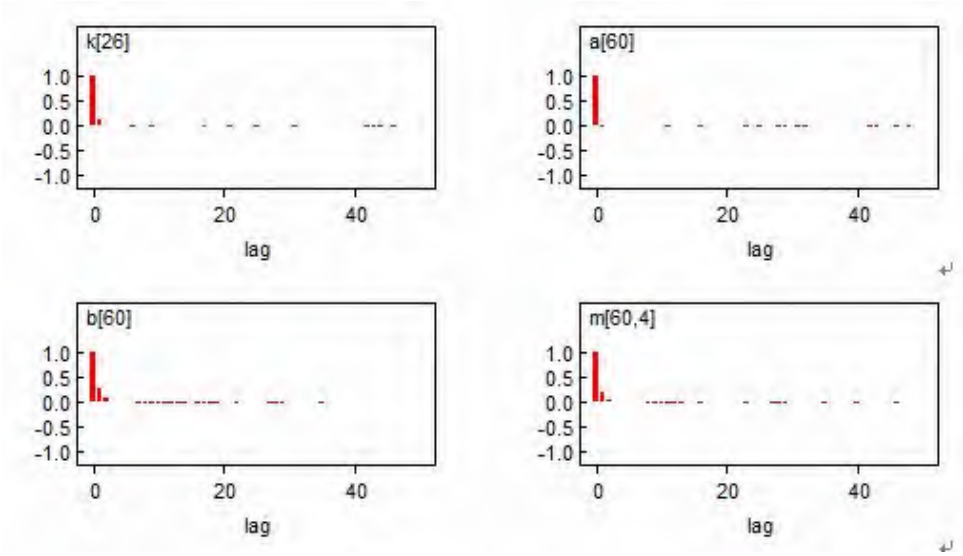


图 3 参数自相关图

对其余450个参数，经计算得到其MC误差项和标准差之比都小于2%，其时间

序列和自相关图也显示明显收敛，因此模型参数的收敛性效果是相当令人满意的。

### 3.2 数值模拟

在消费和风险投资配置比例的表达式中，涉及的参数包括利率r，时间偏好参数ρ，养老金缴费参数τ，退休年龄T ，最大生存年龄 D，风险资产投资比重π，风险厌恶系数γ，夏普比θ等参数，因为本文的主要目的是在对比其他因素不变的情况下长寿风险即生存概率的变化对个人生命周期消费与风险资产投资比重的影响，故我们可以按照我们经济社会实际情况和惯例将除生存概率以外的参数设定如下表2：

表2 数值模拟取值

| 名称 | 取值 | 含义 |
|---|---|---|
| r | 0.03 | 无风险利率 |
| $\rho$ | 0.02 | 时间偏好系数 |
| a | 0.1 | 养老金缴费率 |
| T | 60 | 退休年龄 |
| D | 91 | 最大生存年龄 |
| γ | -4 | 风险偏好系数 |
| θ | 0.139 | 夏普比 |
| μ | 0.08 | 期望收益率 |
| σ | 0.36 | 波动率 |

接下来利用上文预测的2020-2030年的死亡力数据并利用Python软件来呈现个人生存概率与最优消费和风险投资比重的趋势图。

下图4则为2020-2030年的个人生存概率趋势图：

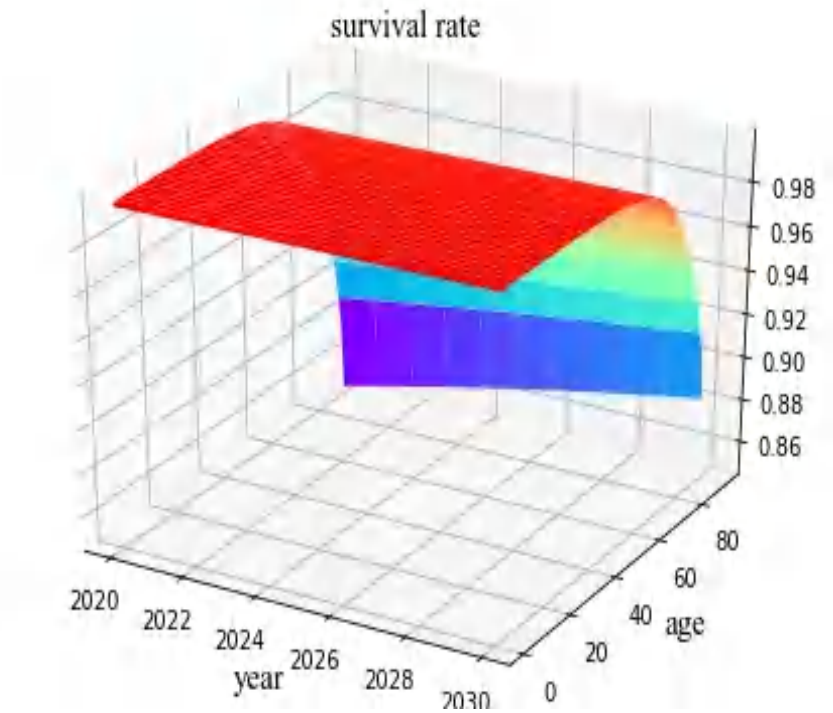


图4 个人生存概率趋势图

从图4可以看出2020年到2030年人们的生存概率逐渐增加，即人们的预期寿命越来越长，长寿风险越来越大。

下图5为2020-2030年份当个人为60岁时预期寿命从61岁增加到91岁时个人消费占财富比重趋势图：

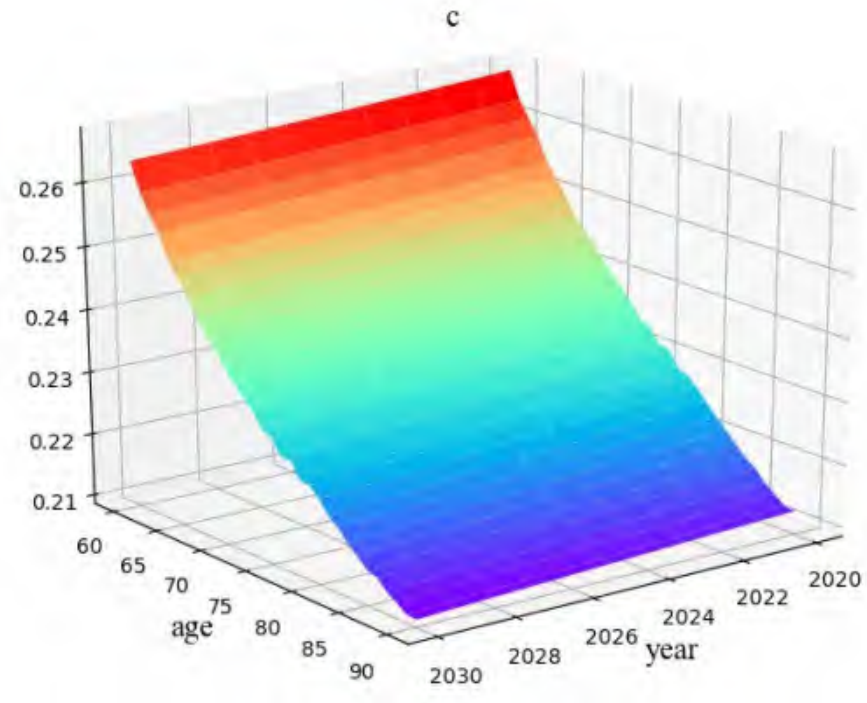


图5 个人消费占财富比重趋势图

从图5我们可以看出，居民个人的消费在60-91年龄段中呈现出持续下降的趋

势，长寿风险通过降低边际消费倾向减少消费。可见寿命延长将使得个人面临退休后养老资源不足的风险，行为人必须进行更多的储蓄以维持老年时期的正常生活，理性人将会调整其终身财富的分摊，降低退休期的消费来维持生活稳定性。结合我国现实情况来看，2020年《中国统计年鉴》指出中国人的平均预期寿命达到76.34岁，处于世界中上等水平，相比1990年我国人口平均预期寿命 68.55 岁，提高了7.79岁。而我国的居民消费率(居民消费支出占GDP比重)从2000年的46.4%下降到2019年的38.8%，降幅较明显，就整体而言消费需求不振，居民消费率持续低迷。在上文中，我们发现个人的消费水平不仅仅取决于金融财富，也受到人力财富的影响，所以若想提高消费水平，可以提高将来的人力资本积累。

下图6为2020-2030年份预期寿命增加时个人风险投资比重趋势图：

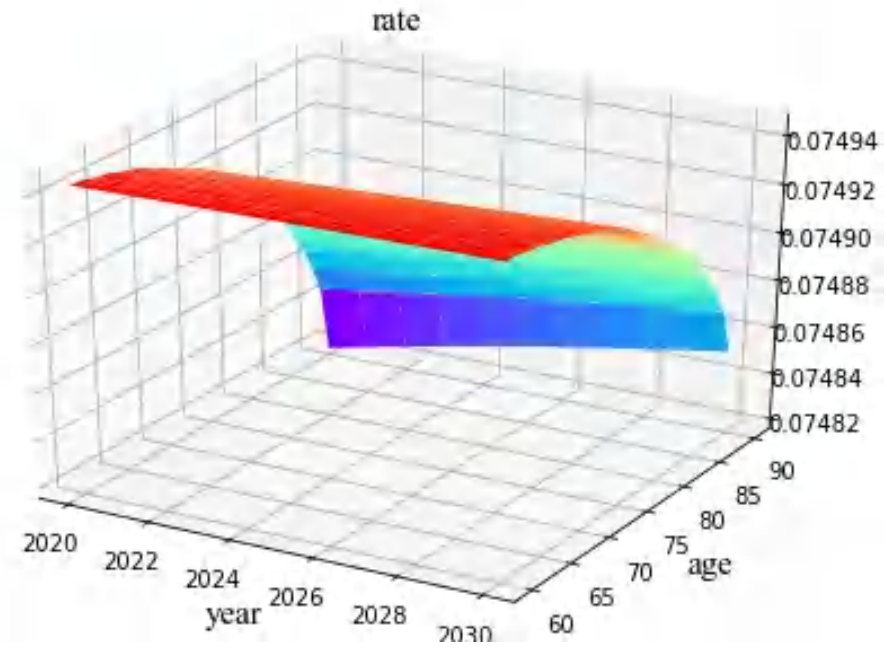


图6 个人风险投资资产比重趋势图

从纵向来看，人们在老年时期，养老基金投资于风险资产的比重随年龄增长而逐渐降低，因为随着投资者年龄的增加,未来收入的现值相对于金融性资产的重要性降低。由于未来收入的现值可以看作无风险资产的近似替代,并且随着投资者变老,未来收入的现值与总财富的比率降低,无风险资产的比重在投资者整个生命周期中的比重应该逐年增加，这也意味着生存参保人可以获得的生存者利益降低。结合中国现实国情，一方面老年抚养比的增加使得中年人抚养老人的负担加重，医疗、健康等消费的增加使得人们投资于股票市场的资金减少，另一方面，中年人口逐渐转化为老年人口，而老年人的风险厌恶系数相对较高，也使得投资于股票市场的资金减少。

但从横向来看，2020年至2030年，死亡强度普遍减小，2030年的风险资产配置比例整体上大于2020年的风险资产配置比例。可以看出，在未来人们的预期寿命不断增加，越来越多的资产将会投资于风险资产以提高养老金收益来应对未来

的养老压力。从现实生活中看，随着社会的快速发展，人们的物质生活条件有了很大的改善、医疗卫生科技越来越发达，人们对自己健康质量的重视程度加深，预期寿命越来越长，死亡率逐渐降低，投资风险资产可以增加人们老年时期的财富积累，为人们的老年生活提供可靠的保障。从个人角度看，社会个体对自己的健康状况愈加了解，若个人健康状况良好，那么在理性的情况下，他会选择投资更多的风险资产，但是一个健康状况差的人则不会选择配置更多的风险资产。

该结论对养老金管理实践有着重要的启示，参保人和养老金管理者可以通过提高风险资产的配置比例，增加积累额来对冲长寿风险的不利影响，政府要鼓励年轻人多进行风险资产的投资，人们将资金增值的目标在年轻阶段完成，则可以保障中年后养老金积累的平稳性和可靠性，同时由于人力资本的改善也能够促进个人在风险资产配置时更多地参与到金融市场和股票市场中，所以也要注重人力资本的积累。

## 4．结论与启示

国家基本养老保险在人口老龄化和转制过程中“空账”运行的背景下，形成巨大的养老金支付压力，使养老金投资资本市场实现保值增值具有必要性和紧迫性。 若不能有效地解决我国养老金隐性债务和实现保值增值的问题，我国将来会面临着巨大的养老金支付危机。长寿风险加大了个人为退休后生活筹资的压力，因而必然影响到个人的消费与投资决策。本文在长寿风险这一背景下，通过生命周期框架研究个人最优消费与风险资产配置决策研究，利用随机最优控制方法得出最优消费与最优风险资产投资比重的显式解，并进行死亡率预测与数值模拟，研究发现预期寿命的延长对个人的消费比重有消极影响，个人消费率随预期寿命的延长而下降，但人力资本有利于刺激消费。人力资本的存在也对资产选择会产生财富效应，能够缓冲长寿风险这种外生冲击带来的部分不利影响，对个人的股票市场参与产生正向作用。另外，从生命周期的纵向来看，风险资产最优投资比重呈下降趋势，即最优风险资产配置策略随距离积累期结束时间变短且趋于保守，人口平均预期寿命延长会使人口年龄结构发生改变，而老年人口持有的风险资产比重较低，这种“人口结构效应”会削弱长寿风险对个人的股票市场参与的正向影响；但从横向来看呈现上升趋势，即主观预期寿命越长，资产组合中投资于风险资产的比重越高。随着人口平均预期寿命的延长，退休期间也相应延长，由于个体要在退休期间保持一定的消费水平，这种“前瞻性预期”对退休时的物质资本积累水平提出了更高的要求，从而激励其增加对股票等风险资产的投资比重。

依据这些结论，对长寿风险的防控有一定的启示。第一，对有养老需求的投资者，依据生命周期理论的投资策略既能有效控制资产风险，又能实现养老金增值。政府应该对养老金系统进行完善和改革，对人们的自发趋势进行引导，例如

可通过媒体舆论等渠道对公众预期进行引导，促进居民个人参与金融市场投资，合理配置家庭资产。对有养老需求的投资者，随着年龄变化的投资策略既能有效控制资产风险，保障“救命钱”安全，又能获得高于单纯银行储蓄的投资回报，战胜通货膨胀。第二，要发挥人力财富作为不利冲击“稳定器”的作用，鼓励年轻人在工作时期努力奋斗，尽可能地积累人力财富。教育是人力资本最基本也是最主要的方式，政府部门应当加大教育投资力度、增加公共教育设施投入，促进居民受教育水平提高与居民的就业和再分配，从而提高居民人力资本，有更充足的余力去投资金融资产，优化消费结构。第三，政府要把握长寿风险对人们消费的影响，顺应人口老龄化不断加深的趋势，明确宏观政策导向，并配以合理的产业政策，促进老年消费发展。同时政府部门也应加大对技术创新的资金投入与政策支持，鼓励企业创新发展，促使企业转型升级，提高产品品质，在新的消费环境下抓住新的消费热点，促进居民消费。

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# 长寿风险下个人最优消费与投资决策研究

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**关键词：** 长寿风险; 生命周期模型; 死亡率预测; 资产配置.

**摘要.** 2021年政府报告显示，“十三五”期间，中国人均预期寿命从76.3岁提高到77.3岁，我国人口老龄化所带来的养老金收不抵支的风险逐渐增加，因此长寿风险管理逐渐成为学术研究的热点，也成为决策层重点关注的话题之一。从微观主体角度探讨如何进行长寿风险管理，合理的消费与风险资产配置至关重要。一方面合理的资产配置可以提高个承担长寿风险的能力。另一方面可以推动我国养老体制的完善，促进社会长久稳定。

国内外关于资产配置理论模型的研究多以消费效用的最大化为目标，并根据研究的需要，在模型中引入不同的条件或假设。但很少有文献将长寿风险作为条件引入到模型中。且以往文献更多关注政府、保险公司或企业层面的长寿风险管理问题，较少从微观主体角度考虑，本文在传统的生命周期理论框架中嵌入精算建模和现代金融计量方法，在生命周期理论的基础上研究长寿风险对个人最优消费与最优风险资产投资比重决策的影响。本文选取期末消费效用最大化作为控制与优化目标，并建立个人账户积累额变动的随机微分方程，将养老金的积累阶段和发放阶段放在一个统一的框架下研究，同时将人力资本引入到生命周期模型中，根据现期金融财富、资产未来的回报和劳动收入来选择消费比率、风险资产比率，通过连续时间金融方法解决最优消费与最优风险资产投资比重问题，并得出解析解。

同时，本文使用WinBUGS软件编程，进行贝叶斯Markov Chain Monte Carlo运算，根据1998-2019年全国人口死亡率历史数据预测了2020-2030年死亡率数据，并利用Python对数据结果进行数值模拟，画出可视性较好的三维立体图。结

果发现，从生命周期的纵向来看，风险资产最优投资比重呈下降趋势，即最优资产配置策略随距离积累期结束时间变短且趋于保守，但从横向来看呈现上升趋势，即主观预期寿命越长，资产组合中投资于风险资产的比重越高。人力资本的存在也对资产选择会产生财富效应。另外，预期寿命的延长对个人的消费比重有消极影响，但人力资本有利于刺激消费。

本研究有以下三点启示，第一，对有养老需求的投资者，依据生命周期理论的投资策略既能有效控制资产风险，又能实现养老金增值。第二，要发挥人力财富作为不利冲击稳定器的作用，尽可能地积累人力财富。第三，政府要把握长寿风险对人们消费的影响，明确宏观政策导向，促进老年群体消费发展。

# Optimal Retirement Age under Longevity Risk -- Based on Bayesian MCMC Method

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**Keywords:** Optimal retirement age, life expectancy, MCMC, longevity risk

**Abstract:** At present, the problem of longevity risk of the Chinese population is becoming increasingly prominent, which has caused serious impact on the pay-as-you-go pension system in China and increased the pressure on the income and expenditure of the pay-as-you-go account. Theoretically, the introduction of a policy of delaying retirement in order to increase income and reduce expenditure is very

important to maintain the sustainability of PAYG accounts and the balance of the pooling account of our PAYG. However, for individual accounts with accumulated system, the comprehensive impact of China's endowment insurance system with unified accounts is still not clear. Therefore, considering life expectancy, population structure, personal pension wealth and personal lifetime utility and the basic pension system and so on a variety of factors, to adjust the current retirement age, study and formulate feasible delay retirement age, scientific and effective evaluation delay retirement policy effect, provide effective basis for relevant government departments to formulate policies, It has important theoretical value and practical significance. Existing studies only obtain the optimal retirement age by setting parameters of different life expectancy, which lacks data integrity and rigor. In this paper, from the perspective of maximizing the personal utility of workers in the whole working cycle, Bayesian MCMC was used to establish a relevant dynamic actuarial model, and the effective parameters and influencing factors under the current pension system were adopted to collect the death rate data of the population of all ages by gender from 1995 to 2019, a total of 25 years. The remaining life of workers was divided into three stages: before the starting age to the statutory retirement age, before the statutory retirement age after the statutory retirement age and after the statutory retirement age. The mortality rate was predicted by using Winbugs software, and the life expectancy of male and female in the next 20 years and the mortality rate of the three stages were obtained. The optimal retirement age of male and female with different life expectancy can be obtained by subsuming life expectancy and three-stage mortality into the actuarial model. The results show that the optimal retirement age is positively correlated with life expectancy, economic growth rate and starting age, and negatively correlated with the number of years of planning, among which the life expectancy has the greatest impact on the optimal retirement age, and the difference between men and women also leads to significant differences in the optimal retirement age between the two. Therefore, the government and workers when making choice retirement policy should fully consider various factors, respect for different interests of labourers, clear work period and pension period income public relations, increase worker to retire the flexible choice of time, reduce the pressure of pension reform, finally play the significant role of delay retirement policy.

## 1. 引言

当前我国人口的长寿风险问题日益突出，给我国的现收现付制养老金体系造成了严重的冲击，增加了现收现付制账户收支压力。理论上讲，推出延迟退休的政策，以此来增加收入，减少支出，对于维持现收现付制账户的可持续性和我国现收现付制统筹账户平衡有着非常重要的作用。但是对于积累制的个人账户而言，我国统账结合的养老保险制度的综合影响尚不明晰。因此，综合考虑预期寿命，人口结构，个人养老金财富和个人终身效用及基本养老金制度等多种因素，对现行的退休年龄进行调整，研究制定合理可行的延迟退休年龄方案，科学有效的评估延迟退休政策效果，为政府相关部门制定政策提供有效依据，具有重要的理论价值和现实意义。

由于西方发达国家比我国提前步入老龄化社会，因此对于退休年龄研究的方面开展的更早，更深入，其中很多学者对于延迟退休年龄缓和老龄化和长寿风险的作用有着独特的见解，也有着更加深刻的理论基础。国外学者埃斯特勒詹姆斯（Estell James）(2003)认为中国的退休年龄相比于西方国家的退休年龄较低，导致了产生大量的成本，在旧体系下导致养老金账户存在大量缺口，造成了相当大的财政负担。而且当在2015年劳动人口年龄比重持续下降时，制度内的财政负担会继续加重。采用合理的精算方法将积累的基金转换成年金形式，那么养老金的财富值会增加，从而激发人们的工作积极性。但如果只是简单的将退休年龄往后延长，而不考虑预期寿命对最优退休年龄的影响的话，会导致人们的工作动机减少，解决这一问题最好的方法就是通过精算公式构建合理有效的模型进行推理，考虑各方面的因素，对退休年龄做出反应。Samwick（1998）运用代际模型分析了养老金计划对退休政策的影响，他认为可以通过经济激励来抑制提前退休，鼓励延迟退休。国外大部分学者对于延迟退休年龄政策采取支持的态度，但也有少部分学者对延迟退休年龄持另一种观点。其中最为典型的就是Weller，他使用NCHS数据测量出当退休年龄延迟时造成的福利损失。退休年龄提高导致人们缴税的时间延长，拿到福利的时间被延后并且当退休年龄延后时，有部分人可能因死亡拿不到养老金，从而造成福利的净损失。Weller（2005）在《为社会保障提高退休年龄》一文中通过对大量数据的分析得出，延迟退休年龄的政策会为那些依靠社会保障基金维持退休收入的工作们产生负面影响。

20世纪90年代以来，人口老龄化和长寿风险问题趋于严重，国内学者们为了解决这些社会问题将目光集中于几乎一成不变的退休年龄。对于是否延迟退休年龄的争论已经在学术圈内存在许久，总体概况上呈现两点观点。目前我国学术界的主流观点认为应该延迟退休年龄，实行弹性退休制度，采取逐步缓慢地提高退休年龄，避免一刀切政策。但也有学者认为延迟退休年龄并不能有效的改变现收现付制账户的财政负担，反对延迟退休年龄的政策，认为现今的国情和社会情况并不能满足延迟退休年龄的条件，尚未成熟。

支持延迟退休年龄的学者通常从缓解养老金账户的财政缺口，应对长寿风险和人口老龄化的危机角度出发，提出实行弹性退休制度，逐步提高退休年龄。根据《中国养老保险基金测算与管理》（2001）课题组测算，当退休年龄每延迟一岁，养老统筹基金可增加40亿元，减少支出160亿元，减缓基金缺口200亿元。李红岚（2000）构建了延迟退休年龄导致失业率上升的测算表，得出了退休年龄提高越快，失业率上升的越迅速，过快的提高退休年龄，会产生严重的失业情况，造成社会动荡，因此应该逐步提高退休年龄。何舰(2010)指出我国延长法定退休

年龄可选择每隔5年提高1岁的分步走的办法,逐步把法定退休年龄提高至65岁。王增文(2010)认为中国目前的法定退休年龄和最优退休年龄存在不同步的情况，最优退休年龄经济模型的结果表明了人口死亡概率和最优退休年龄的动态经济规律。阳义南（2014）和余桔云（2014）认为不同性别和参保年龄会影响延迟退休对增加养老金财富的积极作用。郑苏晋和王文鼎(2017)，韩冰洁和周志凯(2018)用生命周期精算模型证明了延迟退休会增加退休人员的养老金财富。殷红(2019)研究发现职工延迟退休后的养老金收益受其休闲偏好和养老金替代率的影响，所以有必要依据行业休闲偏好的差异性制定弹性退休政策。

反对延迟退休年龄的学者通常从延迟退休年龄和就业压力的矛盾出发。陈李翔(2010)认为退休年龄提高和就业压力呈正相关性。退休年龄的提高对缓解社会养老负担有着重要的意义，但同时也会加剧青少年们的就业压力，因此应该合理的制定延迟退休政策和最优退休年龄。严成樑（2016）认为延迟退休政策会降低在职劳动者的消费、储蓄和投资水平，最终抑制经济增长。曹园（2017）认为虽然延迟退休对于增加退休人员养老金财富具有积极作用，但是仍无法从根本上解决养老金收支不平衡的问题，最终会加重养老金个人账户的财政负担。邹铁钉（2017）认为除了会加重养老金个人账户的财政负担，还会对新增劳动力产生就业挤出效应。李晓鹤（2016）认为在低利率、低初始就业年龄的现实条件下，延迟退休会造成个人福利损失。高彦,赵君彦和曹园（2021）认为基于相关的研究证明可选择的弹性延迟退休政策在一定的性别和经济增长情况等前提条件下，有利于增加养老金财富值和最优个人效用，但并没有结合劳动者不同的预期寿命，给出合理的退休年龄的具体建议。

已有的研究仅通过设定不同的预期寿命的参数得出最优退休年龄，缺乏数据的完整性和严谨性。本文将从劳动者全工作周期的个人效用最大化角度出发，利用贝叶斯MCMC建立相关的动态的个人效用精算模型，采用当前养老金制度下的有效参数和影响因素等，通过收集全国分性别的1995-2019年各年龄的人口死亡率，再利用winBUGS软件进行死亡率预测，预测出未来20年分性别的预期寿命和三个阶段的死亡率，再将未来的预期寿命和各阶段死亡率代入精算模型可以得出未来不同预期寿命下的男女性的最优退休年龄。

## 2. 建立模型

假设每个工作者都相同，都要经历工作期与退休期。每个人在工作期向劳动市场无弹性的提供一单位的劳动，取得工资收入，缴纳养老保险费，消费可支配收入的一部分，储蓄剩余部分。到了退休期，每个人将其工作期储蓄的本金与得到的积累制养老金消费掉。假设每个劳动者所缴纳的养老金金额皆相等，缴纳比率相同。且退休后每年的养老金收入相同，养老金和储蓄按同一增长率。增长率包括名义利率，通货膨胀率引起的综合变化。假设劳动者的预期寿命分布于以下三个阶段，即会在以下的三个阶段内发生死亡：

- 劳动者在参加工作后，法定退休年龄之前死亡，概率为$p_1$
- 劳动者在参加工作后，法定退休年龄之后，个人养老金计发月数内死亡，概率为$p_2$
- 劳动者在退休年龄后，法定退休年龄之后，个人养老金计发月数之后死亡，概率为$p_3$ 且$p_1 + p_2 + p_3 = 1$

每个人都是从其工作期总消费$c_1$和退休期总消费$c_2$中得到满足，用可分离相加的对数函数来描述效用。因此，个人选择储蓄$s_t$和两期消费来使效用最大，个人效用U通过两期消费总额来获得，即U（$c_1$,$c_2$,$s_t$）=ln（$c_1$）+θ ln（$c_2$）,个人效用$U$ 满足Inada条件：$U^{'}>0,U^{''}<0$,且具有相同的边际效应，对应上述三个阶段，劳动者效用分别为$U_1,U_2,U_3$。

本模型按照劳动者不同预期寿命的三个阶段，利用工资收入，养老金缴纳额和储蓄分别计算每一阶段的劳动者的个人效用，在根据每个阶段发生死亡的概率，从而可以得出劳动者的个人总效用。最后考察个人总效用最大化时，劳动者的退休年龄，以及影响最优退休年龄的重要因素。

设$t_1$为入学年龄，$t_2$为劳动者的入职年龄，R为退休年龄，D为死亡年龄，$w_0$为每年工资数额，$c_1$为工作期内消费折算至劳动者入职年龄$t_2$的消费总金额，$c_2$为退休期消费折算至退休年龄R时的消费总额，$\alpha$为养老金保险个人缴费率，$\beta$为个人储蓄率，ε为年增长率，养老计发年数为n年，f为学历系数，θ∈（0,1）为折现因子。

(1)劳动者在参加工作后，法定退休年龄之前死亡

$$c_1=(1-\alpha-\beta)w_0(1+f)[1+(1+\varepsilon)^{-1}+\ldots+(1+\varepsilon)^{t_2-D}]$$

$$=(1-\alpha-\beta)w_0(1+f)\frac{(1+\varepsilon)-(1+\varepsilon)^{t_2-D}}{\varepsilon}$$

$$c_2=(\alpha+\beta)w_0(1+f)\left[(1+\varepsilon)^{R-t_2}+(1+\varepsilon)^{R-t_2-1}+\ldots+(1+\varepsilon)^{R-D}\right]$$

$$=(\alpha+\beta)w_0(1+f)(1+\varepsilon)^{R-D}\times\frac{(1+\varepsilon)^{D-t_2+1}-1}{\varepsilon}$$

根据养老金的OLG模型：U（$c_1$,$c_2$,$s_t$）=ln（$c_1$）+θln（$c_2$）可得：

$$U_1=\ln\left((1-\alpha-\beta)w_0(1+f)\frac{(1+\varepsilon)-(1+\varepsilon)^{t_2-D}}{\varepsilon}\right)$$

$$+\theta\ln\left((\alpha+\beta)w_0(1+f)(1+\varepsilon)^{R-D}\times\frac{(1+\varepsilon)^{D-t_2+1}-1}{\varepsilon}\right)$$

(2)劳动者在参加工作后，法定退休年龄之后，个人养老金计发月数内死亡

$$c_1=(1-\alpha-\beta)w_0(1+f)\left[1+(1+\varepsilon)^{-1}+\ldots+(1+\varepsilon)^{t_2-R}\right]$$

$$=(1-\alpha-\beta)w_0(1+f)\times\frac{(1+\varepsilon)-(1+\varepsilon)^{t_2-R}}{\varepsilon}$$

$$c_2=(\alpha+\beta)w_0(1+f)\left[(1+\varepsilon)^{R-t_2}+(1+\varepsilon)^{R-t_2-1}+\ldots+1\right]$$

$$=(\alpha+\beta)w_0(1+f)\times\frac{(1+\varepsilon)^{R-t_2+1}-1}{\varepsilon}$$

根据养老金的OLG模型：U（$c_1$,$c_2$,$s_t$）=ln（$c_1$）+θln（$c_2$）可得：

$$U_2 = \ln\left( （1-\alpha-\beta）w_0（1+f）\times\frac{（1+\varepsilon）-（1+\varepsilon）^{t_2-R}}{\varepsilon}\right)+\theta\ln\left（（\alpha+\beta）w_0(1+f）\times\frac{（1+\varepsilon）^{R-t_2+1}-1}{\varepsilon}\right)$$

(3)劳动者在退休年龄后，法定退休年龄之后，个人养老金计发月数之后死亡

$$c_1 = （1-\alpha-\beta）w_0(1+f)\left[1+（1+\varepsilon）^{-1}+\ldots+（1+\varepsilon）^{t_2-R}\right]$$

$$=（1-\alpha-\beta）w_0（1+f）\times\frac{（1+\varepsilon）-（1+\varepsilon）^{t_2-R}}{\varepsilon}$$

$$c_2 = (\alpha+\beta)w_0(1+f)\left[(1+\varepsilon)^{R-t_2}+(1+\varepsilon)^{R-t_2-1}+\ldots+1\right]$$

$$=（\alpha+\beta）w_0(1+f）\times\frac{（1+\varepsilon）^{R-t_2+1}-1}{\varepsilon}$$

$$I = \alpha w_0(1+f)\left[（1+\varepsilon）^{R-t_2}+（1+\varepsilon）^{R-t_2-1}+\ldots+1\right]$$

$$=\alpha w_0(1+f）\times\frac{（1+\varepsilon）^{R-t_2+1}-1}{\varepsilon}$$

I为养老金在退休年龄时的累计值。根据2005年国发38号文，个人账户养老金将按照退休年龄的养老金累积金额在计发年份（月份）平均发放，超过计发月数（年数），政府将通过财政补贴的形式继续承担超过计发月数（年数）的养老金。本文将计发月数（年数）后补贴的养老金在退休年龄时点的现值定义为养老金净值，记为$I_{净}$。对计发年数取整，记为n年。

$$I_{净} = \alpha w_0(1+f)\times\frac{(1+\varepsilon)^{R-t_2+1}-1}{n\varepsilon}\times\left[\frac{1}{(1+\varepsilon)^{n}}+\ldots+\frac{1}{(1+\varepsilon)^{D-R}}\right]$$

$$=\alpha w_0(1+f）\times\frac{（1+\varepsilon）^{R-t_2+1}-1}{n\varepsilon}\times\frac{\left[（1+\varepsilon）^{1-n}-（1+\varepsilon）^{R-D}\right]}{\varepsilon}$$

根据养老金的OLG模型： $U（c_1,c_2,s_t）=\ln（c_1）+\theta\ln（c_2）+\ln I_{净}$ ，可得：

$$U_3 = \ln\left( （1-\alpha-\beta）w_0（1+f）\times\frac{（1+\varepsilon）-（1+\varepsilon）^{t_2-R}}{\varepsilon}\right)$$

$$+\theta\ln\left( （\alpha+\beta）w_0(1+f）\times\frac{（1+\varepsilon）^{R-t_2+1}-1}{\varepsilon}\right)$$

$$+\ln\left(\alpha w_0(1+f）\times\frac{（1+\varepsilon）^{R-t_2+1}-1}{n\varepsilon}\right.$$

$$\left.\times\frac{\left[（1+\varepsilon）^{1-n}-（1+\varepsilon）^{R-D}\right]}{\varepsilon}\right)$$

考虑到劳动者在以上三个阶段的生存概率，可以得出劳动者全工作周期的总效用为：

$$U = P_1U_1 + P_2U_2 + P_3U_3$$

$$= P_1\left\{\ln\left((1-\alpha-\beta)w_0(1+f)\frac{(1+\varepsilon)-(1+\varepsilon)^{t_2-D}}{\varepsilon}\right)\right.$$

$$\left.+\theta\ln\left((\alpha+\beta)w_0(1+f)(1+\varepsilon)^{R-D}\times\frac{(1+\varepsilon)^{D-t_2+1}-1}{\varepsilon}\right)\right\}$$

$$+P_2\left\{\ln\left((1-\alpha-\beta)w_0(1+f)\times\frac{(1+\varepsilon)-(1+\varepsilon)^{t_2-R}}{\varepsilon}\right)\right.$$

$$\left.+\theta\ln\left((\alpha+\beta)w_0(1+f)\times\frac{(1+\varepsilon)^{R-t_2+1}-1}{\varepsilon}\right)\right\}$$

$$+P_3\left\{\ln\left((1-\alpha-\beta)w_0(1+f)\times\frac{(1+\varepsilon)-(1+\varepsilon)^{t_2-R}}{\varepsilon}\right)+\theta\ln\left((\alpha+\beta)w_0(1+f)\times\right.\right.$$

$$\left.\left.\frac{(1+\varepsilon)^{R-t_2+1}-1}{\varepsilon}\right)+\ln\left(\alpha w_0(1+f)\times\frac{(1+\varepsilon)^{R-t_2+1}-1}{n\varepsilon}\times\frac{\left[(1+\varepsilon)^{1-n}-(1+\varepsilon)^{R-D}\right]}{\varepsilon}\right)\right\} = P_1\theta\ln(1+\varepsilon)^{R-D}+$$

$$(P_2+P_3)ln\left[1-(1+\varepsilon)^{t_2-R-1}\right]+\theta(P_2+P_3)ln\left[(1+\varepsilon)^{R-t_2+1}-1\right]+P_3ln\left[(1+\varepsilon)^{R-t_2+1}-\right.$$

$$\left.1\right]+P_3ln\left[(1+\varepsilon)^{1-n}-(1+\varepsilon)^{R-D}\right]+A$$

其中：A=

$$P_1\left\{\ln\left((1-\alpha-\beta)w_0(1+f)\frac{(1+\varepsilon)-(1+\varepsilon)^{t_2-D}}{\varepsilon}\right)+\theta\ln\left((\alpha+\beta)w_0(1+f)\times\frac{(1+\varepsilon)^{D-t_2+1}-1}{\varepsilon}\right)\right\}$$

$$+P_2\left\{\ln\left(\frac{(1-\alpha-\beta)w_0(1+f)\times(1+\varepsilon)}{\varepsilon}\right)+\theta\ln\left(\frac{(\alpha+\beta)w_0(1+f)}{\varepsilon}\right)\right\}$$

$$+P_3\left\{\ln\left(\frac{(1-\alpha-\beta)w_0(1+f)(1+\varepsilon)}{\varepsilon}\right)+\theta\ln\left(\frac{(\alpha+\beta)w_0(1+f)}{\varepsilon}\right)+\ln\left(\frac{\alpha w_0(1+f)}{n\varepsilon^2}\right)\right\}$$

本文研究的重点在于劳动者全工作期个人效用处于最大化时的最优退休年龄，因此可令$\frac{\partial U}{\partial R}=0$可得出：$P_1\theta\ln(1+\varepsilon)+(P_2+P_3)\frac{\ln(1+\varepsilon)(1+\varepsilon)^{t_2-R-1}}{1-(1+\varepsilon)^{t_2-R-1}}+\theta(P_2+P_3)\frac{\ln(1+\varepsilon)(1+\varepsilon)^{R-t_2+1}}{(1+\varepsilon)^{R-t_2+1}-1}+P_3\frac{\ln(1+\varepsilon)(1+\varepsilon)^{R-t_2+1}}{(1+\varepsilon)^{R-t_2+1}-1}-P_3\frac{(1+\varepsilon)^{R-D}\ln(1+\varepsilon)}{(1+\varepsilon)^{1-n}-(1+\varepsilon)^{R-D}}=0$

化简可得：$P_1\theta+(P_2+P_3)\frac{(1+\varepsilon)^{t_2-R-1}}{1-(1+\varepsilon)^{t_2-R-1}}+\theta(P_2+P_3)\frac{(1+\varepsilon)^{R-t_2+1}}{(1+\varepsilon)^{R-t_2+1}-1}+P_3\frac{(1+\varepsilon)^{R-t_2+1}}{(1+\varepsilon)^{R-t_2+1}-1}-P_3\frac{(1+\varepsilon)^{R-D}}{(1+\varepsilon)^{1-n}-(1+\varepsilon)^{R-D}}=0$

又因为$\frac{\partial^2 U}{\partial R^2}<0$,所以劳动者个人终身效用可以取到最大值，在各项参数$P_1$,$P_2$,$P_3$,$\theta$,$\varepsilon$,$\alpha$,$\beta$,n,R,D,一定的条件下，可以解出个人终身效用最大化时的最优退休年龄；在各项参数变化的情况下，可考察参数变化对最优退休年龄的影响程度，并考察出最优退休年龄的变动趋势。

## 3. 参数设定

由于中国男女的预期寿命存在着较大差异，普遍女性的预期寿命远高于男性的预期寿命，同时，现行的男女性的退休年龄也差异较大，为了使本文献更具有现实意义和说服力，模型的结果更加真实科学，因此本文将分性别进行参数设定，并通过模型计算出不同性格的最优退休年龄。

（1）劳动者的入职年龄$t_2$：根据中国劳动力市场的现状，在职职工的平均入职年龄男性为19.2岁，女性为19.1岁，考虑到当前中国人均受教育的年限逐渐延长，因此本文将男性入职年龄$t_{21}$设定为21.2岁，女性入职年龄$t_{22}$设定为21.1岁。

（2）养老金计发年数n:按照《国务院关于工人退休，退职的暂行办法》（国发文104号）文件所规定退休年龄，现行的退休年龄是男性60周岁，女干部55周岁，女工人50周岁。在对照基本养老保险个人账户保险金计发月数表，可得出男性计发月数为139个月。考虑到我国目前女干部和女工人的比例差异较大，现将我国女性的退休年龄暂定为51周岁，在参照保险金计发月数表可得知，女性计发月数为190个月。即男性计发月数约为$n_1$=11.58年，女性计发月数约为$n_2$=15.83年。

（3）三个阶段死亡率$P_1$,$P_2$,$P_3$：通过整理1996年到2020年的《中国人口统计年鉴》和《中国人口与就业统计年鉴》，选择1995年到2019年的全国人口分性别死亡率历史数据，共采用0到90+共91个数据组。利用winbugs软件进行死亡率预测，得到未来二十年每个年龄分性别的生存概率，再通过对生存概率整理计算得出未来二十年分性别的$p_1$，$p_2$，$p_3$，上文中对男性入职年龄设定为21.2岁，女性入职年龄设置为21.1岁，男性退休年龄为60周岁，男性退休年龄暂定为51周岁，所以男性计发月数为11.58年，女性计发月数约15.83年，对以上数据进行四舍五入，其中计算公式如下：男性$P_{11}=1-lx[60，n]/lx[21，n]$ $P_{21}=1-lx[72，n]/lx[60，n]$ $P_{31}=1-P_{11}-P_{21}$；女性$P_{12}=1-lx[51，n]/lx[21，n]$ $P_{22}=1-lx[67，n]/lx[51，n]$ $P_{32}=1-P_{12}-P_{22}$。lx[60,10]表示在观察数据基础上的得到的预测第十年的生存概率，即为2029年60岁的生存概率。具体的数据将和分性别预期寿命整合在同一表格中。男女性的$P_1$,$P_2$,$P_3$随年份变动情况如下，如图1和图2。

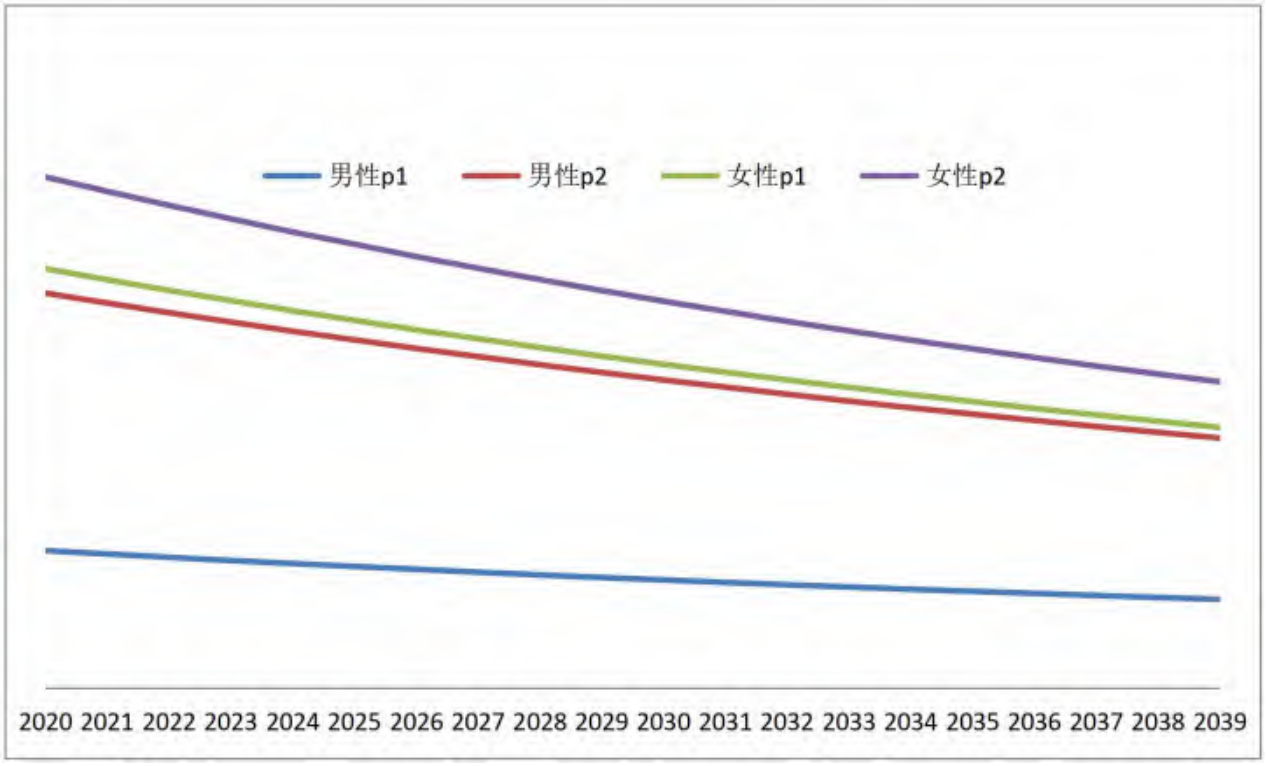



图 1 男女性 p1，p2 随年份变动情况

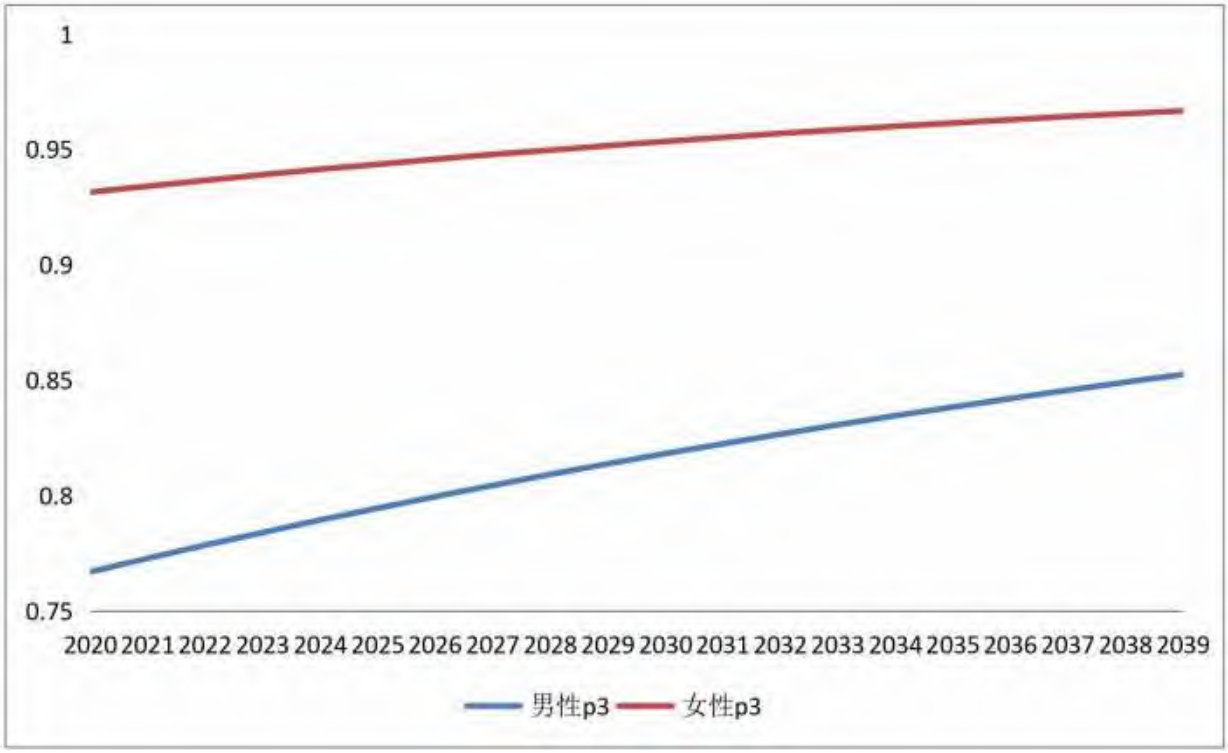



图2 男女性p3随年份变动情况

从图 1，图 2 可以看出随着年份的增长，第一阶段和第二阶段的死亡率逐年下降，第三阶段的死亡率逐年递增，且在各个阶段中，女性死亡率都明显高于男性死亡率。

（4）增长率 ε：增长率应该包括工资回报率、实际利率、通货膨胀率等综合因素的影响。依据经验工资分布曲线，将工资回报率纳入模型内，James H提出借鉴Heckman、Lochner等成果，设定工资回报率为 1 %；个人账户的名义记账利率为一年期银行存款利率，根据中国人民银行发布的金融机构人民币一年期存款基准利率和居民消费价格指数，实际利率为 2%；近年来中国年通货膨胀率基本控制在 5 %以内，据国家统计局统计与预测，本文设定通货膨胀率为 2 %。综合上述三个影响增长率 $\varepsilon = 0.051$。

（5）社会养老保险的个人基本缴费率α:中国当前的社会养老保险的个人基本缴费率规定为$\alpha = 8\%$。

（6）个人储蓄率 β：从居民储蓄存款趋向，即居民储蓄存款/居民可支配收入来看，下降速度更快。2008年达到顶峰31.1%之后，出现趋势性下将，到2017年已降至12.7%。这意味着居民将收入用于储蓄存款的比重越来越小。因此本文将个人储蓄率 β 设置为 $\beta = 10\%$。

（7）折现因子 θ： $c_1$为工作期内消费折算至劳动者入职年龄$t_2$的消费总金额，$c_2$为退休期消费折算至退休年龄R时的消费总额，根据养老金的OLG模型： $U(c_1, c_2, s_t) = \ln(c_1) + \theta \ln(c_2)$，因此设置折现因子为0.75。

（8）预期寿命R:本文研究的重点在于其他因素不变时，不同预期寿命对最优退休年龄的影响，因此预期寿命是至关重要的变量。在研究退休年龄的相关文献中，大多数文献采取全国普查数据进行定量分析，但由于全国普查五年进行一次，选用全国普查数据缺乏时间上连续性和时效性。因此本文利用lee-carter模型来进行死亡率预测，其中将用到三个参数序列：$a_x$，$b_x$和$k_t$来描述t岁的人在观察时的中心死亡率$m_{xt}$的自然对数，公式为：ln（$m_{xt}=a_x+b_xk_t+\varepsilon_{xt}$）。

这里的$k_t$时一个随时间而变化的参数，表示对所年龄段都相同的时间效应，年龄相关的参数$b_x$给出了各个不同年龄对参数的敏感性，参数$a_x$给出了对每个年龄x来说独立于参数$k_t$的年龄效应，可以看作各年龄对数死亡率的平均水平。

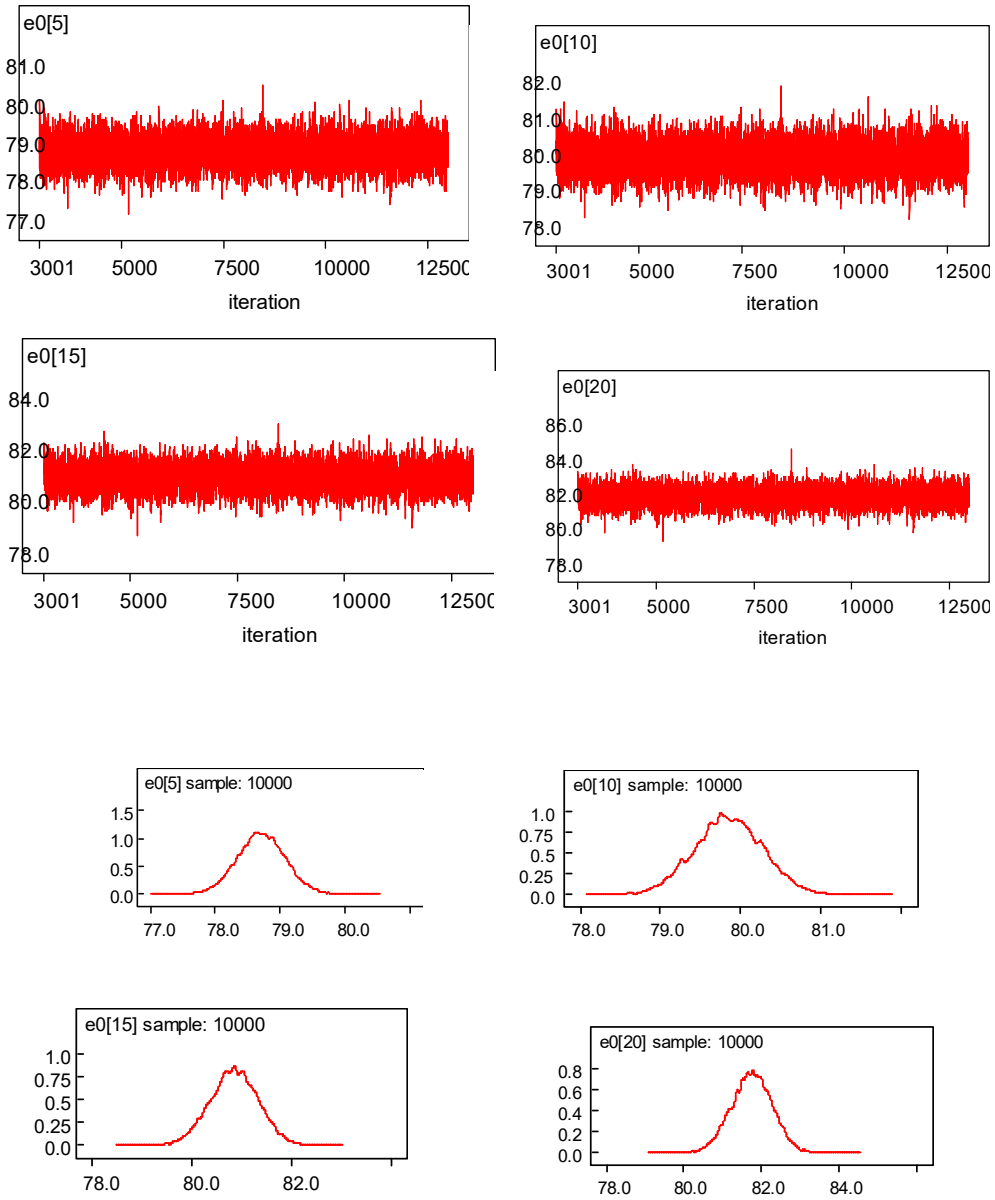
通过整理整理1996年到2020年的《中国人口统计年鉴》和《中国人口与就业统计年鉴》，选择1995年到2019年的全国人口男性死亡率历史数据，共采用0到90+共91个数据组。使用winbugs软件编程，进行贝叶斯Markov Chain Monte Carlo运算，通过建议一个平稳分布的Markov链，对其进行抽样，然后基于这些样本做各种统计推断。得出参数后验分布的均数，标准差，95%置信区间和中位数等信息。本文进行了13000次的抽样，舍弃前3000次结果，以后10000次样本计算参数估计值，共给出男性未来预期寿命e020次监测参数的估计值，如下表1。每个参数都给出了均值，方差，mc误差，2.5%分位点，中值和97.5%分位点等相应的计算结果。

表1 未来二十年男性预期寿命的预测值

| Year | node | mean | sd | MC error | 2.5% | median | 97.5% | start | sample |
|---|---|---|---|---|---|---|---|---|---|
| 2020 | e0[1] | 77.69 | 0.306 | 0.003759 | 77.08 | 77.69 | 78.29 | 3001 | 10000 |
| 2021 | e0[2] | 77.95 | 0.3221 | 0.004026 | 77.31 | 77.95 | 78.58 | 3001 | 10000 |
| 2022 | e0[3] | 78.21 | 0.3386 | 0.00422 | 77.54 | 78.21 | 78.88 | 3001 | 10000 |
| 2023 | e0[4] | 78.46 | 0.3538 | 0.004329 | 77.77 | 78.46 | 79.15 | 3001 | 10000 |
| 2024 | e0[5] | 78.71 | 0.367 | 0.004485 | 77.98 | 78.71 | 79.43 | 3001 | 10000 |
| 2025 | e0[6] | 78.95 | 0.3796 | 0.004719 | 78.21 | 78.95 | 79.69 | 3001 | 10000 |
| 2026 | e0[7] | 79.18 | 0.3925 | 0.004893 | 78.42 | 79.18 | 79.95 | 3001 | 10000 |
| 2027 | e0[8] | 79.41 | 0.4051 | 0.005113 | 78.62 | 79.41 | 80.2 | 3001 | 10000 |
| 2028 | e0[9] | 79.63 | 0.4172 | 0.00528 | 78.82 | 79.63 | 80.45 | 3001 | 10000 |
| 2029 | e0[10] | 79.85 | 0.4279 | 0.005471 | 79.01 | 79.85 | 80.68 | 3001 | 10000 |
| 2030 | e0[11] | 80.06 | 0.4395 | 0.005615 | 79.2 | 80.06 | 80.91 | 3001 | 10000 |
| 2031 | e0[12] | 80.27 | 0.4503 | 0.005804 | 79.38 | 80.27 | 81.14 | 3001 | 10000 |
| 2032 | e0[13] | 80.47 | 0.4604 | 0.006004 | 79.56 | 80.47 | 81.36 | 3001 | 10000 |
| 2033 | e0[14] | 80.67 | 0.4707 | 0.006192 | 79.74 | 80.67 | 81.58 | 3001 | 10000 |
| 2034 | e0[15] | 80.86 | 0.4801 | 0.006346 | 79.91 | 80.86 | 81.79 | 3001 | 10000 |
| 2035 | e0[16] | 81.04 | 0.4892 | 0.006449 | 80.07 | 81.05 | 81.98 | 3001 | 10000 |
| 2036 | e0[17] | 81.23 | 0.4976 | 0.006598 | 80.24 | 81.23 | 82.18 | 3001 | 10000 |
| 2037 | e0[18] | 81.4 | 0.5064 | 0.006684 | 80.4 | 81.41 | 82.38 | 3001 | 10000 |
| 2038 | e0[19] | 81.58 | 0.5145 | 0.006868 | 80.55 | 81.58 | 82.56 | 3001 | 10000 |
| 2039 | e0[20] | 81.75 | 0.523 | 0.007036 | 80.71 | 81.76 | 82.74 | 3001 | 10000 |

其中e0[10]表示在观察数据基础上的得到的预测第十年的预期寿命，即2029年的预期寿命。接下来对e0[5]，e0[10]，e0[15]，e0[20]进行参数收敛性分析。模型的收敛性时其预测结果可靠的前提，一般地，参数估计的mc误差小于其标准差的3%就表示已经收敛，再结合参数的时间序列和自相关图就能做出准确的判断。

时间序列和自相关图如下：




对于其他参数而言，经计算得到其mc误差项和标准差都小于2%，其时间序列和自相关图也显示收敛，因此模型参数的收敛性效果是相当满意的。

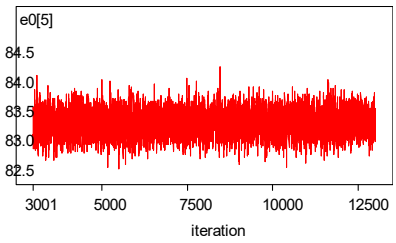
同样选取选择1995年到2019年的全国人口女性死亡率历史数据，共采用0到90+共91个数据组。使用winbugs软件编程，对其进行抽样，然后基于这些样本做

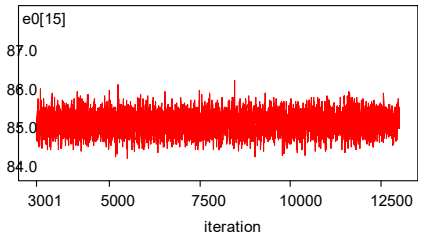
各种统计推断。得出参数后验分布的均数，标准差，95%置信区间和中位数等信息。进行了13000次的抽样，舍弃前3000次结果，以后10000次样本计算参数估计值，共给出女性未来预期寿命e020次监测参数的估计值，如表2。每个参数都给出了均值，方差，mc误差，2.5%分位点，中值和97.5%分位点等相应的计算结果。

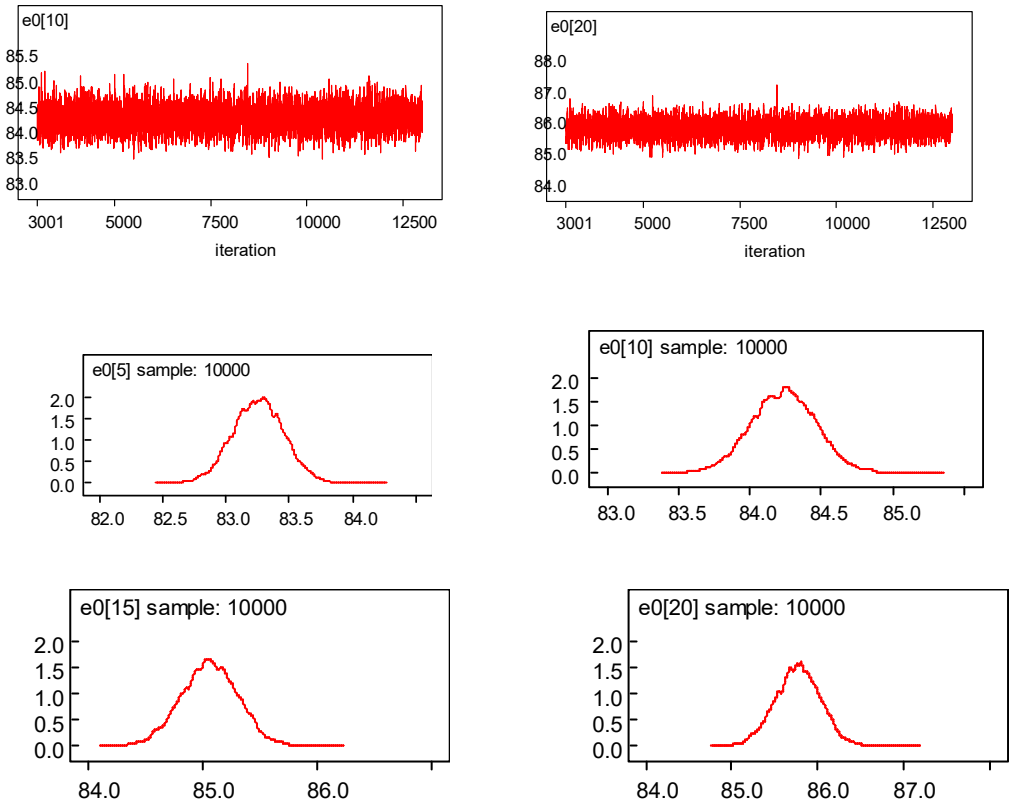
表2 未来二十年女性预期寿命的预测值

| year | node | mean | sd | MC error | 2.5% | median | 97.5% | start | sample |
|---|---|---|---|---|---|---|---|---|---|
| 2020 | e0[1] | 82.34 | 0.1775 | 0.002779 | 81.99 | 82.34 | 82.68 | 3001 | 10000 |
| 2021 | e0[2] | 82.58 | 0.1838 | 0.002894 | 82.22 | 82.58 | 82.94 | 3001 | 10000 |
| 2022 | e0[3] | 82.81 | 0.1909 | 0.002986 | 82.44 | 82.81 | 83.18 | 3001 | 10000 |
| 2023 | e0[4] | 83.04 | 0.1974 | 0.003075 | 82.65 | 83.04 | 83.42 | 3001 | 10000 |
| 2024 | e0[5] | 83.26 | 0.203 | 0.003189 | 82.86 | 83.26 | 83.66 | 3001 | 10000 |
| 2025 | e0[6] | 83.47 | 0.2081 | 0.003328 | 83.06 | 83.47 | 83.87 | 3001 | 10000 |
| 2026 | e0[7] | 83.67 | 0.2137 | 0.003454 | 83.25 | 83.67 | 84.08 | 3001 | 10000 |
| 2027 | e0[8] | 83.86 | 0.219 | 0.003601 | 83.43 | 83.87 | 84.29 | 3001 | 10000 |
| 2028 | e0[9] | 84.05 | 0.2239 | 0.00371 | 83.61 | 84.06 | 84.49 | 3001 | 10000 |
| 2029 | e0[10] | 84.24 | 0.2285 | 0.003823 | 83.79 | 84.24 | 84.68 | 3001 | 10000 |
| 2030 | e0[11] | 84.41 | 0.2333 | 0.003925 | 83.95 | 84.42 | 84.86 | 3001 | 10000 |
| 2031 | e0[12] | 84.59 | 0.2376 | 0.003998 | 84.12 | 84.59 | 85.04 | 3001 | 10000 |
| 2032 | e0[13] | 84.75 | 0.2416 | 0.004092 | 84.28 | 84.75 | 85.21 | 3001 | 10000 |
| 2033 | e0[14] | 84.91 | 0.2453 | 0.004169 | 84.43 | 84.91 | 85.38 | 3001 | 10000 |
| 2034 | e0[15] | 85.07 | 0.2487 | 0.004269 | 84.57 | 85.07 | 85.54 | 3001 | 10000 |
| 2035 | e0[16] | 85.22 | 0.2519 | 0.00429 | 84.72 | 85.22 | 85.7 | 3001 | 10000 |
| 2036 | e0[17] | 85.36 | 0.2547 | 0.004387 | 84.85 | 85.36 | 85.85 | 3001 | 10000 |
| 2037 | e0[18] | 85.5 | 0.2576 | 0.004438 | 84.99 | 85.5 | 86.0 | 3001 | 10000 |
| 2038 | e0[19] | 85.64 | 0.2601 | 0.004502 | 85.12 | 85.64 | 86.14 | 3001 | 10000 |
| 2039 | e0[20] | 85.77 | 0.2629 | 0.004584 | 85.24 | 85.77 | 86.27 | 3001 | 10000 |

同样对e0[5], e0[10], e0[15], e0[20]进行参数收敛性分析。时间序列和自相关图如下：






根据计算得出收敛性良好，对于其他参数其时间序列和自相关图也显示收敛，因此模型参数的收敛性效果是相当满意的。

## 4. 数值模拟及参数相关性

根据我国现行的政策和具体情况，对以下参数进行赋值定义。具体参数赋值结果见表3。

表3 初始赋值参数

| 参数含义 | 男性 | 女性 |
|---|---|---|
| 入职年龄$t_2$ | 21.2 岁 | 21.1 岁 |
| 养老金计发月数 n | 11.58 年 | 15.83 年 |
| 工资，养老金和储蓄叠加下的积累率 ε | 0.051 | 0.051 |
| 社会养老保险的个人基本缴费率α | 0.08 | 0.08 |
| 个人储蓄率 β | 0.1 | 0.1 |
| 折现因子 | 0.75 | 0.75 |

利用1995-2019年过去二十五年的死亡率数据通过winbugs软件预测得出未来二十年的男女性预期寿命和三个阶段死亡率p1，p2，p3的数值。见下表4。

表4 预测结果参数汇总

| | 男性 | | | | 女性 | | | |
|---|---|---|---|---|---|---|---|---|
| 年份 | e0[n] | P1 | P2 | P3 | e0[n] | P1 | P2 | P3 |
| 2020 | 77.69 | 0.081054 | 0.152021 | 0.766925 | 82.34 | 0.014392 | 0.05412 | 0.931488 |
| 2021 | 77.95 | 0.079096 | 0.148116 | 0.772788 | 82.58 | 0.013781 | 0.052122 | 0.934097 |
| 2022 | 78.21 | 0.07714 | 0.14434 | 0.77852 | 82.81 | 0.013172 | 0.050234 | 0.936593 |
| 2023 | 78.46 | 0.075194 | 0.140817 | 0.783989 | 83.04 | 0.012665 | 0.048254 | 0.939081 |
| 2024 | 78.71 | 0.073451 | 0.137125 | 0.789424 | 83.26 | 0.012058 | 0.046481 | 0.941461 |
| 2025 | 78.95 | 0.071709 | 0.133775 | 0.794516 | 83.47 | 0.011551 | 0.044914 | 0.943535 |
| 2026 | 79.18 | 0.070069 | 0.130345 | 0.799585 | 83.67 | 0.010946 | 0.043253 | 0.945801 |
| 2027 | 79.41 | 0.068337 | 0.127255 | 0.804408 | 83.86 | 0.010541 | 0.041599 | 0.94786 |
| 2028 | 79.63 | 0.066707 | 0.124084 | 0.809209 | 84.05 | 0.010136 | 0.04015 | 0.949713 |
| 2029 | 79.85 | 0.065178 | 0.121046 | 0.813776 | 84.24 | 0.009633 | 0.038703 | 0.951664 |
| 2030 | 80.06 | 0.063751 | 0.118032 | 0.818217 | 84.41 | 0.00923 | 0.037262 | 0.953508 |
| 2031 | 80.27 | 0.062324 | 0.115244 | 0.822431 | 84.59 | 0.008826 | 0.035924 | 0.95525 |
| 2032 | 80.47 | 0.060905 | 0.112479 | 0.826617 | 84.75 | 0.008424 | 0.034591 | 0.956985 |
| 2033 | 80.67 | 0.05958 | 0.109722 | 0.830698 | 84.91 | 0.008122 | 0.03336 | 0.958518 |
| 2034 | 80.86 | 0.058262 | 0.107093 | 0.834644 | 85.07 | 0.00782 | 0.032131 | 0.96005 |
| 2035 | 81.04 | 0.057045 | 0.10459 | 0.838364 | 85.22 | 0.007418 | 0.031105 | 0.961477 |
| 2036 | 81.23 | 0.055829 | 0.102095 | 0.842076 | 85.36 | 0.007116 | 0.029982 | 0.962902 |
| 2037 | 81.4 | 0.054613 | 0.099713 | 0.845674 | 85.5 | 0.006815 | 0.02886 | 0.964325 |
| 2038 | 81.58 | 0.053403 | 0.097455 | 0.849142 | 85.64 | 0.006613 | 0.027839 | 0.965547 |
| 2039 | 81.75 | 0.052288 | 0.095203 | 0.852509 | 85.77 | 0.006312 | 0.026921 | 0.966767 |

将以上参数$P_1$,$P_2$,$P_3$,θ，ε,R,α,β,n代入公式，得出性别差异和不同预期寿命对最优退休年龄的影响。

$$P_1\theta+(P_2+P_3)\frac{(1+\varepsilon)^{t_2-R-1}}{1-(1+\varepsilon)^{t_2-R-1}}+\theta(P_2+P_3)\frac{(1+\varepsilon)^{R-t_2+1}}{(1+\varepsilon)^{R-t_2+1}-1}+P_3\frac{(1+\varepsilon)^{R-t_2+1}}{(1+\varepsilon)^{R-t_2+1}-1}-$$

$$P_3\frac{(1+\varepsilon)^{R-D}}{(1+\varepsilon)^{1-n}-(1+\varepsilon)^{R-D}}=0$$

## 4．1 最优退休年龄与平均预期寿命

表5 男性最优退休年龄与平均预期寿命

| 年份 | 平均预期寿命 | 最优退休年龄 |
|---|---|---|
| 2020 | 77.69 | 61.22 |
| 2021 | 77.95 | 61.44 |
| 2022 | 78.21 | 61.67 |
| 2023 | 78.46 | 61.89 |
| 2024 | 78.71 | 62.10 |

| | | |
|---|---|---|
| 2025 | 78.95 | 62.31 |
| 2026 | 79.18 | 62.51 |
| 2027 | 79.41 | 62.71 |
| 2028 | 79.63 | 62.90 |
| 2029 | 79.85 | 63.09 |
| 2030 | 80.06 | 63.28 |
| 2031 | 80.27 | 63.46 |
| 2032 | 80.47 | 63.64 |
| 2033 | 80.67 | 63.81 |
| 2034 | 80.86 | 63.98 |
| 2035 | 81.04 | 64.14 |
| 2036 | 81.23 | 64.31 |
| 2037 | 81.4 | 64.45 |
| 2038 | 81.58 | 64.61 |
| 2039 | 81.75 | 64.76 |

男性最优退休年龄与平均预期寿命对应的数值如表5。在当前制度参数和经济发展水平，实现个人效用最大化的目标下，通过winbugs预测得出2020年男性全国的平均预期寿命达到77.69岁，利用个人效用精算模型计算出最优退休年龄为61.22岁，略高于当前制度政策所规定的男性退休年龄，但该数额存在合理性，因为近来年，随着医疗水平和生活质量的普遍提高，平均预期寿命也逐年提高，现有的退休年龄政策已经无法满足劳动者对退休后资金流的要求，同时平均预期寿命是影响最优退休年龄的重要因素，两者之间呈较显著的相关关系，因此最优退休年龄将高于退休政策设置的退休年龄，且会随着年份的增加而增加。

表6 女性平均预期寿命与最优退休年龄

| 年份 | 平均预期寿命 | 最优退休年龄 |
|---|---|---|
| 2020 | 82.34 | 61.46 |
| 2021 | 82.58 | 61.68 |
| 2022 | 82.81 | 61.89 |
| 2023 | 83.04 | 62.10 |
| 2024 | 83.26 | 62.30 |
| 2025 | 83.47 | 62.49 |
| 2026 | 83.67 | 62.67 |
| 2027 | 83.86 | 62.84 |
| 2028 | 84.05 | 63.02 |
| 2029 | 84.24 | 63.19 |
| 2030 | 84.41 | 63.35 |
| 2031 | 84.59 | 63.51 |
| 2032 | 84.75 | 63.66 |
| 2033 | 84.91 | 63.80 |
| 2034 | 85.07 | 63.95 |
| 2035 | 85.22 | 64.09 |

| | | |
|---|---|---|
| 2036 | 85.36 | 64.22 |
| 2037 | 85.5 | 64.34 |
| 2038 | 85.64 | 64.47 |
| 2039 | 85.77 | 64.59 |

女性最优退休年龄与平均预期寿命对应的数值如表6。通过winbugs软件预测出的2020年女性预期寿命为82.34岁，利用个人效用精算模型计算出2020年女性最优退休年龄为61.46岁，远高于《国务院关于安置老弱病残干部的暂行办法》和《国务院关于工人退休、退职的暂行办法》文件所规定的退休年龄，女干部55周岁，女工人50周岁。这是因为本文仅从个人效用最大化的目标出发，平均预期寿命是决定女性最优退休年龄的重要参数，而政策制定要考虑到家庭情况，婚姻状况，身体健康状况以及社会保障程度等方面，其次中国的男主外，女主内的传统思想根深蒂固，政府在制定女性退休年龄的时候也会充分考虑到具体情况，因此本文的最优退休年龄高于政策设定值属于合理范围内。

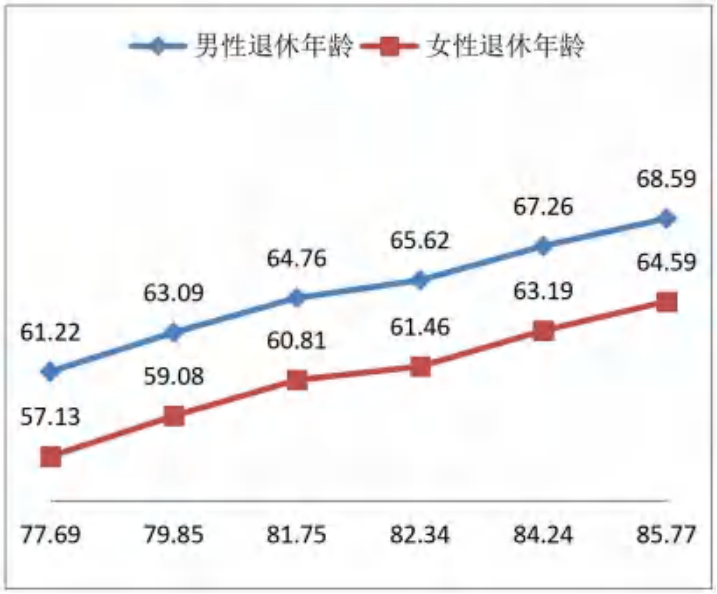



图3 相同预期寿命下的最优退休年龄

总体而言，在个人效用最大化的目标下，最优退休年龄随着预期寿命的增加而增加，也呈显著的线性相关性。在相同预期寿命的条件下，男性最优退休年龄较女性退休年龄高4岁左右，由此可见，中国当前的退休男女差距偏大，且均未实现个人效用最大化。

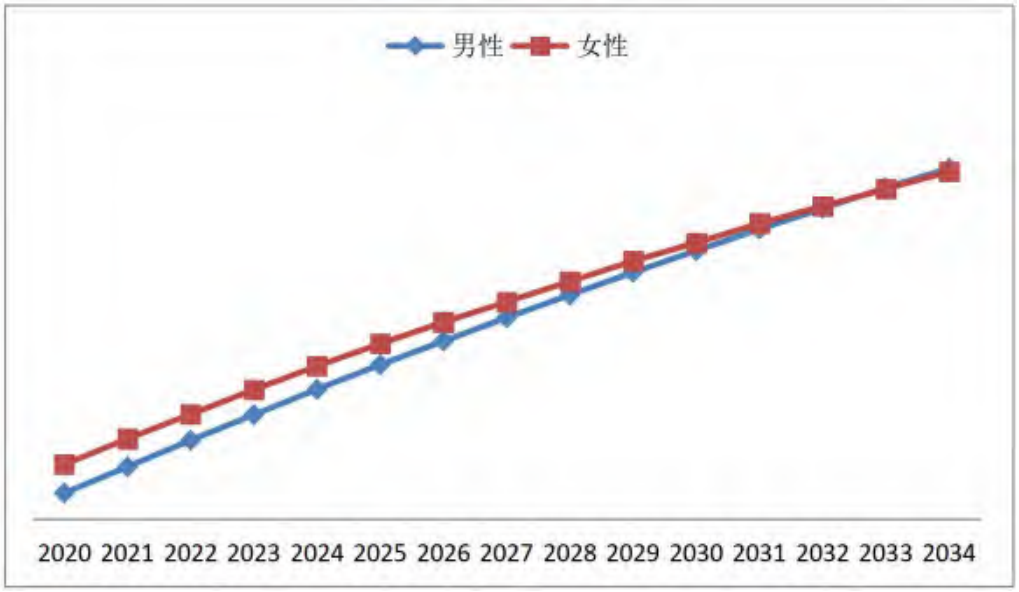



图 4 2020-2034 年的最优退休年龄

图5 2035-2039年的最优退休年龄

从图4可以看出，前十五年女性最优退休年龄高于男性最优退休年龄，且差异逐渐减少。图5中显示后五年中，男性的最优退休年龄高于女性退休年龄，且最优退休年龄的差距逐渐拉开。原因在于女性的预期寿命远大于男性预期寿命，且最优退休年龄与平均预期寿命呈显著的正相关性，才出现了女性最优退休年龄高于男性最优退休年龄的现象，与当前制定的退休年龄政策不相符合。但随着年份的增加，男女性平均预期寿命的差距逐渐减少，由平均预期寿命带来的退休年龄的正效用逐渐减弱，男性最优退休年龄的增长幅度明显大于女性最优退休年龄的幅度，最终超过女性的最优退休年龄，差距随着年份增加而拉开，且这种现象会随着时间的增加愈发明显。

## 4.2 计发年数与最优退休年龄

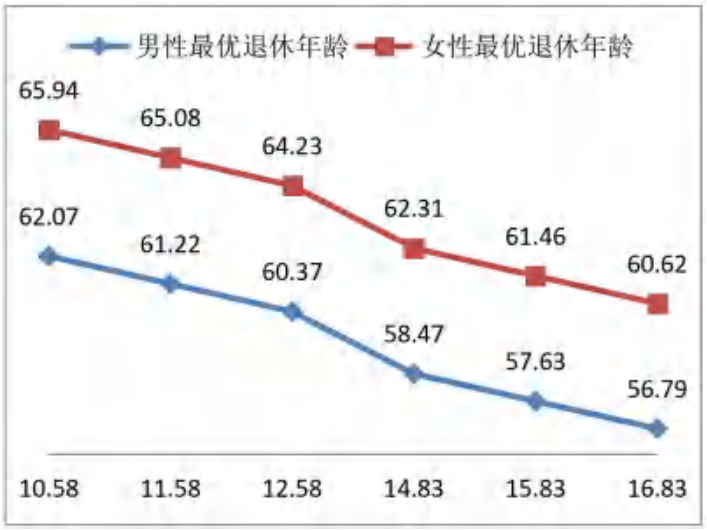



图6 不同计发年数下的最优退休年龄

本文以2020预测的男女性预期寿命e0和三个阶段的死亡率p1，p2，p3为例，分别选择计发年数为10.58年、11.58年、12.58年、14.83年、15.83年和16.83年六个自变量，考察分性别不同计发年数下的最优退休年龄。从图中可以看出，在个人效用最大化的目标下，最优退休年龄随着计发年数的增加而下降，两者之间线性关系较明确。在相同的计发年数下，对应的最优退休年龄随性别有较大差异。当男性计发年数增加为12.58年和14.83年，男性最优退休年龄下降至60.37岁和58.47岁。当女性计发年数为14.83年和16.83年，女性最优退休年龄为62.31岁和60.62岁。而在当前的政策制度上，男女性劳动者的个人账户养老金计发年数仅按照年龄进行确定计发年数，而没有体现出性别之间的差异，这在一定程度上影响了不同性别劳动者获得个人效用最大化的目标。

## 4.3 入职年龄与最优退休年龄

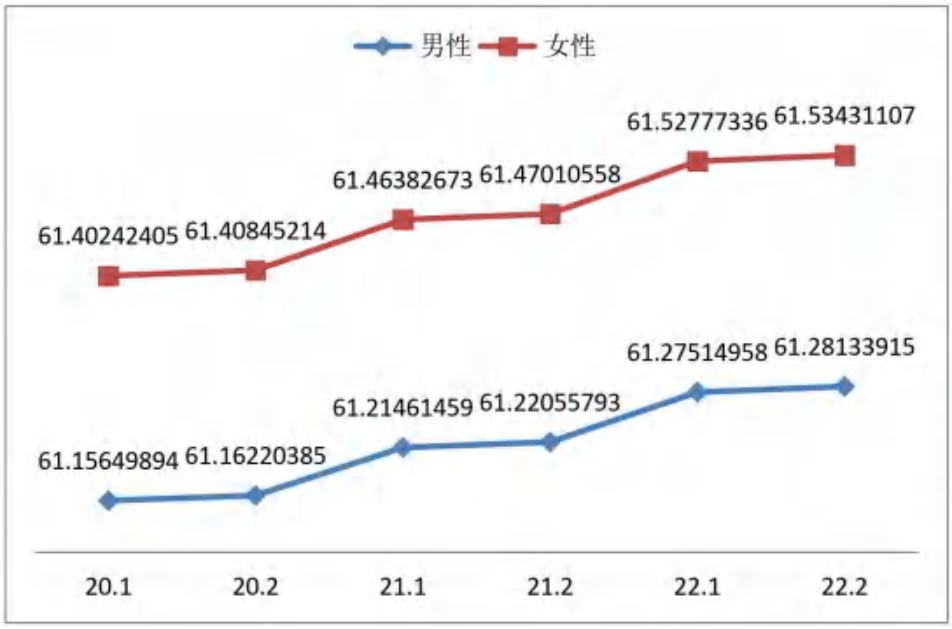



图 7 不同入职年龄下的最优退休年龄

从图 7 中可以看出不同入职年龄对最优退休年龄的影响程度较小，当男性入职年龄分别为 20.2 岁，21.2 岁和 22.2 岁时，最优退休年龄为 61.16 岁，61.22 岁和 61.28 岁。当女性入职年龄分别为 20.1 岁，21.1 岁和 22.1 岁时，女性最优退休年龄为 61.4 岁，61.46 岁和 61.53 岁。可以通过数据处理得出，入职年龄推迟一年，最优退休年龄仅增加 0.06 岁，因此入职年龄对最优退休年龄的影响因子较小。

## 5．结论与建议

纵观多数世界人口老龄化问题严重的国家，都采用了延迟退休的政策来保证养老保险制度的可持续性。中国是典型的未富先老国家，劳动者养老问题主要依靠现有社会的基本养老保险制度，此制度的可持续性关系到每一位劳动者的切身利益。中国虽然已经在研究渐进式延迟退休年龄等政策措施，但是由于劳动者对延迟退休政策及其影响尚不了解，对于延迟退休方案理解不到位，导致该政策尚未实施。本文旨在梳理清晰延迟退休政策对个人效用的 影响作用，在不同的经济增长、预期寿命等因素影响下，合理确定最优退休年龄，为政府制定利国利民的延退政策提供理论依据。

第一，实施弹性退休制度有利于减少政策实施阻力，也有利于劳动者根据多种因素灵活选择个人最优的退休年龄。基于个人效用最大化的目标，文章使用赋值模拟和参数预测，给出了未来二十年对应的分性别的最优退休年龄的调整方法。出于个人效用最大化目标下，根据winbugs软件进行的死亡率预测结果计算出男性未来二十年的最优退休年龄的合理区间在61.22-64.76岁，女性未来二十年的最优退休年龄的合理区间在61.46-64.59岁，皆高于我国当前对退休政策的限制年龄。同时近年来预期寿命会继续延长，所以劳动者最优退休年龄也会随之提高，延迟退休势在必行。但是考虑到劳动者不同个体的预期寿命，个人对最优退休年龄有不同的偏好。不同行业劳动者的工资收入和增长速度差异较大，不同时期社会实际利率和通货膨胀率也不尽相同，所以当劳动者面对积累率的各种差异时，对个人最优退休年龄也有不同的看法。因此，在改革初期，在一定范围内实施弹性退休制度，尽可能避免一刀切方案，方便劳动者根据多种因素灵活选择退休年龄，更有利于政策落地实施，降低运行阻力。

第二，分性别合理设定个人账户养老金计发月数，真正实现不同性别劳动者个人效用的最大化目标。 中国男女劳动者预期寿命相差较大，却实施相同的计发政策。当前男性最优计发年数明显低于政策计发年数，尤其是退休年龄提高时，两者差异亦增大。当前女性最优计发年数高于政策计发年数，但是当退休年龄提高时，两者差异缩小。预期寿命是影响最优退休年龄的最重要因素，与退休年龄密切相关的计发政策应与预期寿命相协调，男女性别间的寿命差异决定了最优退休年龄和计发年数分性别差异设定的必要性。总而言之，科学合理的延迟退休政策于国于民都具有重大意义，是中国未来退休制度改革的一个重要方向，只有尊重不同劳动者的利益诉求，公开明晰当前和未来利益关系，增加劳动者对退休时间的灵活选择权，才能减少退休制度改革面临的阻力，最终发挥其作用。

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# 长寿风险下的最优退休年龄—基于贝叶斯 MCMC 方法

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**关键词：**最优退休年龄 预期寿命 MCMC 长寿风险

**中文摘要：**当前我国人口的长寿风险问题日益突出，给我国的现收现付制养老金体系造成了严重的冲击，增加了现收现付制账户收支压力。理论上讲，推出延迟退休的政策，以此来增加收入，减少支出，对于维持现收现付制账户的可持续性和我国现收现付制统筹账户平衡有着非常重要的作用。但是对于积累制的个人账户而言，我国统账结合的养老保险制度的综合影响尚不明晰。因此，综合考虑预期寿命，人口结构，个人养老金财富和个人终身效用及基本养老金制度等多种因素，对现行的退休年龄进行调整，研究制定合理可行的延迟退休年龄方案，科学有效的评估延迟退休政策效果，为政府相关部门制定政策提供有效依据，具有重要的理论价值和现实意义。已有的研究仅通过设定不同的预期寿命的参数得出最

优退休年龄，缺乏数据的完整性和严谨性。本文将从劳动者全工作周期的个人效用最大化角度出发，利用贝叶斯 MCMC 通过建立相关的动态的精算模型，采用当前养老金制度下的有效参数和影响因素等，通过收集全国分性别的 1995-2019 年各年龄的人口死亡率，共 25 年的死亡率数据。将劳动者的剩余寿命分为入职年龄到法定退休年龄前，退休年龄之后法定计发年数前和法定计发年数后三个阶段，利用 winBUGS 软件进行死亡率预测，得出未来二十年的男女性的预期寿命和三个阶段的死亡率大小，再通过将预期寿命和三阶段死亡率代入精算模型可以得出不同预期寿命下的男女性的最优退休年龄。结果表明，最优退休年龄与预期寿命，经济增长速度，入职年龄正相关，与计发年数呈现负相关，其中预期寿命对最优退休年龄的影响最大，且男女间的差异也会导致两者的最优退休年龄有着显著的区别。因此，政府和劳动者在制定选择退休政策时要充分考虑各项影响因素，尊重不同劳动者的利益诉求，公开明晰工作期和养老期收入的关系，增加劳动者对退休时间的灵活选择性，减少退休制度改革面临的阻力，最终发挥延迟退休政策的重大作用。

# Dynamic Mortality Forecasting and Mortality-Linked Structured Pricing - Based on a Jump Diffusion Stochastic Mortality Model

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**Keywords:** mortality projection; mortality options; bootstrap methods.

**Abstract.** The projection of human mortality has always been a fundamental subject in actuarial research of insurance. On the one hand, with the improvement of people's living standards and the advancement of medical technology, the mortality rate of all ages shows a clear downward trend; on the other hand, the occurrence of catastrophe risk and public health emergencies will cause a large short-term increase in mortality. Therefore, traditional actuarial methods which relying on static life tables will inevitably lead to overestimation or underestimation of mortality and become increasingly difficult to meet the requirements of insurance product pricing and risk assessment, what's more, the risk management and sound operation of insurance companies will be seriously affected. Consequently, this article will try to explore the coping strategies from the perspective of stochastic modeling of mortality and innovation of mortality-derived products. First, this paper will build a stochastic modeling of mortality with a jump process, and use the bootstrap method and maximum likelihood estimation method to estimate the parameters in the model based on the actual mortality data of China from 1995 to 2017. By analyzing the parameter standard errors and confidence intervals, and testing the robustness of the parameters, it is found that, compared with the traditional method, the bootstrap method has a more accurate judgment on the accuracy of the statistics when the sample mean obey

normal distribution or the sample size is not large enough. Secondly, this article innovates in product design: embedding a European option of mortality in annuity products which grants insurance companies the right to adjust the compensation when actual mortality deviates too much from the predicted mortality. In addition, based on the theory of asset pricing, the paper studies the product pricing and risk characteristics under the new system design. The results show that the embedded mortality options are rooted in the real basis of dynamic changes in human mortality, straighten out the power and relationship between the annuities, take the fairness of pricing and the rationality of risk management into account, which greatly improve the accuracy and robustness of insurance product risk measurement and has important practical significance and reference value to promote the development of commercial annuity.

## 1. 研究背景及意义

随着科学技术的进步与医疗水平的提升，人口死亡率的逐渐改善已经成为了不争的事实，人口老龄化已经成为了各国学者研究的重要方向。根据人口老龄化的定义，我国早在 2000 年就已经成为了老龄化大国，并且老龄化逐年加剧，又因为上世纪 60 年代的婴儿潮，预示着中国未来仍然会加速老龄化。

人口老龄化加速意味着由于人口实际寿命超出预期寿命而带来的风险加剧，也就是长寿风险加剧。现阶段，各寿险公司进行年金产品的定价所运用的死亡率数据大都是来自经验生命表中的死亡率数据，而最新经验生命表也是 2016 年颁布的《中国人身保险业经验生命表（2010－2013）》简称 CL00-03 生命表，其经验期为 2010-2013 年，而全世界人类的寿命都普遍性的延长（如图一所示），这意味着年金和养老金的支付期限会增加，提高寿险公司的运营成本；另外，人口寿命的延长，使得政府给付养老金的期限长于预期给付养老金期限，造成我国社保的养老金给付困难，加大养老金给付的压力，导致人力资源与社会保险部实行推迟退休年龄等政策，引发民众热议与各种不良情绪。不论对于政府还是企业，控制和对冲长寿风险都存在重要意义。

与长寿风险相对应的是巨灾风险，即由于巨灾（如地震、洪水、台风、核电站爆炸等）或者公共卫生事件（如突发性的流性疾病，新型冠状肺炎等）造成的短期内死亡率激增而带来的风险。虽然巨灾在日常生活中发生的概率很低，但是一旦发生，将给保险公司的偿付带来巨大的考验，经常会出现保险公司死亡赔付远远不足，出现巨额的偿付缺口，提高保险企业的破产风险。风险证券化使得保险市场中的风险分散到资本市场中成为可能。相对于保险市场，资本市场具有资金总额大，流动性好等优势；由于证券化的保险产品以死亡率为风险标的，与市场中其他资产趋向不相关，有利于资本市场中的投资者分散投资风险，使得证券化保险产品更有吸引力。因此，单纯依靠保险市场自身实力无法应对突发的巨灾风险，需要将巨灾风险分散到资本市场中去。

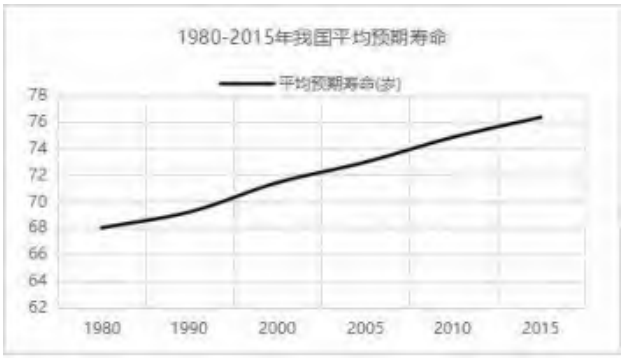



图 1 1980-2015 年我国平均预期寿命

在国外相关研究中，Lee, Charter(1992)率先提出了动态死亡率预测模型，也就是 Lee-Charter 模型，他们基于美国 1900-1987 年的死亡率真实数据预测美国的未来死亡率，模型提出后，各国学者也对本国死亡率进行预测并且进行相关改进；Dahl (2004) 将死亡率强度描述为随机过程；Cairns, Blake, and Dowd (2006) 展示了如何对死亡率风险进行建模并且运用利率衍生品发展而来的框架（如短期利率模型、远期死亡率模型和死亡率市场模型）来对死亡率相关的金融工具进行定价；Biffis (2005), Schrager (2006), and Miltersen and Persson (2005) 构建了随机死亡率模型，Cox, Lin, and Wang (2006) 则表示在死亡率预测中应该加入由于短期发生的巨灾风险而产生的死亡率的跳跃的部分，才能对死亡率进行更好的预测，所以他们加入了跳跃死亡率的部分，提出了跳跃扩散模型来描述死亡率的动态变化；Lin, Cox, and Pedersen (2010) 将一般死亡率，扩散过程，永久寿命跳跃过程和暂时死亡率跳跃过程相结合，运用到他们的死亡率预测模型中；Wang, Yang 和 Huang（2015）运用一种动态的 Copula 方法，构建了多国家的死亡率依赖模型，并应用于生存指数互换的定价；Hao,Wang, Zheng 和 Zhou（2016）基于中国人口数据构建死亡率预测模型，并定价对应的长寿债券；Leung,Fung 和 0'Hare（2018）采用抽样的贝叶斯方法，基于贝叶斯状态空间死亡率模型，分析比较了几种长寿风险证券定价方法的优缺点。

在国内的相关研究中，余伟强（2006）最早将长寿风险带入国内学者的视野，并且探讨了如何将长寿风险证券来；王晓军、蔡正高（2008）对死亡率预测模型的新进展进行了总结；曾燕、陈曦和邓颖璐（2016）对于传统的 Lee-Carter 模型进行改进，运用 Bootstrap 法估计了参数的置信区间，得到了较好的拟合结果；郑湘怡（2016），刘丽文（2016）运用了中国人口死亡率的真实数据，建立了长寿互换定价模型，并且对其进行推导和解释；孙佳美和许素英（2012）将 Heligman-Pollard 模型与 Carriere 模型相结合，运用中国分年龄、分性别的全年龄人口死亡率数据对模型参数进行估计，并且运用 Bootstrap 法进行标准误检验并给出置信区间，最后提出了相应的拟合建议；陈浩（2016）梳理了有关长寿风险证券化的定价研究及其应用；刘丽文（2016）和郑湘怡（2016）采用中国人口的死亡率数据，研究长寿互换的定价模型。田玲、姜世杰和樊毅（2017）设计了一款长寿债券，其主要创新和特点是触发下限可调整，并对其进行定价。

基于国内随机死亡率模型研究的不足，本文从 Cox, Lin, and Wang (2006) 提出的带跳跃扩散的死亡率模型出发，利用中国 1995-2017 年各年龄段死亡率的真实数据利用最大似然估计方法对相关参数进行估计，并运用参数 Bootstrap 法对各个参数的标准误和百分比置信区间进行计算，检验参数的准确度。最后设

计了与死亡率相关的欧式期权，将长寿风险分散到资本市场中去。

## 2.跳跃随机模型概述

为了研究死亡率相关证券产品价格的定价，就需要对未来随机死亡率进行预测。死亡率预测模型从最早的静态死亡率模型——De Moivre 模型，到离散型随机死亡率预测模型，到连续性随机死亡率预测模型，有了长足的进展。本文利用的是 Cox, Lin, and Wang (2006) 提出的带跳跃的随机死亡率模型，所以下面对该模型进行着重研究。

Cox et al.(2006)认为死亡率的变化应该分为两个部分，分别为死亡率随机游走和死亡率的跳跃扩散，所以他假设死亡率应该服从以下动态模型

$$\frac{dq_t}{q_t} = (\alpha - \lambda k)dt + \sigma dW_t + (Y-1)dN_t \tag{1}$$

其中，α 是不排除跳跃扩散变化下的期望死亡率的瞬时变化率，当 α 为负的时候说明死亡率有所改善，（α－λk）是随机部分的漂移率；σ 是随机过程的波动率，是在没有发生跳跃事件的情况下的死亡率瞬时可变率；$N_t$ 是从 0 时刻到 t 时刻发生的跳跃事件的数量，并且服从泊松过程，即 $P(N_t = n) = e^{-\lambda t}\frac{(\lambda t)^n}{n!}$，λ 是 0 时刻到 t 时刻泊松分布的跳跃强度；Y 表示死亡率跳跃的规模，即当 t 时刻发生跳跃事件时，死亡率从原来的 $q_t$ 变为 $Yq_t$，并且假设 Y 是相互独立的随机变量，服从 $Y = e^{m+su}$，其中 m 和 s 是常数，u 服从标准正态分布，即 u～N(0,1)，我们可以得到 Y 服从对数正态分布，其均值为；我们定义 $k = E(Y-1) = e^{m+\frac{1}{2}s^2} - 1$，从而确保 α 是死亡率的期望瞬时变化率。

对上述微分方程进行求解，得到

$$q_t = q_0 \cdot e^{(\alpha - \frac{1}{2}\sigma^2 - \lambda k)t + \sigma W_t} \cdot Y(N_t) \tag{2}$$

其中 $q_0$ 是死亡率预测的起点，也就是初始死亡率，在本论文中运用的是 1995 年中国各年龄段死亡率的真实数据；Y（$N_t$）是死亡率的累计跳跃规模，即 $Y(N_t) = \prod_{b=1}^{N_t} Y_b$，其中，每次的跳跃规模 $Y_b$ 独立同分布。

## 3.基于中国 1995-2017 年真实数据进行最大似然估计

### 3.1 参数估计的设计

当 $N_t$=n 时，对等式（2）左右两边同时取对数得，

$$\ln q_t = \ln q_0 + (\alpha - \frac{1}{2}\sigma^2 - \lambda k)t + \sigma W_t + \ln[Y(n)]$$

由上式可得 $q_t$ 服从均值为 $\tilde{\mu}_n = \ln q_0 + (\alpha - \frac{1}{2}\sigma^2 - \lambda k)t + nm$，方差为 $\tilde{\sigma}_n = \sigma^2 t + ns^2$ 的对数正态分布，

由对数正态分布定义得，当 $N_t$=n，$q_t$ 条件概率密度为，

$$f(q_t = q | N_t = n) = \frac{1}{q\sqrt{2\pi\tilde{\sigma}_n^2}} \cdot e^{-\frac{1}{2\tilde{\sigma}_n^2}(\ln q - \tilde{\mu}_n)^2}$$

因此，根据全概率公式得到 $q_t$ 的概率密度为，

$$
\begin{aligned}
f(q_t = q) &= \sum_{n=0}^{\infty}[f(q_t = q|N_t = n)\cdot P(N_t = n)] \\
&= \sum_{n=0}^{\infty}[\frac{1}{q\sqrt{2\pi\tilde{\sigma}_n^2}}\cdot e^{-\frac{1}{2\tilde{\sigma}_n^2}(\ln q-\tilde{\mu}_n)^2}\times\frac{e^{-\lambda t}(\lambda t)^n}{n!}]
\end{aligned}
\tag{3}
$$

根据上式得到的概率密度，经计算得到 $q_t$ 的分布函数，

$$
\begin{aligned}
F(q_t \le q) &= \int_0^q f(q_t = x)dx \\
&= \int_0^q\sum_{n=0}^{\infty}[\frac{1}{x\sqrt{2\pi\tilde{\sigma}_n^2}}\cdot e^{-\frac{1}{2\tilde{\sigma}_n^2}(\ln x-\tilde{\mu}_n)^2}\times\frac{e^{-\lambda t}(\lambda t)^n}{n!}]dx \\
&= \sum_{n=0}^{\infty}[\frac{e^{-\lambda t}(\lambda t)^n}{n}\Phi(\frac{\ln q-\tilde{\mu}_n}{\tilde{\sigma}_n})]
\end{aligned}
$$

其中，$\Phi(\cdot)$表示标准正态分布的累积分布函数。

根据上述推导得出的概率密度，我们可以采用最大似然估计对参数进行估计。由于不同年龄段死亡率的方差、对巨灾风险的敏感度、对医疗技术提高的敏感度等方面的不同，本文对不同年龄段的参数估计分开进行讨论，将新生儿（本文中假设为 0 岁）到 90 岁分为 91 组数据对参数进行最大似然估计，以减少误差。

### 3.2 参数估计结果分析

根据上述参数估计的设计，利用 R 软件求得 91 组参数的估计值，并根据结果运用 excel 分别绘制参数的折线图如下（具体数据结果见附录 1），观察全部参数估计值及图表，可以得到如下结论：

同一年龄的每组数据有较大差别，说明不同年龄参数应该分开回归的必要性，即符合前一小节检验设计假设中的各个年龄段对各种风险变化的敏感度不同的假设。

α 表示期望死亡率的瞬时变化率，当 α 为负的时候说明死亡率有所改善。经观察，各个年龄的参数 α 的值全都为负值，说明同一年龄段的当没有跳跃事件影响时，死亡率得到改善。这与现实情况相匹配，随着科技水平和医疗技术的提高，全球的死亡率都得到的不同程度的改善；并且 α 的值不同，说明不同年龄对对这种正的改善的敏感度也不同，且 0-70 岁 alpha 值偏小（绝对值较大），说明 0-70 岁死亡率得到改善的情况较为明显。

λ 表示死亡率发生跳跃的次数。经观察发现，大部分年龄的 λ 值都不为 0 且各不相同，说明跳跃过程的存在且不同年龄发生跳跃事件的次数不同，所以需要在模型中加入死亡率的跳跃部分且分年龄进行讨论。

在带跳跃扩散过程的随机死亡率模型中，参数 m 和 s 分别代表了，跳跃规模对数的均值和标准差。在上表中，各年龄的 m、s 都不相同，说明了各年龄对同一风险的敏感度不同。

Sigma 表示死亡率随机部分的波动情况。0-30 岁的 sigma 值较大，说明在预测 0-30 岁死亡率时，死亡率的随机部分波动较强；另外此时 m 值也较大，死亡率跳跃部分的跳跃规模也较大，进而导致死亡率可能存在较大的误差。

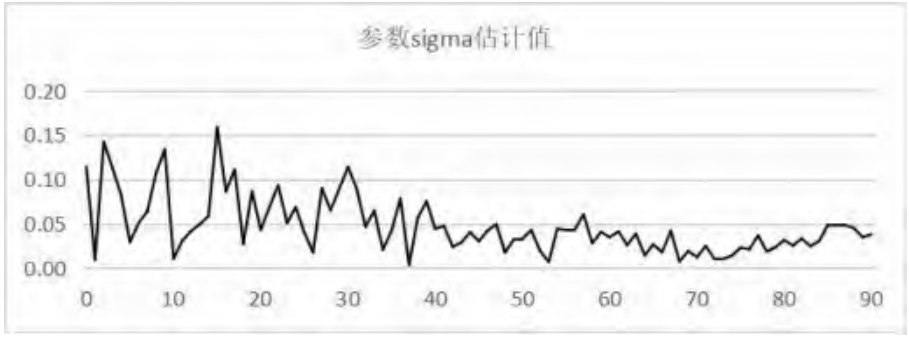



图 2 参数 sigma 估计值

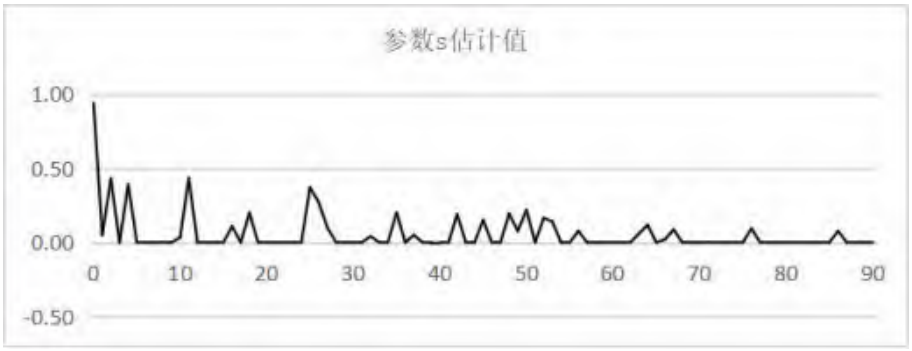



图 3 参数 s 估计值

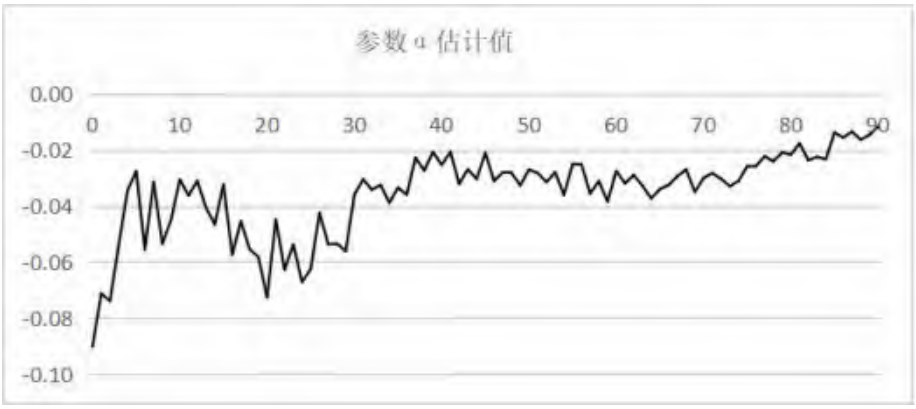



图 4 参数α估计值

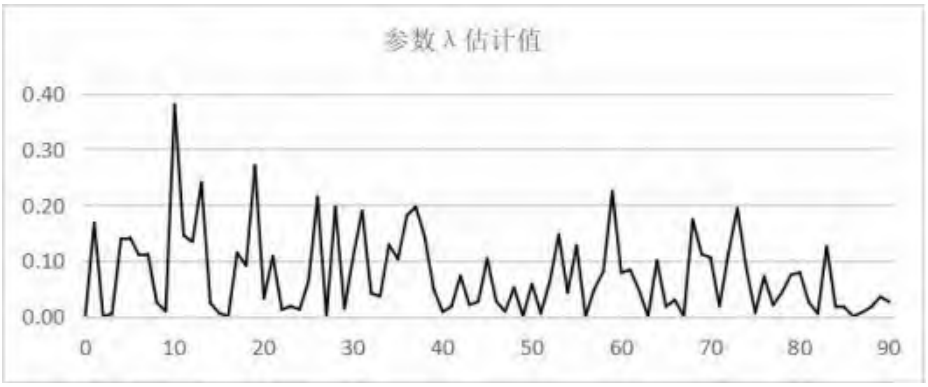



图 5 参数λ估计值

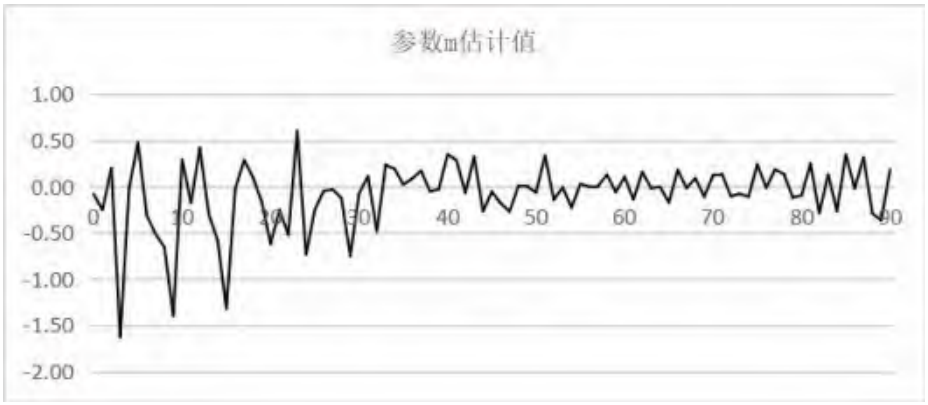



图 6 参数 m 估计值

## 3.3 模型拟合效果分析

经观察，2-30 岁与 70-90 岁的死亡率差距过大，为更易观察，更好的得出结论，将一幅折线图分为一组两幅，分别为 0-45 岁的预测值与真实值的比较与 46-90 岁的预测值与真实值比较。由于 1996-2017 年回归图表过多，此处仅展示 1996 年、2006 年、2017 年的三组图表数据（全部图表见附录 2），下图较为直观的说明了跳跃扩散死亡率随机模型在拟合 1996-2017 年中国全年龄人口死亡分布时的模型拟合效果，其中实线部分为中国全年龄人口死亡率的真实值，虚线部分为根据死亡率随机模型得到的预测值。

观察上图得到，除了个别点拟合效果不佳之外，用带跳跃扩散的死亡率随机模型拟合我国不同年份全年龄人口死亡分布的效果还是比较理想的，尤其是 2-75 岁的部分拟合效果尤佳；其他部分拟合效果稍欠佳的可能性在于新生儿和老年人受到身体机能等方面的限制，风险更大，死亡率的随机性更强。

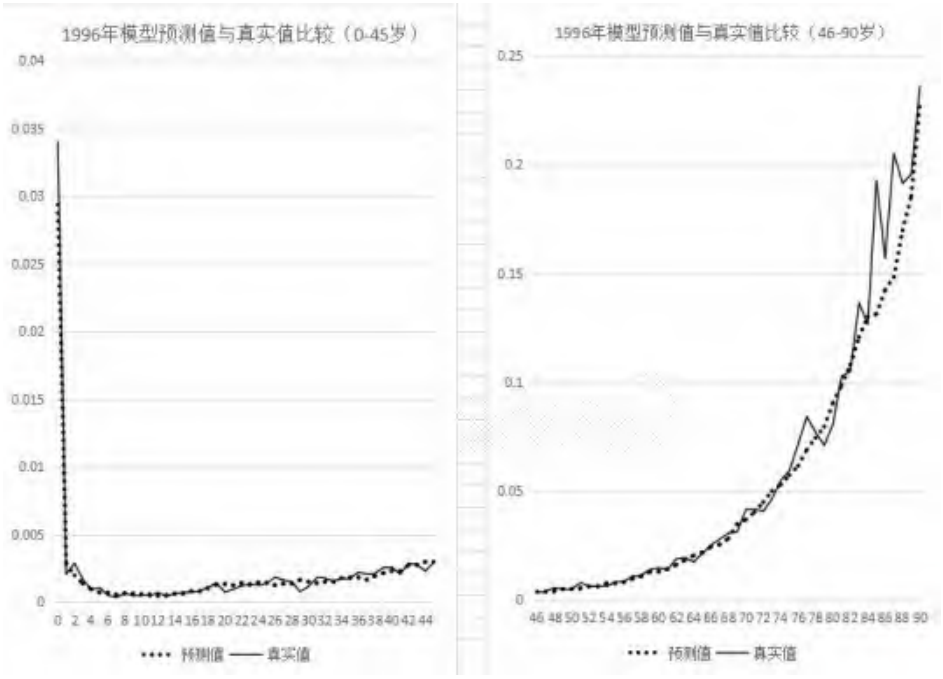



图 7 1996 年模型预测值与真实值比较

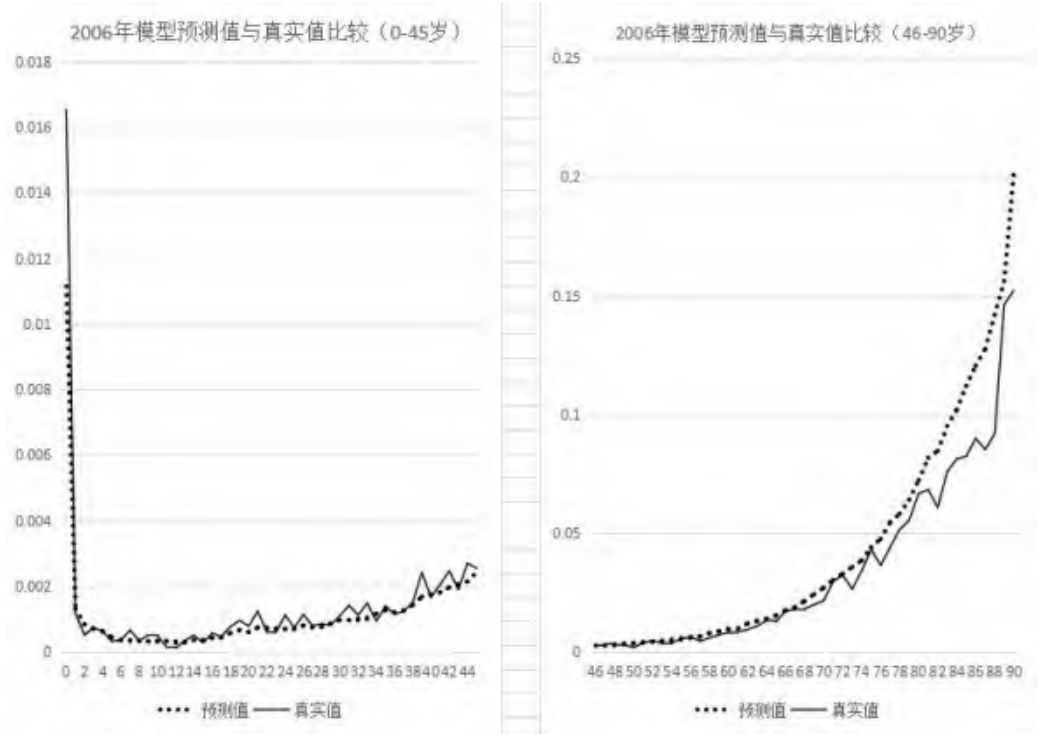



图 8 2006 年模型预测值与真实值比较

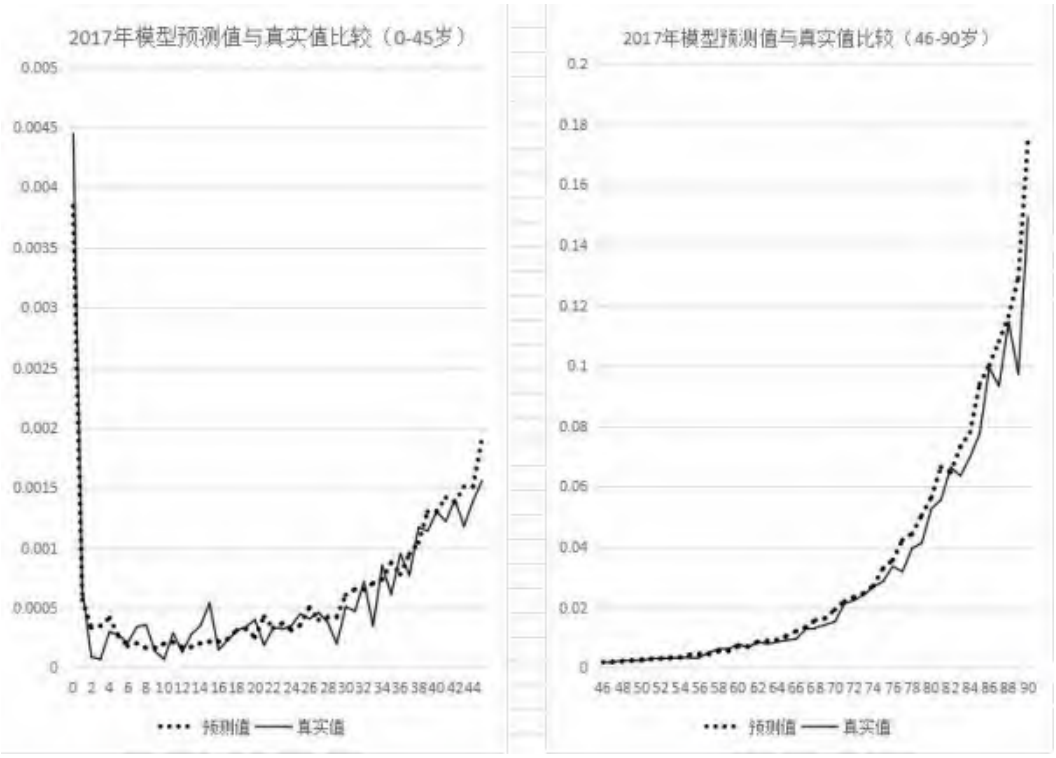



图 9 2017 年模型预测值与真实值比较

为了反映模型整体的预测水平，本节还运用 sigmaplot 软件，以 1996 年-2017 年由模型预测出的死亡率与真实死亡率所有数据进行 3D 作图，进而做出分析比较，3D 图分别如下，观察图 11 可以得到，除了预测死亡率的头部和尾部与真实死亡率存在较大的差值，2-60 岁年龄段的预测死亡率与真实死亡率基本一致。

正如之前讨论的，不论是新生儿与老年人的随机死亡率部分或者跳跃死亡率部分都比其他年龄波动大，最终导致预测结果不准确。

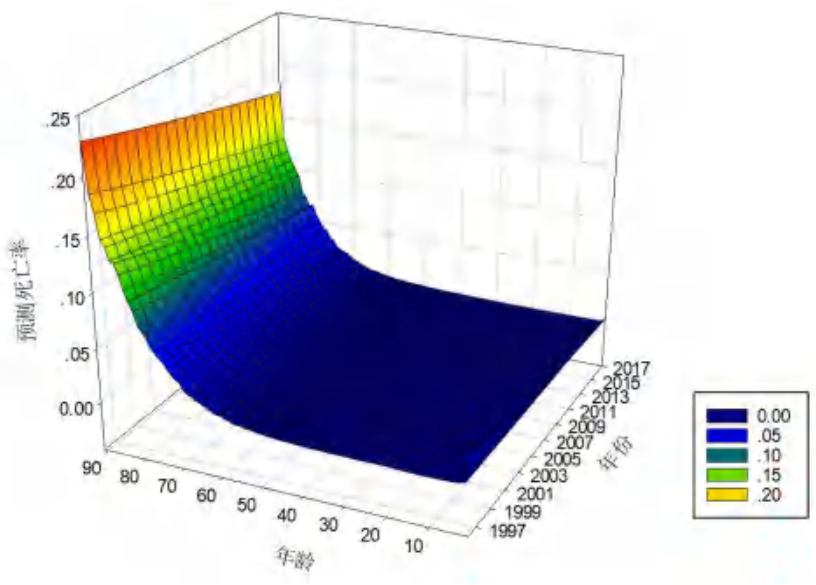



图 10 1996 年-2017 年死亡率预测值总体 3D 图

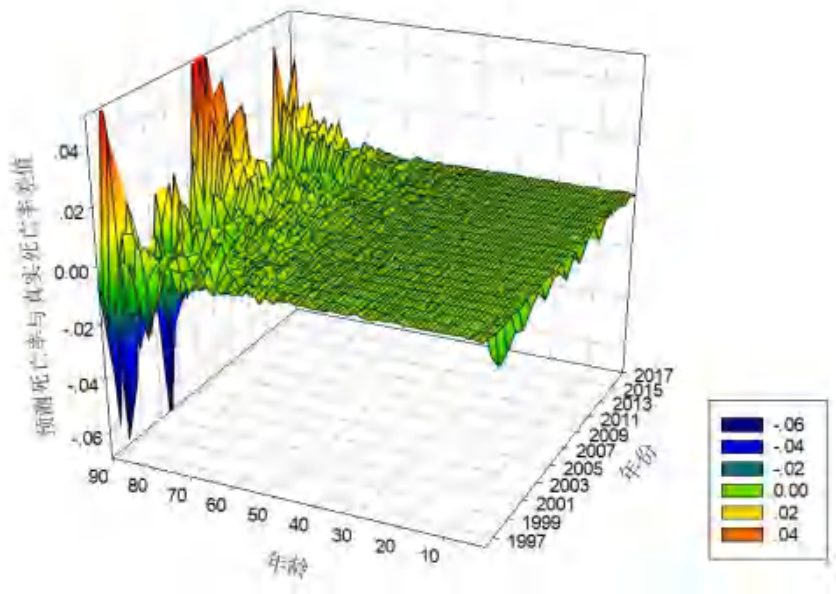



图 11 1996 年-2017 年死亡率预测值与真实值差值 3D 图

在本文中，采用参数 Bootstrap 法对参数进行 t 检验，按照每个年龄段分组重复进行以下具体步骤对不同参数准确性进行检验：

1、根据前文步骤运用最大似然估计确定模型的参数。将得到的参数带入模型中，得到确定的（2）式，进而获得 $\ln q_t$ 的方差 $\sigma t$；

2、随机生成 2000 组服从均值 $\ln q_t$，方差为 $\sigma t$ 的数据，得到 2000 组 Bootstrap 样本；

3、对每一组 Bootstrap 样本进行最大似然估计，得到参数的分布；

4、根据参数的分布，得到参数的标准误与百分位置信区间；

5、可以通过 t 检验来检验参数是否显著，对每一组模型参数进行如下判断：原假设 $H_{0t}$：待检验的参数为 0；备择假设 $H_{1t}$：待检验的参数不为 0（其中 t 为年龄）。用 Bootstrap 样本参数估计的均值与参数估计的标准误之比，求出 t 统计量；当 t 统计量超出 t 分布双侧分布的临界值 $t_{\alpha/2}$（2000）时，拒绝原假设，即认为各个参数显著。

运用 R 软件，可以得到如下 t 检验结果（仅展示 60 岁参数检验结果，全部结果见附录 1）：

研究参数检验结果可得，参数 sigma、alpha、λ 在 99%的置信水平下，在全年龄段显著，说明了模型中参数 sigma、alpha、λ 的必要性。观察发现，参数 s 仅有 1 组在 90%置信水平下和 4 组在 95%置信水平下显著，其余组别都在 99%的置信水平下显著。

经研究发现，在 90 组参数检验中，参数 m 在 90%置信水平下，有 34 组年龄的数据不显著，且绝大多数参数不显著数据分布在 0-50 岁。由于 m 在模型中表现为风险对死亡率影响跳跃规模的对数期望，而前章也假设了不同年龄对风险的敏感度不同，从而造成跳跃规模不同，即 0-50 岁人群对巨灾风险等敏感不较低，较难造成死亡率跳跃的情况，最终导致参数 m 不显著；而 51-90 岁人群对巨灾风险等敏感度较强，较容易造成死亡率发生跳跃的情况，从而这些年龄组的参数 m 较显著。所以在模型讨论时，参数 m 依然需要作为一项必要参数进行讨论。

表 1 60 岁参数检验结果

| | Coef. | s.d. | t | 95% Conf. Interval | |
|---|---|---|---|---|---|
| sigma | 0.03471693 | 0.00026198 | 156.10046408*** | 0.00708753 | 0.06624436 |
| s | -0.00000001 | 0.00295444 | 9.24071984*** | -0.00002152 | 0.19250598 |
| α | -0.02750283 | 0.00000527 | 5073.40272308*** | -0.03140585 | -0.02233038 |
| λ | 0.07851836 | 0.00569407 | 13.14112591*** | 0.00000000 | 0.25311873 |
| m | 0.10166947 | 0.05602579 | 0.75876951 | -0.58303482 | 0.32046334 |
| k | 0.10701751 | / | / | / | / |

## 4. 与死亡率相关的期权模型概述

### 4.1 死亡率期权定价模型的原理与假设

期权是购买方支付一定的价格后所获得的权利，该权利赋予期权购买方在将来某个时刻时间买或卖一定数量的基础商品。根据无套利定价原理，期权的价格等于期权未来获利的现值。以欧式看涨期权为例，即：

$$C_0(P,K) = e^{-r(T+1)}E[\max(P-K,0)] \tag{4}$$

其中，P 是标的物价格；K 是期权的执行价格；$C_0$ 是欧式看涨期权的价格，是由标的物价格和期权执行价格决定的；r 是连续复利的无风险利率；T 是欧式

期权的到期日距离现在的时间。

根据期权的理论基础，我们可以得到一下与死亡率相关的欧式看涨期权定价模型；

$$C_0(q,K)=e^{-r(T+1)}E[\max(q-K,0)] \tag{5}$$

其中 q 为真实死亡率，K 为期权的执行死亡率。

将（3）带入（5）中得

$$\begin{aligned}E[\max(q-K,0)]&=\int_K^{\infty}(x-K)\cdot f(q=x)dx\\&=\int_K^{\infty}\sum_{n=0}^{\infty}\frac{1}{\sqrt{2\pi\sigma_n^2}}e^{-\frac{1}{2}(\frac{\ln q-\mu_n}{\sigma_n})^2}\times\frac{e^{-\lambda T}(\lambda T)^n}{n!}dx-K\int_K^{\infty}f(q=x)dx\\&=\frac{e^{-\lambda T}}{\sqrt{2\pi}}\times\sum_{n=o}^{\infty}\frac{(\lambda T)^n}{\sigma_n n!}\times\int_K^{\infty}e^{-\frac{1}{2}(\frac{\ln x-\mu_n}{\sigma_n})^2}dx-K\int_K^{\infty}f(q=x)dx\end{aligned}$$

由于，当 N=n 时，q 的条件分布服从对数正态分布，

$$\begin{aligned}\int_K^{\infty}f(q=x)dx&=\sum_{n=0}^{\infty}\int_K^{\infty}f(q=x|N=n)\times f(N=n)dx\\&=\sum_{n=0}^{\infty}\frac{e^{-\lambda T}(\lambda T)^n}{n!}\times[1-\Phi(\frac{\ln K-\mu_n}{\sigma_n})]\end{aligned}$$

又令 $z=\frac{\ln x-\mu_n}{\sigma_n}$，则 $x=e^{z\cdot\sigma_n+\mu_n}$，带入上式

$$\begin{aligned}\int_K^{\infty}e^{-\frac{1}{2}(\frac{\ln x-\mu_n}{\sigma_n})^2}dx&=\sigma_n\int_{\frac{\ln K-\mu_n}{\sigma_n}}^{\infty}e^{-\frac{1}{2}z^2+z\cdot\sigma_n+\mu_n}dz\\&=\sigma_n\times e^{\mu_n+\frac{1}{2}\sigma_n^2}\int_{\frac{\ln K-\mu_n}{\sigma_n}}^{\infty}e^{-\frac{1}{2}(z-\sigma_n)^2}dz\\&=\sqrt{2\pi}\sigma_n\times e^{\mu_n+\frac{1}{2}\sigma_n^2}\times[1-\Phi(\frac{\ln K-\mu_n}{\sigma_n}-\sigma_n)]\end{aligned}$$

最终，得出欧式看涨期权定价模型为：

$$C_0(q,K)=e^{-r(t+1)}\sum_{n=0}^{\infty}e^{\frac{-\lambda t(\lambda t)^n}{n!}}\times\{e^{\mu_n+\frac{1}{2}\sigma_n^2}\times[1-\Phi(\frac{\ln K-\mu_n}{\sigma_n}-\sigma_n)]-K\cdot[1-\Phi(\frac{\ln K-\mu_n}{\sigma_n})]\}$$

同理，得到欧式看跌期权定价模型为：

$$C_0(q,K)=e^{-r(t+1)}\sum_{n=0}^{\infty}e^{\frac{-\lambda t(\lambda t)^n}{n!}}\times\{K\cdot[\Phi(\frac{\ln K-\mu_n}{\sigma_n})]-e^{\mu_n+\frac{1}{2}\sigma_n^2}\times[\Phi(\frac{\ln K-\mu_n}{\sigma_n}-\sigma_n)]\} \tag{6}$$

## 4.2 期权与长寿连接型年金的定价

在不完备的保险市场中，死亡率是一种不能连续交易的资产，所以需要运用相应的技术手段将死亡率风险中性化。在不完备的保险市场中，对死亡率风险中性化常用的技术手段是 Wang（2000,2002）提出的王变换法。由于王变换法具有变换前后不改变原正态分布和对数正太分布形式的良好特征，被保险定价学术界广为使用。本文中采用王变换法的特殊形式，单参数王变换法，即

$$F^*(x)=\Phi[\Phi^{-1}(F(x))+\varphi]$$

对文章中的死亡率风险中性化处理，运用到期权定价与长寿连接型年金定价中，其中$\varphi$是风险的市场价格。

结合王变换法与跳跃死亡率预测模型可以得到不同市场风险价格条件下，中性化死亡率的计算方式，即

$$q_t^* = q_0 \cdot e^{(\alpha-\frac{1}{2}\sigma^2-\lambda k)t+\sigma\varphi\sqrt{t}+\sigma W_t^*} \cdot \prod_{b=1}^{N_t} Y^* e^{\varphi s} \tag{7}$$

当$N_t$=n 时，ln（$q_t^*$）服从均值为$\tilde{\mu}_n = \ln q_0 + (\alpha - \frac{1}{2}\sigma^2 - \lambda k)t + \sigma\varphi\sqrt{t} + n(m+\varphi s)$，方差为$\tilde{\sigma}_n = \sigma^2 t + ns^2$的对数正态分布。

图 12 中展示的是 20 岁时不同风险市场价格下，经过风险中性化后，其死亡率概率分布的变化。可以看出死亡率概率密度随风险市场价格变大向右移动，即风险中性化后的死亡率大于真实死亡率，体现了风险中性化对死亡率的影响，从而影响期权定价的准确性。

有了以上的理论准备，对期权和长寿连接型年金进行定价。为了方便起见，将风险市场价格取 0.5，以一个 2020 年 x 岁的人购买期初支付的延期 60-x 年的预期各期支付为 1 的永续年金为例，我们将延期 5 年到 30 年的各支付阶段长寿风险值和支付值作图如下。

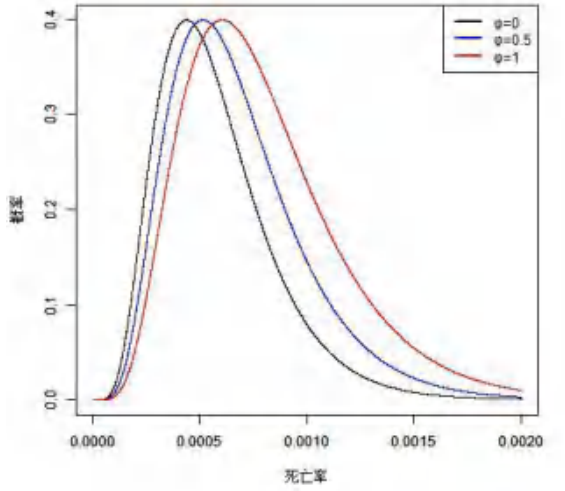
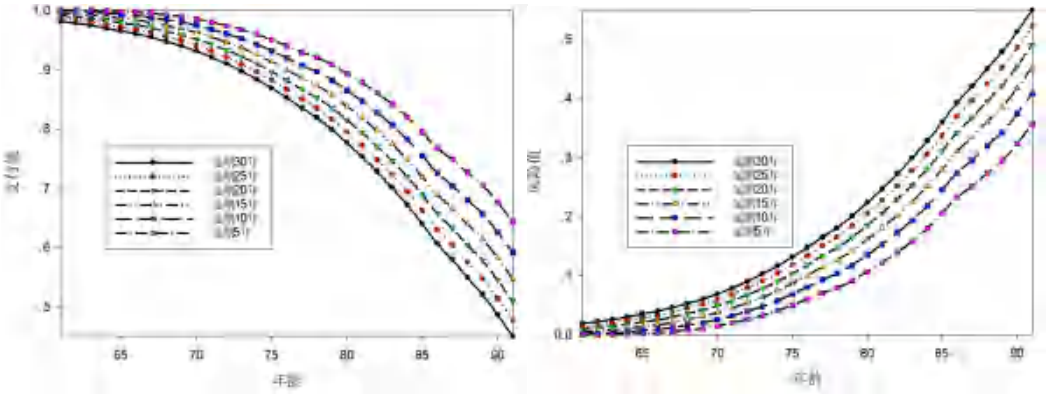



图 12 不同市场风险价格下，同一年龄死亡率概率分布的比较

从图 13 中，横向对比可以看出 65 岁前，长寿风险相对有限，支付值与预期支付的偏差较小，都低于实际值的 5%，之后随着年龄增加长寿风险也加速上升，从而导致实际支付与预期支付偏差越来越大；纵向对比可以看出，延期时间越长，长寿风险风险值越高，从而导致实际支付偏差越大，实际支付值就越低。综上得，随着年龄上升和延期年限的增加，都会造成长寿风险的上升，此时就需要长寿期权来分散这一部分的风险，对实际支付值做出调整。



（a） （b）

图 13 不同延期年限各期支付值与风险值比较

以 5%的固定利率水平对普通延期年金。长寿连接型延期年金与期权价格进行计算，并得出下表，由表 2 可知，普通延期年金与长寿连接型延期年金的价格随着延期的缩短而增加，这是因为购买人的年龄上升导致的；期权的价格随着延期年限的缩短而下降，这是由于死亡率信息间隔时间较短，造成的实际死亡率与预测值偏差变小，降低了死亡率期权的价格；由于年金随延期缩短而增加，期权随延期年限的缩短而减少，导致了期权占年金的比重也下降，所以延期年限长的年金对购买人有着更大的吸引力；不论是 30 岁购买还是 55 岁购买延期长寿连接型年金，其价格都可以下降原普通延期年金的 10%左右，这对购买人相对有吸引力。

表 2 不同年金及期权的价格变化

| 年龄 | 30 | 35 | 40 | 45 | 50 | 55 |
|---|---|---|---|---|---|---|
| 普通延期年金 | 12.504 | 12.548 | 12.618 | 12.712 | 12.857 | 13.083 |
| 期权价格 | 1.230 | 1.203 | 1.173 | 1.143 | 1.117 | 1.101 |
| 长寿连接延期年金 | 11.274 | 11.345 | 11.444 | 11.569 | 11.740 | 11.983 |
| 期权与长寿年金比 | 10.91% | 10.60% | 10.25% | 9.88% | 9.52% | 9.19% |
| 期权与普通年金比 | 9.84% | 9.59% | 9.30% | 8.99% | 8.69% | 8.42% |

## 4.3 定价结果分析

4.3.1 定价敏感性分析

为了研究期权在不同市场风险价格下的敏感程度，对当市场风险价格为 0/0.1/0.3/0.5 的情况下期权价格进行计算，得出下表。

观察下表可以得到，同一市场风险价格下，长寿期权价格随着延期期限的下降而下降；同一延期期限的普通递延年金，长寿期权的价格随市场风险价格的上升而上升；同一市场风险价格下，期权价格占普通年金产品的比例随延期年限的减少而减少；同一延期年限的普通递延年金，长寿期权价格占普通年金产品的比例随市场风险价格的上升而上升。长寿连接型年金的购买人通过更大幅度的年金价格下降来弥补确定性支付的牺牲。

表 3 不同市场风险价格下期权价格比较

| 年龄 | 30 | 35 | 40 | 45 | 50 | 55 |
|---|---|---|---|---|---|---|
| 普通递延年金 | 12.774 | 12.812 | 12.870 | 12.955 | 13.082 | 13.273 |
| 期权价格 | | | | | | |
| $\varphi$=0 | 1.063 | 1.036 | 1.007 | 0.978 | 0.953 | 0.937 |
| $\varphi$=0.1 | 1.095 | 1.068 | 1.039 | 1.009 | 0.983 | 0.968 |
| $\varphi$=0.3 | 1.160 | 1.133 | 1.104 | 1.074 | 1.048 | 1.032 |
| $\varphi$=0.5 | 1.230 | 1.203 | 1.173 | 1.143 | 1.117 | 1.101 |
| 长寿连接型年金价格 | | | | | | |
| $\varphi$=0 | 11.711 | 11.776 | 11.863 | 11.976 | 12.129 | 12.336 |
| $\varphi$=0.1 | 11.679 | 11.744 | 11.831 | 11.945 | 12.098 | 12.306 |
| $\varphi$=0.3 | 11.613 | 11.679 | 11.766 | 11.880 | 12.033 | 12.241 |
| $\varphi$=0.5 | 11.544 | 11.609 | 11.697 | 11.811 | 11.964 | 12.172 |

为了研究不同理论对不同市场风险价格的长寿期权价格的影响，在 3%的利率水平下对不同期权价格进行计算，并得到下表。与表 4 中的 5%利率相比，可以看出，普通年金与长寿期权的价格随利率的下降而上升，这是由于利率下降导致折现率下降，从而导致年金与期权的现值上升；与表二相似，相同年金延期期限下，市场风险价格越大期权价格越高，相同市场风险价格下，延期期限越短期权价格越地，这一结论没有因利率变化而变化是稳健的；市场风险价格与年金延期期限都相同的条件下，利率越低，长寿期权占普通年金的比例越大，所以低利率下，年金购买者更加愿意购买长寿连接型年金。

表 4 3%利率水平下期权价格比较

| 年龄 | 30 | 35 | 40 | 45 | 50 | 55 |
|---|---|---|---|---|---|---|
| 普通递延年金 | 15.458 | 15.504 | 15.575 | 15.677 | 15.831 | 16.062 |
| 期权价格 | | | | | | |
| $\varphi$=0 | 1.619 | 1.590 | 1.556 | 1.522 | 1.491 | 1.474 |
| $\varphi$=0.1 | 1.668 | 1.638 | 1.604 | 1.569 | 1.539 | 1.522 |
| $\varphi$=0.3 | 1.768 | 1.738 | 1.705 | 1.669 | 1.639 | 1.622 |
| $\varphi$=0.5 | 1.875 | 1.845 | 1.811 | 1.776 | 1.745 | 1.728 |
| 长寿期权占普通年金比 | | | | | | |
| $\varphi$=0 | 10.48% | 10.25% | 9.99% | 9.71% | 9.42% | 9.18% |
| $\varphi$=0.1 | 10.79% | 10.56% | 10.30% | 10.01% | 9.72% | 9.47% |
| $\varphi$=0.3 | 11.44% | 11.21% | 10.94% | 10.65% | 10.35% | 10.10% |
| $\varphi$=0.5 | 12.13% | 11.90% | 11.63% | 11.33% | 11.02% | 10.76% |

4.3.2 期权可行性分析

根据上文可知，长寿年金购买者通过牺牲固定的年金支付来换取更低的年金价格，长寿年金购买者如果觉得更低的年金价格能够弥补牺牲的年金支付就会购买长寿连接型年金，反之年金购买者将不会购买长寿连接型年金转而购买普通年

金，所以本章将对不同类型的年金购买者的这两个方面进行量化处理进行比较，从而确定期权的可行性。

参照 Bravo and Freitas（2018）中的方法，我们以确定性等价消费来度量年金购买人的福利效用改善情况。可以表示为：

$$U = E(\sum_{k=1}^{\omega-(x+1)} e^{-\delta(k-1)} *_k p_x * \frac{c_k^{1-\eta}}{1-\eta}), \eta \neq 1, \eta > 0$$

其中，在长寿连接型年金计算中，$c_k$ 等于真实死亡率调整的动态支付；δ 表示年金购买人的主观时间偏好取值大于 0；η 是相对风险厌恶系数。再将年金购买人的期望终生效用转换成等效用固定年金收入，

$$EA = [\frac{U(1-\eta)}{\sum_{k=1}^{\omega-(x+1)} e^{-\delta(k-1)} *_k p_x}]^{\frac{1}{1-\eta}} \tag{8}$$

根据上式，我们就可以计算等效用固定生存年金的公平定价，通过计算得出的转换的等效用固定年金收入与真实年金价格进行对比，就可以判定出长寿连接型年金购买人的效用改善情况。

为了方便起见，假设在利率水平 i=5%，主观时间偏好 δ=0.02，相对风险厌恶系数 η=2 的情况下，对 2020 年 60 岁投保的期初支付为 1 的永续普通年金与长寿连接型年金价格进行计算，得出以下表格。

观察可知，相对于普通年金，长寿连接型年金由于牺牲了固定支付而带来了更低的价格；长寿风险全部转移，由原来年金发行人承担 100%长寿风险，转移为由年金购买人承担 100%风险，但是相对价格下降了，这在保险精算方面是等价的；而从福利角度来看，长寿连接型年金以普通年金 91.6%的价格给年金购买人带来了 94.3%的等效用固定收入。综上得，相对于年金发行人而言，长寿期权将长寿风险分散出去；相对于年金购买人而言，年金购买人得到了更高的福利，这是一个帕累托改进，可以证明该长寿期权的有效性和可行性。

表 5 不同年金相关指标比较

| | 年金发行人各项指标 | | 年金购买人各项指标 | | |
|---|---|---|---|---|---|
| | 价格 | 风险承担 | 风险承担 | EA | $P / \ddot{a}_{60}^{F_k}$ |
| 普通年金 | 13.082 | 100% | 0% | 1 | 100% |
| 长寿连接型年金 | 11.988 | 0% | 100% | 0.943 | 91.6% |

为了验证长寿期权的广泛性，即面对不同年金购买者期权的吸引程度，分别对主观时间偏好 δ=0.02（耐心），0.04（一般），0.08（不耐烦）和相对风险厌恶参数分别 η=2（低风险），5（中风险）和 10（高风险）的年金购买人的等效用固定年金收入做出比较。

观察下表，在相同主观时间偏好下，不同风险厌恶程度的年金购买人的 EA 随着风险厌恶程度的上升而下降；在相同风险厌恶程度的条件下，不同主观时间偏好的年金购买者的 EA 随主观时间偏好的上升而上升；主观时间偏好越高，风

险厌恶程度越低的人，长寿连接型年金对他们的吸引力越大；高风险厌恶的人（η=10）和小部分主观时间偏好较小的人（δ=0.02，η=5），其等效用确定年金收入小于普通年金的 91.6%，他们认为相对于长寿连接型年金中牺牲的固定支付要高于得到的价格优惠，长寿连接型年金对这一群人来说不具有吸引力。

表 6 不同年金购买人等效用固定年金收入年金比较

| EA | | η | | |
|---|---|---|---|---|
| | | 2 | 5 | 10 |
| δ | 0.02 | 0.921 | 0.900 | 0.831 |
| | 0.05 | 0.943 | 0.924 | 0.867 |
| | 0.08 | 0.960 | 0.947 | 0.900 |

## 5. 结论

首先，本文从保险公司本文从死亡率整体下降的大背景出发，介绍了死亡率预测对于保险公司经营情况的重要性；然后，从 Cox, Lin, and Wang (2006) 提出的带跳跃扩散的死亡率模型出发，对该模型进行了概述，并且根据我国 1995-2017 年的真实数据对模型参数进行分组最大似然估计；然后对 Bootstrap 法进行了简要的介绍，并且用 Bootstrap 法对上述模型参数进行检验，检验模型参数的必要性和准确性；最终，运用将期权定价模型应用到随机死亡率中，将死亡率的变化作为期权执行的条件，建立与死亡率相关的期权定价模型，计算出长寿连接型年金产品与长寿期权的价格，并验证了不同系数下长寿期权的敏感度，从等效用年金收入出发验证长寿连接型年金产品的吸引力和可行性，在寿险公司将死亡率风险分散到资本市场中起重要作用。

跳跃随机死亡率预测模型和嵌入欧式期权的创新型保险产品对于未来真实死亡率的预测和分散死亡率变化带来的风险有着重要的现实意义和参考价值。不论是保险公司自身还是发展国内保险市场、完善国内保险系统都有着重要的意义；

（1）有利于国内保险企业营运能力，偿付能力和抗风险能力的提高。通过跳跃随机死亡率模型预测出来的死亡率，更接近未来真实死亡率，使得保险公司产品的定价更加准确，降低由于国内人口老龄化发展，造成年金保险公司支付期限延长的风险；降低由于巨灾事件的发生，短期内实际死亡率骤升，造成的短期内寿险公司偿付能力不足的风险。从而提高国内保险企业的营运能力，偿付能力和抗风险能力。通过对保险产品中嵌入欧式期权的方式，同时也可以分散由于真实死亡率与预期死亡率存在较大差异的风险。

（2）有利于缓解政府养老金给付压力。我国养老保险制度由于人口老量化加剧在运行过程中也出现“赤字”和“空帐”局面。为了缓解政府养老金给付的压力，政府也做出了相应的调整，如延缓支付期限，延长退休年龄等方式，但这只是解决养老金给付问题权宜之计。社会养老保障体系的关注重点和迫切需求已经逐渐转向长寿风险的控制和分散。死亡率的预测能有效控制长寿风险，长寿风险证券化能有效分散风险，从而在根本上缓解政府养老金给付的压力。

（3）有利于提高国内保险公司的国际竞争力。由于国内保险市场发展起步较晚，开发程度较低，国内保险公司在运营和资本实力方面都与国外发达国家保险公司存在一些差距，再加上中国加入 WTO 之后，国外保险公司以合资的形式进

入保险市场，给国内保险公司发展带来了巨大的挑战和压力。国内保险公司通过跳跃随机死亡率模型对真实死亡率的精准预测，可以提升国内保险公司较国外相同保险产品价格优势和相同价格的保险产品的服务水平，从而提升国内保险公司的运营水平和综合实力，提高国内保险公司的国际竞争力。

（4）有利于完善保险市场，提高保险市场与资本市场的融合程度。将普通的保险产品与死亡率期权现结合，使得保险市场与资本市场相互渗透、相互融合。这不仅仅可以提升资本市场的规模和效率，同时还可以帮助保险市场分散自身风险，将保险市场承担的风险分散到资本市场中去。

本文的不足之处及后续研究：

1. 由于男女死亡率存在差异，而本文模型中没有将这部分死亡率差异考虑在内，后续研究可以对模型进行拓展，加入性别的哑变量；

2. 本文中应用的利率是固定的，而现实生活中利率也是随机游走的，在后续的研究中可以将利率随机模型应用到期权定价中，使期权定价更合理准确。

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# 死亡率动态预测与期权定价——基于跳跃扩散死亡率随机模型

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**关键词:** 死亡率预测；死亡率期权；bootstrap方法

**中文摘要.** 人口死亡率的预测一直是保险精算研究的重要基础性课题，一方面随着人们生活水平的提高和医疗技术的进步，各个年龄段的死亡率呈现出明显的下降趋势；另一方面巨灾风险和突发公共卫生事件的发生又会造成死亡率的短期大幅度上升，因此依赖静态生命表的传统精算方法将难以避免的造成死亡率的高估或低估，越来越难以满足保险产品定价和风险评估的要求，并严重影响保险公司的风险管理和稳健运营。鉴于此，本文将尝试从死亡率的随机建模和死亡率衍生产品创新的角度来探讨应对方案。首先，本文将建立带跳跃过程的随机死亡率建模，并根据我国1995-2017年实际死亡率的数据，运用bootstrap方法和最大似然估计法对模型中的参数进行估计。通过对参数标准误和置信区间进行分析，以及对参数稳健性的检验，本文发现，相对于传统方法，bootstrap方法在均值样本分布是正态分布或者样本容量不够大的情况下，对统计量的精确程度有着更准确的判断。其次，本文在产品设计上进行创新，在年金产品中嵌入一个欧式死亡率期权，给予保险公司当死亡率与预测死亡率偏离过大时调整赔付额度的权利，并且运用资产定价理论研究了这种新型制度设计下的产品定价和风险特征，研究结

果表明嵌入式死亡率期权根植于人口死亡率动态变化的真实基础，理顺了年金双方的权责关系，兼顾了定价公平和风险管理的合理性，能大幅提高保险产品风险度量的准确性和稳健性，对促进商业年金的发展具有重要的现实意义和参考价值。

# Research on the Dynamic Relationship of Stock Market Fluctuations in Various Countries under the Epidemic

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**Keywords:** COVID-19 epidemic; VAR model; Stock market; Dynamic relationship

**Abstract:** In 2020,the COVID-19 epidemic spread around the world,which not only posed a threat to people's lives and health,but also impacted the global real economy,thus affecting the financial market.The financial market in the United States and other countries began to fall off a cliff,which is rare in history.In recent years,although many scholars have studied the correlation of stock markets,there are still few researches on the dynamic relationship of stock markets in different countries.This paper selects the daily stock closing price data of the top four GDP countries in the world in 2020:the United States,China,Japan and Germany,among which the Shanghai Composite index represents the Chinese stock market,the Nikkei 255 index represents the Japanese stock market,the German DAX index represents the German stock market,and the Dow Jones index represents the American stock market.The sample interval is solstice on November 1,2019 and February 26,2021.After eliminating the missing data,291 sample data are obtained to establish

the VAR model for empirical analysis,to explore the linkage of global stock market return volatility,as well as the conduction path of stock market risk and the degree of response to dynamic shocks.

Firstly,the Granger causality test not only confirms the existence of Granger causality in the stock markets of the four countries under the epidemic.After a country's stock market is impacted by an emergency,it may also have a certain impact on the stock markets of other countries, that is, There is linkage in the global stock market,and the risk transmission path of the four-country stock market has been obtained;Secondly,the impulse response analysis shows that the epidemic has a long-term negative impact on global stock markets;After that, through the variance decomposition, it can be seen that the Shanghai Composite index yield and the Nikkei 255 index yield, the German DAX index yield, and the Dow Jones index yield are most affected by the interference and changes of their own factors,while the impact of the fluctuations in the stock markets of the other three countries is relatively small.Its own lagging order has an obvious effect on the current or future, and it has a relatively strong predictive function on the changes of its own indicators.Finally,some policy recommendations are put forward on this basis to provide some references for the government and investors:(1)Investors should allocate financial assets reasonably,adjust investment strategies in a timely manner,and pursue higher returns as much as possible under the established risk level.(2)The government should speed up the establishment of an international coordination mechanism,formulate a multi-country coordination system and emergency management system to prevent the impact of emergencies on the financial market and maintain market confidence;(3)For the impact of emergencies,China should strengthen the risk contagion mechanism,guide the investment behavior of investors, and reduce the losses in the financial market.

## 1.引言

2019 年，中国经济抵抗住了外来冲击的影响，保持总体平稳、稳中有进的态势，向外界展现了巨大的韧性与潜力[1]。但在 2020 年初，突如其来的 COVID-19 疫情对于全球来说无疑是一场灾难，新冠肺炎最初在中国武汉爆发，接着蔓延到全国，甚至全球，疫情不仅对人们的生命健康财产带来了严重的威胁，也对全球的经济带来了极大的冲击，几乎每个国家短期内各类生产活动停滞，整体经济下滑，还对各国股票市场带来了严重的冲击。随着病毒的传播、病例数量的不断增加，人们越来越关注 COVID-19 疫情的发展走向。图 1 为 2020 年全球排名前十国家 GDP 增长率，由图可得，除了中国，其他九个国家的 GDP 都呈现负增长。股票市场作为经济发展的“晴雨表”，股价预示着经济未来走势，其波动可能导致实体经济衰退。以资本市场为代表的全球金融市场断崖式下跌，美国股市更是在 8 个交易日中，发生 4 次熔断。很多国家都制定了政策，此次疫情是否会引发金融危机受到各界的广泛关注。新冠肺炎疫情这一突发事件会对全球国家的股市带来怎么样的影响的？各国的股市有着怎么样的联动性和风险传导性？

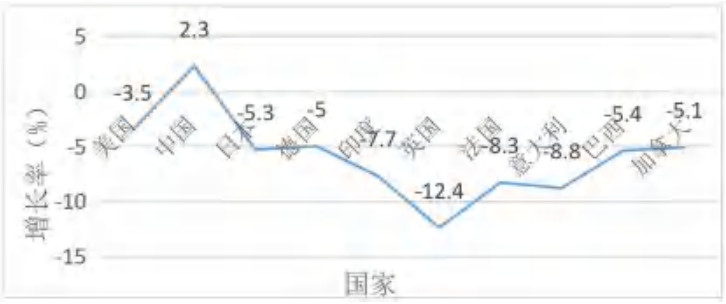


图 1 2020 年全球排名前十国家 GDP 增长率

从动态冲击影响来看，突发事件不仅会对金融市场造成冲击，而且冲击可能具有持续性。刘晓华（2007）通过研究上证 180 指数，研究表明“9.11”事件对中国股市的冲击是一个连续的过程[2]。Ichev 和 Marinc（2017）研究指出，地理上更接近埃博拉病毒爆发事件发源地的企业受股市冲击更严重[3]。考虑到股票之间相互影响具有不对称性，存在显著的非线性信息溢出效应。周璞等（2012）通过格兰杰因果检验，对中国股票市场和世界其他股票市场进行研究，研究表明两者之间存在显著的非线性信息溢出效应[4]。Vrost 等(2015)通过格兰杰因果检验对全球股票市场的收盘价格进行研究，结果表明金融危机对美国股票市场的冲击减小，在全球范围内关系越紧密的市场，相应的溢出效应越高[5]。

从全球股票市场的联系来看，各国的股票市场之间可能具有一定的动态关系。张双妮等(2019) 选取上证指数、道琼斯指数等指数数据，利用 GARCH(1，1)、Granger 因果检验等对其进行研究，研究发现纳斯达克指数和道琼斯指数是上证指数的格兰杰原因，美股对中国股市具有持久冲击的影响，美股对中国股具有较弱的传导效应[6]。钟熙维等（2020）利用脉冲响应函数和方差分解对股票数据进行研究。研究发现：上证指数、道琼斯指数和恒生指数三大指数之间具有联动性，疫情对全球股票市场的动态冲击具有持久性[7]。

综合国内外研究，发现学者们在中美股票市场的联动性已有大量研究，但是多国股票的联动性的研究却比较少，在疫情背景下，本文以中、日、德、美四国的股票市场为例，探讨全球股票市场收益率波动的联动性，以及股票市场风险的传导路径和对动态冲击的响应程度，并在此基础上提出一些政策建议，为政府和投资者提供参考。

## 2.数据说明

本研究选取 2020 年 GDP 全球排名前四的美国、中国、日本、德国四国的股票日收盘价数据，其中上证指数、日经 255 指数、德国 DAX 指数和道琼斯指数分别代表中国、日本、德国和美国股票市场。样本区间为 2019 年 11 月 1 日至 2021 年 2 月 26 日，由于每个国家的股市开盘日有所差异，为此对存在缺失数据的日期进行剔除后得到 291 个样本数据，并根据收盘价分别计算每支股票收益率，上证指数收益率、日经 255 指数收益率、德国 DAX 指数收益率、道琼斯指数收益率分别用 $r_1$、$r_2$、$r_3$、$r_4$表示。数据来源于英为财情网站。

## 3.实证分析

### 3.1 平稳性检验

股票数据通常带有时间趋势，为了消除“伪回归”现象，需要对股票收益率序列进行平稳性检验。由 ADF 检验结果（表略）可知：在不同的置信水平下，四国股票收益率序列的 t 统计量皆小于临界值，因此得出四国股票收益率序列都是平稳的。可以进行建模和估计。

### 3.2 滞后阶数的确定

在通过 VAR 模型分析时，根据 LR、FPE、AIC、SC 和 HQ 五个常用指标，确定了本文的最佳滞后阶数。由表 1 可以得出，当滞后期为 2 时，LR、FPE、AIC 通过检验，表现为“*”符号最多[8]，因此最优滞后阶数为 2。建立 VAR（2）模型。

表 1 滞后阶数选取检验结果

| Lag | LagL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 3212.510 | NA | 2.12e-15 | -22.43713 | -22.38600 | -22.41664 |
| 1 | 3301.956 | 175.7638 | 1.27e-15 | -22.95074 | -22.69507* | -22.84826* |
| 2 | 3325.561 | 45.72605* | 1.20e-15* | -23.00393* | -22.54373 | -22.81947 |
| 3 | 3330.819 | 10.03695 | 1.30e-15 | -22.92880 | -22.26408 | -22.66236 |

注：*表示在 5%的置信水平下通过检验

### 3.3 格兰杰因果检验

在新冠肺炎疫情下，四国股票收益率之间是否存在因果关系，因此通过 Granger 因果检验对四国股票收益率之间的关系进行检验，见表 2。

表 2 Granger 因果关系检验结果

| 原假设 | $X^2$统计量 | P 值 |
|---|---|---|
| $r_2$ does not Granger Cause $r_1$ | 5.248318 | 0.0725 |
| $r_1$ does not Granger Cause $r_2$ | 2.878163 | 0.2371 |
| $r_3$ does not Granger Cause $r_1$ | 4.112798 | 0.1279 |
| $r_1$ does not Granger Cause $r_3$ | 5.870276 | 0.0531 |
| $r_4$ does not Granger Cause $r_1$ | 1.380865 | 0.5014 |
| $r_1$ does not Granger Cause $r_4$ | 0.781974 | 0.6764 |
| $r_3$ does not Granger Cause $r_2$ | 5.985830 | 0.0501 |
| $r_2$ does not Granger Cause $r_3$ | 34.54381 | 0.0000 |
| $r_4$ does not Granger Cause $r_2$ | 5.730199 | 0.0570 |
| $r_2$ does not Granger Cause $r_4$ | 1.106573 | 0.5751 |
| $r_4$ does not Granger Cause $r_3$ | 15.61680 | 0.0004 |
| $r_3$ does not Granger Cause $r_4$ | 1.352784 | 0.5084 |

注:格兰杰果关系检验的置信水平为 10%

由表 2 可知，在 10%的显著水平下，在第一组中，上证指数收益率和日经 255 指数收益率存在单向的格兰杰原因，在新冠疫情的背景下，日经 255 指数收益率滞后项对上证指数收益率当前值有一定预测能力；在第二组中，上证指数收益率

和德国 DAX 指数收益率也存在单向的格兰杰原因，上证指数收益率对德国 DAX 指数收益率有一定预测能力；在第三组中，上证指数收益率和道琼斯指数收益率无格兰杰因果关系，彼此之间无预测能力；在第四组中，日经 255 指数收益率和德国 DAX 指数收益率存在双向的因果关系，从实质上讲，日经 255 指数收益率滞后项对德国 DAX 指数收益率当前值有一定的影响，德国 DAX 指数收益率滞后项也会对日经 255 指数收益率当前值有一定的预测能力；在第五组中道琼斯指数收益率对日经 255 指数收益率有一定的预测能力；在第六组中道琼斯指数收益率对德国 DAX 指数收益率有一定的预测能力。

相对于中国，其他三国的的疫情发展比较严重，而中国作为率先控制疫情进行复工复产的国家，对全球经济的复苏起着中坚力量的作用，全球资本市场对中国经济政策的变动更加敏感，因此投资者对 A 股市场的信心相对较高。疫情下四国股票市场的风险传染路径如图 2。

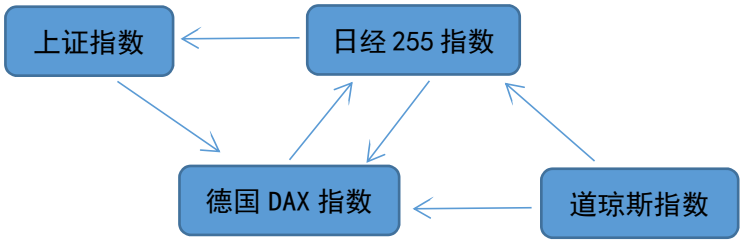


图 2 四国股票市场风险传导路径

### 3.4 VAR 模型估计

对该 VAR 模型进行估计，结果见表 3。

表 3 VAR 模型参数估计值

| | $r_1$ | $r_2$ | $r_3$ | $r_4$ |
|---|---|---|---|---|
| $r_1(-1)$ | 0.033894 | -0.163518 | -0.147479 | -0.067355 |
| | [0.49932] | [-2.25038] | [-1.47525] | [-0.67390] |
| $r_1(-2)$ | 0.005615 | -0.015797 | -0.125641 | -0.090183 |
| | [0.08205] | [-0.21565] | [-1.24672] | [-0.89506] |
| $r_2(-1)$ | -0.127598 | -0.268247 | 0.129260 | 0.195656 |
| | [-1.69595] | [-3.33074] | [1.16658] | [1.76616] |
| $r_2(-2)$ | -0.028953 | -0.068628 | -0.178735 | -0.109648 |
| | [-0.41823] | [-0.92610] | [-1.75313] | [-1.07571] |
| $r_3(-1)$ | 0.098691 | 0.413376 | -0.016368 | 0.033992 |
| | [1.46464] | [5.73104] | [-0.16495] | [0.34261] |
| $r_3(-2)$ | 0.154840 | 0.171729 | 0.142281 | 0.419176 |
| | [2.14302] | [2.22036] | [1.33713] | [3.94011] |
| $r_4(-1)$ | 0.007724 | 0.065988 | 0.054949 | -0.283392 |
| | [0.12436] | [0.99245] | [0.60068] | [-3.09855] |
| $r_4(-2)$ | -0.046457 | -7.88E-05 | 0.099198 | -0.093346 |
| | [-0.78525] | [-0.00124] | [1.13851] | [-1.07157] |
| C | 0.000651 | 0.001023 | 0.000262 | 0.000507 |
| | [0.81939] | [1.20339] | [0.22409] | [0.43382] |

由表 3 可知，由 t 值可以看出大多数的参数都通过了检验，虽然一些估计参数未通过检验，但 VAR 模型主要研究多变量之间的结构关系，所以，可以使用 VAR 模型的相关结论来进一步分析各国股票之间的关系。

### 3.5 VAR 模型的稳定性检验

当最优滞后期数为 2 时，对模型的稳定性进行检验。由图 3 可知，该模型 8 个特征根皆落在单位圆内，说明都小于 1，表明模型具有稳定性。所以可以进行脉冲分析。

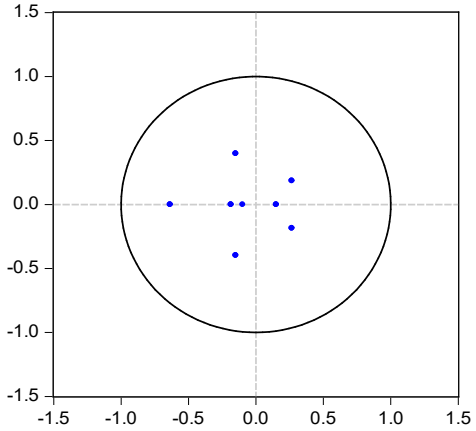


图 3 单位圆示意图

### 3.6 脉冲响应函数分析

脉冲响应函数可以很好的说明各个变量之间的动态影响，它反映的是一个内生变量对残差造成的冲击所产生的反应。如图 4、图 5、图 6、图 7 所示。

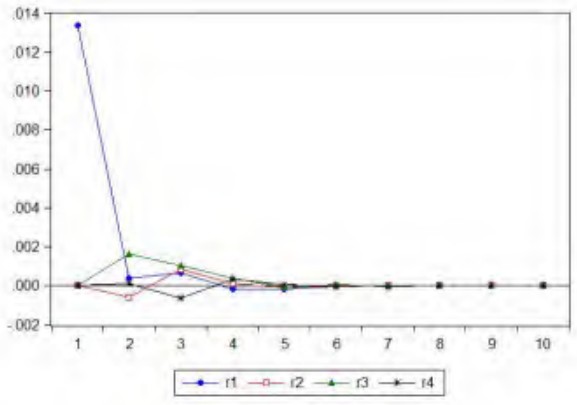


图 4 上证指数收益率（$r_1$）的脉冲响应

由图 4 可知，上证指数收益率受自身冲击在第 1 期达到最大值，随后大幅下降，在第 2 期开始呈上升趋势，到第 5 期以后逐渐趋向于 0；说明上证指数收益率受自身的影响比较大，且后期影响较稳定；上证指数收益率对日经 255 指数收益率，在第 1 期无反应，第 2 期呈负向响应，随后在第 3 期呈正向响应，随着期数的增加，其响应趋向于 0，说明日经 255 指数收益率对上证指数收益率既有正向冲击，也有着负面冲击；上证指数收益率对德国 DAX 指数收益率，在第 2 期达到最大值，紧接着下降，说明德国 DAX 指数收益率对上证指数收益率的冲击相对

较小并且稳定；上证指数收益率对道琼斯指数收益率在第 1 期无反应，在 2 期反应很微弱，到第 3 期达到最大值，呈负向响应，之后同样趋向 0，粗略的说整体上呈负向效应，道琼斯指数收益率对上证指数收益率具有较小的负影响作用。

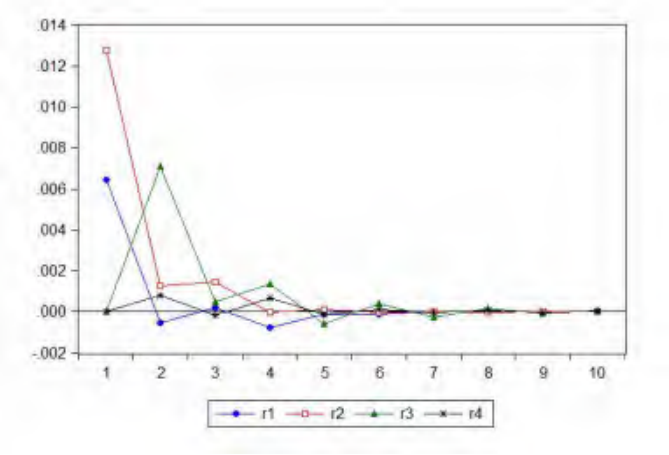


图 5 日经 255 指数收益率（$r_2$）的脉冲响应

由图 5 可知，日经 255 指数收益率受自身影响在第 1 期达到最大值，随后大幅下降，在第 4 期之后逐渐趋于 0，说明日经 255 指数收益率受自身的冲击比较大。日经 255 指数收益率对上证指数收益率，在第 1 期做出反应并达到最大值，在第 2 期和 4 期呈负影响，但值很小，表明日经 255 指数收益率受上证指数收益率的影响较大，我国股票市场与日本股票市场负向相关关系不怎么明显；日经 255 指数收益率对德国 DAX 指数收益率，在第 1 期未做出反应，在第 2 期达到最大值，随后开始下降，8 期后逐渐变为 0，说明德国 DAX 指数收益率对日经 255 指数收益率也有着很大的影响；日经 255 指数收益率对道琼斯指数收益率，在第 1 期没有做出反应，在第 2 期达到最大值，随后开始下降，从第 3 期响应由负变为正向，整体为正向冲击，说明道琼斯指数收益率对日经 255 指数收益率有着很小的影响。

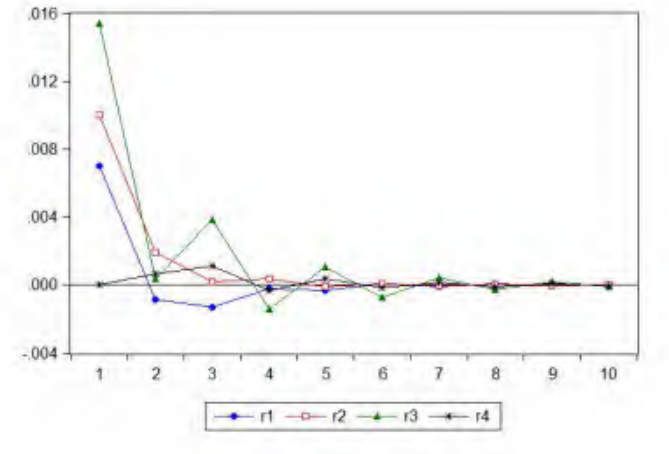


图 6 德国 DAX 指数收益率（$r_3$）的脉冲响应

由图 6 可知，德国 DAX 指数收益率受自身影响在第 1 期最大，紧接着大幅下降，到第 4 期响应程度由正向变成微弱的负向关系，随后正负响应交替，8 期以后逐渐消失，说明德国 DAX 指数收益率受自身的影响比较大。德国 DAX 指数收益

率对上证指数收益率，在第 1 期达到最大值，随后大幅下降，由正向响应变为负向响应，在第 5 期后逐渐趋向于 0，表明上证指数收益率对德国 DAX 指数收益率的影响较显著，且影响有正有负；德国 DAX 指数收益率对日经 255 指数收益率，在第 1 期就做出反应并达到最大值，随后呈下降趋势，直至趋于 0，说明日经 255 指数收益率对德国 DAX 指数收益率有着较大的影响；德国 DAX 指数收益率对道琼斯指数收益率，在第 1 期未做出反应，随后呈微弱的上升趋势，在第 3 期达到最大值后紧接着下降，并在第 7 期后消失，可以看出:道琼斯指数收益率对于德国 DAX 指数收益率的影响程度十分微弱。

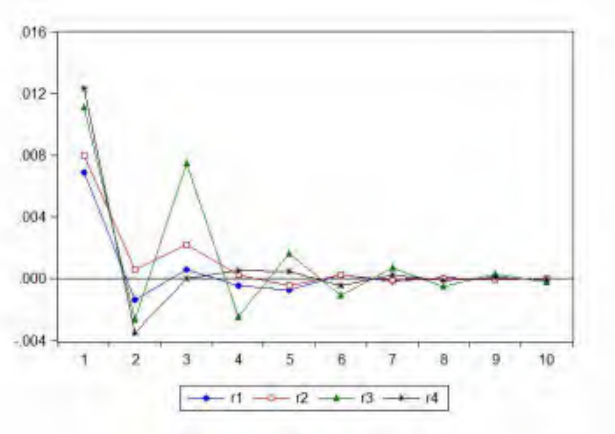


图 7 道琼斯指数收益率（$r_4$）的脉冲响应

由图 7 可知，道琼斯指数收益率受自身冲击，在第 1 期达到最大值，随后大幅下降，在第 2 期呈负向响应，之后逐渐趋向于 0，说明道琼斯指数收益率受自身的影响比较大；道琼斯指数收益率对上证指数收益率，在第 1 期做出反应，达到最大值，随后呈下降趋势，响应正向变为负向，说明上证指数收益率对道琼斯指数收益率的冲击相对较大；道琼斯指数收益率对日经 255 指数收益率，在第 1 期达到最大值，紧接着下降，第 5 期呈负向响应，说明道琼斯指数收益率受日经 255 指数收益率冲击较大；道琼斯指数收益率对德国 DAX 指数收益率，在第 1 期就做出反应并达到最大值，第 2 期后又呈上升趋势，到 10 期逐渐消失，表明德国 DAX 指数收益率对道琼斯指数收益率冲击的反应较为灵敏，表明德国 DAX 指数收益率对道琼斯指数收益率的影响较为显著。

综合来看，通过脉冲响应可得新冠肺炎疫情对各国的股票市场有着较长时间的影响，各国应做好长期对战疫情的准备。

## 3.7 方差分解分析

在脉冲分析的基础上，进一步采用方差分解来解释各国股票收益率之间的动态关系。由于所分析的数据受到多种因素的影响，使得其呈波动状，方差分解则能够较好的分析引起变量波动原因，能够说明各个变量受到每个扰动项的影响程度。

表 4 上证指数收益率（$r_1$）的方差分解结果（%）

| Period | $r_1$ | $r_2$ | $r_3$ | $r_4$ |
|---|---|---|---|---|
| 1 | 100.0000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 98.38777 | 0.184272 | 1.422976 | 0.004983 |

| | | | | |
|---|---|---|---|---|
| 3 | 97.24283 | 0.551977 | 1.982882 | 0.222308 |
| 4 | 97.08833 | 0.557786 | 2.063379 | 0.290500 |
| 5 | 97.08085 | 0.559963 | 2.066217 | 0.292972 |
| 6 | 97.07865 | 0.560115 | 2.067363 | 0.293873 |
| 7 | 97.07834 | 0.560186 | 2.067597 | 0.293876 |
| 8 | 97.07820 | 0.560240 | 2.067616 | 0.293948 |
| 9 | 97.07812 | 0.560240 | 2.067671 | 0.293972 |
| 10 | 97.07809 | 0.560240 | 2.067694 | 0.293972 |

由表 4 可以看出：在第 1 期中，影响上证指数收益率的随机扰动全部都是来自于本身，而其他三国的股票收益率对上证指数收益率没有冲击。到第 10 期时，上证指数收益率受到自身冲击的预测误差在 97%左右；从第 2 期开始，受到其他三国收益率的影响缓慢增长，其中受到德国 DAX 指数收益率在第 10 期达到 2%以上；而日经 255 指数收益率、道琼斯指数收益率两者之和，在第 10 期在 0.8%左右，增加的非常缓慢。由此可见，上证指数收益率除了受到自身的影响之外，德国 DAX 指数收益率也对上证指数收益率有着一定的影响，但影响很小，而道琼斯指数收益率、日经 255 指数收益率则对上证指数收益率的冲击更是微弱。

表 5 日经 255 指数收益率（$r_2$）的方差分解结果（%）

| Period | $r_1$ | $r_2$ | $r_3$ | $r_4$ |
|---|---|---|---|---|
| 1 | 20.41187 | 79.58813 | 0.000000 | 0.000000 |
| 2 | 16.33119 | 63.80287 | 19.60960 | 0.256343 |
| 3 | 16.19801 | 64.02309 | 19.51169 | 0.267212 |
| 4 | 16.25706 | 63.32989 | 19.97687 | 0.436185 |
| 5 | 16.24114 | 63.24465 | 20.07165 | 0.442562 |
| 6 | 16.23550 | 63.20633 | 20.11309 | 0.445079 |
| 7 | 16.23149 | 63.18994 | 20.13269 | 0.445873 |
| 8 | 16.23035 | 63.18457 | 20.13866 | 0.446423 |
| 9 | 16.22982 | 63.18202 | 20.14144 | 0.446722 |
| 10 | 16.22959 | 63.18104 | 20.14255 | 0.446821 |

由表 5 可以看出，在第 1 期，日经 255 指数收益率随机扰动的主要来自于其自身，达到 79%以上，另一个来自上证指数收益率，影响达到 20%以上，成为影响日经 255 指数收益率预测误差的第二大冲击来源，德国 DAX 指数收益率、道琼斯指数收益率对日经 255 指数收益率没有影响。从第 2 期开始，日经 255 指数收益率受到自身和上证指数收益率的冲击缓慢减少，速度很慢，在第 10 期时，受到自身影响的贡献值达 63%左右，上证指数收益率对其的影响下降到 16%左右，这时道琼斯指数收益率、德国 DAX 指数收益率对日经 255 指数收益率的影响程度也在逐步递增，但两者增加的幅度有着很大的差别，在第 10 期，道琼斯指数收益率的扰动贡献率仅达到 0.4%左右，而德国 DAX 指数收益率的扰动贡献率达到

20%左右。可见，日经 255 指数收益率受到自身扰动的影响非常大，其次是日经 255 指数收益率，受到道琼斯指数收益率的影响最小，甚至可以忽略。

表 6 德国 DAX 指数收益率（$r_3$）的方差分解结果（%）

| Period | $r_1$ | $r_2$ | $r_3$ | $r_4$ |
|---|---|---|---|---|
| 1 | 12.73074 | 25.88018 | 61.38909 | 0.000000 |
| 2 | 12.75989 | 26.49127 | 60.63211 | 0.116729 |
| 3 | 12.64432 | 25.35515 | 61.58845 | 0.412084 |
| 4 | 12.58410 | 25.24309 | 61.73251 | 0.440310 |
| 5 | 12.56923 | 25.16127 | 61.80233 | 0.467169 |
| 6 | 12.55304 | 25.12813 | 61.84554 | 0.473299 |
| 7 | 12.54834 | 25.11696 | 61.85890 | 0.47580 |
| 8 | 12.54625 | 25.11190 | 61.86480 | 0.477041 |
| 9 | 12.54541 | 25.10997 | 61.86709 | 0.477537 |
| 10 | 12.54507 | 25.10916 | 61.86802 | 0.477740 |

由表 6 可以看出，在第 1 期，影响德国 DAX 指数收益率的随机扰动主要是来自其本身，其次是日经 255 指数收益率，对德国 DAX 指数收益率的贡献度超过了 25%，上证指数收益率对其影响贡献度为 12%以上。随着期数的增多，德国 DAX 指数收益率受到自身影响在缓慢增加，从第 1 期到第 10 期增加 0.5%左右。上证指数收益率、日经 255 指数收益率对其的影响程度也在减少，但减少的幅度也比较小，而道琼斯指数收益率在第 2 其开始对德国 DAX 指数收益率的冲击逐渐增加，在第 10 期仅有 0.5%左右。说明上证指数收益率、日经 255 指数收益率对德国 DAX 指数收益率的影响相对比较大，而道琼斯指数收益率对其影响则微乎其微。

表 7 道琼斯指数收益率（$r_4$）的方差分解结果（%）

| Period | $r_1$ | $r_2$ | $r_3$ | $r_4$ |
|---|---|---|---|---|
| 1 | 12.37166 | 16.48143 | 31.96763 | 39.17927 |
| 2 | 12.17920 | 15.70382 | 31.96492 | 40.12206 |
| 3 | 10.67228 | 14.72616 | 39.69992 | 34.90164 |
| 4 | 10.55956 | 14.53127 | 40.44104 | 34.46813 |
| 5 | 10.58662 | 14.46038 | 40.70237 | 34.25063 |
| 6 | 10.56416 | 14.42937 | 40.81947 | 34.18700 |
| 7 | 10.55426 | 14.41308 | 40.87541 | 34.15725 |
| 8 | 10.54939 | 14.40576 | 40.90304 | 34.14182 |
| 9 | 10.54769 | 14.40318 | 40.91320 | 34.13594 |
| 10 | 10.54709 | 14.40218 | 40.91705 | 34.13368 |

表 7 可以看出，在第 1 期，道琼斯指数收益率受到的影响主要来自于自身，超过了 39%，而其他三国股票收益率对其有着不同程度的冲击。在第 2 期，道琼斯指数收益率对于自身的随机扰动在增加，但在 3 期以后在减少，但减少的速度很慢，在第 10 期时，贡献值减少到 34%；随着期数的增多，德国 DAX 指数收益率对道琼斯指数收益率影响程度在逐步增加，在第 10 期，贡献率达到 41%左右，而日经 255 指数收益率和上证指数收益率对其的冲击在减少，但减少的幅度比较慢，都减少了 2%左右。可见，道琼斯指数收益率受到自身和德国 DAX 指数收益率扰动的影响非常大，上证指数收益率、日经 255 指数收益率对其也有着一定的影响。

## 4 结论及建议

### 4.1 结论

在新冠肺炎疫情背景下，对上证指数收益率、日经 255 指数收益率、德国 DAX 指数收益率、道琼斯指数收益率建立 VAR 模型及进行相关的检验分析，得到如下结论：

（1）四国股票市场存在格兰杰因果关系，一国股票市场变化也可能引起其他国家股票市场的改变，全球股票市场存在着联动性。其中日经 255 指数收益率是上证指数收益率和德国 DAX 指数收益率波动的原因，德国 DAX 指数收益率是日经 255 指数收益率波动的原因，上证指数收益率是德国 DAX 指数收益率波动的原因，道琼斯指数收益率是日经255指数收益率和德国DAX指数收益率波动的原因，建立 VAR（2）模型也是良好的。

（2）疫情对全球股票市场的动态冲击具有持久性。通过脉冲响应函数说明疫情对全球股市造成了较长时间的负面影响；通过方差分解可知四国股票指数收益率受到自身的冲击比较显著，而受到其他三个因素的冲击相对较小，自身的滞后阶数对当前或未来的影响显著，对自身也有比较强的预测功能。上证指数收益率受其他三个因素影响较小；日经 255 指数收益率和德国 DAX 指数收益率受道琼斯指数收益率的影响较小，而受到其他两个的影响相对较大；而道琼斯指数收益率受到其他三个的影响相对比较大，其中受到德国 DAX 指数收益率的影响最大。在生活中，可以根据自身滞后项，预测未来走势，对投资策略及时做出相应的调整。

### 4.2 政策建议

根据研究得出的结论，本文提出以下几点建议:

（1）在疫情对全球股票市场的冲击下，由疫情这类突发性的外部冲击事件引发的股票市场动荡，可能产生多米诺骨牌效应，引起风险的跨市场传染。因此，在现实的经济生活中，可以利用自身滞后项相互影响对未来走势进行预测，对于投资者来说，要合理配置金融资产，股票市场存在联动性，当一国股票发生下跌时，投资者应立即对各个市场均作出相应预判，及时调整投资策略，“莫要将所有鸡蛋放在一个篮子里”，从而在既定的风险水平下，尽可能地去追求较高的收益。

（2）在新冠肺炎疫情的冲击下，对于一国政府而言，要加快建设国际协调机制，特别是在重大突发事件中更要加强合作，有针对性地制定多国协调体系和

应急管理系统，以防范突发事件对金融市场的冲击。在处理重大突发事件时，短期内需要做的是维护市场信心，投资者应该加强风险防范意识，做好长期投资的准备，投资者既要看到短期股市低迷的情况，也要有股市长期积极向好的信心，因此，投资者应根据自己的实际情况，合理安排短期投资和长期投资的比例。

（3）政府应加强监管力度，推出创新型财政和货币政策，强化政策执行力度，各项政策之间协调配合。在改革开放后，我国同世界的交流日益密切，尤其进入 21 世纪以来，经济呈现全球化，各国经济同步发展，各个国家的股票市场的联动性也逐渐增强，因此，对于突发事件的影响，我国应加强风险传染机制，引导投资者的投资行为，减少金融市场损失。

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# 疫情下各国股票市场波动的动态关系研究

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**关键词**：新冠肺炎疫情；VAR 模型；股票市场；动态关系

**中文摘要**：2020 年新冠肺炎疫情在全球蔓延开来，疫情不仅对人们的生命健康带来了威胁，也使全球实体经济遭到了冲击，进而影响到金融市场，美国等国家金融市场开始出现断崖式下跌，历史罕见。近年来，虽有不少学者对股市的联动性进行了研究，但对于多国股市动态关系的研究还比较少。本文选取 2020 年 GDP 全球排名前四的美国、中国、日本、德国四国的股票日收盘价数据，其中上证指数代表中国股票市场、日经 255 指数代表日本股票市场、德国 DAX 指数代表德国股票市场、道琼斯指数代表美国股票市场，样本区间为 2019 年 11 月 1 日至 2021 年 2 月 26 日，剔除缺失数据后得到 291 个样本数据对其建立 VAR 模型进行实证分析，探讨全球股票市场收益率波动的联动性，以及股票市场风险的传导路径和对动态冲击的响应程度。

首先通过格兰杰因果检验不仅证实了疫情下四国股票市场存在格兰杰因果关系，一国股票市场受到突发事件的冲击后，它可能会对其他国家股票市场也产生一定的影响，即全球股票市场存在着联动性，还得出了四国股票市场的风险传

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导路径;其次通过脉冲响应分析说明了疫情对全球股市造成了较长时间的负面影响；之后通过方差分解可知上证指数收益率、日经 255 指数收益率、德国 DAX 指数收益率、道琼斯指数收益率受到自身因素干扰变动的影响最为明显，而受到其他三个国家股票市场波动的影响相对比较小，自身的滞后阶数对当前或者未来的影响作用明显，对其自身指标的变动有比较强的预测功能。最后在此基础上提出一些政策建议，为政府和投资者提供一些参考：（1）投资者应合理配置金融资产，及时调整投资策略，在既定的风险水平下，尽可能地去追求较高的收益；（2）政府应加快建设国际协调机制，制定多国协调体系和应急管理系统，以防范突发事件对金融市场的冲击，维护市场信心；（3）对于突发事件的影响，我国应加强风险传染机制，引导投资者的投资行为，减少金融市场损失。

# Deep Learning Algorithm Modeling for Outstanding Claim Reserves

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**Keywords:** Outstanding Claims Reserve, Deep Learning, Algorithm Modeling, Autoencoder.

**Abstract.** This paper discusses the modeling of outstanding claims reserve from the perspective of deep learning algorithm. Firstly, based on the recurrent neural network, a "sliding window" mechanism without manual design of reserve characteristics is proposed, which simplifies the data preprocessing process and dynamically shows the preprocessing and data structure of variable incremental claims and case reserves in the range of 1 ~ 10 reporting delay years. The predicting accuracy of outstanding reserves is improved by using the structure of LSTM, GRU and Autoencoder.

## 1．引言

保险业务准备金是保险人为应付未来可能发生的赔款或履行责任，从所收的保险费或资产中提留的一部分资金。对于未到期保险单，需要提存未到期责任准备金；对于已发生保险事故但尚未决定赔付或应付而未付赔款，需提存未决赔款准备金。因此，准确预测赔款准备金对投资者、保险公司等保险发生过程中的各个主体来说都非常关键。

一个多世纪以来，精算师们致力于基于流量三角形数据结构的聚合索赔模型，来预测未决赔款准备金。30年代，Astesan, E（1938）将链梯估计的技术形式化。90年代，Mack, R（1993）证明了简单的随机模型可以完成链梯估计，England, P.D.和Verrall, R.J.（2003）对与链梯方法相关的随机模型的进行了全面概述。Charpentier, A.（2016）认为宏观层面的模型都是基于流量三角形中的聚合数据。Arjas, E.（1989）提出了利用点过程和鞅理论等一些关于概率建模的思想来进行索赔准备金的估计。Jewell, W.S. (1989)利用基本贝叶斯模型预测了在给定时间内发生的IBNYR索赔的总数。Norberg, R（1993）采用时间连续方法来预测非寿险公司的总负债。Hesselager, O.（1994）提出了分别计算IBNR和RBNS准备金的方法，以及相应的预测误差。

近年来，随着深度学习方法在许多领域的成功应用，未决赔款准备金文献中逐渐出现了机器学习和深度学习方法的身影。Wüthrich（2018）针对异质性和个人索赔特征信息，使用神经网络对链梯法进行了改进。Gabrielli 和Wüthrich（2018）基于神经网络开发了一个随机模拟机器，用于生成非人寿保险索赔的个人索赔历史。孟生旺、王海淘（2019）基于个体索赔信息，使用机器学习算法对提升了传统准备金评估模型的预测效果。Kevin（2020）利用循环神经网络针对多个准备金预测目标进行训练，在考虑自动性和可扩展性的同时保持了准确性。

传统链梯法是未决赔款准备金评估最常用的确定性方法（张连增，段白鸽，2011）。在链梯法中，其基本假设是每个事故年的赔款支出具有相同的进展模式。本文基于流量三角形和链梯法思路，借助深度学习模型，给出相较从前传统模型和机器学习模型更加高精度的准备金预测方法。

本文的主要贡献：一是基于循环神经网络和卷积神经网络分别建立模型，利用长短时记忆单元、门控循环单元和自编码器等结构，进一步提高了未决准备金的预测精度；二是提出“滑窗”机制，避免了人工特征设计，简化了数据预处理过程，并且能够动态地展现在报案延迟年1～10范围内，变量增量赔款和个案准备金的处理过程和数据结构；三是在处理离散时序数据问题时，将其堆叠为二维平面数据，使用卷积神经网络提取其空间特征，并利用基于反卷积的自编码器将特征恢复到输出数据分布上。这样，模型充分考虑了在局部延迟年的范围内，增量赔款和个案准备金二者之间的联动影响。

本文第二部分是利用传统链梯法进行未决赔偿准备金预测的概述，第三部分详述了用于未决赔偿准备金预测的深度学习模型，第四部分是结论与展望。

## 2．传统链梯法进行未决赔偿准备金预测

传统链梯法是未决赔款准备金评估最常用的确定性方法，链梯法应用流量三角形评估未来赔款进展模式（张连增和段白鸽，2011）。如表1所示，在时点$M$，观测值可表示为：

$$\mathcal{D}_M: = \{P_{m,n} | 1 \le m \le M \text{ 和 } 1 \le n \le min\{N, M - m + 1\}\}$$

对于$M > N$，集合$\mathcal{D}_M$形成一个梯形，对于$M = N$，观测值集合就形成一个三角形。我们需要预测的是$\mathcal{D}_M^c$的分布。

链梯因子$r_l$可以表示为：

$$\hat{r}_l: = \frac{\sum_{m=1}^{M-l} P_{m,l+1}}{S_l}$$

$$S_l: = \sum_{m=1}^{M-l} X_{k,l}$$

需要满足的条件有：

(1)事故年$m$是独立的；

(2)$P_{m,n}(n = 1，2，\ldots，N)$，每个$m(1 \le m \le M)$形成一个马氏链（Markov chain）；

(3) $E[P_{m,n} | P_{m,n-1}] = r_{n-1} \cdot P_{m,n-1}$；

(4) $Var[P_{m,n} | P_{m,n-1}] = \sigma_{n-1}^2 \cdot P_{m,n-1}$。

不同的事故年份是独立的，对于$1 \le n \le N$和$0 \le m \le M$，事故年$m$发生的赔案截至延迟年$n$的累积赔付可以表示为：

$$P_{m,n} = r_{n-1} \cdot P_{m,n-1} + \sigma_{n-1} \cdot \sqrt{P_{m,n-1}} \cdot \varepsilon_{m,n}$$

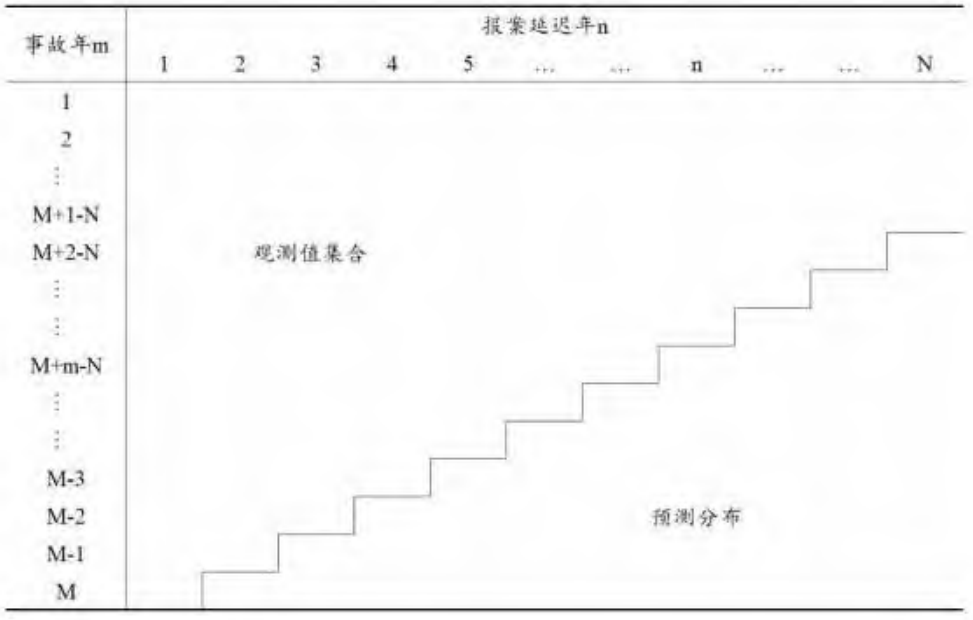
其中，$\sigma_{n-1} > 0, \varepsilon_{m,n}$独立，$E[\varepsilon_{m,n}] = 0$，$E[\varepsilon_{m,n}^2] = 1$

在时点$M$,根据累积赔付$P_{m,n}$，得到上三角的观测值$\mathcal{D}_M: = \{P_{m,n} | 1 \le m \le M$和$1 \le n \le min\{N, M - m + 1\}\}$，则未来累积支付额的估计量可以表达为：

$$\widehat{P}_{m,n} = P_{m,m^*} \cdot \hat{r}_{m^*} \cdot \hat{r}_{m^*+1} \cdot \ldots \cdot \hat{r}_{n-1}$$

$$E[P_{m,n} | \mathcal{D}_M] = P_{m,m^*} \cdot r_{m^*} \cdot r_{m^*+1} \cdot \ldots \cdot r_{n-1}$$

表1 赔款数据结构



## 3．基于深度学习的未决准备金预测

### 3.1 数据采集与处理

本文实证研究中使用的数据来源于全美保险专员协会 (National Association of Insurance Commissioners，NAIC) 数据库中的数据集Schedule P，包括不同保险机构、各事故年和延迟年的索赔数据。保险集团在集团公司内可能会有再保险安排，本文数据不考虑再保险损益。本文重点关注单个实体的记录，数据准备处理过程如下：

3.1.1 数据初筛:

为保证数据的有效性，防止离群数据对深度学习模型训练的稳定性造成影响，我们按照一定的标准从数据集中筛选出可用于训练和测试的部分，并对特定数据项进行归一化处理。

3.1.2 数据预处理:

在处理输入数据和输出数据过程中，我们提出“滑窗”机制来保证序列化数据的连续性。将增量赔款值和个案准备金值放入该“滑窗”中，依照时间顺序从中提取序列送入到深度学习网络的输入层中。

3.1.3 分割数据集:

为将数据集应用于全流程，我们根据事故年的先后顺序，将其依次划分为训练集、验证集和测试集，其中训练集和验证集在训练模型时使用，而最终对比方法时则使用测试集进行评价。

### 3.2 循环神经网络

循环神经网络（RNN）是人工神经网络中最适用于处理时序数据的一种网络结构，其主要由RNN单元组成。本文中，RNN实质上是由RNN单元遵循时序展开而来，每个单元处理时序中某个时刻的数据，后续进行特征提取过程，如图1。

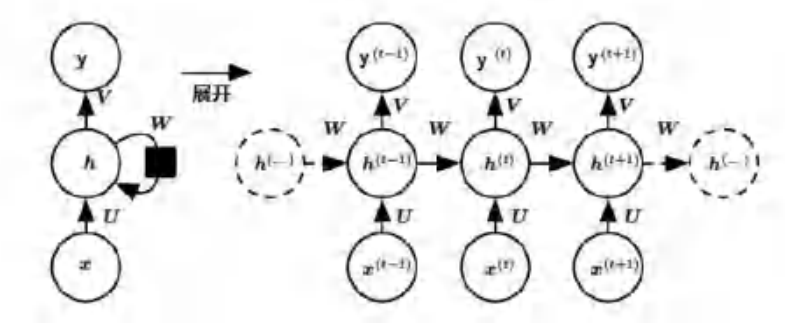



图1 RNN模型结构

特别的，我们分别构造了两种网络结构，分别选用长短时记忆单元（LSTM）和门控循环单元（GRU）来处理时序输入并产生隐藏编码，在特定单元中使用dropout机制以降低网络整体的过拟合风险。在网络的后半部分将隐藏编码与公司代码嵌入层进行连接，并使用时序共享权重的全连接层对其进行解码并产生输出。

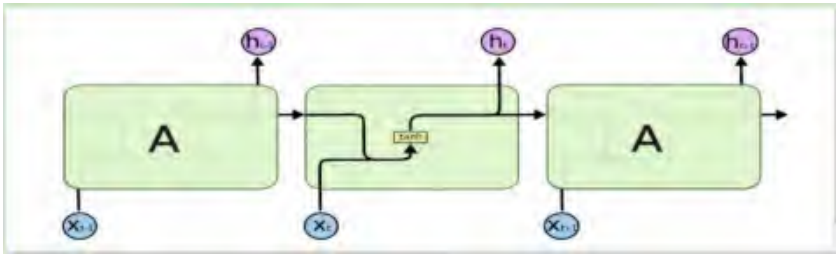



图2 LSTM框图

长短时记忆(Long Short-TermMemory，LSTM) (Hochreiter 和 Schmidhuber, 1997) 网络与普通RNN的重要区别是自循环的权重并非固定不变，而是根据前序时间节点的累积状态进行“记忆”和“遗忘”， 如图2所示。通过逻辑门控制自循环的权重(由另一个隐藏单元控制)，可以动态调整累积时间尺度（Goodfellow I，2016）。

门控循环单元（Gate Recurrent Unit，GRU）(Cho等, 2014b;Chung等, 2014, 2015; Jozefowicz等, 2015; Chrupala等, 2015)是RNN的一种变体，是在LSTM基础上进行简化并大幅提高训练效率的新型循环单元。GRU只有两个门：重置门和更新门，它们可以分别“忽略”部分状态向量。一般来说，同等复杂度的LSTM网络和GRU网络相比，GRU网络的训练能够更快收敛，模型的参数量也更少，但二者的性能指标却别无二致。

### 3.3 卷积自编码器

几十年来，自编码器一直是神经网络发展过程中重要的一部分(LeCun, 1987; Bourlard and Kamp, 1988; Hinton and Zemel,1994)。自编码器是试图将其输入复制到其输出的神经网络。自编码器由两部分组成：编码器和解码器。自编码器与普通前馈网络不同点在于，它不仅要挖掘出数据的内在数据分布，还要将其恢复映射到输入数据所在的数据域上，于是表现为模型能够近似复制与训练数据相似的输入。

我们创新性地构建了基于CNN和自编码器的准备金预测模型。该网络中采用类似自编码器（Auto-Encoder）的编码-解码结构，使用卷积层和反卷积层进行特征的提取和重建，挖掘时序数据以一定方式堆叠后的空间特征并在预测域上进行重建。

### 3.4 公司代码

嵌入层（Embedding Layer）（Bengio 等, 2003）是一种经过训练，可以将索引对应的独热编码转化为恰当的稠密矩阵的人工神经网络层，其作用是将输入中的简单数组或序列映射到向量空间上。本文将数据集中的公司代码CC属于Z输入至一个嵌入层，用来提高公司作为自变量数据属性的丰度。

### 3.5 损失函数

3.5.1 MSE损失:

在训练过程中，获得网络对于每条训练数据的预测结果，然后计算其与标签的向量之间的有效索引位置上的累积均方误差，以其均值作为反向传播的损失。MSE损失都可表示为：

$$\frac{1}{M-m+1-(n-1)}\sum_{t=n}^{M-m+1}\frac{(\widehat{P_{m,t}}-P_{m,t})^2+(\widehat{R_{m,t}}-R_{m,t})^2}{2}$$

3.5.2 Huber损失:

为了解决MSE损失有可能造成梯度爆炸的问题，在损失较小时提高训练对于离群数据的鲁棒性，保证模型训练全过程的稳定性，我们使用Huber损失（Huber，1992）对网络进行训练，并与使用普通MSE损失训练的同配置模型进行对比。Huber损失都可表示为：

$$L_\delta(y,f(x))=\begin{cases}\frac{1}{2}(y-f(x))^2, & \text{当 } |y-f(x)|\le\delta\text{时}\\ \delta\cdot(|y-f(x)|-\frac{1}{2}\delta), & \text{其它}\end{cases}$$

## 3.6 结果分析

表2 Mack链梯法和五种配置的深度学习模型之间的预测效果比较

| 业务线 | MAPE | | | | | | RMSPE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mack | 选型一 | 选型二 | 选型三 | 选型四 | 选型五 | Mack | 选型一 | 选型二 | 选型三 | 选型四 | 选型五 |
| 商用汽车 | 0.060 | 0.046 | 0.046 | 0.045 | 0.046 | 0.044 | 0.080 | 0.062 | 0.062 | 0.061 | 0.068 | 0.060 |
| 其它 | 0.134 | 0.110 | 0.107 | 0.105 | 0.093 | 0.094 | 0.202 | 0.152 | 0.149 | 0.147 | 0.132 | 0.135 |
| 私人汽车 | 0.038 | 0.024 | 0.025 | 0.024 | 0.035 | 0.034 | 0.061 | 0.041 | 0.043 | 0.039 | 0.049 | 0.046 |
| 工人福利 | 0.053 | 0.050 | 0.054 | 0.054 | 0.052 | 0.052 | 0.079 | 0.070 | 0.073 | 0.073 | 0.071 | 0.071 |

我们将建模过程中涉及到的网络结构、超参数调整以及模型训练方式等多种变量进行排列组合，设计了五种配置选型的深度学习模型，最后将它们在各个业务线的评测集上的MAPE值和RMSPE值列成矩阵式表格，如表2所示，并从中得出结论：深度学习模型在预测任务的评测表现上已全面超越Mack（1993）链梯法模型；更进一步的，使用Huber Loss作为损失函数训练模型可以产生明显的提升作用，其预测精度表现总体强于使用MSE损失训练的同架构网络；同时，基于CNN和自编码器的网络结构总体保持了最低的误差；以GRU为循环单元的模型性能略强于以LSTM为循环单元的同参数量模型。

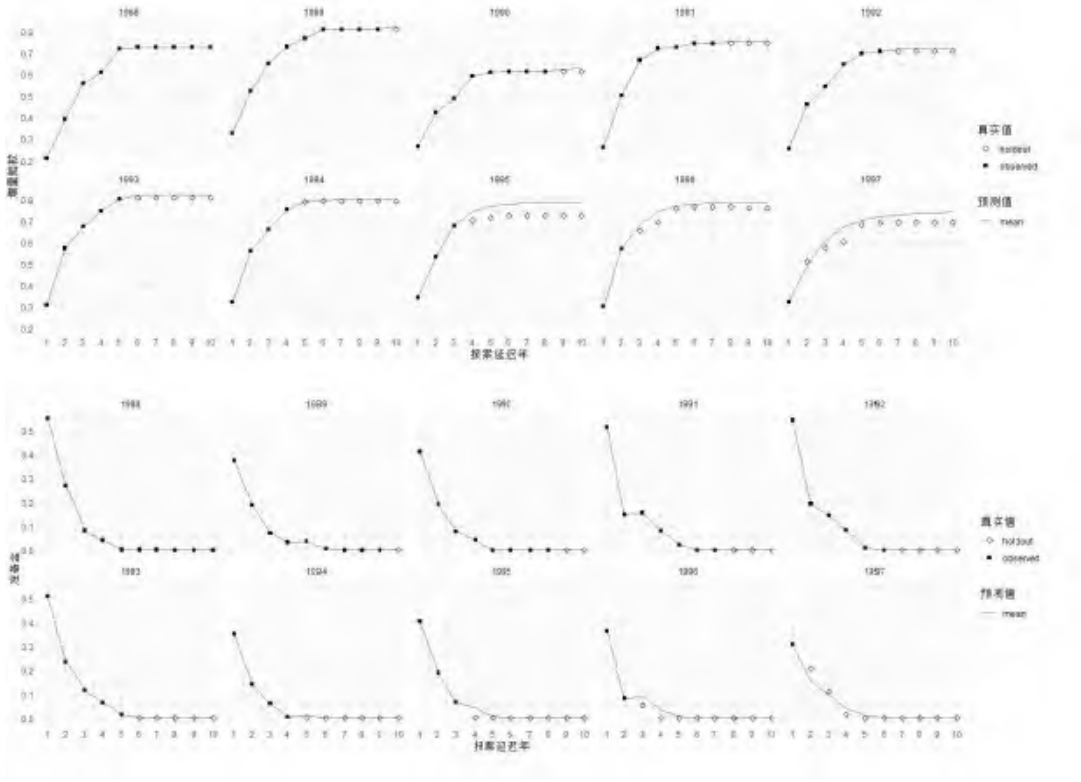



图3 基于LSTM的深度学习模型的预测表现（私人汽车业务线，代码为15393的公司）

为了更详尽和直观地展现我们所设计的深度学习模型在预测未来某年的赔款值和准备金数值时的实际表现，我们挑选了基于LSTM的深度学习模型在代码为15393的公司的私人汽车业务线，如图3所示，其绘制出每个进展年的预测值与真实值的曲线。

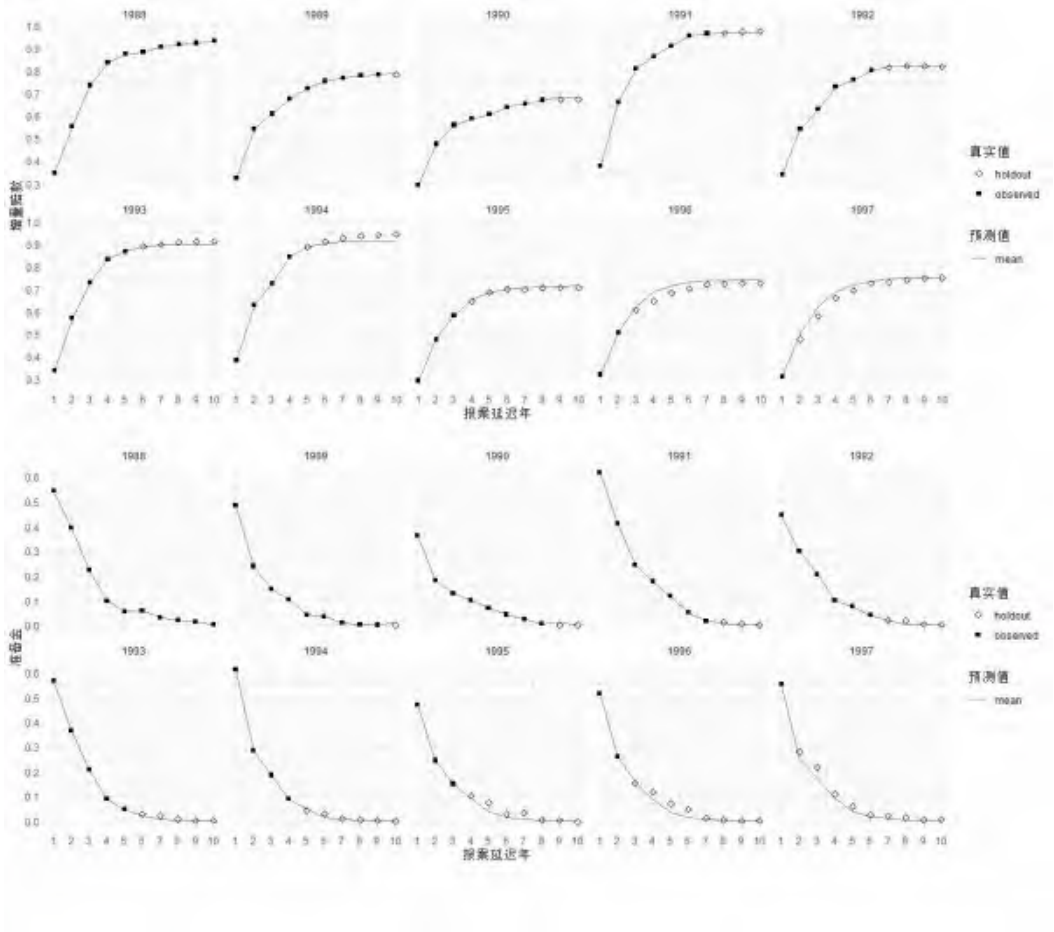



图4 基于GRU的深度学习模型的预测表现（私人汽车业务线，代码为4592的公司）

另外，我们又挑选了基于 GRU 的深度学习模型在代码为 4592 的公司的私人汽车业务线上的预测表现，如图 4 所示。这有利于我们更深入地了解单个深度学习模型对于不同业务线、不同公司的预测能力有何差异。从图中我们可以看出，各种选型的深度学习模型在随机选择的业务线上都能很好地预测待观测日历年的赔款值和准备金，在已观测日历年上也能很好地拟合训练数据，说明模型的预测性能有所提高。

## 4．结论

本文基于覆盖20年的保险索赔准备金数据，提出了“滑窗”机制，以处理在复杂的保险准备金时序数据上进行数据预处理的问题；利用长短时记忆单元（LSTM）和门控循环单元（GRU）的循环神经网络、卷积层和自编码器，建立了深度学习网络架构，在不同损失函数下进行模型训练，并比较不同模型的精度表现，证实了深度学习方法在准备金预测任务上可以达到较高的准确度。然而，本文对于深度学习网络内部各层对于数据特征的挖掘方式并未进行深入的探究，数据的丰度、质量和适用性问题仍有待解决；同时，关于模型在预测准备金过程的解释性上仍有待进一步深入研究。

## 致谢

本文为国家自然科学基金项目《基于机器学习的长期护理保险精算预测模型与风险分析》（71771163）的资助的阶段性成果之一。

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# 未决赔款准备金评估的深度学习算法建模

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**关键词：**未决赔款准备金；深度学习；算法建模；自编码器

**中文摘要.** 本文从深度学习算法建模视角讨论未决赔款准备金的评估模型。首先，基于循环神经网络，提出“滑窗”机制，避免了准备金特征的人工设计与选取，简化了数据预处理过程，并且能够动态地展现在报案延迟年1～10范围内，变量增量赔款和个案准备金的处理过程和数据结构；然后，利用长短时记忆单元、门控循环单元和自编码器等结构，提升未决准备金的预测精度。

# Typhoon Catastrophe Bond Pricing Based on Mixed Copula Model

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**Keywords:** Typhoon catastrophe bond, Compound trigger mechanism, Mixed Copula model, Vasicek model.

**Abstract.** Due to the catastrophe risk has the characteristics of low frequency, large disaster loss, and wide range of impact, it is difficult for China to cope with the pressure brought by catastrophe by means of financial allocation and social donation. However, the issuance of catastrophe bonds can effectively realize the connection between the insurance market and the capital market, and disperse catastrophe risks on a larger scale. This paper collects the data of typhoon direct economic loss and central maximum wind speed in China from 2006 to 2018, uses R software to fit their marginal distribution functions, and then uses MATLAB to construct the mixed Copula function. Based on this, the typhoon catastrophe bond is designed, and the price of the typhoon catastrophe bond is obtained on the basis of the equilibrium pricing theory and the Vasicek stochastic interest rate model. The research results show that the main factors affecting the pricing of typhoon catastrophe bonds are the bond maturity and the selection of catastrophe trigger value. Among them, the longer the bond maturity, the lower the bond price; the higher the catastrophe trigger value, the higher the bond price, and the adjustment of the trigger value has a more significant impact on bonds with a longer maturity. In addition, although the stochastic interest rate model can better reflect the real situation of the market, short-term fluctuations in the financial market have less impact on the price of typhoon bonds.

## 1. Introduction and literature review

Since the 21st century, global natural disasters have occurred frequently, which has had a huge impact on people's production and life. In 2019, various natural disasters caused 130 million people to be affected, and the direct economic loss was 327.09 billion yuan. In 2020, the number of people affected by the disaster was 138 million, and the direct economic loss was 370.15 billion yuan. Compared with 2019, the loss increased by 13.2%, which not only brought tremendous pressure on the finances, but also seriously threatened the solvency of insurance companies. However, catastrophe bonds can effectively transfer catastrophe risks to the capital market. While reducing financial burdens and insurance business risks, it also increases the supply of capital market products and enriches investors' choices for investment.

After Goshay and Sandor put forward the idea of catastrophe risk securitization in the 1970s, many scholars at home and abroad have carried out in-depth research in this field. Their research mainly focuses on three aspects: catastrophe bond pricing model, trigger mechanism and loss fitting.

In terms of catastrophe bond pricing, domestic and foreign research can be divided into theoretical models represented by Cox[1] and empirical models

represented by Lane[2], Wang[3] and Christofides[4]. The former is based on financial theory, pricing catastrophe bonds on the premise of relevant theories and assumptions; The latter is based on the actual situation of catastrophe bond market, and the bond price can better reflect the risk factors it faces. In the study of empirical models, Tian Ling et al. find that Wang two-factor model performs the best in terms of pricing accuracy, but its model processing is more complex; LFC model and Christofides model are easy to deal with, but LFC model does not absorb market periodicity and seasonal risk, and Christofides model is difficult to determine the risk aversion level value ρ[5]. Since the development of catastrophe bond market in China has just started and the historical data is not perfect, the theoretical pricing model is more suitable for China's actual situation[6]. Besides, due to the immature mechanism of China's financial market, it cannot be regarded as a complete market, and the emergence of catastrophe bond introduces catastrophe risk into the capital market, which deepens its incompleteness[7]. Therefore, the equilibrium pricing model in the theoretical model is more suitable for catastrophe bond pricing.

In terms of trigger mechanism, scholars divide trigger mechanism into single trigger mechanism and compound trigger mechanism. Scholars who adopt the single trigger mechanism generally use the loss-type trigger mechanism, and take the direct economic loss data of disaster events as the research object. For example, Zhu Menghua et al. takes the earthquake direct economic loss as the trigger indicator[8], Shi Jianxiang et al. takes the flood disaster loss as the trigger indicator[9], Shao Xinli et al.[10] and Zhan Kai et al.[11] respectively design catastrophe bonds with typhoon economic loss and cumulative crop loss as trigger indicators. Compound trigger mechanism is a combination of different single trigger mechanisms. Tian Ling briefly introduces single trigger mechanism and compound trigger mechanism[12]. Compared with the single trigger mechanism, the compound trigger mechanism can reduce the impact of basis risk and moral hazard as much as possible, thus making the price of catastrophe bonds more reasonable and feasible. For example, Li Yong et al. select the property loss data and disaster area caused by typhoon catastrophe as trigger indicators, and calculate the price of typhoon catastrophe bonds based on marginal distribution function fitting and fixed interest rate[13]. Yang Fan et al. use the magnitude and insurance loss as compound trigger indicators to design bonds and calculate bond prices[7].

In terms of loss fitting, the commonly used right partial joint distribution function cannot well reflect the correlation between the two trigger indicators of catastrophe bonds, while Copula method not only allows multiple forms of marginal distribution, but also can measure the non-linear dependency structure relationship[14]. At the same time, Copula method can also well describe the thick tail characteristics of variable distribution[15]. For example, Li Yong et al. combine Clayton-Copula function to complete the pricing process of multi-event triggered catastrophe bonds[16]. Zhang Xiaoding et al. use Frank-Copula function to establish the joint distribution function under the compound trigger mechanism, and calculate

the price of 1-5 years earthquake catastrophe bonds[6]. Zhan Kai et al. establish a "loss-wind speed" compound trigger pricing model based on the historical data of typhoon catastrophe in Guangdong Province, and use Gumbel-Copula function to fit its joint distribution to obtain the price of typhoon catastrophe bonds[17]. Furthermore, some scholars construct mixed Copula function on the basis of single Copula function to better describe the correlation between variables and avoid the distortion caused by fitting data with only one Copula function[18]. At present, the mixed Copula function method is widely used in the field of financial investment, and some scholars also use it in the pricing of insurance products. For example, Liu Suchun et al. use the mixed Copula method to study the pricing of apple income insurance[19], and Zhao Yu et al. use the mixed Copula method to determine the insurance premium rate of rice[20]. However, there is less research on the pricing of catastrophe bonds.

Through combing the related literature on catastrophe bond pricing, it is found that due to the differences in the actual situation of various countries, the lack of catastrophe data, and the imperfection of various statistical indicators, scholars choose different pricing models, trigger mechanisms and time distribution of loss data when conducting bond pricing research. This article combines the actual situation of China's market, and hopes to fit the loss to the greatest extent when taking into account the basis risk and moral hazard. Based on the equilibrium pricing model and compound trigger mechanism, this article innovatively uses the mixed Copula method to provide new ideas for the pricing of typhoon catastrophe bonds.

## 2. Theoretical model

### 2.1 Equilibrium pricing model

In the equilibrium pricing model, assuming that there is a risk-neutral measure in the investment market, denoted as ϱ. Under this risk-neutral measure, the initial price of the uncertain cash flow $\{d(k), k=1,2,3,\cdots,T\}$ at each moment in the future is:

$$E^{\tilde{n}}=\left[\sum_{k=1}^{T}\frac{1}{\left[1+r(0)\right]\left[1+r(1)\right]\cdots\left[1+r(n-1)\right]}d(k)\right].$$

* MERGEFORMAT (1)

Among them, $\{r(k), k=1,2,\cdots,T-1\}$ is the random process of interest rate in time T, and represents the interest rate at time k. Use $P(0,n)$ to denote the price of a zero coupon bond with a face value of 1 at time 0 and a maturity date of time n, we have:

$$P(0,n)=E^{\tilde{n}}\left[\sum_{k=1}^{T}\frac{1}{\left[1+r(0)\right]\left[1+r(1)\right]\cdots\left[1+r(n-1)\right]}\right].$$

* MERGEFORMAT (2)

Use t to represent the moment when the catastrophic loss first appears. If it happens, $t\in\{1,2,\cdots,T\}$. Assume that the payment function is f and the indicative function l. When both interest and principal are at risk, the holder's cash flow can be expressed as:

$$d(k)=\begin{cases} dl(t>k)+f(d+1)l(t=k) & k=1,2,\cdots,T-1 \\ (d+1)l(t>k)+f(d+1)l(t=k) & k=T \end{cases}.$$

* MERGEFORMAT (3)

Under the condition of the risk-neutral measure ϱ, suppose that catastrophe bonds are traded in a no-arbitrage investment market, and the time of catastrophe occurrence has nothing to do with the term structure. Combining Eq. 2 and Eq. 3, we can find that the price of the catastrophe bond at time 0 is:

$$d\sum_{k=1}^{T}P(0,T)\varrho(t>k)+P(0,T)\varrho(t>T)+f(1+d)\sum_{k=1}^{T}P(0,k)\varrho(t=k).$$

* MERGEFORMAT (4)

In this formula, if under the risk-neutral measure ϱ, there is no catastrophe before time k or the factor level of the catastrophe has not reached the trigger condition, it is recorded as $\tilde{n}(t>k)$. The rest can be deduced by analogy.

Subsequently, assume that the investor's consumption process can be explained by a representative consumer model in an incomplete market, that is, the investor's consumption decision depends on its utility function. Consumption flow is a stochastic adaptation process and only depends on observable information. Use $\{c(k),k=1,2,\cdots,T\}$ to represent a type of consumption flow. The comprehensive consumption process refers to the feasible consumption in the economy at each state and time point, expressed by $\{c^{*}(k),k=1,2,\cdots,T\}$. $c^{*}(w,k)$ is the number of consumer goods in the entire economy in the state ω at time k. The comprehensive consumption amount $c^{*}(k)$ is determined only when $k=0$, and random when $k\geq 1$.

Assuming that in the representative consumer model, its utility function is additive, divisible and differentiable, then there is a utility function μ. For any consumption flow, the investor's expected utility can be expressed as: $E^{x}\left[\sum_{k=0}^{T}\mathrm{m}_{k}\left(c\left(k\right)\right)\right]$. At the same time, assume that the interest rate of k at any time is $\left\{r\left(k\right),k=1,2,\cdots,T-1\right\}$, we make the following definition:

$$\frac{1}{1+r\left(k\right)}=\frac{1}{\mathrm{m}_{k}\left(c^{\text{æ}}\left(k\right)\right)}E\left[\mathrm{m}_{k+1}\left(c^{*}\left(k+1\right)\right)\right],\ k=0,1,\cdots,T-1.$$

* MERGEFORMAT (5)

In the case of no arbitrage, introduce the measure P, so that ϱ is absolutely continuous relative to P. For any random variable $X$, it can be obtained by the Padon-Nikodym derivative $\frac{d\tilde{\mathrm{n}}}{dP}$:

$$E_{\tilde{\mathrm{n}}}\left(X\right)=E_{P}\left(X\frac{d\tilde{\mathrm{n}}}{dP}\right).$$

* MERGEFORMAT (6)

$$\frac{d\tilde{\mathrm{n}}}{dP}(\mathrm{w})=\left[1+r\left(0\right)\right]\left[1+r\left(\mathrm{w},1\right)\right]\cdots\left[1+r\left(w,T-1\right)\right]\frac{\mathrm{m}'_{T}\left(c^{*}\left(\mathrm{w},T\right)\right)}{\mathrm{m}'_{0}\left(c^{*}\left(\mathrm{w},0\right)\right)}.$$

* MERGEFORMAT (7)

Therefore, under the assumptions of the above model, we can calculate the uncertain cash flow at every moment in the future. The price at the initial moment is:

$$\mathrm{V}\left(0\right)=E^{\tilde{\mathrm{n}}}\left[\sum_{k=1}^{T}\frac{1}{\left[1+r\left(0\right)\right]\left[1+r\left(1\right)\right]\cdots\left[1+r\left(k-1\right)\right]}d\left(k\right)\right].$$

* MERGEFORMAT (8)

Since whether and when a catastrophe occurs has no correlation with variables in the financial market, the above formula can be further rewritten as:

$$\mathrm{V}\left(0\right)=E^{\text{耦}}\left[\sum_{k=1}^{T}\frac{1}{\left[1+r\left(0\right)\right]\left[1+r\left(1\right)\right]\cdots\left[1+r\left(k-1\right)\right]}\right]E\ d\left(k\right)=\sum_{k=1}^{T}P\left(0,k\right)E\ d\left(k\right).$$

* MERGEFORMAT (9)

Eq. 9 shows that under the equilibrium pricing model, the price of catastrophe bonds is composed of the sum of two parts, namely the expected value of cash flow in each future period and the price of zero coupon bonds under this period.

## 2.2 Mixed Copula model

The commonly used joint distribution function cannot well reflect the correlation between the two trigger indicators of catastrophe bonds, while the Copula function proposed by Sklar makes multiple unary distribution functions form joint distribution functions, and well describes the correlation between multivariate variables, which makes up for the deficiency of joint distribution function. The binary form of Sklar's theorem is: if $G(x,y)$ is a binary joint distribution function of continuous marginal distributions $F_1(x)$ and $F_2(y)$, then there is only one Copula function $C$ such that $G(x,y)=C(F_1(x),\ F_2(y))$.

Copula functions can be divided into Elliptic Copula functions, Archimedean Copula functions, and Extreme Copula functions. Among them, the Archimedean Copula function can mainly be divided into Gumbel Copula, Clayton Copula and Frank Copula. The G-Copula function has asymmetric tails and is more sensitive to changes in the upper tail. The C-Copula function also has asymmetric tails but is more sensitive to changes in the lower tail. The F-Copula function has a symmetric tail but is not sensitive to changes in the upper and lower tails. Different function forms can be selected according to different characteristics of the data. Therefore, the analysis in this article is based on the Archimedean Copula function, and Table 1 lists the distribution function form of the Archimedean Copula function family:

Table 1. Distribution function form of the Archimedean Copula function family

| Function name | Distribution function |
|---|---|
| Gumbel Copula | $C_G(u,v)=\exp\left\{-\left[(-\ln u)^{\theta}+(-\ln v)^{\theta}\right]^{\frac{1}{\theta}}\right\}$ |
| Clayton Copula | $C_c(u,v)=\left(u^{-\theta}+v^{-\theta}-1\right)^{-\frac{1}{\theta}}$ |
| Frank Copula | $C_F(u,v)=-\frac{1}{\theta}\ln\left[1+\frac{\left(e^{-\theta u}-1\right)\left(e^{-\theta v}-1\right)}{\left(e^{-\theta}-1\right)}\right]$ |

In order to describe the correlation between random variables more accurately, this paper constructs a mixed Copula function on a single Copula function. By assigning weights to multiple Copula functions, a linear combination of multiple Copula functions is constructed. The form of the constructed binary mixed Copula function is:

$$C(u,v)=\sum_{k=1}^{m}1\ {}_kC_k(u,v\text{?}).\qquad \backslash\text{* MERGEFORMAT (10)}$$

Among them, $C_k$ is a single Copula function, $\theta$ is used to indicate the degree of correlation between two random variables in the Copula function, $m$ is the number of single Copula functions that construct the mixed Copula function, $\lambda_k$ is the weight of each Copula function, and $0 \le \lambda_k \le 1$, $\sum_{k=1}^{m} \lambda_k = 1$.

## 3. Loss distribution fitting

### 3.1 Data sources and descriptive statistics

The data of typhoon direct economic loss and the central maximum wind speed comes from the *China Meteorological Disaster Yearbook (2006-2018)*, with a total of 100 typhoon effective data. Taking into account the impact of inflation and other factors, all direct economic losses are adjusted using the CPI price index based on 2018. Table 2 is the descriptive statistics of the adjusted typhoon direct economic loss data, and Table 3 is the descriptive statistics of the typhoon wind speed data.

Table 2. Descriptive statistics of typhoon loss data in China (100 million yuan)

| Mean value | Standard deviation | Minimum value | Maximum value | Skewness | Kurtosis |
|---|---|---|---|---|---|
| 71.86661 | 117.4883 | 0.0994933 | 628.2005 | 2.575668 | 9.819791 |

Table 3. Descriptive statistics of typhoon wind speed data in China (m/s)

| Mean value | Standard deviation | Minimum value | Maximum value | Skewness | Kurtosis |
|---|---|---|---|---|---|
| 31.02 | 10.05237 | 15 | 70 | 0.9971652 | 4.354009 |

It can be seen from Table 2 and Table 3 that the kurtosis and skewness of typhoon direct economic loss data are 9.819791 and 2.575668, showing the distribution characteristics of peak, right deviation and thick tail. The kurtosis and skewness of typhoon wind speed data are greater than 3 and 0, showing the distribution characteristics of peak and right deviation. Therefore, in the process of fitting, we use the right skewed distribution to fit the typhoon direct economic loss data. Furthermore, because the peak value and skewness of the normal distribution are similar to the descriptive statistics of typhoon wind speed data, we use the normal distribution and the common right skewed distribution to fit the typhoon wind speed. By observing the fitting effect, this paper finally selects the best fitting distribution model.

### 3.2 Marginal distribution fitting

#### *3.2.1 Typhoon direct economic loss fitting*

Based on the data characteristics of the direct economic loss of typhoons, this paper selects common right-skewed distributions: lognormal distribution, gamma

distribution and Weibull distribution to fit loss. The parameters are estimated with the help of the fitdistrplus package in the R software, and the goodness of fit is determined by the KS test. The results are shown in Table 4:

Table 4. Comparison of typhoon direct economic loss data fitting effect

| Distribution function | Parameter estimate | D value | P value |
|---|---|---|---|
| Lognormal distribution | m =2.895847， s =2.014935 | 0.088638 | 0.4118 |
| Gamma distribution | a =0. 465636， b =1/ 0. 00648 | 0.084522 | 0.4726 |
| Weibull distribution | $k = 0.59413$， l = 46.878913 | 0.046557 | 0.9818 |

As shown in the Table 4, it can be found that whether it is the D value or the P value, the fitting effect of the Weibull distribution is higher than the other two. And comparing the three function fitting effect diagrams showed in Fig. 1, it is found that the fitting function curve of the Weibull distribution almost completely overlaps the empirical data distribution, so we choose the Weibull distribution as the loss distribution model for subsequent research.

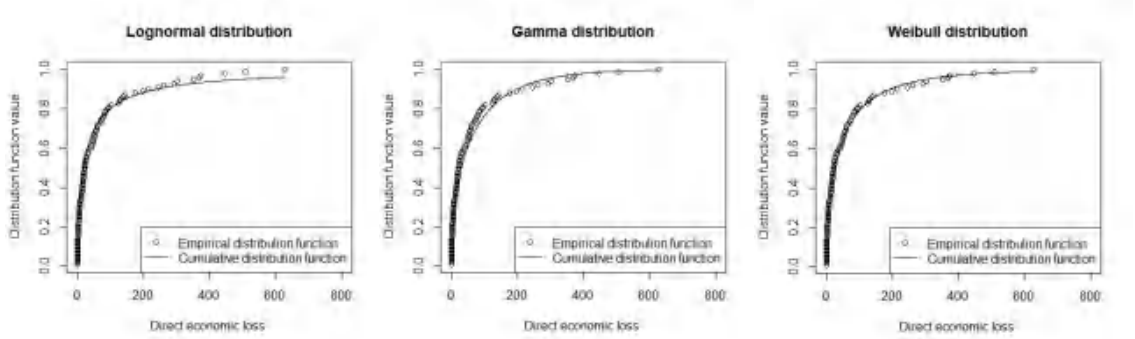


Fig. 1. Function fitting effect diagram

### *3.2.2 Typhoon central maximum wind speed fitting*

The same analysis is performed on the maximum wind speed. Since the wind speed data statistics are similar to the normal distribution statistics, in addition to using the right skewed distribution to fit the typhoon maximum wind speed data, we also add the normal distribution form. The results are shown in Table 5:

Table 5. Comparison of typhoon wind speed data fitting effect

| Distribution function | Parameter estimate | D value | P value |
|---|---|---|---|
| Normal distribution | m =31.02000， s =10.00198 | 0.11031 | 0.1753 |
| Lognormal distribution | m =3.3860607， s =0.3091229 | 0.087243 | 0.4319 |
| Gamma distribution | a =10. 4607792， b =1/ 0. 3371864 | 0.097608 | 0.2965 |
| Weibull distribution | $k = 3.192131$， l = 34.567121 | 0.10379 | 0.2316 |

It can be seen from Table 5 that the D value of the lognormal distribution is the lowest and the P value is the largest. Similarly, comparing the four function fitting effect diagrams in Fig. 2, we finally choose the lognormal distribution to fit the

typhoon wind speed data.

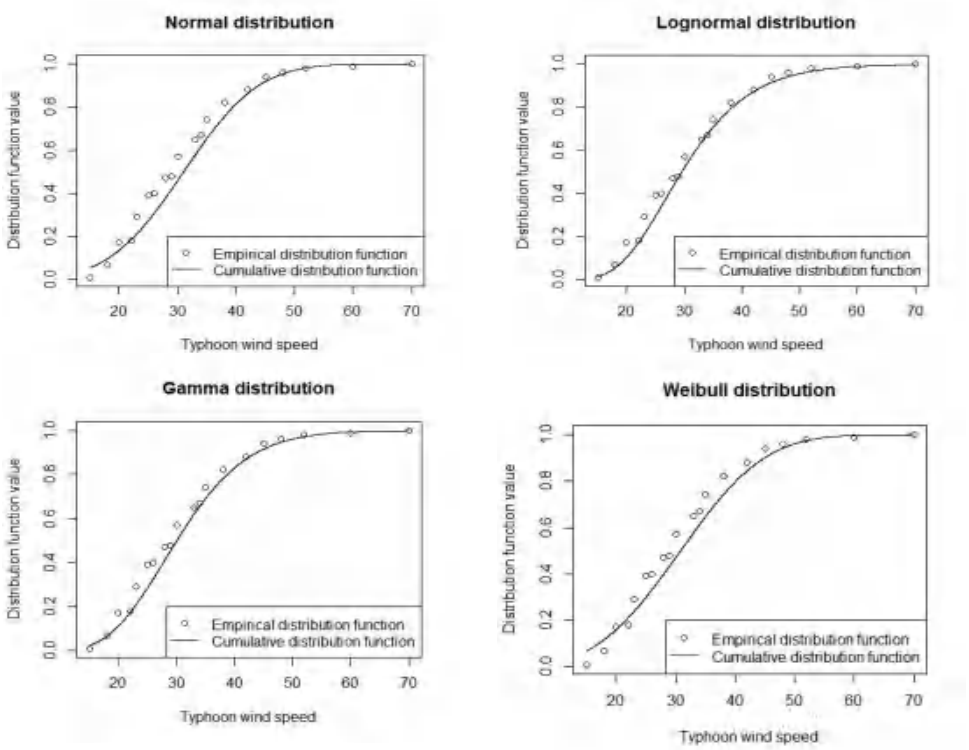


Fig. 2. Function fitting effect diagram

### *3.2.3 Typhoon frequency fitting*

According to the relevant catastrophe bond literature, it can be inferred that the number of typhoon disasters per year follows a Poisson distribution. Assume that the number of typhoon disasters per year is $Z$. There are 100 typhoon data and a total of 13 years have been recorded. Therefore, assuming that the number of typhoons follows a Poisson distribution of $\lambda = 100/13$, the specific calculation process of chi-square statistics is shown in Table 6.

Table 6. Chi-square test of typhoon frequency

| The number of typhoons per year $i$ | Observation frequency $n_i$ | Poisson probability $p_i$ | Theoretical frequency $np_i$ | Chi-square value $c_i^2$ |
|---|---|---|---|---|
| 5 | 1 | 0.102417745 | 1.331430682 | 0.082502453 |
| 6 | 4 | 0.131304801 | 1.706962413 | 3.080338111 |
| 7 | 1 | 0.14429099 | 1.875782872 | 0.408893614 |
| 8 | 3 | 0.138741337 | 1.803637376 | 0.793553929 |
| 9 | 2 | 0.118582339 | 1.541570407 | 0.136327015 |
| 11 | 2 | 0.06378824 | 0.829247126 | 1.652899659 |

Assuming $H_0$: $\lambda=100/13$, at the significance level of 0.05, there is $c^2(5)=11.071$, which is greater than $c^2=6.154514781$. Therefore, the null hypothesis cannot be rejected at the significance level of 0.05, and the number of

typhoons obeys the Poisson distribution with $\lambda = 100/13$, namely:

$$P(z=k)=\frac{\left(\frac{100}{13}\right)^{2}}{k!}e^{-\frac{100}{13}},\ k \in N. \qquad \text{* MERGEFORMAT (11)}$$

### 3.3 Mixed Copula function construction

Through the previous research, we have gotten the marginal distribution function of typhoon direct economic loss and typhoon maximum wind speed, that is, the loss follows the Weibull distribution with $k(shape)=0.59413, \lambda(scale)=46.878913$, and the wind speed follows the lognormal distribution with $\mu = 3.3860607$, $\sigma = 0.3091229$.

Next, this paper uses the mixed Copula method to construct the joint distribution function. Based on the Gumbel-Copula, Clayton-Copula, and Frank-Copula functions, this paper first obtains the correlation degree θ of a single Copula function. Then, according to the research of existing scholars, assuming that the initial weight λ of three single Copula Functions is 1/3, and use the EM algorithm to iterate. The values in the calculation process are shown in Table 7:

Table 7. Mixed Copula numerical table

| | G-Copula | C-Copula | F-Copula |
|---|---|---|---|
| Initial value$\lambda$ | 1/3 | 1/3 | 1/3 |
| Final value $\lambda$ | 0.3944 | 0.0436 | 0.5620 |
| Initial value $\theta$ | 1.68 | 1.18 | 4.85 |
| Final value$\theta$ | 1.2398 | 8.0547 | 8.2444 |
| Squared Euclidean distance（initial value $\theta$ ） | 0.02435137 | 0.0501232 | 0.01309755 |

When the weight $\lambda$ and the correlation degree $\theta$ tend to be stable, the weight of G-Copula tends to 0.3944, the weight of C-Copula tends to 0.0436, and the weight of F-Copula function tends to 0.5620. According to the squared Euclidean distance, the fit of the F-Copula function is better than that of the G-Copula function and the C-Copula function. Correspondingly, in the mixed Copula form, the weight of the F-Copula function is greater, followed by the G-Copula function. Based on the mixed Copula method, the joint distribution function of the direct economic loss and the central maximum wind speed is:

$$C(u,v)=0.3944C_G(u,v)+0.0436C_c(u,v)+0.5620C_F(u,v).$$

* MERGEFORMAT (12)

In this formula:

$$u = F(x), X \sim Weibull(0.5941312, 46.8789134)$$

$$v = F(y), \ln(Y) \sim N(3.3860607, 0.3091229^2)$$

$$C_G(u,v) = \exp\left\{-\left[(-\ln u)^{1.2398} + (-\ln v)^{1.2398}\right]^{\frac{1}{1.2398}}\right\}$$

$$C_c(u,v) = \left(u^{-8.0547} + v^{-8.0547} - 1\right)^{-\frac{1}{8.0547}}$$

$$C_F(u,v) = -\frac{1}{8.2444}\ln\left[1 + \frac{\left(e^{-8.2444u} - 1\right)\left(e^{-8.2444v} - 1\right)}{\left(e^{-8.2444} - 1\right)}\right]$$

## 4. Empirical Analysis on the design and price of typhoon catastrophe bonds in China

### 4.1 Typhoon catastrophe bond design based on Vasicek Model

#### *4.1.1 Bond design*

In order to better discuss the factors that affect bond prices, this paper sets the maturity and type of bonds to 1-5 years interest-bearing catastrophe bonds. Combined with the compound trigger mechanism, the corresponding trigger rules are shown in Table 8. From the bond design, it can be inferred that there is no risk of loss in the principal of Class A bonds, and their price is the highest compared to the other two bonds, which is suitable for investors with low risk preference. Since the interest and principal of Class C bonds face the risk of total loss, their price is the lowest compared to the other two bonds, which is suitable for investors with high risk preference.

Table 8. Bond design

| Bond type | Trigger one condition | Trigger two condition |
|---|---|---|
| Principal protected bond (Class A bonds) | Interests for the current and remaining periods will be returned in proportion, and all principal will be returned | Interests for the current and remaining periods will not be returned, and all principal will be returned |
| Partial principal protected bond (Class B bonds) | Interests for the current and remaining periods will not be returned, and all principal will be returned | Interests for the current and remaining periods will not be returned, and the principal will be returned in proportion |

Table 8. Bond design (continued Table)

| Bond type | Trigger one condition | Trigger two condition |
|---|---|---|
| Unsecured principal bond (Class C bonds) | Interests for the current and remaining periods will not be returned, and all principal will be returned | Interests for the current and remaining periods will not be returned, and the principal will not be returned |

### *4.1.2 Interest rate term structure design*

Due to the impact of market changes in real life, the risk-free interest rate has been changing dynamically. Therefore, this paper chooses the Vasicek stochastic interest rate model to design the interest rate term structure of typhoon catastrophe bonds. The core idea of Vasicek's stochastic interest rate model is: Assuming that the short-term interest rate process is a diffusion process with constant parameters, given a fixed date, the expected rate of return per unit risk is independent of the bond maturity time, and its interest rate form is:

$$dr = \mathrm{a}\left(\mathrm{b} - r\right)dt + \mathrm{s}\ dB\,. \qquad \backslash\text{* MERGEFORMAT (13)}$$

For the Vasicek stochastic interest rate model, Table 9 shows the meaning and assignment of the formula variables. For the initial value setting of risk-free interest rate, select SHIBOR's (Shanghai Interbank Offered Rate) one-year offer rate of 3.032% at 11:00 on April 16th, 2021, namely $r(0) = 0.03$, and select SHIBOR's latest quoted interest rate of 4.65% on the five-year loan market at 9:30 on March 22, 2021, namely $\mathrm{b} = 4.65\%$. The frequency of interest rate changes is 360 times a year. Based on the existing research in the relevant literature, reasonable assignments to the remaining variables in the model are shown in Table 9:

Table 9. The meaning and assignment of variables in the Vasicek stochastic interest rate model

| Variable | Variable meaning | Assignment |
|---|---|---|
| $r$ | Interest rate | 3% |
| a | Mean reversion speed | 0.1 |
| b | Average forward interest rate | 4.65% |
| s | Interest rate volatility | 1% |
| $B$ | Standard Brownian Motion | - |

Based on the assignment of model variables, we can simulate the changes in the 5-year risk-free interest rate. The following Fig. 3 shows the single-time simulated 5-year interest rate trend. The risk-free interest rate used in bond pricing is given by random simulation, and the specific value is not given here.

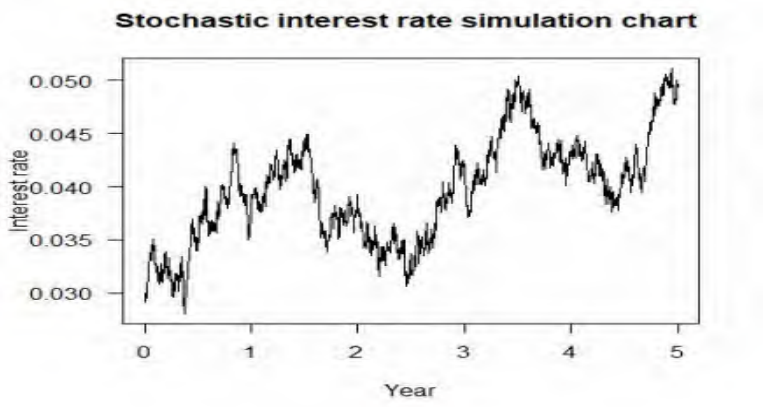


Fig. 3. Vasicek stochastic interest rate simulation chart

## 4.2 Trigger value selection and trigger probability determination

Since catastrophe bond is a compensation measure taken after catastrophe insurance and reinsurance reach the upper limit of compensation, referring to relevant literature research, this article selects 90% quantile of loss and wind speed data as the trigger value, and it can be concluded that the trigger value of typhoon direct economic loss is 216.9673 million yuan, and the trigger value of typhoon wind speed is 45 m/s.

In this paper, we use Monte Carlo simulation to determine the trigger probability in five years. First, generate five random numbers that obey Poisson distribution with mean value of 100 / 13. The five random numbers can simulate the number of typhoon disasters in each year, and the sum of the five numbers is n. Then generate n random numbers that obey the mixed Copula function, and thus obtain the corresponding typhoon direct economic losses and typhoon wind speed values. Compared with the trigger value, exceeding the trigger value is recorded as a risk event. Repeated this process for N times. According to the design of bond triggering, divide the total number of risk events by the total number of simulations to approximate the corresponding trigger probability.

Using R software to perform 100,000 Monte Carlo simulations, and the final trigger probability is shown in Table 10:

Table 10. Trigger probability (1-5 years)

| | 1st year | 2nd year | 3rd year | 4th year | 5th year |
|---|---|---|---|---|---|
| Trigger one indicator | 0.65433 | 0.8818 | 0.95909 | 0.9861 | 0.99521 |
| Trigger two indicators | 0.30583 | 0.57833 | 0.75876 | 0.86769 | 0.93045 |

## 4.3 Bond price calculation

Suppose that the maturity date of the bond is T, the face value of the bond is F (F=100), the coupon rate is 5%, and the return ratio of interest and principal is 0.5. According to the above design of three kinds of bonds and the trigger probability, we use Vasicek stochastic interest rate model to estimate the stochastic interest rate of 1-5 years, and use the equilibrium pricing model to get the prices of three kinds of

bonds of 1-5 years. Here is an example of the interest that may be obtained in Class A bonds. Assuming that the probability of triggering only one indicator is $p$ and the probability of triggering two indicators is $q$, then the probability of obtaining all interest R is $1-p$, and the probability of total interest loss is $q$, and the probability of obtaining partial proportional interest is $1-q-(1-p)=p-q$. Under the assumption that the interest repayment ratio is 0.5, the expected interest is $R^*(1-p)+0.5R^*(p-q)$. The prices of the three types of typhoon bonds are shown in Table 11 and Fig. 4:

Table 11. Three types of typhoon catastrophe bond prices (1-5 years)

| Class A bonds | One-year | Two-year | Tree-year | Four-year | Five-year |
|---|---|---|---|---|---|
| Present value of interest | 3.029265 | 4.725723 | 5.640341 | 6.117504 | 6.357431 |
| Present value of principal | 97.01876 | 93.99281 | 90.92811 | 87.85259 | 84.78277 |
| Bond price | 100.048 | 98.71853 | 96.56845 | 93.97009 | 91.1402 |
| Class B bonds | One-year | Two-year | Tree-year | Four-year | Five-year |
| Present value of interest | 1.676824 | 2.232321 | 2.418315 | 2.479372 | 2.499678 |
| Present value of principal | 82.18314 | 66.81338 | 56.4318 | 49.73818 | 45.3397 |
| Bond price | 83.85996 | 69.0457 | 58.85012 | 52.21756 | 47.83938 |
| Class C bonds | One-year | Two-year | Tree-year | Four-year | Five-year |
| Present value of interest | 1.676824 | 2.232321 | 2.418315 | 2.479372 | 2.499678 |
| Present value of principal | 67.34751 | 39.63395 | 21.9355 | 11.62378 | 5.896641 |
| Bond price | 69.02434 | 41.86627 | 24.35381 | 14.10315 | 8.396319 |

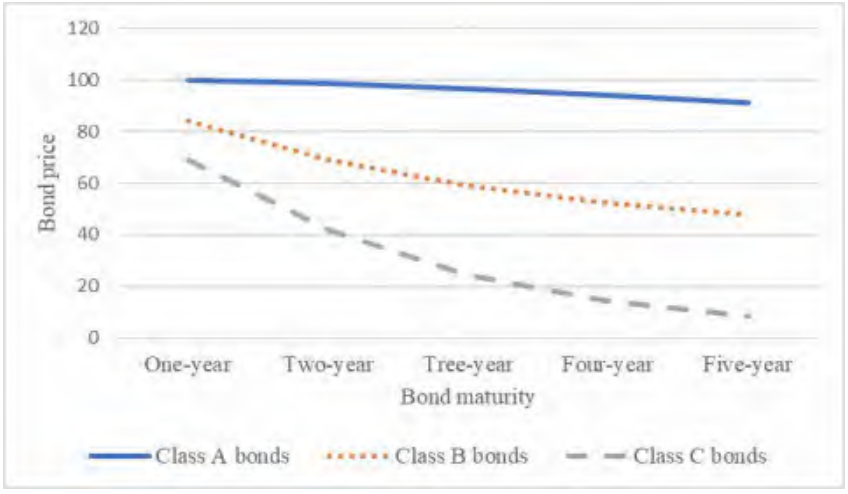


Fig. 4. Comparison of three types of bond prices

It can be clearly seen from the Fig. 4 that there is a negative correlation between price and maturity, that is, the price of bonds decreases with maturity. In addition, comparing the prices of the three types of bonds, bond prices decrease as risks increase. When the maturity of the bond is extended, although bond purchasers may receive more interest, the probability of the index reaching the trigger value is

also increasing exponentially, and the rapid increase of risk leads to the lower price of the bond. The prices of different types of bonds also reflect different degrees of risk compensation. As the possibility of losing principal and interest and the degree of loss continue to rise, bond prices gradually decline.

### 4.4 Parameter sensitivity analysis

In order to analyze the factors that affect the price of catastrophe bonds more clearly, this part takes Class C bonds as an example to adjust the trigger value and the parameters in the stochastic interest rate model, and analyze the differences.

#### *4.4.1 Trigger value adjustment*

In the above study, the trigger value selected for typhoon direct economic loss is 21.69273 billion yuan, and the trigger value selected for the typhoon wind speed is 45 m/s. Our paper increases and decreases the trigger value by 5% and 10% respectively to study the impact of trigger value changes on bond prices, that is, the trigger value of loss is 22.7737 billion yuan, 20.6089 billion yuan, 23.862 billion yuan and 19.5234.6 billion yuan, and the trigger value of wind speed is 47.25 m/s, 42.75 m/s, 49.5 m/s and 40.5 m/s. The final bond price is shown in Table 12, and the broken line chart of corresponding prices under five different trigger values is shown in Fig. 5.

Table 12. Bond prices under the trigger value adjustment

| Class C bonds | One-year | Two-year | Tree-year | Four-year | Five-year |
|---|---|---|---|---|---|
| Increase 10% | 80.81253 | 59.49707 | 42.46327 | 29.87988 | 21.18217 |
| Increase 5% | 75.23851 | 50.64477 | 32.65175 | 21.01443 | 13.69534 |
| Original value | 69.02434 | 41.86627 | 24.35381 | 14.10315 | 8.396319 |
| Decrease 5% | 61.97817 | 33.40985 | 17.29566 | 9.291023 | 5.433552 |
| Decrease 10% | 55.46074 | 26.64216 | 12.67948 | 6.40544 | 3.591868 |

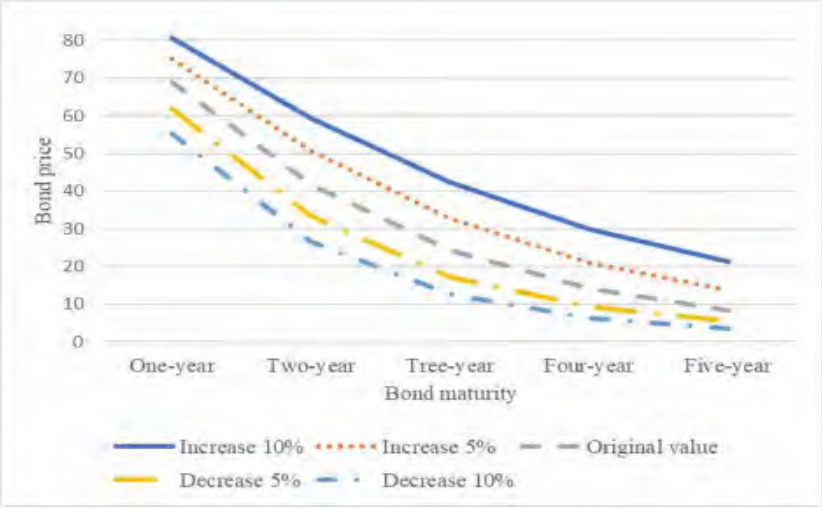


Fig. 5. Comparison of bond prices under different trigger values

It can be seen from Table 12 and Fig. 5 that the price of typhoon catastrophe bonds is significantly affected by catastrophe risk variables. The price of typhoon

catastrophe bonds increases with the increase of trigger value, and the adjustment of trigger value has a significant impact on the price of long-term bonds. The increase of trigger value reduces the possibility of cash flow loss to a certain extent, which reduces the risk compensation and increases the bond price. In addition, since typhoon disasters in each natural year are independent of each other, the probability of no loss of principal and interest is approximately equal to the product of the probabilities of each year, which leads to an exponential increase in catastrophe risk factors under the accumulation of time. Therefore, when pricing typhoon catastrophe bonds, the trigger value should be selected according to the actual bond issuance requirements, so as to improve the feasibility of bond issuance.

*4.4.2 Vasicek model parameter adjustment*

In this part, we adjust the parameters in the Vasicek model to observe the influence of financial market variables on bond prices. In view of the fact that the initial value of the risk-free interest rate and the average value of the forward interest rate are derived from the SHIBOR data, there is no change here. The mean reversion speed α represents the speed of regression when the interest rate is far away from the mean, and the interest rate volatility σ represents the fluctuation of interest rates when the interest rate changes randomly. The previous article assumes $a = 0.1, s = 1\%$, so we adjust these two indicators to $a = 0.2, 0.5, s = 5\%, 10\%$, and find the bond price when an indicator changes. The results are shown in Table 13:

Table 13. Bond price under parameter adjustment of stochastic interest rate model

| Class C bonds | One-year | Two-year | Three-year | Four-year | Five-year |
|---|---|---|---|---|---|
| $a = 0.5, s = 1\%$ | 68.83585 | 41.50801 | 23.9843 | 13.80616 | 8.191829 |
| $a = 0.2, s = 1\%$ | 68.96964 | 41.75395 | 24.22711 | 13.99365 | 8.315942 |
| $a = 0.1, s = 1\%$ | 69.02434 | 41.86627 | 24.35381 | 14.10315 | 8.396319 |
| $a = 0.1, s = 5\%$ | 69.03385 | 41.84359 | 24.27013 | 13.97911 | 8.268208 |
| $a = 0.1, s = 10\%$ | 69.06579 | 41.75243 | 24.02285 | 13.62183 | 7.911135 |

It can be seen from Table 13 that the effect of adjusting α and σ in the stochastic interest rate model on bond prices is basically negligible. We can conclude that when interest rates fluctuate within a short period of time in the financial market, the impact on the price of typhoon catastrophe bonds is minimal, and the price of typhoon catastrophe bonds is mainly affected by catastrophe risk factors.

## 5. Research conclusions and policy recommendations

Based on data of typhoon direct economic loss and central maximum wind speed in China from 2006 to 2018, this article builds the compound trigger mechanism, selects Weibull distribution and lognormal distribution as their marginal

distribution functions, and constructs the mixed Copula function of typhoon loss and wind speed. According to this, this article designs the typhoon catastrophe bond, uses the Vasicek stochastic interest rate model to construct the bond's interest rate term structure, and obtains the price of the typhoon catastrophe bond on the basis of equilibrium pricing theory. Furthermore, this article carries out parameter sensitivity analysis, discusses the influence of different trigger values and different Vasicek stochastic interest rate model parameters on bond prices in the pricing process.

The main point of this paper is that the factors affecting the pricing of typhoon catastrophe bonds mainly include bond maturity and catastrophe trigger value. The three types of 1-5 years typhoon catastrophe bonds designed in this paper show that bond prices are negatively correlated with bond maturity. Further comparison found that the lower the catastrophe trigger value, the greater the probability of catastrophe occurrence, and correspondingly the lower the bond price. Besides, the adjustment of the trigger value has a more significant impact on bonds with longer maturities. In addition, although the stochastic interest rate model can better reflect the real situation of the market, short-term fluctuations in the financial market have less impact on the price of typhoon bonds.

At present, there are few researches on catastrophe bond pricing in China, and no systematic analysis framework has been formed. Therefore, this article puts forward the following policy suggestions: (1) Speed up the construction of catastrophe insurance legal system, and give corresponding policy and legal support. The United States, Japan and other developed countries have provided legal support for catastrophe risk management through legislation under the guidance of the government, but the legislation of catastrophe insurance in China is still blank. China should speed up the legislation process of catastrophe insurance, form a complete and unified legal framework from special legislation to comprehensive legislation. (2) Strengthen the management of disaster database to provide support and guarantee for the issuance of catastrophe securities in China. Whether the catastrophe risk database is complete will affect the rationality of catastrophe bond pricing. Relevant statistical departments and institutions should adopt effective technical means to collect and sort out natural disaster statistical data, ensure the timeliness and accuracy of the data, and provide reliable data support for the establishment of catastrophe risk models. (3) Establish catastrophe bond issuing institutions scientifically and encourage innovation in catastrophe bond product categories. Catastrophe bond issuing institutions must have high credit ratings and strong resistance to risks. In addition, bond issuers should innovate bond design and price reasonably according to the actual situation of the capital market, so as to increase the types of product supply in the capital market and enrich the choice of investment varieties for investors.

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# Prediction of Mortality Rate of Elderly Population Based on Lee-Carter Model

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**Keywords:** Mortality prediction, Elderly population, Lee- Carter model.

**Abstract.** Longevity risk is caused by the uncertainty of the long-term trend of mortality. Establishing a scientific predictive model of mortality of the elderly population is the basis for measuring and evaluating longevity risk. In the age-specific survey data in China, the effective accumulation years of the mortality data of the elderly population are few, and the data fluctuates greatly, which brings trouble to the establishment of the mortality prediction model. In this paper, a classic Lee-Carter model is established based on the data of population mortality from 1994 to 2019. The iterative weighted least squares estimation method is used to solve the problem of irregular data, and the age factor of the model is extended to 110 years old, which provides a new method for predicting the mortality of the elderly in China. The

mortality and life expectancy of the elderly population in China are predicted by the established model, and the longevity risk of individual pension accounts is evaluated.

## 1．引言

人口问题始终是我国面临的全局性、长期性、战略性问题，第七次人口普查全面查清了我国人口数量、结构、分布等方面情况，准确反映了当前人口变化的趋势性特征。年龄构成中60岁及以上人口为26402万人，占18.70%（其中，65岁及以上人口为19064万人，占13.50%）。老龄化加剧问题更加突出，60岁以上人口比上个十年提高了5个百分点以上，65岁以上提高了4个百分点以上，未来一段时期内将面临人口持续老龄化的压力。长寿风险（Longevity Risk）是由于死亡率持续改善与长期趋势的不确定性而造成的。正确的预测高龄人口死亡率和预期寿命对于掌控长寿风险非常重要，而建立死亡率预测模型是预测死亡率的基础。

死亡率预测模型中的Lee-Carter是一个比较著名的模型。Lee-Carter模型是全年龄模型，该模型利用过去的死亡率数值，将时间变化趋势考虑进来，使模型的预测更加客观可信；而且Lee-Carter模型形式简单，预测时只需对时间因子进行预测。

但是中国高龄人口死亡率的历史数据较少，波动较大，质量较差，使Lee-Carter模型在我国高龄人口死亡率应用具有局限性。赵明和王晓军(2014)[1]突破了传统Lee-Carter模型的框架，直接从死亡率改善产生的原因入手，采取Monte Carlo方法建立中国高龄人口死亡率随机波动趋势模型，使得预测的死亡率更加准确可信。吴晓坤等(2019)[2]根据0岁预期寿命利用Lee-Carter模型得到高年龄人口预期寿命，对CBD模型的时间因子进行参数调整，改善了CBD模型的预测结果。王晓军和赵晓月(2019)[3]借助多人口联合建模思想，基于单人口CBD模型，提出了一个适用于老龄死亡率建模的Logistic多人口模型，得到了更好的拟合效果和长期预测一致性效果。

本文采用Lee-Carter模型拟合我国1994-2019年间分年龄人口死亡率，然后对Lee-Carter模型的年龄效应因子进行高龄拓展至110岁，并运用年龄拓展的Lee-Carter模型预测未来高龄人口死亡率和预期寿命。Lee-Carter模型的高龄拓展为我国积极应对人口老龄化，进行人口死亡率与长寿风险研究提供了死亡率预测的模型参考。

## 2．Lee-Carter模型

### 2.1 Lee-Carter模型

Lee和Carter在1992年时经研究提出了Lee-Carter死亡率预测模型[4]

$$\ln(m_{x,t}) = \alpha_x + \beta_x \times \kappa_t + \varepsilon_{x,t} \tag{1}$$

其中 $x$ 表示人口的年龄，$t$ 表示时间，$m_{x,t}$ 表示中心死亡率，$\alpha_x$ 与 $\beta_x$ 分别反映 $x$ 岁的平均死亡率水平和 $x$ 岁死亡率的下降快慢程度，其中 $\kappa_t$ 表示时间因子，体现不同时间死亡率的水平，$\varepsilon_{x,t}$ 为误差项，并且服从正态分布，$\varepsilon_{x,t} \sim N(0,\sigma^2)$。

### 2.2 加权最小二乘法

Wilmoth(1993)[5]提出了一种加权的最小二乘法来估计模型的参数。在估计参数时需要对模型加一对约束条件，如下：

$$\sum_{t=t_1}^{t_n}\kappa_t = 0, \sum_{x=x_1}^{x_m}\beta_x = 1 \tag{2}$$

本文采用了这种迭代加权最小二乘法（WLS）对模型的参数进行估计，权重为死亡人数，死亡率缺失年龄的数据权重设为0，并对数据缺失位置的数据赋予任意的一个正整数，由此形成规则的数据，以方便后续的参数估计，估计方程如下：

$$O_{WLS}(\alpha,\beta,\kappa) = \sum_{x=x_1}^{x_m}\sum_{t=t_1}^{t_n} w_{xt}(\ln \hat{m}_x(t) - \alpha_x - \beta_x\kappa_t)^2 \tag{3}$$

其中 $w_{xt} = d_{xt}$， $d_{xt}$ 为死亡人数权重矩阵

## 3. 数据处理

### 3.1 数据来源

本文选取了1994年-2019年国家统计局公布的分年龄分性别的人口死亡数据，包括分年龄年中人口数、年死亡人口数和中心死亡率。其中2000年和2010年是人口普查数据，1995年、2005年和2015年为1%人口抽样数据，年龄范围均为0-100岁；其余各年为1‰变动人口抽样数据，其中1996年数据的年龄上限为85岁，其余为90岁。首先选取年龄上限为100岁的2000年与2010年人口普查年份与1995年，2005年和2015年1%抽样年份的死亡率进行分析，如下图1：

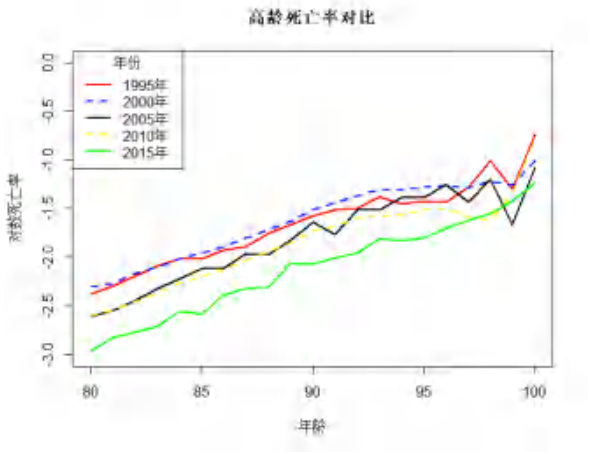


图1 五年高龄死亡率对比

通过观察比较发现高龄人口在95岁之前趋势还比较明显，具有一定规律性，但在97岁以后数据量较少，波动性较大，随时间变动的趋势不明显，很难捕捉死亡率随年龄和时间的变动规律，为建立模型带来了麻烦。

### 3.2 缺失值处理

人口变动情况抽样调查数据在低龄和青年人口死亡情况的观测中存在无死亡记录的观测，如果不加任何处理，将这些数据放到一起无法形成规则的矩阵形数据，数据年龄上限有100岁，90岁和85岁，高年龄数据的缺失会对建模造成不便[6]，不能运用这些数据建立死亡率经典模型——Lee-Carter模型。本文采用迭代加权最小二乘法对参数进行估计，权重为死亡人数，死亡率缺失年龄的数据权重设为0。在参数估计过程中，为便于计算，给缺失值赋一个任意正数，这样年龄上限不规则的数据就变成形式上的规则数据，但由于0权重的作用，这样做并不

会影响参数估计的结果，同时也保证了所有存在的数据都能参与模型计算，避免丢失信息。

利用加权的最小二乘法（WLS）估计出Lee-Carter模型的参数年龄效应因子 $\alpha_x$， $\beta_x$ 与时间因子 $\kappa_t$ 如下图2：

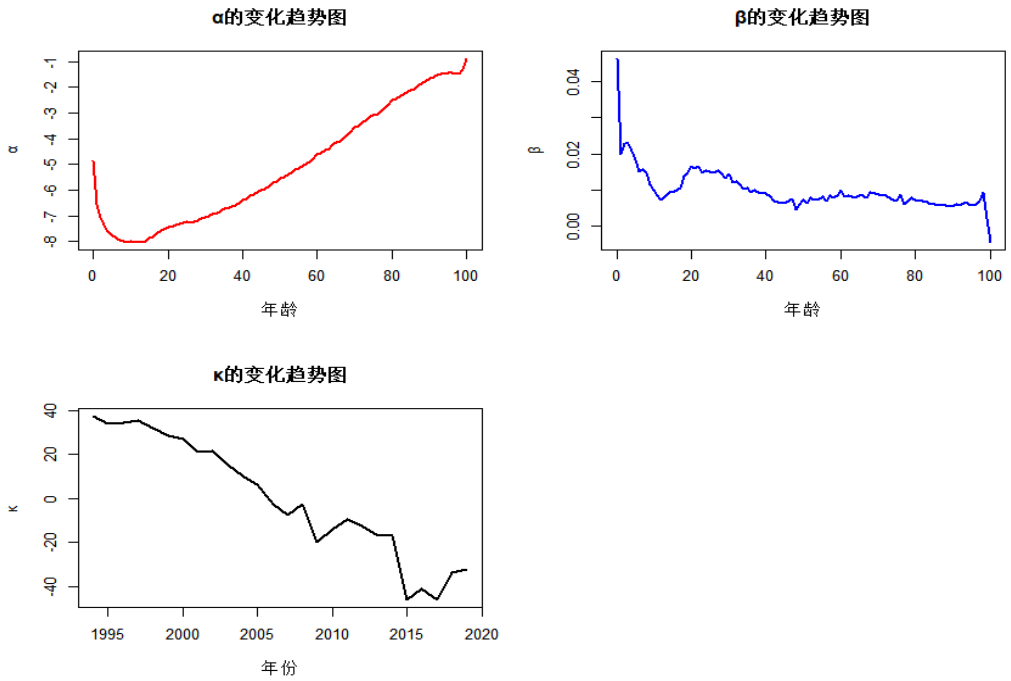


图2 最小二乘法拟合模型参数估计值

## 4. 年龄因子的延拓

### 4.1 Coale–Kisker模型

为了预测高龄人口的死亡率，本文选取了两种方法进行延拓进行对比。先选择较为简单的依赖于指数年龄中心死亡率变化率的Coale和Kisker提出的模型（简称CK模型）[7]，定义如下：

$$k_x = \ln \frac{m_x}{m_{x-1}} \tag{4}$$

该模型假设 $k_x$ 在85岁以上时是线性的

$$k_x = k_{85} - (x-85)s \tag{5}$$

假定110岁必然死亡，即给 $m110$ 提供预定值为1。根据所记录的观测数据计算 $k_{85}$ 进而确定参数s。对于给定的值 $k_x$， $x = 85,86,\ldots,110$， 可以从上式得到：

$$m_x = m_{85} \exp(\sum_{b=86}^{x} k_b) \tag{6}$$

从而可以看出，Coale–Kisker模型揭示了高龄人口的中心死亡率呈现指数二次函数变化，即，

$$m_x = \exp(ax^2 + bx + c) \tag{7}$$

利用Coale-Kisker模型，基于85岁之前的死亡率进行延拓，可以得到110岁之前的死亡率。首先选取了1995年,2000年，2005年，2010年这4年，对85岁到99岁这个年龄段利用Coale-Kisker模型得到了高龄拓展到100岁的拟合值结果，然后与观测数据对比观察。如下图3，实线代表了观测数据，虚线代表了利用该方法拟合得出的高龄数据，进行了对比。

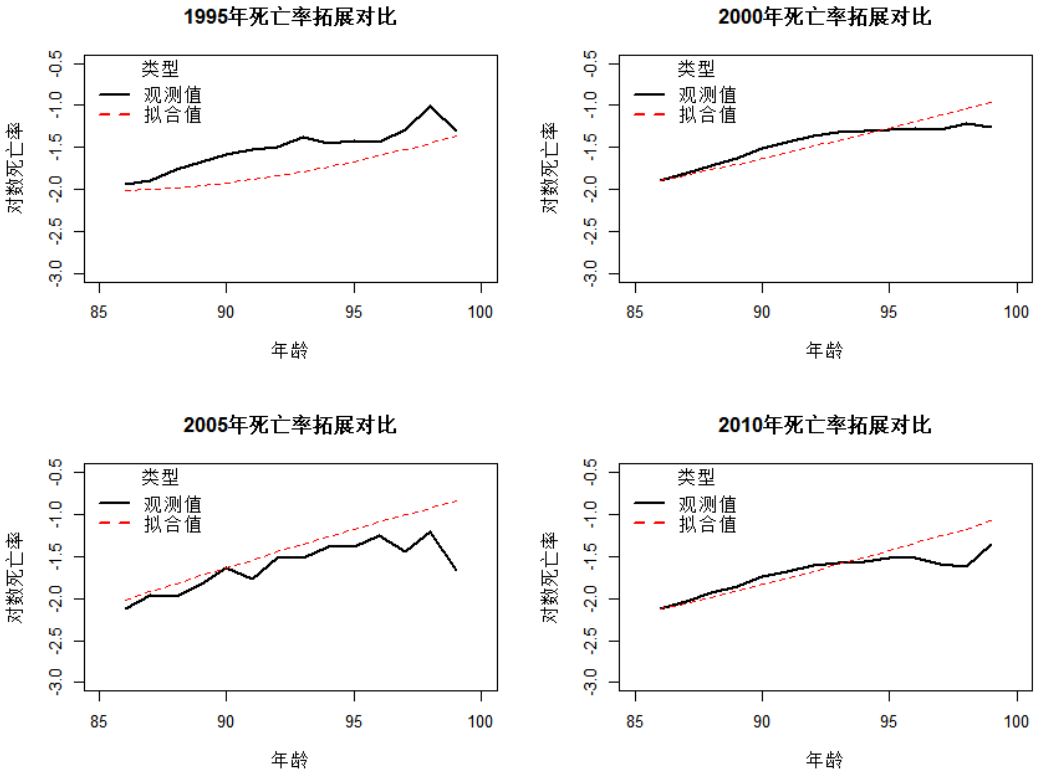


图3 C-K模型4年拟合值与观测值对比

## 4.2 年龄效应因子延拓

Dowd etc. (2019)[8]对Lee-Carter模型的年龄因子进行延拓，这种方法可以解除样本的最大年龄约束，并且可以使用拟合的模型来预测未来的死亡率。我们对加权最小二乘法得到Lee-Carter模型的年龄效应因子 $\alpha_x$ 与 $\beta_x$ 分别进行延拓。选取了81-94岁这个年龄段对年龄因子 $\alpha_x$ 进行延拓，得到较为符合死亡规律的结果图4，

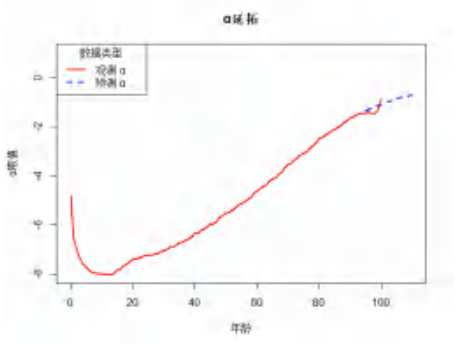

图4 α 110岁延拓值

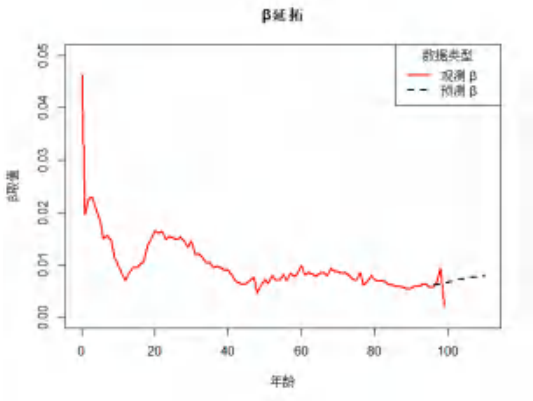

图5 β 110岁延拓值

然后对另一个年龄因子 $\beta_x$ 进行拟合，发现三次曲线可以更好的拟合 $\beta_x$ 的变化，在85岁之后 $\beta_x$ 尾部呈现略微上翘的走向，从而对 $\beta_x$ 进行延拓，如图5所示。

### 4.3 模型参数再调整

运用未进行参数调整的Lee-Carter模型拟合死亡率时，往往与真实数据存在较大偏差。利用国家统计局发布的预期寿命数值，对于Lee-Carter模型时间因子进行再调整，可以提高了模型对预期寿命估计的准确性。利用死亡率(生存概率)可以计算某一年龄人群的预期寿命[9]，$x$ 岁的预期寿命公式为：

$$e_x = \sum_{k=1}^{\omega-x} {}_k p_x + \frac{1}{2} \tag{8}$$

其中年龄为 $x$ 岁的人在未来 $k$ 年内的生存概率用 ${}_k p_x$ 表示，生命表年龄上限为 $\omega$。

$${}_k p_x = p_x p_{x+1} \cdots p_{x+k-1} \tag{9}$$

$$p_x = e^{-m_x} \tag{10}$$

为确保预测结果的准确性，利用国家统计局公布的0岁预期寿命进行对比，如图6。

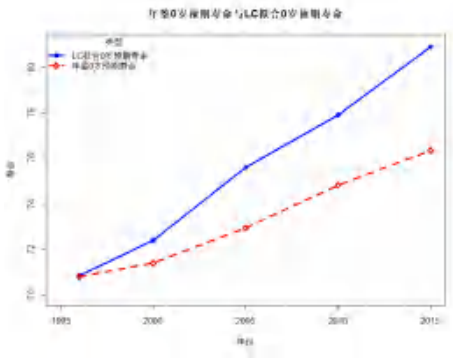

图6 年鉴与Lee-Carter模型0岁预期寿命

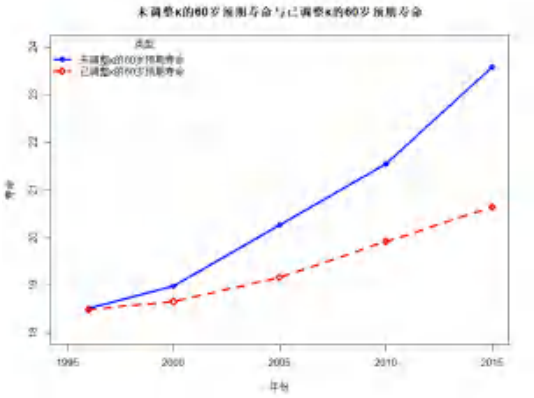

图7 调整与未调整的60岁预期剩余寿命

Lee-Carter模型拟合的0岁预期寿命与国家统计年鉴公布的0岁平均预期寿命有着3岁到5岁左右的差异，若不进行调整直接进对死亡率预测，结果难免失真，会对计算60岁人口的预期剩余寿命造成极大影响。对Lee-Carter模型进行参数调整时，将预期寿命设置为调整目标，把 $\alpha_x$ 和 $\beta_x$ 的估计值固定，通过调整 $\kappa_t$ 的值，使得模型对应的某一年龄 $x_0$ 的预期寿命等于设定的某一数值(这里 $x_0 = 0$)。利用调整后 $\kappa_t$ 的计算60岁人口的预期剩余寿命，与未调整的 $\kappa_t$ 进行对比，如图7，发现60岁人口的预期剩余寿命经过时间因子调整后下降了1到3岁。

### 4.4 拟合值与观测值对比

考虑到我国分年龄死亡率波动性较大，高龄部分数据稀疏的情况，选择数据量较大，数据质量较好的普查年和1%抽样调查年的2000年、2005年、2010年和2015年的死亡率数据，将两个模型的拟合结果与观测值作对比，首先对2010年进行分析，见图8。通过观察发现，利用加权最小二乘法拟合的0-100岁死亡率与国

家统计局公布的分年龄人口死亡率几乎重合，因此可以利用最小二乘法拟合值代替观测值进行对比研究。

通过图9对比分析发现，利用加权最小二乘法所拟合的85岁-100岁的死亡率波动较大，受到了高龄数据稀缺的影响。而利用Coale-Kisker模型，基于85岁之前的死亡率进行延拓，得到了110岁之前的死亡率，呈现指数二次函数增长，但是不符合我国死亡率发展规律。而根据年龄因子进行延拓，得到的这四年人口死亡率趋势上升幅度显著变缓，符合当今社会死亡率发展规律。

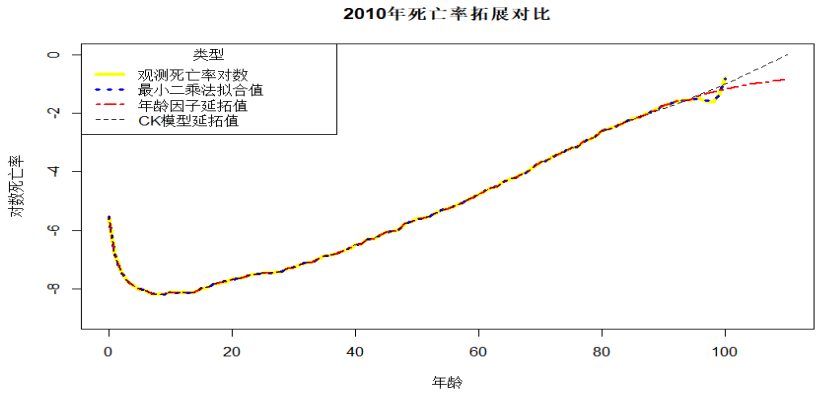


图8 2010年观测值与拟合值比较

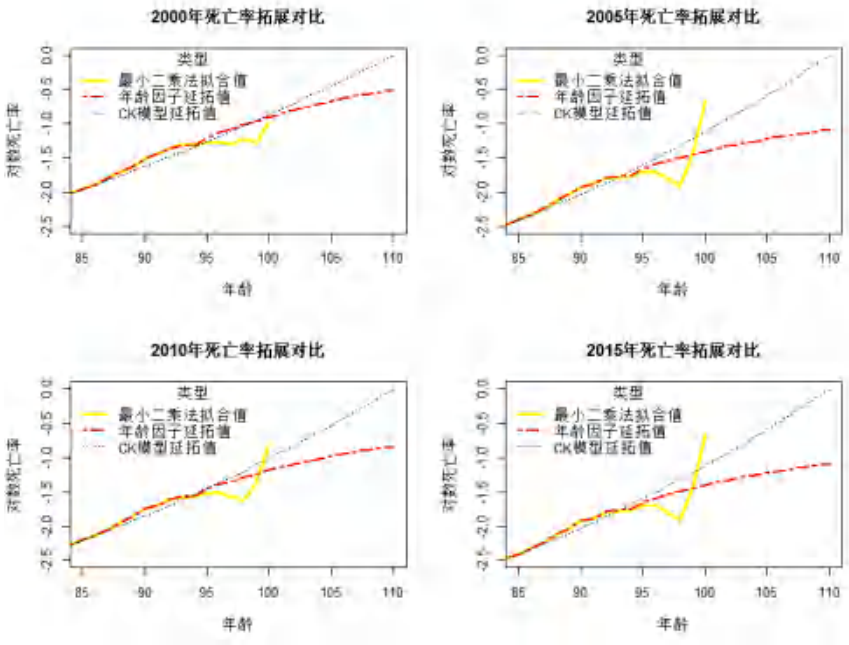


图9 四年死亡率延拓值与拟合值比较

## 4.5 预测值与观测值比较

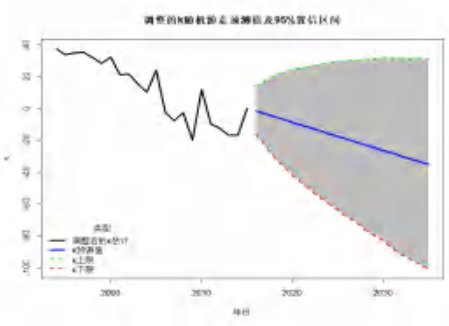

图10 κ 随机游走过程

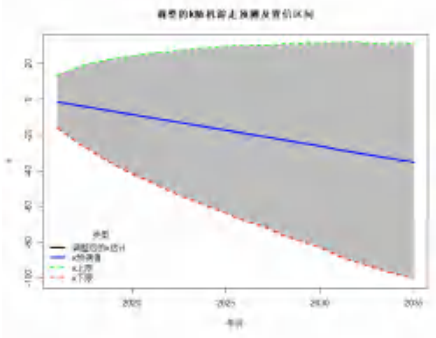

图11 未来20年κ 预测值及置信区间

为了判断通过年龄效应延拓的高龄人口死亡率的准确性，本文选取1994-2015年分年龄人口死亡率数据进行预测，得到未来20年的死亡率预测值，对比分析2016-2019年死亡率对数观测值与预测值，判断该方法的可靠性。在对时间因子$\kappa_t$进行预测时，利用带漂移项的随机游走模型[10]的经典方法来对调整后的时间因子进行预测。对1994-2015年已调整时间因子$\kappa_t$的参数估计进行随机游走如图10，得到未来20年的$\kappa_t$预测值以及95%的置信区间如图11：

利用预测的$\kappa_t$时间因子可以得到2016-2019年，年龄区间为60-110岁死亡率预测值以及95%置信区间，与观测值对比进行研究，如图12。真实值完全落入预测区间内，预测区间宽度基本不随年龄变化，预测区间的轻微浮动反应了历史数据波动性。

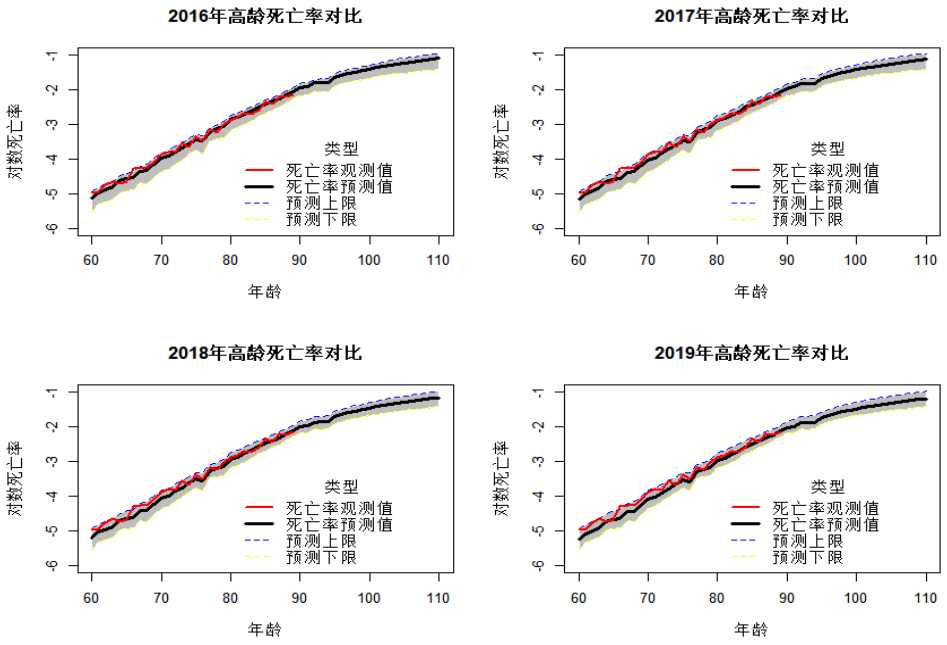


图12 2016-2019高龄死亡率对数

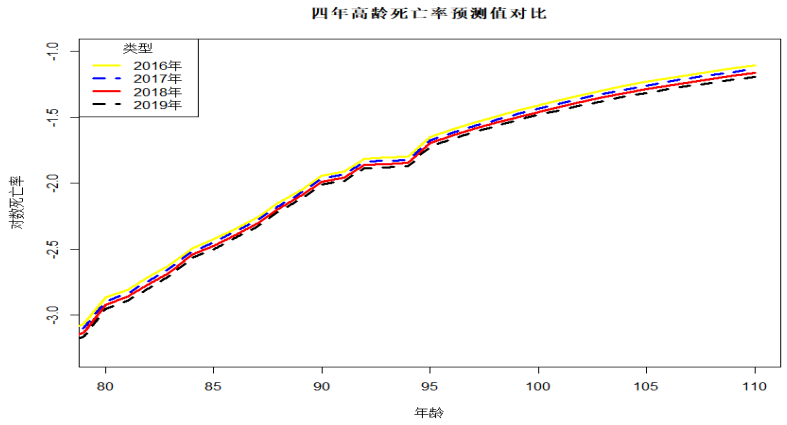


图13 2016-2019高龄死亡率预测值

观察图13对比2016-2019年这4年老年人80-110岁死亡率预测值，随着年龄增长，死亡率增长趋势逐渐减缓，随着年份增加死亡率也呈现降低趋势，印证了人口老龄化程度进一步加深，未来一段时期将持续面临人口长期均衡发展的压力。结果表明预测年龄效应得到的拟合值和预测值效果较好，预测误差较低、预测区间完全涵盖真实值，因此可以利用该方法预测未来的分年龄人口死亡率。

## 5．应用

### 5.1 预测未来死亡率

利用调整好 $\kappa_t$ 通过随机游走得到的未来20年的 $\kappa_t$ 预测值可以预测未来20年死亡率，下图14，图15分别为2025年和2035年死亡率对数预测值以及95%置信区间。

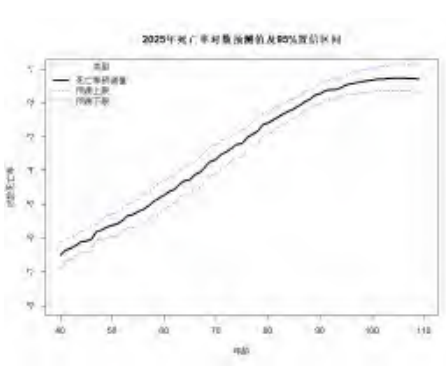

图14 2025年对数死亡率预测

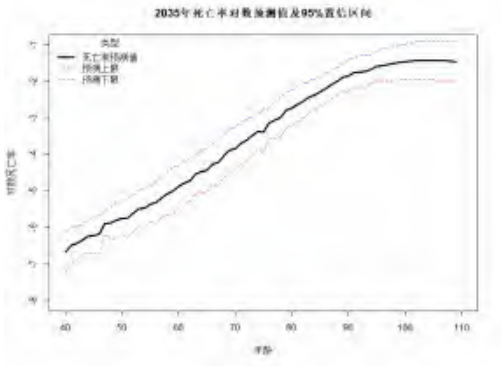

图15 2035年对数死亡率预测

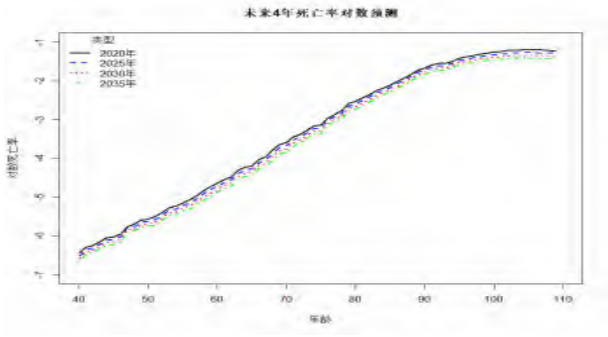


图16 未来4年死亡率对数预测值

选取预测的2020年，2025年，2030年，2035年预测值，观察更为直观的死亡率对数的图像，可以发现同一年份，随着年龄越大，对数死亡率越高，变化后的真实死亡率也呈现递增现象，但80岁以后人口死亡率虽然呈现上升趋势，但是上升幅度却变得愈加缓慢，侧面反映死亡率降低导致养老金体系偿付能力不足的长寿风险这一问题越来越严峻，需要我们积极应对。同一年龄，随着年份的增加，对数死亡率逐渐降低，即死亡率降低，说明未来我们国家人口的死亡率还会出现持续下降，预期寿命持续增长的趋势。由于人类寿命的极限限制了死亡率随时间和年龄的变化范围，高年龄人口死亡率间的差异随着年份增加也呈现出逐渐减小的趋势，符合我们对人口生命周期的基本认知。积极应对人口老龄化的现实迫切性空前凸显。

## 5.2 预期寿命预测

根据年龄效应模型计算得到的死亡率预测值，利用预期寿命的计算公式，我们可以求出未来20年60岁和85岁人口预期剩余寿命的预测值和95%置信度下的区间估计，如下图17和图18。可以看出，60岁人口和85岁人口的预期剩余寿命逐渐延长，到2035年60岁人口的预期剩余寿命达到了22.86岁，而85岁人口的预期剩余寿命则为6.74岁，进一步表面人口老龄化将是社会发展的重要趋势，也是今后较长一段时期我国的基本国情，这既是挑战也存在机遇。

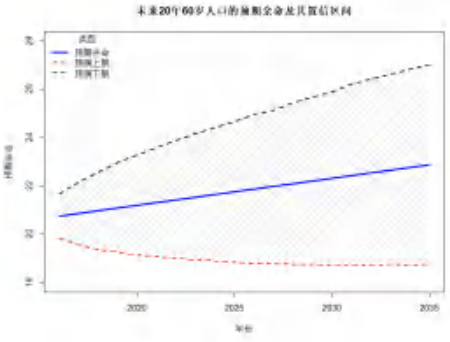

图17 未来20年60岁人口的预期寿命

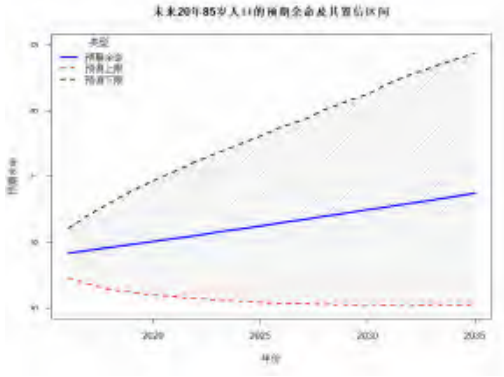

图18 未来20年85岁人口的预期寿命

## 5.3 养老保险计发月数

目前，我国的养老金账户由社会统筹和个人账户两部分组成，本文只研究预期寿命变化对个人账户的影响。设职工退休后到直至死亡为止，这段期间每月月初领取 $P$ 元，该职工可以领取的年金现值为：

$$M = P \times 12 \times a_x^{(12)} \tag{11}$$

其中，$M$ 为退休时个人账户总金额；$\ddot{a}_x^{(12)}$ 表示对于 $x$ 岁的职工每月初支付一次每次支付 1/12 元，的生存年金现值。$\ddot{a}_x^{(12)}$ 的精确计算较为麻烦，可进行近似计算，近似公式[11]为

$$\ddot{a}_x^{(12)} \approx \ddot{a}_x - \frac{12-1}{2\times 12} = \sum_{k=0}^{\omega-x} v^k {}_k p_x - \frac{12-1}{2\times 12} \tag{12}$$

其中，$v$ 为折现系数，$v = \frac{1}{1+i}$，$i$ 为投资收益率(利率)，$\omega$ 为最高年龄。若养老金计发月数为 $A$，则 $P = M / A$ ，再由(11) (12)可以计算出记发月数 $A$。

本文利用预测出的60岁人口预期寿命，研究预期寿命的延长对未来养老金账户的影响。在实际年利率为4%的情况下，计算2020年至2035年的计发月数的预测值。现有的企业养老保险的个人账户计发月数为2005年国发38号文，规定60岁、55岁和50岁计发月数分别为139、170和195个月。图19为利用预测的计发月数与现行养老金保险制度规定的计发月数139个月进行比较。

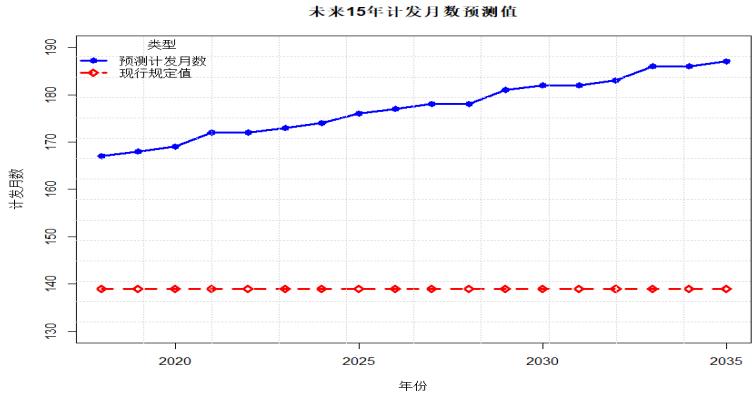


图19 未来15年养老金的计发月数

观察图19可见，相比于国家公布的60岁人口的计发月数139个月，2020年计发月数为168个月，多出的29个月的养老金将从国家统筹账户支出。不考虑调待、基准情景下，预测未来15年的个人账户计发月数均高于现行政策。综上，考虑到现行养老保险制度下个人账户计发月数偏小，个人账户基金将会提前支付完毕，如此违背了精算平衡原则，加剧个人账户的收支不平衡，进而引发长寿风险。

## 6．结论

本文基于1994-2019年人口死亡率数据建立了经典Lee-Carter模型，利用加权最小二乘估计法解决了数据不规则问题对模型的影响，得到了年龄上限为100岁的新模型，由于高龄人口死亡率数据在97岁之后不具有明显趋势性，本文选取了预测年龄效应的方法预测年龄效应因子，与通过Coale-Kisker模型延拓得到了110岁之前的死亡率进行对比，参照观测值与置信区间。通过对比死亡率对数预测值与现有2016-2019年真实值，发现预测区间完全涵盖真实值，预测区间的轻微浮动反应了历史数据波动性，该方法更为合理。

利用死亡率预测值对未来20年60岁预期剩余寿命和85岁预期剩余寿命以及社会基本养老保险个人账户的计发月数进行分析，研究表明未来老年人口的预期寿命显著提高，现有的计发月数与预测的计发月数之间的差距逐年增大。因此，计发月数不应该一成不变，而应该随着人口预期寿命的变化做出调整。积极应对人口老龄化的现实迫切性空前凸显，人口老龄化既是挑战也存在机遇，我们应该勇于面对人口老龄化造成的长寿风险问题，主动摆脱长寿风险带来的困境。

## 致谢

本研究是国家自然基金人口老龄化背景下延迟退休政策精算设计及决策方法研究（72071076）和中央高校基本科研业务费专项资金：Lee-Carter模型与CBD模型的研究、应用与扩展（2018MS127）的阶段性成果并获得相应的研究资助。

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# 基于Lee-Carter模型的高龄人口死亡率预测

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**关键词:** 死亡率预测; 高龄人口; Lee-Carter模型

**中文摘要.** 长寿风险是由于死亡率长期趋势的不确定性而造成的，建立科学的高龄人口死亡率预测模型，是度量和评估长寿风险的基础。我国分年龄的调查数据中的高龄人口死亡率数据有效累积年份少、数据波动情况较大，这为建立死亡率预测模型带来了麻烦。本文基于1994-2019年人口死亡率数据建立了经典

Lee-Carter模型，利用迭代加权最小二乘估计法解决了数据不规则问题，并将模型的年龄因子拓展至110岁，为我国高龄人口死亡率预测提供了一种新的方法。运用建立模型对我国高龄人口死亡率、预期寿命进行了预测，并对养老金个人账户的长寿风险进行了评估。

# The Gap of Basic Pension Insurance in China

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**Keywords:** Basic Pension Insurance (BPI); Cohort Component Method; Revenue and Expenditure Gap; Financial Subsidies; Gradual delayed retirement.

**Abstract.** Based on the data of the sixth population census, this paper uses the cohort component method to project the population of China by age, gender and area profile in the next 80 years. On the basis of population forecast, we respectively project the revenue and expenditure of basic pension insurance (BPI) fund for enterprise employees, state organs and public establishments employees, and urban and rural residents during 2020-2100. After that, we implement policy simulation to assess if different policies, e.g. financial subsidies, social security fund, raising fund investment yield, and gradual delayed retirement, are able to resolve the fiscal pressure caused by the BPI fund gap. The results show that in the absence of financial subsidies, there will always be a gap during the inspection period. After considering a series of policies, there will be no payment crisis in the next 40 years. In order to maintain the balance of revenue and expenditure in a longer period of time, the government needs to take more measures, such as increasing financial subsidies, improving the contribution standards, or reducing welfare expenditure.

## 1. Introduction

With the development of economy, the improvement of living standards and the advancement of medical technology, most countries in the world are experiencing the process of increasing life expectancy and deepening population aging. In 2000, the proportion of the population over 65 years old reached 7.0%, which means that China basically entered a population aging society. The degree of population aging has been deepening since then. By 2019, the proportion of the population over 65 years old has risen to 12.6%. According to the latest seventh population census, the proportion of the population over 60 years old in China has reached 18.7%, and the proportion of the population over 65 years old has reached 13.5%. It is expected that the aging of the population will continue to deepen for a long period of time in the future [1]. The population aging has brought a series of problems, which have a great negative impact on the human capital market and macroeconomic development. The Revenue and expenditure of the basic pension insurance (BPI) fund, which are more sensitive to the change of population structure, will also be greatly affected. By the end of 2019, the number of people participating in BPI nationwide was 967.54 million. The total revenue of the BPI fund for the year was 5702.6 billion yuan, including 4051.6 billion yuan of contribution revenue, the total expenditure was 5234.2 billion yuan, and the accumulated balance of the fund at the end of the year was 6,287.3 billion yuan. Since 2013, the contribution revenue of the BPI fund began to be less than the fund expenditure. In recent years, the gap has been increasing. It can be seen that the current BPI fund in China has been facing a serious problem of deficit. With the increasingly prominent problem of population aging, the BPI fund is facing mounting pressure to pay. The establishment of an actuarial model for China's BPI fund to project and warn its revenue and expenditure is of both great theoretical and empirical importance to the pension insurance system and even the whole social security system.

Many scholars have already conducted research on the gap of BPI based on different perspectives. CAO (2011), MA, ZHANG and LI (2012), WANG and MI (2013) respectively measured the gap of China's pension funds from the perspective of implicit liabilities [2-4]. AUERBACH, GOKHALE and KOTLIKOFF (1992) used intergenerational accounting to explore the reform of pension system in the United States [5], JIANG combined the theory with the actual situation in China to analyze the intergenerational balance of China’s enterprise pension insurance, new rural social pension insurance, and migrant worker pension insurance [6-8]. In addition, many scholars used actuarial methods to project the revenue and expenditure of BPI fund and analyze the effects of corresponding policies. YU and ZENG (2015), ZENG, REN and LIU (2015), JING and HU (2016) discussed the balance ability of the BPI fund under different fertility policies [9-11]. WHITEFORD and WHITEHOUSE (2006), LIN (2010), JING and HU (2017), CHEN (2017), JING (2018), ZHENG (2018), and QI (2019) analyzed the effect of changing the contribution rate on the revenue and expenditure of BPI fund [12-18]. WELLER (2002), BOVENRERG (2003), CREMER and PESTIEAU (2003), LIN (2003), RAO (2005), BREYER and HUPFELD (2010), YU (2012), YU et al. (2018), ZENG, WEI, LI and YANG (2019) empirically research the effect of extending retirement age on the long-term solvency of BPI fund [19-27]; JIANG (2013) and ZHANG (2016) proposed to improve the management system of BPI fund and further improve the rate of return on pension investment [28-29].

Although there are many studies on the gap of BPI in China, there are some differences in various projection results due to differences in methods, calibers, assumptions, and models. China's BPI system has undergone continuous changes in recent years: the BPI for state organs and public establishments employees has gradually broken the dual-track system and incorporated into the overall plan, the BPI for urban residents and the new rural insurance have gradually merged and expanded, and the BPI for migrant workers has become more and more perfect. All these need to be reconsidered in the projection process. Based on existing research, we establish an actuarial model of China's BPI fund to project the revenue and expenditure of "full caliber BPI", which covers the BPI for urban employees (including enterprises, organs, institutions and others), BPI for urban and rural residents (including urban and rural areas), and BPI for migrant workers. The effects of a series of government policies such as financial subsidies, social security fund, raising fund investment yield, and gradual delayed retirement are further analyzed. The projection of the revenue and expenditure of BPI fund for state organs and public establishments employees is based on the latest regulations of Guo Fa [2015] No.2 Document; for migrant workers, according to the "Measures for migrant workers to participate in basic pension insurance (Summary)" in 2009. We also analyze the impact of changes in population, economy and system factors. The demographic aspect is mainly based on the two-child policy that was liberalized in 2015. In the economic aspect, we mainly consider the changes in productivity. As for the system aspect, we adjusted the contribution rate in accordance with the provisions of the Guo Fa [2019] No.13 Document.

## 2. Actuarial model and assumptions

### 2.1 Demographic methods and assumptions

#### *2.1.1 Population forecast*

In order to project the BPI funds' revenue and expenditure in the next 80 years, we first need to forecast the size and structure of the population. Based on the traditional population forecast model, we fully consider the migration of urban and rural population, and construct a population forecast model which is divided into three dimensions: gender, age and area. Specifically, using the cohort element method, we can obtain the population of each age and gender in the next year through the population and mortality rate of each age and gender in this year; according to the demographic structure of women of childbearing age, fertility rate and sex ratio of newborns, the number of newborns by sex can be obtained. Finally, we need to consider the migration of rural population to urban population, that is, the situation of urbanization.

Take the forecast of urban female population structure as an example:

$$x(t+1) = L(t).* x(t) + M(t)B(t)x(t) + f(t). \quad (1)$$

The population matrix of urban women of all ages is:

$$x(t) = \begin{bmatrix} x_0(t) \\ x_1(t) \\ \dots \\ x_m(t) \end{bmatrix}, \; x(t+1) = \begin{bmatrix} x_0(t+1) \\ x_1(t+1) \\ \dots \\ x_m(t+1) \end{bmatrix}. \quad (2)$$

$x_a(t)$ is the urban female population aged a at the beginning of year t, $x_{a+1}(t+1)$ is the urban female population aged a+1 at the beginning of year t+1, and m represents the maximum life span;

The population matrix of urban women of all ages at the beginning of year t surviving to year t+1 is expressed as:

$$L(t).*x(t) = \begin{bmatrix} 0 \\ x_0(t)l_0(t) \\ x_1(t)l_1(t) \\ \dots \\ x_{m-1}(t)l_{m-1}(t) \end{bmatrix}. \quad (3)$$

$l_a(t)$ is the retention rate of female population aged a at the beginning of year t;

$$B(t) = \begin{bmatrix} 0 & \dots. & b_{15}(t) & \dots & b_{49}(t) & \dots & 0 \\ 0 & \dots & \dots & \dots & 0 & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & \dots & 0 & \dots & 0 & \dots & 0 \end{bmatrix}. \quad (4)$$

$b_i(t) = l_{00}(t)h_i(t)k_i(t)$, $i = 15, \dots, 49$; $h_i(t)$ is the fertility pattern of female population aged i in year t; $k_i(t)$ is the proportion of female infants in year t; $l_{00}(t)$ is the female infants retention rate in year t; $M(t)$ is the total fertility rate in year t; $f(t)$ is the population migration vector, that is, the number of rural women migrating to cities by age each year.

*2.1.2 Parameter assumption*

Total fertility rate: In the sixth census in 2010, the total fertility rate of women in mainland China was 1.18, of which the urban total fertility rate was 0.88, the town's total fertility rate was 1.15, and the rural total fertility rate was 1.44. Demographic researchers generally believe that the statistical results of the Fifth and Sixth Census have the problem of underreporting the population of 0-9 years old. According to the assumption of ZENG (2012), the total fertility rate of women will increase to 2.01 after the two-child policy is liberalized, and the fertility rates of urban and rural women will be 1.80 and 2.27 respectively [30].

Neonatal mortality: According to the statistical results published in the "China Health Statistics Yearbook 2020", the total neonatal mortality rate in China in 2000 was 22.8‰, of which the urban neonatal mortality rate was 9.5‰, and the rural neonatal mortality rate was 25.8‰; in 2010, the total neonatal mortality rate dropped to 8.3‰, of which the urban neonatal mortality rate was 4.1‰, and the rural neonatal mortality rate was 10‰; in 2019, the total neonatal mortality rate further dropped to 3.5‰, of which the neonatal mortality rate in urban and rural areas was 2.0 ‰ and 4.1 ‰ respectively. The yearbook also published the neonatal mortality rate of the world's major countries in 2018. The neonatal mortality rate in developed countries was basically between 2‰ and 3‰. Therefore, we assume that the urban neonatal mortality rate will remain at 2‰ and the rural neonatal mortality rate will drop to 3.0‰ by 2025, and then remain unchanged.

Sex ratio of newborns: In 2010, the sex ratios of newborns in urban and rural areas were 120.15 and 122.09 respectively, which were severely higher than normal. With the full liberalization of the two-child policy at the end of 2015 and the reduction of people's gender preference, the sex ratio of newborns is expected to drop significantly and gradually become normal. It is estimated that by 2050, the sex ratio of newborns in urban and rural areas will drop to 105 and 107 respectively, and will remain unchanged thereafter.

Mortality: We adopt the mortality rate of different age groups and life expectancy in 2000-2050 provided in the "Estimation and Management of China Pension Fund", and assume that the mortality rate will remain stable after 2050.

Urban-rural migration: The peak of urbanization of developed countries can be roughly divided into three categories: less than 65%, such as Greece and Finland; between 65% and 80%, such as Germany and France; and more than 80%, such as the United Kingdom and the United States. According to the "2001-2002 China Urban Development Report", the proportion of China's urban population will increase to more than 75% by 2050, basically reaching the level of developed countries. Therefore, we assume that there were an average of 12 million people migrating from rural to urban areas each year before 2015, and the scale of migration will drop to 10 million in 2020, 6 million in 2030, and 4 million in 2050. After that, the urban and rural population structure will remain stable and the migration will stop.

## 2.2 Assumption of economic environment parameters

Labor productivity growth rate: The growth rate of labor productivity is the main influencing factor of wage growth. It is generally believed that the average wage growth rate of the whole society is consistent with the nominal labor productivity growth rate. By comparing the prediction results of many scholars, we select the average results based on Maddison and pwt9.0 of BAI and ZHANG (2017) as the assumption of the actual labor productivity growth rate [31].

Inflation rate: Consumer price index directly affects factors such as the nominal GDP level, social average wage, and the social security fund contribution base, which in turn affect the revenue and expenditure of BPI fund. we assume that the inflation rate for each year during the inspection period will remain unchanged at 2%.

Average social wage growth rate: Theoretically speaking, the marginal output of labor is equal to labor compensation under the condition of perfect competition market, that is, the growth rate of wage and labor productivity should be consistent. Taking into account the actual situation in China, the government has repeatedly proposed that “the growth of labor remuneration should be synchronized with the growth of labor productivity". Therefore, we assume that the average social wage growth rate is consistent with the nominal labor productivity growth rate.

Wage matrix of urban employees: Various official statistical yearbooks only disclose the average wages of employees in enterprises, institutions, and government agencies, and there is no detailed wage data divided by age and gender. We adopt the wage matrix of three types of units by age and gender estimated by JIANG when building China's intergenerational accounting system as the base year wage data.

Discount rate: The critical condition for the transition between the PAYG system and the accumulation system is that the natural population growth rate plus the average social wage growth rate is equal to the internal rate of return of assets under its accumulation system. In the long run, the nominal GDP growth rate is approximately equal to the natural population growth rate plus the nominal labor productivity growth rate plus the labor participation rate growth rate. It is also assumed that the social average wage growth rate is in accordance with the nominal labor productivity growth rate. Therefore, the internal rate of return is equal to the nominal GDP growth rate and is used for discounting.

## 2.3 The Actuarial Model and Assumption of BPI

### *2.3.1 Projection of BPI funds’ revenue and expenditure*

China's BPI system includes two types of BPI for urban employees and BPI for residents. According to the different types of employment units of urban employees, the BPI for urban employees can be further divided into BPI for urban enterprise employees, and BPI for urban state organs and public establishments employees. According to the geographical type of residents, the BPI for residents can be divided into BPI for urban residents and the new rural pension insurance. In 2014, the State Council promulgated the "Opinions on Establishing a Unified Basic Pension Insurance System for Urban and Rural Residents", deciding to merge the new rural pension insurance and BPI for urban residents and establish a unified BPI for urban and rural residents nationwide. The goal is to establish a fair, unified and standardized urban and rural residents' BPI system by 2020. Therefore, we also combine the two insurances into BPI for urban and rural residents in this paper.

The target population of BPI for urban enterprise employees (including others and migrant workers) includes: urban pure enterprise employees, people employed in other ways such as self-employed individuals, and insured migrant workers. The retirement age is 60 for male, 55 for female cadres and 50 for female workers. The employer contribution rate was 20%, which reduced to 16% from 2019, and the individual contribution rate remains 8%; the contribution rate of migrant workers is 12% for employers and 8% for individuals. As for the pension expenditure of urban enterprise employees, the old method is adopted to grant pension to the "old people" and "middle people", and the new method is adopted to grant pension to the "new people", which include basic pension and individual account pension[1].

The target population of BPI for urban state organs and public establishments employees includes: employees of urban state organs and public establishments included in the overall planning system. The retirement age is 60 for male and 55 for female. The revenue and expenditure projected in this paper only include those who are included in the overall planning system. The contribution base of the insured employees is the average wage of the employees of state organs and public establishments. The employer contribution rate was 20%, which reduced to 16% from 2019, and the individual contribution rate remains 8%. For those who retire from the overall planning system in 2015 and later, the pension will be paid according to the new method, including two parts: basic pension and individual account pension; those who retire from the overall planning system before 2015 will still enjoy pension benefits according to the old method[2].

The target population of BPI for urban and rural residents includes: Rural residents and non-employed urban residents who are over 16 years old (excluding school students) and do not participate in BPI for urban employees. The retirement age is 60 years old. The pension also includes basic pension and individual account pension. The basic pension is determined at a fixed annual amount, and the method of determining the individual account pension is the same as that of urban employees.

The following is the formula for projecting revenue and expenditure for these types of insurance:

[1] Enterprise employees who retired before 1996 belong to the "old people"; the employees who took part in work after 1997 belong to the "newcomers"; and those who took part in work before 1996 and retire after 1997 belong to the "middle people". In the design of the transitional pension system for the "middle people", the transitional pension vary greatly in different regions and is difficult to calculate. This paper assumes that the "middle people" enjoy the same level of pension benefits as the "old people".

[2] Since October 1, 2014, the BPI system for state organs and public establishments employees has been implemented nationwide, which combines the pooling account and individual account. For the sake of data acquisition, we assume that the new system was officially implemented on January 1, 2015, and the three months at the end of 2014 was ignored.

Revenue projection:

Annual contribution of BPI for urban employees in year n:

$$RZ_n = \sum_{i,j,s} c_{ijsn} A_{ijsn} R_{ijsn} x_{ijsn} w_{ijsn} h_{ijsn}. \quad (5)$$

$A_{ijsn}$ is the target population, $c_{ijsn}$ is the coverage rate, $R_{ijsn}$ is the proportion of actual contribution population, $x_{ijsn}$ is the contribution base, $W_{ijsn}$ is the contribution rate, and $h_{ijsn}$ is the collection rate.

Annual contribution of BPI for urban and rural residents in year n:

$$RJ_n = \sum_{i,k,s} c_{iksn} B_{iksn} R_{iksn} I_{iksn}. \quad (6)$$

$B_{iksn}$ is the target population, $c_{iksn}$ is the coverage rate, $R_{iksn}$ is the proportion of actual contribution population, and $I_{iksn}$ is the per capita contribution.

Expenditure projection:

Pension for the “middle people” and “old people” of BPI for urban employees in year n:

$$EMO_n = \sum_{i,j,s} (M_{ijsn} + O_{ijsn}) x_{ijsn} G_{ijsn}. \quad (7)$$

$M_{ijsn}$ is the population of retired "middle people", $O_{ijsn}$ is the population of retired "old people", $x_{ijsn}$ is the regional average wage level, and $G_{ijsn}$ is the pension replacement rate.

Pension for the “new people” of BPI for urban employees in year n:

$$EN_n = \sum_{i,j,s} 12 \times (q x_{ijsn} + \frac{P_{ijsn}}{139}) N_{iksn}. \quad (8)$$

$N_{iksn}$ is the population of retired "new people", $x_{ijsn}$ is the regional average wage level, q is the calculation standard, and $P_{ijsn}$ is the amount of individual account deposit.

Pension of BPI for urban and rural residents in year n:

$$EJ_n = \sum_{i,k,s} 12 \times (x_{iksn} + \frac{P_{iksn}}{139}) J_{iksn}. \quad (9)$$

$J_{iksn}$ is the retired population of BPI for urban and rural residents, $x_{ijsn}$ is the basic pension issued by the government, and $P_{iksn}$ is the individual account deposit of urban and rural residents.

*2.3.2 Parameter assumption*

Working age: According to the labor law, the minimum age of labor resources is 16. The retirement age of employees is 60 for males, 55 for female cadres, and 50 for female workers; the retirement age of residents is 60.

Coverage rate[3]: The coverage rate is 100% for enterprise employees, and 30% for urban self-employed persons; according to the pension reform of state organs and public establishments, since 2015, the coverage rate has been 100% for state organs employees, and 70% for public establishments employees; the urban and rural residents’ coverage rate rose from 12.86% in 2010 to 77.45% in 2019, and then will increase at a constant rate to 100% in 2025; the number of migrant workers participating in the BPI for enterprise employees is 11.78% of the urban population of working age.

Contribution rate: The employer contribution rate of BPI for urban employees remained unchanged at 20% from 2010 to 2018, and dropped to 16% from 2019,

[3] Because of space limitation the details will not be dealt with here. Please feel free to contact the authors for any questions.

while the individual contribution rate remains 8%. The individual contribution of BPI for urban and rural residents is a fixed value every year, the per capita contribution was 345 yuan in 2019, and the annual contribution will increase according to the growth rate of labor productivity. The employer contribution rate of migrant workers is 12%, the individual contribution rate is 8%, and the contribution base is 60% the average wage of enterprise employees.

## 3. Results

Based on the population forecast results, we use matlab software to conduct actuarial evaluations on the financial operation of BPI fund in the short-term (2020-2030) and long-term (2020-2100) periods.

### 3.1 Short-term actuarial evaluation

In the short term, the condition for the solvency of BPI fund to be sufficient is that the fund can ensure the full payment of the benefits of the insured persons on time. we set the index of "fund solvency ratio", which represents the ratio of the accumulated fund balance at the beginning of the year to the estimated fund expenditure of the year. When the "fund solvency ratio" is greater than 100%, the accumulated fund balance at the beginning of the year is sufficient to meet the expenditure, indicating that the BPI fund has sufficient solvency ability.

According to formulas (5) to (9) and relevant assumptions, the revenue and expenditure of the BPI fund, the accumulated balance at the end of the year, and the fund solvency ratio during the period 2020-2030 are projected as shown in Table 1.

Table 1. Operation of the BPI fund from 2020 to 2030 (unit: billion yuan).

| | Contribution revenue | | | Expenditure | | | Net balance | Accumulated balance | Solvency ratio |
|---|---|---|---|---|---|---|---|---|---|
| | Employees | Residents | Total | Employees | Residents | Total | | | |
| 2019 | | | | | | | | 6287 | |
| 2020 | 4200 | 112 | 4312 | 5248 | 313 | 5561 | -1250 | 5245 | 113% |
| 2021 | 4536 | 125 | 4660 | 5543 | 358 | 5901 | -1241 | 4177 | 89% |
| 2022 | 4877 | 138 | 5015 | 5937 | 414 | 6351 | -1336 | 2979 | 66% |
| 2023 | 5217 | 151 | 5368 | 6441 | 490 | 6931 | -1563 | 1514 | 43% |
| 2024 | 5589 | 165 | 5754 | 6945 | 572 | 7517 | -1763 | -199 | 20% |
| 2025 | 5982 | 181 | 6164 | 7525 | 682 | 8208 | -2044 | -2249 | -2% |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2026 | 6378 | 191 | 6570 | 8183 | 781 | 8963 | -2394 | -4717 | -25% |
| 2027 | 6810 | 202 | 7012 | 8861 | 871 | 9732 | -2721 | -7594 | -48% |
| 2028 | 7247 | 212 | 7460 | 9707 | 981 | 10689 | -3229 | -11073 | -71% |
| 2029 | 7720 | 224 | 7944 | 10608 | 1097 | 11705 | -3761 | -15200 | -95% |
| 2030 | 8213 | 237 | 8450 | 11265 | 1229 | 12494 | -4044 | -19745 | -122% |

Notes: The contribution revenue of BPI for urban employees includes two parts: the employer's contribution and the individual contribution; the contribution revenue of BPI for urban and rural residents only includes the individual contribution; Government subsidies are not considered; Fund solvency ratio = accumulated fund balance at the beginning of the current year / estimated fund expenditure for the current year.

It can be seen that the contribution revenue and expenditure of BPI fund will increase year by year during 2020-2030, but the contribution revenue will always be less than the expenditure, hence there will be gaps every year, and the accumulated balance will always be in a state of decline. The fund solvency ratio will also always be in a declining state, which will be less than 100% from 2021, indicating the insufficiency of fund's solvency. The accumulated fund balance will be exhausted in 2024, and the pension payment will be in crisis if government won't take measures.

### 3.2 Long-term actuarial evaluation

The evaluation of the long-term operation of BPI fund is conduced from the following two aspects: Evaluation of cash flow of revenue and expenditure (including revenue ratio, expenditure ratio and gap ratio) and evaluation of cumulative present value of revenue and expenditure (including the cumulative present value ratio of revenue, the cumulative present value ratio of expenditure and the cumulative gap ratio).

#### *3.2.1 Long-term cash flow evaluation of revenue and expenditure*

This part is mainly to calculate and analyze the revenue ratio, expenditure ratio and gap ratio of BPI fund. The revenue ratio refers to the ratio of the contribution revenue to GDP in each year; the expenditure ratio refers to the ratio of the welfare expenditure to GDP in each year. The difference between the expenditure ratio and the revenue ratio is the gap ratio. When the gap ratio is greater than 0, the revenue cannot cover the expenditure, and the gap appears. The gap ratio represents the proportion of the gap relative to GDP in each year. Fig. 1 shows the revenue ratio, expenditure ratio and gap ratio of BPI fund in each year from 2020 to 2100.

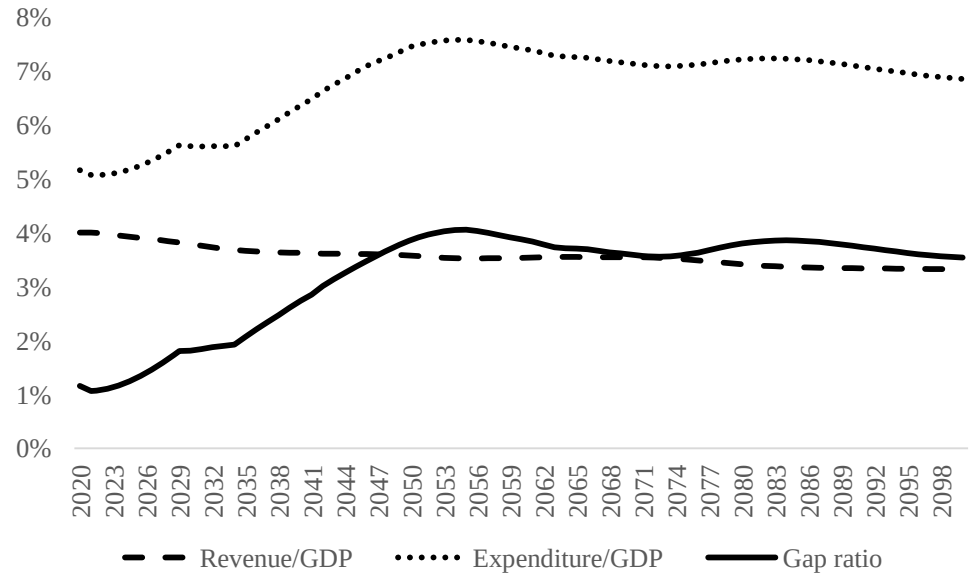


Fig. 1. Trends in the revenue ratio, expenditure ratio and gap ratio of BPI fund from 2020 to 2100.

It is can be seen that the revenue ratio will decrease slightly in the long term, from 4% in 2020 to 3.32% in 2100, which is relatively stable, indicating that the change of the contribution revenue relative to GDP is small in the long run. The expenditure ratio shows a significant upward trend, and is expected to increase from 5.17% to 6.86% during the period 2020 to 2100. In this process, the expenditure growth rate is fast affected by the population aging during 2020 to 2055, from 5.17% to 7.58%; and is relatively stable, with a slight decrease during 2055 to 2100.

The gap ratio of BPI fund is a key factor in evaluating whether the fund can achieve a balance of revenue and expenditure in the long-term. In our projection results, the gap ratio is always positive, increasing year by year in the early stage, reaching a peak of 4.06% in 2055, and then remaining stable, slowly decreasing to 3.54% in 2100. This shows that the contribution revenue of BPI fund cannot cover the expenditure. The growth rate of the gap ratio is significant between 2020 and 2055, which is consistent with the trend of the expenditure ratio, reflecting the significant effect of the population aging on the BPI fund.

*3.2.2 Long-term cumulative present value evaluation of revenue and expenditure*

We estimate the long-term capital adequacy of insurance fund by taking the "fund revenue and expenditure in the next 80 years" as a whole in this section. The "cumulative present value" is obtained by discounting the fund revenue and expenditure of each year during the inspection period to the current period and adding them up. The cumulative present value ratio of revenue is the proportion of the cumulative present value of contribution revenue plus the initial fund balance to the cumulative present value of GDP in the corresponding period. The cumulative present value ratio of expenditure is the proportion of the cumulative present value of welfare expenditure plus the present value of fund balance required for the fund solvency ratio to reach 100% at the end of the inspection period relative to the cumulative present value of GDP in the corresponding period. The cumulative gap ratio is the difference between the cumulative present value ratio of expenditure and the cumulative present value ratio of revenue. "The cumulative gap ratio is 0" means that the welfare expenditure during the inspection period can be paid in full as a whole (it is not required that the welfare expenditure can be paid in full in each year), and the fund solvency ratio is 100% at the end of the inspection period. "The cumulative gap ratio >

0" means that the sum of fund initial balance and the cumulative present value of contribution revenue is less than the sum of the cumulative present value of welfare expenditure and the present value of the fund balance required to achieve 100% fund solvency at the end of the inspection period. Generally speaking, it can be considered that the BPI fund is sufficiently capitalized if the fund's cumulative gap ratio remains non-positive for a period of time. Furthermore, even if the fund has a small positive cumulative gap ratio, it may still be solvency as long as its cumulative balance is always positive. The cumulative present value ratios and gap ratios of BPI in different inspection periods are summarized, as shown in Table 2.

Table 2. The cumulative present value ratio and gap ratio of BPI fund during different inspection periods.

| | Cumulative present value ratio of revenue | | | Cumulative present value ratio of expenditure | | | Cumulative gap ratio |
|---|---|---|---|---|---|---|---|
| | Contribution revenue | Initial fund balance | Total | Welfare expenditure | Final target fund balance | Total | |
| 2020-2035 | 3.85% | 0.36% | 4.21% | 5.40% | 0.37% | 5.76% | 1.55% |
| 2020-2050 | 3.74% | 0.19% | 3.93% | 6.03% | 0.24% | 6.28% | 2.35% |
| 2020-2100 | 3.56% | 0.07% | 3.64% | 6.76% | 0.08% | 6.85% | 3.21% |

The cumulative gap ratio is 1.55% during the 15-year inspection period, indicating that the BPI fund does not have sufficient solvency in the next 15 years. Similarly, during the 30-year and 80-year inspection period, the fund still does not have sufficient solvency. Through the comparison of the above three inspection periods, we find that the cumulative gap ratio will increase significantly with the extension of the inspection period. The reason is that the revenue and expenditure gap ratio is expected to increase year by year, reaching a peak around 2055, and remaining at a high level since then. The government needs to adopt a series of policies in order to ensure the long-term capital adequacy of insurance fund. In the next section, we will simulate the operation of BPI fund under different policies.

Further analysis on the calculation process of BPI fund gap ratio is shown in Table 3. The indicator of unfunded liabilities(I) is obtained by subtracting the initial fund balance(H) from the "difference between total welfare expenditure and total contribution revenue"(G), which represents the gap of revenue and expenditure when the initial fund balance is exhausted. The present value of cumulative gap(K) is the sum of unfunded liabilities(I) and the present value of the target fund balance at the end of the inspection period(J), reflecting the actual present value of the revenue and expenditure gap during the whole inspection period. According to our projection, the present values of unfunded liabilities and cumulative gap in the next 80 years are 272,630 billion yuan and 279,998 billion yuan, respectively.

Table 3. The cumulative gap during the 80-year inspection period.

| | Present value in 2020 (billion yuan) |
|---|---|
| A: contribution revenue of urban employees | 301871 |
| B: contribution revenue of urban and rural residents | 8847 |
| C: total contribution revenue (A+B) | 310717 |
| D: expenditure of urban employees | 515727 |
| E: expenditure of urban and rural residents | 73908 |

| | |
|---|---|
| F: total expenditure (D+E) | 589635 |
| G: total expenditure - total contribution revenue (F-C) | 278918 |
| H: initial fund balance | 6287 |
| I: unfunded liabilities (G-H) | 272630 |
| J: present value of the target fund balance at the end of the inspection period | 7368 |
| K: present value of cumulative gap (G-H+J) | 279998 |
| L: present value of cumulative GDP | 8720491 |
| M: cumulative gap ratio (K/L*100%) | 3.21% |

## 4. Policy simulation

The previous results show that China's BPI fund is facing great payment pressure, and may even have a payment crisis. In the absence of government subsidies, the accumulated balance of BPI fund will be exhausted within five years. Based on the established actuarial model, we simulate the long-term financial operation of the fund after the implementation of a series of policies such as financial subsidies, gradual delayed retirement, raising the investment yield, and using social security fund to make up for the gap in this section. According to the results, we further propose supporting policy recommendations to improve the sustainability of BPI fund, so as to promote the sustainable development of China’s social insurance system.

### 4.1 Policies

Financial subsidies: The contribution revenue of BPI fund began to be less than the expenditure since 2013. The government provides subsidies to the pension system every year to maintain the operation of BPI fund. We select the level of 1.33% in 2019 as the proportion of financial subsidies in the GDP in the next 80 years to investigate the future operation of BPI fund under the level of current financial subsidies.

Gradual delayed retirement: Delaying the retirement age is an effective choice to alleviate payment pressure of BPI fund and maintain intergenerational fairness. In order to observe the effect of the delayed retirement more intuitively, we set the plan as follows: China will implement the gradual delayed retirement policy in 2022, and the retirement age of male, female cadres and female workers will be delayed synchronously by 6 months each year. By 2031, the retirement ages of male, female cadres and female workers will be extended to 65, 60, and 55 respectively.

Raising investment yield of BPI fund: The investment of BPI fund takes security as the primary goal, and its rate of return has much room for improvement. We assume that the investment yield will increase to 8% during the inspection period.

Social security fund: The national social security fund is composed of central budget allocation, state-owned capital transfer, fund investment revenue and funds raised by other ways approved by the State Council. It is specifically used to supplement and adjust social security expenditure such as pension benefits during the peak period of population aging. We assume that the social security fund will be used to make up the

gap of BPI fund and provide a buffer period for the government to take measures when the accumulated balance is exhausted.

## 4.2 Actuarial evaluation results under different policies

### *4.2.1 Changes of fund solvency ratio under different policies*

Table 4 summarizes the changes of fund solvency ratio and the years when the accumulated fund balance will be exhausted under different policies. When implementing a combination of three policies including financial subsidies, gradual delayed retirement, and raising the investment yield of BPI fund, the fund solvency ratio will be more than 100% and continue to increase in the short term, reaching the maximum value of 254.86% in 2040, which indicates that the short-term solvency of BPI fund is sufficient under the combination of the three policies.

Table 4. Changes of solvency ratio of BPI fund under different policies from 2020 to 2100.

| | | | | Policies combination of financial subsidies and delayed retirement | |
|---|---|---|---|---|---|
| | No policy | Delayed retirement only | Financial subsidies only | Remaining the investment yield unchanged | Raising the investment yield to 8% |
| 2020 | 113.06% | 113.06% | 113.06% | 113.06% | 113.06% |
| 2021 | 88.88% | 88.88% | 113.15% | 113.15% | 118.15% |
| 2022 | 65.77% | 65.77% | 113.42% | 113.42% | 123.38% |
| 2023 | 42.98% | 45.29% | 112.18% | 118.20% | 133.73% |
| 2024 | 20.14% | 27.49% | 110.02% | 121.56% | 142.02% |
| 2025 | - | 9.18% | 106.28% | 123.53% | 149.13% |
| 2026 | - | - | 101.09% | 125.85% | 157.06% |
| 2027 | - | - | 94.65% | 127.57% | 164.11% |
| 2028 | - | - | 86.10% | 126.12% | 167.56% |
| 2029 | - | - | 75.69% | 124.62% | 171.74% |
| 2030 | - | - | 65.28% | 125.85% | 179.53% |
| 2035 | - | - | 12.42% | 131.93% | 219.09% |
| 2050 | - | - | - | 19.98% | 181.86% |
| 2060 | - | - | - | - | - |
| 2070 | - | - | - | - | - |
| 2080 | - | - | - | - | - |
| 2090 | - | - | - | - | - |
| 2100 | - | - | - | - | - |
| Maximum fund solvency ratio | 113.06% | 113.06% | 113.42% | 137.94% | 254.86% |
| Year of realization | 2020 | 2020 | 2022 | 2039 | 2040 |
| Year when the accumulated fund balance is exhausted | 2024 | 2025 | 2035 | 2051 | 2059 |
| Year when the social security fund is exhausted (Investment yield is 8%) | 2027 | 2028 | 2039 | 2055 | 2062 |

Note: '-' means that the value is negative and has no meaning

From the perspective of the years when the accumulated fund balance is exhausted, the accumulated fund balance will be exhausted in 2024 when the government does not adopt any policy. In the case of the combinations of the three policies, the year when the fund accumulated balance is exhausted will be extended to 2059. The use of

social security fund can buffer around 3 years, and the social security fund will be exhausted in 2062. The above results shows that the BPI fund will still be able to maintain continuous operation in the next 40 years under the effect of these financial response and buffer mechanisms. In order to maintain the stable operation for a longer period of time (more than 40 years), the government needs to take more measures such as increasing financial subsidies, increasing the fund contribution revenue, or reducing the welfare expenditure.

### *4.2.2 Changes of fund gap ratio under different policies*

As shown in Fig. 2，the combination of the three policies will effectively delay the emergence of the fund gap. In the case of policies combination, the BPI fund will have a positive gap since 2050, which is delayed for 30 years compared to the situation without any policy. The gap ratio will grow rapidly between 2050 and 2060 after its emergence, reaching a peak of 1.97% in 2060, and then remaining a high level, slowly dropping to 1.49% by 2100.

Compared with the situation of no policy, the implementation of various policies significantly reduce the gap ratio. We can compare the effects of different policies from Fig. 2. Financial subsidies are slightly better than delayed retirement, and the effect is most obvious when multiple policies are implemented at the same time. For example, by 2030, the delayed retirement will reduce the gap ratio from 1.82% to 1.05%, a decrease of 42.31%; financial subsidies will reduce the gap ratio from 1.82% to 0.49%, a decrease of 73.08%, while the implementation of the combination of the three policies will reduce the gap ratio from 1.82% to -1.01%, a decrease of 155.49%.

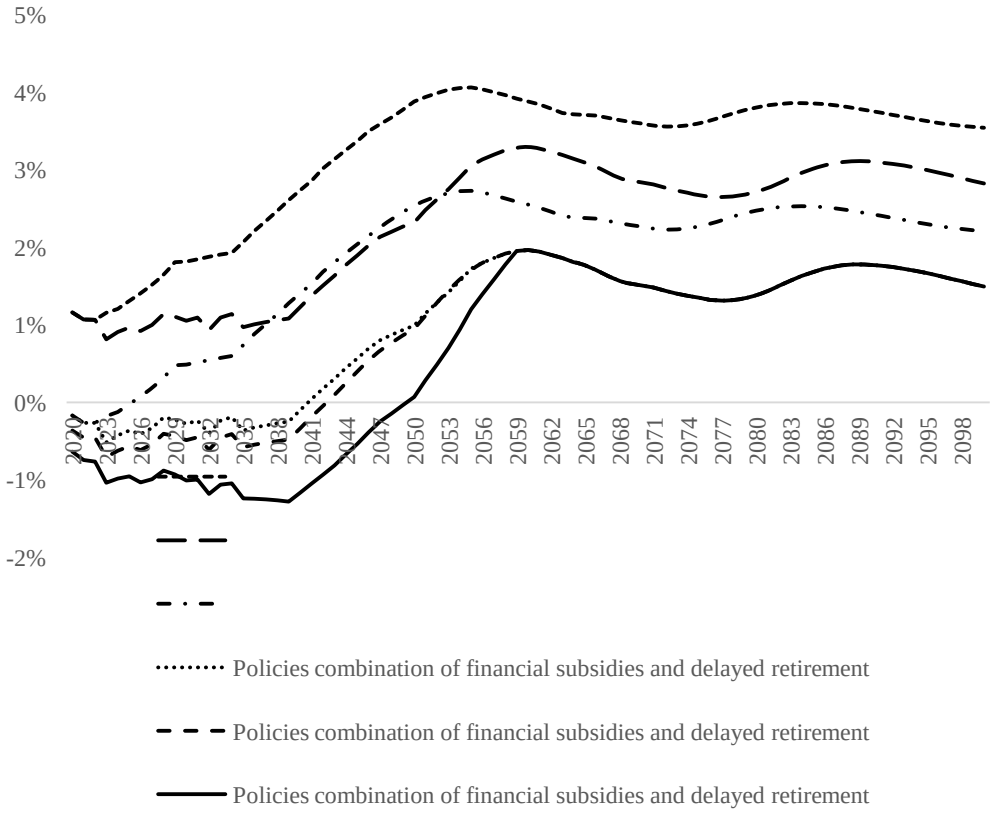


Fig. 2. Changes of the gap ratio of BPI fund under different policies from 2020 to 2100.

### *4.2.3 Long-term cumulative present value evaluation of revenue and expenditure under different policies*

Table 5 summarizes the cumulative gap ratio under different policies in the next 15 years, 30 years, and 80 years. The implementation of various policies will effectively reduce the cumulative gap ratio compared with the situation without any policy. The effect is most obvious when the combination of the three policies is implemented at the same time. In the case of the combination of three policies: the cumulative gap ratio is -1.02% during the 15-year inspection period, which is a negative value, indicating that the BPI fund have sufficient solvency in the next 15 years. Similarly, the cumulative gap ratio is -0.83% during the 30-year inspection period, indicating that there is still sufficient solvency in the next 30 years. When the inspection period is extended to 80 years, the cumulative gap ratio increases to 0.62%, which is a positive value, indicating that the fund does not have sufficient solvency during the 80-year inspection period.

Table 5. The cumulative gap ratio of BPI fund during different inspection periods under different policies.

| | Cumulative gap ratio | | | | | |
|---|---|---|---|---|---|---|
| | No policy | Delayed retirement only | Financial subsidies only | Policies combination of financial subsidies and delay retirement | | |
| | | | | Regardless of investment yield | Remaining the investment yield unchanged | Raising the investment yield to 8% |
| 2020-2035 | 1.55% | 0.98% | 0.22% | -0.35% | -0.56% | -1.02% |
| 2020-2050 | 2.35% | 1.34% | 1.02% | 0.01% | -0.18% | -0.83% |
| 2020-2100 | 3.21% | 2.33% | 1.88% | 1.00% | 0.93% | 0.62% |

We can simply analyze the measures that the government can take to maintain the stable operation of BPI fund from the perspective of the cumulative present value ratio of revenue and expenditure, and the cumulative gap ratio. The cumulative gap ratio of the BPI fund in the next 80 years is 0.62%, that is, the proportion of the cumulative present value of the BPI fund gap to the cumulative present value of GDP in the next 80 years is 0.62%. The ratio of current financial subsidies to GDP is 1.33%. It can make up for the gap and ensure the smooth operation of BPI fund in the next 80 years by raising the financial subsidies to 1.95%. We can also consider ways to increase contribution revenue or reduce expenditure. Table 6 shows the cumulative present value ratio of the revenue and expenditure under the combination of the three policies. From the perspective of increasing contribution revenue, we can get that the cumulative present value ratio of contribution revenue in the next 80 years is 4.24% by subtracting the ratio of financial subsidies to GDP 1.33% from the cumulative present value ratio of total revenue 5.57%. The gap can be made up by raising the cumulative present value ratio of contribution revenue to 4.86%, that is, increasing the current contribution standard by around 15%. From the perspective of reducing expenditure, the cumulative present value ratio of expenditure in the next 80 years is 6.19%. To make up the gap, it needs to reduce the cumulative present value ratio of expenditure to 5.57%, that is, reducing the current pension standard by around 10%.

Table 6. The cumulative present value ratio and gap ratio of BPI fund during different inspection periods under the combination of the three policies.

| | Cumulative present value ratio of revenue | | | Cumulative present value ratio of expenditure | | | Cumulative gap ratio |
|---|---|---|---|---|---|---|---|
| | Revenue | Initial fund balance | Total | Expenditure | Final target fund balance | Total | |
| 2020-2035 | 6.01% | 0.36% | 6.37% | 5.04% | 0.31% | 5.35% | -1.02% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2020-2050 | 6.18% | 0.19% | 6.37% | 5.33% | 0.21% | 5.54% | -0.83% |
| 2020-2100 | 5.57% | 0.07% | 5.65% | 6.19% | 0.08% | 6.27% | 0.62% |

## 5. Conclusions

As an important part of the social security system, the BPI system has a wide coverage and a long duration, which has a profound impact on the national life. Based on the data of the sixth population census in 2010, this paper uses the cohort component method and combines the urban-rural dual population structure to project the population of China by age, gender and area profile in the next 80 years, and obtains a three-dimensional population data structure including age, gender and area. On the basis of population forecast and historical operation data of various types of BPI fund, we respectively project the revenue and expenditure of BPI fund for enterprise employees, BPI fund for state organs and public establishments employees, and BPI fund for urban and rural residents during 2020-2100 by making assumptions on key parameters. Then we implement policy experiments to assess the effect of different policies, e.g. financial subsidies, social security fund, raising fund investment yield, and gradual delayed retirement.

Through the analysis of the projection results, the following conclusions can be drawn: First, there will always be a gap during the inspection period in the absence of financial subsidies. In the short term, the solvency of the fund will be insufficient and the accumulated fund balance will be exhausted in 2024, resulting in a payment crisis. In the long term, affected by the population aging, the revenue and expenditure situation will continue to deteriorate. The gap ratio will reach its peak in 2055 and remain at a relatively high level since then. Second, considering the next 80 years as a whole, the cumulative gap ratio of BPI fund from 2020 to 2100 is 3.21%, that is, the cumulative present value of the gap accounts for 3.21% of the cumulative present value of GDP. The present values of unfunded liabilities and cumulative gap in the next 80 years are 272,630 billion yuan and 279,998 billion yuan, respectively. Third, after considering a series of policies such as financial subsidies, social security fund, raising fund investment yield, and gradual delayed retirement, the year when the fund accumulated balance is exhausted will be delayed to 2062, and there will be no payment crisis in the next 40 years. In order to maintain the stable operation of BPI fund for a longer period of time, the government needs to take more measures. Fourth, from the perspective of the cumulative present value of revenue and expenditure, the government can make up for the gap by increasing financial subsidies, increasing fund contribution revenue, or reducing fund expenditures. Specifically, the government can increase the financial subsidies from 1.33% to 1.95%, increase the current contribution standard by 15%, or reduce the current pension standard by 10%, so as to maintain the smooth operation of the BPI fund in the next 80 years.

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# Chapter 6. Insurance Economics

# Comparative Research on the Development Characteristics and Policy Effects of National Forestry Insurance

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**Keywords:** Forestry insurance; High-quality development; Policy effects; Inter-provincial differences

**Abstract.** Based on an in-depth analysis of China's forest insurance premium growth, compensation levels, types of insurance, and regional structural characteristics, aiming at high-quality development. This paper studied current status of China's forest insurance and differences between provinces using indicators from three dimensions: subsidy efficiency, industrial security level and institutional sustainability. The study found that forest insurance has achieved a lot in promoting large-scale forest land management, but still hasn't achieved high quality development. In most provinces, problems like diminishing returns to scale of financial subsidies, low subsidy efficiency and redundant investment funds still exist. Besides, effect of industrial guarantees differs greatly between provinces. Central financial subsidies have a high level of guarantee leverage, but unreasonably determined insurance premium still exists. In terms of sustainability, institutions have healthy financial situation but suffer from insufficient growth. Finally, this paper also studied the main factors hindering forest insurance from achieving high-quality development and the corresponding measures. It is believed that the development of fruit tree insurance urgently needs central financial subsidies and local government

intervention. Forest insurance should establish a differentiated subsidy mechanism and an effective catastrophe dispersion system. Innovate product supply forms and zoning of risk and rate are also necessary.

## 1.引言

林业作为农业系统的重要组成部分，是我国重要的基础产业与公益事业。然而，林业的生产经营受自然环境影响重，对风险的抵御能力弱，因此如何维持林业稳定向好的发展就变得尤为重要。在我国深入推进林权制度改革的进程中，林业保险可有效提高林农对风险的抵御能力，在保障生态安全、推进林业发展、保障林农收益等方面起到关键作用。

林业保险是指林业经营者按照合同规定缴纳保险费，同时国家给予保费补贴，当林业生产遭受自然灾害及意外事故的损失时，保险公司给予一定经济补偿的行为。投保人可以是林业专业户、林业股份制企业、集体所有制林场、国有林业生产单位等。1984 年我国首次开展了林业保险试点工作，但效果不甚理想，林业保险发展较为缓慢。2009 年我国为推进林业保险快速发展，开展了中央财政林业保险保费补贴试点工作，很大程度上提高了参保率。但随着林业产业逐步发展，保费补贴规模和林业保险覆盖面也在逐步扩大。2018 年各级财政补贴额已达 40.72 亿元，占总保费的 84%，远超林农自付比例。2019 年 10 月 9 日，四部门联合印发了《关于加快农业保险高质量发展的指导意见》，依据文件我国林业保险要逐步由过去的数量扩张向高质量发展路径转变。

从国内现有的文献来看，学者们针对林业保险的研究较少，大大滞后于对农业保险的探索。总体来看，林业保险的研究大致可以总结为三个方面。一是对林业保险发展现状和对策的研究。石焱等（2009）借鉴日本、芬兰、美国等具有较完善森林保险制度的国家发展经验，为我国林业保险发展提出启示：我国需加快林业保险立法，完善森林保险的其他配套措施，并简化手续。牛浩等（2019）从我国林业保险不同省发展水平的差异出发，剖析了政策支持不完善的现实困境，并提出加大产品差异化与创新化供给力度，改善政府部门之间衔接力度等方面的改进思路。二是对林业保险补贴效率的研究，邓晶等（2018）运用 DEA 模型，根据 2011-2015 年六省数据对林业保险财政补贴效率进行评价，发现制度效率有提升空间，认为应构建承保机构有序竞争机制；富丽莎（2020）运用柯布-道格拉斯生产函数，分别对全国、东部、中西部地区林业部保险保费补贴的政策效率评估比较，提出林业保险保费补贴政策对产出有激励效应，且随着风险的提高，激励效果会下降。建议调整“倒补贴”联动机制，提高对经济落后地区补贴比例；郑彬等（2019）则基于 Malmquist 指数与 DEA 模型，得出当前林业保险保费补贴全要素生产率呈下降趋势的结论，认为应创新林业保险产品供给、进一步完善补贴政策。三是对典型省林业保险的个案研究。如赵新华（2014）、韩婷（2015）、王天会（2019）等分别对山东省、河北省、浙江省林业保险各自发展的状况进行研究并提出针对性建议。从上述文献看，大多数基于国外经验或个别省份的发展现状，提出林业保险发展的建议，或仅对林业保险补贴的效果进行研究，没有从林业保险高质量发展视角，特别是没有结合高补贴的林业保险对林业产业保障的效果、经营机构的可持续视角综合进行全面的对比分析。

因此，本文主要基于农业保险高质量发展的目标要求，运用 DEA 模型对全国 31 个省市的林业保险财政补贴效率进行评价；同时，选用相应指标对各省林业

保险对林业生产保障的效果和经营机构的可持续性进行比较分析，在此基础上提出推进林业保险高质量发展的系列政策建议。

## 2．我国林业保险的发展现状与主要特征

我国林业保险包括林木保险、水果和果树保险两大类。其中：

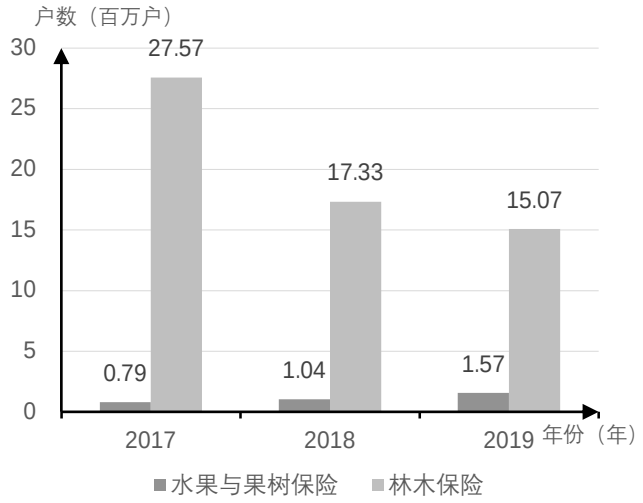
林木保险，也叫森林保险，是以天然林或人工林生长中的林木,或已采伐待运的林木为保险对象的一种农业保险。其保障对象可划分为两大类：（1）可维持生态可持续发展的公益林，如水土保持林、防风固沙林、环境保护林等。其建设与管理以各级人民政府投入为主；（2）以满足人类社会经济需求为主体功能的商品林，如木材林、薪炭林和经济林等。

水果与果树保险，是以生长期的水果与果树为保险标的，多为家庭经营与投保。

近年来我国林业保险发展的主要特征是：

### 2.1 总体看承保户数有所下降，但保费收入持续增长

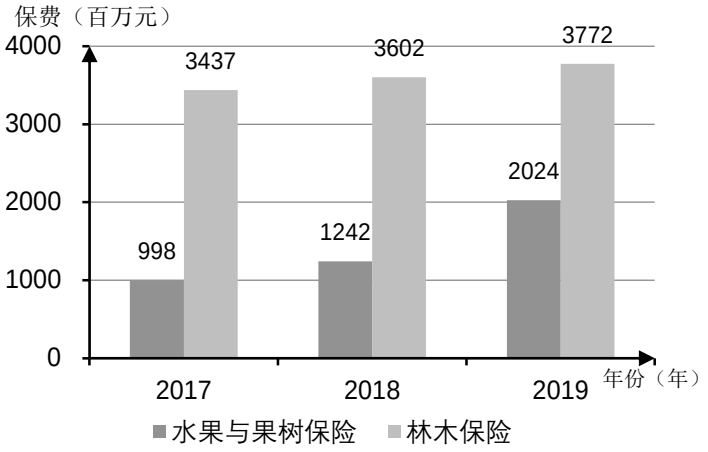
2017-2019 年我国投保林业保险的总户数降至 1664 万户，较上年减少了 173 万户（图 1），林农数量总体减少的同时，保费收入却持年增长。这是由于承保户数的统计，既包括以家庭为单位的个体农户，也包括以林场为单位的集体组织，故两项指标反向变动表明一定比例种植规模较小的林农退出了林业保险，而种植规模较大的农户更为注重林木保险的保障功能；其中，水果与果树保险参保户数远低于林木保险投保户数，该险种还有很大的发展空间。同时其农户数目呈逐年增长的趋势，说明有越来越多种植水果与果树的农户开始注重投保。




数据来源：中国银行保险监督委员会

图 1 2017-2019 年我国林业保险承保户数

2017-2019 年我国政策性林业保险总体规模呈增长趋势。如图 2 所示，2019 年全国林业保险保费总额为 57.96 亿元，同比增长 19.67%，近三年平均增速为 14.43%。其中，水果与果树保险近三年保费增幅近一倍，三年平均增速为 43.73%；林木保险费也持年稳步增长，保费增加 3.35 亿元，三年平均增速为 4.76%。说明，近几年我国通过林权改革，推动林地规模化经营已经取得初步成效。




数据来源：中国银行保险监督委员会

图 2 2016-2018 年我国林业保险保费收入

## 2.2 从险种和地区结构看，不同省市林业保险发展水平差异大

2018 年全国各省市林业及其分险种的保费情况如表 1 所示。总体来看，林业保险保费在各省市间差异较大。分险种来看，各省市林木保险发展情况也存在较大差距，这是由于林木保险标的物的特殊性，使得保费收入在很大程度上依托于各省固有的森林面积。由表 1 与各省森林面积排名对比来看，林木保险签单保费前十名的省份中内蒙、黑龙江、四川、广西、湖南、江西、广东均同时为全国森林覆盖面积排前十的省市，林木保险保费数额与森林覆盖面积基本成正比。而水果与果树保险各省市间差异同样较大，签单保费前十名的省份保费占比为全国的 79.89%，其余 21 各省市占比仅为 20.11%。但投保总保费相对较低，水果与果树保险总保费 12.45 亿元，约为林木保险保费的 1/3。

表 1　2018 年各省市林业保险分险种保费收入及占比

| 排名 | 地区 | 林业保险保费（百万元） | 占比（%） | 林木保险保费（百万元） | 占比（%） | 水果与果树保费（百万元） | 占比（%） |
|---|---|---|---|---|---|---|---|
| | 全国 | 4848.25 | 100.00% | 3603.18 | 100.00% | 1245.07 | 100.00% |
| 1 | 内蒙 | 677.64 | 13.98% | 673.97 | 18.70% | 3.67 | 0.29% |
| 2 | 广西 | 396.61 | 8.18% | 277.85 | 7.71% | 118.77 | 9.54% |
| 3 | 贵州 | 376.58 | 7.77% | 344.59 | 9.56% | 31.99 | 2.57% |
| 4 | 湖南 | 323.67 | 6.68% | 241.36 | 6.70% | 82.31 | 6.61% |
| 5 | 广东 | 261.96 | 5.40% | 126.34 | 3.51% | 135.63 | 10.89% |
| 6 | 陕西 | 247.53 | 5.11% | 108.30 | 3.01% | 139.23 | 11.18% |
| 7 | 四川 | 242.38 | 5.00% | 157.41 | 4.37% | 84.97 | 6.82% |
| 8 | 江西 | 209.20 | 4.32% | 209.20 | 5.81% | 0.00 | 0.00% |
| 9 | 山西 | 172.06 | 3.55% | 104.98 | 2.91% | 67.08 | 5.39% |
| 10 | 海南 | 162.81 | 3.36% | 29.11 | 0.81% | 133.70 | 10.74% |
| 11 | 福建 | 161.93 | 3.34% | 161.74 | 4.49% | 0.20 | 0.02% |
| 12 | 北京 | 158.19 | 3.26% | 68.84 | 1.91% | 89.34 | 7.18% |
| 13 | 黑龙江 | 144.67 | 2.98% | 144.67 | 4.02% | 0.00 | 0.00% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 14 | 河北 | 127.64 | 2.63% | 126.15 | 3.50% | 1.49 | 0.12% |
| 15 | 吉林 | 122.97 | 2.54% | 122.96 | 3.41% | 0.01 | 0.00% |
| 16 | 安徽 | 122.05 | 2.52% | 102.80 | 2.85% | 19.24 | 1.55% |
| 17 | 云南 | 115.70 | 2.39% | 115.65 | 3.21% | 0.05 | 0.00% |
| 18 | 甘肃 | 97.76 | 2.02% | 76.52 | 2.12% | 21.25 | 1.71% |
| 19 | 河南 | 96.42 | 1.99% | 19.87 | 0.55% | 76.55 | 6.15% |
| 20 | 山东 | 93.93 | 1.94% | 62.63 | 1.74% | 31.29 | 2.51% |
| 21 | 辽宁 | 85.96 | 1.77% | 82.14 | 2.28% | 3.82 | 0.31% |
| 22 | 上海 | 78.64 | 1.62% | 42.08 | 1.17% | 36.56 | 2.94% |
| 23 | 江苏 | 77.74 | 1.60% | 10.67 | 0.30% | 67.07 | 5.39% |
| 24 | 浙江 | 72.60 | 1.50% | 42.01 | 1.17% | 30.59 | 2.46% |
| 25 | 重庆 | 62.64 | 1.29% | 38.95 | 1.08% | 23.69 | 1.90% |
| 26 | 新疆 | 52.18 | 1.08% | 30.58 | 0.85% | 21.60 | 1.73% |
| 27 | 青海 | 51.33 | 1.06% | 51.33 | 1.42% | 0.00 | 0.00% |
| 28 | 湖北 | 31.93 | 0.66% | 30.06 | 0.83% | 1.87 | 0.15% |
| 29 | 宁夏 | 21.25 | 0.44% | 0.41 | 0.01% | 20.84 | 1.67% |
| 30 | 天津 | 2.27 | 0.05% | 0.00 | 0.00% | 2.27 | 0.18% |

数据来源：中国银行保险监督委员会

## 2.3 保费结构方面，林木保险的补贴比例高，水果与果树保险的支持力度有限

林业保险保费总收入中，2018 年各级财政补贴占比高达 84%，林农个人缴纳保费比例约为 15.19%（表 2）。其中，各级财政补贴的分担比例为中央、省与地市级财政各占 32.28%、30.84%与 20.88%。但是，各级财政对林业保险的不同险种补贴力度差异很大。

关于林木（森林）保险的补贴政策，根据 2016 年财政部印发的《中央财政农业保险保险费补贴管理办法》的规定：“森林。公益林在地方财政至少补贴 40%的基础上,中央财政补贴 50%;对大兴安岭林木集团公司,中央财政补贴 90%。商品林在省级财政至少补贴 25%的基础上,中央财政补贴 30%;对大兴安岭林木集团公司,中央财政补贴 55%。”我国各级财政对公益林的保费补贴比例最高，高达 90%以上，对商品林的保费补贴比例也达到至少 55%。在高补贴的政策扶持下，2018 年我国公益林参保面积高达 18.28 亿亩，商品林参保面积 4.97 亿亩。中央财政对全国林木保险保费的实际补贴比例为 43%，省级财政补贴比例平均为 14%；地市财政补贴比例高于省财政补贴水平，高达 31%，林农个人仅需缴纳林木保险保费的 11%。

对于水果与果树保险，目前为止中央财政还没有将其纳入补贴对象，主要作为地方特色型农险险种开展，以地方财政补贴为主。中央财政通过“以奖代补”的方式对部分地区的果树保险试点进行支持，总体补贴力度极小，2018 年补贴额仅占果树保险总保费的 0.02%。省级财政与地市财政补贴力度相对较大，分别补贴占比 31%、39%。另外，不同省市对果树保险开展的扶持力度差异较大，各省、地市财政根据自身财力情况决定补贴比例。表 2 显示东部沿海地区经济较发达的省市,以地市级财政补贴为主,而西部地区则以省级财政支持为主。总体看，水果与果树保险的农户个人缴费比例要明显高于林木保险,缴费金额约占总保费的 28%。可见，水果与果树保险保费补贴力度明显低于林木保险，同时，果树保险仅对成本进行了保障,尚未对其收入进行保障,保额水平低,保障程度还不够。

因此，果树保险的发展一直较为缓慢。

表 2　2018 年各省市林业保险的保费来源结构占比

| | 中央财政 | 省级财政 | 地市县财政 | 农户缴纳 | 其他来源 |
|---|---|---|---|---|---|
| 全国平均 | 32.28% | 30.84% | 20.88% | 15.19% | 0.81% |
| 北京 | 8.73% | 47.38% | 21.47% | 22.39% | 0.04% |
| 天津 | 0.00% | 60.00% | 10.00% | 30.00% | 0.00% |
| 河北 | 42.03% | 25.86% | 17.99% | 13.82% | 0.29% |
| 山西 | 30.50% | 21.75% | 33.62% | 13.05% | 1.08% |
| 内蒙 | 44.82% | 33.79% | 10.91% | 10.49% | 0.00% |
| 辽宁 | 43.94% | 28.21% | 17.56% | 10.00% | 0.29% |
| 吉林 | 45.73% | 32.23% | 8.14% | 13.89% | 0.00% |
| 黑龙江 | 88.26% | 0.00% | 0.00% | 11.74% | 0.00% |
| 上海 | 0.00% | 42.71% | 30.49% | 26.79% | 0.00% |
| 江苏 | 0.00% | 25.71% | 47.33% | 24.07% | 2.90% |
| 浙江 | 22.63% | 17.21% | 37.35% | 20.96% | 1.84% |
| 安徽 | 30.16% | 24.82% | 30.69% | 13.39% | 0.93% |
| 福建 | 37.66% | 27.66% | 12.76% | 21.91% | 0.00% |
| 江西 | 34.84% | 31.05% | 5.83% | 25.77% | 2.51% |
| 山东 | 32.81% | 21.97% | 28.12% | 17.03% | 0.08% |
| 河南 | 7.25% | 5.92% | 76.86% | 9.97% | 0.00% |
| 湖北 | 44.95% | 36.06% | 13.34% | 5.56% | 0.09% |
| 湖南 | 25.92% | 27.20% | 18.94% | 26.70% | 1.24% |
| 广东 | 22.98% | 35.25% | 29.58% | 12.09% | 0.10% |
| 广西 | 26.82% | 50.64% | 11.39% | 11.15% | 0.00% |
| 海南 | 7.84% | 37.78% | 21.94% | 32.43% | 0.00% |
| 重庆 | 28.44% | 30.54% | 25.21% | 15.76% | 0.06% |
| 四川 | 27.97% | 17.75% | 33.63% | 20.47% | 0.18% |
| 贵州 | 39.48% | 29.61% | 25.43% | 1.82% | 3.66% |
| 云南 | 43.15% | 31.60% | 19.53% | 5.67% | 0.04% |
| 陕西 | 21.86% | 30.79% | 24.88% | 19.39% | 3.09% |
| 甘肃 | 39.06% | 35.67% | 17.33% | 7.95% | 0.00% |
| 青海 | 49.29% | 30.84% | 14.12% | 5.76% | 0.00% |
| 宁夏 | 0.00% | 54.01% | 27.17% | 16.88% | 1.93% |
| 新疆 | 29.30% | 38.96% | 16.27% | 15.14% | 0.33% |

数据来源：中国银行保险监督委员会

## 2.4 赔付率方面，林木保险赔付较为稳定，果树保险经营风险偏高

如表 3 所示，2017-2019 年全国林业保险的平均赔付比率有所下降，2017 年的平均赔付比为56.43%，而2019年跌至55.46%，低于2019年种植业保险80.32%与养殖业保险79.50%的平均赔付率。

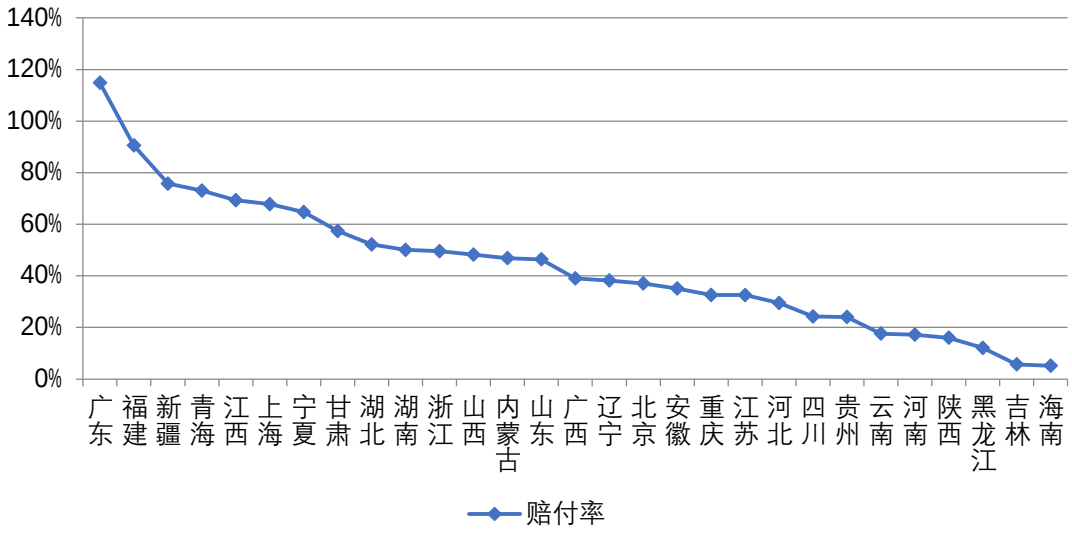
分险种看，林木保险赔付率较低且稳定，三年赔付率均未超过 50%，保险公司有适当盈利，承保意愿强。然而果树保险赔付率三年均高出 80%，保险公司面临亏损，赔付随保费同向变动，保的越多赔的越多，导致保险公司对水果与果树保险积极性低，故急需中央财政对水果与果树保险保费进行补贴。

表 3 2017-2019 年水果与果树保险、林木保险赔付率

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| 林业保险 | 56.43% | 61.01% | 55.46% |
| 林木保险 | 44.75% | 42.58% | 41.26% |
| 水果与果树保险 | 96.66% | 114.45% | 81.93% |

数据来源：中国银行保险监督委员会

分地区来看（图 3），林业保险经营风险与赔付率在各省市间存在较大差异，2018 年有 4 个省市赔付率超过 70%，六个省市低于 20%。此外，林业保险农户受益比只有 3.89%，也就是 3.89%的投保林农收到全部赔款支出，这一比率与同年种植业保险 3.8%的水平相近，而远低于养殖业保险 50%的水平，说明在林业保险的实际赔付中，仅有少数的林农遭受损失，并收到赔付金，体现林业风险具有低频率、高强度的特征。




数据来源：中国银行保险监督委员会

图 3 2018 年全国各省市的林业保险简单赔付率

## 3.我国林业保险发展质量的衡量方式与财政补贴效果的省际比较

### 3.1 我国林业保险发展质量的衡量方式

根据 2019 年 10 月财政部、农业农村部、银保监会、林草局四部委发布的《关于加快农业保险高质量发展的指导意见》（财金〔2019〕102 号），包括林业保险在内的我国农业保险发展目标是：到 2022 年，基本建成功能完善、运行规范、基础完备，与农业农村现代化发展阶段相适应、与农户风险保障需求相契合、中央与地方分工负责的多层次农业保险体系；到 2030 年，农业保险持续提质增效、转型升级，总体发展基本达到国际先进水平，实现补贴有效率、产业有保障、农民得实惠、机构可持续的多赢格局。

林业保险作为农业保险系统的重要组成部分，同为政策性保险，其政策目标的完成程度即为衡量其发展质量的重要依据。据此，林业保险发展质量应从财政补贴效率、林业产业保障效果、农民得实惠程度与保险机构经营可持续性效果四个方面来衡量，其中林农得实惠方面，由于林农收入与种植农户收入数值是合并统计的，缺乏林农收入的精准数据，暂无法评价林农收入保障效果，故本文将从

另外三个方面对我国林业保险发展的政策效果及其省际差异进行综合评估。具体指标的说明如表 4 所示。

表 4　林业保险发展效果评价指标体系

| 一级维度 | 具体指标 | 单位 | 指标说明 |
|---|---|---|---|
| 财政补贴效率 | 保险费补贴效率 | % | 运用 DEA 模型从投入产出角度进行计算 |
| 产业保障效果 | 保障水平 | % | 林木保险金额/林业产值 |
| | 保障杠杆 | 倍 | 林木保险金额/林木保险费、补贴额/总保额 |
| 经营机构可持续效果 | 保费收入增长率 | % | 业务可持续性：3 年保费收入年均增长率 |
| | 简单赔付率 | % | 财务可持续性：3 年简单赔付率均值 |

## 3.2 林木保险财政补贴效率的省际比较

为准确衡量我国林业保险高质量发展绩效的水平，本文选取林业保险中主要险种林木保险为例，运用 DEA 模型，对 2016-2018 年各省份林木保险费的补贴效率进行量化分析。

### 3.2.1 财政补贴效率衡量方法的选择：DEA 模型

规模报酬可变的数据包络分析模型，即 DEA-BCC 模型，可直接运用产出数据构建非参数的模型，并进行经济研究，主要应用于分析多种投入及产出的决策单元（DUM）的有效性与非有效性的原因与程度。本文从产出导向角度探究在既定的林木保费补贴投入下，多种产出的数据的相对效率，适用于这种方法。

对于 DEA-BCC 模型来说，假设实行林木保险保险费补贴政策的有 $n$ 个省份，即有 $n$ 个决策单元 $DMU_j(j=1,2,\cdots,n)$，每个决策单元均有 $i$ 种输入和 $r$ 种输出，第 $j$ 个决策单元的输入变量为 $X_j=(x_{1j},x_{2j},\cdots,x_{ij})^T$，输出变量为 $Y_j=(y_{1j},y_{2j},\cdots,y_{ij})^T$，则模型为：

$$\begin{cases} \min\theta \\ s.t.\sum_{j=1}^{n}\lambda_j x_j + s^- = \theta x_0 \\ \sum_{j=1}^{n}\lambda_j y_j - s^+ = \theta y_0 \\ \sum_{j=1}^{n}\lambda_j = 1 \\ \lambda_j \geq 0,\ j=1,2,\cdots n \\ s^+ \geq 0, s^- \leq 0 \end{cases}$$

其中，$\theta$ 为决策单元的综合效率值，且 $0\leq\theta\leq1$，当 $\theta=1$ 时，该决策单元有效，当 $\theta<1$ 时，该决策单元缺乏效率，该 DUM 还存在改进空间。

DEA-BCC 模型可测算各决策单元的综合效率，综合效率又可分解为纯技术效率与规模效率。本文中综合效率是指在既定的保险费补贴投入下产出最大化的能力。纯技术效率反映保费补贴资金配置的结构效率，是指在林木保险费补贴投入

规模一定的情况下，相关林木保险费补贴的配置标准与比例是否对林木保险的实施与管理起促进作用。规模效率则反映补贴投入的额度是否合理，在纯技术效率一定的情况下，若规模效率实现 DEA 有效，则说明财政补贴投入恰当，既不浪费也不短缺。

3.2.2 指标选取与数据来源

（1）指标选取

林木保险财政补贴的数额可直接作为投入指标衡量政府对林木保险的补贴力度。而产出指标的选择范围很广，财政补贴可以起到提高林农参保率、扩大林木保险覆盖面、增加保费收入、提高赔款支出对风险损失的补偿等多方面作用，不同的数据选择会导致结论不同。因此在选择产出指标时，本文以指标能够客观反映其运行效率作为首要原则，在技术上要避免输出指标之间具有较强的线性关系，同时还要结合数据的实际获取情况。最终使用林木保险费收入、赔付支出、林木保险深度及林木保险覆盖率作为产出指标来计算各省份林木保险的保险费补贴效率。其中赔付支出越高说明林地受灾之后林农受到的补贴越充足，林木保险分散风险的效果越明显，在投入一定的情况下财政补贴的效率越高；保费收入可以计算各省市保费补贴的比例，体现林木保险的绝对规模，为分析各省有效的财政补贴比例提供依据；林木保险深度计算每单位林业总产值受到林木保费保障的程度，体现了林木保险的相对规模，直接说明林业保险市场发展效果的优劣，林木保险覆盖率则代表林业保险市场的覆盖水平。具体指标如表 5 所示。

表 5 林木保险费补贴效率衡量指标

| 一级指标 | 具体指标 | 计量单位 | 指标说明 |
|---|---|---|---|
| 投入指标 | 林木保险费补贴数额 | 万元 | 包括中央、省级、地方的财政补贴 |
| 产出指标 | 保费收入 | 万元 | - |
| | 赔付支出 | 万元 | - |
| | 林木保险深度 | % | 保费收入/林业总产值 |
| | 林木保险覆盖率 | % | 林木承保面积/林地面积 |

（2）数据来源

本文选取 2016-2018 年 25 个省市的数据，林木保险的保险费收入、赔付支出与补贴金额来自保监会数据，林业总产值来自《中国统计年鉴》，林木保险覆盖率来自历年中国森林保险发展报告，其中 2018 年各省份林业保险费补贴效率衡量指标数据值如表 6 所示。

表 6 2018 年各省份林木保险费补贴效率衡量指标数据值

| 地区 | 投入指标 | 产出指标 | | | |
|---|---|---|---|---|---|
| | 林险补贴额（万元） | 保费收入（万元） | 赔付支出（万元） | 保险深度（%） | 保险覆盖率（%） |
| 北京 | 5672.55 | 6884.27 | 2550.09 | 0.72% | 71.90% |
| 河北 | 10882.67 | 12615.36 | 3717.4 | 0.68% | 49.77% |
| 山西 | 10496.44 | 10498.17 | 5062.04 | 1.05% | 49.20% |
| 内蒙 | 60406.94 | 67396.82 | 31580.52 | 6.72% | 38.55% |

| | | | | | |
|---|---|---|---|---|---|
| 辽宁 | 7520.91 | 8213.92 | 3137.63 | 0.55% | 49.62% |
| 吉林 | 10587.63 | 12295.74 | 699.19 | 1.68% | 22.01% |
| 黑龙江 | 12768.91 | 14467.26 | 1742.83 | 0.78% | 17.09% |
| 浙江 | 3784.67 | 4200.97 | 2082.01 | 0.24% | 53.22% |
| 安徽 | 9061.64 | 10280.46 | 3607.64 | 0.31% | 77.27% |
| 福建 | 12633.35 | 16173.51 | 14645.49 | 0.42% | 76.55% |
| 江西 | 15004.55 | 20920.46 | 14498.56 | 0.65% | 76.06% |
| 山东 | 6126.45 | 6263.41 | 2905.63 | 0.34% | 29.29% |
| 河南 | 1799.45 | 1986.77 | 341.73 | 0.15% | 31.47% |
| 湖北 | 2877.83 | 3006.48 | 1568.14 | 0.13% | 18.53% |
| 湖南 | 18954.86 | 24135.87 | 12079.41 | 0.62% | 67.08% |
| 广东 | 12151.83 | 12633.57 | 14507.81 | 0.32% | 39.21% |
| 广西 | 25369.93 | 27784.61 | 10836.56 | 0.73% | 55.55% |
| 海南 | 2533.04 | 2910.66 | 149.88 | 0.29% | 35.01% |
| 重庆 | 3667.01 | 3895.13 | 1268.44 | 0.35% | 74.86% |
| 四川 | 13425.74 | 15740.98 | 3812.35 | 0.44% | 66.74% |
| 贵州 | 33010.69 | 34459.47 | 8282.85 | 1.36% | 81.07% |
| 云南 | 10908.73 | 11564.94 | 2037.47 | 0.29% | 70.19% |
| 陕西 | 9783.41 | 10830.35 | 1733.74 | 1.04% | 55.48% |
| 甘肃 | 7259.68 | 7651.64 | 2944.57 | 2.31% | 51.42% |
| 青海 | 4837.23 | 5132.78 | 1551.43 | 4.94% | 27.79% |
| 北京 | 5672.55 | 6884.27 | 2550.09 | 0.72% | 71.90% |
| 河北 | 10882.67 | 12615.36 | 3717.4 | 0.68% | 49.77% |
| 山西 | 10496.44 | 10498.17 | 5062.04 | 1.05% | 49.20% |

数据来源：中国银行保险监督委员会和《中国统计年鉴》

（3）实证结果

利用 DEAP2.1 软件对 DEA-BCC 模型进行计算得到 2016-2018 年全国 25 个省市林木保险市场保险费补贴效率如表 7 所示。

表 7　2016-2018 年全国各省份林业保险市场保险费补贴效率

| 地区 | 2016 年 | | | | 2017 年 | | | | 2018 年 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 综合效率 | 纯技术效率 | 规模效率 | 规模报酬 | 综合效率 | 纯技术效率 | 规模效率 | 规模报酬 | 综合效率 | 纯技术效率 | 规模效率 | 规模报酬 |
| 福建 | 1.00 | 1.00 | 1.00 | - | 1.00 | 1.00 | 1.00 | - | 1.00 | 1.00 | 1.00 | - |
| 青海 | 1.00 | 1.00 | 1.00 | - | 0.83 | 0.84 | 0.99 | irs | 1.00 | 1.00 | 1.00 | - |
| 江西 | 1.00 | 1.00 | 1.00 | - | 0.82 | 0.89 | 0.92 | irs | 1.00 | 1.00 | 1.00 | - |
| 重庆 | 0.97 | 1.00 | 0.97 | drs | 0.84 | 1.00 | 0.84 | drs | 1.00 | 1.00 | 1.00 | - |
| 北京 | 0.65 | 0.89 | 0.74 | irs | 0.83 | 0.84 | 0.99 | irs | 1.00 | 1.00 | 1.00 | - |
| 广东 | 0.62 | 0.71 | 0.87 | drs | 0.80 | 0.95 | 0.84 | drs | 1.00 | 1.00 | 1.00 | - |
| 河南 | 0.88 | 0.94 | 0.93 | irs | 0.76 | 0.87 | 0.87 | irs | 0.99 | 1.00 | 0.99 | irs |
| 海南 | 1.00 | 1.00 | 1.00 | - | 0.90 | 1.00 | 0.90 | drs | 0.97 | 0.98 | 0.99 | irs |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 浙江 | 0.99 | 1.00 | 0.99 | drs | 0.88 | 0.90 | 0.97 | drs | 0.94 | 0.96 | 0.98 | irs |
| 湖南 | 0.75 | 1.00 | 0.75 | drs | 0.80 | 0.81 | 0.98 | irs | 0.91 | 0.96 | 0.95 | drs |
| 安徽 | 0.84 | 0.93 | 0.90 | drs | 1.00 | 1.00 | 1.00 | - | 0.88 | 1.00 | 0.88 | drs |
| 吉林 | 0.75 | 1.00 | 0.75 | irs | 0.80 | 0.81 | 0.99 | irs | 0.86 | 0.87 | 0.99 | irs |
| 甘肃 | 0.82 | 0.86 | 0.95 | drs | 1.00 | 1.00 | 1.00 | - | 0.86 | 0.86 | 1.00 | - |
| 四川 | 0.74 | 1.00 | 0.74 | drs | 0.72 | 0.89 | 0.81 | drs | 0.85 | 0.85 | 1.00 | - |
| 河北 | 0.74 | 0.82 | 0.91 | drs | 0.74 | 0.75 | 0.99 | irs | 0.84 | 0.85 | 0.99 | irs |
| 陕西 | 0.77 | 0.87 | 0.89 | drs | 0.84 | 0.85 | 0.99 | drs | 0.83 | 0.83 | 1.00 | - |
| 辽宁 | 0.76 | 0.81 | 0.94 | drs | 0.84 | 0.90 | 0.94 | irs | 0.83 | 0.83 | 1.00 | - |
| 黑龙江 | 0.61 | 0.74 | 0.82 | drs | 0.91 | 0.94 | 0.97 | irs | 0.82 | 0.83 | 0.99 | irs |
| 内蒙古 | 0.62 | 1.00 | 0.62 | drs | 0.82 | 0.83 | 0.99 | irs | 0.82 | 1.00 | 0.82 | drs |
| 云南 | 0.71 | 0.73 | 0.97 | drs | 0.83 | 0.84 | 1.00 | irs | 0.80 | 0.80 | 1.00 | - |
| 湖北 | 0.71 | 0.84 | 0.84 | irs | 0.85 | 0.99 | 0.86 | drs | 0.79 | 0.94 | 0.84 | irs |
| 广西 | 0.66 | 0.90 | 0.73 | drs | 0.91 | 1.00 | 0.91 | irs | 0.79 | 0.86 | 0.92 | drs |
| 山东 | 0.75 | 0.75 | 1.00 | - | 0.84 | 0.94 | 0.89 | irs | 0.75 | 0.78 | 0.96 | irs |
| 贵州 | 0.63 | 1.00 | 0.63 | drs | 0.79 | 0.79 | 1.00 | - | 0.75 | 1.00 | 0.75 | drs |
| 山西 | 0.67 | 0.77 | 0.88 | drs | 0.74 | 1.00 | 0.74 | drs | 0.75 | 0.75 | 1.00 | - |
| **均值** | 0.79 | 0.90 | 0.87 | | 0.84 | 0.91 | 0.93 | | 0.88 | 0.92 | 0.96 | |

注：irs、-、drs、分别表示规模报酬递增、不变、递减。

综合效率逐年提高，但整体偏低，补贴效率存在提升空间，各省份间存在一定差异。2016-2018 年间综合效率稳步提升，25 个省市综合效率均值由 2016 年的 0.79 提升至 2018 年的 0.88（表 7）。将保费补贴效率测算结果按照 2018 年保费补贴综合效率的高低进行排序发现，2018 年仅福建、青海、江西、北京、重庆、广东 6 个省市的综合效率为 1，财政补贴规模适度，财政补贴机制完善，在既定的保险费补贴投入下产出达到最大化。而对于其他省市而言林木保险费补贴政策的效率仍存在一定提升空间，2018 年各省份林木保险费补贴政策的综合效率、纯技术效率及规模效率的最小值均在 0.75 左右，说明全国各省市的林木保险费补贴效率有所不同，省份间差距较大。综合效率等于纯技术效率与规模效率的乘积，而全国 25 个省市的纯技术效率平均值（0.92）低于规模效率（0.96），说明大多数省份林木保险保费补贴的综合效率无效是由纯技术效率导致的。

纯技术效率偏低，且增长缓慢，是制约我国林木保险保费补贴效率的主要原因。由表 7 可知，2016-2018 年间，纯技术效率均值仅增长 0.02，到 2018 年全国 25 个省市中有 10 个省市的纯技术效率为 1，即林木保险费补贴投入规模一定的情况下，仅 10 个省市的林木保险费补贴制度有效。整体来讲各省市林木保险费补贴的纯技术效率不高，其中山西、陕西、黑龙江均只有公益林参保，国家对公益林的保费补贴比例高，而公益林产值又较低，故纯技术效率较低。山东省纯技术效率低是由于其保险费率为 0.5%相对较高，保费投入高而赔付率仅为 46%，大部分补贴了保险公司。总体来说，应加大力度进行林木保险补贴制度的创新，改善财政补贴机制，根据不同地区的风险水平，因地制宜的施行差异化的保费补贴制度，减少对直接保险的补贴比例，才能有效提升林木保险费补贴利用效率。

规模效率有明显改善，但有效地区仍不足一半，其余省市大多规模报酬递减，补贴投入冗余。由表 7 可知，2016 年有 5 个地区规模报酬不变，2018 年则提升至 12 个，即在林木保险费补贴相关制度一定的情况下，有 12 个地区林木保险补贴投入规模有效率。福建、广西与青海连续三年维持规模报酬不变，说明林木保

险保费补贴投入规模恰当，规模效率长期维持在有效的水平；四川、云南、广东作为林木保险试行期进行试点的省份，制度施行较早，完善时间长，对财政补贴比例多次调整，2018 年也使补贴投入达到高效。北京、甘肃、吉林、河北等 12 个省份的规模效率也经过调整使补贴投入高效利用，即使稍有冗余，也处于合理范围。湖北、山东与浙江规模报酬递增，说明林木保险投资规模过剩，造成了资金浪费的现象。而湖南、广西、安徽、内蒙、贵州五个地区规模报酬递减，林木保险投资规模不足，其中安徽、内蒙与贵州地区规模效率最低，低于 0.9，是由于该地区林木保险以公益林为主，财政补贴比例高、保险赔付比例低，导致大部分地区在现有的林木保险补贴制度下，保险费补贴规模投入冗余，存在利用不合理的资源浪费现象。因此，对于规模报酬递减的地区，不能一味地扩大保费补贴投入规模，而应该结合多年数据，适当降低林木保险费补贴投入规模，着重考虑如何改进保险产品设计，提高保障水平与实际赔付水平。同时，可转而加大对林木保险巨灾风险再保险的财政扶持力度等。

## 4.林木产业保障效果与经营机构可持续性的省际比较

### 4.1 林木产业保障效果

林业保险发展的最终目的是使经济损失得到及时且充足的补偿，让林业获得稳定可持续的发展，风险保障功能作为林业保险的核心功能，是评定其发展水平的重要依据。以下依旧选用林木保险为例，评价其产业保障的效果。在以往的研究中，多使用林木保险保障水平这一指标来衡量林木保险能为林业提供风险保障的程度与效果，但其主要体现的是保险金额的作用，而忽略了林农和政府为了获得保险金额所进行的前期投入。因此，为了更好的衡量各省份的林木保险是否真正做到了使林木产业有保障。本文从产业保障水平、保障杠杆两方面来衡量林木保险对整个林木产业的风险保障效果。

#### 4.1.1 林木保险的产业保障水平

基于林木视角分析 2018 年全国各省市的林木保险对每单位林业产出的保障水平，即总保险金额占林业产值的比重，测算的结果如表 8 所示：

表 8　2018 年全国各省林木保险的产业保障水平

| 地区 | 林业用地面积（万公顷） | 总保险金额（百万元） | 林业总产值（百万元） | 单位产值的保障水平（%） |
|---|---|---|---|---|
| 全国 | 32368.55 | 1483181 | 543240 | 273.02% |
| 青海 | 819.16 | 33036 | 1040 | 3176.58% |
| 内蒙 | 4499.17 | 269797 | 10030 | 2689.90% |
| 甘肃 | 1046.35 | 38258 | 3310 | 1155.84% |
| 陕西 | 1236.79 | 60591 | 10460 | 579.27% |
| 贵州 | 927.96 | 140887 | 25330 | 556.20% |
| 上海 | 10.19 | 8416 | 1580 | 532.68% |
| 山西 | 787.25 | 46519 | 9990 | 465.66% |
| 吉林 | 904.79 | 30691 | 7330 | 418.71% |
| 四川 | 2454.52 | 144629 | 35870 | 403.20% |
| 重庆 | 421.71 | 31024 | 11040 | 281.02% |
| 云南 | 2599.44 | 109728 | 39690 | 276.46% |
| 福建 | 924.4 | 100121 | 38900 | 257.38% |

| | | | | |
|---|---|---|---|---|
| 广西 | 1629.5 | 90193 | 37990 | 237.41% |
| 浙江 | 659.77 | 39365 | 17700 | 222.40% |
| 江西 | 1079.9 | 67245 | 31960 | 210.40% |
| 黑龙江 | 2453.77 | 36168 | 18640 | 194.04% |
| 辽宁 | 735.92 | 27142 | 14950 | 181.55% |
| 河北 | 775.64 | 33198 | 18660 | 177.91% |
| 北京 | 107.1 | 14683 | 9510 | 154.39% |
| 湖南 | 1257.59 | 54079 | 38710 | 139.70% |
| 河南 | 520.74 | 12640 | 12900 | 97.98% |
| 广东 | 1080.29 | 31769 | 39060 | 81.33% |
| 新疆 | 1371.26 | 5097 | 6270 | 81.29% |
| 安徽 | 449.33 | 25994 | 33290 | 78.08% |
| 海南 | 217.5 | 7186 | 10110 | 71.08% |
| 山东 | 349.34 | 12574 | 18160 | 69.24% |
| 湖北 | 876.09 | 10637 | 23520 | 45.23% |
| 江苏 | 174.98 | 1442 | 14730 | 9.79% |
| 宁夏 | 179.52 | 68 | 920 | 7.44% |

数据来源：中国银行保险监督委员会和《中国统计年鉴》

全国各省份林业保险平均保障水平为 273.02%，有 20 个省市保障水平高于 100%，说明部分省份一定程度上存在着保障过度的问题。但是，更重要的原因是林业部门产值的准确衡量存在较大难度和不足。这是由于林木保险标的物具有一定特殊性，其产值的衡量与普通农产品不同，公益林难以计算产值，且部分果树种植多年才能产果，而统计产值时只能计算当年的市场价值，而非标的本身的实际价值，就导致了产值远低于保险金额。

森林覆盖面积较高的省份中，林业面积居全国首位的内蒙古自治区，林木保险保障水平高达 2689.90%，主要由于该地区多为防护林，总产值的统计数额低于实际价值，且内蒙古地处西部地区，经济欠发达，国家对林业保险保费补贴力度大，高达 89.63%，高比例的林业保险费补贴使得内蒙古更倾向于开发林业保险险种，例如在单一火灾险的基础上增加了综合险险种，令单一树种有多个险种同时为其提供风险保障，增强了林木的抗风险能力，但过高的保障水平也会导致资源浪费现象发生。

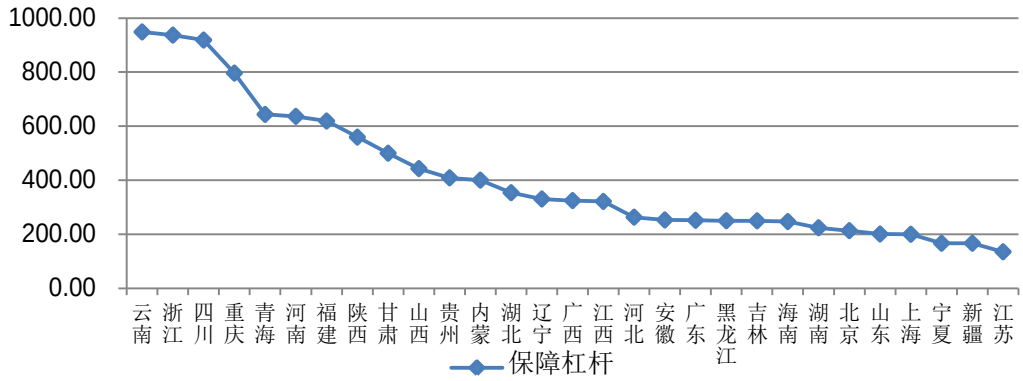
虽然相对于林业产值，林木保险为林业生产经营提供的保障水平总体较高，但也存在部分省区保障不足问题。如湖北、江苏、宁夏等地区的林木保险保障水平仅为林业产值的 10%左右。特别是商品林、水果与果树种植面积较大的省区（如海南、山东等省），其经济林产值较高，但保险覆盖范围有限，林业产业的总体保障水平偏低，不能适应园林经济发展需要。

需要补充说明的是，由于多年生果树的经济价值受影响因素多，标的本身的价值衡量存在一定难度，部分林木保险标的（如公益林）产值难以科学统计，这些导致林业保险承保过程中确定保险金额水平时欠缺合理、科学的衡量依据，林业保险的产品设计和经营具有较大不确定性，同时也使林业保险要为林木、果树产业提供有效、充分的保障带来较大难度。

## 4.2 林木保险保障杠杆

### 4.2.1 林木保险保费的保障杠杆

首先，用林木保险金额与林木保险费的比值来衡量林木保险保费的保障杠杆。林木保险保障杠杆越小，意味着相同的保险费投入所取得的风险保障水平越低，或者相同的风险保障水平所需要付出的保险费越高。2018 年各省林木保险保费保障杠杆如图 5 所示。




数据来源：中国银行保险监督委员会

图 5　2018 年全国各省份林木保险保费保障杠杆

2018 年全国各省份林业保险保障杠杆均值较高，为 412 倍，全国各省份中仅有 10 个省份的林业保险保障杠杆达到均值，说明大部分省份的林业保险保障杠杆过低，仍有较大的改进空间。2018 年全国各省份林业保险保障杠杆差距较大，林业保险保障杠杆最高的地区是云南省为 949 倍，最低地区为江苏仅为 135 倍，二者相差 814，也就是说云南省单位保险费下云南省与江苏省分别可以获得 949 与 135 元的风险保障，说明各省份林业保险保障杠杆存在很大差距。

### 4.2.2 林木保险中央财政补贴的保障杠杆

其次，为明确中央财政补贴撬动的保障杠杆，再对各省市林木保险金额与中央财政补贴的比值进行测算，结果如表 9 所示。

表 9　2018 年全国各省份林木保险中央财政补贴保障杠杆

| 地区 | 保障杠杆 | 地区 | 保障杠杆 | 地区 | 保障杠杆 |
|---|---|---|---|---|---|
| 浙江 | 2402.71 | 甘肃 | 1001.98 | 湖南 | 644.54 |
| 云南 | 2197.65 | 贵州 | 947.72 | 河北 | 618.75 |
| 四川 | 2133.08 | 江西 | 922.61 | 海南 | 562.80 |
| 河南 | 1808.05 | 内蒙 | 888.37 | 吉林 | 545.75 |
| 重庆 | 1751.74 | 山西 | 886.38 | 广东 | 527.78 |
| 福建 | 1641.54 | 广西 | 848.06 | 山东 | 408.01 |
| 青海 | 1305.84 | 湖北 | 740.93 | 新疆 | 333.33 |
| 陕西 | 1119.79 | 辽宁 | 721.00 | 黑龙江 | 283.25 |
| 北京 | 1063.06 | 安徽 | 706.09 | 均值 | 947.92 |

数据来源：中国银行保险监督委员会和《中国保险年鉴》

各省市的保障杠杆均值为 948，中央财政补贴放大效应明显，撬动了 948 倍

的保障杠杆，其中浙江、云南与四川保障杠杆超过 2000 倍，补贴效果极为明显。而保障杠杆较低的地区中，新疆地区保费仅依靠财政补贴，故保险金额较低；而黑龙江省，签单保费较高，保险金额的额度设定却过低，导致中央财政补贴的保障杠杆偏低。

### 4.3 经营机构的可持续性效果

林业保险市场高质量发展的前提是林业保险机构具有可持续的经营能力，实现多方共赢。经营机构的可持续性，可划分为业务可持续性与财务可持续性两方面。

#### 4.3.1 业务可持续性

选取各个省份林木保险市场 3 年保费收入平均增长率作为衡量经营机构业务可持续的重要指标，进而对 2016-2018 年各省市林木保险市场中经营机构的业务持续性变化趋势进行测算，结果如表 10 所示。

表 10　2016-2018 年全国各省份林木保险保费增长率

| 地区 | 2016 | 2017 | 2018 | 均值 | 趋势 |
|---|---|---|---|---|---|
| 全国平均 | -1.45% | 6.98% | 4.78% | 3.37% | 上升 |
| 吉林 | 29.80% | 32.02% | 20.45% | 27.32% | 下降 |
| 北京 | 20.79% | 53.06% | 7.62% | 25.77% | 下降 |
| 青海 | 264.95% | 98.70% | -75.84% | 20.55% | 下降 |
| 贵州 | 25.71% | -1.46% | 36.48% | 19.13% | 上升 |
| 广西 | 27.54% | 20.64% | 1.96% | 16.20% | 下降 |
| 河北 | 10.85% | 24.23% | 5.30% | 13.19% | 下降 |
| 宁夏 | 12.13% | 8.73% | 17.17% | 12.63% | 上升 |
| 江西 | -37.99% | 108.97% | 6.77% | 11.43% | 上升 |
| 安徽 | 1.76% | 6.29% | 6.26% | 4.75% | 上升 |
| 黑龙江 | 0.08% | -47.74% | 116.50% | 4.23% | 上升 |
| 湖南 | 6.02% | 7.57% | -1.18% | 4.07% | 下降 |
| 江苏 | -15.94% | 37.65% | -3.21% | 3.85% | 上升 |
| 广东 | 7.88% | 6.22% | -5.05% | 2.85% | 下降 |
| 内蒙 | -0.18% | 0.36% | 1.25% | 0.47% | 上升 |
| 山西 | 1.45% | -0.77% | 0.62% | 0.43% | 下降 |
| 辽宁 | -0.60% | 0.15% | 1.01% | 0.19% | 上升 |
| 陕西 | -14.23% | 15.57% | -0.28% | -0.39% | 上升 |
| 福建 | -20.91% | 15.62% | 0.10% | -2.90% | 上升 |
| 山东 | -25.52% | 13.10% | 3.35% | -4.51% | 上升 |
| 湖北 | -11.56% | 8.52% | -20.72% | -8.70% | 下降 |
| 重庆 | 8.31% | -7.95% | -27.62% | -10.30% | 下降 |
| 四川 | 0.69% | 0.16% | -28.76% | -10.43% | 下降 |
| 海南 | 8.18% | -0.63% | -33.27% | -10.48% | 下降 |
| 上海 | -31.01% | 6.96% | -2.95% | -10.53% | 上升 |
| 河南 | 3.46% | 0.94% | -32.61% | -11.05% | 下降 |
| 浙江 | -24.88% | -44.32% | 65.87% | -11.47% | 上升 |
| 云南 | -44.35% | 21.93% | 0.36% | -12.02% | 上升 |

| | | | | | |
|---|---|---|---|---|---|
| 新疆 | -76.58% | 18.71% | 90.74% | -19.05% | 上升 |
| 甘肃 | 21.50% | 20.58% | -73.42% | -26.98% | 下降 |

数据来源：中国银行保险监督委员会

*均值计算公式：{（GR2016+1）*(GR2017+1)*(GR2018+1)}^(1/3)-1

从连续三年的业务增长趋势来看，全国保费增长率呈上升趋势，其中有 15 个省份的保费收入年增长率上升，14 个省份的保费收入年增长率下降，整体变动不大。从三年的平均增长率来看，虽全国保费平均增长率为正增长，但仅有 8 个省市近三年的林木保险市场保费收入均值超过 10%，还有 13 个省市为负增长，说明大部分省份的林木保险经营机构的业务可持续性不好。

### 4.3.2 财务可持续性

财务可持续性，即为保险业务能够稳定增长、不断拓展的程度，需在收支平衡的基础上使保险公式适当盈利，令其得以可持续发展。由于没有各省管理费用等具体经营成本的数据，选取林木保险市场 3 年平均简单赔付率（林木保险赔款与林木保险费的比值）作为衡量经营机构财务可持续的重要指标及财务持续性，结果如表 11 所示

表 11　2016-2018 年全国各省份林木保险赔付率

| 地区 | 2016 | 2017 | 2018 | 均值 |
|---|---|---|---|---|
| 全国平均 | 50.91% | 44.75% | 42.58% | 45.92% |
| 福建 | 284.11% | 166.31% | 90.55% | 175.40% |
| 新疆 | 286.09% | 344.08% | 75.73% | 97.03% |
| 广东 | 73.19% | 96.71% | 114.84% | 95.01% |
| 江西 | 107.15% | 48.87% | 69.30% | 68.39% |
| 浙江 | 60.72% | 74.48% | 49.56% | 59.66% |
| 湖北 | 71.89% | 49.49% | 52.16% | 57.87% |
| 内蒙 | 39.62% | 58.02% | 46.86% | 48.17% |
| 上海 | 62.22% | 15.33% | 67.77% | 47.93% |
| 湖南 | 41.50% | 50.94% | 50.05% | 47.63% |
| 山东 | 42.21% | 39.85% | 46.39% | 42.88% |
| 辽宁 | 43.02% | 37.70% | 38.20% | 39.63% |
| 广西 | 48.97% | 31.62% | 39.00% | 39.31% |
| 甘肃 | 36.86% | 28.39% | 57.37% | 38.76% |
| 河北 | 38.50% | 45.34% | 29.47% | 37.57% |
| 宁夏 | 31.59% | 23.96% | 73.02% | 36.77% |
| 河南 | 49.98% | 36.09% | 17.20% | 36.48% |
| 安徽 | 38.05% | 24.77% | 35.09% | 32.58% |
| 江苏 | 47.47% | 20.40% | 32.52% | 32.05% |
| 山西 | 28.19% | 17.61% | 48.22% | 31.36% |
| 海南 | 58.89% | 20.06% | 5.15% | 30.95% |
| 青海 | 0.00% | 36.20% | 64.73% | 29.71% |
| 云南 | 58.96% | 10.98% | 17.62% | 27.28% |
| 贵州 | 28.52% | 28.99% | 24.04% | 26.85% |
| 重庆 | 23.49% | 22.57% | 32.56% | 25.50% |

| | | | | |
|---|---|---|---|---|
| 北京 | 11.34% | 19.37% | 37.04% | 24.42% |
| 四川 | 28.57% | 17.84% | 24.22% | 23.47% |
| 黑龙江 | 11.56% | 25.67% | 12.05% | 14.55% |
| 陕西 | 12.92% | 11.88% | 16.01% | 13.63% |
| 吉林 | 4.81% | 9.94% | 5.69% | 6.90% |

总体来看全国三年平均赔付率为46%，赔付率水平较低，即使加上20%的管理费用，仍有34%的保费结余，在计提大灾准备金之后，保险公司还是有适当盈利，故近几年保险机构参与林木保险的积极性较高。然而各个省的实际损失状况严重不均衡，从各省份林木保险三年平均赔付率来看，福建、广东与新疆赔付率均高于95%。2016年风险较高，福建与新疆地区均出现了超额赔付，林业保险简单赔付率超过了100%。广东地区则是2018年出现了超额赔付，即使三年保费与赔付综合互抵，在扣除管理费用之后，仍面临收不抵支的潜在危险，使得财务稳定性受到了冲击。有9个省份三年平均赔付率低于30%，可能是由于实际赔付力度较低，或对保险费率高估，存在一定降费空间。其他省份林木保险经营机构的财务可持续性相对较好，当年收取的林木保险费收入足以支撑当年的林木保险赔付支出，且有一定剩余，具有良好的财务稳定性。

## 5.林业保险高质量发展面临的障碍与对策建议

上文从林业保险高质量发展视角进行综合评估发现：财政补贴效率整体偏低，17个省市规模效率递减，投入资金过多，资金冗余；同时纯技术效率偏低，制约了补贴的利用率，说明林业保险在制度设计、费率设置等方面存在不足；在产业保障效果方面，保障杠杆高，特别是作为引导资金的中央财政投入具有较强保障杠杆效应，但也存在保额水平确定不合理，甚至过度保障的问题；机构可持续性方面，保险公司的赔付率稳定、财务可持续性较好，但业务可持续性较差，三年平均保费增长率仅3.37%。阻碍当前林业保险高质量发展的主要因素及其因应措施是：

### 5.1 水果与果树保险发展缓慢，急需中央财政补贴和地方政府干预

从林业保险不同险种结构来看，水果与果树保险发展明显滞后于林木保险。从赔付率来讲，水果与果树保险赔付率较高，是由于其风险系统非常复杂，主要灾害类型为病虫害与火灾，而此类灾害的发生具有系统性的特征，即某一区域遭受灾害，与之临近的区域很有可能会遭受同种灾害，违背了保险的“大数法则”，一旦发生灾害，赔付额也就较为高昂；从保费角度来讲，2018年中央财政补贴率仅为0.02%，远低于中央财政给予林木保险32.28%的补贴比例。同时赔付随保费同向变动，保的越多赔得越多，导致保险公司对开展水果与果树保险业务的积极性较低。

随着我国国民收入水平的提高，国民对水果的需求也在加大。然而水果与果树保险保障发展速度缓慢，目前该险种覆盖面很小，且仅对种植成本的部分进行保障，而未对其价格、收入提供风险保障，部分地区保险金额远低于实际价值，甚至不及再植成本，果树保险产品供给严重不足。故急需中央财政对水果与果树保险保费进行财政补助，将规模化经营水果与果树的区域纳入国家政策性保险保费补贴范围。加大中央财政补贴力度，减轻省级与地市级的财政压力，才能有效的弥补亏损，降低林农缴费比例，从而提高林农投保积极性，进而扩大水果与果

树保险覆盖面。同时应加快水果与果树保险立法，利用法律手段促进水果与果树保险发展，以法律形式明确水果与果树保险由政府支持的政策性，明确政府在森林保险中应发挥的职能和作用，避免政府支持水果与果树保险的随意性。

另外，赔付率过高也体现了我国在水果与果树保险产品定价方面的能力缺失、大灾风险分散机制的不健全。保险产品定价的科学性与公平性是维持保险市场长期向好发展的基础。目前我国地方各级政府未参与到林业保险的具体经营，仅提供信息数据支持，而由林业保险机构自主进行精算定价、自担大灾风险。然而，作为政策性的保险制度，政府部门若不适当干预，其合理性与公平性很难得到保障，因此，建议政府可根据保险精算原理对其定价科学性、合理性进行监管，同时应提供财政支持的林业保险大灾损失分摊机制或再保险扶持，使林业保险经营者不会亏损的同时，也不会长期获得超过行业平均水平的利润。

### 5.2 林木保险易出现巨灾风险，经营不稳定，急需建立有效巨灾分散制度

林木保险面临巨灾风险。林木经营风险低频率、高强度的特征，使得林木保险赔付率较低，然而一旦出现自然灾害就会有大面积的林木受灾，赔付金额极高，保险公司将面临巨大的赔付压力，造成财务经营不稳定，例如四川、内蒙、黑龙江 2018 年都发生了重大火灾，造成严重经济损失。传统种植业保险等已在《条例》基础上，出台并试点了大灾风险分散机制，但政策性林业保险方面，目前仅有《农业保险条例》为其提供政策依据，尽管财政部、国家林业和草原局、国家银保监等部门鼓励地方出台林业保险相关政策，但目前进展缓慢，还没有完备的政策出台，就导致许多方面缺乏法律支持与制度依据，保险公司和林农都缺乏积极性，林木保险供需意愿不强。对于保险公司而言，保费低廉，保险金额却极高，存在较大的经营风险，一旦发生巨灾，无疑是雪上加霜。

针对此问题需建立巨灾分散机制，提高风险保障水平。森林灾害具有系统性特征，空间相互联系的区域极有可能同时发生灾害，导致高额赔付。林木保险与社会救助的偿付能力有限，故在灾害发生时仅能分担农户部分损失，而不能消除农户面临的全部风险。因此为了维持保险公司林木保险经营的信心与业务的稳定，政府在大力推广林木保险的同时，对于大灾风险发生频率高、强度大的地区，还应在全国范围内尝试大灾风险分散制度的构建。由于森林风险系统的复杂性，森林大灾保险制度还需要建立政府多部门之间的衔接机制，不断完善相关法律制度，明晰部门间的业务范围，以法规的形式对林业保险大灾风险分散制度予以规范，逐步实现准备金全国统筹，逐年滚存，不断累积，多渠道共担大灾风险，体现国家财政对极端大灾风险兜底的守护作用。

### 5.3 林木保险省际之间补贴效率不均衡，应建立差异化补贴机制

我国林木保险省际之间保费补贴效率不均衡，规模效率有增有减。上文对 2018 年全国各省份林木保险市场的保险费补贴效率进行了测算，发现有 10 个地区为规模报酬不变，仅有宁夏规模报酬递增，其余 16 个地区均为规模递减。对于规模报酬递减的地区，若继续扩大林木保险费补贴规模，其林木保险费补贴金额的利用率将会进一步下降。

据此，应因地制宜的采取差异化补贴机制。目前我国中央依据《中央财政农业保险保险费补贴管理办法》对各地区采取统一的补贴标准，而未考虑到各地区自身的经济实力与林业资源状况等因素的影响，忽略了各地区间的巨大差异。因此，为促进各地区均衡发展，对于林木保险费补贴效率处于规模递增状态的地区，应加大补贴规模，提高其补贴效率；而对于处于规模递减状态的地区，其保险费

补贴规模已达到饱和，不应再扩大林木保险补贴规模，而应通过完善林木保险费补贴相关制度来提高林木保险发展效果。各级政府需重新划分补贴责任，通过调节中央财政补贴比例减小各省市林木保险发展的差异。

### 5.4 林业保险统一费率导致低效率供给，需通过风险区划与费率分区创新产品供给形式

根据对 2018 年林木保险发展的测算，发现当年各省份林木保险保费补贴的综合效率低主要是由纯技术效率引起的，这反映了保费补贴资金配置的结构效率低，保险制度的设计不合理。同时，保险费率方面存在不足，目前我国没有对林业保险费率进行区域划分。大多数地区仅区分公益林和商品林，尚无后续风险分区和费率分区，然而我国新疆、内蒙、黑龙江等省份幅员辽阔、生态极具多样性，使用统一的费率进行投保缺乏一定合理性，这一矛盾也是导致 2018 年种植规模较小的林农大量退出了林业保险市场的原因之一，林业保险产品科学供给的缺陷明显。

林业保险采用“一省一费”的简单方法，会导致风险与保费的不对等，产生逆向选择与违规的问题。目前农作物保险已逐步改为根据实际风险状况进行费率区划，开展了稻谷、玉米、小麦三大主粮作物的全国风险区划。林业保险也急需开展风险区划研究，依托保险数据与精算模型，对各地区森林资源的价值与风险状况进行科学化的评估，推进保险产品的精准定价，并建立科学的林险费率拟定机制与调整机制。同时考虑到多年的灾害损失，国家财政资源以及林业生产经营者的经济承受能力，设计切实可行的林业保险条款，逐步向林业保险高质量发展转型升级。

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# 我国林业保险的高质量发展衡量指标与实现路径

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**关键词**：林业保险；高质量发展；政策效果；省际差异

**摘要**. 论文在深入分析我国林业保险保费增长、补偿水平、险种及地区结构特征等的基础上，以高质量发展为目标，从补贴效率、产业保障程度及机构可持续性三个维度选用相关指标衡量分析了我国林业保险现阶段的发展质量及省际之间的水平差异。研究发现，林业保险在推动林地规模化经营等方面已取得初步成效，但与高质量发展仍有一定差距。多数省份财政补贴的规模报酬递减，补贴效率低，投入资金冗余；产业保障效果在省际间存在较大差异，中央财政补贴的保障杠杆水平高，但也存在保额确定不合理现象；机构可持续性方面，财务状况良好，但业务增长存在不足。最后，论文还研究了阻碍当前林业保险高质量发展的主要因素及其因应措施，认为果树保险的发展急需中央财政补贴和地方政府干预，林木保险应建立差异化补贴机制和有效巨灾分散制度，通过风险区划与费率分区创新产品供给形式等。

# Analysis of Urban Insurance High-Quality Development Evaluation System: Based on 19 Vice-provincial and Municipalities Cities

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**Keywords:** High-quality insurance development; Evaluation index system; Entropy evaluation method; Insurance development performance

**Abstract.** High-quality insurance development is an inevitable measure for the insurance industry to adapt to accommodate future development. This paper constructs the urban insurance high-quality development indicator system based on the innovative development concept and some new insurance development performance indicators. Through the empirical study of 19 cities from 2010 to 2018, the paper found that the high-quality development of regional insurance in China is unbalanced. Specifically, the eastern cities' relevant development is obviously better than other cities, and the first-tier cities' relevant development is better than other non-first-tier cities. From the perspective of each subsystem, the paper found that: 1) the cities with the highest development environment index have higher per capita GDP and urbanization rate, and the tertiary industry is relatively mature. 2) The cities with the highest development power index show outstanding performance in insurance institution completeness, policy, talent and other factors. 3)Most of the cities with top development achievement index are characterized by prominent proportion of innovation insurance premium income and significant advantage in per capita policy holding. 4)The risk assurance rate and insurance density of the top cities in the development performance index have high levels.

## 1. 引言

由于金融行业自身存在发展不充分和不平衡两大主要问题，金融高质量发展势在必行（何德旭，2018）。具体到保险行业，当前面临的主要矛盾正由“有没有”相关保险产品或保险功能转向保险产品或保险功能“好不好”的问题（缪新民，2018），本质上体现了保险供给体系和质量不能满足日益迸发、不断升级的保险需求的结构性矛盾（秦立建等，2018；姜华，2019）。只有通过保险业的高质量发展才能有效解决这种供给与需求之间不平衡、不适应的矛盾（冯占军等，2018），才能更好地满足各领域日益增长的风险保障需求（郑伟，2020）。

那么，什么是保险的高质量发展？该如何测度衡量？这就需要我们在准确理解和把握高质量发展内涵的基础上，构建一套科学合理的评价指标体系加以反映。为此，本文将在分析、界定保险高质量发展的内涵和理论基础上，尝试建立保险高质量发展的评价体系。本文的创新点主要体现在以下三个方面：一是传统评价保险发展的指标集中于评价市场规模，本文则兼顾考察保险产生的社会影响（绩效）。二是评价测算方法有客观方法和主观方法之分，各有利弊，本文将主客观方法混合使用，扬长避短。三是构建城市保险高质量发展评价体系，不局限于对比不同城市的保险发展成果，本文会综合考虑影响成果与绩效差异的原因，形成综合且全面的评价指标体系，进而得到公正且有深度的评价结论。

## 2．关于保险高质量发展内涵及其评价指标体系的讨论

### 2.1 关于保险高质量发展内涵的讨论

高质量发展是质量与数量的统一（张军扩等，2019），保险业的高质量发展要体现保险行业的规模扩张，更要体现其运行质量和效益的提高，包括保险产品和服务的高品质、保险供给和需求的高匹配和保险资源和要素配置的高效率，要求整个行业的运行轨迹稳定、健康、有价值和可持续性（冯占军 等，2018；龚新宇，2018）。也就是说，保险业高质量发展的核心是质量第一、效益优先，主要实现途径是质量、速度和效率的“三大变革” （余贤群，2018）。保险业的高质量发展要求主要体现在行业功能提升、行业发展驱动力升级和行业发展速度合理稳健三个具体形态上（锁凌燕，2018）。这三种形态的实现，需要保险行业从要素驱动的数量型增长模式向创新驱动的质量提升型增长模式转变，从劳动密集型的人海战术向技术密集型的科技赋能转型（周雷等，2020）。

扎根于服务实体经济、适应消费者和投资者需求而进行保险创新，为经济高质量发展来提供有力支持和全面保障对保险业高质量发展提出了更高的要求（房永斌，2018；王辉，2018）。一方面要求保险业进一步提升行业服务的质量和效率、扩大服务范围（朱俊生，2019），另一方面也要求其持续强化长期稳健风险管理和保障的功能，深入探究运行机制和管理机制等战略性问题，重塑保险市场良序运行的制度基础，充分发挥保险机制在经济转型过程中的作用（叶朝晖，2018）。保险业高质量发展至少要体现以下三大功能的实现：一是服务国家重大战略，二是保障实体产业，三是聚集民生社会事业（锁凌燕，2019）。

虽然现有相关研究从不同角度来阐述保险业高质量发展的内涵，但其意义指向都是一致的，即：a）以“更好地满足各领域风险保障需求”为目的，b）以“高质量”为根本要求，既涵盖微观层面的产品和服务也涵盖宏观层面的结构和效率，c）以“创新”为根本动力，不断提升综合效率，d）以“持续”为根本路径，不

断优化各种关系。理解这些意义，是构建保险业高质量发展评价指标体系的基本前提和出发点。

## 2.2 关于保险高质量发展评价指标体系的探讨

由于高质量发展理念提出时间较短，当前直接探讨保险业高质量发展评价指标体系的文献还不多。王国军（2018）认为，构建保险业高质量发展评价指标体系需要从保险基本功能入手，在原保监会制定的《保险业功能服务指标体系》基础上加以修订和完善，进一步强调保险的风险分散、经济补偿、资金融通和风险管理四大功能的发挥；可对保险业的一般风险保障、服务防灾减灾、服务农业生产流通，推动现代金融制度建设、助力社会保障制度建设、参与社会管理、创造经济价值和社会价值等方面的业绩，设定更为科学、也更为具体的定性与定量化指标；同时，要根据社会经济环境的变化，进一步将保险业高质量发展的指标体系细化到具体的险种和业务环节，最终形成一个完整的涉及面更为广泛的指标体系，以便能够科学计量和系统评估保险业在服务经济社会发展中所发挥的作用。按照此思想，可从保险业规模评价、保险业结构评价、保险业效率评价、保险业功能评价、保险业稳健性评价等五个维度来构建保险业高质量发展评价指标体系（郑文燕、王兴，2019）。

以上保险业发展相关评价指标体系基本上能够评价保险业高质量发展程度，也为本文研究提供了较为坚实的研究基础，但还存在如下问题：一是偏向使用结果指标。高质量发展不仅是行业发展的结果体现，也需要反映行业发展的过程，应是结果指标与过程指标的综合，而上述指标体系中大部分都属于结果指标，相应的评价维度也多是发展结果的平级罗列，相互之间缺乏关联性，无法体现协调等理念，也不能对具体发展水平追根溯源；二是同类指标重复。评价指标的选择要抓住核心，避免重复出现存有较高相关性或相似性的指标，而上述指标体系中的保费收入、保险密度、保险深度之间具有较强的相关性或相似性。三是部分指标测度较困难，例如城市的创新保险个数等，因统计口径问题，数据取得都较为困难。

## 2.3 关于评价指标体系相关算法的研究

评价指标体系的算法主要包括指标遴选方法、指标权重确定方法及评价结果计算方法等三方面的内容。在现有保险相关评价的研究中，指标遴选环节大多采用专家调查法及层次分析法对评价体系的指标进行遴选（张洪涛 等，2014；杨馥、刘悦，2018；邵文赫，2019），前者的优点是可最大限度发挥专家能力，但无法避免主管偏向性带来的评估偏误问题；后者适用于无结构特性的系统评价，但无法基于理论或经验来甄别指标。指标权重确定环节既有用专家打分法和层次分析法等主观评价方法，也有用熵权法和逐级等比例法等客观评价方法（郑军、朱甜甜，2014；王超、黄英君，2017；郑军、杜佳欣，2020）。主观方法可突显不同指标的重要性差异，但因主观性较强，计算结果会存在争议；纯客观方法最大的优点就是简便，但也存在无法基于理论或经验来体现不同指标重要性程度，而且这类方法更适合于横向截面数据，当用于评价指标的纵向比较时要么因不同年度的权重差异而导致无法比较，要么因纵向名义指标难以剔除价格因素而存在评估偏误。评价结果计算环节运用最广泛的方法是综合指标法或加权求和法（孙蓉 等，2019）。该方法计算简便且能够充分展示各指标对评价总体结果的贡献差异，但存在过于依赖指标权重的弊端。也有不少研究采用主成分分析法来对多个指标进行降维计算（姜政一，2008；陶存文 、徐景峰，2012；朱南军 等，2018；

周小菲 等，2019），以尽量少的综合指标能尽可能多地反映原始数据信息，且能有效消除指标间相关而在评价时反映的重复信息，但降维的同时无法避免有用信息被忽视问题，而且无法充分考虑各指标的现实意义及影响。鉴于此，本文拟采用结合保险业高质量发展评价指标体系的目标和内容，充分考虑主客观评价方法的优缺点，在不同环节上均采取主客观综合算法，以图更客观、更科学、更系统地反映各经济主体保险业高质量发展的程度。

## 3．城市保险高质量发展指标评价体系的构建

本文以创新发展理念为基础构建的城市保险高质量发展评价指标体系包括发展环境、发展动力、发展成果和发展绩效。

第一，发展环境主要考察影响保险发展成果及绩效的外部因素，关注的是被考察城市相关宏观因素对保险行业自身发展及赋能作用发挥的影响程度。直接影响保险发展的宏观环境主要包括两方面，一方面是直接影响消费者保险需求和购买力的经济环境，经济越发达的地区对经济的保障需求越高，能购支付保费的能力越强，可用人均 GDP、人均可支配收入、人均储蓄、第三产业占比来表现；另一方面是影响保险产品购买规模的人口环境，汇集人口越多或人口增长越快的地区消费保险的人群基数越大，城市人群较农村人群更倾向于保险保障，而城市老年人口越多也会刺激相应保险需求，所以可用人口密度、常住人口增长率、城镇化率和老龄化率来表现。

第二，发展动力是保险发展的基础与源泉，主要来自于两方面，一是自身的基础条件，二是所拥有的创新能力。自身基础条件主要指保险行业本身已具备的条件和优势，主要包括机构、薪酬和行业秩序，具体体现为机构完备度、工资水平和合规经营情况，基础实力越强的保险市场发展起点越高。创新能力体现为创新要素的集聚，是支持保险主体在各实践领域中不断提供新理论、新产品、新服务的要素的集合，可分为人员储备、研发支持和政策支持三部分。第三，发展成果直接体现的是发展环境和发展动力共同作用下保险行业的发展状况，可从市场规模、行业结构和运营效率等三方面考察。市场规模方面，保费收入规模是国际通用的评价指标，考虑到不同城市的体量差异，可用保费收入增长率考察市场总体规模的变化情况，用保险密度反映人均消费保险的规模及保险渗透的情况。行业结构指产寿险市场的构成及产寿险之间的比例关系，可反映保险发展的内容，可用产寿险比例和行业集中度来表示。发展成果中的运营效率是指保险行业发展的质量，这既包含保险市场在国民经济中所占的比重，也涉及到保险业内部的工作效率，以及保险的社会认可度，可用保险深度、劳均保费以及人均保单持有量来反映。

第四，发展绩效反映在一定宏观环境和行业条件共同作用下，保险赋能经济社会发展的广度和深度，重点体现保险在服务经济发展、参与社会治理和完善民生保障方面的助力情况。根据中国银保监会于 2019 年底发布的《中国银保监会关于推动银行业和保险业高质量发展的指导意见》，本报告主要从经济发展、民生保障和社会治理等三个方面来设置保险发展绩效指标。

基于以上解释和分析，遵循可行性、科学性、代表性和可比性的基本原则，本文建立了包括 4 个一级指标，38 个基础指标的城市保险高质量发展评价指标体系，具体包括发展环境（8 个）、发展动力（10 个）、发展成果（8 个）、发展绩效（12 个）。

表1 城市保险高质量发展评价指标体系

| 一级指标 | 二级指标 | 三级指标 |
|---|---|---|
| 保险高质量发展水平 | 发展环境 | 人均GDP（元） |
| | | 人均可支配收入（元） |
| | | 第三产业占比（%） |
| | | 人均储蓄（元） |
| | | 人口密度（人/平方公里） |
| | | 老龄化率（%） |
| | | 常住人口增长率（%） |
| | | 城镇化率（%） |
| | 发展动力 | 机构完备度 |
| | | 金融业职工平均工资（元） |
| | | 行政处罚频率（次/亿元） |
| | | 百万人口在校大学生数量（万人/百万人） |
| | | 保险专业高校师生数量（人） |
| | | 保险研发机构数量（家） |
| | | 万人新增保险科技企业数量（家/万人） |
| | | 万人发表保险论文数量（篇/万人） |
| | | 保险试点实践 |
| | | 新增保险创新政策（项） |
| | 发展成果 | 保费收入增长率（%） |
| | | 保险密度（元/人） |
| | | 行业集中度（%） |
| | | 产寿险比例（%） |
| | | 创新保险保费收入占比（%） |
| | | 保险深度（%） |
| | | 劳均保费（元/人） |
| | | 人均保单持有量（份/人） |
| | 发展绩效 | 风险保障率（%） |
| | | 融资增信支持度（‰） |
| | | 工程项目保障度（%） |
| | | 货运物流保障度（分/吨/公里） |
| | | 商业养老保险密度（元/人） |
| | | 商业养老险给付强度（%） |
| | | 商业健康险密度（元/人） |
| | | 商业健康险赔付强度（%） |
| | | 弱势群体保险覆盖率（%） |
| | | 农险保费收入占比（%） |
| | | 社会纠纷重点领域保险覆盖率（%） |
| | | 公共安全重点领域保险覆盖率（%） |

## 4．数据来源与测度方法

### 4.1 样本选择与数据来源

基于对城市代表性和数据可得性的考虑，本文选择 2014-2018 年 19 个副省级以上城市的相关数据。样本期内，这 19 个城市的保费收入占全国保费收入比重在最低的年份也超过 30%，说明样本代表性很高，能够满足研究需要。相应原始数据主要来自于各城市的城市统计年鉴及中国保险年鉴，对某些城市的缺失数据使用线性插值法进行填补。

### 4.2 赋权方法

评价指标体系的测算过程一般为，先确定权重，再根据权重层层加权求合，最终得到总得分。该过程中最为关键的一步便是确定权重。当前通用的赋权方法可分为两类，一类是主观赋权法，一类是客观赋权法。

4.2.1 序关系法赋权

主观赋权法包括集值统计迭代法、层次分析法、G1 与 G2 法等。其中，层次分析法与序关系法最为常用，本文采用后者。序关系法改善了层次分析法的一些缺陷，能够做到无需构建判断矩阵，也无需进行一致性检验，从而使计算量大幅减少，且方法可操作性强。具体评估步骤如下：

（1）确定序关系。在某评价准则下，将将第$i$个一级个一级指标下的评价指标$x_{i1}^{*} > x_{i2}^{*} > \cdots > x_{im}^{*}$，按照重要程度度排序，即：$x_{i1}^{*} > x_{i2}^{*} > \cdots > x_{im}^{*}$，则认为$x_{i1}$，$x_{i2}$，…，$x_{ij}$按照“>”确立了序关系。这里$x_{im}^{*}$为$\{x_{in}\}$按照序关系“>”排定顺序后的第第$n$个评价指标（$m$，$n=1$，$2$，…，$j$）。为了不失一般性，序关系式记为：$x_{i1} > x_{i2} > \cdots > x_{ij}$。

（2）确定重要程度。设第第$i$个一级指标下的评价指标$x_{ik-}$与$x_{ik}$之间的重要程度之比$w_{ik-1}/w_{ik}$的理性判断为$r_{ik} = w_{ik-1}/w_{ik}$，$k=j$，$j-1$，…，$3$，$2$。其中，$r_{ik}$的赋值见表 2。

表2 $r_{ik}$赋值参考表

| $r_{ik}$ | 评价指标$x_{ik-1}$与$x_{ik}$ |
|---|---|
| 1.0 | 同等重要 |
| 1.2 | 稍微重要 |
| 1.4 | 明显重要 |
| 1.6 | 强烈重要 |
| 1.8 | 极端重要 |
| 1.1，1.3，1.5，1.7 | 对应两两上邻指标判断中间情况 |

（3）计算权重系数$w_{ik}$，即

$$w_{ik} = \left[1 + \sum_{k=2}^{j} \prod_{m=k}^{j} r_{im}\right]^{-1}$$

其中，$w_{ik-1} = r_{ik} w_{ik}$，$k=j$，$j-1$，…，$3$，$2$

（4）重复上述方法得到第$i$个一级指标的权重$w_i$。

4.2.2 熵权法赋权

考虑到主观权重计算方法不可避免的存在受到主观因素影响的风险，故采用基于差异驱动原理的赋权法，即客观赋权法，来评估各评价指标的价值。常用的客观赋权法有均值法、极差法、接开档次法和熵权法。本文采用的熵权法，根据指标信息量大小决定相应权重系数，可避免专家主观因素对指标权重的影响。设$X_{ij}$为第$i$个一级指标的第$j$项基础指标（$i=1$，2，3，$n$；$j=1$，2，3，…，$m$）。对给定的指标$j$，$X_{ij}$的差异越大，其包含和传输的信息量就越多，同时对整个系统的影响程度就越大。用熵权法进行赋权的步骤如下：

（1）标准化处理数据：

正向指标：$X_{ij}=\left(X_{ij}-minX_{ij}\right)/\left(maxX_{ij}-minX_{ij}\right)$

逆向指标：$X_{ij}=\left(maxX_{ij}-X_{ij}\right)/\left(maxX_{ij}-minX_{ij}\right)$

第$i$个一级指标的第$j$项基础指标的权重

$$Y_{ij}=X_{ij}\Big/\sum_{j=1}^{m}X_{ij}$$

（2）计算熵权。设第$j$个指标的熵值为$e_{ij}$

$$e_{ij}=-k\sum_{j=1}^{m}y_{ij}lny_{ij}$$

（3）计算权重。第第$j$个指标的权重$W_{ij}=\left(1-e_{ij}\right)/\sum_{j=1}^{m}\left(1-e_{ij}\right)$

4.2.3 合成权重

为兼顾客观权重和主观权重各自表达的信息，本文采用特定方法将两类权重进行合成。此处将通过序关系法和熵权法得到的权重分别标记为$u$和$v$。与之相应的系数为$\alpha$和$\beta$，而$w$是最终的合成权重。依据相对熵的理念，可建立如下模型来求解合成权重：

$$\min Q(\alpha,\beta)=\sum_{k=1}^{K}w_k\ln\left(w_k/u_k\right)+\sum_{k=1}^{K}w_k\ln\left(w_k/v_k\right)$$

$$s.t.\ \ \alpha+\beta=1, w_k=\alpha u_k+\beta v_k, 0\le\alpha\le1, 0\le\beta\le1$$

其中$Q(\alpha,\beta)$为相对熵，$\alpha$和$\beta$分别为主观权重$u$和客观权重$v$的系数。计算上式可得到合成权重$w$。

## 5．测算结果与分析

### 5.1 城市保险高质量发展综合水平测算结果及分析

根据图 1 所示（限于篇幅和清晰度，仅列前十，下同。）从整体上看，城市保险高质量发展综合水平呈上升趋势，主要原因是近年来人均 GDP 和人均可支配收入不断增加、人口老年化比重不断上升和保险行业发展的体制机制愈加健全等为城市的保险高质量水平发展提供了一个良好的内外部环境。

从总指数排名情况来看，如表 3 所示，北京五年来稳居第一，广州、深圳、上海位列其后，四城市间综合水平差距逐渐缩小。重庆、长春、哈尔滨、天津四个城市五年来排名一直处于末流，其中重庆在 2014 年-2017 年连续四年总指数排名倒数第一。北京良好的高质量发展态势主要归功于发展动力和发展绩效表现

突出，其发展动力指数连续五年来排名第一。排名靠后城市在发展环境和发展动力方面与北京、广州等城市存在较大差异。

根据《2018 中国城市商业魅力排行榜》对城市的划分，2018 年城市保险高质量发展水平排在前十的城市中除了济南不是一线城市外，其他 9 个城市都是一线城市，排在后四位的除重庆外，均不是一线城市。说明一线城市的保险高质量发展情况明显优于非一线城市。在这前十个城市中，北京、广州、深圳、上海等 8 个城市位于东部地区，表明东部地区保险高质量发展综合水平表现较为优越。长春、哈尔滨、沈阳这 3 个东北城市历年来保险高质量发展水平均表现较差，中西部地区大部分城市保险质量综合水平表现一般，这一结果表明城市保险高质量发展城市分布不平衡。

表 3　2018 年各城市保险高质量发展指数归档情况

| 档次 | 城市 | 测度水平 |
|---|---|---|
| 第一档 | 北京、深圳、广州、上海 | 50-59 |
| 第二档 | 杭州、南京、济南、武汉、成都 | 40-50 |
| 第三档 | 青岛、宁波、厦门、西安、大连、天津 | 30-40 |
| 第四档 | 沈阳、哈尔滨、重庆、长春 | 24-30 |

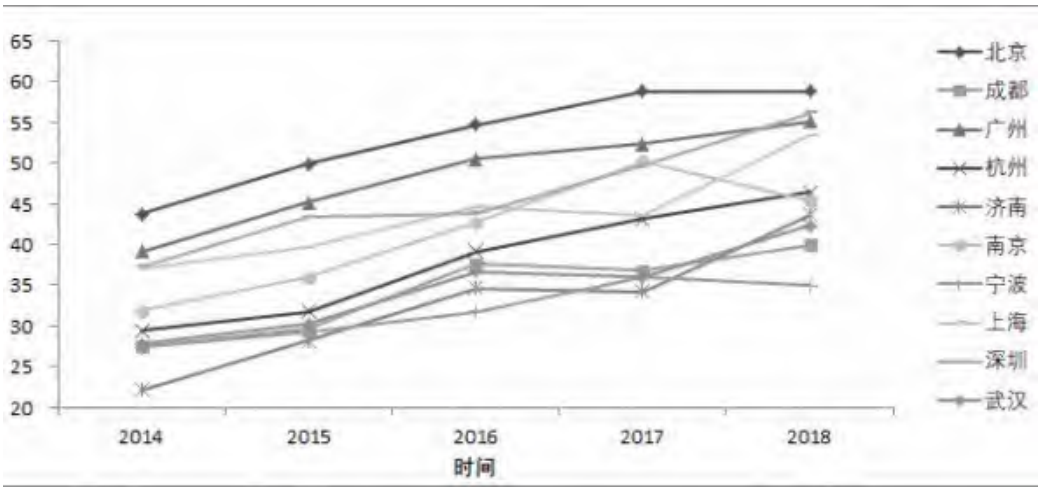


图 1 城市保险高质量发展指数位列前十城市的变化趋势图（2014-2018）

## 5.2　保险高质量子要素发展结果分析

表 4　2018 年各城市发展环境指数归档情况

| 档次 | 城市 | 测度水平 |
|---|---|---|
| 第一档 | 深圳、上海、北京、广州 | 12-15 |
| 第二档 | 杭州、南京、天津、宁波、厦门、武汉、大连、青岛、济南、西安、沈阳、成都 | 7-12 |
| 第三档 | 长春、哈尔滨、重庆 | 4-7 |

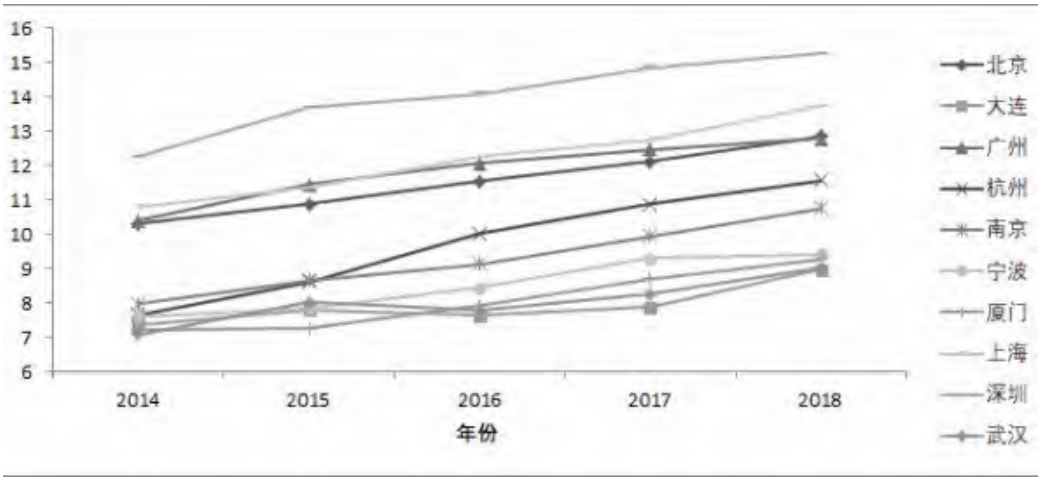


图 2 发展环境指数位列前十城市的变化趋势图（2014-2018）

由表 4 可知 2018 年发展环境水平最高的四个城市分别是深圳、上海、北京、广州，排名最后的三个城市分别是长春、哈尔滨、重庆。深圳、上海等城市在测度结果中人均 GDP 水平和城镇化率较高，第三产业占比较大，为地区保险高质量发展提供了良好的外部环境。长春、哈尔滨、重庆等地排名靠后的主要原因是人口密度低、地区老龄化率低。

发展环境指数在测度中总值为 20.97，而在 2018 年，除深圳、上海、北京、广州、杭州、南京 6 个城市的发展环境指数高于 10 外，其他城市保险发展环境水平均在 10 以下，占所考察城市的 63.16%左右，表明我国大多数城市保险发展环境水平有待提升。

表 5　2018 年各城市发展动力指数归档情况

| 档次 | 城市 | 测度水平 |
|---|---|---|
| 第一档 | 北京、上海、广州 | 12-17 |
| 第二档 | 济南、南京、杭州、成都、武汉、深圳 | 8-12 |
| 第三档 | 天津、西安、青岛、重庆、哈尔滨、宁波、沈阳、厦门、长春、大连 | 4-8 |

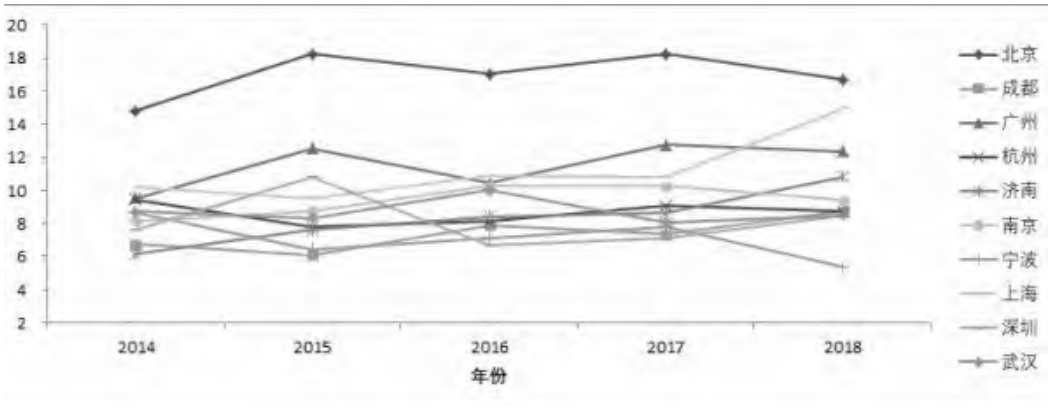


图 3 发展动力指数位列前十城市的变化趋势图（2014-2018）

由表 5 可知 2018 年，发展动力水平排名前三的城市分别是北京、上海、广州，排名最后的两个城市是大连、长春。其中北京发展动力指数五年来稳居第一，主要原因是其凭借独特的政治区位优势和人才优势在保险机构完备度和保险研发机构数量上遥遥领先。上海作为改革的试验田，保险试点实践指数较高；广州周边高校众多，百万人口在校大学生数量较多。大连、长春动力指数均不及 5%，在机构完备度和保险专业高校师生数量方面与北京等城市存在较大差距。

由图 3 可知，城市发展动力指数总体差距较大，呈现较为明显的两级分化趋势。

表 6 2018 年各城市发展成果指数归档情况

| 档次 | 城市 | 测度水平 |
|---|---|---|
| 第一档 | 深圳、广州、武汉、杭州、南京 | 13-15 |
| 第二档 | 北京、上海、成都、济南、青岛、西安、厦门、宁波 | 9-13 |
| 第三档 | 哈尔滨、沈阳、大连、长春、重庆、天津 | 6-9 |

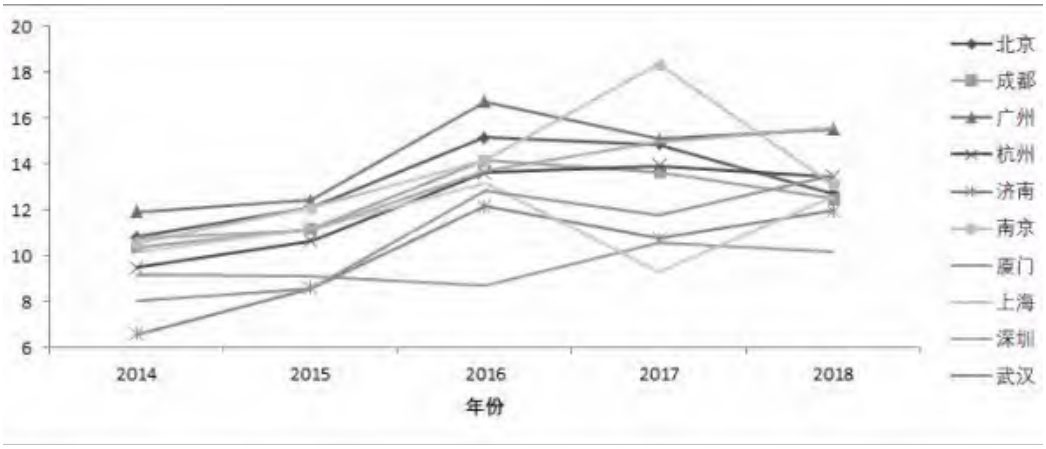


图 4 发展成果指数位列前十城市的变化趋势图（2014-2018）

由表 6 可知，2018 年发展成果指数排名前三的城市是深圳、广州、武汉，排名靠后的城市有天津、重庆、长春。发展成果指数排名靠前的城市多具有以下特点：创新保险保费收入占比突出，有 7 个城市此项收入占比超过 7%，人均保单持有量优势显著。而排名靠后的城市虽然行业集中度、产寿险比例不低，但劳均保费、保险密度与深圳、广州等城市相差较大，导致指标占比偏低。

由图 4 可知，大部分城市的发展成果指数集中在 0.11-0.14 区间内，2018 年 19 个城市的发展成果指数极差为 0.0879，在四个子要素中极差值为最小，说明城市间发展成果差距不大。

表 5 2018 年各城市发展绩效指数归档情况

| 档次 | 城市 | 测度水平 |
|---|---|---|
| 第一档 | 深圳、北京、广州 | 14-16 |
| 第二档 | 杭州、济南、上海、南京、武汉、成都、青岛、宁波、厦门 | 10-12 |
| 第三档 | 大连、西安、哈尔滨、重庆、沈阳、天津、长春 | 7-10 |

由表 5 可得，发展绩效排名前三的城市分别是深圳、北京、广州，三地的风险保障率较高，商业养老保险密度近千元。发展绩效排名最后的三个城市分别是长春、天津和沈阳，三个城市的保险密度、覆盖率和给付强度都不足，远低于北京、深圳等城市，原因是这三个城市的人均可支配收入较低，其中长春 2018 年

人均可支配收入为 24659.67 元，大约为北京人均可支配收入的三分之一，所在地区企业员工保险福利制度不够完善也是导致保险密度、深度不足的重要原因。

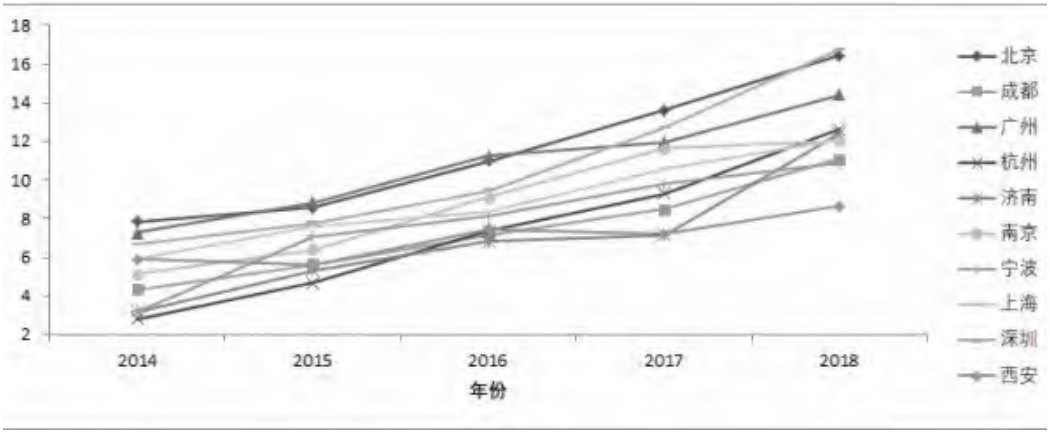


图 5 发展绩效指数位列前十城市的变化趋势图（2014-2018）

由图 5 可见，城市间发展绩效指数的变化趋势与城市保险发展水平一致，都呈现整体上升趋势，说明了保险发展绩效随着城市保险发展水平的逐年提升而不断提高，进一步证实了高质量的城市保险发展水平能反作用于城市经济发展、民生保障和社会治理，重视城市保险高质量发展对赋能经济社会发展具有重要意义。

## 6．结论与建议

### 6.1 结论

基于本文构建的我国城市保险高质量发展水平测度体系，利用序关系法和熵权法对 2014-2018 年我国 19 个副省级以上城市保险高质量发展各子系统水平及综合水平进行测度，分析其变化规律。得到的结论如下：

从综合水平看，我国城市保险高质量发展不平衡。东部地区的保险高质量发展情况明显优于其他地区；一线城市的保险高质量发展情况明显优于非一线城市。从各子系统看，发展环境指数排名靠前的城市人均 GDP 水平和城镇化率较高，第三产业发展较为成熟；发展动力指数排名靠前的城市在保险机构完备度、政策、人才等要素上表现突出；发展成果指数靠前的城市多具有创新保险保费收入占比突出、人均保单持有量优势显著等特点；发展绩效指数排名靠前的城市风险保障率和保险密度均具有较高水平。

### 6.2 建议

根据上述研究结论，为积极推进我国各城市间的保险高质量发展，本文提出以下建议：

（1）坚持以经济建设为中心，充分激发保险市场需求。据本文分析数据显示，发展环境水平较高的城市人均 GDP 水平和城镇化率较高、第三产业发展较为成熟。这提示我们城市建设要始终坚持以经济建设为中心，全国各城市要积极做好产业结构优化、寻找产业新动能、推进城镇化转型升级。着力发展现代服务业，培育新的经济增长点。以经济的稳步增长和人均收入的不断提高拉动企业和城乡居民的投保需求。

（2）以供给侧结构性改革为主线，提升保险行业供给质量。一方面，各城市要主动对接中央政策，做到保险产品服务国家战略实施，增加保险市场有效供

给。另一方面，城市保险机构要聚焦风险保障这一主业，降低保险行业资产风险，破除保险市场无效供给和低效供给。改革过程中要求城市全行业必须保持战略定力，继续强化保险产品保障属性，遏制保险资金脱实向虚势头，补齐保险业发展短板。

（3）完善城市保险体系，构建多层次的保险市场。北京、上海等城市在发展动力指数中排名靠前的主要原因是其在保险机构完备度和保险研发人员和机构数量上遥遥领先。因此我国各城市完善城市保险体系的主要路径是：注重引进和培养保险高素质人才，利用优惠政策吸引保险机构和保险产业园落户，通过保险发展要素的集聚和整合为地区保险体系建设提供持续的发展动力。

（4）重视保险行业运营效率，实现保险质量、速度和效率“三大变革”。城市保险发展要注重发展动能转换，由传统粗放式的人员扩张、机构扩张转向科技赋能、创新驱动，加入金融科技提高创新保险保费收入。同时城市保险机构要积极探索整合金融服务模式，在高效的承保经营、精细化的成本控制的基础上，强化业务中的金融属性，实现可持续发展。

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# 城市保险高质量发展水平的测度与比较研究
## ——以 19 个副省级以上城市为例

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**关键词：**保险高质量发展；评价指标体系；熵权法；保险发展绩效

**中文摘要.** 保险高质量发展是保险业顺应新经济形势的必然举措，也是之后保险市场发展的根本方向。本文采用 19 个副省级以上城市 2010-2018 年的相关数据，基于创新发展理念，加入保险发展绩效指标，构建城市保险高质量发展指标体系。研究发现：我国城市保险高质量发展不平衡。东部地区的保险高质量发展情况明显优于其他地区；一线城市的保险高质量发展情况明显优于非一线城市。从各子系统看，发展环境指数排名靠前的城市人均 GDP 水平和城镇化率较高，第三产业发展较为成熟；发展动力指数排名靠前的城市在保险机构完备度、政策、人才等要素上表现突出；发展成果指数靠前的城市多具有创新保险保费收入占比突出、人均保单持有量优势显著等特点；发展绩效指数排名靠前的城市风险保障率和保险密度均具有较高水平。

# Efficiency Research of Corporate Governance Supervision on the Captive Insurance Companies in China

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**Keywords:** Captive insurance company, Corporate governance, Government regulation, Market failure.

**Abstract.** Captive insurance companies originated in the 1920s and have become a very important part of the international insurance industry. Captive insurance companies is a new thing in China, people's understanding of its management and development mode is still insufficient. This paper first analyzes the corporate governance characteristics of the four captive insurance companies in China, then evaluates the corporate governance supervision of the four captive insurance companies in China according to the relevant provisions of the China Banking and Insurance Regulatory Commission, and through a comparative analysis of the current regulatory failure of the China Banking and Insurance Regulatory Commission on the corporate governance of China's captive insurance companies, finally puts forward some suggestions to improve the corporate governance supervision of China's captive insurance companies Policy recommendations on corporate governance supervision of insurance companies.

# 1. 引言

## 1.1 研究背景及意义

自保公司是由非保险企业拥有或控制的，主要为母公司及其子公司的某些风险提供保险保障的保险公司。自保公司作为一种新型保险模式，具有传统商业保险公司不可比拟的优势，赢得了许多大中型企业的青睐。自保能为企业提供更经济、更全面的保险服务；有利于企业加强风险管理；有利于企业获得再保险保障；可增进企业现金流量的稳定性；减轻企业税赋负担，增加利润收入。在世界范围内，自保凭借其优势发展迅速，绝大多数世界500强企业均拥有自己的自保公司，但我国自保公司发展尚为缓慢，截至2020年底，我国仅有8家自保公司，4家在内地，4家在香港。

表1 我国8家自保公司成立情况

| 自保公司名称 | 成立时间 | 注册地 | 注册资本 |
|---|---|---|---|
| 中石油专属财产股份有限公司 | 2013.12 | 新疆 | 60亿人民币[1] |
| 中国铁路财产保险自保有限公司 | 2015.07 | 北京 | 20亿人民币 |
| 中远海运财产保险自保有限公司 | 2017.02 | 上海 | 20亿人民币 |
| 广东能源财产保险自保有限公司 | 2017.11 | 广州 | 5亿人民币 |
| 中海石油保险有限公司 | 2000.08 | 香港 | 12亿港元[2] |
| 中石化保险有限公司 | 2013.11 | 香港 | 5亿港元[3] |
| 中广核保险有限公司 | 2015.03 | 香港 | 5亿港元 |
| 上海电气保险有限公司 | 2019.02 | 香港 | 3.5亿港元 |

公司治理是现代企业在所有权与经营权分离下，为维护各个利益相关方的利益，实现公司健康、可持续发展而形成的股东、董事会及管理人员间的一种制约机制。良好的公司治理是公司健康稳定高效发展的基础。保险公司作为全社会的风险管理者，其公司治理机制是否健全不仅关系到公司的发展及股东利益，更关乎所有保单持有人的切身利益、整个保险市场的平稳运行及社会乃至国家的风险管理水平。

由于我国自保发展尚处于初级阶段，缺乏独立的自保监管体系，保险监管机构对于自保公司的监管政策及内容仍参照普通商业保险公司进行。在自保公司治理监管方面，《关于自保公司监管有关问题的通知》（保监发〔2013〕95号）及《关于进一步完善自保公司监管有关问题的通知》（保监发〔2015〕23号）虽放宽了对自保公司的董事、监事的数量要求，但并不具体细化，且在公司治理评估中，监管机构往往按照传统保险公司的治理标准进行要求，忽视了自保公司的特殊属性，造成了对自保公司治理评估结果的不公平，评估结果不能反映自保公司的公司治理水平和风险管理能力，一定程度上造成了监管的低效，也限制了自保公司的发展。

[1] 2012年注册时资本金为50亿人民币。
[2] 2000年注册时资本金为200万港元。
[3] 2013年注册时资本金为3亿港元。

在此背景下，本文意在通过实证方法测算现行自保公司治理监管制度运行效率，为优化专业自保公司治理监管提供可行方向，以完善我国专业自保公司治理监管制度，为专业自保公司提供良好的发展环境。

## 1.2 文献综述

国际自保发展历史悠久，可追溯到20世纪50年代美国杨斯顿钢铁公司的自保安排，但当时因设立自保公司要遵从严格的监管政策并承担高昂的运营成本，自保公司数量并不多。至20世纪60年代，百慕大及开曼群岛等离岸金融市场的出现及繁荣以及当地宽松的监管政策促进了自保公司的快速发展。至20世纪60年代末，在百慕大注册成立的自保公司数量位于全球首位，百慕大也因此成为自保圣地。发展到20世纪80年代，美国企业成为设立自保公司的主力军，自保公司的保费收入占据美国保险市场的10%以上[4]。进入21世纪后，传统商业保险市场发展逐步成熟并趋缓，为专业自保发展提供了机遇，自保公司在这一时期迅速扩张，并不断创新形式，类别更加多元化。

国际自保监管也伴随着自保的发展而不断完善成熟，梳理国际主要自保市场的监管政策可以发现，各地均呈现出政策性支持的宽松监管态势，在确保自保公司具有保险实质的前提下，主要以偿付能力监管为主，对于公司治理监管则较为宽松。从监管内容上看，国际上的自保监管大致可以分为两类：一是重点监管自保公司偿付能力，而对其他方面的要求非常少，以中国香港、新加坡为代表；二是既监管自保公司的偿付能力，也监管自保公司的公司治理，但对于保险公司治理等方面的监管较商业保险更为宽松[5]，以都柏林为代表。

### 1.2.1 美国

美国对于专业自保公司的公司治理监管，由于自保公司可能会与其关联方（发起人或集团内其他公司）订立各种类型的协议（例如行政服务协议）。一些司法管辖区对这些协议施加了限制，例如要求所订立的协议须是公平合理的，双方进行的是“公平交易”，但并非所有州都会有此类要求。佛蒙特州还要求每家自保公司应在其执行官或董事发生任何变动后的30天内向监管当局报告，包括在报告中说明新的执行官或董事的业务和专业从属关系。

### 1.2.2 欧洲

在公司治理方面，欧洲联邦风险管理协会（FERMA）要求自保公司董事会应至少有三人，其中至少一名董事是当地居民或其主要工作地点在注册地内。自保公司工作人员或第三方服务提供商（如专业人员）数量的确定要基于对承保量、索赔量及保单复杂性的考虑。自保公司的风险管理、精算、合规和内部审计等职能需要由当地监管机构预先批准，这些服务通常由外包服务提供商和具有适当技能和经验的个人来履行。自保公司在注册地需要设立一个核保委员会或核保职能部门，负责核保承保事宜并对自身的承销行为进行监督。所有关键职能部门的人员，比如自保公司董事等都需要满足注册地保险监管机构要求的人员职业标准。自保公司的持股情况需要当地保险监管机构根据适当的标准预先批准，董事在其注册地每年至少召开两次会议[6]。自保公司应遵守注册地的公司治理法（或同等法规），自保公司在其注册地受“基于风险”的保险监管制度的约束：需要符合国

[4] 数据来自《国际自保市场研究报告》（梁涛，2015）。
[5] 孙天印.自保在我国保险体系架构中的定位和监管探析[J].保险理论与实践,2017(10):57-70.
[6] https://www.ferma.eu/app/uploads/2017/06/2017.06-FERMA-Information-Paper-on-Captive-reInsurance-Guidelines.pdf.

际保险监督官协会发布的保险核心原则，或受偿付能力标准II的全面监管或同等制度的约束。

欧洲自保公司在注册地需要定期披露其财务报告，实现透明化运作。法定审计服务由当地管辖区内信誉良好的审计事务所提供。无论是作为职业自保经理还是自保公司的员工，都需要具有相关经验、技能和获取承保支持的能力，自保公司还应定期出具合规和监管报告。董事会需要一份关于技术性条款的精算意见，由精算职能部门每年编制。此外，精算职能部门还需要每年就核保政策、再保险、偿付能力资本要求以及自身风险和偿付能力评估报告(ORSA)提供意见。

在根西岛，设立的所有自保公司都必须持有根西岛金融服务委员会(GFSC)颁发的执照，自保公司提出的任何业务变更也都必须得到GFSC的通知和批准。[7]除非自保公司拥有适当水平的资源进行自我管理，否则他们必须任命一名自保经理，该自保经理主要提供承保、会计、合规、公司治理等服务。专属自保公司通常会设立一个董事会，该董事会由集团代表和当地的非执行董事组成，通常还包括指定保险经理的代表。根据公司的需要，董事会通常每年召开2-6次会议。自保公司需要定期向监管部门提供业务计划及公司内部详细的财务结构(负债、资本、风险缺口、保费、对再保险的依赖等)。根西岛金融服务委员会主要通过定期的场外监督和现场监督来规范自保公司的经营活动。

在爱尔兰都柏林，爱尔兰中央银行要求自保公司董事会成员不得少于三人，且必须任命一名董事会主席。自保公司需严格遵照爱尔兰中央银行发布的《公司治理条例》中对于董事会的组成和会议频率、董事成员的任命和工作职责等的规定。自保公司应按时提交年度偿付能力与财务情况报告（Solvency & Financial Condition Report, SFCR）、监管合规报告（Regular Supervisory Report，RSR）、偿付能力定量计算表格（Quantitative reporting template，QRT)以及法定年度财务审计报告等。在自保公司出现重大事件时，如偿付能力出现问题时也需要及时向监管机构汇报。央行一般采取概率风险和影响系统矩阵(Probability Risk and Impact System Matrics，即PRISM)对自保公司进行风险评估，建立起一套风险导向型的监管框架，该框架下监管机构对自保公司的问题出现频率和波及范围进行了不同程度的划分，主要有超高、高、中高、中低或低五个区间。其中大部分自保公司都被划分为低或中低类别，证明其运营并不存在较大问题，它们受到的监管要求也会适当放低。此外，爱尔兰中央银行会不定期地对自保公司进行现场检查，通过会议和报告的形式明确自保公司存在的问题及解决方案，并责令其在一定期限内及时改正。

1.2.3 新加坡

新加坡金融监管局注重评估自保公司控股股东的财务稳健性，自保公司的控股权变更必须得到监管部门的批准。如果母公司缺乏经营自保公司的经验和能力，则必须委托自保经理代为管理，自保经理的聘任也需通过监管部门批准。经营有寿险业务的自保公司必须设有一名执行总裁及精算师，所有重要管理人员的任命和变更均需得到监管批准。此外，自保公司必须严格遵守新加坡金融监管局的其他各项规定。[8]

1.2.4 中国香港

香港保监局（HKIA）要求自保公司在满足《公司条例》的前提下，至少设置两名董事，可不设监事，但必须设置一位行政总裁。自保公司的管理团队应至

[7] https://giia.gg/wp-content/uploads/2015/07/Gnsy_Ins_SPV_Guidance_2015.pdf.
[8] 高大宏.自保公司经营与监管[M].中国金融出版社,2015.

少由4名管理人员组成，包括一名首席执行官和其他负责核保、理赔和财务的关键人员。自保公司必须在香港设立办事处，并委派一名驻港行政总裁监督其业务运作，按照监管要求，自保公司应提供公司内部组织架构图，并于每季度和年度末按时提交公司的财务精算报告和合规审计报告。与新加坡等地相比，中国香港的自保市场仍处于过渡阶段，尽管保监局允许甚至支持自保公司为寻求专业化管理而将业务外包出去，但目前已设立的自保公司基本均为自我管理模式，其原因主要是中国香港的自保经纪市场尚不发达，第三方服务还有很大的改进空间。

1.2.5 百慕大

百慕大金融管理局(BMA）要求自保公司在注册地当地安排办事处和一名代表或在当地注册的自保管理公司，每年应在全球任意地点举行一次股东大会。由于国际上许多自保公司规模较小或不愿将公司高级管理人员派遣到当地工作，为了满足这一监管要求，这些自保公司选择了聘请百慕大当地自保管理公司服务的方式，这些管理公司能够满足监管所需的保险专业知识和技能要求。对于没有采用管理公司服务的自保公司，监管机构通常要求自保公司的董事会成员及高级管理人员证明其专业知识能够满足他们的职位要求，包括核保技能和财务技能。

1.2.6 开曼群岛

开曼群岛金融管理局（CIMA）要求自保公司高管应具备相应的任职执照。对于每一风险领域，董事会必须制定相应的书面管理政策，作为日常经营运作的组成部分。CIMA对于企业风险管理，通常采用现场检查和会议等各种方式进行监管，监管重点是观察公司的商业策略、管理风格和态度。

综合而言，虽然各国或地区对于自保市场的发展定位不同，所采取的公司治理监管政策也不相同，但是从总体上看，自保的监管理念呈现出更为宽松、更为开放的特点，主要以控制风险为主，且自保公司人员精简，可以进行管理服务外包，推出了很多的豁免性或例外性的规定，以达到监管宽松、低成本且高效率的自保业务活动环境，从而吸引自保公司的落地，推动自保市场的完善与发达。

我国由于自保发展时间短且公司治理监管无太大差异，学界对于自保公司的公司治理并无专题性研究，而主要在保险公司这一大层面研究公司治理绩效。邓文剑（2008）[9]、许敏敏（2019）[10]均通过构建保险公司治理评价指标体系的方式，测算保险公司治理效率。杨馥（2009）[11]理论与实证相结合，搭建保险公司治理监管制度的经济学分析框架，并通过多元回归分析法、成本收益分析和博弈论分析法分析保险公司治理的绩效与影响因素。陈彬（2011）[1]在分析我国保险公司治理的现实环境并借鉴国外保险公司治理的规范和模式下，提出了“以外部人模式为主，内部人模式为辅；以董事会为核心，监事会行使监督职能为补充，维护利益相关者利益”的理想治理模式。

但对于专业自保公司监管制度，大多数学者认为，目前我国缺乏同专业自保公司特点和经营业务相配套的监管体系。刘小微(2016)[12]认为，我国专业自保公司设立的门槛比较高，缺乏配套的监管措施和良好的外部环境，监管政策不具有差异化的特征，这些措施制约了我国专业自保公司的设立。林伟（2017）[13]提出，政府监管部门要完善对专业自保公司组织形式、业务和经营实质的监管，完善法规中关于保险本质属性的定义，以确保专业自保公司真正地发挥风险分散的作

[9] 邓文剑.中国保险公司治理评价体系研究[D].湖南大学,2008.
[10] 许敏敏,郭琦.保险公司治理指数模型构建、测算与评价——以财险公司为例[J].会计之友,2019(18):55-62.
[11] 杨馥. 中国保险公司治理监管制度研究[D].经济科学出版社, 2009.
[12] 刘小微. 自保公司发展亟待加大监管差异化[N]. 金融时报,2016-08-03(010).
[13] 林伟.创新型风险管理方式监管理论研究——基于专业自保公司的视角[J].浙江金融,2017(06):52-60.

用。孙天印（2017）[14]认为，现有的保险监管规则同专业自保公司的经营不相适应，应当根据专业自保公司的风险特点制定适宜的专业自保公司监管体制，建立专业自保公司的分级监管制度。

综合文献所述，我国亟待建立完善的自保监管制度体系，自保公司治理监管作为其中重要的一大支柱，也亟待优化完善。国际自保市场公司治理监管为我国自保公司治理制度优化提供了优化思路，可以适当地降低监管的要求，既满足对专业自保公司的监管要求，又推动专业自保公司的发展。

### 1.3 概念界定及研究方法说明

1.3.1 自保公司的公司治理监管制度运行效率的概念界定

效率，即投入与产出的对比关系。对于保险公司治理监管而言，监管制度运行效率不仅体现在监管机构耗用监管资源预防、发现并处置公司治理违法违规现象方面，还体现在被监管对象反映出的监管成效。有效的保险监管是能够以较小的监管成本获得较大的监管成效，即保险监管制度能够准确识别保险机构风险痛点并有针对性地加以预防与处置，从而起到维护保险消费者权益的作用，并推动保险业健康有序发展。

因此，本文自保公司的公司治理监管制度运行效率指，保险监管主体在公司治理维度对保险公司耗费的监管成本，与保险公司所反映出的监管成效的对比关系。

1.3.2 自保公司的公司治理监管制度运行效率研究方法说明

本文主要运用实证研究法对专业自保公司治理监管制度运行效率进行研究，在效率的评估方面，本文采用成本收益对比法，即在假定对于不同保险公司实施公司治理监管的成本相同的前提下，以各公司在公司治理方面的表现反映监管成效，保险公司在监管制度的约束下表现地越好，则说明监管制度运行效率越高。在专业自保公司的公司治理监管制度运行效率的评价方面，本文采取将自保公司与普通财产保险公司相对比的方式，并结合专业自保公司的风险及经营特点，说明自保公司治理监管制度运行效率水平。

## 2. 我国专业自保公司的公司治理概述

### 2.1 我国专业自保公司的公司治理现状

公司治理包括内部治理及外部监督，内部治理以公司治理的组织结构为基础，配备董事会、监事会及高级管理层进行经营管理。外部监督主要体现在公司进行信息披露供外部监督者了解、监督公司的运营情况。

在公司治理结构方面，专业自保公司仅承保母公司的风险，业务规模较普通商业保险公司而言较小，故人员配置也较少。

1. 董事会。董事会通常由5名董事组成，其中2名董事应当来自母公司。国有独资专业自保公司的董事会成员中应当有公司职工代表。

我国政府发布的《关于进一步完善自保公司监管有关事项的通知》规定，自保公司根据公司经营实际情况，可以在设置股东大会（股东会）、董事会、监事会的基础上，适当减少董事和监事数量，取消独立董事数量和比例要求。自保公司可以不设置合规负责人、审计责任人、法律责任人等相关岗位。董事会主要负责制定公司的发展战略规划、风险管理规划、内部管理机构的设置、管理制度等，

[14] 孙天印.自保在我国保险体系架构中的定位和监管探析[J].保险理论与实践,2017(10):57-70.

并承担信用风险的最终责任。董事会下设委员会。董事会设立的委员会主要包括核保委员会、理赔委员会和投资委员会等，对公司的风险管理情况进行监督、监控、评价，监控风险管理的有效性。

表2 四家专属自保公司董事会概况

| 公司简称 | 董事会人事 | 独立董事人数 | 董事会下设委员会数量 |
|---|---|---|---|
| 中石油自保 | 7 | 0 | 0 |
| 中国铁路自保 | 7 | 0 | 0 |
| 中远海运自保 | 7 | 0 | 3 |
| 广东能源自保 | 4 | 0 | 3 |

2. 监事会。监事会通常由3人组成，由于专业自保公司的股东数量较少，可以设1-2名监事，也可以不设立监事会。

我国保监会发布的《关于进一步完善自保公司监管有关事项的通知》规定，自保公司根据公司经营实际情况，可以在设置股东大会（股东会）、董事会、监事会的基础上，适当减少董事和监事数量，取消独立董事数量和比例要求。董事、高级管理人员不得担任监事。监事会主要负责检查公司财务、对董事、高级管理人员执行公司职务的行为进行监督等。必要时，监事可以聘请会计师事务所等协助其工作。

表3 四家专业自保公司监事会概况

| 公司简称 | 监事会人数 | 职工监事人数 |
|---|---|---|
| 中石油自保 | 3 | 1 |
| 中国铁路自保 | 3 | 1 |
| 中远海运自保 | 4 | 2 |
| 广东能源自保 | 3 | 1 |

1. 经理层（或高级管理层）。专业自保公司的经理层由董事会聘任或者解聘。例如，我国《公司法》规定，经国有资产监督管理机构同意，董事会成员可以兼任经理。经理主要负责落实董事会制定的发展战略规划、风险管理规划等，并对具体的风险管理制度和流程进行审定。

总体而言，受制于公司业务规模限制，我国四家专业自保公司的公司治理结构较为简单，人员较为精简。

在信息披露方面，《保险公司信息披露管理办法》（银保监发〔2018〕2号）清晰具体地对保险公司进行信息披露的方式、时间及内容做出了规范，我国4家自保公司也均按照要求进行了信息披露，但在披露及时性及完善度方面仍有待加强，如部分财务辅助信息及风险管理信息。专业自保公司虽不面向广大公众开办业务，但信息披露依旧是监管部门、母公司以及同业了解公司经营状况的重要途径，仍需大力重视。

## 2.2 专业自保公司的公司治理监管

保险公司内部机制体制是否健全、内部管理是否恰当高效、公司治理是否能维护公司可持续发展，均是关乎保险市场健康有序运行、保险消费者权益得到有效保护的关键。经过多年探索实践，保险公司治理监管不断发展完善，成为保险

监管重要支柱之一，在规范保险公司治理结构、防范化解公司治理风险等方面发挥着重要作用。

为提升公司治理有效性，促进银行业和保险业长期稳健发展，中国银保监会及其派出机构对银行保险机构公司治理水平和风险状况进行判断、评价和分类，并根据评估结果依法实施分类监管。

2.2.1 制度建设

《关于规范保险公司治理结构的指导意见（试行）》（保监发〔2006〕2号）作为我国第一部关于保险公司治理的规范性文件，从股东、董监高运作、关联交易及信息披露等方面对保险公司治理结构进行规范引导，开启了保险公司治理监管的法制化进程。在此基础上，监管部门又发布多项配套规章及指引文件充实保险公司治理监管体系，如《保险公司股权管理办法》（保监发〔2018〕5号）明确了股权取得及变更的条件及申报事项；《保险公司董事会运作指引》（保监发〔2008〕58号）、《保险公司董事、监事和高级管理人员任职资格管理规定》（保监发〔2014〕1号）、《保险公司信息披露管理办法》（银保监发〔2018〕2号）则规制了保险公司进行信息披露的内容及方式，《保险公司独立董事管理办法》（银保监发〔2018〕35号）等对董事会、监事会的设立及运作，以及董事、监事及高级管理人员的数量及聘任进行规范；《保险公司关联交易管理办法》（银保监发〔2019〕35号）明确了关联方及关联交易的认定、关联交易的管理及监管等内容；《中国银保监会关于印发银行保险机构公司治理监管评估办法（试行）的通知》（银保监发〔2019〕43号）对保险机构的合规性评价、有效性评价、重大事项调降评级等做了明确的规定，对公司治理水平和风险状况进行判断、评价和分类，并根据评估结果依法实施分类监管。

除了法律法规的丰富完善，银保监会还设立了公司治理监管部负责公司治理评估、监管及整治工作，通过严格审查、高管谈话制度及加强信息披露等监管手段加强监管，助力保险公司提升治理能力和治理水平。

2.2.2 评估结果和运用

公司治理监管评估结果是衡量保险机构公司治理水平的重要标准，依据相关规定，将保险机构的公司治理水平分为A级、B级、C级、D级及E级共五级。

银保监会将公司治理监管评估结果作为监管部门配置监管资源、采取监管措施和行动的重要依据，并在市场准入、现场检查立项、监管评级、监管通报等环节加强对评估结果的运用，实施分类监管。

2.2.3 自保机构的公司治理

《关于自保公司监管有关问题的通知》（保监发〔2013〕95号）规定，指标公司应当按照现代企业制度独立运营，在人员、资金、财务管理等方面与母公司建立“防火墙”。

《关于进一步完善自保公司监管有关事项的通知》（保监发〔2015〕23号）规定，自保公司可以在设置股东大会（股东会）、董事会、监事会的基础上，适当减少董事和监事数量，取消独立董事数量和比例要求。自保公司可以不设置合规负责人、审计责任人、法律责任人等相关岗位。

《关于自保公司监管有关问题的通知》（保监发〔2013〕95号）和《关于进一步完善自保公司监管有关事项的通知》（保监发〔2015〕23号）均规定母公司应当恪守对自保公司承担全部风险责任的承诺。因此，母公司事实上承担了自保公司所承担风险的无限责任。

自保公司建立季度业务报告制度，于每季度结束后15日内向中国保监会数目报告上一季度承保标的、保险金额、保费收缴、赔款支出、业务分出、资金运用、偿付能力等有关情况和下季度主要业务计划。承保境外业务的，还应报告保险金额100万元人民币以上的境外承保和赔付情况。

虽然在公司治理方面，对自保公司做了一些规定，但是在公司治理评估中，中国银保监会及其派出机构往往按照传统保险公司的治理标准进行要求，造成了对自保公司治理评估结果的不公平，评估结果不能反映自保公司的公司治理水平和风险管理能力。

### 2.3 专业自保公司的公司治理监管问题

与普通商业保险公司不同，自保公司不是公众公司，业务范围固定且数量有限，在公司治理等方面的风险概率很低，风险事件不外溢。目前许多关于保险公司治理方面的规定都是针对商业保险公司（实为公众公司，监管以保护普通消费者利益为首要目标）而制定的，并未考虑自保公司的固有属性，自保公司不得不在人员设置、信息报送披露、关联交易等方面花费大量时间、精力、费用，经营的灵活性受到限制，削弱了自保公司成立的预期目标。如根据《关于进一步完善自保公司监管有关问题的通知》（保监发〔2015〕23号）第三条规定，“自保公司根据公司经营实际情况，可以在设置股东大会(股东会)、董事会、监事会的基础上，适当减少董事和监事数量，取消独立董事数量和比例要求”，但现行的公司治理评估指标中对自保公司的独立董事设置仍有要求，与保监发〔2015〕23号不一致。再如，自保公司由于股权结构简单，董事、监事多是由母公司及其他股东单位人员兼职，其履职行为均代表其派出公司的意见，因此应适度放宽对董、监事在保险从业经验方面要求。在关联交易方面，目前自保公司的客户均为其股东系统内关联方，关联方众多且稳定，虽然根据银保监会《保险公司关联交易管理办法》规定，自保公司的自保业务不适用关联交易管理范畴，但现行的公司治理监管评估中，对自保公司的关联交易及关系管理方面仍然存在诸多必要性不强的环节和要求，增加了自保公司不必要的工作量，降低工作效率。在信息披露和消费者保护方面，自保公司基本不参与社会化的保险行为，股东承担全部风险，侵害消费者利益的风险很小，但目前与商业保险公司同样的监管环节、市场约束指标及信息披露要求，无疑对自保公司而言限制过多，必要性不强，可以适当放宽。

## 3. 我国专业自保公司的公司治理监管效率评估

### 3.1 评价指标体系[15]

公司治理是现代企业在所有权与经营权分离下，为维护各个利益相关方的利益，实现公司健康、可持续发展而形成的股东、董事会及管理人员间的一种制约机制。保险公司作为全社会的风险管理者，其公司治理机制是否健全不仅关系到公司的发展及股东利益，更关乎所有保单持有人的切身利益、整个保险市场的平稳运行及社会乃至国家的风险管理水平。

国际保险监督管协会（IAIS）发布《保险公司治理结构核心原则》强调了股东、董事会、高管层、信息披露等对公司治理的重要性。我国《银行保险机构公

[15] 在公司治理评估中，关于“党的领导”部分，由于没有能够查到比较完备的数据，暂不列入。

司治理监管评估办法（试行）》（银保监发〔2019〕43号）明确保险公司治理监管评估内容包含党的领导、股东治理、董事会治理、监事会和高管层治理、风险内控、关联交易治理、市场约束、其他利益相关者治理等方面。学界也多有研究在参考国际国内公司治理监管要求的基础上，以股权结构、董事会运作、监事会运作、高管层治理、信息披露机制等指标为主体框架构建保险公司治理评价指标体系，如邓文剑（2008）[16]、杨馥（2009）[17]、陈彬（2011）[18]、许敏敏（2019）[19]。本文以我国保险机构治理监管评估办法为基础，参照学界现有研究，依照指标可得性、全面性、客观性的原则，构建保险公司治理评价指标体系。

表4 保险公司治理评价指标体系

| 一级指标 | 二级指标 | 三级指标 | 指标性质 |
|---|---|---|---|
| 保险公司治理指数（A） | 股权结构与股东利益（$B_1$） | 第一大股东持股比例($B_{11}$) | 负向定量指标 |
| | | 关联交易总额占上一年度公司总资产的比重($B_{12}$) | 负向定量指标 |
| | | 关联交易总额占上一年度公司净资产的比重($B_{13}$) | 负向定量指标 |
| | 董事会治理($B_2$) | 董事人数($B_{21}$) | 正向定量指标 |
| | | 独立董事人数($B_{22}$) | 正向定量指标 |
| | | 董事会下设薪酬委员会数量($B_{23}$) | 正向定量指标 |
| | | 董事长是否兼任CEO($B_{24}$) | 负向定性指标 |
| | 监事会治理($B_3$) | 监事人数($B_{31}$) | 正向定量指标 |
| | | 职工监事人数($B_{32}$) | 正向定量指标 |
| | | 监事兼任董事、高级管理人员($B_{33}$) | 负向定性指标 |
| | 高管层治理($B_4$) | 高级管理人员设置是否符合监管规定（至少设置董事会秘书、合规负责人、审计责任人）($B_{41}$) | 正向定量指标 |
| | | 是否设置总精算师制度($B_{42}$) | 正向定性指标 |
| | | 董事长、总经理是否存在缺位现象($B_{43}$) | 负向定量指标 |
| | 信息披露机制($B_5$) | 信息披露及时性($B_{51}$) | 正向定量指标 |
| | | 信息披露渠道广泛性($B_{52}$) | 正向定性指标 |
| | | 基本信息披露满足监管规定的程度($B_{53}$) | 正向定量指标 |
| | | 财务信息披露满足监管规定的程度($B_{54}$) | 正向定量指标 |
| | | 风险管理信息披露满足监管规定的程度($B_{55}$) | 正向定量指标 |
| | | 经营信息披露满足监管规定的程度($B_{56}$) | 正向定量指标 |
| | | 偿付能力信息披露满足监管规定的程度($B_{57}$) | 正向定量指标 |

### 3.1.1 股权结构与股东利益

该指标从股东股权集中度及股东利益输送可能性两个角度反映公司股东治理情况。

在股权集中度方面。大量研究表明，股权集中一方面可以降低公司决策成本，提升决策效率；但另一方面可能因股权过于集中而丧失决策民主性，存在大股东以公谋私损害公司利益的风险。基于保险公司经营具有较大的社会性，本文更倾向于将股权集中度（以“第一大股东持股比例”进行反映）设置为负向指标，股权

[16] 邓文剑. 中国保险公司治理评价体系研究[D].湖南大学,2008.
[17] 杨馥. 中国保险公司治理监管制度研究[D]. 经济科学出版社, 2009.
[18] 陈彬. 保险公司治理对企业绩效影响的实证研究[D].复旦大学,2011.
[19] 许敏敏,郭琦.保险公司治理指数模型构建、测算与评价——以财险公司为例[J].会计之友,2019(18):55-62.

分散所能起到的决策民主作用更有助于保险公司维护广大被保险人利益,积极发挥风险管理的职能。

在股东利益输送可能性方面。关联交易为股东进行利益输送从而损害公司及其他中小股东利益提供了渠道，过多的关联交易会增加公司的经营风险，使得公司过分依赖关联方而降低公司的独立性及竞争性。《保险公司关联交易管理办法》（银保监发〔2019〕35号）也明确规定保险公司关联交易限额应低于上一年度末公司总资产的30%及净资产二者中的较低者。本文设置“关联交易总额占总资产的比重”、“关联交易总额占净资产的比重”两项负向指标反映公司关联交易情况。

3.1.2 董事会治理

董事会作为公司的经营决策机构，起着上对股东负责、下对高管人员监督管理的作用，在公司治理中占据着核心地位。首先，董事会应保有充足的人力履行董事会职责，《公司法》规定有限责任公司董事应为3-13人，股份有限公司董事应为5-19人。本项目选取“董事人数”作为正向指标。其次，董事会还应保有一定的独立性保证决策的民主，防止董事会沦为股东操控公司的工具。《保险机构独立董事管理办法》（银保监发〔2018〕35号）指出“保险机构董事会独立董事人数应当至少为3名，并且不低于董事会成员总数的1/3”。据此，本项目以“独立董事人数”作为正向指标衡量董事会独立性。再次，公司还应按照监管指引设置相应的专业委员会，辅助董事会行使部分权利，提升董事会的管理效能，本文以“董事会下设专业委员会数量”为正向指标反映董事会职能履行保障程度。同时，研究表明，董事长与CEO两职分离一方面有利于维护董事会对公司管理的独立监督性，另一方面有利于防止CEO权利过大导致的逆向选择和道德风险，从而对公司治理的提升具有积极意义。因此，本项目将“董事长是否兼任CEO”这一指标纳入董事会治理指标层次。

3.1.3 监事会治理

监事会是公司的监督机构，通过对董事及高管的监督检查以规范公司治理。同董事会相似，监事会要保持人员充足以充分发挥监督职能，也要保持充分的独立性保证监督的公正可靠。本文选取“监事人数”反映监事会规模，选取“职工监事人数”、“监事兼任董事及高级管理人员情况”反映监事会的独立性。

3.1.4 高管层治理

高级管理人员是切实参与公司日常经营，发挥管理作用的主力军。高级管理人员设置的恰当性及充分性关乎公司经营运转的效率及质量。依据《关于规范保险公司治理结构的指导意见（试行）》（保监发〔2006〕2号）、《保险机构内部审计工作规范》（保监发〔2015〕113号）、《保险公司董事会运作指引》（保监发〔2008〕58号）的相关要求，保险公司应配置至少包括董事会秘书、合规责任人、审计责任人在内的关键管理人员。《中国保监会关于财产保险公司和再保险公司实施总精算师制度有关事项的通知》（保监财险〔2017〕271号）则进一步要求各财险公司实施总精算师制度，以完善非寿险精算监管制度。依据以上明文监管规定，本文选取“高级管理人员设置是否符合监管规定（至少设置董事会秘书、合规负责人、审计责任人）”、“是否设置总精算师制度”指标反映高管层结构是否符合监管规定。同时，考虑到董事长及总经理是公司决策及执行机构的领导者，若长期缺位，势必会影响公司决策执行效率，危及公司治理。因此，本文将“董事长、总经理是否存在缺位现象”指标纳入高管层治理指标层次。

3.1.5 信息披露机制

阳光是最好的防腐剂，完善的信息披露有助于降低公司利益相关者与公司管理者之间的信息不对称，缓解委托代理矛盾，并让保险消费者能够更好地了解保险公司，也有助于监管层及时准确发现公司问题，维护保险业平稳健康发展。《保险公司信息披露管理办法》（银保监发〔2018〕2号）清晰具体地对保险公司信息披露的方式、时间及内容作出了规范，本文依据此办法，分别设置“信息披露及时性”“信息披露广泛性”“基本信息披露满足监管规定的程度”“财务信息披露满足监管规定的程度”“风险管理信息披露满足监管规定的程度”“经营信息披露满足监管规定的程度”“偿付能力信息披露满足监管规定的程度”七项指标对保险公司信息披露制度进行评价。

## 3.2 评价方法

在确定指标体系的基础上，本文参照邓文剑（2008）[20]、许敏敏（2019）[21]的做法，采用层次分析法确定各级指标权重。

对于二级指标的权重，本文引用上述文献评分的结果，并适当修正予以确认，结果如表所示。据此，保险公司治理指数表达式为：

$$A=13\%B_1+34\%B_2+9\%B_3+26\%B_4+18\%B_5 \quad (1)$$

表5 二级指标权重

| 二级指标 | 指标权重 |
|---|---|
| 股权结构与股东利益($B_1$) | 13% |
| 董事会治理($B_2$) | 34% |
| 监事会治理($B_3$) | 9% |
| 高管层治理($B_4$) | 26% |
| 信息披露机制($B_5$) | 18% |

对于二级指标得分，采用加权平均法确定：

$$B_i=\frac{\sum_{j=1}^{n}B_{ij}}{n}\times 100 \quad (2)$$

其中，$B_{ij}$表示二级指标下的三级指标得分，$n$表示二级指标下三级指标的个数。

对于三级指标得分，先将各指标做正向化处理，对于定性指标，从优到差分别赋值1、0.5和0；对于定量指标，将同一指标下各保险公司数据进行排序并均分为3组，从优到差分别赋值1、0.5和0。

## 3.3 公司治理监管效率实证分析

[20] 邓文剑.中国保险公司治理评价体系研究[D].湖南大学,2008.

[21] 许敏敏,郭琦.保险公司治理指数模型构建、测算与评价——以财险公司为例[J].会计之友,2019(18):55-62.

本文以所有财产保险公司为研究对象，依据数据可得性原则最终确定了70家公司（包含3家专业自保公司[22]）作为样本公司，以其官网最新披露的公司治理概要及2019年财务数据为样本数据，进行后续实证测算。

经上述公司治理评价指标体系的测算，结果显示，在现行保险公司治理监管的相关要求下，我国自保公司治理水平远低于财险行业平均水平。

表6 自保公司治理指数总览

| | 行业均值 | 行业最大值 | 行业最小值 | 中石油专属自保 | 中远海自保 | 广东能源自保 |
|---|---|---|---|---|---|---|
| 公司治理指数 | 62.85 | 90.61 | 29.64 | 36.11 | 33.06 | 41.82 |

深入指标体系进行分析，自保公司在信息披露方面的表现是优于财险行业平均水平的，但在股东、董事会、监事会及高管层治理方面的表现均较差。

表7 自保公司治理二级指标得分情况

| | 股权结构与股东利益 | 董事会治理 | 监事会治理 | 高管层治理 | 信息披露机制 |
|---|---|---|---|---|---|
| 财险公司平均值 | 50.00 | 60.71 | 66.67 | 74.29 | 57.76 |
| 财险公司最大值 | 100.00 | 100.00 | 100.00 | 100.00 | 92.86 |
| 财险公司最小值 | 0.00 | 0.00 | 16.67 | 0.00 | 21.43 |
| 中石油自保 | 33.33 | 12.50 | 66.67 | 33.33 | 71.43 |
| 中远海自保 | 66.67 | 12.50 | 66.67 | 0.00 | 78.57 |
| 广东能源自保 | 33.33 | 37.50 | 50.00 | 33.33 | 64.29 |
| 自保公司均值 | 44.44 | 20.83 | 61.11 | 22.22 | 71.43 |

在股权结构及股东利益方面，考虑自保公司的特殊属性，其作为母公司的专属保险机构，必定由母公司全额控股，且只与母公司及集团内兄弟公司发生保险业务，严格来讲其所有交易均为关联交易。因此，在股东治理方面采取同普通商业财险公司相同的评价方式，势必会对自保公司产生不合理、不公平的评价结果。

表8 股权结构及股东利益三级指标得分情况

| | 第一大股东持股比例 | 关联交易占总资产比重 | 关联交易占净资产比重 |
|---|---|---|---|
| 平均值 | 0.51 | 0.50 | 0.49 |
| 最大值 | 1.00 | 1.00 | 1.00 |
| 最小值 | 0.00 | 0.00 | 0.00 |
| 中石油自保 | 0.00 | 0.50 | 0.50 |
| 中远海自保 | 0.00 | 1.00 | 1.00 |
| 广东能源自保 | 0.00 | 0.00 | 0.50 |
| 自保公司的平均值 | 0.00 | 0.50 | 0.67 |

在董事会治理、监事会治理及高管层治理方面，自保公司仅承保母公司及集团内兄弟公司相关业务的经营模式，导致自保公司业务规模拓展能力受限，远不及普通传统保险公司。而人员及机构的设置需要支付相应的资金成本，本着成本与业务规模相适应的原则，自保公司不具备像普通传统保险公司同样的实力配置过多的管理人员，从而使得其在公司治理人员配置方面得分较低。

[22] 由于铁路自保公司相关指标数据不健全，无法进行合理评估，故将其剔除。

表9 董事会治理三级指标得分情况

| | 董事人数 | 独立董事人数 | 董事会下设专业委员会数量 | 董事长兼任CEO |
|---|---|---|---|---|
| 平均值 | 0.51 | 0.51 | 0.90 | 0.51 |
| 最大值 | 1.00 | 1.00 | 1.00 | 1.00 |
| 最小值 | 0.00 | 0.00 | 0.00 | 0.00 |
| 中石油自保 | 0.00 | 0.00 | 0.00 | 0.50 |
| 中远海自保 | 0.00 | 0.00 | 0.00 | 0.50 |
| 广东能源自保 | 0.00 | 0.00 | 1.00 | 0.50 |
| 自保公司平均值 | 0.00 | 0.00 | 0.33 | 0.50 |

表10 监事会治理三级指标得分情况

| | 监事人数 | 职工监事人数 | 监事兼任董事及高级管理人员 |
|---|---|---|---|
| 平均值 | 0.514 | 0.514 | 0.971 |
| 最大值 | 1.000 | 1.000 | 1.000 |
| 最小值 | 0.000 | 0.000 | 0.000 |
| 中石油自保 | 0.500 | 0.500 | 1.000 |
| 中远海自保 | 0.000 | 1.000 | 1.000 |
| 广东能源自保 | 0.500 | 0.000 | 1.000 |
| 自保公司平均值 | 0.333 | 0.500 | 1.000 |

表11 高管层治理三级指标得分情况

| | 高级管理人员设置是否符合监管规定 | 是否设置总精算师制度 | 董事长、总经理是否存在缺位现象 |
|---|---|---|---|
| 平均值 | 0.771 | 0.829 | 0.629 |
| 最大值 | 1.000 | 1.000 | 1.000 |
| 最小值 | 0.000 | 0.000 | 0.000 |
| 中石油自保 | 0.000 | 0.000 | 1.000 |
| 中远海自保 | 0.000 | 0.000 | 0.000 |
| 广东能源自保 | 0.000 | 1.000 | 0.000 |
| 自保公司平均值 | 0.000 | 0.333 | 0.333 |

保险公司治理监管通过规范公司内部治理结构、引导保险公司建立有效的内控制度所要达成的目标有三：一是保护保险消费者的利益，这是整个保险监管的核心目标，也是保险公司治理监管的核心；二是保护股东及公司利益相关者的利益；三是降低公司经营风险，保护公司稳定经营，从而推动行业健康发展。

就自保公司而言，自保公司不面对外部保险消费者，其所面对的保单持有人是与自己利益同步的母公司，故其不存在损害保险消费者利益的风险，反而作为股东的风险管理平台，其生而就是为管理母公司风险、维护母公司利益而存在的。因此，自保公司可以说是不存在损害保险消费者利益及股东利益的风险的。同时不可忽视的是，我国自保公司的母公司均是大型国有集团，其本身具备较为完善、系统化的内部管理机制，集团母公司先进的公司治理经验有助于降低自保公司的经营风险。

## 4. 专业自保公司的公司治理监管政策优化建议

从全球范围来看，自保并不是新事物。但是，自2013年中国内地首家自保公司诞生至今，我国内地只有4家自保公司，自保产业的发展尚处于起步阶段。与传统保险公司不同，自保公司在股权结构、公司治理、业务经营、风险管理模式等方面都受到母公司的指导和管理。为提升自保公司监管效率，促进中国自保产业健康快速发展，本文认为应该实施区别于传统保险公司监管体系的自保公司监管政策，在坚持分类监管原则、科学监管原则、协同监管原则、高效监管原则的基础上，提出了完善我国专业自保公司的公司治理监管制度的对策建议。

### 4.1 完善专业自保公司的公司治理监管制度原则

1. 分类监管原则。专业自保公司与传统保险公司在股权结构、公司治理结构、业务经营模式和风险管理等方面有所不同。为了更好地统筹监管资源，完善专业自保公司的监管工作体制机制，提高监管有效性、针对性，建议基于专业自保公司的特点和国际监管经验，对专业自保公司实施差异化监管，提升监管精准度。

2. 科学监管原则。所谓科学监管，即监管机构通过综合分析自保公司的经营指标和风险数据，评估研判自保产业经营特点、整体风险水平和发展趋势，依据自保产业的发展规律，通过监管来维护自保产业安全稳健运行和可持续发展。包括自保产业在内的财产保险业自身发展的周期性、规律性是非常强的。往往在经济发展期间能够推动经济进一步高涨, 在经济衰退阶段可能会导致经济进一步萎缩,这种周期行为或客观规律性,国外的相关研究较多,相应的对策较多,而我国在这方面的研究较少,缺乏有效的对应之策，需要加强相关方面的研究和监管经验的总结。

3. 协同监管原则。当前我国保险产业的监管基本是纵向监管，即中国银保监会及其派出机构对各保险机构主体或行为等进行监管，通过现场检查、非现场评估、信息披露等方式对其进行从上到下的强势监管、穿透式监管。但是，在部分保险企业逐利违规冲动下,由于监管资源有限，事后处罚的频率和金额越来越高，保险机构的违规违法行为层出不穷，是“治已病”而不是“治未病”。因此，本文认为应该实施“条块结合”的纵向监管与协同监管相结合。当前，我国内地四家自保公司的母公司都是国有大型企业，所谓协同监管主要涉及到中国银保监会及其派出机构，自保公司的股东（母公司），股东单位的所属管理机构这三类机构，即在上述三类机构之间建立起监管责任清晰、自保公司的风险由母公司承担全部责任的协同监管模式，并从实现国有企业保值增值，服务实体经济和建设“一带一路”的角度建立中国银保监会与国务院国有资产监督管理委员会的联系沟通机制。

4. 高效监管原则。保险监管效率是指保险监管机构发现有问题的保险公司并合理处置这些问题的监管工作效率，通过监管的成本与监管的产出来进行衡量。在我国保险监管资源有限，保险违规事故频发，行政处罚的频率和罚款金额飞速提高的情况下，坚持高效监管原则，从提升监管效率的视角完善中国自保公司的监管，银保监会针对自保公司在公司治理方面存在的共性问题提出具有可行性的政策建议，进行高效监管。这对于降低自保公司的经营成本，提升保险产业

的承保能力、服务能力和承保意愿，增强各行业保险意识的提升和保险需求具有重要的意义。

### 4.2 完善专业自保公司治理监管制度的政策建议

1. 由中国银保监会直接监管。自2020年8月1日属地监管政策执行后，我国境内4家自保公司分别划分至注册地银保监局进行监管。监管权力是否应该下放，取决于多种因素，其中非常重要的是地方监管水平及力量能否达到监管要求与目标，能否提高监管效率。对于自保公司而言，因其在我国发展时间短，研究少，自保人才储备不多，而且各地银保监局的人才资源不均衡，因此，短期内由属地对自保公司进行监管将意味着支出更多的教育培训成本、沟通成本，影响到监管的一致性。由银保监会设立自保公司监管部门进行直接监管，可以更好地发挥集中监管、专业监管的优势，同时可以在监管过程中不断积累经验，加深对自保公司及市场的了解，把握自保公司发展的独特规律，储备专业人才，为以后建立在岸自保中心和离岸自保中心的建立奠定基础。

2. 完善自保公司治理相关法律法规。截至目前，我国专门针对专业自保公司的法律法规少之又少，《关于自保公司监管有关问题的通知》（保监发〔2013〕95号）及《关于进一步完善自保公司监管有关问题的通知》（保监发〔2015〕23号）虽弥补了我国自保相关领域的法律空白，一定程度上指导了自保公司的公司治理监管，但并不具体细化，依照普通商业保险公司相关法律法规对自保公司实行监管却又忽视了自保公司的特殊性，造成监管的低效及无效。提升自保公司治理监管效率的前提与基础便是建立与其经营管理及发展相适应的监管制度，为自保公司发展提供适宜的成长沃土。

3. 差异化进行自保公司的公司治理监管。公司治理的目标是实现公司的持续健康发展，防止出现侵害消费者利益的问题。自保公司股东单一，股东与自保公司客户实为一体，不存在利益冲突，且受制于业务规模的限制，公司规模及人员体量均无法与普通商业保险公司比拟，故现行的一些公司治理评估指标对于自保公司而言是缺乏公平性的，无法真正反映自保公司治理的真实水平。同时，自保公司的大部分董事、监事及高级管理人员均为母公司委派，他们可能没有保险业的从业经验，但却对母公司的风险更为了解。因此，自保公司与普通商业保险公司在公司治理层面的监管标准及监管内容应是有所差异的。本文建议，在公司人员设置方面，精简自保公司岗位及人员设置要求，取消对独立董事的设置要求，适度放宽对董事、监事在保险从业经验方面要求，允许部分管理服务外包。同时应注意加强对自保公司管理人员的培训，提升其保险实操技能，实现自保公司人员精、效率高的良好公司治理局面。

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# 我国专业自保公司的公司治理监管效率研究

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**关键词：**公司治理；专业自保公司；市场失灵；政府监管

**中文摘要.** 自保公司发端于上世纪二十年代，已成为国际保险产业中非常重要的部分。自保公司在我国还是新兴事物，人们对其经营管理、发展模式等方面的认识还有所不足。本文首先分析中国内地四家自保公司的公司治理现状，然后依据中国银保监会的有关规定，对中国内地四家自保公司的公司治理监管进行评价，说明当前中国银保监会对中国内地自保公司的公司治理监管存在监管失灵现象，最后提出了完善中国专业自保公司的公司治理监管的政策建议。

# Dynamic Evolution of Insurance cycle and Economic Cycle under the Background of Insurance Technology

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**Keywords:** Insurance cycle, Economic cycle, Insurance technology.

**Abstract.** It is the main direction of insurance cycle research to scientifically measure the dynamic correlation between insurance cycle and economic cycle in order to grasp the development trend of insurance industry, which will provide a clear direction for the development strategy decision-making of insurance companies, and greatly improve the predictability of insurance industry regulation and the effectiveness of regulatory measures. The rapid development of insurance technology has greatly promoted the construction process of modern insurance industry and reshaped the linkage relationship between insurance cycle and economic cycle. In view of this, on the basis of in-depth interpretation of the theoretical definition of insurance cycle and economic cycle, this paper studies the dynamic correlation trend of insurance cycle and economic cycle in different development stages of China's insurance technology by using the annual data of premium income and gross domestic product (GDP) from 1980 to 2020.Furthermore, it explores the driving effect of the development level of insurance technology on the correlation of the dynamic evolution of the two cycles, so as to predict the development direction of China's insurance industry under the condition of high development of insurance technology in a more scientific and effective way.

According to the division of Eoo Think Tank, the application and development of insurtech can be divided into three stages: 1980-2008, 2008-2014, and 2014-present.Continuing this time division, this paper studies the dynamic correlation between the insurance cycle and the economic cycle from the following three aspects. Firstly, the correlation image of premium income and GDP is divided into three stages for comparative analysis, so as to show the impact of insurtech on the economy and insurance cycle. Then, the Pearson correlation coefficient method is used to conduct static analysis on the correlation between the two cycles. Secondly, the DCC-GARCH model was established to dynamically analyze and predict the linkage situation. An econometric model is established, which takes the market size of insurance and insurance industry and the Internet premium income data of insurance-technology financing industry as indicators to measure the development level of insurance-technology, and analyzes the dynamic evolution process of insurance-technology in the insurance cycle and economic cycle.

The innovation of this research is mainly reflected in two aspects. First, the development level of insurance technology is taken as an exogenous variable to study the linkage between insurance cycle and economic cycle, which reflects the latest development pattern of the current insurance industry. Second, the DCC-GARCH model is constructed based on insurance development indicators and economic operation indicators, and the linkage relationship between the two cycles is explored from a dynamic perspective.

This article research results to scientific and technological progress under the background of macro economic operation and form a reasonable expectations, the insurance industry development will help insurance under the height of science and technology development trend of the development of the insurance company decisions, as well as insurance regulators optimization methods and measures for regulation to provide theory support, and promote the overall national economic developing, nice and fast.

## 1．引言

2007年的次贷危机和2008年的金融危机都使得世界各国经济出现了不同程度的波动，从而引发各国金融监管部门和研究学者对于金融业和实体经济互动关系的关注。保险作为金融业的重要分支，除了具有分散风险和提供损失补偿的功能，还能够通过聚集资金，在资本市场进行投资，为资本市场提供了大量资金，起到了融通资金的作用，因此，保险行业的发展与宏观经济密切相关。

2011年，时任保监会主席吴定富在北大赛瑟论坛（CCISSR）上指出，保险业要实现科学发展与监管，必须深入探索保险业发展与经济周期的互动关系。北大教授孙祁祥也呼吁“应加大对‘保险周期’的理论研究”，认为“要正确把握保险业的波动规律，就必须更多地关注国家宏观经济的波动，从而形成对保险业发展和周期波动的合理预期”。

近年，我国保险行业增速放缓，亟待向创新驱动的质量提升型增长模式转变，向技术密集型的科技赋能转型。保险科技正在崛起，将不可逆转的彻底改变保险业，理解保险数字革命背后的理念、趋势和驱动力变得尤为重要。短期内，保险

科技主要以推动保险行业销售，调整保险资产端结构以刺激保费收入增加，提升保险行业风险承担能力及投资风险水平为主。同时，科技有助于社会财富的创造与重新分配，有利于推动经济高质量可持续发展，充分发挥大数据等技术优势，还能助力提升国家经济监测预测和宏观调控水平。因此，在保险科技背景下，探究保险科技与经济周期联动性及其变化趋势，有助于更加科学、有效地预测在保险科技高度发展状态下我国保险业的发展方向。

## 2．国内外文献综述

通过梳理相关文献，现阶段对保险周期与经济周期的研究归纳为以下三个方面：包括承保周期、经济周期以及保险周期与经济周期之间关系。国外没有严格区分承保周期（Underwriting Cycle）和保险周期（Insurance Cycle），但整理文献后发现，国外的研究主要集中在证明承保周期的存在性、探究承保周期的影响因素上。而“保险周期”概念是孙祁祥教授通过对比国内外保险市场特点，并结合我国国情现状在2011年首次提出的，此后，国内研究才将注意力从承保周期转向保险周期，并且展开对保险周期与经济周期关系的研究。

最早开始对保险业周期波动和经济周期波动进行研究的是曹乾和何建敏（2006）使用向量自回归模型和误差修正模型对我国GDP数据和保费收入两项指标，来对经济增长和保险增长进行分析，证实在GDP和保费收入之间具有协整关系，但在此基础上做Granger因果检验后却仅存在经济增长是保费收入增长的格兰杰原因，而保费收入增长并不是经济增长的格兰杰原因。王丽珍等（2010）对承保周期产生因素进行分析，并率先引入用于分析保险市场结构的HHI指数，并在考虑政策因素在我国保险市场形成和发展中具有的重要作用的基础上，增加虚拟变量来分析政策性因素对保险市场的影响。熊海帆等（2011）对宏观经济波动可能引致保险周期的内在机理作了理论分析,然后利用协整模型并辅以误差修正模型验证了中国的现实情况,发现保险行业运行在长期来看与经济体系的发展较为一致,其周期特性得到间接证明,但经济的短期扰动对保险行业影响不大,同时,保险经营业绩与利率变动负相关,产险业的发展与宏观经济的联系不太紧密。孙祁祥等（2011）的研究对我国及其它工业化国家与新兴市场国家保险周期的基本特征、决定因素以及与经济周期的联动关系进行了全面的对比分析。荣幸等（2012）使用非寿险市场的赔付率指标来进行了High-Pass滤波分析，滤波结果表明承保周期确实存在，然后又构建回归模型对经济周期和承保周期的相互影响进行了说明，再利用方差分解方法和VaR模型的脉冲响应函数对具体贡献率进行了量化分析。模型结果显示出在承保周期的众多影响因素中，宏观经济作为一个整体对承保周期的解释能力达到22%，大大高于其他扰动项产生的影响。张玉春等（2016）考察了我国保险周期和经济周期波动形态的差异及其二者的协同性。李小林等（2020）采用BBQ算法和Morlet小波分析考察了我国保险周期和经济周期的波动特征和动态关联。这些研究均紧扣“保险周期”是“围绕保险业长期增长趋势重复出现的周期性波动”这一含义，因而在度量保险周期时，均以整个市场或分险种市场的保费收入的周期性波动成分为指标。

现阶段还没有学者将科技与保险周期、经济周期相结合进行研究。本文重点研究保险科技作用下对保险周期与经济周期的动态关联程度的影响。实证分析在保险科技的出现与发展对我国保险行业乃至整个宏观经济周期性波动的影响效果，探索在保险科技飞速发展的大背景下保险周期与宏观经济增长的相互关系，

思考保险业如何借科技之势提升行业效率，提出应对周期波动的保险业发展政策，将对保险业和社会经济持续、健康、稳定发展产生重大而深远的影响。

## 3．保险周期与经济周期的联动性分析

在经济学有关文献中，联动性一般是指经济变量之间的相关性。保险周期与经济周期的联动性可以用相关系数来衡量，相关系数越高说明两周期的联动性更强。

### 3.1 保险周期与经济周期的联动性及变化

保险周期和经济周期的波峰波谷交替出现，要想判断两周期之间的联动性，测度周期长度至关重要。为研究中国保险行业周期与经济周期的关系，首先对二者进行变量选择。美国国家经济研究局（NBER）经济波动周期确定委员会通过总产出、收入、就业、贸易等指标来测度经济周期，这其中最主要的是国民生产总值GDP。对于保险业来说，保费收入与GDP的增速有一定的关联性。人均国民生产总值的增加将导致人均可支配收入增多，收入增加，促使人们增加了对各类保障的需求，从而产生投资购买保险产品的欲望，保险需求随之增加，由此可知保费收入与GDP的增长之间关联程度较大。综上，为探讨我国保险周期与经济波动的关系，本文参考孙祁祥等（2011）、吴杰和粟芳（2014,2018）将使用保费收入作为测度保险周期的指标，基于GDP测度经济周期。除特别标注外,本文的研究样本数据均来源于《中国统计年鉴》，样本期间为1980～2020年。

专家学者们在测度周期时常用的方法主要有两类：谱分析法和ARIMA（差分自回归移动平均模型）模型法。具体来说，ARIMA模型以二阶自回归模型（AR（2））为代表，但是其假设序列须服从线性平稳过程，较为严格，且这一假设不太符合事实。除此之外，AR（2）在计算中会忽略过程中的顺周期现象，使保险周期波动的振幅变小；并且通过计算得到的是固定值的保险周期，也与实际上非固定值的保险周期现象不一致。谱分析法则不受模型假设的限制，而且可以基于较短的时间序列样本计算得到并非固定值的周期长度。一般而言，谱分析法对变量的波频范围进行滤波，常见的方法包括HP滤波、BK滤波和CF滤波等。相较来说，High-Pass（HP）滤波法是在所有处于不同频率的成分中，分离出有一定趋势变化的频率较高和较低平滑序列，也就相当于去掉长期的趋势项，对留下的短期随机波动进行度量。所以，本文将采用谱分析法中的HP滤波法，以消除保险波动和经济波动的趋势成分，得到保险周期、经济周期波动趋势序列图。

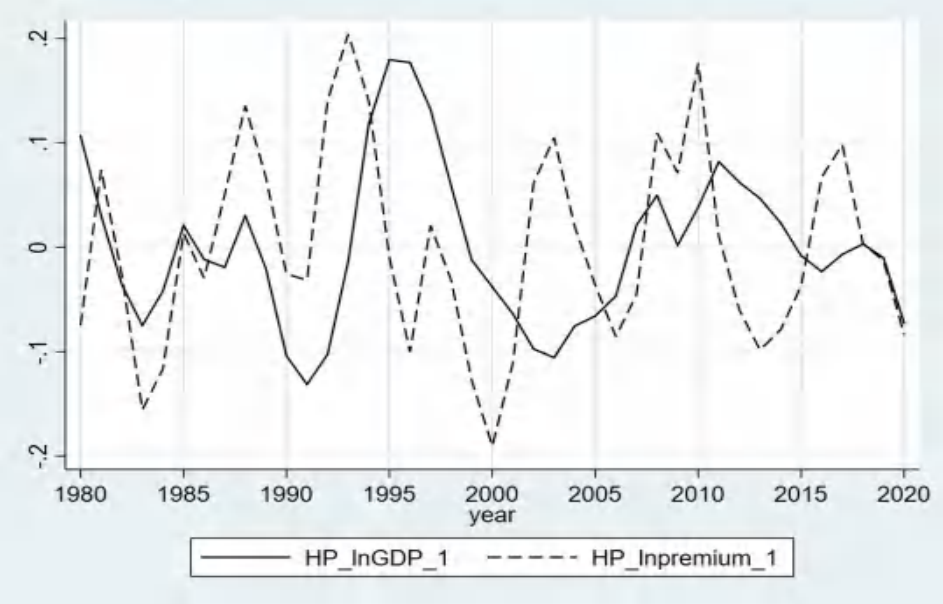


图1 1980-2020年中国保险周期与经济周期波动对比图

分析图1，可以看出在剔除了我国保费收入的长期趋势后，运用HP滤波滤掉随机波动的影响，序列呈现出明显的周期性。在保险科技在2008年之前处于萌芽阶段，1979年我国刚刚恢复保险业，百废俱兴，因此保险行业保费收入呈现明显的大幅度起落的发展趋势，保费收入序列的周期波动频率较为密集，共经历了6个完整的周期，周期长度大致为3-4年。从2008年开始，保险科技进入积累式发展期，保险行业网络化、移动化趋势明显，到2014年进入保险科技爆发期。从2014年开始，保险科技进入创新阶段。这时的发展以保险场景化为主，特别是与流量入口的结合，比如携程、淘宝、腾讯、京东结合互联网的业务场景来做保险的定制，形成退货运费险、账户安全险、航班延误险、酒店取消险等。这个阶段的特征是场景化定制，根据不同的场景需求来定制更具针对性的产品，这个阶段出现了很多个性化产品。同时，在这个阶段，诸如大数据、人工智能、物联网等技术，开始在保险业务的局部环节逐步发挥作用。保险周期图表明，2014年至今保险行业周期长度长达7年，周期明显变长，变动频率降低。过去的2018年，整个保险市场的原保费收入达到3.8万亿，同比增长3.92%，单从增长率看，保费规模的增长速度在显著放缓。2017年，整个保险市场的原保费收入相比2016年增长了20%，2018年对比2017年增长不到4%。其中寿险只增长了不到1%，产险增长了11.5%。出现这个变化的主要原因，是2017年底保险业监管层面根据市场形势变化在监管政策方面做了较大的调整，特别是对寿险趸交理财产品方面监管思路做了调整，导致保险行业的整体业务结构发生了一定变化。这个变化促使行业回归到了保险保障的本质，回归了保险业长期良性发展的正确道路，所以对于整体保险行业2019年及后续形势仍然看好。

经济周期在1980-2008年期间经历了4个周期，平均每个周期长度为5-6年。同保险周期一样，在2010年保险科技开始融入保险市场之后，周期波动频率下降。随着2015年我国提出“国家大数据战略”，全面推动数字经济发展和加快数字化转型的政策不断深化和落地，宏观经济从2015年开始进入繁荣时期。在经济上行周期，保险公司业务大幅度扩张，资产质量好，盈利能力强，资本积累能力增强，使资本充足状况改善，可以支持更大规模的投资，推动宏观经济的进一步高涨。

反之，若经济周期进入下行时期，业务减少，资产质量下降，盈利能力减弱，资本充足程度降低，迫使保险公司压缩投资规模，从而进一步加剧宏观经济衰退。另外，经济衰退时期，保险公司盈利能力下降，甚至动用资本冲销损失，并且金融市场疲软导致外部筹资困难或成本上升，导致资本充足率下降；经济繁荣时期，保险公司经营损失下降，盈利能力增强，更容易获得外部资本的支持，资本充足率则上升。

我国保费收入序列和GDP序列的波动规律基本一致，GDP序列波动滞后于保费收入序列的波动，保费收入序列所表现的保险周期显现的波动周期明显长于经济周期。保险周期与经济周期的动态相关关系在样本期内基本上为正相关关系，可见在样本期内,宏观经济指标对保险行业的周期波动具有重要的影响。

从保险周期经济周期的Pearson相关系数看，两者之间Pearson相关系数值为0.9850，所有通过显著性检验的系数均为正，体现出保险业的波动与宏观经济波动关联程度较高。

### 3.2 保险周期与经济周期的动态联动性及趋势

普通模型只能静态分析两个序列的波动，Dynamic Conditional Correlation (DCC-) GARCH模型获得的条件相关系数可以衡量经济周期的动态同步性（Sethapramote，2015），可以实现经济变量之间动态波动分析，即序列间波动并非为一个常数，而是一个随着时间的变化而变化的系数，现被广泛运用于探究市场间联动关系的研究。本文采用DCC－GARCH 模型 ，推导出动态（时变的）条件相关系数（tim－varing conditional correlation）来刻画我国保险周期与经济周期在1980-2020年之间同步性的变化趋势。

theta(1)表示ARCH项系数，指代滞后一期标准化残差的乘积对动态相关系数产生的影响，也就是说，变量下一期的波动性会受到现有信息的影响的程度，它的数值越大，表示变量对新信息的敏感性越大。theta(1)结果为0.6178，数值较大说明保险业对宏观经济所传递的信息较为敏感。theta(2)表示GARCH项系数，指代两个变量之间相关关系的持续性，值越大表示先关性持续的时间越长。theta(2)为0.2762，这项数值较小，说明保险业与宏观经济的相关性具有很低的持续程度，未来随着保险业成熟发展，科技水平发展到一定程度，其周期波动受经济周期波动影响会变小。此外，两变量的theta (1) + theta (2) 小于1，满足模型的约束条件，且两个参数之和接近于1，说明所建立的DCC-GARCH(1,1)模型是比较稳定的。

### 3.3 保险科技影响保险周期与经济周期联动性的实证分析

本文研究在保险科技高速发展背景下能否影响我国保险周期与经济周期联动性，各因素在多大程度上解释两周期的联动。

#### 3.3.1 数据选取和模型介绍

本文以保险周期与经济周期经过DCC-GARCH后的联动性结果（movement）为因变量。保险科技的大规模投资始于2014年众安保险的成立，到2017年保险科技企业在四年内共收获次数超200次，金额超110亿的融资。融资作为一个行业筹集资金的过程，代表着市场资金的转向，大规模资金的投入一定会对保险及宏观经济波动产生影响；保险科技市场规模（根据企业投资额计算）的增速与保险公司保费收入规模的增速情况基本一致，我国头部险企加快保险科技布局，将促进保险行业市场规模的扩大；随着互联网技术的普及，线上投保热潮使得互联网保

费收入占保费收入的比重越来越大，会在一定程度上影响周期的波动。综上，本文将选取互联网保费收入（Internet）、保险科技市场规模（market）以及保险科技行业融资（financing）作为将影响保险周期和经济周期联动性的自变量。还需说明的是，由于保险科技投融资从2014年开始统计，数据量较少，无法做出准确实证估计，因此本文在已有2014-2020年数据的基础上运用回归插补，将数据扩充至67个，使结果更具有说服力。

基于以上分析，构造如下回归方程：

$$movement = \beta_0 + \beta_1 Internet_t + \beta_2 market_t + \beta_3 financing_t + u_t \quad (1)$$

其中脚标t代表第t期的观察值。表1报告了方程（1）的回归结果。

表 1　保险周期与经济周期影响因素回归结果

| Source | SS | df | MS | Number of obs | = | 67 |
|---|---|---|---|---|---|---|
| | | | | F(3, 63) | = | 412.44 |
| Model | .022752932 | 3 | .007584311 | Prob > F | = | 0.0000 |
| Residual | .001158503 | 63 | .000018389 | R-squared | = | 0.9516 |
| | | | | Adj R-squared | = | 0.9492 |
| Total | .023911435 | 66 | .000362294 | Root MSE | = | .00429 |

| movement | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lninternet | -.0046439 | .0166387 | -0.28 | 0.781 | -.0378937 | .028606 |
| lnmarket | .0275726 | .0067576 | 4.08 | 0.000 | .0140686 | .0410766 |
| lnfinancing | .0242525 | .0024854 | 9.76 | 0.000 | .0192859 | .0292192 |
| _cons | .2068457 | .0772593 | 2.68 | 0.009 | .0524553 | .361236 |

表1显示互联网保费收入的回归结果不显著，表明互联网保费收入对联动性的影响不大，这是因为互联网保险保费收入只占据总保费收入的一部分，且保费收入中占比最大的寿险，尤其是长期寿险多是通过线下的渠道进行交易。保险科技市场规模和融资的回归系数均为正值，检验结果均为0.000，表明保险科技市场规模和保险科技融资与周期联动性之间存在正相关关系。也就是说，根据企业投资额计算出的保险科技市场规模和保险科技融资都是保险周期与经济周期联动性的显著影响因素。

## 4．结论

不同于以往的静态相关系数分析周期的关联性，本文引用对经济市场波动性的研究方法DCC-GARCH模型，加入动态维度分析了保险周期与经济周期的联动效应，充分说明了保险与宏观经济之间的动态关联关系，1980-2008，保险复业，方兴未艾，科技发展还处于起步阶段，保险受宏观经济影响较大，保险周期与经济周期波动的关联性很强；经历2008年全球金融危机之后，经济波动较为剧烈，在保险科技积累发展期，保险行业处于飞速发展阶段，因此二者关联性稍微减弱；2014年保险科技呈现爆发式增长之后，两周期的又恢复了较强的关联性，监管部门应该合理预期这种波动变动，制定合理的监管政策。

理解保险科技对保险周期与经济周期联动性的影响事实与程度至关重要。本文着眼于保险科技行业三大变量，从多个方面探究保险科技对保险周期与经济周

期的影响，具有现实意义。首先，互联网保费收入虽然在近几年呈急速上涨趋势，但在总保费收入中的占比仍然较小，在现阶段对于周期波动的影响较小。其次，随着保险科技市场规模的不断扩大与融资增加，其对周期联动性的影响会逐渐凸显。因此保险监管部门和整个保险行业要密切关注保险科技行业投融资情况，以免造成行业的剧烈波动，及时制定合理的监管政策，以更加科学、有效的手段预测在保险科技高度发展状态下我国保险业的发展方向。

## 致谢

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# 保险科技背景下保险周期与经济周期动态演变研究

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**关键词:** 保险周期; 经济周期; 保险科技；联动性

**中文摘要.** 科学测度我国保险周期与经济周期的动态关联性以把握保险业发展趋势，将为保险公司发展战略决策明确方向，并极大提高保险行业监管的预见性和监管措施的有效性，是保险周期研究的主要方向。保险科技的迅速发展极大推动了现代保险业的建设进程，同时也重塑了保险周期与经济周期的联动关系。鉴于此，本文在深入诠释保险周期与经济周期的理论界定基础上，利用1980年至2020年我国保费收入和国内生产总值（GDP）年度数据研究了我国保险科技的不同发展阶段的保险周期与经济周期的动态关联性的变化趋势，进而探寻保险科技发展水平对两个周期动态演变关联性的驱动作用，以更加科学、有效地预测在保险科技高度发展状态下我国保险业的发展方向。

按照亿欧智库的划分，保险科技的应用和发展进程可以分成三个阶段：1980-2008、2008-2014、2014至今。本文延续这一时间划分，从如下三方面展开对保险周期和经济周期的动态关联性研究。首先，将保费收入和GDP指标的联动性图像分为这三个阶段进行比较分析，以表现保险科技对经济和保险周期的影响作用效果，并用Pearson相关系数法对两周期联动性进行静态分析；其次，建立DCC-GARCH模型，动态分析预测联动性情况；建立计量模型将保险科技融资保、险科技行业市场规模和互联网保费收入数据作为衡量保险科技发展水平的指标，对保险科技在保险周期和经济周期动态演变过程进行分析。

本文研究的创新性主要体现在两个方面，一是将保险科技发展水平作为研究保险周期与经济周期联动相关性的外生变量，体现了当前保险业发展的最新形态；二是基于保险发展指标与经济运行指标构建DCC-GARCH模型，从动态视角探寻两个周期之间的联动关系。

本文的研究成果能够对科技进步大背景下对宏观经济运行以及保险行业发展形成合理预期，将有助于保险科技高度发展态势下的保险公司的发展决策，同时也为保险监管机构优化监管方法与措施提供理论支持，进而推动整体国家经济又好又快向前发展。

# Specific-cause Mortality Prediction Model Based on Coherence Test

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**Keywords:** Specific Cause Mortality, Coherence, Li-Lee Mortality Model.

**Abstract.** In this paper, we sort out the research progress and estimation problems of specific cause mortality. Based on the latest death cause data of disease surveillance points system(DSPs), the eastern, central and western regions of China are grouped into a multi-population group. Besides, the convergence test of international coherence of cause-specific by N.Li and Lee(2005) was used for reference, and the mortality model of cause-specific was constructed. The results show that: (1) From the convergence test of international coherence of cause-specific, neoplasms, vascular diseases and other diseases show international coherence in eastern, central and western of China. (2) From the performance in the sample, the estimated value of specific cause mortality based on the international coherence is similar to that of Lee-Carter models. (3) From the results of out-of-sample prediction, the new model has better out-of-sample performance in a longer prediction range.

## 1. 引言

近年来，人口预期寿命的持续增长已引起社会各界广泛关注。而人口预期寿命增长的不确定性为社会保障部门和养老金行业带来巨大挑战。在现有的死亡率预测应用中，Lee-Carter（1992）、CBD（2006）、RH（2006）等单总体模型以及避免相似人群预期死亡率出现差异的多总体模型（Li-Lee，2005）仅研究了分性别、分地区单一维度的死亡率情况，尚未考虑死亡原因维度。

对于死因死亡率的研究，目前尚未将多总体死亡率模型纳入死因死亡率模型。对于多总体死亡率模型，N.Li和Lee（2005）将Lee-Carter模型扩展为公共因子模型，该模型反映了一组人群中死亡率的长期趋势，同时允许该组中每个子群体的短期变化，由此可以对一组人群进行“一致性”的全因死亡率预测。其中“一致性”意味着该组子群体的死因死亡率以相同的速度下降，并长期保持子群体之间恒定的死亡率差异。

对于死因别死亡率区域一致性的检验，在实际中，由于通信技术的快速进步和信息的快速增长有助于某些病因（如：肿瘤、血管疾病）医学进步跨境快速交换，从而导致某些病因的死亡率在某些地区下降速度相似。另外，为了检验死因别的区域一致性假设，本文采用N.Li和Lee（2005）方法验证多总体之间的死因别死亡率是否趋于相同水平。简而言之，第一步是验证地区别的死因别死亡率是否趋于相同水平，第二步是检验这些死因别死亡率是否趋于以相同速度提高。

据此，本文从死因别角度出发，构建了2种死因别死亡率模型：死因别Lee-Carter模型（简称模型1）与死因别Li-Lee模型（简称模型2）。其中模型1中只考虑了死因信息，而模型2反映了死因信息与死因别区域一致性。将死因别Li-Lee模型与死因别Lee-Carter模型进行比较，结果显示，死因别Li-Lee模型的样本内拟合更优。

## 2．数据选取与描述

### 2.1　数据选取

本文数据来源于《全国疾病监测系统死因监测数据集》。最终选取2008-2019年男性-地区别-年龄别-死因别死亡率作为研究对象。其中，地区别包含东部、中部、西部；年龄别为0岁、1-4岁、5-9岁、10-14岁、……、80-84岁以及>85岁共19个年龄段；死因别包含肿瘤（NM），血管疾病（VM），其他死因（OM）。

### 2.2　数据描述

根据图1我国分地区、死因别死亡率的趋势，注意到在85岁以上的死亡率数据于2012年骤降（其余地区别死亡率同样呈现2012年骤降），其原因在于中国人口老龄化大爆发。2012年85岁及以上高龄人口数较2011年翻倍增加，而死亡人数并没有显著变化。根据死亡率公式：死亡率＝死亡人数/人口数，该年的死亡率较上一年出现骤然下降的趋势，是合情合理的。并且，人口老龄化是一个持续的状态，速度也在不断增加。

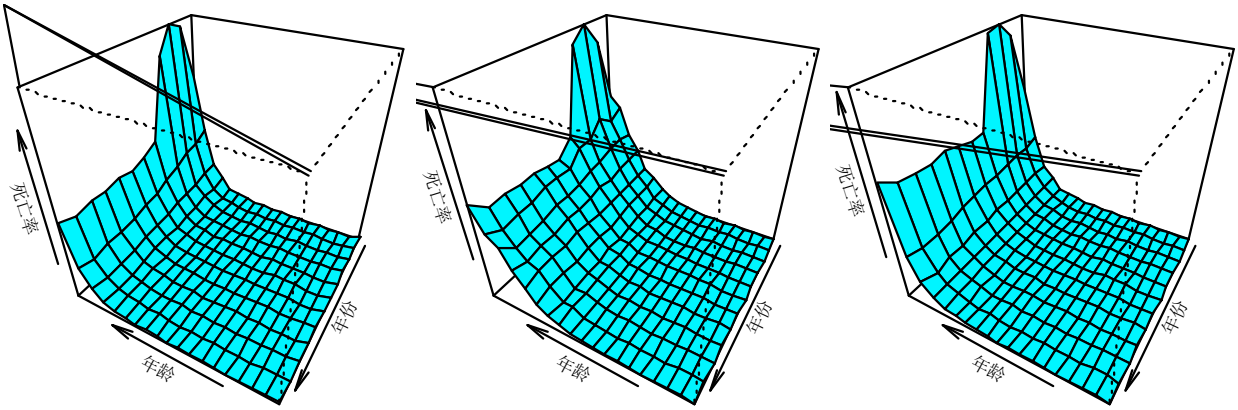


图1 中部地区男性其他疾病（左）肿瘤（中）血管（右）死亡率数据

为进一步研究某些重要的死亡原因，例如肿瘤和血管疾病，根据年龄调整[1]（Arnold和Sherris（2013））后的死因别死亡率分析了东部、中部和西部地区死因的动态变化情况。

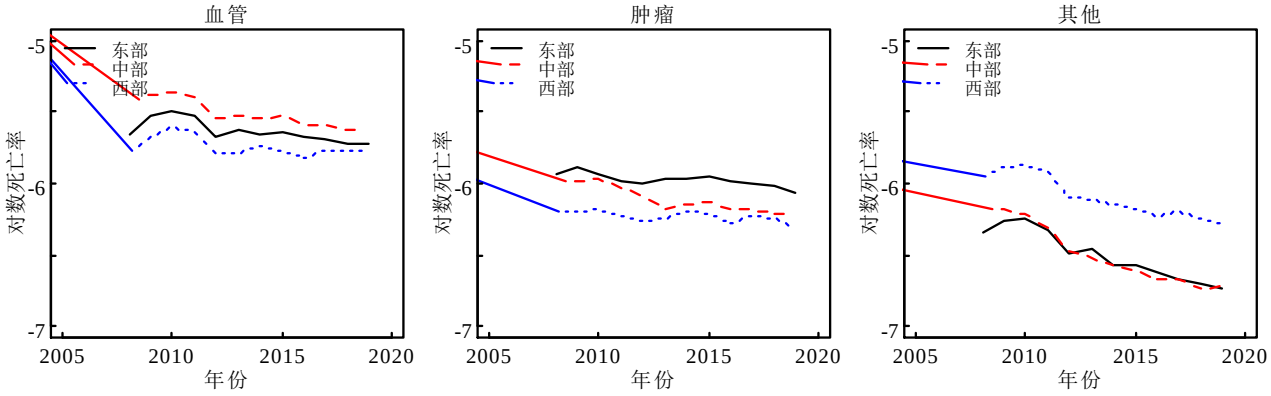


图2 基于年龄调整后的3种死因死亡率变动情况

图2绘制了基于年龄调整后的地区别、死因别死亡率变动情况。从死因别来看，男性的心血管疾病、肿瘤的死亡率显著高于其他死因的死亡率，其中心血管疾病的死亡率位居首位，其次为肿瘤。从地区别来看，东部、中部和西部的肿瘤、心血管、其他死因的死亡率表现相似，可以观察到这三个地区之间可能存在“追赶效应”。也就是说，中部的肿瘤死亡率（红色）从2010年开始以显著的速度下降，随后是东部（黑色）和西部（蓝色）。2013年之后，这三个地区的肿瘤死亡率再次相似。图2左图，东部，中部和西部的血管疾病的死亡率以相似的速度下降。纵观图2可发现肿瘤、血管、其他疾病的死亡率可能存在区域一致性，也就是说，从长远来看，相似地区的死因别死亡率以相同的速度变化。

## 3 死因别死亡率区域一致性检验

从第二节东部、中部和西部死因别死亡率的一致性结果可知，不同地区之间的死因别死亡率可能存在“追赶效应”，即从长远来看，不同地区的死因别死亡率将朝着相同的死亡率水平发展。本文拟通过N.Li和Lee（2005）方法来确定不同地区的死因别死亡率是否存在“追赶效应”，也就是说对于某种死因死亡率，东部、中部和西部地区是否表现出一致性。而检验其一致性主要是为了证明3种死因可以构建多总体死亡率模型，因为构建多总体死亡率模型的前提是“多总体”之间需要保持“一致性”，即该群体的死因别死亡率以相同的速度下降并长期保持群体间恒定的死亡率差异。其中N.Li和Lee（2005）方法如下：

$$\log(m_{x,t}^{r,d}) = \alpha_x^{r,d} + B_x^d K_t^d + b_x^{r,d} k_t^{r,d} + \varepsilon_{x,t}^{r,d} \tag{1}$$

$$k_t^{r,d} = \beta_0^{r,d} + \beta_1^{r,d} k_{t-1}^{r,d} + \mu_t^{r,d} \tag{2}$$

式(1)中，$m_{x,t}^{r,d}$ 为地区 $r$，年龄 $x$，时间 $t$，死因为 $d$ 的死亡率；$\alpha_x^{r,d}$ 是地区 $r$ 针对死因 $d$ 中年龄段 $x$ 的平均死亡率；$B_x^d K_t^d$ 是该群体中每个地区死因 $d$ 的共同因素，$K_t^d$ 是死因 $d$ 的公共周期，$B_x^d$ 是年龄段 $x$ 对死因 $d$ 的公共周期影响的敏感程度；

[1] $m_t^{r,d} = D_t^{r,d} / E_{2019}^r$； $D_t^{r,d} = \sum_x (m_{x,t}^{r,d} \times E_{x,2019}^r)$； $E_{2019}^r = \sum_x E_{x,2019}^r$

$b_x^{r,d}k_t^{r,d}$ 是个体因素，$k_t^{r,d}$ 是地区 $r$ 死因 $d$ 在第 $t$ 年的单个期间效应，$b_x^{r,d}$ 为地区 $r$ 死因 $d$ 在年龄段 $x$ 的各期间的灵敏度；误差项 $\varepsilon_{x,t}^{r,d}$ 满足通常的回归假设。

式(2)中，对于单个时期效应 $k_t^{r,d}$ 参数采用 AR(1)拟合其过程，$\beta_0^{r,d}$ 为漂移项，$\beta_1^{r,d}$ 为滞后项系数，$\mu_t^{r,d}$ 为随机误差项，满足正态性假设。

N.Li 和 Lee（2005）方法中关键系数为 $\beta_1^{r,d}$。$\beta_1^{r,d}$ <1对应于收敛的死亡率水平；$\beta_1^{r,d}$ >1对应于发散的死亡率水平。因此，若 $\beta_1^{r,d}$ <1，则表明地区 $r$ 属于死因 $d$ 的一致性区域中，也就是说 $k_t^{r,d}$ 是一个稳定的过程；否则，地区 $r$ 不属于死因 $d$ 的一致性区域中，即不能将该地区列为多总体中的一员。

根据式(1)与式(2)，为得到关键系数为 $\beta_1^{r,d}$，则需要通过以下两步得到，其中：第一步，利用奇异值分解法（SVD），获得 $k_t^{r,d}$ 参数估计结果；第二步，对上步 $k_t^{r,d}$ 的估计结果采用AR(1)拟合其过程，最终得到地区别、死因别 $\beta_1^{r,d}$ 值，下面分别逐一介绍相关步骤：

第一步：获得 $k_t^{r,d}$ 参数的估计结果。根据式(1)可知，等式左端（$\log(m_{x,t}^{r,d})$）为地区别、死因别的对数死亡率，等式右端中 $\alpha_x^{r,d}$、$b_x^{r,d}$ 和 $k_t^{r,d}$ 为地区别、死因别的相关参数，与等式左端（$\log(m_{x,t}^{r,d})$）的维度相同，即都包含地区别与死因别信息。但等式右端中 $B_x^d$ 和 $K_t^d$ 为全地区死因别相关参数，与等式左端维度不相同，因为 $B_x^d$ 和 $K_t^d$ 仅包含死因别维度，而等式左端包含地区别、死因别两类维度。故，首先应选取与 $B_x^d$ 和 $K_t^d$ 全地区死因别参数相同维度的死亡率 $m_{x,t}^d$，仿照Lee-Carter模型（$\log(m_{x,t})=\alpha_x+B_xK_t+\varepsilon_{x,t}$），构建全地区死因别死亡率模型，如下式：

$$\log(m_{x,t}^d)=\alpha_x^d+B_x^dK_t^d+\varepsilon_{x,t}^d \tag{3}$$

其中，$m_{x,t}^r$ 表示地区 $r$ 年龄组 $x$ 时间 $t$ 的全因死亡率，如下式：

$$m_{x,t}^r=\frac{\sum_d D_{x,t}^{r,d}}{E_{x,t}^r} \tag{4}$$

式(4)中，$D_{x,t}^{r,d}$ 表示地区 $r$，年龄 $x$，时间 $t$，死因为 $d$ 的死亡人数，$d$ 表示死亡原因（$d\in\{NM,VM,OM\}$）；$r$ 表示地区（$r\in\{$东部,中部,西部$\}$）；$x$ 表示年龄组（$x\in\{0,1\text{-}4,...,80-84,85+\}$）；$t$ 表示时间（$t\in\{2008,...,2019\}$）。$E_{x,t}^r$ 为地区 $r$ 中 $x$ 年龄组第 $t$ 年的全因风险暴露人数。

根据式(3)，利用奇异值分解法（SVD），得到全地区死因别参数 $B_x^d$ 和 $K_t^d$，将式(1)中等式左端的地区别、死因别对数死亡率 $\log(m_{x,t}^{r,d})$ 减去全地区死因别的共同因素 $B_x^dK_t^d$，如下所示：

$$\log(m_{x,t}^{r,d})-B_x^dK_t^d=\alpha_x^{r,d}+b_x^{r,d}k_t^{r,d}+\varepsilon_{x,t}^{r,d} \tag{5}$$

其中，式(5)左端 $\log(m_{x,t}^{r,d})-B_x^dK_t^d$ 为地区别、死因别对数死亡率去除共同因素 $B_x^dK_t^d$ 之后的个体因素，即为每个地区、每种死因的“对数死亡率”。根据式(5)，再次利用SVD，得到 $k_t^{r,d}$ 估计结果。

第二步：获得关键系数 $\beta_1^{r,d}$。根据式(2)，利用第一步获得的 $k_t^{r,d}$，即对于地区 $r$ 死因 $d$ 在 $t$ 时刻的时期效应，采用AR(1)拟合其过程，得到 $k_t^{r,d}$ 滞后项系数 $\beta_1^{r,d}$，最终结果如表1所示。

表1 死因别死亡率的区域一致性检验结果

| 地区 | 其他疾病 | 肿瘤 | 血管 |
|---|---|---|---|
| 东部 | 0.1291 | 0.3100 | 0.6192 |
| 中部 | 0.5593 | 0.1834 | 0.0047 |
| 西部 | 0.3952 | 0.4387 | 0.2165 |

由上表可知，所有地区的死因别 $\beta_1^{r,d}$ 均小于1，即所有死因别的死亡率在东、中和西部地区均表现出区域一致性，与第二节中的结果一致。在下文中将死因别死亡率的区域一致性应用到死因别Li-Lee模型中。

## 4．死因死亡率模型

本文介绍了2种死因死亡率模型，死因别Lee-Carter模型（模型1）、死因别Li-Lee模型（模型2，该模型包含了死因的区域一致性）。

### 4.1 死因别死亡率模型

（1）死因别Lee-Carter模型（简称模型1），具体形式如下：

$$\ln(m_{x,t}^{r,d}) = \alpha_x^{r,d} + b_x^{r,d} k_t^{r,d} + \varepsilon_{x,t}^{r,d} \tag{6}$$

（2）死因别Li-Lee模型（简称模型2），具体形式如下：

$$\ln(m_{x,t}^{r,d}) = \alpha_x^{r,d} + B_x^d K_t^d + b_x^{r,d} k_t^{r,d} + \varepsilon_{x,t}^{r,d} \tag{7}$$

其中，$\alpha_x^{r,d}$ 是地区 $r$ 针对死因 $d$ 中年龄段 $x$ 的平均死亡率。从长远来看，为了防止该群体（东部、中部和西部地区）中的子群体彼此分离，$B_x^d K_t^d$ 是该群体中每个地区死因 $d$ 的共同因素。$K_t^d$ 是死因 $d$ 的公共周期，$B_x^d$ 是年龄段 $x$ 对死因 $d$ 的公共周期影响的敏感程度。为了允许该群体中的子群体短期变化，$b_x^{r,d} k_t^{r,d}$ 是长期消失的个体因素。$k_t^{r,d}$ 是地区 $r$ 中死因 $d$ 在第 $t$ 年的单个期间效应，$b_x^{r,d}$ 为地区 $r$ 死因 $d$ 在年龄段 $x$ 的各期间的灵敏度。

### 4.2 参数估计

对于上述两类死因别死亡率模型本文采用奇异值分解法（SVD），其中死因别Li-Lee模型（模型2）通过两步奇异值分解（SVD）来估计，具体方法如下：

第一步，利用SVD方法，根据全地区的对数死因别死亡率 $\ln(m_{x,t}^d)$，得到公因子 $B_x^d K_t^d$：

$$\ln(m_{x,t}^d) = \alpha_x^d + B_x^d K_t^d + \varepsilon_{x,t}^d \tag{8}$$

第二步，将地区 $r$ 的对数死因别死亡率减去全地区死因别的共同因素 $B_x^d K_t^d$，从每个地区的对数死因别死亡率出发，再次利用SVD，得到各地区死因别参数估计结果：

$$\ln(m_{x,t}^{r,d}) - B_x^d K_t^d = \alpha_x^{r,d} + b_x^{r,d} k_t^{r,d} + \varepsilon_{x,t}^{r,d} \tag{9}$$

其中，死因别Li-Lee模型的约束条件为：

①$\sum_x B_x^d = 1$，$\sum_t K_t^d = 0$ ②$\sum_x b_x^{r,d} = 1$，$\sum_t k_t^{r,d} = 0$

## 5．死因死亡率型的拟合与预测

选取2008-2019年男性死因数据对上述2种死因别死亡率模型：死因别Lee-Carter模型、死因别Li-Lee模型进行拟合。

### 5.1　死因别死亡率模型样本内拟合

为了体现死因别死亡率模型的数据拟合能力，文中绘制了两种模型的拟合图（参见图3），同时还选取MAPE值（平均绝对百分误差）进行拟合效果的评估。

表2 死因别死亡率模型MAPE值

| 地区 | 其他疾病 | | 肿瘤 | | 血管 | |
|---|---|---|---|---|---|---|
| | 模型1 | 模型2 | 模型1 | 模型2 | 模型1 | 模型2 |
| 东 | 8.02 | 7.41 | 8.84 | 7.18 | 10.83 | 8.87 |
| 中 | 7.92 | 7.38 | 7.97 | 6.74 | 11.95 | 11.01 |
| 西 | 8.36 | 7.23 | 8.72 | 8.02 | 10.50 | 10.15 |

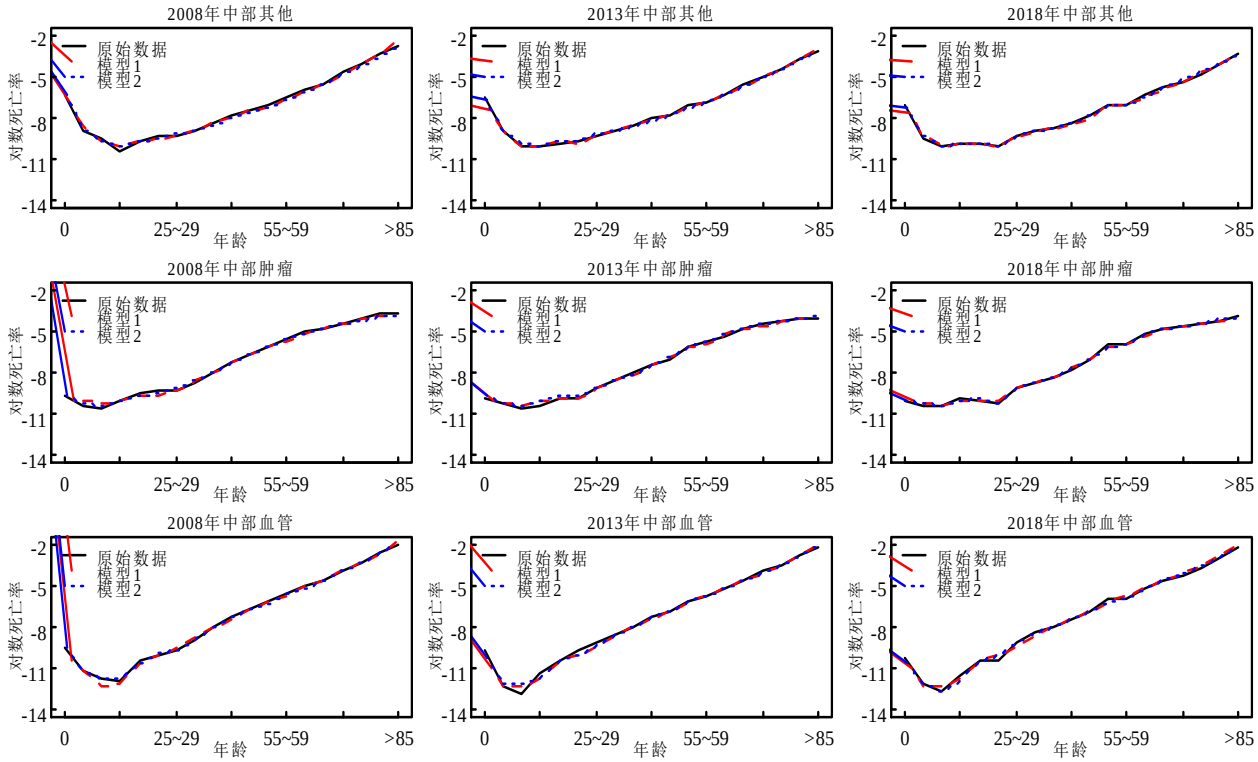


图3 中部地区血管、肿瘤和其他死因死亡率拟合图

表2为死因别死亡率模型（模型1和模型2）的MAPE值，结果表明：模型2的样本内拟合性能均优于模型1，其中血管疾病MAPE值均高于其余2种病因。从图3中可以看出，模型2的样本内拟合优于模型1，对于某种疾病的死亡率在某地区内波动较大，考虑到区域一致性的模型2可以消除一个地区内部的短期波动，从长远来看，其样本内拟合表现更佳。简而言之，对于死因别死亡率模型，模型2在样本中的表现可与模型1相媲美，拟合效果更佳，整体表现更优。

### 5.2　死因死亡率预测

对东部、中部、西部男性2020~2050年0岁、1-4岁、…、85岁以上的死亡率展开预测。模型2包含死因别一致性，而模型1并未考虑一致性，但两者均包含死

因信息。根据死因死亡率模型结构，需要对共同时期效应 $K_t^d$ 与个体时期效应 $k_t^{r,d}$ 进行预测，其中共同时期效应参数遵循带漂移项的随机游走，表达式为：$K_t^d = B^d + K_{t-1}^d + \varepsilon_t^d$ ；个体效应参数遵循AR（1）过程，表达式为：$k_t^{r,d} = \beta_0^{r,d} + \beta_1^{r,d} k_{t-1}^{r,d} + \varepsilon_t^{r,d}$ 。基于上述参数的预测结果，得到样本外（2020~2050年）共同时期效应与个体时期效应的预测值，将其分别带入模型1与模型2，最终得到2020~2050年男性地区别、死因别死亡率预测值。

图4为模型1与模型2的样本区间外预测结果。对比两类模型，可看出中部（东部与西部地区相似）地区肿瘤与血管疾病的死亡率预测结果接近；对于中部地区（东部与西部地区相似）其他死因死亡率，模型1与模型2的预测结果存在差异，且随着预测年份的增加，模型1与模型2（包含死因别区域一致性）的死亡率预测结果差异逐步增大。

## 6．结论

本文使用2008-2019年中国东部、中部和西部《全国疾病监测系统死因监测数据集》死因数据，旨在根据死因别死亡率数据提供全因死亡率预测。基于N.Li和Lee（2005）方法的死因别区域一致性结果，构建了死因别Li-Lee多总体死亡率模型（模型2）。结果显示模型2的样本内拟合优于经典Lee-Carter模型（模型1）。根据死因别死亡率模型1与模型2，对2020-2050年男性死因别、地区别死亡率进行预测，结果显示：对于肿瘤和血管疾病的死亡率预测值，模型1与模型2相似，而其他疾病的死亡率预测结果两模型存在差异，模型1预测值高于模型2。

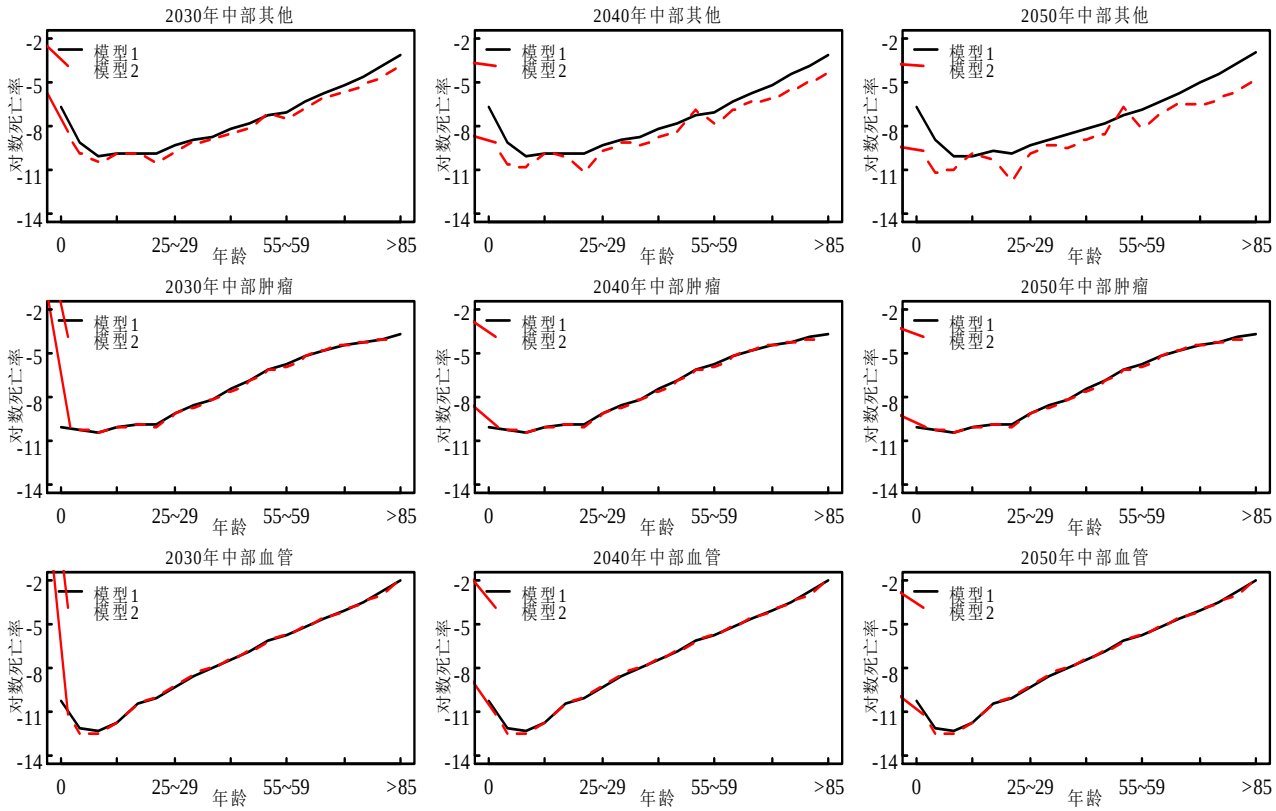


图4　模型1与模型2中部地区2030、2040、2050年死亡率预测值

**致谢**

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# 基于一致性检验的死因死亡率预测模型

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**关键词:** 死因死亡率；一致性；Li-Lee模型

**中文摘要.**本文从死因别死亡率角度出发，基于全国死因监测数据集的最新死因数据，将中国东部、中部和西部地区组成一个多总体人口群体，借鉴N. Li和Lee（2005）的“死因别区域一致性”检验结果，构建了死因别死亡率模型——死因别Li-Lee模型。研究结果显示：（1）从死因别区域一致性的检验看，肿瘤、血管和其他疾病3种死因在中国东部、中部和西部地区均表现出区域一致性。（2）从样本内的表现看，基于“一致性”检验的死因别死亡率的拟合结果与Lee-Carter模型相似。（3）从样本外预测结果看，新模型在较长的预测范围内具有更好的样本外性能。

# History and Analysis of Natural Catastrophe ILS Issues 2001-2020

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**Key Words.** Insurance Linked Securities, ILS, Cat Bonds, Loss, Expected Loss, Conditional Expected Loss, Natural Catastrophes, Catastrophic Loss, Loss Experience, Events, Extended Maturities, Indemnity.

## Abstract

*"If there were no losses; there would be no premiums",* Insurance proverb.

This paper presents a history of natural catastrophe Insurance Linked Securities [ILS] for the 2 decades from 2001 to the end of 2020. The varying nature of ILS issued during those two decades is captured by representing each year's issued securities as a single portfolio. Then, it is possible to trace the shifting expectations of the market more easily, as well as the risks being assumed, and the premiums being charged year by year. It is also then possible to trace out the growth and vibrancy of the ILS market.

A more detailed record is provided of the losses incurred by those same bond issues. This involves an empirical examination of why and where losses occurred. Were they riskier bonds? What exposures caused the losses? Were the losses 'total' for the affected bonds? And just as importantly, what calibration of losses should be used? Are there insights for investors that might help future investor performance?

Given the risks the market assumed (in the collective issuance) and the losses they experienced, another most important question is, should investors be surprised or disappointed by the results? This is another way of asking if the risk analyses that natural catastrophe modeling companies provide in the issue Offering Circular (OC) have done a good job of predicting losses. Does experience match expectations? The broad answer is a qualified yes. Qualified because it turns out to be a challenging question to answer with certainty – even after 20 years of results.

It is believed the approach and analysis herein provide an examination of these fundamental forensic questions for the increasingly important ILS market for the first time.

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# 1. Introduction

The purpose of this paper is to document the issuance of 144A registered[1] Natural Catastrophe [Nat Cat] Insurance Linked Securities [ILS] together with their loss performance for the past two decades. The era of securitizing and derivatizing insurance arguably began in the decade before 2001 (1992-2001) but only 36 small experimental deals were issued then, with highly variable results. Those early deals are recorded in the appendix but are not the main subject of this paper. Similarly, not all ILS issued have been for protection against natural catastrophe, but that is the focus of this report. Other non-Nat Cat issues and their loss experience are recorded in the appendices. Finally, while full details for the ILS under review are not documented on a deal-by-deal basis, they are aggregated on a year-of-issue basis and weighted averages are used to represent the different character of each year's issue.

The paper is divided into three main sections, each representing a different aspect of the ILS Nat Cat history. Section 2 documents the issuance and the varying character of the ILS that have been issued. Section 3 documents the loss experience of these Nat Cat issues. In each of these parts further detail is also given on the characteristics of issued ILS and loss-affected ILS. In Section 2 this includes observations on trends in risk assumption, perils and peril structure, aspects of pricing and simple models thereon. In Section 3 the observations include contrasting the nature of those loss-affected deals with those that were unaffected – the types of deals that incurred loss, including their cedants (issuers) and their layer structure.

Section 3 of the paper seeks to marry-up the risks said to be included in ILS (usually summarized in the phrase "Expected Loss" [EL]) with actual experience of loss. This is a difficult exercise, not least because one needs to define which "EL" is under review and what is the actual "Loss". Complicating the comparison is that each ILS has a term of more than one year, and yet the most considered EL is annual. Similarly, in this as in traditional insurance one might expect the loss in a particular year, but its emergence or final estimate may be several years hence. The answer to the "experience vs. expectation" question also depends on where one positions oneself when asking the question – in the past looking forward or in the present looking backward. We answer that question with a series of contingent forecasts in the past looking forward on a one-year-ahead basis and contingent on experience to that date.

The ILS market has grown and prospered since inception. Early on, investors were skeptical that they would be the recipients of poorly priced risks that they neither knew nor fully understood. Nat Cat modeling companies (Air Worldwide, RMS and EQECAT) stepped in to

[1] Not including Private or Cat Lite deals, usually issued under Reg. 20.

provide an independent valuation of risks in terms that could be more fully understood by those investors. They did understand and continue to rely on those analyses to the present. Twenty years on however is a good time to ask, was their faith justified? That is the purpose of this paper. In a sense, is anyone watching the watchers? That is always a difficult question to address, no less in this context than any other. We believe we have fully addressed the question in all its complexity and provide a first in forensic accountability for the ILS market.

## 1.2 Background and Context

Most of the analysis in this paper will concern the expectations and experience internal to the ILS market and its models. However, the ILS market does not exist in a vacuum. One of the complexities of making an evaluation of the ILS market is that events outside the vacuum affect it. To say the world-at-large or more precisely the Nat Cat world at large impinges, would be an understatement. The Nat Cat history drives the ILS experience. We cannot understand the past twenty years of ILS without knowing the global Nat Cat history for the past twenty years. This is true even if we need to acknowledge that the next twenty years will be different. It is the history of natural catastrophes themselves and the resulting insured losses that concern ILS investors.

That history is most reliably documented by the Swiss Re Institute[2] via its publicly available "Sigma" publications.

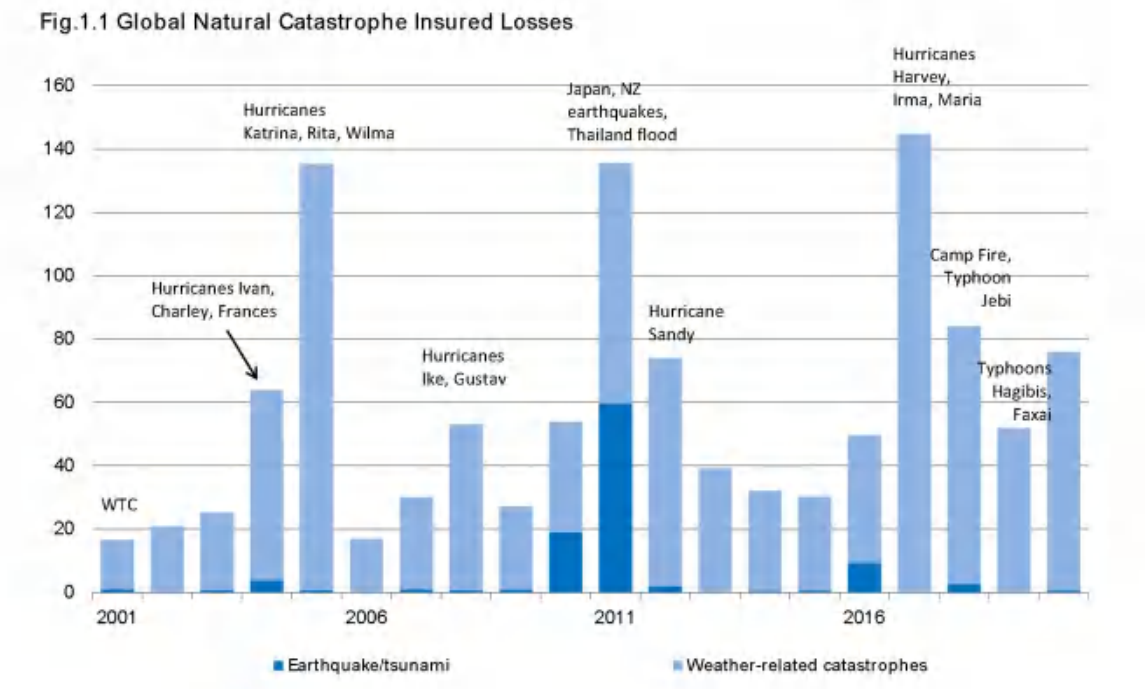



Figure 1.1 shows Swiss Re's total insured losses worldwide for each year in the past twenty years.

[2] Munich Re and the reinsurance brokers, AON, Guy Carpenter, among others, also provide comparable data.

Figure 1.1 Insured catastrophe losses 2001 - 2020 in USD billion, (at 2019 prices) Source: Swiss Re Institute reports, Author amended data, omitting man-made losses and showing only last 20 years of history.

What the picture reveals is that not all Nat Cat years are the same. Most involve weather related (wind) loses; some involve earthquakes. Some years involve hurricane in the North Atlantic; some involve typhoons in the Pacific. Some years involve losses excess of $120 billion, others involve losses less than $20 billion.

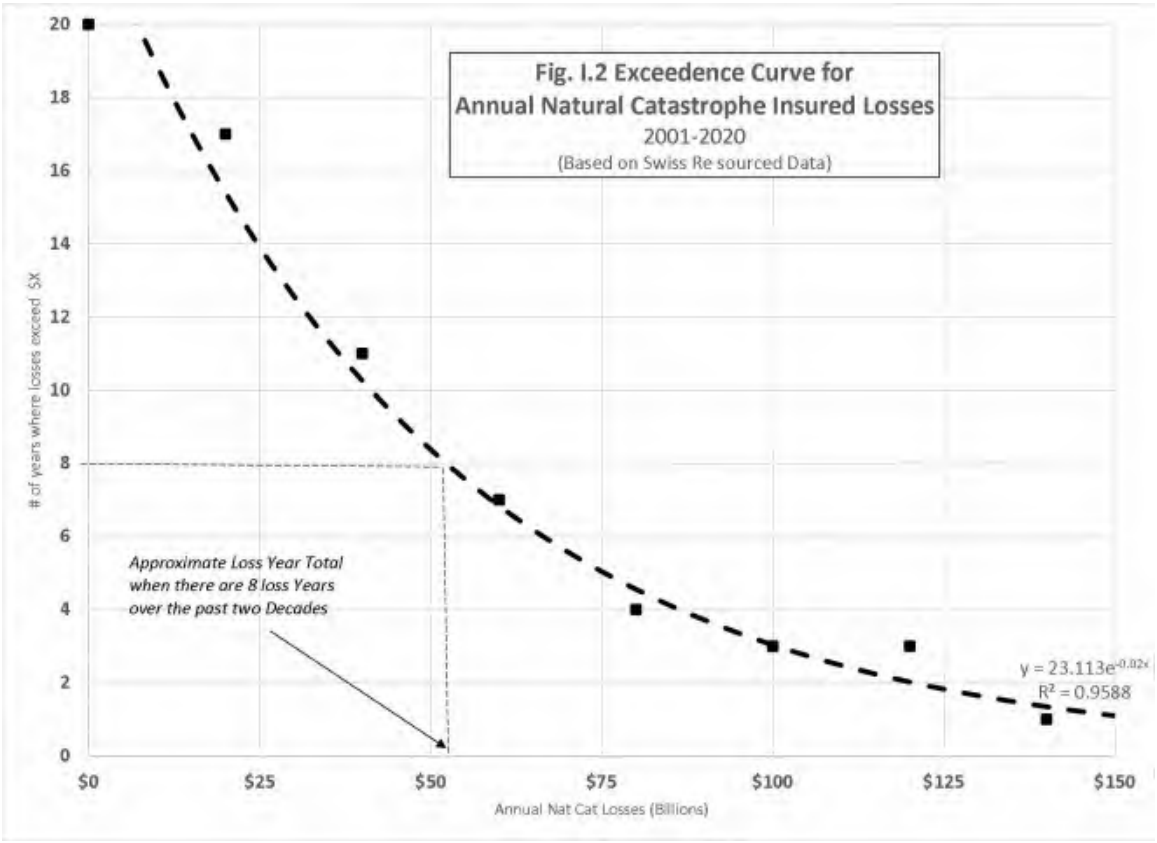



Figure 1.2 Implied or Inferred Exceedance Curve from Swiss Re Data

This last observation can be used to fashion a simple exceedance graph of the background against which the ILS market offers protection – see Fig 1.2. It conveys the frequency with which large versus small catastrophic loss years happen and this will be important in Section 4 of our analysis. To give something of a tease, if there are no large catastrophes there will be no ILS losses. Even if the deals' model/risk analysis has "expected" losses every year, given the remote levels of risk protection, the ILS losses will only occur in years of large losses. No Cat; No Loss. No matter what the model says.

## 2. Historical Issuance

Overview

An overview of the whole ILS market is laid out in Table 2.1. It shows a summary of issuance of all aspects of the ILS market since inception of the market. Our intention here is to demonstrate that while our focus is on Nat Cat issues, there is a rich history of experimentation where ILS cover non-cat perils. In a future world it is to be expected that those other perils (Health, Liability, Finance, Terrorism, Pandemic, as well as Mortgages and Auto perils) will prosper as well as Nat Cat.

**Table 2.1 TOTAL ILS ISSUANCE**

Since Inception, by Type, Total and Issue-Weighted Averages to end **2020**

| | Date of 1st Issue | Limit or Cumulative Face Amount of Issuance (Millions) | Number of Issues or Tranches | Weighted Average Spread at issue | Weighted Average EL SSST | Weighted Average EL WSST |
|---|---|---|---|---|---|---|
| NAT CAT pre-2001 | 1996 | $3,270 | 36 | 5.09% | 0.97% | 0.97% |
| NAT CAT ILS | 2001 | $102,549 | 757 | 6.46% | 2.02% | 2.19% |
| LIFE | 2003 | $4,474 | 40 | 2.04% | 0.27% | 0.27% |
| OTHER* | 2005 | $3,238 | 30 | 3.60% | 0.74% | 0.74% |
| PRIVATE aka CAT-Lite | 2008 | $5,181 | 182 | na | na | na |
| **TOTAL** | | $118,712 | 1045 | 6.16% ** | 1.88% ** | 2.04% ** |

Assumed Average size Lite Isssues $30 million
* Includes Health, Liability, Financial, Terrorism and Pandemic.
** Does not include Lite issues

Table 2.1 Total ILS Issuance. (since inception.)

A couple of features of the comprehensive overview of the ILS universe, aside from the dominating number of deals in the highlighted Nat Cat section of the table, shows that the other sections of the table evidence smaller average deal sizes and significantly lower risks (see average ELs). This shows both experimentation and caution. It is notable that the area under study has succeeded in embracing risk and has done so with more and higher risk over time (see Table 2.2 below). We believe this is in part because the market has grown more and more comfortable with the Nat Cat modeling by AIR Worldwide, RMS and EQECAT. We also note that in much of what follows we have been the grateful recipients of model analysis by AIR

Worldwide. Any mistakes in the interpretation of those models are, however, solely the responsibility of the author.

Further commentary on the non-Nat Cat part of Table 1 is confined to the Appendices.

Table 2.1 shows the aggregate history of the subject ILS. Table 2.2 breaks this total into parts by year-of-issue.

**Table 2.2 Characteristics of Annual ILS Nat Cat Issuance**

2001 - 2020; $millions

| Year | Calendar Annual Total | # of Deals or Tranches | Wghtd Avg Premium | Avg Issue Date | Wghtd Avg PFL | Wghtd Avg EL | Wghtd Avg PFL | Wghtd Avg EL | Maturity TRM |
|---|---|---|---|---|---|---|---|---|---|
| | Limit Issued | | | Date | SSST | SSST | WSST | WSST | Avg Term |
| 2001 | $964 | 11 | 5.35% | 7/17/2001 | 1.06% | 0.66% | 1.06% | 0.66% | 2.4 |
| 2002 | $956 | 20 | 4.57% | 7/20/2002 | 1.09% | 0.76% | 1.09% | 0.76% | 2.8 |
| 2003 | $1,720 | 29 | 4.41% | 9/8/2003 | 1.11% | 0.87% | 1.11% | 0.87% | 3.6 |
| 2004 | $1,143 | 16 | 5.34% | 9/3/2004 | 1.79% | 1.32% | 1.79% | 1.32% | 3.2 |
| 2005 | $1,588 | 15 | 6.35% | 8/25/2005 | 1.94% | 1.54% | 1.94% | 1.54% | 2.5 |
| 2006 | $4,581 | 61 | 8.93% | 8/10/2006 | 2.47% | 1.84% | 2.77% | 2.08% | 2.5 |
| 2007 | $7,031 | 60 | 5.85% | 7/20/2007 | 1.90% | 1.39% | 2.03% | 1.48% | 2.9 |
| 2008 | $2,636 | 26 | 6.78% | 5/23/2008 | 2.07% | 1.46% | 2.26% | 1.59% | 2.8 |
| 2009 | $3,398 | 31 | 10.46% | 8/15/2009 | 2.67% | 1.99% | 2.97% | 2.17% | 2.8 |
| 2010 | $4,799 | 40 | 7.20% | 8/6/2010 | 2.20% | 1.66% | 2.40% | 1.81% | 3.0 |
| 2011 | $4,270 | 33 | 8.79% | 8/11/2011 | 2.75% | 2.16% | 2.96% | 2.32% | 3.3 |
| 2012 | $5,855 | 43 | 9.89% | 6/30/2012 | 2.25% | 2.08% | 2.44% | 2.25% | 3.1 |
| 2013 | $7,382 | 46 | 5.51% | 7/8/2013 | 2.08% | 1.60% | 2.34% | 1.80% | 3.2 |
| 2014 | $8,126 | 36 | 4.87% | 6/27/2014 | 2.16% | 1.54% | 2.38% | 1.72% | 3.6 |
| 2015 | $6,318 | 30 | 4.92% | 6/23/2015 | 2.95% | 2.06% | 3.22% | 2.25% | 3.4 |
| 2016 | $5,590 | 37 | 5.48% | 7/15/2016 | 3.48% | 2.63% | 3.86% | 2.91% | 3.6 |
| 2017 | $10,291 | 68 | 5.36% | 5/30/2017 | 3.40% | 2.56% | 3.70% | 2.77% | 3.5 |
| 2018 | $9,594 | 47 | 4.91% | 5/11/2018 | 2.90% | 2.17% | 3.08% | 2.30% | 3.6 |
| 2019 | $5,284 | 33 | 8.19% | 7/28/2019 | 4.16% | 3.20% | 4.51% | 3.47% | 3.7 |
| 2020 | $11,023 | 75 | 6.91% | 6/23/2020 | 3.10% | 2.36% | 3.38% | 2.55% | 3.1 |
| | $102,549 | 757 | 6.46% | 7/19 | 2.67% | 2.02% | 2.90% | 2.19% | 3.3 |

Note PFL and EL weighted average by deal size.
Shaded area prior to issue of WSST Statistics

Table 2.2 Annual Detail of Nat Cat ILS 2001-2020

Notice several features of this table. First, the early year risk measures as represented by both the EL and the Probability of First $ Loss [PFL][3] started low (like the pre-2001 issues) but has steadily increased. ELs reached a peak in 2019, over 5 times the 2001 level of risk. Also notice two measures of EL risk are given from 2006 and on. That year crystalized a debate for modeling companies over whether the warm weather temperatures in the mid-Atlantic were temporary or longer term. RMS started the practice, followed by other modelers, of quoting both a longer-term estimate of expected loss and frequency of loss, contingent upon the currently warm surface temperatures being temporary - the Standard Sea Surface Temperature [SSST] - and the Warm Sea Surface Temperature [WSST] estimate assuming the elevated temperatures would be much longer lasting. The WSST case in often now referred to as the "Sensitivity" case. That practice has continued now for 15 years and the word temporary takes on new significance. We believe and have written elsewhere (see Lane, M. N. 2018 [35]) that the difference between these two measures is a good proxy for one part of the incremental cost of what is now more commonly referred to as Global Warming and/or Climate Change.

The choice of two measures confronts the investor (and the issuer) with a valuation dilemma. Which estimate is most consistent with their belief? To use 2020 in Table 2.2 as an example, if the issues in that year provide an average annual premium of 6.91% and one believed in the WSST case, then one could expect an annual profit of 4.36% (= 6.91% - 2.55%). Alternatively, believing the SSST case will prevail and temperatures will soon return to long term normalcy would indicate an annual expected profit of 4.55% (= 6.91% - 2.36%).

In practice the marginal buyer determines price, and it is the cautious one - the one who expects the worst of two EL estimates - who will determine price. In much of the following analysis, where WSST EL estimates are available we use that estimate but record both for completeness.

Bearing these remarks in mind consider Figure 2.1 which is based on Table 2.1. Figure 3 illustrates both the rising risks (EL) assumed by the ILS market and the variable pricing associated with those risks. The spikes and dips in pricing correspond to periods of "Hard" and "Soft" markets[4]. The spikes are periods when there is a more aggressive demand for protection from issuers than the appetite for assuming risk among investors - premiums rise as an inducement. Hard markets are said to prevail. The converse defines Soft markets. Notwithstanding the aggregation to issue-year characterizations, the shifting deal characteristics over time show through.

[3] Earlier vesions of this paper had used the Geometric Mean of individual PFLs to represent a particular year's PFL. That may be appropriate for the portfolio of ILS's but subsequently we chose to use the weighted average of PFL's to better summarize the characteristics the average issue in each year.
[4] Regular readers of www.lanefinanciallc.com reports will recognize this graph. However, it should be noted that the regular graph that is updated quarterly uses "Arithmetic" rather than the "Weighted Average" EL and Premiums to illustrate trends used here.

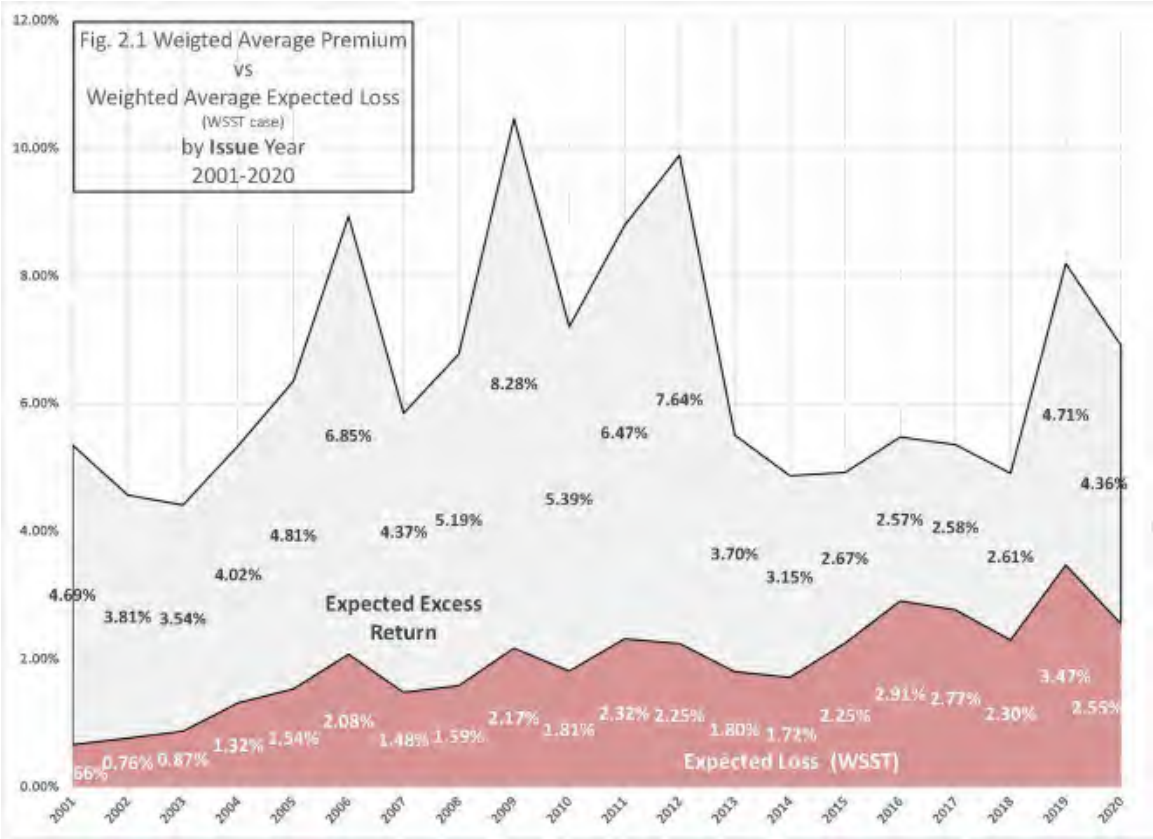



Fig. 2.1 Premium vs. Expected Losses.

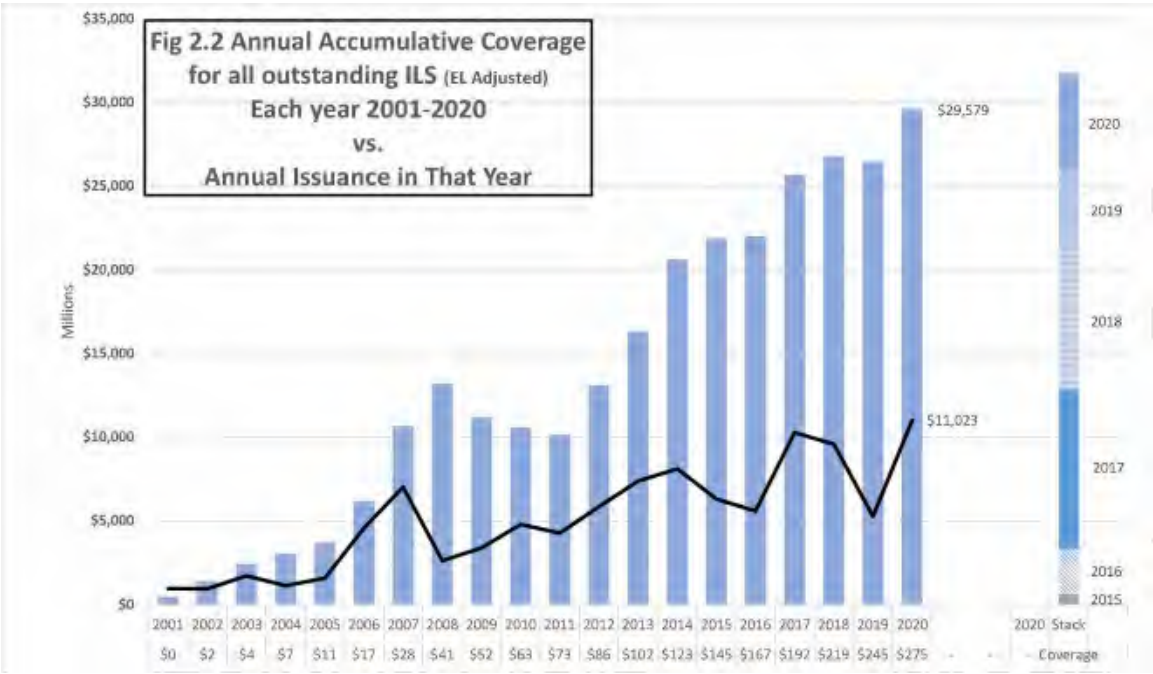



Fig 2.2 Annual Coverage and Annual Issuance

Figure 2.2 shows the strong upward growth of ILS Nat Cat issuance from Table 2.1. It, however, also introduces a concept that will be important when we turn to loss estimates – Still-Outstanding Issues or more specifically Annual Coverage. The cumulative issuance as of 2020 is $102,549 million (corresponding to Table 2.1). However, the cumulative coverage is (we will see later) is $274, 936 million. The right-hand column of Fig.2.2 illustrates. For 2020, ILS from 2015, 2016, 2017, 2018 and 2019 are still on-risk during 2020. This is because they have not matured and/or have not suffered a prior full limit loss. Figure 2.2 illustrates that the limits still exposed are $29,579 million in contrast to the newly issued limit for 2020 of $11,022 million. We will refine this later, but during 2020 in these two numbers - issuance vs. coverage - of the total coverage limit only 34% of the exposure came from new 2020 issues. That feature has become more important to recognize as the Nat Cat ILS market has grown.

Two other observations are in order concerning Table 2.2. First, it is not worthwhile to calculate a formula for premiums vs. risk relationship, in the form of an equation with only twenty annual data points. However, it is possible to look behind the scenes and show the simple regressions on all 757 Nat Cat deals. Simple relationships are shown in Figure 2.3.

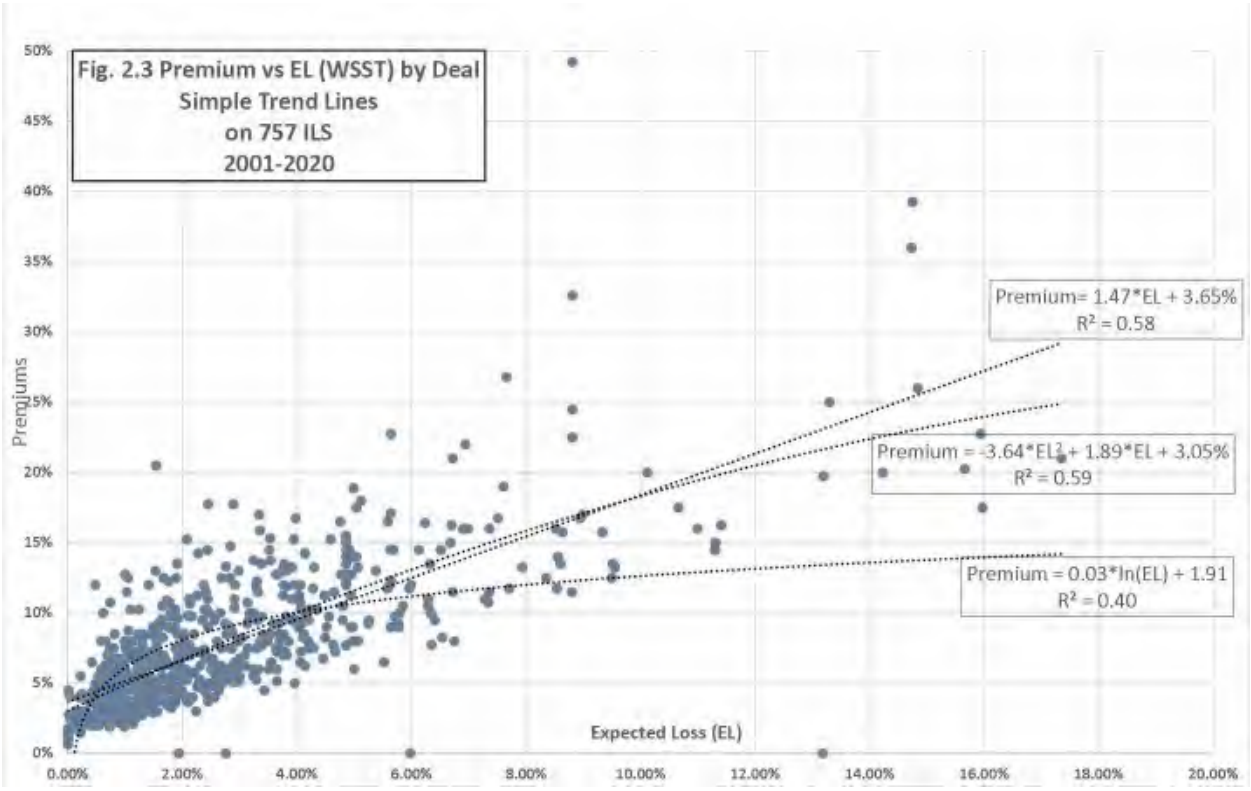



Fig. 2.3 Premium vs. Expected Loss

These three formulaic relationships (Linear, Quadratic and Log-Linear) are not the final word on explaining prices, better models including component perils, financial conditions, and segmentation into Hard/Soft regimes, etc., can be designed. Notwithstanding, the simple equations show that premiums start from a minimum of 2-3% for even the smallest risk and will

rise with higher EL. So that an EL of 4%, say, should command a premium of a little over 9.5% (linear case), a multiple of 2.4 times the risk.

Academics may find the regressions satisfying, but practitioners look for simpler formulas that can be calculated on the fly. They often speak of the multiples of the EL that the premiums represent as a way of comparing one pricing with another. So, from Table 2.2 we can plot each year's Premium multiple against each year's EL (again for simplicity we confine the illustrations to the WSST case).

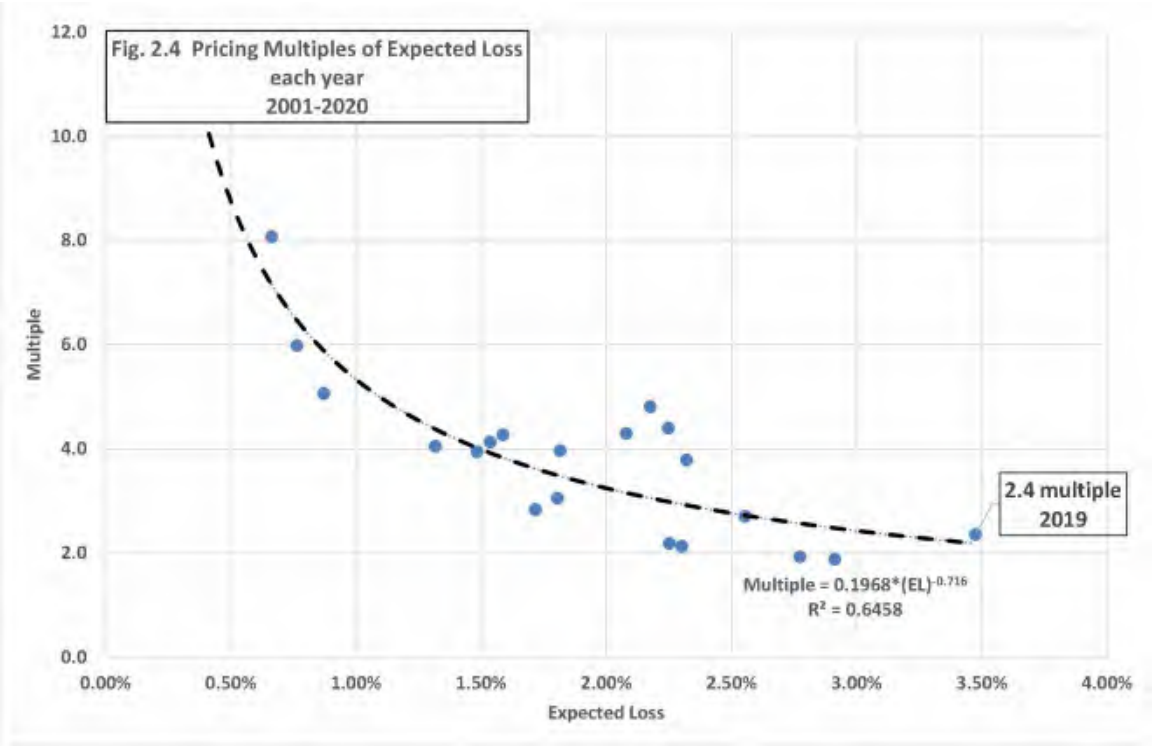



Fig 2.4 Premium Multiples

The plot is laid out in Figure 2.4 and a simple trend line is fitted through the 20 observations. Several things become immediately clear. High premium multiples are required by the market for low-risk deals or years. In the example the weighted average EL for 2001 was 0.66%, the weighted average premium was 5.39% implying a multiple of 8.2 (=5.39%/0.66). Contrast this with 2019 (a high expected loss year) where the multiple was 2.4.

Both the multiple and the regression equation are consistent. What the regression recognizes explicitly is that there is some minimum cost of capital that is going to be charged whatever the risk assumed. The multiple curves do that implicitly.

One other note about the multiple curves and the regressions here is that no allowance is made for whether the year is hard or soft. Once they are filtered out it can be shown that both curves will shift up in hard markets and down in soft markets. While such analysis is availing, it is beyond the scope of the present paper.

## 3. Nat Cat ILS Loss Experience

When catastrophes occur, there is an understandable rush to estimate damages – economic, emotional, and physical – by all concerned. However, the insurance industry, and its child the ILS industry, needs to know something much more specific – resulting insured losses – see e.g., Figure 1.1. In the case of the ILS market, it needs to know how the ILS market is impacted – specifically which deals are the loss-affected, and how much was their loss. That process takes time. Secondary markets for ILS give the first indications of what might be loss-affected – their prices decline. The bigger the decline, the more likely and the bigger is the suspected loss. Then after the smoke clears, so to speak, realities emerge. It becomes clearer which ILS are and are not affected, but the exact amounts may still be unknown. Because of this uncertainty, the settlement of deals is often extended beyond planned maturity to gain time to finalize appropriate claims and calculate final loss. Maturity dates denote the end of the on-risk period; extended maturity dates are the end of the calculation period. The whole process may take several years.

The historical loss experience of the Nat Cat ILS market between 2001 and 2020 is, therefore, defined in three parts, or phases, of that process. The clearest but last phase in the process is the known and closed losses, labelled [K&C] herein. This is the easiest to document, but it rarely applies to the most recent losses – they are still open. Losses on non-closed ILS may still be developing, and their loss can only be estimated.

The intermediate phase of the loss experience is what the traditional market calls 'Incurred but Not Reported', or [IBNR][5] losses. In the case of ILS, these are deals where partial loss payments have been made to cedants thereby recognizing the deal as loss-affected, but the limit of coverage has not yet been exhausted. Further payments may have to be made. In calculating that loss number, we take the 'market estimate' of what that further payment might be. In other words, we take the secondary market price of the remaining limit[6].

The first timewise phase of estimating ILS losses is where no specific loss has been reported but the markets suspect there has been, or will be, a loss from some known event. Price quotes are dropped to reflect that suspicion. The size of the drop in price reflects the 'market estimate' of loss. This is a reasonable enough practice. However, there are other reasons not related to loss for which prices of a particular ILS may decline – changing conditions in the financial markets or non-Nat Cat related events in other parts of the traditional reinsurance market - are just two.

[5] A better acronym might be IBNFR - incurred but not fully reported, but instead we utilize the more familiar IBNR
[6] Secondary market price indications are usually on original issue limit. A convention is developing that when a partial loss payment has been made, price is subsequently quoted on the remaining limit. This creates problems for observers or analysts. The partial payment is not public, different dealers adopt the remaining-limit practice at different times and some may not record the amount of the remaining-limit basis for their quote. This is a confusion could be cured by standardization of practices and/or greater transparency.

Accordingly, we have adopted significant price drops (greater than 20%, leading to a quoted price of less than 80.00) as a way of discriminating between catastrophe loss-affected price drops and other price drops. We define such ILS as 'impaired' for [MTM] for (Marked-to Market) estimated losses. So, a caution, other analysts may use other price discriminators and their estimates of loss will differ from our estimate. Also, one other caution is appropriate, the market can and does make mistakes and changes its mind - suspecting a loss one moment, revising their opinion the next. MTM losses are volatile.

These three categories of loss are detailed in Tables 3.1A and 3.1B on the following pages. Forty three of the 757 ILS issued over the last two decades are listed as loss affected. If we were to consider this frequency as an empirical estimate of the probability of some loss, it would suggest a PFL of 5.68% (= 43 / 757). For reference Table 2.2 shows an expected frequency of 2.90%[7].

Table 3.1A lists the K&C loss-affected ILS. Table 3.1B lists the IBNR and the MTM of loss affected ILS.

Each Table lists a brief description of the Event(s) that caused the loss (far right column), together with the original issue and maturity dates of each affected ILS, the extension of the settlement date, the original premium at issue and a listing of each loss in dollar terms and in % of limit terms. The loss data are organized in columns by type of loss (K&C, IBNR and MTM) and the loss relative to limit as a percentage. Each deal is listed by row and ordered in the sequence in which the causal catastrophic events happened. If multiple events affected a deal it is listed with the first consequential event. Within each event deals are listed by issue date – oldest first.

We should note that all the data in the Tables should come with the label "As far as we know". This not just because of the inherent uncertainty in, for instance, marked-to-market estimates. But it is also necessary because there is a lack of complete transparency in the data. Insurance Linked Securities markets are private markets not public markets. Information is confined to qualified participants and what leaks out is not always full nor complete.

[7] This measure, the probability of first dollar loss or PFL, is a useful indicator frequency of .number of ILS expected to experience loss. It assumes that each ILS is independent. See later in Section 4 for further comments on frequency and independence.

Table 3.1A [K&C] loss-affected ILS deals.

**History of ILS with Natural Castrophe Losses**

(Listed in Loss Event Sequence)

**ILS with Natural Catastrophe Paid Loss of Principal and have Closed**

| Loss Issues a/o 12/31/2020 | Month of Event (+ Indicates Aggregate Loss) | Issue Date | Original Maturity | Extended Maturity | Spread at Issue | Actual or Estimated Loss as a % of Par | Actual or Fully Paid Loss | Partially Paid Known Losses | Market Implied Losses (bid <80) | Total Actual and Est Loss | Investor Payments Pre-Maturity | Loss Triggering Event |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kamp Re | Aug-05 | 7/28/2005 | 3/14/2008 | 12/14/2010 | 5.30% | 76% | $144 | | | $144 | | Katrina, Wilma |
| Nelson Re Class G 2008-1 | Sep-08 | 6/6/2008 | 6/6/2011 | 6/6/2012 | 12.00% | 98% | $38 | | | $38 | | Ike |
| Muteki Ltd | Mar-11 | 5/24/2008 | 5/24/2011 | | 4.40% | 100% | $300 | | | $300 | | Tohoku Earthquake |
| Mariah Re 2010-1 | Mar-11+ | 11/15/2010 | 1/8/2014 | | 6.75% | 100% | $100 | | | $100 | | US Windstorms - Tornado Loss |
| Mariah Re 2010-2 | Mar-11+ | 12/16/2010 | 1/8/2014 | | 8.50% | 100% | $100 | | | $100 | | US Windstorms - Tornado Loss |
| MultiCat Mexico 2012-1 C | Sep-14 | 10/5/2012 | 12/4/2015 | 3/4/2016 | 7.50% | 50% | $50 | | | $50 | | Patricia |
| Gator Re 2014-1 A | Jan-17+ | 3/10/2014 | 1/8/2017 | 11/3/2017 | 6.50% | 18% | $35 | | | $35 | | Aggregate Loss |
| Residentia Re 2013-2 I* | Aug-17+ | 12/3/13 | 12/06/17 | 3/6/2019 | 20.00% | 75% | $60 | | | $60 | | Harvey, Irma, CA WF Aggregate Loss |
| Residential Re 2014-1 B | Aug-17+ | 05/22/14 | 06/06/18 | 9/6/2020 | 14.98% | 100% | $80 | | | $80 | | Harvey, Irma, CA WF Aggregate Loss |
| Residential Re 2015-1 I | Aug-17+ | 05/29/15 | 06/06/19 | 9/6/2020 | 5.96% | 80% | $80 | | | $80 | | Harvey, Irma, CA WF Aggregate Loss |
| Residential Re 2017-1 D | Aug-17+ | 5/3/2017 | 6/6/2018 | | 17.5%* | 100% | $50 | | | $50 | | Harvey, Irma, CA WF Aggregate Loss |
| Atlas IX 2015-1 | Aug-17+ | 03/10/15 | 01/07/19 | 1/7/2021 | 7.00% | 30% | $48 | | | $48 | | Harvey, Irma, Maria Aggregate Loss |
| Manatee Re 2016-1 C | Sep-17 | 3/10/2016 | 3/13/2019 | | 16.25% | 100% | $20 | | | $20 | | Irma, Maria |
| CAR 118 Class A (Mexico) | Sep-17 | 8/4/2017 | 8/11/2020 | | 4.50% | 100% | $150 | | | $150 | | Chiapas EQ |
| Citrus Re 2015-1 C | Sep-17 | 4/8/2015 | 4/8/2020 | | 9.00% | 100% | $30 | | | $30 | | Irma |
| Citrus Re 2015-1 B | Sep-17 | 04/09/15 | 04/09/20 | 4/9/2020 | 6.00% | 100% | $98 | | | $98 | | Irma |
| Citrus Re 2016-1 E | Sep-17 | 02/24/16 | 02/25/19 | 6/25/2019 | 11.03% | 100% | $100 | | | $100 | | Irma |
| Citrus Re 2017-2 B | Sep-17 | 05/11/17 | 03/18/20 | | 10.75% | 100% | $35 | | | $35 | | Irma |
| Residential Re 2018-1 I* | Nov-18+ | 05/14/18 | 06/06/18 | 6/6/2022 | 11.75%* | 100% | $100 | | | $100 | | California Wildfires |
| Cat Phoenix 2018-1 | Nov-18+ | 08/02/18 | 09/13/21 | | 7.50% | 100% | 200 | | | $200 | | California Wildfires |
| CAR 120 | May-19 | 03/07/19 | 02/15/21 | | 6.00% | 30% | $60 | | | $60 | | Peru EQ |
| Atmos Re DAC A | Nov-19 | 03/05/19 | 02/14/22 | | 4.50% | 100% | $51 | | | $51 | | Italy Storms Weather |
| 22 | | | | | | 79% | $1,928 | | | $1,928 | | |

Table 3.1B [IBNR] and [MTM] loss -affected ILS deals

**ILS with Natural Catastrophe Paid Loss of Principal and are still Outstanding**

| | | | | | | $5 | $1 | $E | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Castalanza Re 2017-1 C | Aug-17 | 06/01/17 | 6/04/20 | 16.00% | 96% | | | | | | Harvey, Irma, CA WF Aggregate Loss |
| Residential Re 2018-1 10 | Aug-17+ | 06/11/18 | 06/06/20 | 6/23/2021 | 11.55% | 100% | $46 | $19 | $65 | | Harvey, Irma, CA WF Aggregate Loss |
| Blue Halo 2016-1 B | Sep-17+ | 06/18/16 | 06/21/19 | 6/21/2022 | 19.75% | 85% | $41 | $12 | $53 | | Matthew, Harvey, Irma, Florence |
| Cirrus Re 2017-1-A | Sep-17 | 03/13/17 | 03/18/20 | 3/20/2023 | 5.23% | 99% | $93 | $30 | $123 | | Irma |
| Cirrus Re 2016-1 D | Sep-17 | 02/24/16 | 02/25/19 | 2/25/2021 | 7.85% | 100% | $89 | $61 | $150 | | Irma |
| Caelus Re V 2017-1 D | Sep-17+ | 05/04/17 | 06/05/20 | 5/24/2024 | 9.25% | 86% | $31 | $33 | $64 | $11 | Harvey, Irma, CA WF, Aggregate |
| Akibare Re 2016-1 | Sep-18+ | 03/04/16 | 04/07/20 | 4/7/2023 | 2.28% | 100% | $104 | $96 | $200 | | Jebi |
| | 7 | | | | | 98% | $409 | $253 | $662 | | |

**Currently Outstanding ILS with Market Implied Natural Catastrophe Loss of Principal**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Loma Re 2013-1 C | Aug-17+ | 12/30/13 | 01/08/18 | 1/8/2023 | 17.29% | 77% | | $80 | $50 | | Harvey, Irma, Maria Aggregate Loss |
| Eskalia Re 2015-1 | Aug-17+ | 03/01/16 | 06/09/20 | 3/6/2021 | 5.75% | 35% | | $4 | $4 | $40 | Harvey, Irma, CA WF Aggregate Loss |
| Residential Re 2016-1 10 | Aug-17+ | 06/28/16 | 06/05/19 | 3/6/2021 | 11.00% | 52% | | $26 | $26 | | Harvey, Irma, CA WF Aggregate Loss |
| Caelus Re V 2017-1 C | Sep-17+ | 05/04/17 | 06/05/20 | 5/24/2024 | 6.00% | 95% | | $71 | $71 | | Maria |
| Caelus Re V 2018-1 A | Sep-17+ | 06/10/18 | 06/07/21 | | 3.95% | 20% | | $25 | $25 | | Harvey, Irma, CA WF, Aggregate |
| Caelus Re V 2018-1 B | Sep-17+ | 05/10/18 | 06/07/21 | | 4.64% | 80% | | $45 | $45 | | Harvey, Irma, CA WF, Aggregate |
| Caelus Re V 2018-1 C | Sep-17+ | 05/10/18 | 06/07/21 | | 7.82% | 78% | | $137 | $137 | | Harvey, Irma, CA WF, Aggregate |
| Caelus Re V 2019-1 D | Sep-17+ | 05/10/18 | 06/07/21 | | 10.90% | 95% | | $64 | $64 | | Harvey, Irma, CA WF, Aggregate |
| Frontline Re 2018-1 A | Nov-18 | 06/26/18 | 07/06/22 | | 7.74% | 56% | | $137 | $137 | | Michael |
| Frontline Re 2018-1 B | Nov-18 | 06/26/18 | 07/06/22 | | 11.75% | 95% | | $95 | $95 | | Michael |
| Caelus Re VI 2020-2 A | Aug-20+ | 02/27/20 | 07/07/23 | | 5.50% | 20% | | $16 | $16 | | CA WF, Aggregate |
| Caelus Re VI 2020-2 B | Aug-20+ | 02/27/20 | 07/07/23 | | 7.75% | 45% | | $54 | $54 | | CA WF, Aggregate |
| Caelus Re VI 2020-2 C | Aug-20+ | 02/27/20 | 07/07/23 | | 12.75% | 75% | | $30 | $30 | | CA WF, Aggregate |
| Sanders II 2019-1 B | Aug-20+ | 03/28/19 | 04/07/23 | | 13.80% | 50% | | $150 | $150 | | California Wildfires |
| | 14 | | | | | 58% | | $882 | $882 | | |
| | 43 | Issues with actual and/or M-T-M loss | Average extention period, when extended | 2.1 | | 75% | | $1,135 | $3,472 | | |

Loss Payments indicated are believed accurate although specifics on loss payments - particularly interim payments - are often opaque

* Spread issued at a discount; discount amount shown.

# Interim and final payments are shown in top section, bottom section includes outstanding ILS; the latter ILS are excluded from the count in the lower section to avoid duplication.

At the bottom of Tables 3.1A and 3.1B are some very important statistics summarizing the loss table. As already noted, as of 12/31/2020 43 deals are loss affected, and the sum of all losses, K&C, IBNR and MTM, is $3,472 million. The weighted average term to maturity at issue of all loss-affected deals is 3.42 years. And, when extended, the weighted average time from maturity to extension settlement is 2.1 years.

When a loss is incurred, the weighted average percentage loss, relative to deal limit, is 79%. In the securities market this would be referred to as the 'Loss Given Default' [LGD]. However, default is not quite appropriate in this context and conditional or contingent loss is a more usual description, a natural catastrophe being the contingency for the loss. If we measure the loss as a % of limit in each deal, the answer varies from deal to deal and by category of loss. For K&C losses the average observed loss is 77% of limit. For IBNR losses it is 98% and for MTM losses it is 58% for an overall weighted average of 74%.

While merely interesting at this point these are important ingredients that feed into the narrative to be discussed in Section 4 of this paper – Marrying Experience to Expectations.

To illustrate the nature of loss information in Tables 3.1A and 3.1B, which records the situation as of 12/31/2020, and to show how those estimates have evolved and accumulated over time, see Figure 3.1. The breakdown into the three types of loss is only detailed post the catastrophes of 2017 – hurricanes Harvey, Irma and Maria and the Mexico earthquake.

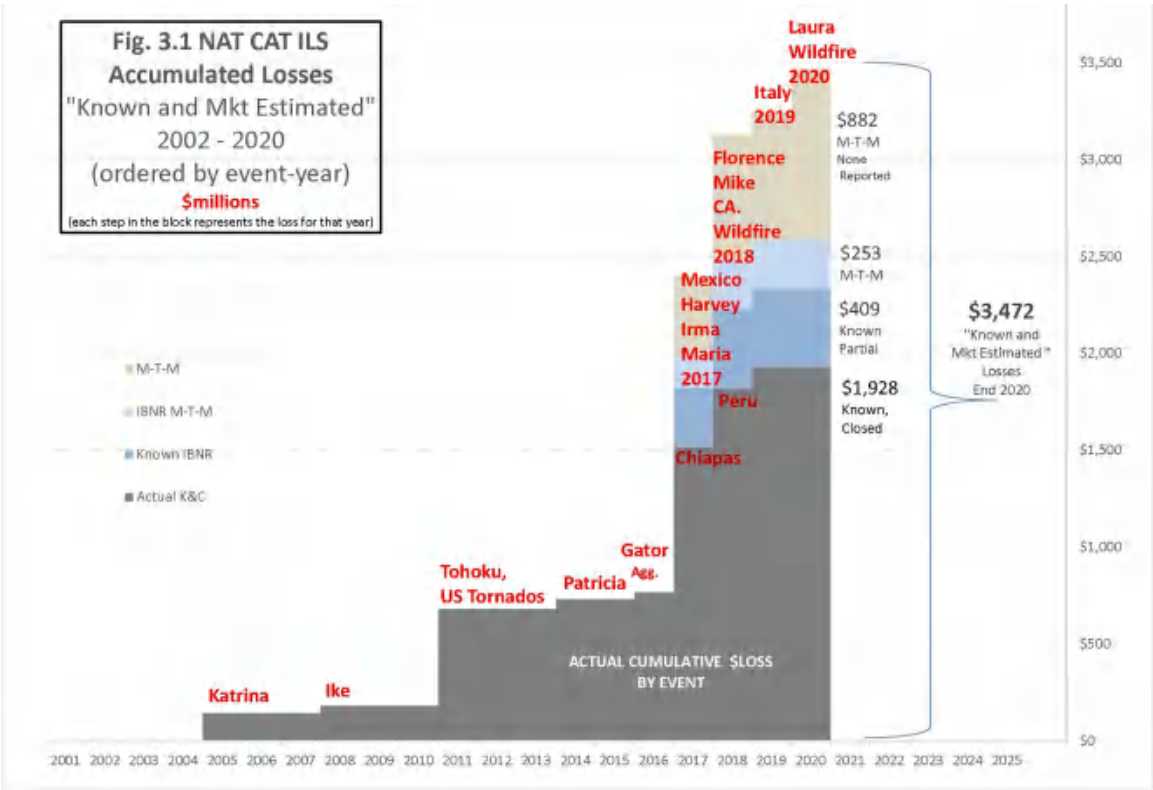



Fig. 3.1 Accumulated Losses 2001-2020

The year-by-year character of losses is also shown in Table 3.2 below mimicking the earlier presentation of issue characteristics in Table 2.2.

**Table 3.2 LOSS AFFECTED ILS ORGANISED BY ISSUE YEAR**

| | ILS Principal Amount Millions | # | Loss amount Millions | Loss % | Premium or Spread | PFL Wghtd Avg WSST | EL Wght Avg WSST |
|---|---|---|---|---|---|---|---|
| 2001 | | | | | | | |
| 2002 | | | | | | | |
| 2003 | | | | | | | |
| 2004 | | | | | | | |
| 2005 | $190 | 1 | $144 | 76% | 5.30% | 1.46% | 1.26% |
| 2006 | | | | | | | |
| 2007 | | | | | | | |
| 2008 | $368 | 2 | $338 | 92% | 5.80% | 1.79% | 1.25% |
| 2009 | | | | | | | |
| 2010 | $200 | 2 | $200 | 100% | 8.50% | 5.41% | 3.77% |
| 2011 | | | | | | | |
| 2012 | $100 | 1 | $50 | 50% | 7.50% | 5.58% | 4.29% |
| 2013 | $145 | 2 | $110 | 76% | 18.66% | 17.89% | 11.88% |
| 2014 | $280 | 2 | $115 | 41% | 8.93% | 7.67% | 4.47% |
| 2015 | $428 | 5 | $281 | 66% | 7.15% | 5.52% | 3.79% |
| 2016 | $640 | 7 | $591 | 92% | 8.00% | 6.98% | 4.71% |
| 2017 | $517 | 7 | $500 | 97% | 7.67% | 7.42% | 5.43% |
| 2018 | $1,300 | 9 | $863 | 66% | 7.44% | 5.42% | 3.92% |
| 2019 | $351 | 2 | $201 | 57% | 11.13% | 2.06% | 1.57% |
| 2020 | $190 | 3 | $79 | 41% | 7.91% | 3.32% | 2.36% |
| | $4,708 | 43 | $3,472 | 74% | 8.08% | 5.60% | 3.91% |

**ORGANISED BY EVENT YEAR**

| Event Year | ILS loss by Event year Millions | Swiss Re Global Cat Loss Millions | ILS Loss Recovery % |
|---|---|---|---|
| 2001 | | $16,625 | |
| 2002 | | $20,825 | |
| 2003 | | $25,217 | |
| 2004 | | $63,819 | |
| 2005 | $144 | $135,263 | 0.11% |
| 2006 | | $16,894 | |
| 2007 | | $30,142 | |
| 2008 | $38 | $53,101 | 0.07% |
| 2009 | | $27,167 | |
| 2010 | | $53,929 | |
| 2011 | $500 | $135,528 | 0.37% |
| 2012 | | $74,019 | |
| 2013 | | $39,228 | |
| 2014 | $50 | $32,039 | 0.16% |
| 2015 | | $30,193 | |
| 2016 | | $49,584 | |
| 2017 | $1,668 | $144,610 | 1.15% |
| 2018 | $732 | $84,013 | 0.87% |
| 2019 | $111 | $51,973 | 0.21% |
| 2020 | $229 | $75,900 | 0.30% |
| | $3,472 | $1,160,069 | 0.41% |
| Cndl Average | $434 | $89,053 | 0.49% |
| Correlation | | 90% | |
| Conditional Correl | | 63% | |

Table 3.2 Loss affected ILS by Year of issue and Year of Event.

The left-hand box shows the loss affected data by year of issue. So, for example in the issues from 2015, 5 ILS were loss affected, representing a principal limit of $428 million, which incurred a loss of $281 million by end of 2020. The apparent loss, given that there was a loss, was 66% of potential limit. To round things out the premium or spread on those loss affected issues was 7.15% and the PFL and EL were respectively 5.52% and 3.79%. This was a multiple of 1.89 (= 7.15%/3.79%). Considering all the issues of 2015, shown in Table 2.2, the multiple was 2.18 (= 4.92%/2.25%). Evidently these loss-affected ILS were not as well priced as the average issue that year.

The totals of the loss affected ILS are also shown and will be referred to again shortly.

Finally notice in Table 3.2 the right-hand panel. It shows the same loss affected ILS but now arranged by the year of the catastrophic event that caused the loss. We place those losses alongside the annual Swiss Re Global Nat Cat Loss numbers to reinforce two points already alluded to. First, it is only in large global Nat Cat years that ILS markets have experienced a loss.

Second, because any year's coverage of loss can come from previously issued ILS the event year loss numbers are different from issue year numbers, a point to which we will return.

One other way to illustrate the nature of the losses in Table 3.1A and 3.1B is shown in Figure 3.2. This bar chart again organizes loss by event year, but visually shows each loss-affected deal and the K&C share of the limit together with the IBNR and MTM components, shown in different colors.

Fig. 3.2 Loss affected ILS status by K&C, IBNR, and MTM

What is noticeable in this showing is the size of the losses. Early losses were considerably larger but were singular and full limit losses. In the most recent occurrences, the loss events have affected more, but smaller, deals. As we will learn this observation is consistent with the idea that deals lower down in the risk structure (i.e., riskier) are smaller in size. It can also be seen that the most recent events are the ones with losses still in the MTM status. With these observations in mind, it is time to look closer at other aspects of the character of these 43 loss-affected ILS.

How do Loss-Affected ILS differ from Non-Affected ILS?

A reasonable question at this point is, is there something about the loss-affected ILS that distinguishes them? Part of the answer is displayed in Table 3.3.

| Table 3.3<br>NAT CAT ILS ISSUES | # of CUSIPs | Wghtd Average Issue Date | Wghtd Average Maturity | Wghtd Average Term, Years | Average Issue Size in USD millions | Wghtd Spread (Premium) at Issue | Wghtd Average SSST Annual PFL at Issue | Wghtd Average SSST Annual Expected Loss At Issue | Wghtd Average WSST Annual PFL at Issue | Wghtd Average WSST Annual Expected Loss At Issue |
|---|---|---|---|---|---|---|---|---|---|---|
| NAT CAT ILS with a LOSS | 43 | 9/18/2015 | 2/16/2019 | 3.42 | $109 | 8.08% | 5.17% | 3.58% | 5.60% | 3.91% |
| NAT CAT ILS without a LOSS | 714 | 11/4/2013 | 2/2/2017 | 3.25 | $137 | 6.38% | 2.51% | 1.94% | 2.73% | 2.11% |
| ALL NAT CAT ILS 2002-2020 | 757 | 12/6/2013 | 3/8/2017 | 3.26 | 135 | 6.46% | 2.66% | 2.02% | 2.90% | 2.19% |
| Fraction of Loss Deals | 5.68% | | | | | | | | | |
| Difference between Loss Deals and Non Loss Deals | | | | 0.17 | $27 | 1.69% | 2.65% | 1.63% | 2.87% | 1.80% |

Table 3.3 Nat Cat issues with and without Loss

Table 3.3 separates the loss-affected deals from the rest of the universe and highlights their differences. As already noted, there are 43 of the 757 with losses (5.68%) leaving 714 untouched by loss. Looking at the weighted average of issue dates, the 43 have been more recent issues. Of course, this could simply be because catastrophe loss events have picked up in frequency in recent years. However, combined with the weighted average maturity dates, the loss-affected deals have been issued with longer than average maturity 3.42 years vs. 3.25 years. Again, it may stand to reason that being on-risk for longer may increase your chance of loss.

Moving further along the comparison rows of Table 3.3 some more pertinent statistics are revealed. First, the average size of the 43 is smaller than the other 714 deals - $109 million vs. $137 million, confirming the visual impression in Figure 3.2. Second, the premium, received annually on top of the floating rate, on the losing deals is higher than the remainder, 8.08% vs. 6.38%, a significant 169 basis points of additional premium. This is certainly not enough to compensate for the losses incurred. It would have to be combined with premiums from the rest of the portfolio to make that assessment - a task we turn to later.

Jumping to the WSST case (the SSST case leads to the same conclusions with slightly lower numbers) observe that a) the loss-affected deals had a much higher annual probability of some loss (PFL), 5.60% vs. 2.73%, and b) a significantly higher expected loss, 3.91% vs. 2.11%. You get what you pay for. If you invest in deals with almost double the chance of loss, by either measure, you will likely be twice as likely to lose. Also, the 168 basis points of premium hardly compensates for the incremental 180 basis points of expected loss (180bps =3.91%-2.11%)

If nothing else, the examination of these results provides strong collateral evidence of the accuracy of Nat Cat risk models. But we can dig even deeper in this regard.

Among the information given to investors in the risk analysis is a breakdown of expected loss into its component perils. Thus, in Table 3.4 we lay out the weighted average component perils for the deals with and without loss.

| Table 3.4 Component Perils Analysis* | Annual EL | US Hurricane | US Wind storm | US Quake | Euro Wind | Euro Quake | Japan Wind | Japan Quake | Other CAT** |
|---|---|---|---|---|---|---|---|---|---|
| **WSST Case** | | FRACTION OF EXPOSURE BY PERIL | | | | | | | |
| LOSS DEALS | 3.91% | 61% | 12% | 6% | 0% | 0% | 1% | 1% | 18% |
| NON LOSS DEALS | 2.11% | 57% | 2% | 18% | 9% | 0% | 1% | 2% | 10% |
| ALL NAT CAT ILS | 2.19% | 58% | 3% | 17% | 8% | 0% | 1% | 2% | 10% |
| What we expected;what we got - | | | | | | | | | |
| ACTUAL LOSS | 3.91% | 47% | 6% | 0% | 0% | 0% | 6% | 9% | 33% |
| SSST Case | | FRACTION OF EXPOSURE BY PERIL | | | | | | | |
| LOSS DEAL | 3.58% | 58% | 13% | 7% | 0% | 0% | 1% | 2% | 20% |
| NON LOSS DEALS | 1.94% | 54% | 2% | 20% | 9% | 0% | 1% | 3% | 11% |
| ALL NAT CAT ILS | 2.02% | 54% | 3% | 19% | 9% | 0% | 1% | 3% | 11% |

* Note Component Breakout not available for all deals - 95% included.
** 'Other' CAT includes newer peril models such as Mexico Quake and US Wildfire.

Table 3.4 Component Peril Comparison ILS deals with and without loss.

Examining the WSST case once again (the SSST provided for the record) two things immediately jump out. First, between Hurricane and Windstorm perils, loss affected deals took on significantly more wind risk than the non-loss deals. Specifically, it is expected that 73% (= 61+12%) vs. 59.% (= 57%+2%) for an increase of nearly 14% expected from wind exposure. The second stand out is in 'Other' perils. Again, loss deals expected more exposure in Other perils, by a significant amount. The 'Other' category will often include new perils such as earthquake exposures in Mexico and new coverages such as Wildfire. Significant losses have occurred in both these perils.

To complete the component peril analysis a line is added recording the actual losses broken down by the peril causing the loss. Actual attribution of loss to peril type is not an unambiguous exercise, however using a best-efforts approach the answer is presented in the middle of Table 3.4. Shockingly, the 'Other' peril category was a cause of loss to an even greater degree than expected – a third of actual loss came from that category. Perhaps it should provoke investors to be more cautious of newer perils and their initial models e.g., Wildfires.

Another query about the loss-affected ILS is where they sit in the risk structure. Are they single peril or multiperil structures? Are they independent single-layer structures, or are they layered tranches stacked one upon another? The multiperil answer is easy enough. Of the loss-affected deals 60% are multiperil deals. The universe contains 50% multiperil.

Table 3.5 provides insight into the layer structure. Of the 43 deals which were

**Table 3.5**

| Range of Structures | With Loss | All | % of Loss in Total ILS | Avg Size All Issues | Limit by Layer |
|---|---|---|---|---|---|
| Independent | 15 | 330 | 4.5% | $159 | $52,306 |
| Junior | 18 | 177 | 10.2% | $103 | $18,294 |
| Snr 1 | 7 | 177 | 4.0% | $133 | $23,588 |
| Snr 2 | 2 | 55 | 3.6% | $108 | $5,934 |
| Snr 3 | 1 | 12 | 8.3% | $131 | $1,570 |
| Snr 4 | | 5 | | $167 | $833 |
| Snr 5 | | 1 | | $25 | $25 |
| | 43 | 757 | 5.68% | $135 | $102,549 |

Note Tranche/Seniorirty not unabiguous

Table 3.5 Range of Structures of Loss affected ILS

loss-affected 15 were single layer, independent deals, which means that 27 were part of some multi-tranche[8] layer structure. Of these, 1 had losses that blew through the junior and 3 senior layers, 2 went through 3 layers, 7 through two layers and 18 only invaded the junior tranche. This suggests an alternative interpretation of the smaller size of the deals with a loss. It is that they are simply disproportionately junior, and these tend to smaller size – see average size.

An investor confronted with an ILS issue that has multiple tranches, might conclude that it may reduce overall losses to avoid the junior tranche. Such a strategy will not, of course, avoid loss, but if history is any guide, it may lessen the probability of loss. Then again, perhaps these tranches have been relatively underpriced and if investors avoid them prices may correct sufficiently to justify the risks associated with them.

**Table 3.6**

**Loss-affected Tranches, by Cedant Frequency**

| Cedant Name | # | LIMIT | Tranche's Names |
|---|---|---|---|
| Nationwide Mutual | 9 | $790 | Caelus Re |
| USAA | 8 | $575 | Residential Re |
| Heritage P&C, Zephyr Ins. | 5 | $503 | Citrus Re |
| American Family Ins | 2 | $350 | Frontline Re |
| First Protective Ins; Frontline Ins. | 2 | $200 | Mariah Re |
| | 26 | $2,418 | |
| Out of total of | 43 | $4,708 | |

Table 3.6 Loss Affected Tranches by Cedant Frequency

[8] The classification of tranches into multi-layered structures is somewhat judgmental. Not all tranches are immediately adjacent in structure or time or loss. Notwithstanding, we believe the designations to be fair representations of cedant intent.

Finally, in this section it is also worth noting the most frequent cedants or claimants involved in a loss. They are listed below in Table 3.6. Notably they identify two issuers (USAA and Nationwide Mutual) who have traditionally issued multi-layered adjacent tranches. Both are US based and both are heavily exposed to hurricane, windstorm, and wildfire risk. Both are indemnity issuers. As we have remarked elsewhere[36] USAA has been a consistent ILS issuer for all the 20 years under exam here. USAA has also consistently expanded its coverage, e.g., introducing Wildfire and Aggregate covers first in 2008. It is those two expanded coverages where claims have arisen in the last three years.

Aggregate as opposed to Occurrence coverage has grown in popularity for all issuers in recent years, to the consternation of certain investors, who feel they are unforgiving structures and probably are underpriced. It shows up in our post-mortem of loss affected deals. Sixty percent (26 of the 43) of loss affected deals are Aggregate in nature. In the universe of non-loss-affected deals the fraction of Aggregate deal is only 33%. Perhaps in future, Aggregate deals will find less accepting investor markets and prices will adjust accordingly.

## 4. Marrying Experience to Expectation.

There are many ways to ask the objective of this section [9]. Does experience marry up to expectations? Did what we expected equal what we got? And so on. At a more elevated level we were driven by the question of whether you could rely on Nat Cat models. Did quantified expected loss measures predict what losses one experienced? Were the models any good?

This is a most important question, but it is a difficult one to answer - even more difficult the closer one looks. And we believe it is not a question satisfactorily addressed even in the academic literature about defaults in other fixed income securities. Indeed, in none of those markets is there a benchmark (such as the Nat Cat Models) against which to precisely gauge the answer to the main question. Rating agency letter ratings are a poor surrogate for the precision of a PFL and an EL and, confusingly, Moodys uses the former (frequency), S&P the latter (expected loss) for their corporate bond ratings

Arguably Ratings Agencies got their start by going from empirical observations to implied frequencies or expectations of default. Academically the early work of Altman[2,3,4], Dwyer[14] and Duffie[13] all went from numbers to estimated probabilities. This paper travels in the opposite direction, from probabilities to actual numbers. ILS present a unique opportunity for such analysis – if one can get it right.

This overview is by way of admitting that our own prior examinations have been too superficial and insufficiently well-reasoned. We were perhaps guilty of 'confirmation bias'. We may still be, since our gut tells us that the Nat Cat models behave quite well. However, it is well to start again at the beginning in a more thorough examination of expectations and experience.

Expected Loss and Expectations

In Part I and II of this paper we made free reference to Expected Loss [EL] as if there was no ambiguity about its meaning. There is. But we are not alone in making that assumption, the academic literature is replete with models using EL without qualification.

At the most elemental level the EL is usually provided by the Nat Cat modeler engaged by the underwriting issuer of the bond. The OC EL is therefore seen as the appropriate EL to use in assessing risk. But if AIR Worldwide is the modeler, RMS may not agree and vice versa. Indeed, the modelers make a practice of remodeling each other's work, based on available public data. In the data herein we are not using re-modeled data but the OC EL. Thus, as a consequence, it must be recognized that EL comes from different source modelers.

[9] For several years, we sought to ask the question implied by the title of this section, most recently with a provocatively titled article *"Losses in your ILS portfolio; well, what did you expect?"* (see www.lanefinancialllc.com 2019). That was preceded by two earlier papers along the same lines entitled "*The Loss File – WYSIWYG, 2013*" and "*After H.I.M - WISIWYG II, 2017"* respectively. The present paper corrects many of the flaws of previous attempts. A few colleagues wrote privately pointing out flaws in previous papers. I would like to thank Andy Sterge for his written comments then, and for helpful insights on this draft. Also, the people who made questioning remarks at presentations of the earlier work in the 2019 Singapore Artemis ILS Asia conference.

Similarly, each of those modelers will add new versions of their models from time to time and at different times one to another. We make no adjustment for that, taking the most recent data available.

OC reported EL is the 'annual' EL. It is not the expected loss on the transaction over its whole life, about which more below. Also, while we can think of some risks being exposed linearly over time (earthquake) others are distinctly seasonal (Atlantic hurricanes). Premiums are paid out linearly (equal amounts quarterly). In the analysis herein we also think of expected loss in the same way – recognizing this as imperfect.

Then there is the matter of "resets".

The OC annual EL is truly accurate for the instant the bonds are issued. Post issue, circumstances change and may cause a new assessment of risk to be different from its original level. Some deals recognize this possibility, ahead of time, and will periodically reevaluate the risks during the life of the bond. When there is a significant departure from initial EL they will reset. This can take the form of an adjustment to premium (up or down). It could also leave the premium unchanged and adjust the trigger point. Not all deals do this and, once again, non - investors may be uninformed about such changes.

We assume that annual risks stay constant year to year at their initial EL level, there being no other data consistently available. We only override the original OC EL if there is a known reset or if there is a *significant* loss - prices below 80.00. Secondary market price shifts can imply a market post issue re-assessment of EL, but they may also emanate from other, non-risk causes. New capital flowing to or from the insurance market, for example. We assume, as already noted, that secondary prices below 80.00 are not just a re-assessment of higher expected loss or new capital flows, but market acknowledgments of real loss of committed capital.

Deal Lifetime Expected Losses

In earlier analyses we assumed that since the bond can only fully default once in its lifetime, we can use the annual expected loss as the lifetime expected loss. The one total loss assumption (pay-off) is correct, but the probability associated with that pay-off is not. Simply put, if we examine a binary payoff bond, it can only default once, but it can do that, in a 3-year bond, in the first, second or third year.

To illustrate, if we image (for simplicity) an ILS with a three-year maturity that is binary (i.e., either no loss, or full loss) we can see how the maturity of the bond affects expectations. (This simple construct will become part of our proxy model later.) Table 4.1 illustrates the possible outcomes. There are four. No loss during its term and a single loss in any of the three years. Of course, if there is a loss in the third year, it must be because there was no loss in the first two years. When the probability of loss is p (in the example p=0.0219, or 2.19%), then the probability of a third-year loss is (1-p)*(1-p)*p or in our example 0.02095128 as shown in the table. The same math works for each of the 4 outcomes. When the outcomes are multiplied by

**Table 4.1 Binary ILS**

| Assumptions | | Year 1 | Year 2 | Year 3 | | Amount of Loss | Probability of Loss |
|---|---|---|---|---|---|---|---|
| ILS | | | | | No Loss | 0 | 0.93572833 |
| Term | 3 | | | | Loss 3rd Year | 100% | 0.02095128 |
| EL | 2.19% | | | | Loss 2nd Year | 100% | 0.02142039 |
| Binary | Yes | | | | Loss 1st Year | 100% | 0.0219 |
| CEL=1 | | EL Yr 1 | EL Yr 2 | EL Yr 3 | | | 1 |
| | Cumul EL | 2.19% | 4.33% | 6.43% | | Life PFL | 6.43% |
| | Ann EL | 2.19% | 2.17% | 2.14% | | Life CEL | 100% |
| | Exp LIMIT | 97.81% | 95.67% | 93.57% | | | |
| Amount | $ 100 | | | | | | 100% |

Table 4.1 A Binary ILS – with associated probabilities of outcomes.

the probabilities and summed the result is a lifetime expected loss of 6.43%. Notice that the average annual EL is 2.14% (= 6.43%/3) which is different from the original EL (=2.19%, which is the overall weighted average of the 20 years). There is something of a circular argument here. For this reason, the OC EL is sometimes reported as the first year EL. This is somewhat elementary, but it is easy to miss and can make a big difference over a longer horizon.

Timing of Issuance

One other detail of issuance also needs clarification if we are to use the data in Table 2 for our proxy model to estimate expectation of losses. Table 2 exposes the fact that not all deals start at the beginning of the calendar year. In fact, the overall average inception or issue date is in July – right at the beginning of the North Atlantic hurricane season. These days, the pre-hurricane season ILS account for the bulk of annual issues. Of course, if the term of an issue is exactly 3 years there will also be a stub through June in the final maturity year. Just as it is important to acknowledge lifetime expected loss, it is equally important to take account of timing of the start and end of the exposure for each annual deal. In what follows we apply fractions of the calendar year to EL to apportion the risk more accurately over time.

Proxy Model to Estimate Expectations 2001-2020

In designing a model to capture the movements of expectations given the last 20 years of issuance - our proxy model - we could continue to build on the binary model highlighted above. We have chosen to use a slightly more realistic model, two stage binary model that behaves as follows. Each year of issue there is a probability of loss equal to that year's PFL and an EL equal to the listed number in Table 2.2. However, when there is a loss, it is equal to the Conditional Expected Loss [CEL]. In each year, the deal is on-risk, the potential loss is confined to the CEL of the initial limit or if there was a prior loss, the remaining limit. We further restrict losses to two before the process is terminated.

For those who like the bucket-of-balls high-school-statistics analogies, think of a bucket of red and white balls in proportion of the probabilities of some loss (red) and probabilities of no loss (white). Each year you get to draw one ball. White - you are loss free that year. Red – you

have a CEL loss. This continues until the deal matures (loss free) or you draw two red balls (loss at 94% of limit).

**Table 4.2 Proportionate Two Step Losses**

| Assumptions | a) 1 Event per period b) CEL is %Loss each Event c) 2nd Loss on remaining Limit d) Only 2 loss events over term of the ILS | Amount of Loss | Probability of Loss |
|---|---|---|---|
| | Year 1 Year 2 Year 3 Year 4 | | |
| ILS | No Loss | 0% | 0.8889492 |
| Term 4 | 1st Loss 4th Yr | 76% | 0.0265495 |
| EL 2.19% | 1st Loss 3rd Yr | 76% | 0.0265495 |
| Two Step | 1st Loss 3rd Yr; 2nd 4th Year | 94% | 0.0007929 |
| CEL | 1st Loss 2nd Yr | 76% | 0.0265495 |
| Amount $100 | 1st Loss 2nd Yr; 2nd 4th year | 94% | 0.0007929 |
| | 1st Loss 2nd Yr; 2nd 3rd Year | 94% | 0.0008166 |
| PFL 2.90% | 1st loss 1st Yr | 76% | 0.0265495 |
| CEL* 75.5% | 1st loss 1st Yr; 2nd 4th Year | 94% | 0.0007929 |
| | 1st loss 1st Yr:2nd 3rd Year | 94% | 0.0008166 |
| | 1st loss 1st Yr; 2nd 2nd Year | 94% | 0.000841 |
| | | | 1 |

| | EL Yr 1 | EL Yr 2 | EL Yr 3 | EL Yr 4 | Average | | |
|---|---|---|---|---|---|---|---|
| Cumul EL | 2.19% | 4.33% | 6.43% | 8.48% | 2.12% | Life PFL | 11.11% |
| Ann ELs | 2.19% | 2.17% | 2.14% | 2.12% | 2.15% | Life CEL | 76.3% |
| Exp LIMIT | 97.81% | 95.67% | 93.57% | 91.52% | | | |

NOTE EL and PFL determine CEL
*NOTE This is % of LIMIT loss

Table 4.2 The Proxy ILS Model – Two-step process

The use of the CEL is derived from the observation that EL = PFL* CEL for every deal. We referred earlier to our historical observations of size of loss post-event, as the equivalent of loss given default in other fixed income studies. This is the pre-event expectation of that relationship[10].

Table 4.2 shows the process at work for an individual bond. Instead of the simplified outcome graph of Table 4.1 with 4 possible outcomes, the two-stage model in Table 4.2 has 11 possible outcomes with associated probabilities. Remarkably, despite the appeal of a more complex proxy model described – the two stage losses - the conclusions to be drawn are almost the same as they would be with the binary model where CEL=1. That would also be true if we had a three-stage model, or even one with proportionate payout, as long as, the comparison preserves the original EL and PFL character. Accordingly, in what follows, we painstakingly lay out the details for the two-stage model and show what a prescient investor could expect in the way of losses. Prescient in the sense that in 2001 he tries to imagine the losses that could be expected if he knew the details of the ILS to be issued in the next 20 years.

We assume that each year, a single ILS is issued with the characteristics displayed in Table 2.2. For example, the proxy ILS for 2001 would have a limit size of $964 million, would be issued on 7/17/2001 with a risk spread or premium of 5.35% with risk statistics of PFL of 1.07%, an annual EL of 0.66% and the deal would have a term of 2.4 years. This is exactly the DNA of the 11 deals issued in 2001, summarized as one.

[10] For a much earlier use of this relationship in the ILS context see Lane 2000[27].

The consequence is laid out in detail in the first line of Table 4.3A. The fraction[11] of the year the deal is exposed in 2001 is 0.4553 (after issue on 7/17/2001). Therefore. the expected loss for 2001 is 0.66%*0.4553. In the second year the expected limit is 0.9934 (=1- 0.66%) and so expected loss is 0.66%*0.9934 =0.6556% . And in the third year since the 2001 deal ends before year end, 0.9628th of the year, the expected limit is 0.9501 (=0.9628*(1-0.66%)^2).

**Table 4.3A PROXY MODEL FOR ASSESSING EXPECTED LOSS (2001-2010) - Given foresight about future issuance**

| | Size | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | $964 | 0.4553 | 0.9934 | 0.9501 | | | | | | | |
| 2002 | $956 | | 0.45 | 0.99 | 0.98 | 0.32 | | | | | |
| 2003 | $1,720 | | | 0.31 | 0.99 | 0.98 | 0.97 | 0.31 | | | |
| 2004 | $1,143 | | | | 0.32 | 0.99 | 0.97 | 0.83 | | | |
| 2005 | $1,588 | | | | | 0.35 | 0.98 | 0.97 | | | |
| 2006 | $4,581 | | | | | | 0.39 | 0.98 | 0.96 | 0.10 | |
| 2007 | $7,031 | | | | | | | 0.45 | 0.99 | 0.97 | 0.40 |
| 2008 | $2,636 | | | | | | | | 0.61 | 0.98 | 0.97 |
| 2009 | $3,398 | | | | | | | | | 0.38 | 0.98 |
| 2010 | $4,799 | | | | | | | | | | 0.40 |
| 2011 | $4,270 | | | | | | | | | | |
| 2012 | $5,855 | | | | | | | | | | |
| 2013 | $7,382 | | | | | | | | | | |
| 2014 | $8,126 | | | | | | | | | | |
| 2015 | $6,318 | | | | | | | | | | |
| 2016 | $5,990 | | | | | | | | | | |
| 2017 | $10,291 | | | | | | | | | | |
| 2018 | $9,594 | | | | | | | | | | |
| 2019 | $5,284 | | | | | | | | | | |
| 2020 | $11,023 | | | | | | | | | | |
| Total | $102,549 | | | | | | | | | | |
| # of Deals outstanding | | 5 | 20 | 40 | 54 | 57 | 84 | 126 | 139 | 104 | 98 |
| # Of Deals Expected with Loss | | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 2 |
| Limit Outstanding during Year | | $439 | $1,387 | $2,402 | $3,018 | $3,674 | $6,145 | $10,658 | $13,184 | $11,148 | $10,579 |
| Weighted Average WSST EL | | 0.66% | 0.69% | 0.74% | 0.89% | 1.11% | 1.34% | 1.57% | 1.73% | 1.66% | 1.82% |
| | | $3 | $10 | $18 | $27 | $41 | $82 | $167 | $228 | $185 | $192 |
| | | | | | | | | | | 1st 10 year sum | $953 |
| Weighted Average SSST EL | | 0.66% | 0.69% | 0.74% | 0.89% | 1.11% | 1.31% | 1.49% | 1.58% | 1.53% | 1.67% |
| | | $3 | $10 | $18 | $27 | $41 | $81 | $159 | $208 | $170 | $177 |
| | | | | | | | | | | 1st 10 year sum | $892 |
| REVENUE | | REVENUE | | | | | | | | | |
| Limit Outstanding during Year | | 439 | 1387 | 2402 | 3018 | 3674 | 6145 | 10658 | 13184 | 11148 | 10579 |
| Weighted Average Premium | | 5.35% | 5.11% | 4.88% | 4.61% | 5.04% | 5.79% | 6.59% | 7.23% | 7.06% | 8.02% |
| | | $23 | $71 | $117 | $139 | $185 | $356 | $703 | $953 | $787 | $848 |
| | | | | | | | | | | 1st 10 year sum | $4,183 |
| BIG CAT YEARS | | | | | | | | | | | |
| Swiss Re Ann Insd Loss($Bn) | | $16.6 | $20.8 | $25.2 | $63.8 | $135.3 | $16.9 | $30.1 | $53.1 | $27.2 | $53.9 |
| Years of ANY ILS loss (1) | | | | | | 1 | | | 1 | | |
| Expected Loss in Cat years $millions) | | | | | | $41 | | | $228 | | |

Table 4.3A Proxy model for assessing Expected Loss (2001-2010)

These expected limits are laid out in the upper panel in Table 4.3A. The purpose of laying this out is to highlight the overlapping consequence issuing multi-year ILS deals. It affects the portfolio of ILS at risk in each year and exposes that each year's portfolio is the weighted average of issues from the current year and several prior years. – in terms of expected exposures, expected losses, and expected number of deals with losses.

The results of this calculation for the first 10 years of the two decades are laid out in Table 4.3A, the second ten years in Table 4.3B. We focus on Table 4.3B where the right-hand columns summarize the results for the whole twenty years. Attention is drawn to the lower summary panels, and the right-hand column totals.

[11] The first line is laid out to 4 decimal places to clarify. The rest of Table 10A and Table 10 B are displayed to 2 decimal places.

**Table 4.3B PROXY MODEL FOR ASSESSING EXPECTED LOSS (2011-2020) - Given foresight about future issuance**

2011 - 2020

| | Size | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | WSST PEL | WSST EL | PREMIUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | $964 | | | | | | | | | | | 1.06% | 0.66% | 5.4% |
| 2002 | $956 | | | | | | | | | | | 1.09% | 0.76% | 4.6% |
| 2003 | $1,720 | | | | | | | | | | | 1.11% | 0.87% | 4.4% |
| 2004 | $1,143 | | | | | | | | | | | 1.79% | 1.32% | 5.3% |
| 2005 | $1,588 | | | | | | | | | | | 1.94% | 1.54% | 6.4% |
| 2006 | $4,581 | | | | | | | | | | | 2.77% | 2.08% | 8.9% |
| 2007 | $7,031 | | | | | | | | | | | 2.03% | 1.48% | 5.8% |
| 2008 | $2,636 | 0.40 | | | | | | | | | | 2.26% | 1.59% | 6.8% |
| 2009 | $3,398 | 0.96 | 0.39 | | | | | | | | | 2.97% | 2.17% | 10.5% |
| 2010 | $4,799 | 0.98 | 0.96 | 0.61 | | | | | | | | 2.40% | 1.81% | 7.2% |
| 2011 | $4,270 | 0.89 | 0.98 | 0.95 | 0.85 | | | | | | | 2.96% | 2.32% | 8.8% |
| 2012 | $6,855 | | 0.50 | 0.98 | 0.96 | 0.59 | | | | | | 2.44% | 2.25% | 9.9% |
| 2013 | $7,382 | | | 0.48 | 0.98 | 0.96 | 0.73 | | | | | 2.34% | 1.80% | 5.5% |
| 2014 | $8,126 | | | | 0.51 | 0.98 | 0.97 | 1.00 | | | | 2.38% | 1.72% | 4.9% |
| 2015 | $6,318 | | | | | 0.52 | 0.98 | 0.96 | 0.88 | | | 3.22% | 2.25% | 4.9% |
| 2016 | $5,590 | | | | | | 0.46 | 0.97 | 0.94 | 0.92 | 0.15 | 3.86% | 2.91% | 5.5% |
| 2017 | $10,291 | | | | | | | 0.59 | 0.97 | 0.94 | 0.85 | 3.70% | 2.77% | 5.4% |
| 2018 | $9,584 | | | | | | | | 0.64 | 0.98 | 0.95 | 3.08% | 2.30% | 4.8% |
| 2019 | $5,284 | | | | | | | | | 0.42 | 0.97 | 4.51% | 3.47% | 8.2% |
| 2020 | $11,023 | | | | | | | | | | 0.52 | 3.38% | 2.55% | 6.9% |
| Total | $102,549 | | | | | | | | | | Wtd Avg | 2.89% | 2.19% | 6.46% |
| # of Deals outstanding | | 89 | 108 | 124 | 137 | 125 | 118 | 145 | 162 | 166 | 188 | 2080 | | |
| # Of Deals Expected with Loss | | 2 | 3 | 3 | 3 | 3 | 4 | 5 | 6 | 6 | 7 | 57 | | |
| Outstanding during Year | | $10,129 | $13,086 | $16,266 | $20,610 | $21,841 | $21,982 | $25,662 | $26,714 | $26,434 | $29,579 | $274,936 | Total Exposure | |
| Weighted Average WSST EL | | 2.01% | 2.12% | 2.11% | 2.06% | 1.94% | 2.08% | 2.37% | 2.59% | 2.76% | 2.81% | | | |
| | | $204 | $277 | $344 | $423 | $423 | $457 | $607 | $692 | $730 | $832 | $5,942 | 20 year Total | |
| | | | | | | | | | | 2nd 10 year sum | $4,989 | | | |
| Weighted Average SSST EL | | 1.85% | 1.99% | 1.94% | 1.87% | 1.75% | 1.88% | 2.15% | 2.38% | 2.54% | 2.60% | 2.16% | 20 Year EL Bin Mod | |
| | | $187 | $255 | $316 | $386 | $383 | $413 | $553 | $636 | $672 | $770 | $5,465 | 20 year Total | |
| | | | | | | | | | | 2nd 10 year sum | $4,573 | | | |
| REVENUE | | | | | | | | | | | | | | |
| | | 10129 | 13086 | 16266 | 20610 | 21841 | 21982 | 25662 | 26714 | 26434 | 29579 | | | |
| | | 8.65% | 8.68% | 8.30% | 7.52% | 6.05% | 5.12% | 5.13% | 5.20% | 5.68% | 6.27% | | | |
| | | $876 | $1,135 | $1,350 | $1,550 | $1,320 | $1,127 | $1,318 | $1,389 | $1,487 | $1,856 | $17,592 | 20 yr Total Revenue | |
| | | | | | | | | | | | | $274,936 | Exposure Base | |
| | | | | | | | | | | | | 6.24% | Profit % | |
| BIG CAT YEARS | | | | | | | | | | | | | | |
| Swiss Re Ann Insd Loss($Bn) | | $135.5 | $74.0 | $39.2 | $32.0 | $30.2 | $48.6 | $144.6 | $84.0 | $82.0 | $75.9 | $1,160 | Total | |
| Years of ANY ILS loss (1) | | 1 | | | 1 | | | 1 | 1 | 1 | 1 | 8 | # ILS Loss years | |
| Expected Loss in Cat years $mil | | $204 | | | $423 | | | $607 | $692 | $730 | $832 | $3,758 | Total Est. ILS Losses | |
| | | | | | | | | | | | | $89.1 | Avg Nat(Cat loss for ILS | |
| | | | | | | | | | | | | $37 | Avg Nat Cat non-ILS Loss | |
| | | | | | | | | | | | | 0.79% | Benefit of Experience | |

Table 4.3B Proxy model for assessing Expected Loss (2011-2020)

In the first summary block it shows the number of deals expected to be on-risk during each year, the number of deals expected to show a loss and the limit exposed by those deals. All these numbers assume that losses will unfold evenly as gauged by the models in the OC EL. Thus for 2020,188 deals are expected to be on-risk, of which 7 are expected to incur a loss and the total outstanding representing an expected exposed limit of $29,579 billion[12]. The weighted average EL for portfolio is 2.81% implying an expected loss of $832 billion for 2020. The sum of all exposed annual limits over the twenty years is $274,936 billion. So, even though a total limit of $102,549 of new ILS have been issued, the coverage they provide, because they are multi-years deals, and because initial limits are expected to be eroded through losses is $274,936 million. That is 2.6 times the original face value of all issues. To repeat, $102,549 million of issue bought $274,936 million of annual coverages during the 20-year period.

Adding up the expected loss estimates for each year implies total expected loss of $5,942 million. That is much higher than the observed losses of from Section 3, (Tables #.1A and 3.1B or in Figure 3.1) of $3,472 billion. Perhaps the proxy model is wrong. Clearly, if it is correct, it is

[12] Eagle-eyed readers will refer to Figure 2.2 and the discussion that the outstanding ILS was higher (at $32,480 million) not $29,579 million. That is because the former calculation did not recognize the fact that some of the 2020 coverage issues were only on risk for part of the year and also did not allow for expected losses.

either too conservative or the Nat Cat market went through a lucky streak of low losses. Or the proxy model is poor, inadequate and needs to incorporate other unacknowledged uncertainty. It is the latter.

Premium Revenue and Expected Profit

One other way to cross-validate the proxy model is to check its implication to premium revenue stream and the consistency with expected profits. The second summary panel called Revenue shows how. Revenues from operating the historical ILS issue portfolios are calculated using the same methodology as expected loss, but now calculating premium revenue. The outstanding ILS limit is multiplied by the weighted average premiums to show the revenue each year. The total of 20 years of revenue is $17,592 million. This was generated by giving coverage on an exposure of $274,936 million as detailed above. That is an expected profit of $11,650 million (=$17,592 – $5,942). Dividing this by the total annual exposure base ($274,936 million) from which it was generated, gives an expected rate of return of 4.24% (=$11,650 / $274,936). And that is precisely 3 basis points (over twenty years and a quarter of a trillion dollars' worth of coverage!) different from what were led to expect when we examined the summary statistics in Table 2.2. Weighted average premium of 6.46% and an expected loss of 2.19%, i.e., expected profit of 4.27%. Close enough for government work. We can be quite confident that the proxy model works well.

Big Cat Years.

If the model is good, why then is there still a big discrepancy between experience versus expectation – the $3,472 million vs. $5,942 million? For that we must look outside the internals of the ILS market and the internals of individual deal expectations. Recall in our introductory remarks the Swiss Re catalogue of insured loss years and the severity of those loss years – see Fig 1.1. In this we refer to Cat years and Big Cat years as loss years for the whole (re) insurance industry but necessarily for the ILS market. Further, recall the crude summary – No Cat: No Loss, even if the ILS model says there is expected loss. And even more selectively - No big Cat Loss: No ILS loss.

With that as a background, we revise our mental bucket-of-balls model. The bucket holding the balls takes a journey around the sun once a year. It makes 20 orbits in the history under review. Each time it returns, the balls proportions are changed to reflect all outstanding issues, but now the lid is open or closed. If it is closed, then we do not get to dip in to take out a ball. It is assumed white. If it is open, we proceed as per the proxy model. What determines if it is open? Why, the size of the insured loss year. The process is driven by the exceedance curve shown in Figure 1.2.

Examining Figure. 1.2 and more precisely in Table 3.2 we infer from the Swiss Re catalogue that when global annual insured losses are greater than approximately $50 billion, ILS losses will occur. Less than that they do not.

The last summary panel in Table 4.3B captures this impact of the outside world on the ILS market. The panel lists the level of insured losses each year. And another row marks those

years when ILS losses take place. Summing the expected losses in just those years, shows total expected losses of $3,758 million vs observed losses of $3,472 million. This is much closer and gives greater comfort to the thesis that the risk models do a good job of predicting losses. Given our knowledge of the way the probabilities work, experience is close to expectations.

This does not mean that investors in ILS have not been a little lucky. The difference between $5,942 million and the observed $3,472 million is $2,470 million. Measured against the total coverage of $274,936 million that is a benefit of 79 bps – see Table 4.3B lower left panel. Investors have received returns, before any floating rate additions, of (4.24% + 0.79% =) 5.03%. This is entirely consistent with the long run insurance return in several compound indices, such as Swiss Re's or Lane Financial LLC's. The Lane 2021 year-end report showed an insurance return of 5.82% CAGR[13].

Notice also that the last summary panel shows years when there was an ILS loss (8 of them) were years the Swiss Re insured losses averaged $89.1 billion. The other 12 years averaged $37 billion insured losses. At the risk of beating a statistical dead horse, total insured losses over the 20 years were, according to Swiss Re, $1,160 billion i.e., over 1 trillion dollars. If the gods had divided that evenly between each year that would have caused an insured loss of $58 billion each year. Under that circumstance, it is entirely likely, but not a certainty, that there would have been losses every year for the ILS portfolio and expectations of $5,942 would have been realized. Randomness is sometimes better than the averages.

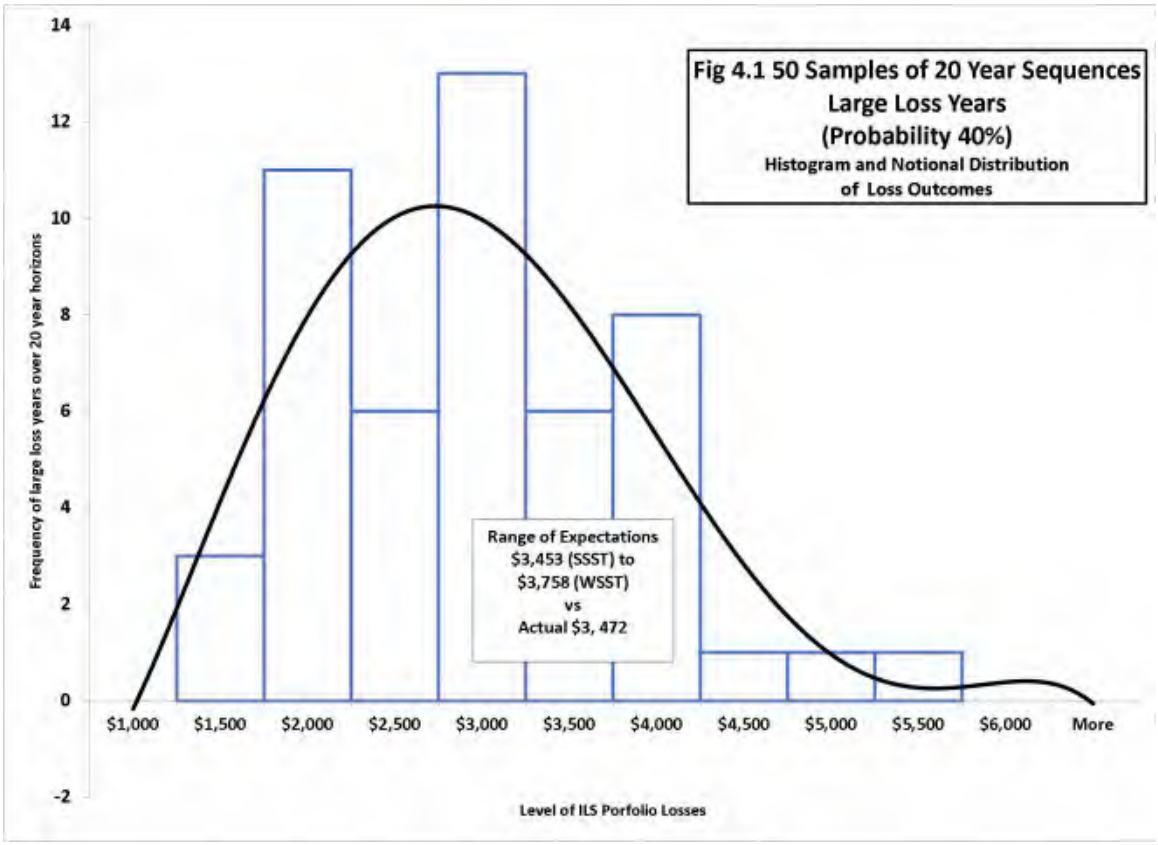
Big Cat Years with Different Occurrences

As much noted, eight big cat years occurred during the 20 years under exam. And by plotting our exceedance curve we imply that the probability of a big cat year occurring on any given year is 40%. This is a very simplified approach. But it allows us to ask what the range of expectations and experience might have been under a different sequence of big cat years from what happened. Recall that as the market grew during 2001-2020 the exposures taken on grew rapidly – small at first, larger later. And unfortunately, the big loss years happened in the biggest exposure years. What would have happened (loss wise) if the big cat years happened early on? To examine this question, we set up a model generating 50, randomly drawn 20-year sequences of events where, in each individual year, the probability of a small loss year is 60% and the probability of a large event year is 40%.

The results are shown in Figure 4.1. The losses from each of 50 random sample sequences is represented by the sample histogram. Fitted over that is the distribution[14] we would expect to see for larger sample sequences. The range of loss outcomes is from losses around $1,000 million to losses up to $6,000 million, with a mean of $2,762 million (and a Standard Deviation of $930 million) . Recall actual losses are $3,472 million. In other words, on average

[13] Compound annual growth rates [CAGR] will always be greater than the $-weighted calculations herein. CAGRs and rates of return on exposure are quite close, in percentage points, if not in exact decimal points.
[14] To be precise, the diagram shows a polynomial fitted to the histogram. It is not a fitted known type of probability density function.

the last twenty years are within one standard deviation of what any twenty years might produce. Assuming our characterization of the process is accurate.




One thing that does emerge from Figure 4.1 is that the loss distribution is long tailed to the upside. That is good news for investors. With that kind of skew, there is more likely to be smaller cat years than large cat years. This is not just from the 60/40 assumed split of occurrence probabilities, but also when transformed into losses as in Figure 9. There will be more years when the returns on exposure are above expected than below it.

Predictions one year ahead

We have been looking at expectations over the long two-decade haul. In Table 4.3B we anticipated, for instance, that expected losses for the year 2020 would be $832 million. But we can do better if we know actual experience of loss prior to the beginning 2020. Table 4.4 shows how.

At the beginning of 2020, deals from 2015, 2016, 2017, 2018 and 2019 were going to be on-risk during 2020. Some had already experienced partial losses; some were loss free. Making allowance for that, their remaining limit, and terms to maturity we can say that expected 2020 losses, given knowledge of prior losses, would total $570.6 million.

**Table 4.4 EXPECTED LOSSES 1/ 1/ 2020 - CONTINGENT ON KNOWING PRIOR LOSSES**

Contingent on knowing prior issues, prior losses and anticipating 2020 issuance, i.e. assuming -
a) All ILS issued prior to 1/ 1/ 2020 and maturing during 2020 or after 12/ 31/ 2020
b) Assuming we know issues that will be issued in 2020.
c) Calculating the on-risk fraction of the year as proxy for individual start dates of 2020 issues
d) Deducting estimated losses, but keeping remaining limit

| | Still Outstanding | Estimated Losses | Remaining Limit | Wghtd EL WSST | SEL 2020 | Fraction of Year | SEL |
|---|---|---|---|---|---|---|---|
| Year of Issue | 1/ 1/ 20 | | | | | | |
| **WSST Case** | | | | | | | |
| 2015 | $650 | | $650 | 1.09% | $7 | 69% | $4.9 |
| 2016 | $2,665 | $315 | $2,350 | 2.01% | $47 | 47% | $22.3 |
| 2017 | $9,509 | $450 | $9,058 | 2.50% | $226 | 73% | $166.3 |
| 2018 | $8,244 | $863 | $7,382 | 1.97% | $145 | 97% | $140.0 |
| 2019 | $4,933 | $201 | $4,732 | 5.03% | $238 | 100% | $237.0 |
| | | | | | | | $570.6 |
| Issued 2020 | $11,023 | $79 | $10,944 | 2.55% | $280 | 52% | $144.0 |
| | $37,024 | $1,829 | $35,116 | 2.67% | $943 | | $714.6 |
| **SSST Case** | | | | | | | |
| 2015 | $650 | | $650 | 1.05% | $7 | 69% | $4.7 |
| 2016 | $2,665 | $315 | $2,350 | 1.83% | $43 | 47% | $20.2 |
| 2017 | $9,509 | $450 | $9,058 | 2.31% | $210 | 73% | $153.8 |
| 2018 | $8,244 | $863 | $7,382 | 1.85% | $137 | 97% | $131.9 |
| 2019 | $4,933 | $201 | $4,732 | 3.33% | $158 | 100% | $156.9 |
| | | | | | | | $467.6 |
| Issued 2020 | $11,023 | $79 | $10,944 | 2.36% | $258 | 52% | $132.9 |
| | $37,024 | $1,829 | | 2.30% | $811 | | $600.4 |

Table 4.4 Expected 2020 losses Contingent on knowing prior Losses

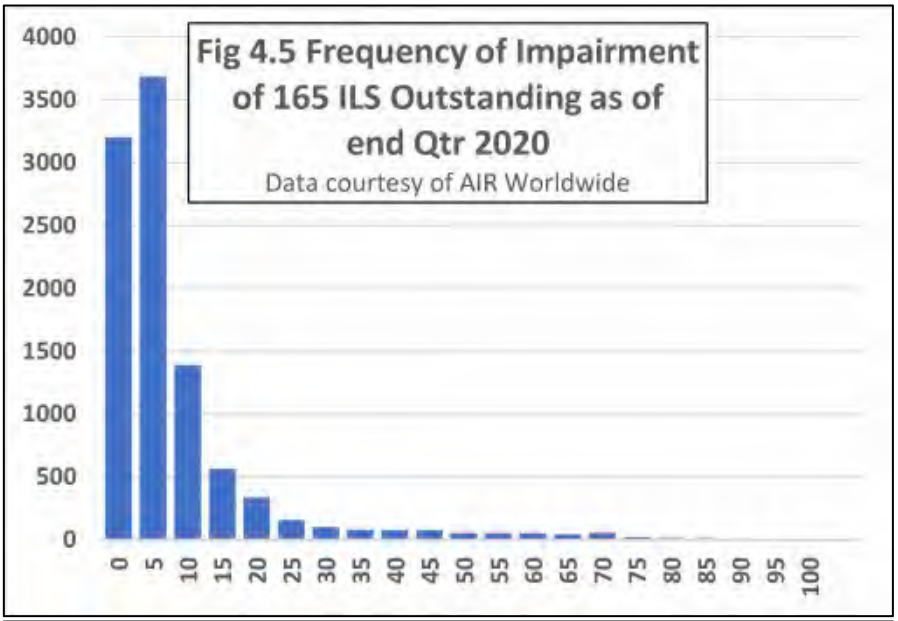
If we were as prescient about what was going to be issued during 2020 as our proxy model has been, we could expect losses to rise to $714.6 million. Both numbers are lower than the proxy $832 million. But both numbers are higher than the suspected MTM losses of $229 million shown in Table 3.1A and 3.1B. Perhaps those suspected losses will develop, and perhaps other deals will be revealed to have had losses not suspected. After all, we now know that 2020 was a Swiss Re $85.3 billion dollar loss year, so can expect real ILS losses. One final caveat needs to be made. Not all $85.3 billion dollar loss years are the same. One might have a lot of Asian wind losses where the ILS portfolio is not heavily exposed, or the converse. We make the point to emphasize once again that our mapping of losses and expectations is not a perfect petri-dish lab science. It is not a 1 to 1 transform.

## A Note on Frequency of Loss

Much of the forgoing analysis is concerned with the amounts (severity) of loss - expected and experienced. And the correspondence of actual loss to expected loss amounts (from our proxy models) is used to come to the conclusion that the models are good predictors of loss over the long haul. A parallel exercise could have been conducted on the frequency of loss. This is the number of ILS deals which experience some loss. We know that Table 3.1A and 3.1B and other exhibits show that 43 ILS were loss-affected. A collateral question to the severity analysis then is,

how good is model expected frequency of loss. Did we expect 43 of the 757 to experience loss? This another potential test of goodness of the model.

At a basic level the PFL is the number necessary to establish frequency of loss. From Table 2.2 the overall PFL is 2.90%. The temptation is to multiply the 757 ILS issued over the 20 years and call that the expected frequency of loss. But this would be in error. PFL is an annual number and we also know that each of the ILS has a term greater than 1 year.




| | # of Impairments | as % of 165 OS ILS |
|---|---|---|
| Average | 6.8 | 4.10% |
| Median | 5 | 3.03% |

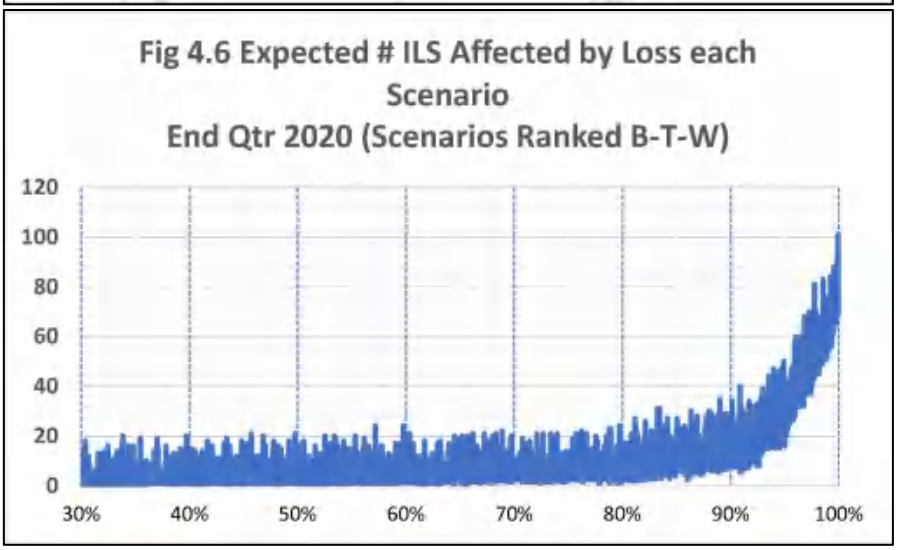



Figure 4.5 & 4.6 Distribution of Frequency loss-affected ILS by Scenario, end Quarter 2020.

From Table 4.3B if we add up the expected number of ILS experiencing a loss from each year's coverage, we see that we would expect 57 ILS to have some loss, see right hand column.

This is higher than the 43 observed. If we try the same device as used with expected amounts – counting only those years with big cat years – the total drops to 33 ILS expected to have a loss. That is lower than the 43 observed.

One reason that the the adjusted figure is lower than the observed is that the simple application of PFL assumes that the impacts of loss events on each ILS is independent of each other. Intuition suggest that this is not true. Full exploration of the independence of ILS impact is beyond the scope of this paper. Certainly data necessary to answer to that question is unavailable to the average investor from the OC's. However, it might be available to the sophisticated investor who has access to the Cat Modelers models themselves.

To give an example of what that shows, we display some results, courtesy of AIRWorldwide's model, showing some insights from the last quarter of 2020. Figure 4.5 shows the probability distribution of the number of possible ILS that might be affected from the then-outstanding 165 ILS coverage. The distribution is heavily skewed but with a mean of 6.8 deals likely to be affected and a median number of 5 deals.This is consistent with our earlier observation, based of summary statistics from the OC.

More important, Figure 4.6 shows the number ILS likely to be affected in each of the 10,000 scenarios, ranked best-to-worst by their loss amount. It shows that for the first 30% of outcomes zero deals would be affected. Beyond that, the next 50-60% of scenarios show a rather stable number of scenarios. However in the last 10-20% of scenarios the number of affected deals rises sharply, with up to 100 deals affected in the worst scenario. It is this last group that shows convincingly that there is statistical dependence between the number of deals affected. Were there none, the number of deals would likely be in a flat range over all scenarios, as appears to be the case between 30% and 80% of the outcomes.

In summary then, the observed 43 deals is higher than the expected 33 loss-affected deals, but it is impossible to say this is because of dependence between events (likely) or just by randomness of outcome. The frequency argument does not contradict the basic conclusion that known Nat Cat models are good, but it does not offer as good an endorsement as the severity measures.

## Concluding Remarks

There is a much-quoted saying attributed to the famous statistician George E. P. Box – "*All models are wrong; some are useful*". This paper has tried to exhaustively examine how "*useful*" are the Nat Cat models upon which investors and issuers in ILS markets base their decisions. It is an important subject.

We have detailed in consecutive sections of the paper, an issuance history for the past two decades, 2001-2020, containing the expectations of the modelers; recorded losses that have actually arisen, and reconciled the expectations with the experience for the ILS market. The result of the analysis is this.

Investors in Nat Cat ILS can be quite confident that the risk analysis provided by AIR Worldwide, RMS and EQECAT gives an accurate characterization of the risks embedded in the ILS they are considering acquiring. Such a bold statement must contain some caveats. One is that the conclusion is based upon what we know, of which see further comment below.

The insurance community, and its child the ILS community, has reeled under three savage years of massive Nat Cat Losses. There is understandably an instinct to say that the models were wrong. Our evidence is to the contrary. Taking the long view and considering the model's predictions – we are getting what we should have expected. Indeed, at the latest reading - expected losses are greater than experience – the models are conservative.

Notwithstanding, by the time the report is read, some of the numbers will have changed. Recall that part of the losses documented here are estimated losses. Estimated by a fickle secondary market. Losses may yet develop further. That may be acceptable as a point-in-time analysis. However, as a conclusive documentation of the past twenty years it will be necessary to wait until loss exposures from events during those years all become "Known and Closed".

We have also noted that others approaching the same point-in-time question - experience vs. expectations - may come to different numerical and/or summary conclusions.

Among those reasons are a) others may use different secondary market prices, b) they may use a different cut-off for distinguishing between indications of real loss vs. reassessment of expected loss, and c) they may have misinterpreted what was being priced (original or remaining limit). As transparency and practice standards become more established, we would expect to see less and less difference between those who seek to compare expectations and experience.

Indeed, we would expect to see much stronger growth in the ILS and other alternative market in the years ahead, expanding both the investor and issuer base. With that we might also expect to see lower prices for Nat Cat protection.

Perhaps then it is also time to question whether the ILS market should remain a private market. It has grown considerably since the 1990s and now represents as much as 10% of the traditional reinsurance capital. The argument that the private market protects the non-qualified investor from big risks is belied in two ways. First, those same investors are already exposed to risks of equal magnitude in a whole host of other products, with full disclosure, and many choose

to stay away – consider, as just one example, the risks in the options market. Second, the present practice of restricting the flow of information outside the market inhibits further research into risks inherent in the market and stunts innovation into the way in which natural catastrophe risks can be transferred more efficiently within the world at large.

Stepping back from the public policy questions to the immediate paper, the forgoing analysis has tried to adhere to our current understanding of pricing, expectations and losses and we believe it has established a framework for reconciling experience and those expectations. We suspect more and better analyses will be forthcoming in future years but for the present we conclude that Nat Cat models are "*very useful*".

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# Appendices

1) Issuance and Losses - Pre-History 1992 -2002

2) Issuance and Losses – Mortality and Private deals 2001 – 2020

3) Issuance and Losses – Other ILS including Health, Liability, Terrorism, Pandemic and Financial

# Appendix 1

## Pre-History - Nat Cat Issuance and Losses 1992-2000

Issuance History

The table below portraying the early ILS issues in the same form as the preceding analysis of the post 2001 Nat Cat ILS, flatters the organization of those early years. There was much experimentation, deal sizes were small and were issued in a time prior to much being available in the way of modeled risk analysis. The Chicago Board of Trade [CBoT] Cat option traders had no models, neither did the copy-cat exchanges in Bermuda and New Jersey.

**Characteristics of Annual ILS Nat Cat Issuance - Pre-History**

1992 - 2000, $millions

| Year | Calendar Annual Total | # of Deals or Tranches | Premium Avg | Geo Mean | Wghtd Avg | Geo Mean | Wghtd Avg | Maturity |
|---|---|---|---|---|---|---|---|---|
| Time Issued | | | Issue Date | PFL SSST | EL SSST | PFL WSST | EL WSST | Wtd Avg Term |
| CBoT 1992-8 | $200* | | Various | na | na | na | na | 3-6 months |
| 1996 | $45 | 1 | | 10/1/1996 | 2.68% | | | 10.0 |
| 1997 | $704 | 8 | 5.29% | 7/31/1997 | 8.33% | 0.68% | | 3.4 |
| 1998 | $1,024 | 10 | 4.92% | 5/21/1998 | 7.72% | 1.19% | | 2.6 |
| 1999 | $587 | 7 | 3.95% | 5/10/1999 | 8.63% | 0.69% | | 4.0 |
| 2000 | $911 | 10 | 6.09% | 7/20/2000 | 1.37% | 0.37% | | 4.1 |
| Securities only | $3,270 | 36 | 5.16% | | 6.51% | 1.10% | | 4.6 |

* Guess/estimate for the five years CBoT Options were traded

The "first" ILS is a matter of some dispute among claimants. The proposed AIG/Merrill Lynch deal of 1992 was novel, but never consummated. AIG Combined Risks was heralded in April 1996 as ushering in a new era by the *Insurance Day*, but final details of that transaction were sketchy. In October 1996 Goldman Sachs introduced a bond containing a quota share from St Paul Re, but was it technically an ILS? And in March of 1997 Sedgwick-Lane (the predecessor to Lane Financial LLC) introduced the first of a series of issues on behalf of Reliance. Other experiments followed and ILS securitization standards emerged. If one had to award laurels based on time, it should probably go to the CBoT who traded their first options spread in early summer 1993 – despite not being an ILS security, it was the spark that lit the ILS industry. More fairly, laurels belong to all those early pioneers. However, record keepers they were not.

Early Losses

| Other ILS transactions where less public, and less specific, loss information is available | |
|---|---|
| CBoT Options | During the experimental phase of PCS Cat options, particular losses were suffered from the Northridge Earthquake |
| Georgetown Re | Losses eroded expected Quota Share returns. Ultimate results marginal. |
| Reliance II | Space launch loss event caused coupon to be reduced from 13.75% to 8.00%. |
| Kelvin | First Event tranche of an early weather bond suffered a total loss. |
| Kaith 3 | One of the repeat Kovol series, K3 suffered a near total loss associated with the 9/11 attack. |
| CCRIF | Payment of $500,000 to Anguilla for Hurricane Gonzalo rainfall, October 2014 |

Amongst the breakthrough competition were other deals, but whose details were not generally available to the public. They became known because they had suffered a loss. Some of those are listed alongside.

Suffice it say those early deals were crude. Some were issued at par but many were issued at a discount. Many included 5 or 6 perils including Space Launch risk, Oil Rig Risk, Weather, Aviation and Man-Made risks. Nearly all provided only primative (internal) risk assesments and many had very high coupons.

# Appendix 2

## Issuance History of Extreme Mortality Bonds

Legend has it that the first Extreme Mortality ILS issued by Swiss Re under the name Vita, was motivated by the scare that terrorists could explode a "Dirty Bomb" in some major capital cities of Europe. True or not, pandemics could achieve the same extreme result for anyone writing life insurance. This was a needed protection that could be packaged and sold to investors as very low risk. The record shows that the market was small and never embraced by many other cedants. No new issues were introduced between 2016 and 2019. This year has seen a slight revival of interest – perhaps this time due to COVID fears.

Extreme Mortality and Embedded Life ILS

| | | ILS Tranche count | Premiums | PFL | Wtd. EL | Wtd Avg Issue Date | Wtd Avg Maturity Date | Avg Term Years |
|---|---|---|---|---|---|---|---|---|
| 2003 | $400 | 1 | 1.35% | 0.08% | 0.02% | 12/ 5/ 2003 | 1/ 1/ 2007 | 3.1 |
| 2004 | | | | | | | | |
| 2005 | $952 | 9 | 0.00% | 0.04% | 0.03% | 7/ 1/ 2005 | 8/ 3/ 2019 | 14.1 |
| 2006 | $852 | 9 | 1.82% | 0.17% | 0.13% | 10/ 18/ 2006 | 5/ 23/ 2010 | 3.4 |
| 2007 | $629 | 6 | 0.30% | 0.04% | 0.03% | 3/ 11/ 2007 | 7/ 21/ 2011 | 4.5 |
| 2008 | $100 | 1 | 1.35% | 0.08% | 0.05% | 2/ 19/ 2008 | 1/ 15/ 2013 | 4.9 |
| 2009 | $75 | 1 | 6.50% | 0.72% | 0.46% | 11/ 24/ 2009 | 1/ 15/ 2014 | 4.1 |
| 2010 | $325 | 4 | 4.35% | 0.72% | 0.51% | 10/ 20/ 2010 | 7/ 2/ 2015 | 4.7 |
| 2011 | $180 | 2 | 3.32% | 0.72% | 0.54% | 8/ 4/ 2011 | 1/ 15/ 2016 | 4.5 |
| 2012 | $275 | 2 | 3.08% | 0.57% | 0.49% | 7/ 30/ 2012 | 1/ 15/ 2017 | 4.5 |
| 2013 | $180 | 1 | 3.25% | 1.16% | 0.92% | 9/ 11/ 2013 | 1/ 17/ 2019 | 5.4 |
| 2014 | | | | | | | | |
| 2015 | $406 | 3 | 2.95% | 1.36% | 1.00% | 6/ 22/ 2015 | 4/ 7/ 2020 | 4.8 |
| 2016 | | | | | | | | |
| 2017 | | | | | | | | |
| 2018 | | | | | | | | |
| 2019 | | | | | | | | |
| 2020 | $100 | 1 | 2.85% | 0.50% | 0.17% | 10/ 23/ 2020 | 10/ 6/ 2023 | 3.0 |
| Total | $4,475 | 40 | 1.75% | 0.36% | 0.27% | 8/ 5/ 2008 | 11/ 5/ 2014 | 6.3 |
| Average | $111.87 | | | | | | | |

There have been no losses in this market.

## Issuance of "Private" ILS a.k.a., Cat Lite Issues

Small transactions not sanctioned under Reg 144A for standard ILS are known as "private" ILS and are conducted under Reg 20. While a record of issuers and size of deal is available, premiums and risks assumed are not. We record the history, such as it is, to provide acknowledgement that this tiny market is thriving and growing fast.

**Private Issues**

| | Amount | Average Size | Number | PFL | EL |
|---|---|---|---|---|---|
| 2008 | $100 | $33 | 3 | na | na |
| 2009 | $4 | $2 | 2 | na | na |
| 2010 | $12 | $12 | 1 | na | na |
| 2011 | $4 | $2 | 2 | na | na |
| 2012 | $90 | $30 | 3 | na | na |
| 2013 | $10 | $10 | 1 | na | na |
| 2014 | $332 | $20 | 17 | na | na |
| 2015 | $624 | $27 | 23 | na | na |
| 2016 | $749 | $37 | 20 | na | na |
| 2017 | $663 | $41 | 16 | na | na |
| 2018 | $1,285 | $36 | 36 | na | na |
| 2019 | $946 | $31 | 31 | na | na |
| 2020 | $361 | $13 | 28 | na | na |
| Average | $399 | $28 | 15 | | |
| Total | $5,181 | | 182 | | |

We do not have a record of loss. *Artemis* lists loss-affected private deals, although not loss amounts.

## Appendix 3

### History of OTHER ILS Issuances for Health, Terrorism and Pandemic

The most significant sequence of ILS issues for a Non-Nat Cat, non-Mortality peril is in Health care. Started in 2010 by Aetna, the Vitality series protects the cedant if there is a rising demand for health treatments above and beyond what was expected. It is fashioned much like the Vita series – extreme healthcare cost rather than extreme mortality. After 2020 there may be a loss given the ratios and COVID, but that remains to be seen.

Health, Liability, Terrorism, Financial, Terrorism and Pandemic

| | | ILS Tranche count | Wtd Avg Premium's | PEL | Wtd EL | Wtd Avg Issue Date | Wtd Avg Maturity Date | Avg Term Years |
|---|---|---|---|---|---|---|---|---|
| **HEALTH** | | | | | | | | |
| 2010 | $150 | 1 | 4.00% | 0.20% | 0.05% | 12/ 7/ 2010 | 1/ 7/ 2014 | 3.1 |
| 2011 | $150 | 2 | 4.89% | 0.36% | 0.08% | 4/ 28/ 2011 | 1/ 7/ 2014 | 2.7 |
| 2012 | $150 | 2 | 4.80% | 0.32% | 0.08% | 1/ 7/ 2012 | 1/ 7/ 2015 | 3.0 |
| 2013 | $150 | 2 | 3.08% | 0.35% | 0.08% | 1/ 23/ 2013 | 1/ 9/ 2017 | 4.0 |
| 2014 | $200 | 2 | 1.98% | 0.29% | 0.07% | 1/ 24/ 2014 | 1/ 7/ 2019 | 5.0 |
| 2015 | $200 | 2 | 1.86% | 0.34% | 0.08% | 1/ 27/ 2015 | 1/ 8/ 2018 | 3.0 |
| 2016 | $200 | 2 | 2.30% | 0.25% | 0.06% | 1/ 28/ 2016 | 1/ 7/ 2020 | 3.9 |
| 2017 | $200 | 2 | 1.83% | 0.27% | 0.06% | 1/ 25/ 2017 | 1/ 8/ 2021 | 4.0 |
| 2018 | $200 | 2 | 1.65% | 0.22% | 0.06% | 1/ 29/ 2018 | 1/ 10/ 2022 | 4.0 |
| 2019 | $200 | 2 | 1.83% | 0.24% | 0.06% | 1/ 14/ 2019 | 1/ 10/ 2023 | 4.0 |
| 2020 | $200 | 2 | 1.59% | 0.26% | 0.06% | 1/ 30/ 2020 | 1/ 9/ 2024 | 4.0 |
| **LIABILITY** | | | | | | | | |
| 2005 | $405 | 3 | 4.49% | 1.75% | 0.56% | 6/ 30/ 2005 | 6/ 8/ 2009 | 3.8 |
| **TERRORISM** | | | | | | | | |
| 2019 | $98 | 1 | 5.90% | 3.05% | 2.71% | 2/ 25/ 2019 | 5/ 7/ 2022 | 3.0 |
| **FINANCIAL** | | | | | | | | |
| 2006 | $373 | 3 | 4.01% | na | na | 1/ 13/ 2006 | 6/ 30/ 2012 | 6.5 |
| **PANDEMIC** | | | | | | | | |
| 2017 | $320 | 2 | 8.27% | 7.18% | 4.81% | 7/ 25/ 2017 | 7/ 15/ 2020 | 3.0 |
| Total | $3,195 | 30 | 3.65% | 1.08% | 0.77% | 6/ 11/ 2013 | 8/ 19/ 2009 | 3.9 |
| **LOSSES** | | | | | | | | |
| **Avalon Re C** | $135 | 1 | 7.75% | 4.25% | 1.21% | 6/ 30/ 2005 | 9/ 8/ 2009 | 4.2 |
| **Crystal Credit A** | $160 | 1 | 1.50% | | | 1/ 13/ 2006 | 6/ 30/ 2012 | 6.5 |
| **Crystal Credit B** | $120 | 1 | 4.25% | | | 1/ 13/ 2006 | 6/ 30/ 2012 | 6.5 |
| **Crystal Credit C** | $93 | 1 | 8.00% | | | 1/ 13/ 2006 | 6/ 30/ 2012 | 6.5 |
| **IBRD Class A** | $225 | 1 | 6.90% | 4.92% | 3.57% | 7/ 25/ 2017 | 7/ 15/ 2020 | 3.0 |
| **IBRD Class B** | $95 | 1 | 11.50% | 9.44% | 7.74% | 7/ 25/ 2017 | 7/ 15/ 2020 | 3.0 |
| Total Affected | $828 | 6 | 6.27% | 6.20% | 5.74% | 9/ 25/ 1972 | 7/ 19/ 1975 | 5 |
| Total Losses | ??? | | | | | | | |
| **(Lehman Affected) LOSSES** | | | | | | | | |
| **Carillon A-1** | $51 | 1 | 10.00% | 1.97% | 1.79% | 6/ 19/ 2006 | 1/ 8/ 2010 | 3.6 |
| **Ajax** | $100 | 1 | 6.25% | 2.20% | 1.94% | 4/ 25/ 2007 | 5/ 8/ 2009 | 2.0 |
| **Willow Re** | $250 | 1 | 5.13% | 1.05% | 0.83% | 6/ 15/ 2007 | 6/ 16/ 2010 | 3.0 |
| **Newton Re 2008A-1** | $150 | 1 | 7.50% | 1.40% | 0.90% | 2/ 21/ 2008 | 1/ 7/ 2011 | 2.9 |
| Total Affected | $551 | 4 | 13.84% | 1.66% | 1.11% | 7/ 10/ 2007 | 5/ 14/ 2010 | 3 |
| Total Losses | ??? | | | | | | | |

Note also the ILS deals protecting against Liability for OCIL, Terrorism, and Pandemic. The World Bank issued a very successful bond in 2017 which saw losses in 2020 – see loss table.

An experimental financial bond based on trade credit was issued, and as the record shows it also suffered a total loss.

Finally, it is well to take note of the four bonds listed as loss-affected because of the Lehman bankruptcy of 2008. Those bonds covered Nat Cat risks and lost money. However, the cause of loss was financial, not catastrophe. They lost because of a LIBOR arrangement with Lehman – the counterparty - who defaulted. Their loss is listed here for the record. They are listed as issued in Part I of this paper but were not included in Nat Cat losses in Part 2 of the paper.

# Analysis on Product Innovation Dynamic Mechanism of Insurance Company--Based on Game Theory Model

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**Key words:** product innovation, dynamic mechanism, game theory.

**Abstract:** In recent years, the insurance industries in China are in the stage of rapid development, but the core elements supporting the rapid growth of the insurance industry, namely the speed and quality of insurance companies' product innovation, are not in harmony with it. The phenomenon of product homogenization and low-price vicious competition in the insurance market is very prominent, which has a great impact on the sustainable development of China's insurance industry. How to

stimulate the driving force of product innovation and strengthen the core competitiveness of insurance companies has become an urgent problem to be solved for the healthy development of China's insurance industry. From the perspective of game theory, this paper tries to analyze the deep-level reasons for the lack of driving force of insurance companies' product innovation by using the Bertrand model, repeated game model, etc., and puts forward relevant opinions and suggestions, to promote the high-speed development of China's insurance industry to move forward to high-quality development.

## 1. Questions raised

General Secretary Xi Jinping emphasized that innovation is the first driving force for development. To grasp innovation is to grasp development, and to seek innovation is to seek the future. The "Proposal of the Central Committee of the Communist Party of China on Formulating the Fourteenth Five-Year Plan for National Economic and Social Development and the Long-term Goals for 2035", which was reviewed and approved by the Fifth Plenary Session of the 19th Central Committee of the Communist Party of my country, also proposed that we must persist in innovation in the modernization of our country. Build a core position in the overall situation. Innovation is the core driving force for the sustainable and high-quality development of the industry and enterprises. In recent years, China’s insurance market has developed rapidly. Driven by the Internet, major insurance companies cater to market hotspots to innovate insurance products, and a large number of innovative insurance products have entered the market. For example, insurance products similar to "love insurance" began to be introduced to the market. Since this insurance product was introduced to the market, it has been favored by consumers because of its novelty. Subsequently, many insurance companies have launched similar products. For a time, various insurance products similar to "love insurance" appeared in the insurance market. Such as: "Century Tongxiang" of Ping An Life Insurance Company of China, "Love Family Pact" of Taikang Life Insurance Company, "Forever Together" of China Life Insurance Company, "Family Portrait Joint Life Insurance" of Xinhua Life Insurance Company and so on. Behind the successive launch of these innovative products, it has highlighted the serious homogeneity of products in the insurance market and the lack of intellectual property protection of innovative products.

The innovation of insurance products has a complex process, including data collection, actuarial calculations, and marketing. The development costs are high. Insurance products are ultimately sold in the form of insurance policies, and the terms of the insurance policy are easily imitated by various insurance companies. Insurance companies transform R&D investment into new insurance products, but they soon face competition from competitors with homogenized products. In addition, the cost of imitation is almost zero, which leads to the indirect apportionment of the income of the new insurance development company by the imitating company. It is possible that the imitating company's revenue exceeds the revenue generated by the product development company. As a result, it is difficult for insurance companies to innovate in products to bring about a competitive advantage. To obtain a comparative

advantage, they rely more on rates and commissions, which may cause the insurance market to be placed in a vicious circle of low-level competition. At the same time, the research and development of new insurance products may also face the risk of R&D failure, which greatly dampens the innovation motivation of insurance companies.

However, the protection of insurance product innovation is a complicated process. On the one hand, if the protection of new types of insurance is too strict, such as providing too long a protection period, it may cause a monopoly of a single insurance product, which is not conducive to the innovation and development of the insurance market; on the other hand, if the protection of new types of insurance is insufficient, then will lead to a large number of homogeneous products in the insurance market. At present, my country does not have clear laws and regulations to protect new types of insurance, so insurance companies are facing great innovation risks, and imitation has become the dominant strategy of most insurance companies, and it is difficult to promote the sound development of the entire insurance industry, and cannot meet the growing needs of policyholders. Therefore, how to stimulate the innovation power of insurance companies and consolidate the core competitiveness of insurance companies has become an urgent problem for the healthy development of my country's insurance industry. Therefore, this article attempts to use Bertrand model, repeated game model, etc. from the perspective of game theory to analyze the deep-seated reasons for the lack of product innovation motivation of insurance companies. It is hoped that the analysis and suggestions in this article can stimulate the innovation power of insurance companies, and at the same time make targeted policy recommendations to insurance regulatory agencies, with a view to promoting a market environment for the high-quality development of my country's insurance industry.

## 2. Literature review

William, Rudelius (1970) and others believe that innovation is still an important way to promote the development of enterprises or industries, they studied six important innovations in the life insurance market and found that innovation is adopted by life insurance companies much faster than the speed adopted by large companies 40 years ago Faster than small companies. Ruth Nyambura Gatha (2018) and others found that the innovation of new types of insurance can increase customer loyalty to insurance companies.

The domestic research on the protection of new types of insurance mainly starts from the legal point of view, using legal and administrative means to protect the new types of insurance.Most scholars such as Kang Jiafeng (2008) believe that there is a close relationship between the innovation of insurance products and the protection of intellectual property rights. They believe that a large part of the lack of innovation in insurance products in my country is due to the inadequate legal protection of insurance products in my country.In the study of protective measures for new types of insurance, Zhang Junyan (2010) used the experience of the United States, Japan, and the European Union as a reference, and put forward the current situation of patent protection of insurance products in my country, “we must actively use administrative

protection and strengthen intellectual property protection. "Encourage my country's insurance product innovation" and other viewpoints.Zhou Jun (2016) believes that there are increasingly prominent contradictions between the innovation of insurance products and the increasingly diversified and personalized insurance needs of consumers. Product innovation has become an increasingly prominent problem in the industry, but the existing laws have It is difficult to guarantee product innovation. It is believed that the problem of property rights protection of innovative products can be solved from three aspects: changing the understanding of insurance products, forming insurance products with technical characteristics, and strengthening the protection of intellectual property rights. As for the reason why insurance products lack innovation motivation, there are few domestic researches. Scholars such as Guo Yuhua and Yin Jing (2011) analyze it from the perspective of game theory.

Scholars at home and abroad agree that innovation is the core driving force for the development of the insurance industry. Most scholars analyze from the perspective of law and administration and propose methods such as strengthening intellectual property protection and providing administrative protection. However, there is a lack of analysis of the reasons for the lack of innovation motivation for new insurance companies. Although a small number of scholars have analyzed from the perspective of game theory, they lack a detailed analysis of the reasons for all possible situations of the game. At the same time, there is also a lack of game-based analysis. Conclusions and recommendations. Therefore, based on previous studies, this article improves the research method, analyzes in detail all possible game situations between insurance companies, and specifically analyzes the reasons for the lack of innovation motivation of insurance companies. First, use a game model to analyze the game situation between two insurance companies of different sizes, analyze in detail the results that various game situations may lead to, and combine repeated games, price games and other models to demonstrate. Finally, based on the results of the analysis, specific opinions and suggestions are put forward.

## 3. Analysis of game model and innovation probability model among insurance companies

### 3.1Analysis of a game model among insurance companies

The basic elements of game theory mainly include 7 aspects: participants, actions, information, public knowledge, strategy, payment function, and equilibrium. The non-cooperative game between the two insurance companies mentioned in this article is a static game of complete information. The performance of the game elements of the two insurance companies:1. The participants are two independent and completely rational insurance companies in the game. The two insurance companies maximize their own interests by choosing appropriate actions, which is the most basic element in the game;2. The action is a simultaneous selection action by both parties involved. Although the two insurance companies have innovation first and imitation behind, the two insurance companies do not know each other’s decisions, and the latter cannot be accurate when the order of action is prioritized. Knowing the specific strategy adopted

by the first mover is also regarded as a static game between the two insurance companies;3. Information is the feature, strategy, and payment function of the opponent between two insurance companies. This information is "public knowledge" for the two insurance companies and belongs to a complete information game;4. Strategy is the skill of two insurance companies when deciding how to act. It is an ordered set of actions. Two insurance companies can only choose to innovate or imitate;5. The payment function is the gains and losses of the two insurance companies in the game, expressed by the utility function.

This article assumes that in addition to the innovation of two insurance companies, the game between the two companies is only for the same insurance product, and the two companies only imitate the same insurance product. Since the size of an insurance company will affect its decision-making, and companies of different sizes have different payment levels, according to the China Banking and Insurance Regulatory Commission's criteria for the scale of insurance companies, this article uses the quantitative indicator "market share" to identify insurance companies with a market share of more than 8% as "large insurance companies", and insurance companies with a market share of less than 8% are identified as "small and medium insurance companies", have a detailed discussion. Therefore, the payment matrix of the product innovation game between the two insurance companies is:

Table 1: Payment matrix of product innovation game between two insurance companies

| | | Insurance Company B | |
|---|---|---|---|
| Insurance Company A | | Innovation | imitate |
| | Innovation | $R_A - C_A + k,\ R_B - C_B + k$ | $r_A - C_A + k,\ r_B - c_B$ |
| | imitate | $r_A - c_A,\ r_B - C_B + k$ | 0,0 |

Among them:$R$:the benefits that an insurance company can gain from successfully innovating the product and the opponent does not imitate;$r$: the insurance company successfully innovated the product, the opponent imitated, and the two insurance companies can each obtain the benefits; $C$: the cost of successfully innovating products for insurance companies;$c$: the cost of an insurance company imitating an opponent. For the imitation of insurance products, the cost is extremely low. This article believes that the cost $c$ required for imitation almost tends to zero.; $k$:taking innovative protection measures for insurance products in the external environment will increase the benefits of product innovation companies.

### 3.2 Analysis on the Probability of Insurance Company Innovation

According to the payment matrix of the product innovation game between two insurance companies, assume that the innovation probability of insurance company A is$\mu, (0 \le \mu \le 1)$, then $\mu = 1$ means insurance company A is innovating, and $\mu = 0$ means insurance company A is imitating, the probability of insurance company B innovating is $\theta, (0 \le \theta \le 1)$, then $\theta = 1$ means insurance company B is innovating, and $\theta = 0$ means insurance company B is imitating. First, given $\theta$, the income of insurance company A from innovation and imitation is:

$$\begin{cases} \pi(1,\theta) = (R_A - C_A + k) * \theta + (r_A - C_A + k) * (1-\theta) \\ \pi(0,\theta) = (h_A - c_A) * \theta + 0 * (1-\theta) \end{cases}$$

When the benefits of insurance company A's innovation are equal to the benefits of imitation, the critical value of whether insurance company A will innovate can be obtained, that is, when $\pi(1,\theta) = \pi(0,\theta)$,we get:

$$\theta = \frac{r_A - C_A + k}{2r_A - R_A - c_A}, 1-\theta = \frac{r_A - R_A - c_A + C_A - k}{2r_A - R_A - c_A}$$

Therefore, when $\theta > \frac{r_A - C_A + k}{2r_A - R_A - c_A}$,insurance company A chooses to innovate; when $\theta < \frac{r_A - C_A + k}{2r_A - R_A - c_A}$, insurance company A chooses to imitate, so insurance company A uses the probability of $\frac{r_A - C_A + k}{2r_A - R_A - c_A}$ as the critical value to choose whether to innovate or not, use the probability of $\frac{r_A - R_A - c_A + C_A - k}{2r_A - R_A - c_A}$ as the critical value to choose whether to imitate. Similarly, when $\mu$ is given, when $\mu > \frac{r_B - C_B + k}{2r_B - R_B - c_B}$, insurance company B chooses to innovate; when $\mu < \frac{r_B - C_B + k}{2r_B - R_B - c_B}$, insurance company B chooses to imitate, so insurance company B chooses whether to innovate with the probability of $\frac{r_B - C_B + k}{2r_B - R_B - c_B}$ as the critical value. Use the probability of $\frac{r_B - R_B - c_B + C_B - k}{2r_B - R_B - c_B}$ as the critical value to choose whether to imitate.

### 3.3Analysis of Repeated Game Model among Insurance Companies

A game can get the benefits of the short-term game between insurance companies, but from a long-term perspective, through repeated game model analysis, insurance companies have two choices. The benefit from the imitation is H1 which is in short run. However, the benefit of innovation is in long term.

Given a repetitive matrix of $n$ stages, assuming the benefit discount factor is $\delta$, the benefit of each stage of the game is $H_2$, then the benefit of the long-term repeated game is:

$$\lim_{n\to\infty} H = H_2 + H_2\delta + H_2\delta^2 + H_2\delta^3 + \cdots + H_2\delta^n = \frac{H_2}{1-\delta}$$

When $\frac{H_2}{1-\delta} = H \geq H_1$, that is: $\delta \geq 1 - \frac{H_2}{H_1}$, the insurance company will choose to continue to innovate at this time and continue the game. The Nash equilibrium in this repeated is both companies choose to innovate. The income discount factor $\delta$ tends to zero, that is: $H_2$ is close to equal to $H_1$, long-term income is equal to short-term income, and the income of choosing imitation and choosing innovation is equal, which means that insurance companies are not willing to choose innovation and having stronger incentive to imitate the product of competitor for the trade short-term benefits rather than long-term losses. On the contrary, when the income discount factor $\delta$ closer to 1, it indicates the insurance companies put more attention on innovation with the awareness of the benefit from long-term innovation.

## 4. An Analysis of New Types of Insurance Starting Engines Based on the Game Theory Perspective

### 4.1 Suppose both are big insurance companies

*4.1.1 Both insurance companies choose to innovate*

The two major insurance companies mainly rely on their product advantages to occupy the market. Whether innovative insurance products can bring benefits depends on whether the products meet market demand. If $R_i - C_i > 0$, the insurance company benefits;if$R_i - C_i < 0$, the insurance company loses. When both companies choose to innovate, their profit can be expressed as: $\pi(1,1) = R_i - C_i$ respectively. Large insurance companies have rich market resources and a large amount of data to provide a basis for product development, which can better meet market needs and increase the innovation revenue $R_i$ of large companies' new types of insurance. Large companies have a complete set of product development processes and innovation costs. The cost of innovation is at an acceptable low level. Therefore, in order to expand the company's revenue and increase the company's reputation, large insurance companies will be more inclined to innovate.

For large insurance companies, under the current competitive conditions, the risk of large insurance companies not carrying out product innovation is increasing, and market demands become diversified. Customers expect a steady stream of new products. Competitors will certainly do their best to meet these needs, which forces big insurance companies to innovate to stabilize their market positions. And the two big insurance companies are innovating. At this time, a good competitive insurance market is formed, which is conducive to the development of the insurance industry. This healthy competition model is also advocated by the insurance industry in my country.

*4.1.2One of the insurance companies chooses to innovate, the other chooses to imitate*

In the game between two large insurance companies, one insurance company chose product innovation, and the other insurance company imitated its innovative insurance products. Both large companies have a lot of market resources. When the product price is the same, it can be understood that the income of the two insurance companies is the same, that is: $R = r$, and the innovative company needs to bear the cost of product development. Obviously, the innovation cost $C$ is greater than the imitation cost $c$, which results in the product development company's income lower than the imitation company's income, namely $r_A - C_A < r_B - c_B$, which greatly dampens the enthusiasm of insurance companies to innovate. In this case, innovative insurance companies will be more inclined to imitate.

In the competition for same insurance product. The price competition is required to gain more profit.I hired Bertrand Competition Model to analyze the pricing strategy of two companies. The decision variable of the company in the Bertrand model is the price, assuming that the product price of the two insurance companies is $P_i(i = A, B)$, the marginal costs are both equal to$C$,the two insurance companies conduct dynamic games by setting different prices for their products. According to the Bowley model, the inverse demand function for two companies is:

$$\begin{cases} q_A = a - b_A p_A + d_A p_B \\ q_B = a - b_B p_B + d_B p_A \end{cases}$$

Which$a, b_i, d_i > 0, i = A, B$.

$p_i (i = A, B)$ are the price, $q_i, (i = A, B)$ are the quantity demanded for the two companies, $d_i (i = A, B)$ represents the substitution rate between products between two insurance companies.$d_i = 0$ means that the products of the two insurance companies are completely different, and $d_i = 1$ means that the products of the two insurance companies are perfect substitutes. If the two insurance companies have no fixed costs, $c_i > 0, (i = A, B)$ are the marginal costs of the $i$-th insurance company, respectively. Therefore, the profit function of the two insurance companies is: $\pi_i(p_\mathrm{A}, p_\mathrm{B}) = p_i q_i - c_i q_i, i = A, B$, namely:

$$\begin{cases} \pi_A(p_A, p_B) = (p_A - c_A)(a - b_A p_A + d_A p_B) \\ \pi_B(p_A, p_B) = (p_B - c_B)(a - b_B p_B + d_B p_A) \end{cases}$$

From this, it can be concluded that the marginal profits of the two insurance companies are:

$$\begin{cases} \dfrac{\partial \pi_A(p_A, p_B)}{\partial p_A} = a - 2b_A p_A + d_A p_B + b_A c_A \\ \dfrac{\partial \pi_B(p_A, p_B)}{\partial p_\mathrm{B}} = a - 2b_B p_B + d_B p_A + b_B c_B \end{cases}$$

If the marginal profit is greater than zero, the insurance company's decision is to increase the price of the product, and vice versa, reduce the price of the product. The dynamic process of insurance product price adjustment is:

$$\tilde{p}_i(t) = \alpha_i(p_i) \frac{\partial \pi_i(p_A, p_B)}{\partial p_i}, i = A, B$$

Among them, $\alpha_i(p_i)$ represents the degree to which the product price of the $i$-th insurance company changes with the marginal profit. It is assumed that the degree of change is linear, namely: $\alpha_i(p_i) = v_i p_i, i = A, B$, where $v_i > 0$ Indicates the price adjustment speed of the $i$-th insurance company. Therefore, a game model for the price decision of two insurance companies can be derived:

$$\begin{cases} \tilde{p}_A(t) = v_A p_A(a - 2b_A p_A + d_A p_B + b_A c_A) \\ \tilde{p}_B(t) = v_B p_B(a - 2b_B p_B + d_B p_A + b_B c_B) \end{cases}$$

In the insurance market, the two major insurance companies use price as the main means of competition. Because the products of both parties are substitutable, the prices of both parties have a positive effect on the prices of the other party, and prices usually show the same increase and decrease. Since the products of the two companies in the market are of the same quality, consumers will give priority to buying insurance products with lower prices. When $P_A = P_B$, consumers have the same demand for the products of the two companies, that is, $q_A = q_B$, and the two insurance companies obtain more market share through price competition, and the price keeps falling until $P_A = P_B = C$, thus Reach the equilibrium, that is, Bertrand equilibrium. In the equilibrium situation at this time, the profits that the two companies can obtain are zero, that is, the "Bertrand Paradox". The products of the two insurance companies tend to be homogenized, and the prices of insurance

products tend to be marginal costs, thereby forming a low-cost homogenization of the competition situation has seriously affected the development of the insurance market. To solve the Bertrand paradox, two major insurance companies are required to innovate, and the diversity of insurance products is an effective method.

*4.1.3Both insurance companies choose to imitate*

Both large insurance companies imitate the same insurance product, and the cost of imitation is extremely low. The benefits of the two large insurance companies are greater than the cost of imitation, that is, $r > c$, so they are more inclined to imitate. For the same insurance product, two major insurance companies will inevitably have price competition as explained above. At this time, the imitation cost is low, and both companies are willing to fight a "price war." However, every insurance company knows that "price wars" will often cause losses for both parties and the entire industry, but they still actively fight "price wars". This is the "prisoner's dilemma". The two insurance companies are equivalent to "prisoners." The behavior of product price reduction between companies is equivalent to "confession". Price reduction behavior includes methods such as rate discounts or increase in fee payment standards. Non-price reduction behavior is equivalent to "non-confession". Suppose the payment matrix is:

Table 2: Payment matrix of product price game between two insurance companies

| | | Insurance Company B | | |
|---|---|---|---|---|
| | | Price cut | No price cut | Expected return |
| Insurance Company A | Price cut | （5，5） | （15，-5） | =5*50%+15*50% =10 |
| | No price cut | （-5，15） | （10，10） | =（-5）*50%+10*50% =2.5 |
| | Expected return | =5*50%+15*50% =10 | =（-5）*50%+10*50% =2.5 | |

For the two insurance companies, the expected return of choosing a price reduction is 10, and the expected return of choosing no price reduction is 2.5. The expectation of choosing a price reduction is greater than that of no price reduction, although both parties know that choosing "no confession" can get more benefits than choosing "candid". That is, no price reduction will bring more benefits, but based on the principle of maximizing their own interests, both insurance companies will choose to reduce prices, and both insurance companies will reduce prices, which constitutes a "Nash equilibrium."

## 4.2 Suppose one of them is a large insurance company and the other is a small insurance company

*4.2.1Both insurance companies choose to innovate*

Both large and small insurance companies choose to innovate. Large insurance companies have a lot of market resources, and the cost of innovation is at an acceptable low level. In the face of competition from small insurance companies for new types of insurance, in order to win a larger market, large insurance companies will be more willing to choose innovation as a dominant strategy. However, for small

insurance companies, market recognition is not high, there is information asymmetry with consumers, lack of sufficient data as the basis for product development, innovation costs are high, and marketing costs are high. The cost of product innovation and promotion of small companies is much higher than that of large companies, and the benefits of innovation are lower than those of imitation, that is: $R - C < r - c$, assuming that the imitation revenue $r$ remains unchanged, $r - C$ becomes smaller, $2r - R$ becomes larger, so the probability of innovation $\frac{r-C+k}{2r-R-c}$ of small insurance companies becomes smaller. In the face of innovation by large companies, small companies will gradually shift from innovation to imitation, and tend to be more inclined Choose imitation as the dominant strategy.

*4.2.2 Large insurance companies choose to innovate, small insurance companies choose to imitate*

From the above analysis, it can be seen that small insurance companies, as followers of the market, are more inclined to choose imitation to reduce costs and increase revenue. However, small insurance companies also have the risk of imitation failure. The reason is that small companies do not have sufficient market resources and lack of understanding of customer needs, which leads to imitation products that cannot meet customer needs.

For large insurance companies, they dominate the market and consumers have a high degree of trust in them. When large companies choose to innovate, although there are small companies imitating them, resulting in the income of new insurance types being divided. However, small insurance companies lack a market. Large insurance companies still dominate the market. They still have a relatively high market share. Consumers are more willing to buy insurance products from large companies, that is, $r_B - C_B > 0$. However, because small companies will choose imitation as the dominant strategy, so large companies can only choose to innovate, because only in this way can their profits be maximized. At this time, a "smart pig game" is formed. Large companies carry out independent innovation and small companies are followers. However, big companies are blindly imitated by small companies, and small companies continue to share the benefits of large insurance companies. In the long run, it will also dampen the enthusiasm of large companies to innovate.

In the short term, small companies may benefit from imitating the insurance product, but in the long run, customers are more willing to favor the products of large companies, and the profits of small companies will gradually decrease. If things go on like this, small companies will choose a price reduction strategy to attract more customers. For large companies, in order to suppress malicious imitation of small companies, they will deliberately engage in price competition and lower product prices, which will lead to vicious price competition. Have an adverse impact on the entire insurance industry.

*4.2.3Large insurance companies choose to imitate, small insurance companies choose innovation*

The cost of innovation for insurance products of small insurance companies is high, and the market does not have a high degree of trust in small insurance companies. As

a result, the innovation income of small companies is very low. If innovative insurance products are imitated by large insurance companies, large companies may occupy the insurance market, and small business will face small profits being divided up again. It may appear that the profits of the imitating company are greater than the profits of the innovative company, and it may even cause the small insurance company to incur losses, that is: $r - C < 0$, which affects the enthusiasm of the innovative entity. For small companies, the benefits of innovation are low, coupled with the imitation of large companies, small companies will still use imitation as a dominant strategy.

*4.2.4Both insurance companies choose to imitate*

Both large and small insurance companies choose to imitate the same insurance product. Although the imitation costs of the two insurance companies are low, the large insurance company has a market position and high market recognition, which will dominate the insurance market, leading to small insurance companies Only low-price competition can be used to obtain more income, which will also cause improper competition in the insurance market.

### 4.3 Suppose both are small insurance companies

Regardless of whether the two small insurance companies choose to imitate or innovate, as in the above analysis, small insurance companies have a high cost of innovation, and the market's recognition is not high. Due to lack of data, they may also face the risk of innovation failure. In other words, the benefits of innovation are lower than those of imitation, and they will eventually be more inclined to imitate.

### 4.4 Insurance company's new product development willingness Summary

In the above game, large insurance companies are the main force of innovation, small insurance companies are followers of the market, and large insurance companies may choose to innovate or imitate in the face of different market conditions. Small insurance companies are more inclined to imitate due to difficulties such as high development costs and low market recognition. The final phenomenon is that large companies may choose to innovate or imitate, while small companies choose to imitate.

## 5. Conclusions and recommendations

In the face of current competitive conditions, the risk of insurance companies not innovating is increasing. Now customers' demand for insurance products is personalized and diversified. Competitors will do their best to meet these needs. Continuous innovation is the best choice for insurance companies to attract customers and gain market share. Through the Bertrand (Bertrand model) model, it can also be seen that if other parameters remain unchanged, if an insurance company's product substitution rate $d_i$ decreases, that is to say, the irreplaceability of the insurance company's products is increased, Then the increase in the income of the insurance company will be greater than the increase in the income of the other insurance company. In order to expand the profits of an insurance company, in the process of

research and development of insurance products, it is necessary to continuously innovate and develop and design more products that meet people's needs.

The innovation level of insurance products is not only a manifestation of the competitiveness of an insurance company, but also reflects the degree of marketization of a country. However, innovation also requires related protection mechanisms, so as to stimulate various insurance companies to actively carry out independent innovation. Therefore, the following suggestions are made:

### 5.1 Establish an incentive mechanism for new product innovation of insurance companies

my country has insufficient legal and administrative protection methods for new types of insurance. Many scholars protect new types of insurance by studying copyright law, patent law, trademark law, and anti-unfair competition laws, but they all have their shortcomings, and the driving force for innovation in new types of insurance lies in the benefits that innovation can bring, only if the benefits meet the expectations of innovative companies, will they encourage companies to actively innovate and promote the development of the entire insurance industry. Therefore, if the external environment rewards innovative insurance companies with $k$, then $R_i - C_i + k > R_i - C_i > 0$ will increase the insurance company's income level; when $R_i - C_i < R_i - C_i + k < 0$ Or when $R_i - C_i < 0 < R_i - C_i + k$, it will reduce the insurance company's loss. At the same time, reward the product development company, $\frac{r_A - C_A + k}{2r_A - R_A - c_A} > \frac{r_A - C_A}{2r_A - R_A - c_A}$, which will increase the probability of insurance companies choosing innovation, $\frac{r_A - R_A - c_A + C_A - k}{2r_A - R_A - c_A} < \frac{r_A - R_A - c_A + C_A}{2r_A - R_A - c_A}$, will also reduce the probability of insurance companies choosing to imitate. Therefore, relevant government departments should formulate incentives or subsidies for product innovation of insurance companies, Including tax relief, etc.

### 5.2 Strengthen the concept of sustainable development of insurance companies

Insurance companies need to treat product innovation as a "long-term game" to balance short-term substitution effects and long-term complementarities. Although imitation will bring short-term benefits to small insurance companies, in the long run, the long-term benefits of the same type of insurance will gradually decrease. Companies that blindly imitate lack the ability to innovate and cannot achieve long-term stable development. Once the market suppresses small companies, small companies are easily paralyzed, which will not only affect the development of the insurance industry, but also cause social instability. Small companies continue to innovate. Although this may limit profitability in the short term, in the long run, they are accumulating market resources. Even if there are other companies competing to imitate, as long as their product innovation speed keeps up, they can cultivate potential customers. In the long run, it will build a stable market position. Most small companies have also found that informal protection methods for new insurance types, such as speeding up listing or confidentiality, are more important than patent protection.

From the repeated game model between insurance companies, it can be seen that if the company repeats the game indefinitely, as long as the $\delta$ income discount factor tends to 1, the companies will choose to innovate each other, and ultimately achieve the goal of healthy competition in the insurance market. The purpose of competition is to achieve long-term mutual benefit, that is, the subgame perfect Nash equilibrium.

Choosing a product differentiation strategy is the only way for insurance companies to achieve sustainable development. They can take the initiative in the market, and the first to adopt the strategy will get more profits. Therefore, insurance companies should take the lead in actively advancing their insurance product differentiation strategy, so as to enhance their competitiveness and continuously increase their market share in order to obtain long-term development of the company. For companies with low R&D intensiveness, they may wish to start with a product-oriented business model. Under this model, they can gain strong complementarities at an early stage, and then as the intensity of R&D increases, it shifts to a customer-oriented business model.

### 5.3 Strengthen cooperation between insurance companies

The design of insurance contract clauses relies on the practical data accumulated by the insurance industry. Insurance companies should strengthen cooperation, share data on single product research and development, jointly build insurance technology databases, and share benefits. This can not only reduce R&D costs and R&D risks, but also avoid the dilemma caused by price competition between the two companies. And the situation of non-cooperative game between insurance companies can be changed. The entire insurance industry can also benefit from the popularization of new products as a whole to achieve a win-win goal.

Of course, in the "production" process of future products, insurance companies should not only focus on the innovation of their own products, but also need to pay close attention to the characteristics of the products produced by another insurance company, absorb the advantages of the other insurance company's products into their own products, thereby enhancing the competitive advantage of their own products.

### 5.4 Enhancing the innovative ideas of insurance company management

The support and encouragement of senior management are the driving factors for innovation and development and success. Only when the management pays attention to innovation as the first driving force of development and possesses the concept of new insurance innovation, can the company's innovation power be activated. At the same time, the company’s management must also recognize the difference between products and competition, and let customers perceive the difference between products developed by their insurance company and competing products, as well as the gaps filled for the products, which demonstrates true innovation. The managers of insurance companies are worried that they will be held responsible for personal negligence or misconduct. Senior managers of insurance companies can protect their rights and interests through D&O insurance. D&O insurance can enhance the manager’s ability to carry risks, which also shows that D&O insurance There is also a significant positive correlation with the innovation of insurance companies.

### 5.5 Full protection mechanism built on the insurance company's new product innovation

One of the contradictions in the "Nash Equilibrium" is the contradiction between the maximization of individual interests and the maximization of overall interests. From the perspective of the insurance market, it is the contradiction between the maximization of individual insurance companies and the entire insurance industry. It is unwilling to change the decision to reduce prices, which leads to the smallest overall interest of the industry, leading to chaos in the competition order of the industry. In many cases, only by sacrificing some partial interests can the overall interests be maximized. Therefore, insurance regulatory authorities need to take certain protective measures to safeguard the overall interests of the insurance industry, such as price control. At the same time, they are also safeguarding the interests of insurance consumers. When necessary, they sacrifice the partial interests of some insurance companies, in order to seek a sub-optimal "Nash equilibrium" that is beneficial to the entire industry, break the situation of non-cooperative games.

Of course, differentiation through product innovation also requires the protection and support of the government and industry departments. For example, the establishment of intellectual property protection mechanisms for new insurance types, check the approval threshold for new types of insurance, granting innovative insurance products a certain period of protection, and increasing the cost of imitation, etc., these protections and support are equivalent to an implicit subsidy policy, which is conducive to incentivizing insurance companies to innovate.

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# 保险公司产品创新动力机制分析—基于博弈论模型

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**关键词：**产品创新;动力机制;博弈论

**中文摘要：**近年来，中国保险业处于高速发展阶段，但支撑保险业高速增长的核心要素即保险公司产品创新速度和质量却与之不协调，保险市场产品同质化、低价恶性竞争等现象非常突出，对中国保险业可持续发展带来较大影响。如何激发保险公司产品创新动力，夯实保险公司的核心竞争力成为中国保险业健康发展亟待解决的一个问题。本文试图从博弈论视角，运用 Bertrand 模型、重复博弈模型等，分析保险公司产品创新动力不足的深层次原因，并针对性提出相关意见和建议，以期促进中国保险业由高速发展向高质量发展迈进。

# Effects of Social Relations on Family Business Insurance Participation Decision-making -- Based on the Perspective of Strong-Weak perspective

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**Keywords:** Social relationship, strong relationship, weak relationship, commercial insurance participation, influence mechanism.

**Abstract.** Social relations have two kinds of complementary and substitution effects on family commercial insurance participation in decision-making.By dividing social relationship into strong relationship and weak relationship, this paper identifies two different effects and their mechanisms.The results show that social relationships can significantly improve the probability and degree of family participation in commercial insurance.For household commercial insurance participation, strong relationship has substitution effect, while weak relationship has complementary effect.Further research found that: strong relationship through the human mechanism can significantly reduce the probability and degree of participation in commercial insurance;However, the weak relationship significantly increases the probability and degree of participation in commercial insurance mainly through the information transmission mechanism.This paper provides a perspective of social characteristics for the development of commercial insurance market under the background of the coexistence of traditional social structure and modern market economy, that is, to pay attention to the

promoting role of social relations and promote the healthy and rapid development of China's commercial insurance market.

## 1. 引言

社会关系是人们在日常的物质和精神活动中与他人产生的相互关系总称。自人类社会产生之日起，人与人之间就产生了各种关系，他们共同构成了社会关系（安东尼·吉登斯著、李康，2009）。人们可以利用社会关系联结和调用各种形式的资源，社会关系不仅能够为行动者个人提供有价值的信息、施加人情影响、增加信任、慰藉情感、协助经济交易和社会交换等，还能够为集体、社区乃至社会整体提供情感基础、信任纽带、非正式约束、集体行动的动力等，从而可促进人们之间的连结、集体的团结、社会的整合（林南，2005）。中国是一个典型的人情关系型社会（梁漱溟，2005），“关系”一词在中国具有极为丰富的行为内涵：感情、人情、面子、回报等等。对于中国传统社会中社会关系的特点，费孝通（1948）以“差序格局”形象描述：“社会关系是逐渐从一个人一个人推出去的，是私人联系的增加，它是由一根根私人联系所构成的网络”。至今，差序格局仍对中国城乡社会发挥着持续的作用，影响人们社会生活的方方面面，成为资源获得（孙立平，1996）、利益诉求（陈俊杰、陈震，1998）、社区治理（党国英等，2017）、新市场理性（肖瑛，2014）的行动逻辑。

作为非正式制度的重要组成部分，社会关系对人们经济行为的影响受到大量学者关注。研究发现，社会关系可以分担风险及平滑消费（Munshi & Rosenzweig，2009）、传递信息（Hong et al.，2004）、提高收入（Grootaert，1999；黄英伟、洪如玲，2011）、提高借贷概率（胡枫、陈玉宇，2012）、降低贫困和收入差距（Chantarat & Barrett，2011；周广肃、马光荣，2015）、降低储蓄率（Chantarat & Barrett，2011；易行健等，2012）。

商业保险作为现代金融经济体系中一个非常重要的组成部分，必然也会受到社会关系的影响。从已有研究来看，社会关系对家庭参与商业保险决策可能具有两方面影响。一方面，社会关系是一种信息分享和资源配置的重要方式，人们可以通过共享保险信息，加强对商业保险的信任从而促进居民对商业保险的参与。如Desmet et al.，（1999）研究表明人们在社会互动过程中提供了保险信息，从而促进了个体参与社区医疗保险。李丁等（2019）研究发现：社会互动主要通过口头信息交流、交谈获得愉悦而显著提高家庭参与商业保险概率和程度。另一方面，社会关系作为一种非正式制度，可以通过借款、转移支付等互助行为实现风险分担，发挥非正式保险的作用（Munshi & Rosenzweig，2009），从而降低家庭参与商业保险的概率和程度。社会关系的风险分担功能已受到许多学者的关注，如关系网络有助于平滑消费，起到部分风险分担作用（王晓全等，2016）；社会网络通过收入转移和互惠信贷，农户可以彼此分担风险（巴德汗、尤迪，2002）；农户通过社会网络内风险统筹、跨时期收入转移来规避风险（马小勇，2006）；社会网络通过其内部的风险分担机制发挥着非正式保险的作用，进而降低农户储蓄率（王春超、袁伟，2016）。那么，在我国保险市场快速发展的情况下，社会关系对家庭参与商业保险决策的影响究竟是互补作用还是替代作用？不同类型的社会关系发挥的作用都相同吗？它们又是通过什么机制发生作用的？对上述问题的思考不仅有助于理解家庭商业保险参与决策的行为逻辑，而且对与我国保险市场的健康发展有着重要的启示意义。

为了识别社会关系对家庭参与商业保险存在的互补和替代效应，本文将社会关系进一步分为强关系与弱关系。Granovetter(1973)的社会关系理论中，社会关系基于强度差异可以分为强关系和弱关系。强关系网中，人与人关系紧密，信息重复路径多、同质性强；而在弱关系网中，人与人关系较为松散，交往面广，信息重复路径较少、异质性强（Granovetter，1973）。这种分类与费孝通（1948）对中国家庭社会关系的“差序格局”经典描述完全吻合。此外，为了探讨社会关系是如何对家庭参与商业保险决策产生影响的问题，本文根据何凌霄、张忠根（2016）的研究，认为强、弱关系的作用机制分别是人情机制和信息机制。在中国，关系主义文化使得强关系成为网络桥梁，传递人情与帮助，为行动者带来经济回报（Bian，1997）。强关系网中人情机制有助于形成信任和互惠互利，降低人们的交易成本，分担家庭面临的风险降低家庭参与商业保险概率及程度；弱关系凭借网络的信息桥梁与共享作用，为人们提供非重复的信息，动用优质的社会资源促进家庭参与商业保险概率及程度。

本文主要贡献在于：实证验证了社会关系对家庭参与商业保险决策同时存在互补和替代效应；并将社会关系进一步划分为强关系和弱关系研究其作用传导机制。研究发现以人情机制为主的强关系对家庭商业保险参与存在替代效应，以信息传递机制为主导弱关系对家庭商业保险参与存在互补效应，并用中介效应模型验证了强关系、弱关系的不同作用机制。这为正确理解和处理非正式制度的社会关系与现代正式保险制度之间的关系提供了有益的启示，对我国保险业健康快速发展具有重要的参考价值。

本文的主体结构安排如下：第一部分是引言；第二部分是文献综述；第三部分是数据来源及变量描述；第四部分是实证分析；第五部分是进一步讨论；第六部分是主要结论及政策意义。

## 2．文献综述

关系，是一个极具中国特色的词语。中国的社会关系是由无数张以家庭为核心的、重叠的、如蜘蛛网般的关系网构成（费孝通，1948）。随着市场经济的日益发展，社会关系作为一种非正式制度能够牵动诸多资源的流动，影响其流向，因而它早已不只是一种有经济意义的资源，而是一种具有资源配置功能的资源（何清涟，1998）。商业保险作为我国正式保险制度之一，在合理配置资源、促进经济发展和维护社会稳定方面发挥着越来越重要的作用。目前学术界主要从家庭经济状况和人口特征因素角度研究影响商业保险的需求因素，如家庭经济因素包括家庭收入（Albouy & Blagoutine，2001；刘宏、王俊，2012；孙祁祥、王向楠，2013）、住房资产（Davidoff，2010）、社会保障（Brown & Finkelstein，2008；钟春平等，2012）、税收政策（Thomasson，2003；朱铭来、于新亮，2015）等；人口因素包括：教育程度（蒲成毅、潘小军，2012）、风险态度（Cutler et al.，2008；肖芸茹，2000）、家庭抚养比（Liebenberg et al.，2012；樊纲治、王宏扬，2015）等。

家庭参与商业保险是一个复杂的过程，居民做出商业保险决策时必然会受到人们日常交往所建立起来的社会关系网的影响。纵观现有文献，社会关系对家庭商业保险需求具有两方面影响。一方面，社会关系可以通过共享信息和居民的从众心理从而促进居民对商业保险的参与。Desmet et al.（1999）研究表明人们在社会互动过程中提供了保险信息，从而促进了个体参与社区医疗保险。龚晶（2007）利用江苏省和甘肃省870户农民家庭人身保险消费调查数据发现人情开

支可以促进农村家庭参与商业人身保险；何兴强、李涛（2009）采用2004年广东省居民调查数据认为社会资本可以推动家庭商业保险的参与；李丁等（2019）研究发现：社会互动中的内生互动通过口头信息交流机制可以显著提高家庭商业保险参与的概率及程度；张栋浩等（2016）研究表明关系可以通过社会互动提高家庭购买商业保险及获得保险赔付的概率。另一方面，社会关系作为一种非正式风险分担机制，帮助家庭分担风险应对外生冲击，与商业保险形成相互替代关系。蒋远胜等（2003）研究发现四川省农户自发组成更大的家庭风险分担团体对正式的保险组织具有一定的替代性和优越性，且这种风险分担团体能够“挤出”对正式健康保险的需求。阮永锋（2018）运用上海财经大学 2015 年“千村调查”数据，研究发现：基于宗族网络的非正式保险制度对商业保险具有“替代效应”，即宗族网络抑制了农村商业保险的发展。但是该研究仍未对社会关系影响家庭商业保险参与行为的风险分担机制做出细致的解释。显然，上述研究已经指明了社会关系对商业保险的两个关键影响方向，但他们都只关注了其中一种作用，尚未统筹识别社会关系对家庭参与商业保险正反两方面作用。另外，现有研究也未考虑不同的社会关系对家庭参与商业保险的影响后果可能不一样，因此，区分不同社会关系类型对家庭商业保险参与决策研究非常重要。

## 3. 数据来源及变量描述

### 3.1 数据来源

本文所采用的数据来源于西南财经大学2015年中国家庭金融调查（CHFS），数据涵盖全国29个省（自治区、直辖市）、351个县（区、市）、1396 个村（居）委会，共获得 37289户家庭的微观数据，包含了家庭资产负债、保险保障、收入支出以及家庭人口特征等各方面的详细信息；样本覆盖面广泛，具有全国代表性，这为本文的实证研究提供了很好的数据支持。本文未采用西南财经大学2017年中国家庭金融调查（CHFS）数据，主要是因为在处理数据过程中发现2017年CHFS数据中缺少本文应该要讨论的关键核心变量，如家庭在外就餐支出、对于商业保险的信任度、财产险等数据，如果缺少这些数据，可能会使得估计结果出现偏差，研究问题不深入，无法实现本文的研究意义，致使本文的研究分析无法进行。而且2015年CHFS数据已经能够提供本文的关键变量所需数据，为探究社会关系对家庭参与商业保险决策的不同作用提供良好的数据支持。

### 3.2变量选取

被解释变量：一、用家庭是否参与商业保险衡量参与概率。如果家庭成员中至少有一人参与了任意一种商业保险，则认为该家庭参与了商业保险，取值为1。二、用家庭商业保费支出对数衡量参与程度。

核心解释变量：社会关系、强关系和弱关系。社会关系指标：从问卷中选取23个与家庭“关系”相关的变量，通过数据的统计描述剔除不合适的变量，进而对如下的6个变量进行KMO指标和SMC指标检验：户主及配偶的亲兄弟姐妹数、家庭礼金收支、在外就餐支出、交通支出、通信支出、文化娱乐支出。检验结果通过KMO检验，采用因子分析法可行。根据表1，因子1特征值大于1，累计贡献率达82%，根据主因子选取原则，我们选择因子1衡量社会关系。为了得到更具有经济学意义的结果，我们对因子载荷矩阵加以旋转计算得出社会关系综合指标。

表1：因子分析结果

| 因子 | 特征值 | 方差贡献率 | 累计贡献率 |
|---|---|---|---|
| 因子1 | 1.53821 | 0.8252 | 0.8252 |
| 因子2 | 0.20423 | 0.1096 | 0.9348 |
| 因子3 | 0.06037 | 0.0324 | 0.9672 |
| 因子4 | 0.04584 | 0.0246 | 0.9918 |
| 因子5 | 0.01550 | 0.0083 | 1.0001 |
| 因子6 | -0.00018 | -0.0001 | 1.0000 |

强关系指标：用家庭户主及配偶的亲兄弟姐妹数来度量，从而与以往只关注户主亲兄弟姐妹数的研究区别开来。亲兄弟姐妹是以血缘为纽带而形成的强关系，其关系强度远高于亲戚和朋友，它在农户经济中发挥着重要作用（Wenhong & Danqing，2001）。同时纳入配偶的亲兄弟姐妹数，有效避免了中国自计划生育以来独生子女增多导致的大量样本数据为0的情况，一方面使得数据分布更加合理，估计结果更加严谨准确；另一方面也符合当今中国夫妻双方地位平等的社会现状。

弱关系指标：用家庭礼金收支、在外就餐支出、交通支出、通信支出、文化娱乐支出线性相加取对数构造弱关系综合指标衡量，以反映家庭为了维护和建立社会关系所需要的总费用。梁玉成（2010）指出：家庭礼金收支大多存在于为了利益而建立的弱网中，而弱关系的维持需要感情或金钱，支出越多说明发展弱关系的成本越大。以上5个指标都是反映建立和维护社会关系所需的费用，因此可以线性相加后取对数。

控制变量：包括影响家庭商业保险参与行为的传统变量，如户主特征变量：户主性别、年龄及其平方、婚姻状况、受教育年限、工作、是否健康；家庭特征变量：家庭总收入、家庭总支出、家庭固定资产价值、家庭总资产、家庭总负债、家庭抚养比、风险程度、是否参加社保。另外，本文还控制了城乡虚拟变量，以便控制农村和城市家庭之间的差异。

如表2所示。在受调查的37289户家庭中，仅有10105户家庭参与了商业保险，商业保险市场参与率平均为27.1%。样本家庭中，75.5%都是男性户主，平均年龄为53.24岁，86.32%都是已婚家庭。户主的平均受教育年限为9.24年，即初中教育水平，63.8%的户主都有工作；83.2%的户主身体健康。拥有社会保障的家庭占比为97%，家庭老幼总抚养比平均为29.5%，平均而言，受访家庭都为风险厌恶者；其中农村家庭占比为31.3%。

表2：变量的统计描述

| 变量 | 观测值 | 均值 | 标准差 | 最小值 | 最大值 |
|---|---|---|---|---|---|
| 是否参与商业保险 | 37289 | 0.271 | 0.445 | 0 | 1 |
| ln商业保费支出 | 37289 | 1.909 | 3.526 | 0 | 14.52 |
| 社会关系 | 37289 | -4.07e-10 | 0.840 | -2.048 | 2.784 |
| 夫妻双方亲兄弟姐妹数 | 37289 | 1.947 | 2.518 | 0 | 37 |
| 弱关系 | 37289 | 7.884 | 1.908 | 0 | 14.16 |
| 性别（男性=1） | 37289 | 0.755 | 0.430 | 0 | 1 |
| 年龄 | 37281 | 53.24 | 14.34 | 3 | 101 |

| | | | | | |
|---|---|---|---|---|---|
| 年龄的平方 | 37281 | 3040 | 1558 | 9 | 10201 |
| 婚姻状况（已婚/分居=1） | 37289 | 0.862 | 0.344 | 0 | 1 |
| 受教育年限 | 37289 | 9.238 | 4.200 | 0 | 22 |
| 是否有工作（是=1） | 37169 | 0.648 | 0.477 | 0 | 1 |
| 是否健康（是=1） | 37289 | 0.832 | 0.374 | 0 | 1 |
| ln家庭总收入 | 37289 | 9.686 | 3.413 | -13.59 | 15.42 |
| ln家庭总支出 | 37239 | 10.84 | 0.875 | 0 | 16.72 |
| ln家庭固定资产 | 36458 | 13.07 | 8.586 | 0 | 25.98 |
| ln家庭总资产 | 35721 | 15.42 | 6.025 | 0 | 25.98 |
| ln家庭总负债 | 36992 | 3.250 | 6.992 | 0 | 26.94 |
| 家庭抚养比 | 37289 | 0.295 | 0.305 | 0 | 1 |
| 风险厌恶程度 | 37289 | 4.270 | 1.256 | 1 | 6 |
| 是否参加社保（是=1） | 37289 | 0.970 | 0.171 | 0 | 1 |
| 是否为农村地区（是=1） | 37289 | 0.313 | 0.464 | 0 | 1 |

## 4.实证分析

### 4.1 基准回归

首先，本文利用Probit模型研究社会关系对家庭参与商业保险概率的影响。

$$\mathrm{Fcomminsu_dm_i} = \alpha_0 + \alpha_1 \mathrm{Guanxi_i} + \alpha_2 \mathrm{X_i} + \varepsilon_i \qquad (1)$$

其中，$\mathrm{Fcomminsu_dm_i}$表示家庭参与保险概率，$\mathrm{Guanxi_i}$表示家庭的社会关系、强关系和弱关系，$\mathrm{X_i}$是控制变量，包括户主特征、家庭特征和地区特征等，下标$i$代表第$i$个家庭，$\varepsilon_i$为残差项，假设$\varepsilon_i \sim N(\alpha_i, {\sigma_i}^2)$。

其次，为了进一步研究社会关系对家庭商业保险参与程度的影响，本文采用Tobit 模型进行实证分析。用家庭商业保费支出的对数形式来衡量家庭参与商业保险程度。因为可能出现家庭未参与商业保险时，其商业保险费用支出为0的情况，所以采用Tobit模型截断这些数据。模型如下：

$$\mathrm{Lnp_fcomminsu_i} = \beta_0 + \beta_1 \mathrm{Guanxi_i} + \beta_2 \mathrm{X_i} + \mu_i \qquad (2)$$

其中，$\mathrm{Lnp_fcomminsu}$表示家庭参与保险程度，$\mu_i$为残差项，假设$\mu_i \sim N(\alpha_i, {\sigma_i}^2)$，其他变量定义如1式。

表3报告了基准回归结果。社会关系显著提高了家庭参与商业保险的概率和程度，社会关系指标每增加一个单位，家庭参与商业保险概率提高9.6%，参与程度提高近3倍。其中，强关系对家庭参与商业保险概率及程度具有负向影响，兄弟姐妹数每增加一个，家庭参与商业保险的概率降低0.76%，参与程度降低23.79%，反映了基于血缘、姻缘的强关系在家庭面临外部经济冲击时可以帮助家庭分担风险，从而起到非正式保险的作用，对商业保险产生替代效应。而弱关系对家庭商业保险参与具有正向影响，弱关系增加1%，家庭参与商业保险的概率

提高2.1%，参与程度提高70.92%。这是原因随着市场化、城镇化进程的不断加快，地缘、业缘等弱关系的不断拓展，弱关系网中的人们通过共享信息、攀比心理以及合理配置资源提高参与商业保险的可能性和程度。这与王春超、袁伟（2016）研究结论一致。最终从这两种关系叠加的净效果来看，社会关系仍会促进商业保险的参与概率及程度。

就控制变量而言，男性户主家庭会降低参与商业保险的概率，但对参与程度无显著影响；户主年龄系数和年龄平方项的系数分别为正和负，表明家庭商业保险参与可能性和程度随年龄增长呈现明显的“倒 U 型”；婚姻状况、受教育年限均对家庭参与商业保险可能性和程度具有正向影响，且都在1%水平上显著；相比于无工作的户主，有工作的户主会降低商业保险参与行为的概率和程度；此外，健康水平越高，家庭越有可能参与商业保险且参与程度更高。家庭总收入、家庭总支出、家庭固定资产显著提高了家庭商业保险的参与概率及程度，这与大多数研究结果一致；抚养比的提高则会显著降低家庭参与商业保险的概率及程度，抚养比越高，家庭生活更加困难，参与保险的机会成本较高；值得注意的是风险厌恶程度越高，家庭参与商业保险的概率和程度越低，这有悖于传统观念。很可能是因为参与了商业保险的家庭对于未来不确定的外来冲击有了保障后，更可能从事一些高风险的经济活动；另外，我们发现拥有社会保障的家庭会显著提高商业保险的参与概率，一般情况下，拥有较高社会保险水平的家庭有着较高的收入水平和良好的工作单位，因此存在更强的商业保险支付意愿以及支付能力。相比于城镇居民，农村居民会降低商业保险的参与概率及程度，可能的原因是农村地区信息较为闭塞，人们的保险意识较淡薄。这些控制变量的回归结果与已有文献的结论基本一致。

表3：社会关系对家庭参与商业保险概率及程度的影响

| 变量 | 是否参与商业保险 | | | Ln商业保费支出 | | |
|---|---|---|---|---|---|---|
| 社会关系 | 0.0960***<br>(0.0034) | | | 2.9894***<br>(0.1187) | | |
| 强关系 | | -0.0076***<br>(0.0009) | | | -0.2379***<br>(0.0309) | |
| 弱关系 | | | 0.0213***<br>(0.0015) | | | 0.7092***<br>(0.0514) |
| 性别 | -0.0139***<br>(0.0049) | -0.0142***<br>(0.0050) | -0.0170***<br>(0.0049) | 0.0001<br>(0.1625) | 0.0011<br>(0.1655) | -0.0776<br>(0.1645) |
| 年龄 | 0.0124***<br>(0.0011) | 0.0121***<br>(0.0011) | 0.0115***<br>(0.0011) | 0.5603***<br>(0.0386) | 0.5561***<br>(0.0391) | 0.5386***<br>(0.0389) |
| 年龄的平方 | -0.0001***<br>(0.0000) | -0.0001***<br>(0.0000) | -0.0001***<br>(0.0000) | -0.0064***<br>(0.0004) | -0.0065***<br>(0.0004) | -0.0063***<br>(0.0004) |
| 婚姻状况 | 0.0390***<br>(0.0070) | 0.0420***<br>(0.0071) | 0.0377***<br>(0.0071) | 1.2329***<br>(0.2401) | 1.3304***<br>(0.2427) | 1.1996***<br>(0.2427) |
| 受教育年限 | 0.0169***<br>(0.0014) | 0.0257***<br>(0.0014) | 0.0240***<br>(0.0014) | 0.4934***<br>(0.0466) | 0.7631***<br>(0.0461) | 0.7052***<br>(0.0462) |
| 是否有工作 | -0.0071<br>(0.0054) | -0.0120**<br>(0.0055) | -0.0115**<br>(0.0055) | -0.3134*<br>(0.1845) | -0.4609**<br>(0.1862) | -0.4510**<br>(0.1862) |
| 健康水平 | 0.0428*** | 0.0606*** | 0.0586*** | 1.4287*** | 1.9775*** | 1.9064*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.0062) | (0.0062) | (0.0062) | (0.2187) | (0.2202) | (0.2203) |
| ln家庭总收入 | 0.0036*** | 0.0056*** | 0.0046*** | 0.1234*** | 0.1808*** | 0.1500*** |
| | (0.0006) | (0.0006) | (0.0006) | (0.0214) | (0.0218) | (0.0218) |
| ln家庭总支出 | 0.1030*** | 0.1419*** | 0.1255*** | 3.3449*** | 4.5643*** | 4.0129*** |
| | (0.0030) | (0.0026) | (0.0029) | (0.1059) | (0.0980) | (0.1053) |
| ln家庭固定资产 | 0.0291*** | 0.0284*** | 0.0291*** | 0.7788*** | 0.7563*** | 0.7778*** |
| | (0.0009) | (0.0009) | (0.0009) | (0.0301) | (0.0304) | (0.0305) |
| ln家庭总资产 | -0.0341*** | -0.0314*** | -0.0337*** | -0.9140*** | -0.8292*** | -0.9018*** |
| | (0.0012) | (0.0012) | (0.0012) | (0.0404) | (0.0411) | (0.0409) |
| ln家庭总负债 | 0.0026*** | 0.0028*** | 0.0028*** | 0.0719*** | 0.0764*** | 0.0764*** |
| | (0.0003) | (0.0003) | (0.0003) | (0.0084) | (0.0086) | (0.0085) |
| 家庭抚养比 | -0.0210** | -0.0370*** | -0.0336*** | -0.5978** | -1.0258*** | -0.9085*** |
| | (0.0089) | (0.0090) | (0.0089) | (0.3039) | (0.3070) | (0.3061) |
| 风险态度 | -0.0106*** | -0.0162*** | -0.0155*** | -0.4872*** | -0.6580*** | -0.6358*** |
| | (0.0016) | (0.0016) | (0.0016) | (0.0549) | (0.0552) | (0.0551) |
| 是否有社会保障 | 0.0566*** | 0.0608*** | 0.0529*** | 2.0191*** | 2.1652*** | 1.8932*** |
| | (0.0135) | (0.0137) | (0.0137) | (0.4636) | (0.4696) | (0.4694) |
| 是否为农村 | -0.0512*** | -0.0909*** | -0.0825*** | -1.9343*** | -3.1695*** | -2.8901*** |
| | (0.0052) | (0.0051) | (0.0051) | (0.1831) | (0.1804) | (0.1807) |
| 常数项 | | | | -54.9160*** | -69.0061*** | -67.0429** |
| | | | | (1.5869) | (1.5561) | (1.5516) |
| 观测值 | 35,327 | 35,327 | 35,327 | 35,327 | 35,327 | 35,327 |

注: 表格报告的是边际效应，括号内为标准误差；***、**、*分别代表1%、5%、10%的显著水平。如无特别说明，文中其他表格与此注释一致。

## 4.2 稳健性检验

首先，用家庭保费支出占总支出比衡量家庭商业保险参与程度。回归结果显示，社会关系和弱关系对家庭保费支出占比仍有显著正向影响，强关系对家庭商业保费支出占比存在负向影响。这说明家庭运用社会关系不仅可以提高家庭商业保险参与概率和参与程度，还可以增加家庭对商业保险的投入比例，从而影响家庭的消费支出结构。其次，我们还采用户主的兄弟姐妹数作为强关系的代理变量、采用家庭礼金收支、通信支出、交通支出、文化娱乐支出、在外就餐支出分别作为弱关系的代理变量进行稳健性检验。回归结果如表4，稳健性检验结果与基准回归结果一致，说明结论依旧稳健。

表4：稳健性检验回归结果

| 变量 | 家庭保费支出占比 | | | 是否参与商业保险 | Ln商业保费支出 |
|---|---|---|---|---|---|
| 社会关系 | 3.3819*** | | | | |
| | (0.1684) | | | | |
| 强关系 | | -0.2944*** | | | |
| | | -0.0433 | | | |
| 弱关系 | | | 0.7475*** | | |

| | | | | | |
|---|---|---|---|---|---|
| | | | -0.0718 | | |
| 户主亲兄弟姐妹数 | | | | -0.0105***<br><br>-0.0011 | -0.3074***<br><br>-0.0375 |
| 礼金收支 | | | | 0.0048***<br>(0.0007) | 0.1877***<br>(0.0229) |
| 通信支出 | | | | 0.0400***<br>(0.0024) | 1.1060***<br>(0.0820) |
| 交通支出 | | | | 0.0104***<br>(0.0006) | 0.2606***<br>(0.0196) |
| 文化娱乐支出 | | | | 0.0215***<br><br>(0.0012) | 0.6941***<br><br>(0.0404) |
| 在外就餐支出 | | | | 0.0098***<br><br>(0.0007) | 0.3366***<br><br>(0.0248) |
| 其余控制变量 | 控制 | 控制 | 控制 | 控制 | 控制 |
| 观测值 | 35,323 | 35,323 | 35,323 | 35,230 | 35,230 |

注：表格报告的是边际效应，括号内为标准误差；***、**、*分别代表1%、5%、10%的显著水平。表格只呈现关键变量的回归结果。如无特别说明，文中其他表格与此注释一致。

### 4.3 内生性检验

研究社会关系对家庭商业保险参与决策的影响，考虑到它们之间可能存在反向因果和遗漏变量的内生性问题，因此本文分别采用工具变量回归和面板数据固定效应回归加以解决。

1．反向因果内生性问题。社会关系可以推动家庭参与商业保险，同时家庭参保后可能也会反过来增强家庭的社会关系，从而造成社会关系与家庭商业保险的反向因果关系。其中强关系衡量的是血缘姻缘关系，与家庭参与商业保险不存在反向因果关系。所以本文着重关注弱关系与家庭参与商业保险决策的反向因果问题。为此本文选取了2013年中国家庭金融调查（CHFS）数据中没有参与商业保险的家庭样本，用相同方法将家庭礼金收支、在外就餐支出、交通支出、通信支出、文化娱乐支出线性加总取对数构造一个弱关系综合指标作为弱关系的工具变量，因为2013年未参与商业保险的家庭弱关系与2015年家庭是否参与商业保险不相关，但是与2015年家庭弱关系指标高度相关，因此采用该工具变量满足工具变量的相关假设。

表5为IV Probit模型和IV Tobit模型的回归结果。首先从工具变量的一阶段回归的F值来看，本文选取的工具变量不存在弱工具变量的问题，且该模型都在1%的显著性水平下通过了Wald检验，故认为内生性确实存在，所选取的工具变量是合理的。从回归结果来看，在使用了工具变量修正偏误后，弱关系指标对家庭商业保险的参与概率和程度的互补效应依旧显著。

表5：工具变量的回归结果

| 变量 | 是否参与商业保险 | Ln商业保费支出 |
|---|---|---|
| 弱关系综合指标 | 0.2089***<br>(0.0387) | 2.4056***<br>(0.4896) |
| 一阶段F值 | 472.02*** | 472.02*** |
| Wald test | 11.87*** | 13.48*** |
| 观测值 | 15,957 | 15,957 |

2．遗漏变量内生性问题。由于受到样本数据的限制，我们只能观测到一些传统变量对家庭商业保险参与决策行为的影响，对于某些会影响家庭商业保险决策行为但碍于各种因素我们难以获取的变量可能会遗漏，如户主的个人能力、职业性质、性格特征、价值观等等，因此截面回归的估计结果可能会存在偏误，不过我们可以通过面板固定效应模型在一定程度上消除这种偏误。因此，我们构造了2013、2015年两期样本完全相同的平衡面板进行固定效应回归。由于强关系的衡量指标兄弟姐妹数在2013—2015年无变化。于是，本文仅对社会关系和弱关系进行固定效应面板回归，对于家庭是否参与商业保险的面板二值选择变量，由于面板probit无固定效应模型，故使用xtlogit模型；对于家庭参与商业保险程度的面板数据，我们采用pantob模型作为tobit模型面板固定效应回归，以证实本文回归结果的稳健性和可靠性。

如表6所示，无论是xtlogit模型还是pantob模型，社会关系和弱关系对家庭商业保险参与概率和程度都有显著的促进作用，且均在1%的水平下显著。因此我们可以认为通过使用2013—2015年中国家庭金融调查追踪数据基本解决了遗漏变量内生性问题。

表6：面板数据固定效应回归结果

| 变量 | 是否参与商业保险（xtlogit） | | Ln商业保费支出（pantob） | |
|---|---|---|---|---|
| 社会关系 | 0.4107***<br>(0.0515) | | 0.8950***<br>(0.1100) | |
| 弱关系 | | 0.0736***<br>(0.0216) | | 0.2272***<br>(0.0554) |
| 其余控制变量 | 控制 | 控制 | 控制 | 控制 |
| 观测值 | 7,788 | 7,788 | 42,602 | 42,602 |

注: 表格报告的是回归系数结果，括号内为标准误差；***、**、*分别代表1%、5%、10%的显著水平；表格只呈现关键变量的回归结果。如无特别说明，文中其他表格与此注释一致。

## 4.4 影响机制分析

社会关系对家庭商业保险参与概率和程度都有显著正向影响，但强关系、弱关系对家庭商业保险参与行为却有着不同作用。根据何凌霄、张忠根（2016）在研究强关系、弱关系对农户收入的影响时发现强弱关系的作用机制分别是人情机制和信息机制，因此本文认为：在家庭商业保险的参与行为中，强关系主要通过人情机制对其产生影响，弱关系主要通过信息传递机制对其产生影响。为此我们

参照逐步检验法（Baron RM & Kenny，1986）和中介效应分析流程法（温忠麟、叶宝娟，2014）对作用机制进行验证。具体模型如下：

$$Y_i = \theta_0 + \theta_1 X_{i1} + \theta_2 X_{i2} + \mu_{i1} \quad (3)$$

$$Z_{ij} = \gamma_0 + \gamma_1 X_{i1} + \gamma_2 X_{i2} + \mu_{i2} \quad (4)$$

$$Y_i = \delta_0 + \delta_1 X_{i1} + \delta_2 Z_{ij} + \delta_3 X_{i2} + \mu_{i3} \quad (5)$$

其中，$Y_i$表示家庭是否参与商业保险、家庭商业保费支出的对数；$X_{i1}$表示强关系和弱关系；$X_{i2}$控制变量集合，下标$i$表示第$i$个家庭，下标j表示第j个中介变量。$\theta_1$衡量的是$X_{i1}$对$Y_i$的总效应，$\gamma_1$衡量的是$x_{i1}$对中介变量$Z_{ij}$的影响，$\delta_2$是中介变量$Z_{ij}$对$Y_i$的效应；$\delta_1$是$x_{i1}$对$Y_i$的直接效应；间接效应等于系数乘积$\gamma_1\delta_2$；$\mu_i$是回归残差。若系数$\alpha_1$、$\gamma_1$和$\delta_2$都显著，则间接效应显著。由于中介效应检验模型的第一步方程3是本文的基准回归模型（1），因此本节只讨论方程4和方程5。

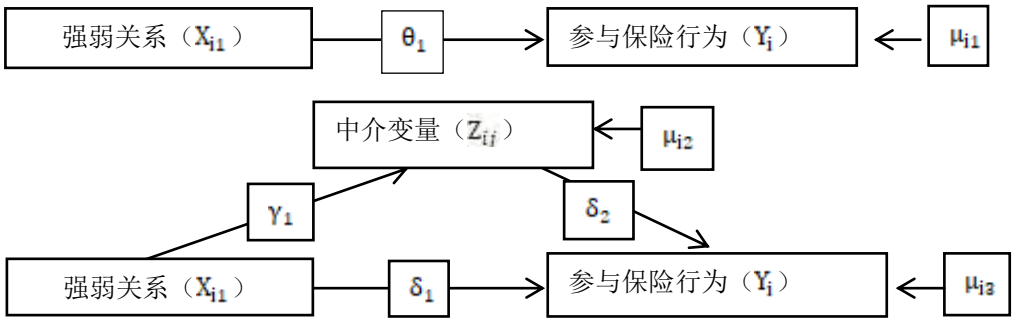


图1　中介效应示意图

4.4.1 强关系的人情机制

强关系网中人们关系密切，传递人情与帮助，可有效分担家庭面临的风险。中国大多数家庭在面临外来经济冲击时会首先向亲友等非正式金融渠道融资而非通过正规的金融渠道。而对于非正规渠道的借贷活动而言，农户之间的借贷关系在大多数情况下都是建立于相互之间的信任与情感，很少以抵押担保或者合同的形式执行（何广文，1999；杨汝岱等，2011）。我们发现家庭对于农/工商业、住房、教育、医疗等主要民间负债项目的最大一笔借款都是来源于兄弟姐妹。因此，本文选取了来源于亲兄弟姐妹的最大借款金额作为中介变量$Z_{i1}$检验强关系的人情机制。

由表7第1、3列可知，强关系对来源于兄弟姐妹的最大借款金额的系数$\gamma_1$显著；由第2、4列可以看出最大借款金额对家庭参与商业保险概率的系数$\delta_2$显著；因此，中介效应系数$\gamma_1\delta_2$也显著，即验证了强关系通过来源于兄弟姐妹的最大借款金额的人情机制确实存在。

表7：强关系的影响机制回归结果

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 变量 | 来源于兄弟姐妹的最大借款金额 | 是否参与商业保险 | 来源于兄弟姐妹的最大借款金额 | Ln商业保费支出 |
| 强关系 | 0.5760*** | -0.0331*** | 0.5760*** | -0.2510*** |
| | (0.0817) | (0.0038) | (0.0817) | (0.0308) |
| 来源于兄弟姐妹的最大借款金额 | | -0.0173*** | | -0.1208*** |

| | | | | |
|---|---|---|---|---|
| | | (0.0031) | | (0.0256) |
| 控制变量 | 已控制 | 已控制 | 已控制 | 已控制 |
| 观测值 | 35,515 | 35,515 | 35,515 | 35,515 |

注: 表格报告的是回归系数结果，括号内为标准误差；***、**、*分别代表1%、5%、10%的显著水平；表格只呈现关键变量的回归结果。下表同

4.4.2 弱关系的信息传递机制

弱关系网中人们关系较松散，信息异质性强，因此信息传递功能更突出。弱关系网越大，他们获取保险相关信息就更容易，进而影响家庭参与商业保险决策。我们将从家庭对商业保险的信任度、省级赔付率、金融知识水平、风险态度4方面验证弱关系的信息传递机制。

（1）居民通过与朋友邻里之间的交流，获取更多的保险信息，转变以往对商业保险的印象，进一步改变居民对商业保险信任度，最终影响家庭参与商业保险的概率与程度。

（2）弱关系网中信息异质性强，关系好的人，获取公开或内部信息都更容易。因此人们通过弱关系网中与他人交谈，获得保险市场赔付率等相关信息，改变家庭参与保险决策。一般情况下，赔付率越高的地区，人们更愿意购买保险。

（3）家庭参与商业保险是一个复杂的过程，居民具备一定的金融知识获取及筛选信息。因此本文参照秦芳等（2016）做法，选取三个和金融知识相关的问题利用因子分析法计算出金融知识水平，以验证弱关系的信息传递机制。

（4）弱关系网中的居民在与他人交流信息时，可能会改变自身的风险态度。因此我们选取风险态度作为中介变量，参照李树、陈刚（2012）处理幸福感的方法，采用Ordered Probit模型分析弱关系的信息传递机制。

由表8、表9的第1、3、5、7列可知，弱关系可以显著提高家庭对商业保险的信任度、省级赔付率、金融知识，即系数$\gamma_1$显著；根据表8、表9的第2、4、6、8列，中介变量对家庭参与商业保险概率和程度也有显著正向效应，即系数$\delta_2$显著；因此，中介效应系数$\gamma_1\delta_2$显著，证实了弱关系的信息传递机制的存在，人们可以通过弱关系的信息传递机制提高商业保险的参与概率和程度。

表8：弱关系对参与概率影响机制回归结果

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 变量 | 对商业保险的信任度 | 是否参与商业保险 | 省级赔付率 | 是否参与商业保险 | 金融知识水平 | 是否参与商业保险 | 风险态度 | 是否参与商业保险 |
| 弱关系 | 0.0122***<br>(0.0045) | 0.0917***<br>(0.0062) | 0.0004***<br>(0.0001) | 0.0913***<br>(0.0062) | 0.0364***<br>(0.0021) | 0.0831***<br>(0.0063) | 0.0434***<br>(0.0041) | 0.0912***<br>(0.0062) |
| 对商业保险的信任度 | | 0.3103***<br>(0.0171) | | | | | | |
| 省级赔付率 | | | | 0.4665**<br>(0.2223) | | | | |
| 金融知识水平 | | | | | | 0.2378***<br>(0.0144) | | |
| 风险态度 | | | | | | | | 0.0235* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | (0.0123) |
| 控制变量 | 已控制 | 已控制 | 已控制 | 已控制 | 已控制 | 已控制 | 已控制 | 已控制 |
| 观测值 | 35,557 | 35,557 | 35,557 | 35,557 | 35,557 | 35,557 | 35,557 | 35,557 |

注:同表7。

表9：弱关系对参与程度影响机制回归结果

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 变量 | 对商业保险的信任度 | Ln商业保费支出 | 省级赔付率 | Ln商业保费支出 | 金融知识水平 | Ln商业保费支出 | 风险态度 | Ln商业保费支出 |
| 弱关系 | 0.0122***<br>(0.0045) | 0.7024***<br>(0.0507) | 0.0004***<br>(0.0001) | 0.7119***<br>(0.0512) | 0.0364***<br>(0.0021) | 0.6209***<br>(0.0512) | 0.0434***<br>(0.0041) | 0.7068***<br>(0.0513) |
| 对商业保险的信任度 | | 2.6785***<br>(0.1341) | | | | | | |
| 省级赔付率 | | | | 4.2806**<br>(1.7729) | | | | |
| 金融知识水平 | | | | | | 2.3410***<br>(0.1183) | | |
| 风险态度 | | | | | | | | 0.4170***<br>(0.1048) |
| 控制变量 | 已控制 | 已控制 | 已控制 | 已控制 | 已控制 | 已控制 | 已控制 | 已控制 |
| 观测值 | 35,557 | 35,557 | 35,557 | 35,557 | 35,557 | 35,557 | 35,557 | 35,557 |

注:同表7。

## 5.进一步讨论

### 5.1 异质性分析

为了进一步分析不同样本间的差异，我们根据受访者、家庭和区域特征的差异性，重点考察不同教育程度、年龄、婚姻状况、有无社会保障、收入水平、区域间的家庭在参与商业保险时受社会关系、强关系、弱关系影响的异质性，这对国家有针对性的制定促进家庭商业保险参与的政策尤为重要。

5.1.1教育程度异质性分析。

我们根据户主受教育年限将样本家庭分为高教育程度（受教育年限>9）和低教育程度（受教育年限<=9）。表9表明，社会关系和弱关系对于不同教育程度的家庭参与商业保险都有显著互补效应，强关系则有显著替代效应。其中社会关系和弱关系对低教育程度家庭的参与概率和程度的促进作用更大，因为相比于低教育程度家庭的主要通过人际交往获取信息外，高教育程度家庭更可能通过其他渠道获取信息。强关系对高教育程度家庭参与商业保险概率的替代效应更大，但对商业保险参与程度却低于低教育程度家庭，不过差异并不大。可能的原因是高教育程

度家庭的收入通常较高，其兄弟姐妹的收入也不低，若遇到外来冲击时受到他们的帮助就更大。

表9：高低教育程度家庭异质性分析

| 变量 | 是否参与商业保险 | | Ln商业保费支出 | |
|---|---|---|---|---|
| | 高教育程度 | 低教育程度 | 高教育程度 | 低教育程度 |
| 社会关系 | 0.0869***<br>-0.0067 | 0.0936***<br>-0.0038 | 1.9380***<br>-0.155 | 3.9451***<br>-0.1886 |
| 强关系 | -0.0094***<br>-0.0018 | -0.0064***<br>-0.001 | -0.2430***<br>-0.0422 | -0.2440***<br>-0.0473 |
| 弱关系 | 0.0173***<br>-0.0031 | 0.0205***<br>-0.0016 | 0.4491***<br>-0.0724 | 0.9143***<br>-0.0781 |
| 观测值 | 12381 | 22946 | 12381 | 22946 |

5.1.2 婚姻状况异质性分析。

由于已婚和未婚人士的社会关系可能存在着较大的差异，因此本文将样本家庭根据户主婚姻状况分为已婚和未婚虚拟变量。已婚=1，否则为0。表10表明，社会关系和弱关系对已婚家庭参与商业保险概率的影响更大，参与程度却低于未婚家庭。可能的原因是：对于已婚家庭，通常其社会关系网络更大，信息来源更广，因此更有可能通过其他渠道了解保险从而提高家庭参与商业保险的概率。但是相比于未婚家庭，已婚家庭经济负担更重，更有可能将收入投入到家庭其他生活费用支出，参与程度比未婚家庭影响更弱。另外，强关系对已婚家庭参与商业保险概率和参与程度都有显著的替代效应，但是对未婚家庭都不显著。可能是因为已婚家庭相比未婚家庭背负着更多责任，经济压力更大，如果强关系帮助分担风险，已婚家庭就可能显著降低参与保险概率及程度。

表10：婚姻状况异质性分析

| 变量 | 是否参与商业保险 | | Ln商业保费支出 | |
|---|---|---|---|---|
| | 已婚 | 未婚 | 已婚 | 未婚 |
| 社会关系 | 0.0997***<br>-0.0037 | 0.0671***<br>-0.0079 | 2.9280***<br>-0.122 | 3.4217***<br>-0.4695 |
| 强关系 | -0.0081***<br>-0.001 | -0.0041<br>-0.0026 | -0.2434***<br>-0.0314 | -0.1633<br>-0.1484 |
| 弱关系 | 0.0223***<br>-0.0016 | 0.0139***<br>-0.0033 | 0.6923***<br>-0.0531 | 0.7822***<br>-0.1945 |
| 观测值 | 30404 | 4923 | 30404 | 4923 |

5.1.3年龄异质性分析。

按照世界卫生组织的分类标准，我们将样本家庭分为高年龄组家庭（户主年龄>=45岁）和低年龄组家庭（户主年龄<45岁）。根据表11，社会关系和弱关系对家庭参与商业保险概率的促进作用随着年龄的增加而下降，但是对参与程度随

着年龄的增加而增加。我们认为可能的原因是年轻家庭通过互联网等工具，社交范围更广，弱关系网可能更大；另外年轻家庭对商业保险的认知度可能更高，因此参与商业保险概率更大。但高年龄家庭在收入、社会财富等方面积累更多，所以参与程度会比低年龄家庭更高。强关系在家庭参与商业保险概率及程度对低年龄家庭的替代效应都更大。

表11：高低年龄家庭异质性分析

| 变量 | 是否参与商业保险 | | Ln商业保费支出 | |
|---|---|---|---|---|
| | 高年龄 | 低年龄 | 高年龄 | 低年龄 |
| 社会关系 | 0.0914*** | 0.0968*** | 3.4922*** | 2.1316*** |
| | -0.0036 | -0.0076 | -0.1648 | -0.1719 |
| 强关系 | -0.0064*** | -0.0104*** | -0.2153*** | -0.2954*** |
| | -0.0009 | -0.0023 | -0.0407 | -0.0518 |
| 弱关系 | 0.0195*** | 0.0240*** | 0.7709*** | 0.6184*** |
| | -0.0015 | -0.0036 | -0.0688 | -0.0807 |
| 观测值 | 25519 | 9808 | 25519 | 9808 |

5.1.4 家庭有无社会保障的异质性分析。

本文将家庭是否有社会保障设为虚拟变量，有社会保障的家庭取值为1，否则为0。根据表12：对于家庭商业保险概率，社会关系和弱关系对有社会保险的家庭正向影响更大；但是在参与程度中，不及没有社会保险的家庭。这也反映了目前我国社会保障体系的不完善性，只能为家庭提供一些最基本的生活保障，同时让商业保险有发挥其补充保障功能的空间，让商业保险成为我国社会保障体系的重要支柱有了更进一步的现实意义。强关系对具有社会保障的家庭替代影响显著，但是对无社会保障的家庭不显著。可能的原因是强关系作为一种基于血缘性的关系，当家庭遇到风险需要帮助时，它并不会因为家庭不具有社会保险就减少帮助。

表12：有无社会保障的家庭异质性分析

| 变量 | 是否参与商业保险 | | Ln商业保费支出 | |
|---|---|---|---|---|
| | 有社会保险 | 无社会保险 | 有社会保险 | 无社会保险 |
| 社会关系 | 0.2190*** | 0.1658*** | 7.1054*** | 8.6300*** |
| | -0.002 | -0.0108 | -0.1007 | -0.8632 |
| 强关系 | -0.0061*** | -0.0049 | -0.2789*** | -0.3857 |
| | -0.0009 | -0.005 | -0.0326 | -0.2873 |
| 弱关系 | 0.0848*** | 0.0631*** | 2.8424*** | 3.2371*** |
| | -0.0013 | -0.0058 | -0.0537 | -0.3979 |
| 观测值 | 36162 | 1127 | 36162 | 1127 |

5.1.5 高低收入家庭异质性分析。

我们按照家庭收入的中位数将样本家庭分为高收入家庭和低收入家庭。表10所示，社会关系和弱关系对低收入家庭参与商业保险概率和程度促进作用更大，因为高收入家庭参与商业保险概率本来就比较高，受关系的影响比低收入家庭小。但强关系对高收入家庭参与商业保险概率影响更大，对低收入家庭参与商业

保险程度影响更大。可能的原因是高收入家庭的兄弟姐妹收入也可能更高，从而遇到困难时强关系的风险分担作用更强。

表13：高低收入家庭异质性分析

| 变量 | 是否参与商业保险 | | Ln商业保费支出 | |
|---|---|---|---|---|
| | 高收入 | 低收入 | 高收入 | 低收入 |
| 社会关系 | 0.0824***<br>-0.0057 | 0.0835***<br>-0.004 | 1.9698***<br>-0.1376 | 4.1749***<br>-0.2464 |
| 强关系 | -0.0084***<br>-0.0015 | -0.0044***<br>-0.001 | -0.2039***<br>-0.0357 | -0.2181***<br>-0.0612 |
| 弱关系 | 0.0107***<br>-0.0025 | 0.0207***<br>-0.0016 | 0.3285***<br>-0.0621 | 1.0653***<br>-0.0992 |
| 观测值 | 16933 | 18394 | 16933 | 18394 |

5.1.6 城乡区域异质性分析。

我们将农村家庭取值为1，城镇家庭为0。如表14所示，社会关系和弱关系对于城市家庭参与商业保险概率的影响更大，但对农村家庭参与商业保险程度更大。强关系对农村家庭参与商业保险可能性和程度无显著影响，但对城市家庭参与商业保险可能性和程度显著负向影响。可能的原因是农村保险市场比较落后，农民收入较低，弱关系网较狭窄，即使存在信息传递机制，他们参与商业保险的概率及程度都不及城市家庭；另外，即使强关系分担了部分风险，也不能显著改变他们参与商业保险。

表14：城乡家庭异质性分析

| 变量 | 是否参与商业保险 | | Ln商业保费支出 | |
|---|---|---|---|---|
| | 农村 | 城市 | 农村 | 城市 |
| 社会关系 | 0.1673***<br>-0.0043 | 0.2375***<br>-0.0027 | 9.0340***<br>-0.3136 | 6.6358***<br>-0.1115 |
| 强关系 | 0.0002<br>-0.0013 | -0.0096***<br>-0.0012 | -0.0247<br>-0.0766 | -0.3567***<br>-0.0352 |
| 弱关系 | 0.0457***<br>-0.002 | 0.0920***<br>-0.0017 | 2.5801***<br>-0.1289 | 2.6505***<br>-0.058 |
| 观测值 | 11654 | 25635 | 11654 | 25635 |

## 5.2 社会关系对家庭参与不同类别商业保险的影响

研究社会关系对家庭参与不同类别商业保险的影响，更有助于深入理解社会关系对家庭参与商业保险概率及程度的作用机制。本节将商业保险按保险的本质功能“保障性”分为保障性保险和投资性保险。保障性保险意味着保单无现金价值，保险期间内若发生保险事故就获得保险金，否则到保险期限末保单就终止。显然，参与保障性保险的目的并非为了将保费用于储蓄或投资，以便未来消费，而是保障当下的财富不会因可保风险而遭受损失。因此保障性保险应该属于消费。本文将各类财产保险、意外险、医疗险、短期健康险及车险视为保障性保险。投资性保险则意味着保单具有现金价值，同时兼具保障和投资成分，所缴保费分

为风险保费和储蓄性保费，风险保费的支出属于消费，储蓄性保费的支出属于投资。目前理论上将投资性保险分为分红险、投连险和万能险。但现实生活中，市场上的人寿保险多为长期性保险，其保单普遍具有现金价值，因此本文将人寿保险、其他分红险、投连险及万能险归为投资性保险。

从表16可知，社会关系和弱关系对投资性保险参与概率促进作用更大，社会关系对投资性保险参与程度更大，弱关系对保障性保险促进作用更大。可能是因为随着社会关系网的扩展和投资性保险的发展，家庭更愿意将商业保险作为一种投资理财工具，而不仅局限于纯保障性保险，且一旦进入保险市场，往往会加大其参与程度。强关系对家庭参与投资性保险决策有负向影响，但对保障性保险无影响。可能的原因是国家实施“计划生育”政策以来，独生子女群体占比增多，家庭规模普遍缩小，因此强关系的风险分担作用逐渐削弱。

表15：社会关系对不同性质的商业保险参与概率的影响

| 变量 | 是否参与商业保险 | | Ln商业保费支出 | |
|---|---|---|---|---|
| | 投资性保险 | 保障性保险 | 投资性保险 | 保障性保险 |
| 社会关系 | 0.0365*** | 0.0028*** | 3.2078*** | 2.6651*** |
| | (0.0026) | (0.0009) | (0.2338) | (0.7778) |
| 强关系 | -0.0012* | -0.0002 | -0.1033* | -0.1795 |
| | (0.0007) | (0.0002) | (0.0594) | (0.1998) |
| 弱关系 | 0.0124*** | 0.0015*** | 1.1034*** | 1.3444*** |
| | (0.0012) | (0.0004) | (0.1029) | (0.3455) |
| 观测值 | 35,327 | 35,327 | 35,327 | 35,327 |

## 6. 结论和建议

本文基于中国家庭金融调查2015年数据，从微观层面分析社会关系对家庭参与商业保险决策的影响，并得到如下主要结论：

第一、社会关系对家庭参与商业保险决策同时具有替代效应和互补效应。总体而言，社会关系显著提高了家庭参与商业保险概率和程度。家庭的社会关系指标增加1%，家庭参与商业保险概率提高9.6%，参与程度提高298.9%。

第二，将社会关系进一步划分为强关系和弱关系具体考察不同类型社会关系对家庭参与商业保险决策的影响，发现强关系对家庭参与商业保险存在替代效应，充分体现社会关系通过内部亲密关系网的风险分担机制发挥了非正式保险的作用；而弱关系对家庭商业保险的参与具有互补效应，表明社会关系可以通过信息异质性强的弱网促进家庭商业保险参与。此外，这些影响在各种稳健性及内生性检验下结论依旧成立。

第三、本文通过来源于兄弟姐妹的最大借款金额、对商业保险的信任情况、省级赔付率、金融知识和风险态度等变量验证了强、弱关系对家庭参与商业保险决策的影响渠道，从实证分析角度更加透彻的理解了其作用机制——人情机制和信息传递机制。

第四、我们的研究也证实了先前学者关于影响商业保险的传统因素的研究结果。户主的年龄、婚姻状况、受教育年限、健康水平对家庭商业保险参与程度有显著正相关；而户主的性别、有工作对家庭商业保险参与程度有显著负相关。家庭的总收入、总支出、总负债、固定资产对家庭商业保险参与程度具有显著的正向影响；总资产越高、抚养比越大、风险态度越厌恶、具有社会保障、农村的家

庭会降低商业保险的参与程度。另外，从异质性分析结果中我们知道，社会关系对不同年龄、性别、教育水平、城乡家庭的影响也存在差异。

本文首次同时验证了社会关系对我国家庭商业保险参与决策的正反两方面影响，也更深入地区分不同社会关系的异质效应及其影响机制。本文的研究为我国商业保险市场和经济社会的发展提供了一个社会结构和社会特征的政策视角：一方面，中国的保险业改革与发展过程中不应仅仅局限于经济因素，家庭的社会特征可能也是其中非常重要的影响因素。因此，有关部门在制定政策时，应该要考虑到社会关系尤其是不同类型社会关系对我国商业保险的发展，要充分发挥社会关系对家庭商业保险参与的积极作用；同时也要进一步规范我国保险市场，加强保险业的诚信建设，充分发挥弱关系网信息传递的促进作用，提升居民对商业保险的信任，从而提高家庭商业保险参与的概率和参与程度，推动我国商业保险的持续健康发展。另一方面，我国的社会保障体系改革应关注家庭社会关系的这些特点，重视社会关系等非正式制度的作用，只有对社会关系加以有效利用，让传统非正式保险制度与现代正式保险制度相互补充，才能为我国经济发展和制度变迁提供强大的推动力。

本文的研究也存在着一些局限。例如，对居民风险态度的测量可能仍不够准确，未能具体针对某类商业保险产品展开研究等，这些都需要更加细致和精确的数据样本。随着市场经济的快速发展，社会关系的作用可能受到不同程度的削减，那么，在当前中国转型时期，社会关系又会扮演什么角色？它的作用是否又会发生改变呢？这些问题都是值得我们深入探讨和研究的课题。

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# 社会关系对家庭参与商业保险决策的影响
# ——基于强弱关系视角

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**关键词:** 社会关系、强关系、弱关系、商业保险参与、影响机制

**中文摘要.** 社会关系对家庭商业保险参与决策具有互补和替代两种效应的影响。本文通过将社会关系划分为强关系和弱关系，识别出两种不同的效应及其作用机制。研究发现，社会关系可以显著提高家庭参与商业保险的概率及程度；对家庭商业保险参与，强关系具有替代效应、而弱关系具有互补效应。进一步研究发现：强关系通过人情机制会显著降低参与商业保险的概率和程度；但弱关系主要通过信息传递机制显著提高参与商业保险的概率及程度。本文为传统社会结构和现代市场经济并存背景下，发展商业保险市场提供了一个社会特征的视角，即重视社会关系的促进作用，推动我国商业保险市场的健康快速发展。

# Research on the Impact of Family Members' Economic Discourse Power on the Decision-making of Commercial Insurance Purchase

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**Keywords:** Family members, Economic discourse power, Decision-making of Insurance purchase, Commercial insurance.

**Abstract.** In recent years, the wealth of Chinese families has been increasing rapidly, and the economic discourse power of family members may have an impact on the family's decision-making of commercial insurance purchase. The present study measures the economic discourse power of a family member with the proportion of personal income of the family member in total family income as an indicator. The study then examines the impact of the economic discourse power on the decision-making of commercial insurance purchase, especially in terms of the possibility of purchase, the premium expenditure, and the varieties of commercial insurance (life or health) as well. The study also conducts a heterogeneity analysis on the impacts of the economic discourse power from the perspectives of urban-suburban locality, regions, family income levels, and the social security development levels.

This paper uses the Logit and Tobit models for an empirical study with the panel data of 2017 China Household Finance Survey (CHFS). The study finds that the economic discourse power of a family member is significantly positively correlated with the possibility of the family's purchase of commercial insurance as well as the premium expenditure. While the economic discourse power may promote the purchase of both life and health insurance, the impact is more significant on the demand of life insurance than that of health insurance. The reason is likely that the family member may think of maintaining the economic security for other family members against his or her accidental injury or death. With the heterogeneity analysis, it is found that in rural areas, eastern regions and areas with lower social security development, the positive influence of family members' economic discourse power on the decision-making of commercial insurance purchase is more significant. In general, this paper empirically explores the impact of family members' economic discourse power on decision-making of the purchase of commercial insurance and provides a new perspective for commercial insurance research. In addition, the research outcome is also of reference values for insurance companies in developing and promoting insurance products.

## 1. 引言

近年来，中国家庭的财富实现快速积累，家庭经济话语权成为热门词汇。经济话语权是指在家庭成员拥有的参与经济决策的权利，个人收入占比高的家庭成员将拥有更多的经济话语权。本文将个人收入占家庭总收入的比重作为衡量家庭成员经济话语权的指标，关注以下问题：一、家庭成员经济话语权对该成员购买商业保险的影响是怎样的？二、家庭成员经济话语权对家庭保险购买决策是否构成了异质性影响？

基于此，本文使用2017年中国家庭金融调查（CHFS）数据，运用 *Logit* 和 *Tobit* 模型实证研究家庭成员经济话语权对商业保险购买决策的影响。本文实证分析家庭成员的经济话语权对商业保险购买决策的影响，为商业保险研究提供了新的视角，同时研究结果对保险公司产品开发和推广具有一定参考价值。

本文安排如下：在第二节中，对国内外学者有关家庭商业保险购买决策和经济话语权的研究成果进行了梳理。在第三节中，对数据选取进行解释说明，建立模型尝试从定量的角度探索家庭成员的经济话语权对商业保险购买决策的影响。在第四节中，对实证回归结果进行分析说明，并进行稳健性检验。在第五节中，按照城乡、东中西区域、以及社会保障发展程度分别进行回归，进行异质性分析。在第六节中，通过本文模型回归结果，提出了相应的政策性建议，对保险公司产品开发和推广提出相关建议。

## 2. 文献综述

### 2.1 家庭商业保险决策影响因素的研究

在社会因素中，社会互动对人们的参保行为产生了极大的促进作用，人们之间的相互交流显著影响着人们的商业保险购买决策， 交流程度越高的家庭参保

的可能性越高（江海洋等，2018）；王怿丹（2020年）在研究中还发现社会人口老龄化会降低中国城乡家庭购买商业保险的意愿，且城乡家庭之间存在差异。

在家庭因素中，家庭规模、老年人口占比以及家庭就业人数占比对家庭整体的人身保险需求起抑制作用，而家庭少儿人口占比起促进作用(樊纲治2015；魏金龙等，2019)；也有研究发现，少儿占比和老年人占比均与家庭整体商业人身保险的需求呈现倒U型关系(王宏杨，2017)；也有学者分析了户籍对家庭商业保险购买行为的影响，发现户籍是导致家庭商业保险市场参与异质性的重要因素，与非农业户口家庭相比，农业户口家庭的商业保险市场参与概率和规模更低（伍再华，2018）。

在消费者个人因素中，受过教育程度越高的户主，其家庭参与商业保险的意愿更加强烈（蒲成毅等，2012）；同时外向性人格对商业保险的购买行为有显著且积极的影响，消费者的人际关系越好，正向情绪的程度越强，更加乐于成为其他人的伙伴，进而其家庭商业保险参与的可能性越高，且支出份额与支出比重都相对更大（赵青等，2018）；此外，户主金融知识的增加将会提高家庭购买商业保险的可能性和保费支出水平(秦芳等，2016；吴雨等2017)；同时户主金融素养的提升和风险偏好的增加对于家庭参与商业养老保险的促进效果更为明显（周弘等，2020）。

## 2.2 经济话语权内涵的研究

话语权可以被定义为：在一定的区域秩序内某主体拥有的制定规则的权力与维护该秩序的运行能力。家庭经济话语权则是指家庭成员在决定家庭事务特别是家庭资源分配时的影响力，与家庭经济决策 (family decision-making) 过程紧密相关；家庭经济权力分配不仅是家庭成员间互动模式的体现，也能反映出家庭成员的角色分工和家庭经济地位，是家庭研究的核心内容之一。

## 2.3 经济话语权的衡量标准的研究

国外学者布拉德 (Blood) 和沃尔夫(Wolfe) 基于对麦克唐纳的研究提出了家庭权力的相对资源理论 (Resource Theory) 认为家庭内部经济话语权取决于该家庭成员能够为家庭提供的经济资源 (resources) 的多少，即经济资源(个人收入)占优势的一方将拥有更多的经济话语权。

本文以相对资源理论为基础，认为家庭成员各自拥有的经济资源决定了他们在家庭的经济话语权，即经济资源(个人收入)占优势的一方将拥有更多的经济话语权。因此本文以“家庭成员各自收入占家庭总收入的比重”作为解释变量，运用 *L*ogit 和 *Tobit* 模型实证研究家庭成员的经济话语权对商业保险购买决策的影响

综上所述，国内外对于商业保险购买行为的研究已经比较丰富，但是尚未以家庭成员经济话语权为视角对商业保险购买行为进行研究。为了更好地分析家庭成员经济话语权对商业保险购买决策的影响，本文将重点关注三个问题：（1）家庭成员经济话语权是否影响该成员购买商业保险，主要考虑两方面的影响，分别是，经济话语权是否影响该成员购买商业保险，以及对该成员商业保险保费支出的影响。（2）家庭成员经济话语权对其购买商业人寿保险和商业健康保险影响是否具有差异性。（3）家庭成员经济话语权对家庭保险购买决策是否构成了异质性影响。

## 3. 变量选取与研究设计

### 3.1 样本数据说明

本文数据源自西南财经大学2017年中国家庭金融调查中心数据库，对全国29个省(市、区)，355个县，1428个村(居)委会，40011户家庭实地调研数据。本文选取了数据库中购买商业保险的家庭样本数据，以家庭成员为研究对象，最终得到4498个有效样本。

### 3.2 变量选取及定义

表1 变量汇总说明

| 变量类型 | 变量名称 | 变量说明 |
|---|---|---|
| 被解释变量 | 是否持有商业保险 | 参保任何一种商业保险则取值为1，否则为0 |
| | 是否持有商业人寿保险 | 参保商业人寿保险则取值为1，否则为0 |
| | 是否持有商业健康保险 | 参保商业健康保险则取值为1，否则为0 |
| | 商业保险支出占比 | 个人商业保险保费支出占家庭商业保险总保费的比值 |
| | 商业人寿保险支出占比 | 个人商业人寿保险保费支出占家庭商业人寿保险总保费的比值 |
| | 商业健康保险支出占比 | 个人商业健康保险保费支出占家庭商业健康保险总保费的比值 |
| 解释变量 | 经济话语权 | 个人收入占家庭总收入的比值 |
| 控制变量 | 年龄 | 年龄的平方 |
| | 性别 | 男性=1，女性=0 |
| | 受教育程度 | 受教育程度3类，分别是=1，否=0 |

| | | |
|---|---|---|
| | 婚姻状况 | 已婚=1，其他=0 |
| | 健康状况 | 对自我健康状况的主观打分5类<br>分别是=1，否=0 |
| | 是否参加社会保险 | 是=1，否=0 |
| | 家庭规模 | 家庭人口数量 |
| | 家庭年收入 | 家庭去年总收入（取对数） |
| | 是否为农村样本 | 是=1，否=0 |

对于被解释变量“家庭成员是否持有商业保险”，本文选取CHFS调查中“被访问的家庭成员购买过哪些商业保险”来表示。其中，1代表“家庭成员持有商业保险”，0则表示“家庭成员没有持有商业保险”“个人商业保险保费支出占家庭商业保险总保费的比重”，本文选取CHFS调查中“被访问的家庭成员去年总共缴纳多少元保费”来衡量。

对于该解释变量，CHFS调查中会问到被访问的家庭成员“年收入多少元”，则“个人收入占家庭总收入的比值”为家庭成员个人年收入/家庭所有成员年收入。

本文参照樊纲治、张雷等学者的研究选取了年龄、性别、健康状况、是否参加社保、家庭规模等作为控制变量。樊纲治（2015）认为户主的年龄是影响商业保险需求的重要因素；由于女性和男性的保险知识掌握情况、风险偏好程度和日常关注的信息均有较大的差异，导致他们在进行商业保险决策时也存在很大的不同；张雷（2020年）认为健康状况对其购买商业保险行为起正向促进作用；商业保险与社会保险有一定的互补性质，Ward 在对亚洲多国 1987-1998 年面板数据进行实证分析得出，社会保险与寿险需求呈现负相关；卢亚娟（2020年）认为家庭成员的商业保险购买行为会受到家庭规模的影响，人口数量越多的家庭，在面对风险时更习惯于采用相互依赖、共同承担的方式，而人口数量较少的家庭，则更多地需要外界的支持即保险来分散风险，这可能会增加商业保险的购买。

### 3.3 模型构建

研究解释变量“个人收入/家庭总收入”对家庭成员是否购买商业保险的影响，选用 *Logit* 模型。

$$Insurance_participate = \alpha_1 + \beta_1 \times Income + \varphi_1 X + \varepsilon \quad (1)$$

在模型1中， *Insurance_participate* 是是否购买商业保险的二元虚拟变量；*Income* 是本文的解释变量“个人收入/家庭总收入”，表示家庭成员的经济话语权； $X$ 是性别、年龄、婚姻状况以及有无社会保障等控制变量。

研究解释变量“个人收入/家庭总收入”对家庭成员商业保险保费支出占家庭总保费支出的影响，选用 *Tobit* 模型。

$$Insurance_\exp enditure = \alpha_2 + \beta_2 \times Income + \varphi_2 X + \varepsilon \quad (2)$$

在模型2中，*Insurance_expenditure* 是本文的解释变量“个人商业保险保费支出/家庭商业保险总保费支出”； *Income* 是本文的解释变量“个人收入/家庭总收入”，表示家庭成员的经济话语权； $X$ 是性别、年龄、婚姻状况以及有无社会保障等控制变量。

## 4. 实证结果及分析

### 4.1 描述性统计

本文为了比较持有商业保险的家庭成员和未持有商业保险的家庭成员之间的区别，将样本数据分为持有商业保险和未持有商业保险两组，给出的变量描述性分析如表2所示，未购买商业保险的家庭成员是1956人，占比约为43.5%，购买商业保险的家庭成员是2542人，占比约为56.5%。参保与未参保家庭成员的“个人收入/家庭总收入”也存在一定程度的差异，购买商业保险的家庭成员“个人收入/家庭总收入”的比值要高于未购买商业保险的家庭成员。

表2 家庭商业保险不同持有情况的变量描述性分析

| | 未购买商业保险 | | | | 购买商业保险 | | | |
|---|---|---|---|---|---|---|---|---|
| 变量 | 均值 | 标准差 | 最小值 | 最大值 | 均值 | 标准差 | 最小值 | 最大值 |
| 经济话语权 | 0.305 | 0.347 | 0 | 1 | 0.509 | 0.386 | 0 | 1 |
| 年龄的平方 | 2,566 | 1,771 | 289 | 11,449 | 2,005 | 997.9 | 324 | 7,744 |
| 性别 | 0.477 | 0.500 | 0 | 1 | 0.503 | 0.500 | 0 | 1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 受教育程度 | 1.088 | 0.716 | 0 | 3 | 1.309 | 0.672 | 0 | 3 |
| 婚姻状况 | 0.794 | 0.404 | 0 | 1 | 0.859 | 0.348 | 0 | 1 |
| 健康状况 | 2.408 | 0.912 | 1 | 5 | 2.354 | 0.840 | 1 | 5 |
| 是否参加社会保险 | 0.771 | 0.420 | 0 | 1 | 0.812 | 0.391 | 0 | 1 |
| 家庭总收入的对数 | 5.640 | 5.101 | 0 | 11.92 | 7.847 | 4.488 | 0 | 11.92 |
| 家庭规模 | 4.245 | 1.408 | 2 | 11 | 3.670 | 1.305 | 1 | 11 |
| 是否是农村样本 | 0.115 | 0.319 | 0 | 1 | 0.107 | 0.309 | 0 | 1 |

同时本文还以个人商业保险保费支出占比的均值为划分依据，将样本数据分为个人商业保险保费支出低于均值和个人商业保险保费高于均值的两组，给出的变量描述性分析如表3所示。个人商业保险保费支出在家庭商业保险保费总支出中占比高的家庭成员的相对收入要远远高于个人商业保险保费支出占比低的家庭成员。

表3 家庭商业保险不同保费支出水平的变量描述性分析

| | 个人保费支出/家庭保费支出低于均值 | | | | 个人保费支出/家庭保费支出高于均值 | | | |
|---|---|---|---|---|---|---|---|---|
| 变量 | 均值 | 标准差 | 最小值 | 最大值 | 均值 | 标准差 | 最小值 | 最大值 |
| 经济话语权 | 0.316 | 0.345 | 0 | 1 | 0.544 | 0.388 | 0 | 1 |
| 年龄的平方 | 2,479 | 1,685 | 289 | 11,449 | 1,977 | 936.8 | 324 | 7,056 |
| 性别 | 0.477 | 0.500 | 0 | 1 | 0.509 | 0.500 | 0 | 1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 受教育程度 | 1.134 | 0.716 | 0 | 3 | 1.306 | 0.669 | 0 | 3 |
| 婚姻状况 | 0.803 | 0.398 | 0 | 1 | 0.864 | 0.343 | 0 | 1 |
| 健康状况 | 2.400 | 0.899 | 1 | 5 | 2.352 | 0.838 | 1 | 5 |
| 是否参加社会保险 | 0.784 | 0.411 | 0 | 1 | 0.805 | 0.396 | 0 | 1 |
| 家庭总收入的对数 | 5.892 | 5.093 | 0 | 11.92 | 8.067 | 4.348 | 0 | 11.92 |
| 家庭规模 | 4.199 | 1.416 | 2 | 11 | 3.588 | 1.260 | 1 | 11 |
| 是否是农村样本 | 0.113 | 0.317 | 0 | 1 | 0.107 | 0.310 | 0 | 1 |

## 4.2 回归结果分析

### 4.2.1 家庭成员的经济话语权对是否持有商业保险的影响

表4 家庭成员经济话语权对商业保险购买的影响

| | 是否购买商业保险 | 是否购买商业人寿保险 | 是否购买商业健康保险 |
|---|---|---|---|
| 经济话语权 | 0.278*** | 0.244*** | 0.051* |
| | (0.030) | (0.029) | (0.026) |
| 年龄 | -0.232*** | -0.207*** | -0.023*** |
| | (0.040) | (0.008) | (0.006) |
| 性别 | 0.042*** | 0.041*** | 0.026* |
| | (0.015) | (0.015) | (0.013) |
| 教育2 | 0.022*** | 0.016*** | 0.032*** |
| | (0.012) | (0.012) | (0.011) |
| 教育3 | 0.046*** | 0.025*** | 0.068*** |
| | (0.010) | (0.019) | (0.020) |

| | | | |
|---|---|---|---|
| 婚姻 | 0.161*** | 0.149*** | 0.033* |
| | (0.019) | (0.019) | (0.020) |
| 健康2 | 0.041** | 0.011** | 0.033** |
| | (0.015) | (0.020) | (0.019) |
| 健康3 | 0.026** | 0.016*** | 0.032*** |
| | (0.015) | (0.015) | (0.013) |
| 健康4 | 0.037** | 0.029*** | 0.045** |
| | (0.018) | (0.017) | (0.023) |
| 健康5 | 0.089** | 0.087** | 0.066*** |
| | (0.012) | (0.012) | (0.008) |
| 是否参与社会保险 | 0.025 | 0.248*** | 0.031* |
| | (0.018) | (0.017) | (0.020) |
| 家庭规模 | -0.056*** | -0.049*** | -0.017*** |
| | (0.005) | (0.005) | (0.005) |
| 家庭总收入 | -0.004* | -0.003 | 0.001 |
| | (0.002) | (0.002) | (0.002) |
| 是否是农村样本 | -0.051** | -0.048** | -0.057** |
| | (0.023) | (0.023) | (0.027) |
| N | 4498 | 4498 | 3571 |

注：*、**、***分别表示在10%、5%、1%的显著水平下通过检验，括号里为标准误。

家庭成员经济话语权对是否购买商业保险在1%的水平下显著为正，即经济话语权高的家庭成员，参与商业保险的可能性越高。这是因为经济话语权高的家庭成员罹患重疾或是遭遇意外，会导致居民家庭收入大幅度下降甚至归零，从而使整个家庭的日常生活难以正常运转。

家庭成员经济话语权高的家庭成员更有可能拥有商业人寿保险。这可能是因为收入高的家庭成员承担了整个家庭的经济重担，当自己一旦发生意外，他们希望能够通过保险赔付为其他家庭成员特别是没有收入来源的子女、老人寻求一份长期的经济保障。

4.2.2 家庭成员的经济话语权对是否持有商业保险的影响

表5 家庭成员经济话语权对商业保险保费支出的影响

| | 个人保费支出/家庭保费支出 | 个人寿险保费支出/家庭寿险保费支出 | 个人健康险保费支出/家庭健康险保费支出 |
|---|---|---|---|
| 经济话语权 | 1.458*** | 1.561*** | 1.074*** |
| | (0.103) | (0.199) | (0.252) |
| 年龄的平方 | -0.000*** | -0.000*** | -0.000*** |
| | (0.000) | (0.000) | (0.000) |
| 性别 | 0.198*** | 0.245** | 0.276** |
| | (0.048) | (0.097) | (0.126) |
| 教育2 | 0.031*** | 0.016*** | 0.032*** |
| | (0.012) | (0.012) | (0.011) |
| 教育3 | 0.041*** | 0.033*** | 0.069*** |
| | (0.010) | (0.019) | (0.020) |
| 婚姻状况 | 0.447*** | 0.808*** | 0.487*** |
| | (0.066) | (0.137) | (0.174) |
| 健康2 | 0.074*** | 0.030** | 0.036** |
| | (0.027) | (0.055) | (0.073) |
| 健康3 | 0.025** | 0.015*** | 0.032*** |
| | (0.015) | (0.013) | (0.013) |
| 健康4 | 0.037** | 0.031*** | 0.042** |
| | (0.017) | (0.018) | (0.023) |
| 健康5 | 0.073** | 0.042** | 0.034*** |
| | (0.012) | (0.015) | (0.008) |

| | | | |
|---|---|---|---|
| 是否参加社会保险 | 0.034 | -0.093 | 0.402** |
| | (0.060) | (0.119) | (0.165) |
| 家庭规模 | -0.189*** | -0.222*** | -0.220*** |
| | (0.018) | (0.037) | (0.050) |
| 家庭总收入的对数 | -0.041*** | -0.039** | -0.025 |
| | (0.008) | (0.017) | (0.022) |
| 是否是农村样本 | -0.165** | -0.393*** | -0.626*** |
| | (0.076) | (0.152) | (0.226) |
| N | 4498 | 4498 | 4498 |

注：*、**、***分别表示在10%、5%、1%的显著水平下通过检验，括号里为标准误。

家庭成员经济话语权对商业保险参与程度的影响均在1%水平下显著为正，说明家庭成员的经济话语权与家庭成员的保费支出呈现正相关，收入占比越高的家庭成员支出的商业保险保费越多，商业保险需求越大。相比于商业健康保险，个人收入占比高的家庭成员越有可能选择购买商业人寿保险。

控制变量中，家庭成员为男性、已婚、健康状况越好的家庭成员，其商业保险的保费支出占比越多；而家庭成员年龄较大、家庭规模越大、家庭收入越高且位于农村地区的家庭，在商业保险的保费支出上则会相对较少。

## 4.3 稳健性检验

### 4.3.1 更换数据库检验

本文选取了2015年中国家庭金融调查（CHFS）数据库进行稳健性检验。表6、表7为稳健性检验结果，从表中可以看到解释变量的回归结果与前文保持一致。

表6 家庭成员经济话语权对商业保险参与的影响——稳健性检验结果

| | 是否购买商业保险 | 是否购买商业人寿保险 | 是否购买商业健康保险 |
|---|---|---|---|
| 经济话语权 | 0.243*** | 0.231*** | 0.078* |
| | (0.029) | (0.025) | (0.021) |
| N | 4081 | 4081 | 4081 |

注：*、**、***分别表示在10%、5%、1%的显著水平下通过检验，括号里为标准误。

表7 家庭成员经济话语权对商业保险保费支出的影响——稳健性检验结果

| | 个人保费支出/家庭保费支出 | 个人寿险保费支出/家庭寿险保费支出 | 个人健康险保费支出/家庭健康险保费支出 |
|---|---|---|---|
| 经济话语权 | 1.447*** | 1.553*** | 1.045*** |
| | (0.101) | (0.187) | (0.243) |
| N | 4081 | 4081 | 4081 |

注：*、**、***分别表示在10%、5%、1%的显著水平下通过检验，括号里为标准误。

4.3.2 样本分组检验

为了进一步验证前述实证结果的可靠性，本文参考现有文献的方法，采用取值为0、1或2的虚拟变量定义家庭成员收入占比情况。将家庭成员“个人收入/家庭总收入”的比值进行分组。“个人收入占家庭总收入”的比值低于40%，定义为相对低收入， 介于40%-60%属于收入中等， 高于60%属于相对高收入，分组后进行 *Probit* 模型回归。采用新的衡量方法后，回归结果未发生明显变化。表8为 *Probit* 模型回归结果。

表8 家庭成员经济话语权对商业保险参与的影响

| | 是否购买商业保险 | 是否购买商业人寿保险 | 是否购买商业健康保险 |
|---|---|---|---|
| 经济话语权 | 0.066*** | 0.313*** | 0.168* |
| | (2.73) | (14.37) | (6.46) |
| N | 4490 | 4490 | 4490 |

注：*、**、***分别表示在10%、5%、1%的显著水平下通过检验，括号里为标准误。

## 5. 异质性分析

### 5.1 城乡差异分析

本小节以户籍为划分依据，将受访的家庭成员划分为城镇和农村两个子样本，分别进行回归分析。

表9 家庭成员经济话语权对是否购买商业保险影响的城乡差异

| | 城镇 | | | 农村 | | |
|---|---|---|---|---|---|---|
| | 是否购买商业保险（1） | 是否购买商业人寿保险（2） | 是否购买商业健康保险（3） | 是否购买商业保险（4） | 是否购买商业人寿保险（5） | 是否购买商业健康保险（6） |
| 经济话语权 | 1.194*** | 1.066*** | 0.364** | 1.454*** | 1.232*** | -0.509 |
| | (8.37) | (7.51) | (2.01) | (6.63) | (5.79) | (-1.42) |
| N | 4498 | 4498 | 3571 | 4498 | 4498 | 3571 |

注：*、**、***分别表示在10%、5%、1%的显著水平下通过检验，括号里为标准误。

表10 家庭成员经济话语权对商业保险保费支出影响的城乡差异

| | 城镇 | | | 农村 | | |
|---|---|---|---|---|---|---|
| | 个人保费支出/家庭总保费支出（1） | 个人寿险保费支出/家庭寿险总保费支出（2） | 个人健康险保费支出/家庭健康险总保费支出(3) | 个人保费支出/家庭总保费支出（1） | 个人寿险保费支出/家庭寿险总保费支出（2） | 个人健康险保费支出/家庭健康险总保费支出(3) |
| 经济话语权 | 0.382*** | 0.208*** | 0.115*** | 0.429*** | 0.296*** | 0.021 |
| | (14.68) | (8.34) | (5.83) | (10.99) | (7.91) | (0.72) |
| N | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 |

家庭成员经济话语权无论在城镇还是农村子样本中，均对家庭成员商业保险购买决策有显著影响，且在农村中家庭成员的经济话语权对商业保险购买的影响更大。在城镇样本中家庭成员经济话语权对商业健康保险购买表现出正向影响，且在1%的置信水平下显著，而在农村样本中仍未表现出明显相关关系，这可能是因为在农村地区，由于发展较为闭塞，人们对于商业健康保险的认识程度不足，就导致了家庭经济话语权对商业保险购买决策的影响在农村地区不够显著。

## 5.2 地区差异分析

本小节以地域分布为划分依据，将受访的家庭成员划分为东部、中部、西部三个子样本，分别进行回归分析。

表11 家庭成员经济话语权对是否购买商业保险影响的地区差异

| | 东部地区 | | | 中部地区 | | | 西部地区 | | |
|---|---|---|---|---|---|---|---|---|---|
| | 是否购买商业保险（1） | 是否购买商业人寿保险（2） | 是否购买商业健康保险（3） | 是否购买商业保险（1） | 是否购买商业人寿保险（2） | 是否购买商业健康保险（3） | 是否购买商业保险（1） | 是否购买商业人寿保险（2） | 是否购买商业健康保险（3） |
| 经济话语权 | 1.306*** | 1.202*** | 0.425** | 1.164*** | 0.995*** | 0.177** | 1.113*** | 0.907*** | -0.102 |
| | (8.65) | (8.01) | (2.27) | (6.81) | (5.88) | (0.78) | (5.96) | (4.94) | (-0.4) |
| N | 4498 | 4498 | 3571 | 4498 | 4498 | 3571 | 4498 | 4498 | 3571 |

注：*、**、***分别表示在10%、5%、1%的显著水平下通过检验，括号里为标准误。

表12 家庭成员经济话语权对商业保险保费支出影响的地区差异

| | 东部地区 | | | 中部地区 | | | 西部地区 | | |
|---|---|---|---|---|---|---|---|---|---|
| | 个人保费支出/家庭总保费支出（1） | 个人寿险保费支出/家庭寿险总保费支出(2) | 个人健康险保费支出/家庭健康险总保费支出（3） | 个人保费支出/家庭总保费支出（1） | 个人寿险保费支出/家庭寿险总保费支出（2） | 个人健康险保费支出/家庭健康险总保费支出（3） | 个人保费支出/家庭总保费支出（1） | 个人寿险保费支出/家庭寿险总保费支出（2） | 个人健康险保费支出/家庭健康险总保费支出（3） |
| 经济话语权 | 0.401*** | 0.221*** | 0.120*** | 0.389*** | 0.242*** | 0.082*** | 0.352*** | 0.189*** | 0.072*** |
| | (14.71) | (8.47) | (5.81) | (12.44) | (8.07) | (3.45) | (10.35) | (5.79) | (2.77) |
| N | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 |

注：*、**、***分别表示在10%、5%、1%的显著水平下通过检验，括号里为标准误。

家庭成员经济话语权对商业保险购买的促进作用在东部地区最大，其次是中部地区，对西部地区促进作用最小。这可能是因为东部地区城市化程度更深，出于对家庭的爱与责任，会增加家庭经济支柱对商业保险的需求。而西部地区往往因为传统观念的禁锢，加上经济来源以农牧业为主，他们需要更多的劳动力进行生产，所以家庭人口数量一般较多，家庭人口越多，家庭承担的金融风险被分摊了，导致其为家庭经济支柱购买商业保险的意愿有所降低。

## 5.3 社会保障发展程度差异分析

为了进一步验证家庭成员的相对收入对商业保险购买决策的影响，本文采用各个省份居民失业保险参与率、城镇基本医疗保险参与率、城镇养老参与率、地方财政人均社会保障和就业支出、地方财政人均医疗卫生支出等指标衡量社会保障发展程度，利于各项指标的均值划分样本。

表13 家庭成员经济话语权对是否购买商业保险影响的社会保障发展程度差异

| | 失业保险参与率低 | | | 失业保险参与率高 | | |
|---|---|---|---|---|---|---|
| | 是否购买商业保险（1） | 是否购买商业人寿保险（2） | 是否购买商业健康保险（3） | 是否购买商业保险（4） | 是否购买商业人寿保险（5） | 是否购买商业健康保险（6） |
| 经济话语权 | 1.356*** | 1.066*** | 0.302 | 1.088*** | 0.878*** | 0.133 |
| | (8.82) | (7.24) | (1.62) | (7.22) | (6.01) | (0.70) |
| N | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 |
| | 城镇医疗参与率低 | | | 城镇医疗参与率高 | | |
| 经济话语权 | 1.162*** | 0.840*** | 0.058 | 1.271*** | 1.097*** | 0.341* |
| | (7.59) | (5.72) | (0.30) | (8.38) | (7.46) | (1.85) |
| N | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 |
| | 城镇养老参与率低 | | | 城镇养老参与率高 | | |
| 经济话语权 | 1.189*** | 0.881*** | 0.162 | 1.253*** | 1.080*** | 0.277 |
| | (7.91) | (6.09) | (0.85) | (8.12) | (7.22) | (1.48) |
| N | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 |
| | 地方财政人均社会保障和就业支出低 | | | 地方财政人均社会保障和就业支出高 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 经济话语权 | 1.367*** | 1.095*** | 0.369** | 1.004*** | 0.788*** | -0.026 |
| | (9.12) | (7.61) | (2.02) | (6.42) | (5.19) | (-0.13) |
| N | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 |
| | 地方财政人均医疗卫生支出低 | | | 地方财政人均医疗卫生支出高 | | |
| 经济话语权 | 1.261*** | 0.988*** | 0.265 | 1.080*** | 0.915*** | 0.074 |
| | (8.76) | (7.13) | (1.48) | (6.17) | (5.38) | (0.34) |
| N | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 |

注：*、**、***分别表示在10%、5%、1%的显著水平下通过检验，括号里为标准误。

在社会保险保障程度低的地区，家庭成员经济话语权对家庭成员商业保险参与的促进作用更明显，在社会保险保障程度高的地区，家庭成员经济话语权对参与商业保险的影响更小。这主要是因为，社会保险保障程度差的地区，失业保险缺失、地方财政人均医疗卫生支出不足等则可能导致居民家庭在家庭经济支柱遭受突发风险时只具备有限的风险应对措施，进而对家庭商业保险需求构成了显著的影响。相反地，社会保障程度高的地区，失业保险等社会保险保障为居民家庭提供了风险应对机制，帮助居民家庭更好地应对了家庭经济支柱失业及医疗等冲击事件，进而一定程度上避免了家庭经济支柱遇到突发风险导致居民家庭收入下降或医疗支出增加对家庭的威胁，因此在社会保险保障程度高的地区，家庭成员的经济话语权对是否参与商业保险的影响更小。

失业保险参与率低、地方财政人均社会保障低和人均医疗卫生支出低的地区，家庭成员经济话语权对家庭成员商业人寿保险参与的促进作用更明显。这主要是因为社会医疗保险系统完善的地区，国家提供医疗救助减轻了很多家庭的医疗费用负担，大家更多考虑的是为家庭未来生活的质量提供一份保障，许多家庭会选择购买商业人寿保险作为补充。

无论是在社会保障程度高的地区还是社会保障低的地区，家庭成员经济话语权对家庭成员商业健康保险参与的影响都不显著。这可能是因为影响购买商业健康保险的因素比较复杂，与家庭成员的经济话语权不是简单的线性关系。

表14 家庭成员经济话语权对商业保险保费支出影响的社会保障发展程度差异

| | 失业保险参与率低 | | | 失业保险参与率高 | | |
|---|---|---|---|---|---|---|
| | 个人保费支出/家庭总保费支出（1） | 个人寿险保费支出/家庭寿险总保费支出（2） | 个人健康险保费支出/家庭健康险总保费支出（3） | 个人保费支出/家庭总保费支出（1） | 个人寿险保费支出/家庭寿险总保费支出（2） | 个人健康险保费支出/家庭健康险总保费支出（3） |
| 经济话语权 | 0.410*** | 0.229*** | 0.117*** | 0.364*** | 0.210*** | 0.087*** |
| | (14.91) | (8.68) | (5.57) | (13.15) | (7.93) | (4.13) |
| N | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 |
| | 城镇医疗参与率低 | | | 城镇医疗参与率高 | | |
| 经济话语权 | 0.379*** | 0.220*** | 0.093*** | 0.365*** | 0.220*** | 0.110*** |
| | (13.59) | (8.21) | (4.39) | (14.39) | (8.37) | (5.27) |
| N | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 |
| | 城镇养老参与率低 | | | 城镇养老参与率高 | | |
| 经济话语权 | 0.387*** | 0.220*** | 0.100*** | 0.387*** | 0.219*** | 0.104*** |
| | (14.12) | (8.38) | (4.79) | (13.91) | (8.21) | (4.92) |
| N | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 |
| | 地方财政人均社会保障和就业支出低 | | | 地方财政人均社会保障和就业支出高 | | |
| 经济话语权 | 0.411*** | 0.229*** | 0.117*** | 0.351*** | 0.205*** | 0.078*** |
| | (15.28) | (8.89) | (5.74) | (12.20) | (7.43) | (3.57) |

| | | | | | | |
|---|---|---|---|---|---|---|
| N | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 |
| | 地方财政人均医疗卫生支出低 | | | 地方财政人均医疗卫生支出高 | | |
| 经济话语权 | 0.396*** | 0.223*** | 0.107*** | 0.359*** | 0.207*** | 0.086*** |
| | (15.15) | (8.93) | (5.37) | (11.27) | (6.76) | (3.54) |
| N | 4498 | 4498 | 4498 | 4498 | 4498 | 4498 |

注：*、**、***分别表示在10%、5%、1%的显著水平下通过检验，括号里为标准误。

家庭成员经济话语权对商业保险购买的促进作用在社会保险保障程度低的地区要大于社会保险保障程度高的地区；同时在社会保障程度低的地区，家庭成员的经济话语权对商业人寿保险参与程度影响的促进作用更明显。家庭成员的经济话语权对商业健康保险参与程度的影响呈现显著的正相关，并且这种正相关的影响在失业保险参与率低、地方财政人均社会保障和人均医疗卫生支出低的地区更为明显。

## 6. 研究结论与政策建议

### 6.1 研究结论

（1）家庭成员的经济话语权对商业保险购买决策有显著的正向影响，即经济话语权越高的家庭成员不仅选择拥有商业保险的可能性更大，支出的保费也会更多。这可能是因为经济话语权较高的的家庭成员承担着日常生活开支、照顾子女和赡养老人的绝大部分责任。

（2）家庭成员的经济话语权对商业人寿保险和商业健康保险的购买均有正向影响，但对商业人寿保险的促进作用更大。这可能是因为中国式家庭非常注重“情义”，所以收入占比高的家庭成员，在购买商业保险时考虑更多的是当自己身故时，能够通过保险赔付为其他家庭成员寻求一份长期的经济保障。

（3）家庭成员的经济话语权对商业保险购买决策的正向影响，在农村地区更显著。一方面，这可能是因为农村家庭收入来源相比于城镇家庭更加单一，当农村家庭中的经济支柱遇到突发性风险时，可能会使整个家庭失去全部的经济来源；另一方面，农村家庭里的经济支柱大部分是通过外出务工来获取收入，在外务工面临的风险因素更多，医疗费用是不可避免的，因此更需要通过购买商业保险来分散风险。

（4）家庭成员经济话语权对商业保险购买决策的正向影响，在东部地区更显著。原因是由于东部地区的整体经济水平较高，其商业保险市场较中、西部地区更加完善，商业保险的品种也更为丰富，这就满足了家庭成员不同的商业保险需求，对家庭成员参加商业保险有促进作用。此外，东部地区金融发展更快，居民的金融素养水平也更高，居民的保险意识更强烈，更希望通过购买商业保险来为家庭的经济支柱提供一份保障。

（5）家庭成员经济话语权对商业保险购买的正向影响，在社会保障发展程度低的地区更显著。这主要是因为，社会保险保障程度差的地区，失业保险缺失、地方财政人均医疗卫生支出不足等则可能导致居民家庭在家庭经济支柱遭受突发风险时只具备有限的风险应对措施，进而对家庭商业保险需求构成了显著的影响。相反地，社会保障程度高的地区，失业保险等社会保险保障为居民家庭提供了风险应对机制，帮助居民家庭更好地应对了家庭经济支柱失业及医疗等冲击事件，进而一定程度上避免了家庭经济支柱遇到突发风险导致居民家庭收入下降或医疗支出增加对家庭的威胁。

## 6.2 政策建议

以上的结论已经对家庭成员的经济话语权对商业保险购买决策的影响进行总结。在此基础上，对于如何进一步提高我国家庭保险需求，提高家庭的风险抵御能力，从而促进保险业的健康发展，本文提出以下建议。

### 6.2.1 保险机构的产品设计应考虑经济话语权对保险购买的影响

本文的实证结果显示，经济话语权越高的家庭成员选择购买商业保险的可能性更大，同时他们支出的商业保险保费也会更多。但是在日常生活中，经济话语权低的家庭成员也面临着很多的健康风险，然而在经济资源和医疗资源的获取方面，经济话语权低的家庭成员远远不及经济话语权高的家庭成员，会造成经济话语权低的家庭成员在面临健康风险冲击时应对能力严重不足的现象。因此，需要进一步加强对这部分家庭成员保障需求的关注。

因此对于保险公司而言，应经济话语权对保险购买的影响，在进行产品开发时，应针对这部分群体设计更多简单化的优秀健康险产品，满足经济话语权低的家庭成员的基本医疗保障和健康需求，使商业保险产品的灵活性和个性化得到充分发挥。同时保险公司在进行营销活动时，应提高经济话语权低的家庭成员的参保积极性。可以通过发展网络视频教育，让家庭成员能基于手机、互联网方便快捷地学习保险知识和了解保险产品，通过减少学习知识的各种成本，鼓励经济话语权低的家庭成员主动参与学习，提高居民对于参保商业保险的认知程度，让经济话语权低的家庭成员认识到购买保险的重要性。

### 6.2.2 保险机构的产品营销应重视目标客户的定位

在异质性分析中看出，家庭成员的经济话语权在农村中对商业保险购买的影响更大。在社会保险保障程度低的地区，家庭成员的经济话语权对家庭成员商业保险参与的促进作用更明显，在社会保险保障程度高的地区，对商业保险购买的影响小。

因此对于保险公司而言，商业保险公司在进行产品营销活动时，应该不断深挖细分市场，根据不同消费者的风险特征进行产品创新，如为家庭的经济支柱设计保障程度更高的人寿保险产品或者健康保险产品，或为多孩、老年人多的家庭设计儿童、老人风险保障程度更高的保险产品，以此来分担家庭经济支柱的压力。

同时保险公司在进行产品营销时应更多地关注家庭经济支柱的保险需求，特别是农村地区和社会保障程度低的地区，并且要结合农村居民的保险知识缺乏、整体受教育程度较低的实际情况，用通俗易懂的语言进行销售和推广，告诉他们为家庭经济支柱购买保险的重要性，降低农民工家庭信息获取成本，对其提供有效的风险保障。

6.2.3 应加深农村地区社会保险、商业保险的发展

本文的实证结果显示，家庭成员的经济话语权在农村中对商业保险参与可能性的影响更大。这可能是农村家庭收入来源相比于城镇家庭更加单一，家庭经济更脆弱，因此当家庭经济支柱遇到突发性风险时，对农村家庭的影响更大。

要加强对农村地区农民家庭的风险保障，减轻农民家庭经济支柱的压力。一方面可以通过提高新型农村合作医疗和基本养老保险的补偿等方式，给予农村家庭更多基本保障，防范因病致贫、养老致贫等情况的出现。另一方面可以加强农村地区商业保险市场的培育，推动商业养老保险扩大覆盖面，同时我们也要结合农村居民的保险知识缺乏、整体受教育程度较低的实际情况，用通俗易懂的语言进行销售和推广，给予农村家庭成员更多风险保障。

6.2.4 应加强商业健康保险的宣传力度

通过实证分析可以发现家庭成员经济话语权虽然都会促进家庭成员对两类保险的购买，但经济话语权高的家庭成员，对商业人寿保险需求高于商业健康保险。

这说明我国商业健康保险市场发展还处于成长阶段，许多消费者的潜在需求还未能挖掘出来，除了我国健康险还不能迎合大众各种各样的需求之外，很大一部分原因是因为我国居民的健康意识以及保险意识还跟不上，其中也包括对社会保险和商业健康保险的区别与定位认知并不清晰，由于商业健康保险开始定位不清晰使得许多居民并未清楚商业健康保险和社会医疗保险之间的区别，在加上商业健康保险的了解也甚少，更别说挑选合适自己的健康险产品，政府部门应该加强对我国居民关于健康知识以及健康保险知识的普及与教育，树立正确的健康观念与保险观念，增强我国居民对商业健康保险的认可度，有利于进一步挖掘出消费者对于健康保险不同层次的需求。

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# 家庭成员经济话语权对商业保险购买决策的影响研究

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**关键词:** 家庭成员；经济话语权;保险购买决策;商业保险

**中文摘要.** 近年来，中国家庭的财富实现快速积累，家庭成员经济话语权对家庭内部购买商业保险的分配决策可能产生影响。本文将个人收入占家庭总收入的比重作为衡量家庭成员经济话语权的指标，关注以下问题：一、家庭成员经济话语权对该成员购买商业保险的影响是怎样的？主要考虑两方面的影响，分别是，经济话语权是否影响该成员购买商业保险，以及对该成员商业保险保费支出的影响。此外，还分析了家庭成员经济话语权对其购买商业人寿保险和商业健康保险的影响。二、家庭成员经济话语权对家庭保险购买决策是否构成了异质性影响？本文按照城乡、区域、家庭收入水平、社会保障发展程度等四个方面进行了异质性分析。

本文使用2017年中国家庭金融调查（CHFS）数据，运用 *Logit* 和 *Tobit* 模型实证研究家庭成员经济话语权对商业保险购买决策的影响。研究发现，家庭成员的经济话语权对是否持有商业保险以及商业保险保费支出金额具有显著正向影响。并且，家庭经济话语权会促进家庭成员对商业人寿保险和商业健康保险的购买，但对商业人寿保险需求的影响比商业健康保险更为显著。这可能是由于，经济话语权高的家庭成员在购买商业保险时，更多考虑当自己发生意外时通过保险为其

他家庭成员提供一份经济保障。进行异质性分析时发现，在农村地区、东部地区和社会保障发展程度低的地区，家庭成员经济话语权对商业保险购买决策的正向影响更为显著。总体而言，本文实证探索了家庭成员的经济话语权对商业保险购买决策的影响，为商业保险研究提供了新的视角。此外，研究结果对保险公司产品开发和推广具有一定参考价值。

# Chapter 7. Behavioral Insurance

# Factors Associated With Risk Perception of COVID-19 among Guangzhou Residents: A Psychological Typhoon Eye Perspective

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**Keywords:** COVID-19, risk perception, psychological typhoon eye, Guangzhou, China

**Abstract.** On the basis of the risk perception level of Guangzhou citizens in the Sanyuanli incident, this study explores the risk awareness of residents in public health events and their risk perception about risk center areas. The data were collected through an online platform. A total of 153 Guangzhou citizens responded to the online survey, and 150 valid samples were used for analysis. Three ordinal regression models were developed to evaluate the factors associated with the three dimensions of risk perceptions. The findings of this study did not confirm the psychological typhoon eye theory but indicated that the understanding of risk situation will influence personal risk perceptions regarding public health emergencies. Considering that personal understanding of risk situation might be associated with media information, the government should strengthen the media management of major public emergencies.

# 1 Research background

Since the outbreak of COVID-19, the Chinese governments at all levels have launched a primary response mechanism for this major public health emergency. Urgent measures that limit or stop work and crowd-related gathering activities and suspend business and classes are performed. A series of compulsory measures such as isolation treatment of patients with COVID-19 and close contacts, medical observation of those with suspected symptoms, and home isolation of ordinary people has also been implemented. With the strict control, the epidemic situation has gradually improved. However, the Sanyuanli event in Guangzhou has caused fear to people once again. On March 28, 30, and 31, 2020, the Disease Control Agency in Yuexiu District of Guangzhou City has successively detected five cases of African Americans with nucleic acid positive in centralized observation sites. A total of 197 close contacts are involved in the incident, which causes great panic.

On the basis of the risk perception level of Guangzhou citizens in the abovementioned Sanyuanli incident, this study explores the risk awareness of residents in public health events and their risk perception about risk center areas, aiming to provide implications for policy makers and implementers to deal with such incidents in the future and reduce the social losses caused by public health events.

## 2 Literature review

Risk perception refers to people's subjective judgment on the characteristics and severity of a specific risk event. It is an important indicator to measure public psychological panic. Starr (1969) proposed a performance preference method to explore the kind of risk that is acceptable to the public. The results show that risk acceptability is related to the cost and benefit assessment of the risk and considers people's subjective will. The research results lay a theoretical foundation for future research on risk perception. Slovic (1987) hypothesized that when using risk assessment to estimate various dangerous things or events, most people primarily relied on intuitive risk judgment, that is, risk cognition. He found that the probability estimation of risk was only moderately related to the actual accident rate. People's risk perception is often inconsistent with the rational economic theory, that is, people's perception of risk is different from the objective risk. Therefore, the study of risk perception provides insights into people's irrational decision-making behavior.

The factors that affect risk perception are complex and diverse. Individual characteristics, risk communication, risk nature, and knowledge structure are the main influencing factors (Zhou et al., 2012). The differences of individual characteristics, including gender, age, and income, will lead to different risk perception characteristics (Su, et al., 2008; Tian, Xue, & Wang, 2010; Cai, Cao, & Long, 2011; Li et al., 2013). With regard to risk communication, the dissemination of risk-related information will affect risk perception. Public risk events have a ripple effect. The depth and breadth of ripple waves depend not only on the nature of the risk event, but also on how the public obtains relevant information and how to perceive and interpret the information through ripple spreading (Liu, Zhou & Huang, 2006). Regarding the nature of risk, studies have shown that people overestimate the risk of events with small probability but high mortality and the risk of immediate occurrence and large one-time damage, while underestimating the long-term and latent risk and the risk of events with high probability and low mortality (Zhou, et al., 2012). With regard to knowledge structure, the more comprehensive people know about a specific risk event and the more information they receive, the more objectively they can perceive the outcome of the event (Liu, Zhou, & Huang, 2006). In addition, some risk characteristics, such as immediacy, the possibility of a disaster, and whether an event affects others, may affect individual's risk perception (Li, 2008).

Another important factor that may influence risk perception is distance from risk things or events. However, the extant results verify two opposite theories: ripple effect theory and psychological typhoon eye effect theory. Ripple effect is a natural phenomenon, which is applied to risk perception. It means that the subjective risk perception of an individual is closely related to the risk of objective events, that is, similar to the ripple caused by throwing stones into the water, the closer to the central area of the risk event, the higher the risk perception of the individual.

The psychological typhoon eye effect refers to the fact that people closer to high-risk locations are calmer. This effect was first discovered and named by Li et al. (2009) after the Wenchuan earthquake in China. Another study conducted by Li et al. (2011) 1 year after the Wenchuan Earthquake showed that the psychological typhoon eye effect remained robust for 1 year. The research team found two "relationship" versions of the psychological typhoon eye effect: the closer the relationship with the victims of property losses, the lower the residents' concerns about health and safety, and the closer the kinship of the affected people, the lower the residents' concerns about health and safety.

After the spread of SARS, Xie, Stone, Zheng, and Zhang ( 2011) investigated the effect of the SARS crisis on the distress level among 647 respondents in China. The results show that the nearness to the center of the SARS epidemic and subjective interpretations of the epidemic situation are negatively associated with the distress level. Similarly, Zheng et al. (2015) confirmed the psychological typhoon eye effect among 220 people in a lead–zinc mining area located in Fenghuang County of China. The results indicate that people under indirect threat from unprotected lead–zinc mining tend to oppose such practices, whereas people under direct threat continue to participate in dangerous mining practices.

During COVID-19, Xu et al. (2020) investigated the association of risk perception and risk level among 351 subjects who were moving in and out of China. The

psychological typhoon eye effect has been detected once again. Tang, Zhang, Li, and Wei (2020) studied the association between the distance to the epicenter and life satisfaction among 308 working adults during COVID-19 on the basis of the psychological typhoon eye theory. The findings indicate that the psychological typhoon eye is significant only for adults who are younger or have smaller families.

Therefore, in the existing literature, individual factors, including age, gender, income, educational background, the objective physical distance from the risk center, subjective psychological distance from the risk center, and risk controllability, have impacts on people's risk perception. Through reviewing the literature, two points must be noted. First, the existing empirical literature on psychological typhoon eye is concentrated on natural disaster events (such as earthquakes), and public health emergencies, particularly sudden major infectious events, are rarely discussed. The characteristic of infectious diseases indicates that the possibility of human-to-human transmission is high. Therefore, the distance among people affects the degree of risk assessment. Does the psychological typhoon eye still have the explanatory power in this specific situation? Second, people in the central risk and low-risk areas obtain information related to the risk event from different media, which is an important condition of the psychological typhoon eye. Furthermore, if obtaining of different information is controlled, then does the psychological typhoon eye effect still exist? This research attempts to answer the two abovementioned questions.

# 3 Methods

## 3.1 Research hypothesis

Considering that the psychological typhoon eye theory was tested in public emergencies, this study presented the following assumptions on the basis of this theory:

**H1:** The farther the geographical distance from the epidemic center, the higher the level of risk perception.

**H2:** The farther the psychological distance from the epidemic center, the higher the level of risk perception.

If H1 and H2 were confirmed, then the psychological typhoon eye effect existed in the Sanyuanli event.

On the basis of the relationship version of the "psychological typhoon eye" effect, Hypothesis 3 was proposed.

**H3:** The closer the relationship with the infected people in the epidemic area, the lower the risk perception.

## 3.2 Data source

On April 7, 2020, the Epidemic Prevention and Control Headquarters office of Yuexiu District, Guangzhou, reported that imported and related cases were found in Kuangquan Street of the Sanyuanli Area, Yaotai District. On the basis of the requirements of epidemic risk prevention and control, the area adopted strict community control. The emergence of the event caused different reactions and responses to the public. This study evaluated the factors associated with the risk perception of Guangzhou residents on the basis of this case and aimed to verify the psychological typhoon eye effect theory.

The data were collected through an online platform. A total of 153 Guangzhou citizens responded to the online survey, and 150 valid samples were used for analysis. This study obtained ethics approval from the Academic Committee of School of Public Administration, Jinan University, Guangzhou, China. All participants voluntarily participated in the survey. Respondents' personal information was confidential.

### 3.3 Variables and measurement

The dependent variable of this study is risk perception. Slovic (1987) reported that risk perception could be divided into three dimensions: consciousness of severity, susceptibility, and controllability. This study measured risk perception on the basis of these three dimensions. Two items were designed for each dimension, with a total of six items. In particular, consciousness of severity was measured by asking the respondents two questions: First, after the incident, how worried are you about the Sanyuanli epidemic affecting the whole Guangzhou? Second, after the incident, do you think it is necessary to implement closed management measures for all residents in Sanyuanli? Susceptibility was measured by answering the following questions: First, after the incident, do you worry that there will be related cases from the Sanyuanli Area? Second, if you live (or stay) in the Sanyuanli Area during the event, do you think you have a high risk of infection? Controllability was measured by answering the following questions: First, after the incident, how much trust do you have in the information about the epidemic situation in the Sanyuanli Area released by Guangzhou authorities? Second, after the incident, what is your confidence in "Guangzhou government can effectively control the epidemic in Sanyuanli"? Each item was scored through a five-point Likert scale from 1 = none to 5 = very, wherein high scores indicated high level of risk perception. The two-item consciousness of severity had a Cronbach's alpha of 0.709. The coefficient alpha for susceptibility was 0.779, and the coefficient alpha for controllability was 0.809, indicating that the internal validity of the three dimensions of risk perception was high.

The independent variables of this study are the individual characteristics (including gender, age, education level, and family income), understanding of the epidemic situation in Sanyuanli, geographical distance from the epidemic center, psychological distance from the epidemic center, and relationship with the infected cases. Among the variables, geographical distance was measured by asking the address of the respondents, and then the geographical distance from the epidemic center was identified using Baidu map. Psychological distance was measured on the basis of respondent's self-feeling of distance from the epidemic center, with the value ranging from 0–100 km, and the larger the value, the farther the psychological distance. The relationship with infected cases was measured by asking the respondents whether they knew the infected cases (no=0, yes=1).

### 3.4 Data analysis

Descriptive statistics was used to understand the basic information of the sample. Afterward, three ordinal regression models were developed to evaluate the factors associated with the three dimensions of risk perceptions. All predicting variables were simultaneously included in the models. The regression models were assessed with statistical package SPSS 24.0.

# 4 Results

As shown in Table 1, the samples in this study were primarily women, with a total proportion of 64.7%. The samples were concentrated in the young and middle-aged, and the proportion of the 20–29 year-old age group was 65.30%. 80.70% of the respondents obtained college or undergraduate degree. Most of the respondents had an annual family income of more than 60,000 RMB (81.3%). 40% of the respondents had a general understanding of the epidemic situation in Sanyuanli; 34.7% of the respondents had no or little understanding of the epidemic situation, and 25.3% had a good understanding or better understanding. The average geographical distance was 21.47 km (SD=15.86). The average psychological distance was 66.67 (SD=26.65). As for the relationship measurement, considering that the number of relevant samples known by respondents was too small (only one interviewee said that someone she or he knew was affected by the Sanyuanli epidemic), this study did not consider the "relationship" version of the psychological typhoon eye effect in the following analysis.

**Table 1 Descriptive statistics of dependent and independent variables (n = 150)**

| Variable | Mean / percentage | SD | Minimum | Maximum |
|---|---|---|---|---|
| Gender (male) | 35.30% | | | |
| **Age group** | | | | |
| 0-19year | 6.70% | | | |
| 20-29year | 65.30% | | | |
| 30-39year | 15.30% | | | |
| 40-49year | 10% | | | |
| 50-59year | 2% | | | |
| 60 and above | 0.70% | | | |
| **Education level** | | | | |
| Primary school and below | 0.70% | | | |
| Junior middle school | 2% | | | |
| High school, or technical secondary school, or technical School | 10% | | | |
| College or undergraduate | 80.70% | | | |
| Master degree and above | 6.70% | | | |
| **Annual family income (RMB)** | 3.21 | 1.79 | 1 | 7 |
| 5 ten thousand and below | 18.70% | | | |
| 6-10ten thousand | 20% | | | |
| 11-20ten thousand | 25.30% | | | |
| 21-30ten thousand | 16% | | | |
| 31-40ten thousand | 6.70% | | | |
| 41-50 ten thousand | 4% | | | |
| Over 50 ten thousand | 9.30% | | | |

| | | | | |
|---|---|---|---|---|
| **Understanding of the epidemic situation in Sanyuanli** | 2.87 | 0.974 | 1 | 5 |
| Do not understand | 8% | | | |
| Do not know much | 26.70% | | | |
| General understanding | 40% | | | |
| Better understand | 21.30% | | | |
| Very well understand | 4% | | | |
| Geographical distance from Sanyuanli area (km) | 21.47 | 15.86 | 4.8 | 72 |
| Psychological distance from Sanyuanli area | 66.67 | 26.65 | 0 | 100 |
| Relationship with infected cases（Yes） | 0.7% | | | |
| Consciousness of severity | 6.36 | 1.894 | 2 | 10 |
| Susceptibility | 6.56 | 2.100 | 2 | 10 |
| Controllability | 7.80 | 1.584 | 2 | 10 |

Table 2 shows the factors associated with respondents' risk perceptions with regard to consciousness of severity, susceptibility, and controllability. The test of parallel lines for the three ordinal regressions had passed (all $p>0.05$). The results showed that after controlling the demographic and socio-economic variables, the geographical distance and psychological distance from the epidemic center were not associated with susceptibility and controllability (all $p>0.1$). The psychological distance from the epidemic center was not associated with the consciousness of severity, whereas the geographical distance from the epidemic center could predict the consciousness of severity at a significance level of 0.1(B=−0.124), indicating that the closer to the risk center, the higher the risk perception. Therefore, the ripple effect was detected in the Sanyuanli event, and the psychological typhoon effect was not verified. Nevertheless, personal understanding or interpretation of the epidemic situation in the Sanyuanli Area was significantly associated with their risk perceptions in three dimensions (all $p<0.05$ except for one, $p<0.1$).

**Table 2 Factors associated with risk perceptions (n=150)**

| Variable | Consciousness of severity | | | Susceptibility | | | Controllability | | |
|---|---|---|---|---|---|---|---|---|---|
| | Estimates | 95% CI | p-value | Estimates | 95% CI | p-value | Estimates | 95% CI | p-value |
| Psychological distance | 0.009 | [-0.003,0.022] | 0.138 | 0.007 | [-0.005,0.019] | 0.268 | 0.005 | [-0.008,0.018] | 0.446 |
| Geographical distance | -0.124 | [-0.27,0.023] | 0.099 | -0.028 | [-0.173,0.117] | 0.706 | 0.090 | [-0.061,0.240] | 0.241 |
| Gender (male) | -0.14 | [-0.804,0.524] | 0.679 | 0.018 | [-0.642,0.679] | 0.957 | 0.774 | [0.087,1.460] | 0.027 |
| Gender (female) | 0[a] | . | . | 0[a] | . | | 0[a] | . | |
| 0-19year | -0.991 | [-4.981,2.998] | 0.626 | -2.225 | [-6.221,1.770] | 0.275 | -20.723 | [-23.170,-18.276] | 0.000 |
| 20-29year | -0.548 | [-4.378,3.283] | 0.779 | -1.032 | [-4.863,2.799] | 0.598 | -20.396 | [-22.567,-18.225] | 0.000 |
| 30-39year | -1.018 | [-4.849,2.813] | 0.602 | -1.646 | [-5.480,2.187] | 0.400 | -20.631 | [-22.960,-18.303] | 0.000 |
| 40-49year | -2.881 | [-6.805,1.043] | 0.15 | -3.054 | [-6.977,0.869] | 0.127 | -18.955 | [-21.361,-16.549] | 0.000 |
| 50-59year | -2.841 | [-7.188,1.506] | 0.2 | -3.601 | [-7.961,0.759] | 0.106 | -19.534 | [-19.534,-19.534] | |
| 60 and above | 0[a] | . | . | 0[a] | . | | 0[a] | . | |
| Primary school and below | 0[a] | . | . | 0[a] | . | | 0[a] | . | |
| Junior middle school | 0.703 | [-1.707,3.113] | 0.567 | -0.712 | [-3.111,1.687] | 0.561 | -0.094 | [-2.532,2.344] | 0.940 |
| High school, or technical secondary school, or technical School | -0.309 | [-1.893,1.276] | 0.703 | -0.662 | [-2.239,0.915] | 0.411 | 0.803 | [-0.819,2.425] | 0.332 |
| College or undergraduate | -0.255 | [-1.548,1.037] | 0.699 | -0.239 | [-1.522,1.045] | 0.715 | -0.101 | [-1.415,1.213] | 0.880 |
| Master degree and above | 0[a] | . | . | 0[a] | . | | 0[a] | . | |
| 5 ten thousand and below | -1 | [-2.212,0.212] | 0.106 | -0.132 | [-1.326,1.063] | 0.829 | -0.113 | [-1.335,1.109] | 0.856 |
| 6-10ten thousand | -0.004 | [-1.215,1.208] | 0.995 | 0.310 | [-0.889,1.509] | 0.613 | -0.065 | [-1.290,1.160] | 0.917 |
| 11-20ten thousand | -0.061 | [-1.203,1.081] | 0.916 | 0.161 | [-0.969,1.291] | 0.780 | -0.238 | [-1.401,0.925] | 0.688 |
| 21-30ten thousand | -0.565 | [-1.786,0.655] | 0.364 | -0.120 | [-1.328,1.088] | 0.845 | -0.968 | [-2.217,0.281] | 0.129 |
| 31-40ten thousand | -0.226 | [-1.743,1.292] | 0.771 | -0.348 | [-1.853,1.156] | 0.650 | -0.529 | [-2.079,1.020] | 0.503 |
| 41-50 ten thousand | -0.684 | [-2.455,1.087] | 0.449 | 0.034 | [-1.728,1.795] | 0.970 | 0.057 | [-1.737,1.851] | 0.950 |
| Over 50 ten thousand | 0[a] | . | . | 0[a] | . | | 0[a] | . | |
| Do not understand | 2.982 | [1.076,4.888] | 0.002 | 2.466 | [0.566,4.367] | 0.011 | -2.638 | [-4.705,-0.571] | 0.012 |
| Do not know much | 2.657 | [0.982,4.331] | 0.002 | 2.534 | [0.849,4.219] | 0.003 | -2.205 | [-4.056,-0.353] | 0.020 |
| General understanding | 3.262 | [1.59,4.933] | 0.000 | 3.127 | [1.450,4.805] | 0.000 | -2.729 | [-4.561,-0.897] | 0.004 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Better understand | 3.575 | [1.817,5.334] | 0.000 | 3.361 | [1.601,5.121] | 0.000 | -1.720 | [-3.607,0.166] | 0.074 |
| Very well understand | 0[a] | . | . | 0[a] | . | | 0[a] | . | |

*Note:* [a] This parameter is redundant, so it is set to zero.

For consciousness of severity, $\chi^2$ =37.549, df=21,p<0.05,Nagelkerke $R^2$=0.226.

For susceptibility, $\chi^2$ =36.634, df=21,p<0.05,Nagelkerke $R^2$=0.221.

For controllability, $\chi^2$ =42.621, df=21,p<0.05,Nagelkerke $R^2$=0.256.

## 5 Discussion

The findings of this study did not confirm the psychological typhoon eye theory but indicated that the understanding of risk situation will influence personal risk perceptions regarding public health emergencies. Considering that personal understanding of risk situation might be associated with media information, the government should strengthen the media management of major public emergencies.

Although the psychological typhoon eye effect existed in some public emergencies, the mechanism behind the psychological typhoon eye effect remained unclear (Wei, Tao, Liu, & Li, 2017). Notably, the study conducted by Xu et al. (2020) had a pre-condition when detecting the psychological typhoon eye effect. That is, the subjects moving in and out of China received different information related to COVID-19 from different media; thus, media information might influence subject's understanding of risk situation. Our study had controlled the effect of media information because all samples were obtained from the same city, and they received the same information delivered by the same media. Thus, the results of our study did not detect the psychological typhoon eye effect.

This study had a limitation in non-random sampling; thus, the ability to generalize the findings to all population in Guangzhou was constrained. Despite this limitation, this study had implications for theories and practice. Moreover, the relational version of the psychological typhoon eye has not been investigated in this study because of selection bias. In future study, more rigorous research design was needed to verify the relational version of the psychological typhoon eye effect.

## 6 Conclusion

COVID-19 has spread worldwide, which causes great turbulence to the world politics and economy. As risk takers, dealing with this kind of global public health events with a wide range and great destructive power is an important issue. The level of risk perception will affect the decision-making of protective behavior. The moderate level of risk perception enhances the ability of disaster prevention and mitigation. Excessive risk perception can trigger psychological reactions, such as fear, helplessness, and anxiety (Li, 2009). Too low or too high risk perception may lead to loss or waste of social resources (Beck, 2002).

Therefore, the government must strengthen information communication to reduce panic, increase information transparency, timely disclose the latest developments of the emergency event, promptly dispel rumors, and use simple and easy-to-understand

methods to inform the public regarding the current situation and the ways to deal with the emergency event (Xu et al., 2020). Moreover, news release platforms need to establish a credibility database of news sources to improve the credibility of media information.

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# A Research on Commercial Endowment Insurance Decision-making Based on Financial Literacy Overconfidence

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**Keywords:** Commercial endowment insurance, Financial literacy, Overconfidence, Cognitive bias.

**Abstract.** In this paper, based on 2020 Chinese residents retirement planning index survey data, with expected to answer the correct number and actual number of correct answer measure public primary and objective financial literacy levels, in both the difference between the value as a measure of overconfidence of financial literacy, with age, sex, marital status, number of children, education degree, family income as control variable, Logit regression was used to analyze the impact of financial literacy and overconfidence in one's own financial literacy on the public's commercial endowment insurance policy.

## 1. 引言

自 1999 年以来，我国老年人口数量不断增加。到 2020 年，我国 65 岁及以上人口达 1.9 亿，占总人口比例的 13.5%。预计到 2050 年前后，我国老年人口数将达到峰值 4.87 亿，占总人口比例达到 34.9%，也就是说届时我国每三个人中就有一位老年人。老龄化程度的不断加剧给我国养老金体系带来巨大压力，其发展失衡问题日益凸显。在我国目前的养老金结构上，截至 2020 年末，第一支柱（基本养老保险和社保基金）占比达 82.7%，第二支柱（企业年金和职业年金）占比 17.3%，第三支柱个人养老金占比仅为 0.002%，这一现象说明我国养老金体系内各支柱发展之间严重失衡，过度依赖公共养老金，第二和第三支柱规模小，发挥的作用十分有限。

商业养老保险作为第三支柱个人养老金的重要组成部分，在我国目前发展得还很有限，面临较大发展瓶颈。以变额年金保险为例，截至目前，我国保险市场上仅存的变额年金产品只有工银安盛的“保得盈”年金保险产品和中美联泰大都会的“步步稳赢”年金保险产品。据统计，保得盈和步步稳赢变额年金保险产品最初申请的销售额度分别为 9 亿和 29 亿，但试点一年期间的保费收入却只有 1.5 亿和 2.4 亿，发展困境可见一斑。

金融素养作为影响储蓄和投资的一项人力资本，在公众进行商业养老保险购买决策时发挥重要作用——例如预估自己需要的保障力度、甄别不同的保险产品信息、理解保险合同条款内容，均对居民的金融素养提出较高要求。然而，传统金融理论对金融素养的研究还相当局限。行为金融学对传统金融理论中的理性人假设提出挑战，认为市场参与者会因为认知局限和心理因素的影响产生包括损失厌恶、过度自信、心理账户等认知偏差。其中，过度自信作为认知偏差的一种，在消费者进行金融决策过程中普遍存在，据《2020 中国居民退休指数调研报告》显示，在金融素养问题中近 80%的人认为自己至少正确回答了两个题目，而实际人数只有 61.8%，说明中国居民对自身金融素养的认知还十分不足，总体上存在对自身金融素养过度自信的现象。大量研究表明金融素养过度自信会导致消费者过度参与市场、提升高风险资产投资比重最终降低收益水平等负面结果。具体到对商业养老保险的影响：消费者因高估自身金融素养水平，产生对退休后生活的盲目乐观，进而作出不符合自身利益最大化的非理性投保决策。

目前，国内对过度自信这一认知偏差的研究主要集中在对于家庭财富、股票市场参与、金融产品投资等领域的影响，而由于我国商业养老保险的发展历程较短，针对商业养老保险购买决策的研究相对还较少。在此基础上，本文基于行为金融学研究金融素养及过度自信对居民商业养老保险投保决策的影响。

## 2. 文献综述

### 2.1 相关概念界定

#### 2.1.1 过度自信

“过度自信”的概念来自于认知心理学，作为一种普遍存在的心理现象，过度自信被认为是在认知心理学领域有关个人判断的研究成果中最强有力的发现（De Bondt&Thaler，1994），二十世纪末，行为金融学提出了过度自信理论，已有文献表明，人是过度自信的，这种倾向在对自我知识准确性、掌握程度的

判断中尤为明显（Koellingeretal，2007；Krueger，2011；王晋中，2013；蒋东明，2016）。

在认知心理学上，Moore 和 Healy（2008）总结了过度自信的过高估计、过高定位和过度精确这三种表现形态。其中，过度估计是最常见的形式，表现为人们对自身的真实能力、绩效水平、成功完成某项事务的概率有了超出合理范制的过高评估; 过高定位是指人们置身于群体之中，判断自己所处的位置时，通常认为自己的能力水平等各方面情况在群体的平均水平之上；过度精确则体现在人们过度相信自己的想法、观点、选择与判断的准确性。

2.1.2 金融素养过度自信

目前，直接研究金融素养过度自信的文献并不多。在已有的文献中，金融素养过度自信多被定义为人们对自我金融素养的主观评价高于金融素养客观得分的情况，即主客观金融素养之间的正差异（Xia，2014；Chu，2016；Nilton Porto & Xiao，2016；胡振，臧日宏，2017），这与过度自信概念中的“校准偏差”相一致。在具体测度中，研究者大都采用混合法对被试者的金融素养分别进行主观与客观衡量，客观金融素养低于均值而主观金融素养高于均值的个体被认为具有金融素养过度自信特征。

## 2.2 金融素养过度自信的影响研究

就金融素养过度自信对金融行为的影响而言，胡振（2017）研究了该特征对股票投资的影响，发现金融素养过度自信对人们的股票市场参与有显著的正向影响，并会显著改变家庭对股票资产的持有比例，且该影响对于股票资产配置比例呈现两极分布（即极少投资于股票或大比例投资于股票）的家庭更为明显，至于影响机制，金融素养过度自信主要是通过风险偏好和教育影响着投资者的金融行为；Xia（2014）研究了金融素养过度自信对于个体股票市场参与度的影响，发现过度自信会导致个体对于股票市场过度参与、自信不足会降低股票市场的参与度，两种情况均会造成个体的福利损失；罗娟（2018）发现金融素养自信偏差对家庭财富有倒 U 型的非线性影响，自信不足程度的降低对家庭财富有正向影响，随着自信程度的上升，过度自信程度的增加会使得家庭财富减少。Kyoung（2019）的研究发现金融素养过度自信对美国家庭拖欠抵押贷款有显著正向影响，金融素养过度自信者（主观素养低于平均值而客观素养高于平均值）拖欠抵押贷款的可能性是主、客观金融素养都较高者的三倍。另外，由于对金融素养过度自信，人们过于相信自己的能力与判断，不愿接受他人的建议或专业人士的指导（Nilton Porto & Xiao，2016），因而难以进行资产的合理分配，承担了更多因投资未充分分散而导致的风险，实际收益低于预期水平。

## 2.3 文献评述

综合已有研究，国内外学者结合行为金融学与社会心理学，对金融素养过度自信和其对金融行为的影响相关研究取得了丰硕的成果，为本研究打下扎实的基础，但同时，也可以发现：目前已有的文献主要从过度自信的角度切入，研究其对家庭财富、股票市场参与度等方面的影响，少有文献对金融素养过度自信和商业养老保险投保决策的关系进行研究。

# 3. 数据来源及变量统计分析

## 3.1 数据来源

本研究的数据来自于 2020 中国居民退休准备指数调研报告数据，该调研报告是荷兰全球人寿退休准备指数调研成果的一部分，由同方全球人寿保险有限公司联合清华大学经济管理学院中国保险与风险管理研究中心，根据调研公司 Cicero Consulting 通过互联网平台实施的问卷调查回收的数据，进行分析并撰写而成。2020 年的调查对象来自中国 29 个省市自治区的 2000 名居民，调查采用了分层随机抽样的方法，调查的主要内容包括：受访者对经济发展、自身财务状况和退休生活的预期、对待退休生活的态度、退休准备指数、退休收入来源、退休收入责任、退休理财计划、影响对退休计划的认识与行动的因素等十个部分。

本文使用的样本数量为 2000 个。

## 3.2 变量设置

### 3.2.1 被解释变量

商业养老保险作为第三支柱个人养老金的组成部分，在我国的养老保障体系中发挥重要作用。本文所采用的问卷中调研了居民为退休准备即将或正在使用的财务手段，问题列举了许多可能的养老准备行为，选项中的可变年金及固定年金共同构成了商业养老保险变量（insurance），即选择年金保险作为财务手段的认为购买了商业养老保险，赋值为 1，反之为 0。

### 3.2.2 解释变量

（1）客观金融素养。金融素养是指个体能够高效合理地管理和处理其所拥有的私人金融资产和金融事务的知识和能力，也是个体对各金融领域的受教育程度和认知水平。国际上通用的衡量金融素养的方式是由美国 Lusard 和 Mitchell 在 2004 年设计的三道选择题（以下简称“三大问题”），分别考察被调查者对于复利、通货膨胀、风险分散三个方面的金融知识和投资意识具备情况，从而做出对其金融素养的评估。客观金融素养是通过询问受访者“三大问题”来测度，每个问题回答正确记 1 分，反之记 0 分，然后对三个问题的分数求和，得出客观金融素养得分。

（2）过度自信。正常情况下，如果个体自己估计的主观金融素养较高，而衡量实际水平的客观金融素养较低，就说明存在高估自身的金融素养这一认知偏差，这种情况称为金融素养过度自信（overconfidence）。本文参考 Xia et al.（2014）的研究中有关金融素养的处理方法，将金融素养分成主观金融素养与客观金融素养。主观金融素养是通过问卷中调研的受访者预估自己分别能够答对 0 到 3 个问题的可能性百分比，得出预估答对题目的期望值作为主观金融素养得分。将未填写该问题的受访者视为对自身金融素养非常不自信，记为 0 分。将样本中主观金融素养得分高于客观金融素养得分的情况归为金融素养过度自信，赋值为 1，反之为 0。

### 3.2.3 其他控制变量

控制变量的选取应遵循外生性原则，本文选取的控制变量，包括性别（sex）、年龄（age）、教育程度（education）、婚姻状况（marriage）、子女数量（children）、家庭年收入（income），排除金融素养及认知偏差以外的因素对居民商业养老保险投保决策的影响；本文将以上变量划分为个人特征因素和家庭特征因素。

受访者个人特征：受访者个人特征因素包括性别、年龄、教育程度、婚姻状况。年龄按照实际年龄赋值；性别为男赋值为 1，性别为女则赋值为 0；婚姻

状况为已婚赋值为 1，其他赋值为 0；教育程度中本科及以上学历赋值为 1，其他赋值为 0；子女数量按照实际抚养孩子数进行赋值；

受访者家庭特征：受访者家庭特征因素包括家庭年收入、子女数量。调查问卷中家庭年收入的回答选项不是具体的数值而是区间，因此本文参照 2020 中国居民退休准备指数调研报告的处理方法[1]，将家庭年收入水平划分为低收入、中等收入、较高收入、高收入四档，分别赋值 0、1、2、3；子女数量按照实际抚养孩子个数赋值。

表 1 变量名称及赋值表

| 变量名称 | 赋值方法 |
|---|---|
| 年龄 | 受访者实际年龄 |
| 性别 | 男=1，女=0 |
| 婚姻状况 | 已婚=1，其他=0 |
| 子女数量 | 受访者实际抚养孩子数量 |
| 教育程度 | 本科及以上=1，其他=0 |
| 客观金融素养 | 受访者实际答对“三大问题”个数 |
| 过度自信 | 主观金融素养得分高于客观金融素养得分赋值为 1，其余为 0 |
| 家庭年收入 | 低收入=0，中等收入=1，较高收入=2，高收入=3 |
| 商业养老保险 | 有将商业养老保险列入退休保障财务手段=1，无=0 |

## 3.3 变量描述性统计

从表 2 中可以发现，商业养老保险的均值仅为 0.17，说明把投保商业养老保险作为退休后养老计划一部分的个体非常少，商业养老保险的影响有限。客观金融素养的得分均值为 1.63，代表受访者在“三大问题”中仅答对 1.63 道题，说明居民总体金融知识水平较低。过度自信变量均值为 0.34，说明 34%的受访者存在金融素养过度自信，这一认知偏差具有普遍性；在受访者个人特征方面，年龄均值为 41.52，受访群体以中年人为主。性别比例为男女几乎各占一半。80%的受访者最终学历为本科及以上，整体教育程度较高。大部分受访者婚姻状况为已婚。在家庭特征方面，大多数家庭抚养子女数量为 1 个。

表 2 变量描述性统计表

| 变量 | 符号 | 均值 | 标准差 | 最小值 | 最大值 |
|---|---|---|---|---|---|
| 年龄 | age | 41.52 | 14.38 | 18 | 80 |
| 性别 | sex | 0.50 | 0.50 | 0 | 1 |
| 婚姻状况 | marriage | 0.80 | 0.40 | 0 | 1 |
| 子女数量 | children | 1.01 | 0.76 | 0 | 5 |
| 教育程度 | education | 0.80 | 0.40 | 0 | 1 |
| 客观金融素养 | ofl | 1.63 | 0.95 | 0 | 3 |
| 家庭年收入 | income | 0.978 | 0.69 | 0 | 3 |
| 过度自信 | overconfidence | 0.34 | 0.47 | 0 | 1 |
| 商业养老保险 | insurance | 0.17 | 0.38 | 0 | 1 |

[1] 在 2020 中国居民退休指数调查报告中，将家庭年总收入划分为四档：低收入为家庭税前年收入低于 8.7 万元；中等收入为家庭税前年收入 8.7-31.2 万元；较高收入为家庭税前年收入 31.2-104.1 万元；高收入为家庭税前年收入 104.1 万元。

## 4. 实证分析

### 4.1 模型构建

为了探究金融素养及过度自信对于居民投保商业养老保险决策的影响，本文构建了如下 Logit 模型：

$$\Pr(insurance) = \alpha + \beta_1 ofl + \beta_3 X + \varepsilon \quad (1)$$

$$\Pr(insurance) = \alpha + \beta_2 overconfidence + \beta_3 X + \varepsilon \quad (2)$$

其中，insurance 为“是否投保商业养老保险”虚拟变量，overconfidence 为过度自信变量，ofl 为客观金融素养变量，X 为控制变量，包括年龄、性别、婚姻状况、教育程度、子女数量等，$\alpha$、$\beta_1$、$\beta_2$、$\beta_3$ 为回归系数，$\varepsilon$ 为误差项。

### 4.2 实证结果

Logit 回归结果如表 3 所示：

表 3 金融素养及过度自信对商业养老保险决策的影响

| 变量 | 模型 1 | 模型 2 |
|---|---|---|
| ofl | 0.357***（5.51） | |
| overconfidence | | -0.461***<br>（-3.30） |
| age | 0.018***（3.83） | 0.018***<br>（3.81） |
| sex | 0.194<br>（1.58） | 0.296**<br>（2.44） |
| marriage | -0.583***（-3.63） | -0.541***（-3.38） |
| children | 0.139<br>（1.45） | 0.119<br>（1.27） |
| education | 0.737***（3.88） | 0.731***<br>（3.90） |
| income | 0.351***（4.06） | 0.354***<br>（4.09） |
| constant | -3.755***（-11.65） | -3.045***（-11.25） |
| Pseudo R2 | 0.056 | 0.046 |
| N | 2000 | 2000 |

注：***、**、* 分别表示在 1%、5%、10%的置信水平下显著。

模型 1 中在控制变量年龄、性别、婚姻状况、子女数量、教育程度、收入水平的基础上加入客观金融素养作为解释变量，结果为影响系数 0.357 在 1%的置信水平下显著，表明居民的客观金融素养水平越高，将投保商业养老保险作为养老计划的意愿越强烈。原因是个体金融素养水平越高，越能意识到目前社会养老保险还不能满足养老需求，因而会选择商业养老保险进行补充。

模型 2 将解释变量客观金融素养替换为过度自信变量，回归结果为变量的影响系数为-0.461 在 1%的置信水平下显著，表明个体对于自身的金融素养过度自信这一认知偏差对于投保商业养老保险具有负向作用。这可能解释为以下两点原因：首先，由于存在金融素养过度自信的认知偏差，个体会产生对于退休后养老准备情况的盲目乐观，意识不到仅仅依靠社会基本养老保险无法保证退休后生活的保障水平，导致风险意识较差；其次，过度自信还会使得个体产生自己掌握的金融知识已经足够的错觉，削减了进一步学习金融知识和了解商业养老保险产品的意愿，对保险的接受度很难提升。最后，过度自信会促进个体将资金用于股票市场投资，从而减少购买养老保险的支出。综合以上三点原因，最终导致金融素养过度自信的个体投保商业养老保险的可能性降低。

在控制变量中，两个模型的回归结果较为一致。在个人特征方面，受访者年龄越高、受教育水平越高，越倾向于投保商业养老保险。这可能解释为：随着年龄的增长，个体愈发认识到养老问题的紧迫性和重要性，从而选择商业养老保险；教育程度越高，会具有更高的风险意识和对商业养老保险的接受度，从而倾向购买商业养老保险；在婚姻状况中，未婚个体相比已婚个体抗风险能力较弱，因此产生更高的投保商业养老保险动机。在家庭特征方面，收入越高对商业养老保险决策有显著正向影响，符合保险是较高层次需求这一特征。子女数量对投保决策的影响不显著，原因可能是抚养子女越多既提升了风险意识更倾向购买保险；同时增加了家庭支出，使得购买能力下降，多因素同时存在导致结果不显著。

## 5. 稳健性检验

在上述回归分析中，本文运用了调查问卷中实际回答问题正确个数和预估回答问题正确个数来度量主、客观金融素养，并进一步利用主、客观得分的差值度量金融素养过度自信。由于本文的主要研究对象为金融素养过度自信这一认知偏差，因此对金融素养过度自信进行稳健性检验。在稳健性检验中本文借鉴 Xia et al.(2014)的处理方法，计算出主、客观金融素养的平均值，据此将样本划分为四个象限，每个象限代表不同类型的样本。在第Ⅰ象限中，样本的主、客观金融素养均高于平均值；在第Ⅲ象限中，样本的主、客观金融素养均低于平均值；在第Ⅱ象限中，样本的主观金融素养高于平均值而客观金融素养低于平均值；在第Ⅳ象限中，样本的主观金融素养低于平均值而客观金融素养高于平均值。本文将第Ⅱ象限中的样本定义为过度自信 2(overconfidence2)并赋值为 1，否则为 0。将上述模型中的 overconfidence 替换为 overconfidence2 进行回归检验。结果显示回归结果中对应解释变量的系数符号相同，且系数数值和显著性相差不大，这表明了本文回归结果的稳健性。

表 4 稳健性检验结果

| 变量 | 模型 2-1 |
|---|---|
| overconfidence2 | -0.359**<br>（-1.99） |
| age | 0.018***（3.78） |
| sex | 0.284**<br>（2.34） |
| marriage | -0.546***（-3.43） |
| children | 0.106<br>（1.13） |
| education | 0.743***（3.95） |
| income | 0.355***<br>（4.11） |
| constant | -3.12***（-11.39） |
| Pseudo R2 | 0.042 |
| N | 2000 |

注：***、**、* 分别表示在 1%、5%、10%的置信水平下显著。

## 6. 结论与建议

### 6.1 结论

商业养老保险在我国三支柱养老金体系中理应发挥重要作用，但现实中无论在国内还是国外其发展都还相当局限。很多研究成果表明，行为因素对居民商业养老保险决策产生影响。因此，本文延续已有研究成果，进一步讨论行为因素中金融素养及过度自信对于个人商业养老保险投保决策的影响，基于2020中国居民退休准备指数调研数据进行实证分析。研究发现：首先，客观金融素养水平会影响居民的商业养老保险投保意愿。具体而言，金融素养水平越高，越能更好的认识长寿风险、认识养老年金的价值，更好地作出养老安排，从而越可能将购买商业养老保险列入养老计划。其次，过度自信这一认知偏差也显著地影响商业养老保险的投保决策。具体而言：过度自信会使个体对于退休后养老准备情况的盲目乐观，意识不到仅仅依靠社会基本养老保险无法保证退休后生活的保障水平；同时过度自信还会使个体产生自己掌握的金融知识已经足够的错觉，削减了进一步学习金融知识和了解商业养老保险产品的意愿，最终导致投保商业养老保险的意愿下降。

### 6.2 建议

针对本文的研究结论，认为要增加我国的商业养老保险需求，可从以下两方面入手：

第一，从消费者自身角度，加强对于养老金融知识的学习，提高对长寿风险和退休计划的认识。造成过度自信的重要原因在于人们很难想象事情会以什么样的方式进展——由于不能预见事情可能的各种发展方向，人们就会对所知道的事情将来的发展过度自信（Russo&Schoemaker，1996）。因此，消费者应加强对于养老金融知识的学习，充分认识到退休后面临的长寿风险、疾病风险、基本养老金不足等问题，从而消除过度自信的认知偏差，以更全面的信息、无偏的心态进行养老计划准备和商业养老保险决策。

第二，从保险公司角度，加强商业养老保险宣传，同时发展保险咨询服务。金融素养的缺乏，使得居民很难主动购买商业养老保险。因此，应加强对商业养老保险和金融知识的普及宣传，增强个人对长寿风险的认识和对商业养老保险的认知，使其更好地认识到进行资产年金化的必要性。同时，商业养老保险市场方面，应鼓励发展“寿险规划师“”等咨询型保险中介业务和保险服务，为个人提供必要的保险知识和专业的产品建议。

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# 金融素养过度自信对商业养老保险投保决策影响研究

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**关键词:** 商业养老保险;金融素养;过度自信;认知偏差

**中文摘要.** 本文基于 2020 中国居民退休准备指数报告调查数据，以预期回答正确个数及实际回答正确个数衡量公众的主客观金融素养水平，以两者的差值作为金融素养过度自信的衡量指标，以年龄、性别、婚姻状况、抚养孩子数、教育程度、家庭收入作为控制变量，运用 Logit 回归分析金融素养和对自身金融素养过度自信对居民商业养老保险投保决策的影响。研究发现：（1）客观金融素养对商业养老保险投保有显著正向影响。（2）金融素养过度自信对商业养老保险投保有显著负向影响。在实证研究结果的基础上，本文提出了对于消费者和保险公司的建议。

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