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主编：陈秉正
迈克尔·鲍尔斯

EDITOR-IN-CHIEF: CHEN Bingzheng
Michael R.POWERS

主　办：
清华大学经济管理学院中国保险与风险管理研究中心
伦敦城市大学卡斯商学院

ORGANIZERS:
CHINA CENTER FOR INSURANCE AND RISK MANAGEMENT OF TSINGHUA UNIVERSITY SEM
CASS BUSINESS SCHOOL, CITY UNIVERSITY LONDON

共同主办：
西安财经学院经济学院

CO-ORGANIZER:
SCHOOL OF ECONOMICS, XI'AN UNIVERSITY OF FINANCE AND ECONOMICS

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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 7th China International Conference on Insurance and Risk Management (CICIRM 2016), which was held on July 27-30 in Xi'an, 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 School of Economics, Xi'an University of Finance and Economics. This event follows upon the successful meetings held in Xining (July 2010), Beijing (July 2011), Qingdao (July 2012), Kunming (July 2013), Shenzhen (July 2014) and Hangzhou (July 2015) 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 the 91 papers submitted to the conference. We are sincerely grateful to them.

We are pleased to present 56 papers in this Conference Proceedings, covering topics of current importance in insurance, risk management, and actuarial science, and coming from 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 Andreas Richter (Ludwig-Maximilians-Universität München, Germany),Mr.YAO Qinghai (President, Insurance Society of China, China), Professor Patricia H. Born (Florida State University, USA), Miss. Jessie LI (Lead China Representative, Society of Actuaries, USA), 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.





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Chapter 1. Development and Regulation of Insurance Market

Can Insurance Industry in Guangdong Province Promote the Local Economic Development?

-Based on the Empirical Study of Two-Departments Model

LIU Shiqi, HUANG Maohai

LIU Shiqi

School of Finance
Fujian Jiangxia University
Fuzhou, 350108
Phone：18960879979
Email：liuwhu@163.com

HUANG Maohai

School of Finance
Fujian Jiangxia University
Fuzhou, 350108

Key words：Two-sector Model; Unit Root Test; Cointegration Test; Regression Model

Abstract：In order to find out the relationship between the insurance sector and economic development, this paper use Two-sector Model, firstly to check the stability of the data, then carrying on the cointegration test after the result of unstability on data，the long-run stable relationship between the economic development，insurance industry，asset investment and the labour-force is discovered. 1% growth of insurance industry can simulate 1.08% economic development comprehensively as well as producing 0.11% externality on the other sector. Meanwhile，the marginal productive force proves to be 0.149 which is higher than the national number. Insurance industry in Guangdong province should keep the growth while carrying out the structural reform to promote local economic development.

1. 问题的提出

得益于改革开放和 2001 年加入世界贸易组织，我国经济发展取得了长足进步。同时，自从 1980 年恢复运营以来，我国保险行业[①]也经历了三十多年的高速增长。那么，对于经济一直稳居全国前列的广东省来说，保险行业对经济发展是否存在着推动力？程度如何呢？这是一个值得理论界和行业内深入探讨的话题。

2. 相关研究进展

关于保险与经济发展的关系，一直是理论界的热点之一。从国际范围内重视保险在经济中的重要地位和作用，到国内学者致力于研究我国经济、保险相互关系，研究的广度和深度都有很大的进展。早在 1895 年，德国综合保险学派的代表学者如数学家 Boblmann、经济学家 Lexis 和法学家 Ehribeg 就开始了对保险、经济关系的研究。②之后世界贸易与发展组织于 1963 年提出："健全的保险与再保险市场是一个国家经济增长的主要特征"。 1970 年美国保险学界和 1973 年瑞士国际保险经济学研究会积极推动保险的交叉研究。③

从实证模型方面考察，学者们进行了很多积极有益的尝试，并取得了丰硕成果。国际上来看，Ward D, Zurbruegg R （2000）使用 VAR 模型进行了 OECD 各国 35 年的数据进行了研究，发现其中一些国家的确存在保险业对经济的促进作用。④Poposki K（2009）的研究借用了面板数据模型⑤，Arena M（2008）⑥、Han L, Li D, Moshirian（2010）和邵全权（2012）提出了系统广义距方法的研究模型。Pradhan R P, Bahmani S, Kiran M U（2015）利用自回归模型揭示保险和经济的关系。国内研究中，VAR 模型似乎最受学者青睐，钱珍（2008）、孙健, 张春海（2010）、黄英君, 陈晔婷（2012）、潘小军, 蒲成毅（2013）都使用了 VAR 模型进行相关研究。上述研究模型尽管丰富多彩，但从使用频率上看，VAR 模型较受关注，在研究方面较为成熟。在未来的研究中，模型的探索研究应当投入更多关注。

赵尚梅, 李勇, 庞玉锋（2009）将我国的经济部门划分为保险和非保险两个部门，用两部门模型简化了关于保险行业的经济贡献率的分析。借鉴了这一结论，结合地方经济发展的实际情况，杨晓荣（2012）运用两部门模型，发现宁夏地区

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① 本文所研究的保险行业，指的是商业保险。

② 魏华林、林宝清.保险学[M].北京：高等教育出版社，1999：6-38

③ 斯凯博. 国际风险与保险[M].北京：机械工业出版社, 1999：8-126

④ Ward D, Zurbruegg R. Does Insurance Promote Economic Growth? Evidence from Oecd Countries[J]. Journal of Risk & Insurance, 2000, 67(4):489-506.

⑤ Poposki K. Insurance Sector Development and Economic Growth in Transition Countries[J]. International Research Journal of Finance & Economics, 2009.

⑥ Arena M. Does Insurance Market Activity Promote Economic Growth? A Cross-Country Study for Industrialized and Developing Countries[J]. Journal of Risk & Insurance, 2008, 75(4):921-946.

的保险费如果能够增加 1 个百分点，那么，直接或者间接的经济增长贡献将达到 1.022%，⑦同时，保险行业的溢出作用可以得到有效提高。广东省经济发展水平较高，一直居于全国领先地位，广东省的保费收入也领先于全国。尽管如此，目前学者们的研究目光主要还是集中于全国范围，缺乏类似于广东省保险业是否能够促进当地经济增长这样的地方性研究成果。

3. 广东省保险发展对经济影响的实证分析

3.1 模型的选择与建立

本文借鉴赵尚梅, 李勇, 庞玉锋关于保险业对经济增长推动作用的实证分析中所使用的两部门模型，研究广东省保险行业对经济发展是否存在推动作用以及推动作用的大小。

假设经济部门可以分成两大部门：保险部门和非保险部门，同时，由于保险固有的风险分散功能、为经济部门提供损失补偿，故假设保险部门对非保险部门存在着一定的正外部性，亦即溢出。在此假设下，保险部门的生产函数以资本、劳动投入为自变量，以保险部门产出为因变量；非保险部门的生产函数是以产出为因变量，而自变量为资本投入、保险产出和劳动力投入。根据以上假设，可以得到如下函数：

$$F = F\left(L_F \ ， \ K_F\right) \tag{1}$$

$$R = R\left(L_R \ ， \ K_R \ ，\mathrm{F}\right) \tag{2}$$

其中，L，K，F，R 分别代表劳动投入、资本投入，保险部门产出和非保险部门产出，（2）式表示保险部门对非保险部门存在溢出效应，因而进入该部门生产函数。

在假设两个部门存在边际生产力递减的情况下，得到如下条件：

$$\frac{\partial F}{\partial {L_F}^2}<0，\ \frac{\partial F}{\partial {K_F}^2}<0 \tag{3}$$

$$\frac{\partial R}{\partial {L_R}^2}<0，\ \frac{\partial R}{\partial {K_R}^2}<0 \tag{4}$$

因为国民经济中只存在保险和非保险部门，故广东省的经济总产出 Y=F+R，对其进行全微分，并根据公式（1）（2），可以得到：

$$dY = \frac{\partial F}{\partial K_F}dK_F + \frac{\partial F}{\partial L_F}dL_F + \frac{\partial R}{\partial L_R}dL_R + \frac{\partial R}{\partial K_R}dK_R + \frac{\partial R}{\partial F}dF \tag{5}$$

而劳动投入 L 和资本 K 分别可以运用如下公式得到：

⑦ 杨晓荣. 保险业发展与经济增长关系的实证分析[J]. 统计与决策, 2012(1):148.

$$L = L_F + L_R$$

$$K = K_F + K_R$$

应当考虑保险与非保险部门的边际要素生产力之间存在差异的可能性，即保险部门劳动边际生产力$\frac{\partial F}{\partial L_F}$、非保险部门的劳动部门边际生产力$\frac{\partial R}{\partial L_R}$，保险部门资本边际生产力$\frac{\partial F}{\partial K_F}$、非保险部门的资本边际生产力$\frac{\partial R}{\partial K_R}$。根据（3）（4）两个条件，可以得到经济均衡时两部门间的如下关系：

$$\frac{\partial F / \partial L_F}{\partial R / \partial L_R} = \frac{\partial F / \partial K_F}{\partial R / \partial K_R} = 1 + \delta \quad (6)$$

引入δ用以衡量两部门间的边际生产力差异，若δ>0，则认为保险部门的边际生产力超过非保险部门，反之则不及非保险部门。若δ=0，则认为两部门间边际生产力相同。将（5）代入以上公式（6），得到如下公式：

$$dY = \left(\frac{\delta}{1+\delta}\right)\left(\frac{\partial F}{\partial K_F}dK_F + \frac{\partial F}{\partial L_F}dL_F\right) + \frac{\partial R}{\partial L_R}\left(dL_R + dL_F\right) + \frac{\partial R}{\partial K_R}\left(dK_R + dK_F\right) + \frac{\partial R}{\partial F}dF \quad (7)$$

显然，有如下关系：

$$dF = \frac{\partial F}{\partial K_F}dK_F + \frac{\partial F}{\partial L_F}dL_F \quad (8)$$

$$dL = dL_R + dL_F \quad (9)$$

$$dK = dK_R + dK_F \quad (10)$$

将（8）（9）（10）代入公式（7），经过整理得到：

$$dY = \left(\frac{\delta}{1+\delta} + \frac{\partial R}{\partial F}\right)dF + \frac{\partial R}{\partial L_R}dL + \frac{\partial R}{\partial K_R}dK \quad (11)$$

将（11）两边同时除以 Y ，以便于计算，可得：

$$\frac{dY}{Y} = \gamma\frac{F}{Y}\frac{dF}{F} + \alpha\frac{dL}{L} + \beta\frac{dK}{Y} \quad (12)$$

上式中，$\alpha = \frac{\partial R}{\partial L_R}\frac{1}{Y/L}$，代表劳动在非保险部门中的边际生产力与整个经济的单位产出之比，$\beta = \frac{\partial R}{\partial K_R}$表示非保险部门资本边际劳动生产力，$\gamma = \frac{\delta}{1+\delta} + \frac{\partial R}{\partial F}$，

衡量保险部门发展对经济的全部贡献。

为了将保险部门的溢出效应数量化，假设保险部门对非保险部门产出的影响是通过不变弹性实现的，即 $R = F^{\eta}\Phi\left(L_R, \mathrm{K}_R\right)$，其中弹性系数 $\eta = \frac{\partial R}{\partial F}\frac{F}{R}$，代入（12），经过整理得：

$$\frac{dY}{Y} = \left(\frac{\delta}{1+\delta} - \eta\right)\frac{F}{Y}\frac{dF}{F} + \eta\frac{dF}{F} + \alpha\frac{dL}{L} + \beta\frac{dK}{Y} \qquad (13)$$

从（13）可以看出，一国或者一个地区的经济增长，不仅依赖于传统意义上的劳动、资本等生产要素，还受到保险行业的影响。为了满足经典计量经济学模型的假设，公式（12）（13）还应增加常数项 k 和随机误差项 μ_t，得到既能涵盖保险部门对非保险部门溢出影响，又能够反映保险部门的经济增长贡献模型：

$$\frac{dY}{Y} = k + \gamma\frac{F}{Y}\frac{dF}{F} + \alpha\frac{dL}{L} + \beta\frac{dK}{Y} + \mu_t \qquad (模型\ 1)$$

$$\frac{dY}{Y} = k + \left(\frac{\delta}{1+\delta} - \eta\right)\frac{F}{Y}\frac{dF}{F} + \eta\frac{dF}{F} + \alpha\frac{dL}{L} + \beta\frac{dK}{Y} + \mu_t \qquad (模型\ 2)$$

其中，$\alpha = \frac{\partial R}{\partial L_R}\frac{1}{Y/L}$，$\beta = \frac{\partial R}{\partial K_R}$，$\eta = \frac{\partial R}{\partial F}\frac{F}{R}$，$\gamma = \frac{\delta}{1+\delta} + \frac{\partial R}{\partial F}$。

4.模型实证分析

4.1 数据选取及数据来源

1) Y：经济系统总产出。本文中，选取广东省[®]国内生产总值（GDP）作为衡量标准。
2) $\frac{dK}{Y}$：固定资产投资率，用广东省固定资产增量除以广东省 GDP 得到。
3) L：以年度就业人口数作为代表。
4) F：以年度原保险费收入替代，考虑到保费收入代表了保险部门对经济中起到保障作用的大小以及由此产生的溢出影响，保费收入越大，则保险业对经济的溢出作用越大。因此以年度原保费收入作为广东省保险部门总产出。因为数据获取困难，且时间跨度足以说明本文研究的问题，因此，数据样本空间选择为 1995 年到 2015 年。
5) DL 和 DF，DY 分别采用当年度的增加量计算获得。

本文数据为广东省年度数据，取 1995-2015 共计 21 年的数据，数据来源为国家统计局网站，中国保险监督管理委员会网站，各年度《广东省政府工作报告》、

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《广东统计年鉴》、《广东国民经济和社会发展统计公报》和《广东经济》、《广东金融发展报告》、《中国保险年鉴》、《中国管理科学文库 2001》、中华人民共和国保险管理委员会广东监管局网站等。其中，2015 年数据根据《2015 年广东省政府工作报告》整理获得。

4.2 模型实证结果分析

由于以上数据为时间序列，Granger（2001）认为，只有对平稳数据进行的回归分析才有价值，甚至于即使数据平稳也有可能出现伪回归现象。因此应检验序列的平稳性，使用 eviews8.0 软件，利用 ADF 检验以上序列的平稳性，如果数据呈现出平稳的性质，则可以进行后续分析。否则，应当进行差分运算，以消除不稳定性。在数据平稳基础上进行回归分析，避免伪回归的出现，得到接近真实的结果。经过 ADF 检验，发现四个变量都存在单位根，而 dF/F 是平稳的，不符合回归分析的平稳性前提。尽管如此，变量间仍然可能存在长期的均衡或稳定关系。因此为了检验是否存在协整关系，对五个变量进行一阶差分，得到如下结果：

表 1：单位根检验结果

检验变量	t 值	p 值	一阶差分	t 值	p 值
(F/Y)(dF/F)	-2.7786	0.081056	1	-5.08478	0.000829
dL/L	-2.55719	0.1187	1	-4.40502	0.003295
dF/F	-3.82465	0.010143	1	-4.78068	0.002555
dk/Y	-1.572	0.4778	1	-4.36249	0.003312
dy/Y	-2.33946	0.170717	1	-2.33946	0.031776

注：（1）利用 eviews8.0 输出结果

（2）样本区间为 1995-2015 年，数据包含深圳市

经过差分操作，所有变量的 p 值都小于 5%显著性水平，通过 ADF 检验，说明一阶差分后的大部分变量都不存在单位根，即除 dF/F 外其它都是一阶单整的，可以进行进一步的协整检验。另外，五个变量中有四个变量一阶，一个为零阶单整，这样的非平稳序列放在一起进行协整检验，并不会影响协整的效果。⑨因此尽管 dF/F 变量为平稳序列，但仍然可以将该变量纳入到协整检验中。

经典协整检验方法有两种，一种是 Engle-Granger 两步法，适用于两个变量之间的协整关系检验；第二种是 Johansen 检验，适合于检验多个变量间是否存在协整关系。由于有五个变量，采用 Johansen 协整检验，得到结果如下：

⑨ 吕杰主编.计量经济学[M].北京：中国农业大学出版社，2014.06：271

表 2：迹统计量检验结果

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.96837	116.8537	69.81889	0
At most 1 *	0.8993	54.68829	47.85613	0.01
At most 2	0.359331	13.36739	29.79707	0.8741
At most 3	0.219346	5.353042	15.49471	0.7702
At most 4	0.04855	0.895822	3.841466	0.3439

注：（1）由于检验结果较长，限于篇幅，仅列出关键性统计结果。
（2）*代表的是最多存在的协整关系个数，Prob.**表示概率 P 值。

同时，还可以利用数据得到最大特征根检验统计量，经检验，得到与迹统计量相同的结果。统计结果显示，原假设 None 表示的是序列不存在协整关系，其概率值 P 为 0，迹统计量为 116.8537，远大于 5%临界值 69.81889，因此拒绝原假设，可以认为至少存在一个协整关系。对下一个原假设进行检验，直至原假设被接受为止。在检验一个和两个协整关系之后，发现前者概率值 P 为 0.01，原假设仍然被拒绝，表明变量间至少存在一个以上的协整，在第二个协整关系时，原假设被接受，认为五个变量间存在一个协整关系。这说明广东省经济总产出，保费收入、劳动投入和固定资产投入等关系变量间存在长期稳定的关系。

对以上存在的协整关系进行经典最小二乘估计（OLS），经过整理，得到如下回归结果：

表 3：两种模型 OLS 结果

	模型一		模型二	
变量	t 值	系数值	t 值	系数值
dF/F			6.320558	0.117985
C	8.035273	0.116252	0.587163	5.114256
(F/Y)(dF/F)	1.269357	3.857237	2.871271	1.082421
DL/L	3.055766	1.064939	-2.62851	-1.18735
F-statistic	4.065346		F-statistic	2.868989
Prob(F-statistic)	0.025229		Prob(F-statistic)	0.059948

注：C 代表常数项

从 F 值和 P 值来看，模型一和二都能通过方程整体显著性的假设检验，说明回归拟合方程整体上比较显著。从表 2 模型一的结果发现，“保险发展可以促进经济发展”的理论假设得到一定的验证，可以发现，保险行业增长 1%，可以之间或者间接的推动 GDP 增加 3.86%，但这种作用的显著性并不理想，t 值只有 1.27，小于相应临界值。

通过模型二的比较，发现 1%的保险行业增长对经济的综合推动作用为 1.08%，且 t 值为 2.87，效应十分显著。因此采用模型二的解释，是符合经济发

展规律的。同时从表 3 模型二，保险费增长 1%，可以产生 0.11％的溢出效应，能够帮助非保险部门的发展，这也支持了 1％的保险发展对经济的综合推动作用为 1.08％的判断。同时，根据回归的结果和可以算出δ＝0.149，这表明广东省保险部门的边际生产力较高，这与广东省的经济地位和快速发展的经济是相对应的。

通过表 3 模型一和模型二的对比，可以发现广东省保险行业在经济发展中占有重要地位。2015 年，广东省包括深圳市在内保险费收入为 2814.37 亿元，GDP 约为 72800 亿元，保险深度为 3.87％，保险密度为 2594.11 元。⑩比较而言，全国保险密度为 1479 元/人，⑪可见，广东省发达的保险市场为广东省经济发展提供了重要的推动力。

5. 结论与政策建议

从模型结果看，通过实证检验，广东省的经济发展指标，保费收入指标，就业人口以及固定资产投资等指标多数无法通过 ADF 单位根检验，这说明变量序列非平稳，同时经过一阶差分操作之后，发现变量之间存在一个协整关系的协整检验值为 54.68829，大于临界值 47.85613，而二个协整关系的检验值被拒绝，说明了四个变量间存在的长期均衡关系。在 ols 的结果中，发现广东省保险业对经济有倍数推动作用，其数值可以达到 1.08 倍，同时，对其他非保险部门的溢出可以达到 0.11 倍。反映保险行业边际生产力指标的δ值为 0.149，与全国的-0.115⑫比较起来，广东省保险行业的发展以及对经济的贡献仍然是可观的。

在政策含义上，无论是模型一还是模型二，都支持了保险行业对经济增长存在促进作用的假设，同时保险部门的产出会带来实际部门的相应变动。尽管效果并不十分显著，但保险部门的溢出效应是积极正面的。这一方面得益于广东省良好的经济发展，另一方面也有赖于广东保险市场自身良好的发展趋势。自从 1979 年我国保险行业恢复运营以来，中国人保一直居于全国垄断地位，直至 1988 年，平安保险在深圳成立，打破人保公司对我国保险市场的垄断局面，并有力地促进了广东省保险市场的发展。这些因素，都对广东的保费收入以及模型结构产生了不可忽视的影响。但注意到，广东省保险行业对经济的综合影响仅达到 1:1.08 的水平，这也暴露出广东省保险发展存在着水平不充分、推动作用尚待提高的问题，可以在保险政策措施上进行一定程度的放宽，积极鼓励广东省保险企业进行企业结构优化，顺应移动互联网发展趋势，推动移动互联网与保险行业融合发展，更大程度上发挥保险对广东省经济的推动作用。

⑩根据保监会网站、广东省 2015 年国民经济和社会发展统计公报整理得出李忠献.2014 年中国保险业发展的区域性差异分析[N].中国保险报，2015-03-19：第三版
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广东省保险行业能够促进当地经济增长吗？

——基于两部门模型的实证分析

柳仕奇 黄茂海

柳仕奇
讲师
金融学院保险教研室
福建江夏学院
福建省福州市闽侯县上街镇溪源宫路 2 号,350108
手机：18960879979
邮箱：liuwhu@163.com

黄茂海
副教授
福建江夏学院金融学院

关键词：两部门模型；单位根检验；协整检验；回归模型

内容摘要：为考查广东省保险部门增长和经济发展间的关系，本文运用两部门模型，通过单位根检验数据的平稳性之后，发现数据并不平稳之后进行了协整检验，发现广东省保险行业和其它行业间、经济发展间存在着长期的均衡关系。检验发现，1%的保险行业增长，可以对广东省经济产生 1.08%的综合影响，并且对其它经济部门产生 0.11%的溢出效应。同时，保险行业边际生产力指标值为 0.149。广东省保险行业应当在保持增长的同时，进行结构创新，以更好地发挥对广东省经济增长的促进和推动作用。

The Empirical Study on the Relationship between Advertising Expense and Insurance Premium Income ------Take 25 Insurance Companies of China From 2010 to 2015 as the Example

LUO Dongfang, ZHU Yurong

LUO Dongfang*
Postgraduate
School of Insurance
The Central University of Finance and Economics
Beijing 102200，China
Phone：18810481178
Email：leastttkx@163.com

ZHU Yurong
Postgraduate
School of Insurance
The Central University of Finance and Economics
Beijing 102200，China
Phone：18911392349
Email：594089881@qq.com

Key words: insurance companies; advertising expense; premium income; Panel data; regression analysis

Abstract: In recent years, China's insurance industry continues to develop, the premium income continued to grow. However, in the era of big data, if insurance companies continue to focus on the traditional marketing model --- personal agent system，which has suffered a crisis of reliance , no doubt they will face the problem of lack of follow-up, slow efficiency, lack of competitiveness and other issues. Advertisement as a kind of marketing means, compared to the traditional price war or

human wave attacks，it has the advantages of wide coverage, transmission speed, novel formation and so on. If insurance company can give full play to its role in marketing it will undoubtedly inject new competitive advantage for the enterprise. For insurance companies, paying attention to the advertising marketing force will not only enhance the brand trust, more important is to pass the insurance information to consumers in order to stimulate growth in premium income.

Of course with the development of market economy, the importance of information is important day by day, and our insurance companies have gradually found advertising's power, so nowadays insurance advertisement is no longer rare, but the number, quality and innovation degree of our ads are far behind the insurance developed regions. And because the information disclosure system is not perfect in our country, the relevant advertising expense data is only reflected in the report of some insurance companies. Therefore, this article takes 25 insurance companies in our country as an example, analyzes the correlation between advertising investment and premium income, in order to highlight the importance of advertising on premium income, and to remind the insurance companies of paying attention to the insurance ads.

Using panel data relating to the premium income and the expense of advertising from the financial statements of our country's insurance companies from 2010 to 2015, this paper uses regression analysis to study the correlation of insurance companies advertising expenses and premium income, the empirical results show that the positive correlation relation exists between advertising and premium income.

1. Introduction

Nowadays, an increasing number of insurance advertising through a variety of media channels to enter the public view, such as inviting celebrity endorsement of the variety shows in TV advertising,being the title of the variety show high ratings, implanting in high ticket movies, improving the exposure of the public welfare project, spending huge sums of money in prime time broadcast advertising, etc. This phenomenon on the one hand reflects the fierce competition among the insurance companies, on the other hand, shows the impact of advertising on the company's corporate image and product sales. In this paper, we use panel data analysis, try to analyze the advertising behavior of China's insurance industry, focuse on the relationship between the insurance company advertising investment expence and the company's premium income.

2. Research background and significance

The social property of insurance reflects the distribution relationship of mutual aid and cooperation. It not only has the basic function of the risk of dispersion and loss compensation, but also the savings fund and the risk of derivative function. Insurance is playing social stabilizer and social aid role in macro and micro economic activities. Nevertheless, because the conditions for the establishment of insurance is the existence of natural disasters and accidents, and the insurance commodity trading is established on the basis of contract and insurance contract with aleatory, compensatory, conditioned, bilateral and other characteristics, so the insurance products is different from the general consumer goods, sales of insurance products has its own characteristics.

Since the reform and opening up, China's insurance industry has developed rapidly, not only the performance of the national premium income continued to grow rapidly, the number of insurance companies continue to increase, but also the insurance product innovation efforts continue to strengthen. However, from the point of view of insurance coverage, whether it is the depth of insurance or insurance density, China's insurance industry is still in a typical buyer's market state. Underwriting and investment as the insurance company's two main business, the need to premium income as the basis, so how to improve the sales of insurance products and thus increase the premium income has become an important issue. In the era of big data, if we continue to hit the traditional marketing model has suffered a crisis of confidence - personal agent system, will undoubtedly face the problem of insufficient follow-up, slow, lack of competitiveness and other issues. And advertising as a means of non price competition, compared to the traditional price war or tactics of sea of faces with wide coverage and transmission speed, in the form of new advantages, if we can give full play to its role in marketing will form a new competitive advantage for the enterprise. For insurance companies, pay attention to the marketing power of advertising will not only enhance the brand trust, more important is through to

consumers transfer insurance information to stimulate the potential demand increase sales to promote the growth of premium income.

With the strong support for the development of the insurance industry in our country, the competition in the insurance market in the growing, product homogeneity is exacerbated by competition of insurance products, the insurance industry is moving from simple price competition in the transition to product and brand competition. Claims efficiency, service quality, service convenience, and consumer experience and satisfaction of the service are part of the competitive advantage of the insurance company. At the same time, in the process of the development of market economy and science and technology, increasingly rich forms of advertising, advertising turnover rapid growth of advertising because of its contribution to the national economy was included in the first echelon key cultural industry. Although our country's insurance advertisement is in constant development, but it is far behind the developed area in the quantity, quality and innovation of the advertisement. Advertising as an important means of branding and product promotion, research on advertising investment in China's insurance industry has important practical significance. Therefore, the article takes 25 insurance companies in our country as an example, analyzes the correlation between the cost of advertising and the premium income, in order to provide reference for the insurance company advertising investment plan.

3. Research status at home and abroad

In our country, the research on insurance advertising is mainly focused on qualitative research, quantitative research is less, but the research on the performance of advertising investment in other areas outside the insurance is instructive.

Hu Tongyi, Mike Conley (2002) in multi-objective decision making in the advertising budget of an enterprise, analyzes the main factors affecting decision-making enterprise advertising budget products, target market, sales target, competitors, the target quantization model and target combination of comprehensive model is established, the special case is a typical integrated optimization model to clarify the ideas and methods of using goal programming theory to achieve advertising budget of multi-objective decision making, and gives the advertising budget of multi-objective decision making on the computer to achieve design block diagram of the DSS.

Mary (2003) the accession to the WTO, Chinese insurance advertisement effect analysis, analysis of China's accession to the WTO after the insurance advertising trends, to Ping An of China, life insurance, Pacific Insurance company image advertising as an example, the effectiveness of advertising and foreign insurance advertisement to the image of Chinese insurance for comparative analysis, draw some suggestions to our country insurance advertisements.

Wang Yijun (2006) of the insurance market advertising behavior and performance of the empirical analysis, to our country insurance market concentrated degree analysis, based on study the advertising behavior of insurance company, then use SPSS software to the insurance company advertising behavior and market

performance empirical analysis, which uses 2003 insurance industry advertising and premium income data for each month. Finally come to the conclusion that the increase of advertising investment and the increase of premium income have a strong positive relationship.

Du Yi, an empirical study on the Fan Wenying (2009), the Chinese advertising fee and sales relationship, with China in 2002 to 2006 during the corresponding sales and advertising expense of the sample data, using panel co-integration analysis to study the advertising expenses of company sales. The empirical results show that there is a positive correlation between advertising expense and sales.

4. Empirical analysis

4.1 Premise and hypothesis

There are a lot of factors that affect the insurance premium income of the company very much, including fluctuations in the market and economy environment, the price and quality of the policy, the size and quality of the insurance marketing team, services provided by the insurance company, advertising quality and strength,and so on. In the empirical research process we cannot take all factors into account, so before we do the research,we assume that other factors remain unchanged so that we can focus on the analysis of the relevance of the premium income and advertising expense; and then we assume that the insurance company's investment in advertising is successful in a certain sense.

4.2 Introduction to the basic model

In order to study the correlation between the premium income and advertising expense,this paper mainly uses the panel data analysis method of Eviews8.0. Panel data contains three dimensional information which is the time, cross sections, and variables. Using the panel data model, we can construct and test a more realistic behavior equation than using the cross section data or time series data separately, so as to carry out a more in-depth analysis.

4.3 Panel data selection

4.3.1 Time：2010---2015

The time we choose is from 2010 to 2015. The reason of selecting 2010 to 2015 for the time series is that in this period the insurance companies with continuing operation have a more stable business, which make it easy to carry out regression analysis.

4.3.2 Cross section: insurance company

There are 25 insurance companies in China disclosuring the advertising expense from 2010 to 2015 which are chosen as the cross section.Those companies are New China Life Insurance Company Ltd(XH), China Life Insurance Company Ltd(ZG), Union life insurance Limited by Share Ltd（HZ), Kunlun Health Insurance Co., Ltd(KL), Sinatay Life Insurance Co., Ltd(XT), Funde Sino Life Insurance

Co.,Ltd(SM), The Great Wall life insurance Limited by Share Ltd(CC), Ping An Life Insurance Company of China, Ltd(PS, Bohai Property Insurance Co., Ltd(BH), Sinosafe General Insurance Company Limited(AH), Tianan Property Insurance Company Limited Of China(TA), Zheshang Property and Casualty Insurance Company Limited(ZS), Ping An Property & Casualty Insurance Company of China, Ltd(PA), Guang Ming Yong DaLife Insurance Co., Ltd(GD), Heng An Standard Life Insurance Company, Ltd (HA), Huatai Life Insurance Company Limited(HT), Hui Feng Life Insurance Company, Ltd (HF), BoComm Life Insurance Company Limited(JY), Zhao Shang Xin Nuo Life Insurance Company, Ltd(ZS), Sino-US United MetLife Insurance Company Ltd(ZM), Libao Insurance Company, Ltd（LB), Meiya Property Insurance Co., Ltd（MY), Qiubo Insurance Co., Ltd(QB), Samsung Property & Casualty Insurance Company (China), Ltd(SX), Zurich General Insurance Company (China) Limited(SL).

4.3.3 Variable

(1) Premium income

Premium income (including the ceded-out premium): recorded as P?in the EViews operation. The insurance company's business is mainly divided into two plates for underwriting and investment, but due to the investment income mainly depends on the quality of the external economic environment changes and insurance company's investment decisions, advertising plays in business investment is not significant. The underwriting business is designed to sell insurance products, in essence, is a broad sales behavior. And the advertising, as to the role it plays on the insurance marketing, can not only increase product sales, but also can enhance the company's market awareness and improve the corporate reputation and image, even can lead to mass on the cognition of the entire insurance industry. But the most directly effects of the advertising is the embodiment of the premium income growth. Therefore, this paper chooses the index of premium income to measure the effect of advertising investment.

(2) Advertising expense

Advertising expense (including business promotional expence): recorded as A?in the EViews operation. Insurance advertisement has forms of a variety of diversity, including insurance ads on television and in the movies, and other promotional activities. In order to quantify the advertising and promotional spending, we choose the advertising expense as the index of advertising investment size.

(3) The logarithmic form of the original data

The logarithmic form of the original data: LNP ?(that is lnP, the logarithm of the original data of the premium income) and LNA ?(that is lnA, the logarithming of the original data of the advertising expense). The reason of logarithm to the original data mainly lies in the pool unit root test of original data to analyze their stability which found the original variables not in the same order integration, which may lead to spurious regression problem. Therefore, with the logarithm of the original data of the variation we can make it into the same order sequence, and then the regression analysis will be developed directly. In the part of the empirical model will be further

explained.

4.4 Data sources

The original data of panel data are from the annual disclosure report of China's Insurance Companies from2010 to 2015. The collation of the original data is shown in Table 1 and table 2.

Table 1: The insurance premium income of 25 insurance companies in 2010---2015

(unit: RMB million)

IC	2010	2011	2012	2013	2014	2015
XH	91679.00	94797.00	97719.00	103640.00	109868.00	111859.00
ZG	318229.00	318252.00	322742.00	326290.00	331010.00	363971.00
HZ	7026.33	9982.50	8121.49	6925.74	11776.08	12334.85
KL	95.47	83.23	329.48	416.29	89.59	132.62
XT	2090.78	2248.23	2042.49	2862.13	1790.57	1364.52
SM	14527.09	23365.44	24490.26	22242.84	36711.25	78998.27
CC	2262.79	3127.32	2789.61	2672.87	2429.25	2681.38
PS	92645.01	118967.41	128771.17	146090.93	173994.83	208447.63
BH	1188.16	1499.99	1529.32	1805.66	2176.16	2392.26
AH	3990.74	4938.27	5820.36	6690.27	7762.87	8764.68
TA	8027.95	7820.35	8130.06	9957.35	11162.63	12905.91
ZS	2181.22	2551.53	2320.62	3085.20	3293.36	3349.57
PA	62319.15	83435.36	98816.07	115411.77	142879.48	163687.63
GD	3,941.85	3,585.41	3,931.25	3,019.25	2,385.11	3,121.54
HA	680.31	1026.79	1468.58	1179.90	1211.97	1356.86
HT	5,133.22	3,042.51	2,856.86	2,891.87	2,523.94	2,782.94
HF	118.35	297.39	528.77	759.38	775.09	852.13
JY	712.87	465.73	721.03	1,344.03	2,640.06	4,072.04
ZS	2,647.63	1,926.70	2,421.54	4,240.27	5,304.54	7,847.15
ZM	718.04	3,175.04	4,661.62	5,670.06	6,752.85	7,543.77
LB	381.54	517.42	715.57	847.01	818.14	888.68
MY	1120.69	1173.23	1237.73	1297.90	1358.08	1682.50
QB	162.63	205.90	203.16	163.26	205.37	222.24
SX	406.15	489.36	142.87	195.56	868.36	977.00
SL	203.48	312.28	418.38	495.82	513.62	624.85

Table 2:Advertising expences of insurance company in 2010---2015

(unit: RMB million)

IC	2010	2011	2012	2013	2014	2015
XH	116.00	185.00	118.00	115.00	116.00	98.00
ZG	1357.00	1405.00	511.00	357.00	393.00	382.00
HZ	49.80	45.73	32.09	44.23	52.41	50.32
KL	0.51	4.55	1.69	3.11	0.33	1.23
XT	3.51	5.70	6.80	16.12	8.16	11.38
SM	48.98	129.01	143.21	156.94	125.01	224.97
CC	9.14	7.26	6.41	4.26	4.70	5.70
PS	1269.49	1939.07	2951.49	3379.00	4603.82	5504.25
BH	14.05	11.46	9.04	3.79	7.81	12.81
AH	13.32	16.07	18.03	27.99	62.51	74.53
TA	12.86	8.19	19.95	41.34	43.93	111.45
ZS	10.95	17.10	30.14	50.50	57.11	62.42
PA	853.94	1385.93	2264.90	2669.41	3780.52	4322.32
GD	23.65	20.00	27.74	12.41	13.03	8.75
HA	1.67	1.33	3.06	1.45	2.55	0.55
HT	12.51	10.03	7.52	5.90	6.45	10.74
HF	3.95	3.69	1.87	0.50	0.26	0.48
JY	0.82	1.12	3.20	5.05	15.08	35.80
ZS	46.27	41.28	40.02	41.25	79.50	118.09
ZM	15.41	32.27	21.19	22.47	16.54	15.00
LB	8.48	19.03	7.52	2.96	4.80	3.26
MY	21.20	18.87	10.31	34.19	26.88	44.87
QB	0.24	0.55	0.44	0.19	0.09	0.06
SX	0.54	0.54	1.00	32.05	27.18	30.32
SL	0.25	0.60	0.48	0.34	2.69	0.58

4.5 Empirical model

4.5.1 Processing of data

In the Eviews software, the original data is processed by data processing, and the 3D data is converted to two-dimensional data. Data is displayed from the top to bottom, according to the time sequence of 2010 to 2015, and each column represents a variable.

4.5.2 Pool unit root test

At first, the original panel data are tested by pool unit root test. The premium income (P?) sequence still exists the unit root after two order difference (the results of Fisher - Chi-square ADF method test rejects the original hypothesis, and the original hypothesis is that there is a unit root).As shown in Figure 1.

Pool unit root test: Summary
Series: PXH, PZR, PHZ, PKL, PXT, PSM, PCC, PPR, PBH, PAH, PTA, PZS, PPC, PGM, PHA, PHT, PHF, PJY, PZM, PLB, PMY, PQB, PSX, PSL
Date: 05/31/16 Time: 13:15
Sample: 2010 2015
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-12.1779	0.0000	24	72
Null: Unit root (assumes individual unit root process)				
ADF - Fisher Chi-square	64.2732	0.0582	24	72
PP - Fisher Chi-square	81.5908	0.0018	24	72

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Figure 1：Pool Unit Root Test on D（P?,2)

Advertising expense (A?) becomes stable after the first order difference of pool unit root test, as shown in figure 2.

Pool unit root test: Summary
Series: AXH, AZR, AHZ, AKL, AXT, ASM, ACC, APR, ABH, AAH, ATA, AZS, APC, AGM, AHA, AHT, AHF, AJY, AZM, ALB, AMY, AQB, ASX, ASL
Date: 05/31/16 Time: 11:46
Sample: 2010 2015
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-26.0983	0.0000	24	96
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-8.43106	0.0000	24	96
ADF - Fisher Chi-square	110.676	0.0000	24	96
PP - Fisher Chi-square	113.945	0.0000	24	96

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Figure 2：Pool Unit Root Test on D（A?)

So the variable sequence are not in the same order integration, that is, the premium income variable (P?) sequence is not stable, and the advertisement expense variable (A?) sequence is stable. At this point, the co-integration test can not be carried out ,and the regression analysis of the original sequence can not be directly carried out too. In this case, by take the logarithm of the original data, the original

sequences are taken to get the new variables, which are LNP? and LNA? ,and then pool unit root test was carried out to the new sequences .The results are shown in Figure 3 and figure 4.

Pool unit root test: Summary
Series: LNPXH, LNPZR, LNPHZ, LNPKL, LNPXT, LNPSM, LNPCC, LNPPR, LNPBH, LNPAH, LNPTA, LNPZS, LNPPC, LNPGM, LNPHA, LNPHT, LNPHF, LNPJY, LNPZM, LNPLB, LNPMY, LNPQB, LNPSX, LNPSL
Date: 05/31/16 Time: 13:33
Sample: 2010 2015
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-37.6950	0.0000	24	96
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.82637	0.0000	24	96
ADF - Fisher Chi-square	90.2256	0.0002	24	96
PP - Fisher Chi-square	111.821	0.0000	24	96

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Figure 3：Pool Unit Root Test on D（LNP?）

Pool unit root test: Summary
Series: LNPXH, LNPZR, LNPHZ, LNPKL, LNPXT, LNPSM, LNPCC, LNPPR, LNPBH, LNPAH, LNPTA, LNPZS, LNPPC, LNPGM, LNPHA, LNPHT, LNPHF, LNPJY, LNPZM, LNPLB, LNPMY, LNPQB, LNPSX, LNPSL
Date: 05/31/16 Time: 13:36
Sample: 2010 2015
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-37.6950	0.0000	24	96
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.82637	0.0000	24	96
ADF - Fisher Chi-square	90.2256	0.0002	24	96
PP - Fisher Chi-square	111.821	0.0000	24	96

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Figure 4：Pool Unit Root Test on D（LNA?）

In combination with figure 3, figure4, which shows that LNP? And LNA sequences are all first-order single integer, that is, after processing the sequences according to the logarithm of the original data, the new sequences are all smooth sequences. So we can directly analyze the new data by regression analysis.

4.5.3 Regression analysis

Through the logarithm of the original data, the new sequences，LNP? And LNA？Have a long-term stable relationship.In order to determine the degree of influence, this paper constructs the mode in which the LNA? Is the independent variable,and the LNP? Is the dependent variable.

(1) Determination on the impact of the form

Firstly，we establish a random effects modelon the bases of the processed data (LNP? and LNA?) , then we use the Hausman test to verify whether it is a random effects model. The test results as shown in Figure 5 is to reject the original hypothesis (the original hypothesis is: should establish the random utility model), so the panel data of regression analysis should use a fixed effects model.

Correlated Random Effects - Hausman Test
Pool: POOL01
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	54.117855	1	0.0000

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
LNA?	0.176975	0.380702	0.000767	0.0000

Figure 5：Hausman Test

(2) Determination on the model form

Because Premium income and advertising expense in different companies are different.We use the F test to select the individual fixed effects regression model for regression analysis on the data.And also due to the number of cross section (25) is greater than the sequential number(2), so we add the section weighted estimation method (cross section weights) in the regression analysis.

(3) Regression analysis and result

The regression results are shown in Figure 6.

Dependent Variable: LNP?
Method: Pooled EGLS (Cross-section weights)
Date: 05/31/16 Time: 16:06
Sample: 2010 2015
Included observations: 6
Cross-sections included: 25
Total pool (balanced) observations: 150
Linear estimation after one-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.630895	0.068643	111.1671	0.0000
LNA?	0.198749	0.023678	8.393779	0.0000
Fixed Effects (Cross)				
XH--C	2.940796			
ZR--C	3.799802			
HZ--C	0.729089			
KL--C	-2.652567			
XT--C	-0.427130			
SM--C	1.665592			
CC--C	-0.107266			
PR--C	2.632279			
BH--C	-0.620494			
AH--C	0.423662			
TA--C	0.869338			
ZS--C	-0.240614			
PC--C	2.405906			
GM--C	-0.089186			
HA--C	-0.695295			
HT--C	-0.014318			
HF--C	-1.520198			
JY--C	-0.814354			
ZS--C	-0.240614			
ZM--C	0.022535			
LB--C	-1.492404			
MY--C	-1.088579			
QB--C	-2.047420			
SX--C	-1.912523			
SL--C	-1.526035			

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.991830	Mean dependent var	16.88531
Adjusted R-squared	0.990183	S.D. dependent var	14.17671
S.E. of regression	0.430168	Sum squared resid	22.94552
F-statistic	602.1665	Durbin-Watson stat	1.104380
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.963861	Mean dependent var	8.193651
Sum squared resid	23.13919	Durbin-Watson stat	0.962906

Figure 6: The regression results

The results of the regression results can be concluded into mathematical formula as follows:

$$LNP_{it} = 7.63 + 0.20LNA_{it} + 2.94D_1 + 3.80D_2 + \cdots\cdots - 1.53D_{25}$$

(0.07) (0.24) R^2=0.99 $SSE_R = 22.95$

The definition of virtual variables D_i is:

$$D_i = \begin{cases} 1, \text{ If i belongs to the i individual , i=1,2.....25} \\ 0, \text{ other} \end{cases}$$

5. Summary and analysis of empirical results

Through an empirical study, the following conclusions can be concluded:

Regression results show the positive correlation between the two variables，and advertising expense of insurance companies have a significant impact on the growth of premium income. Seen from the Figure 6 ,the logarithm of advertising expense will affect the logarithm of insurance company's premium income to the degree of 0.198749.Namely, when the other conditions remain unchanged, the marginal premium income elasticity of advertising expense is $\ell^{0.198749}$,that is, each newly added million advertising expense will lead the average increment about 1.219876 million to the premium income from the model. This also explains the reasons why insurance companies have to attach much weight to the advertising.

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广告费用与保险保费收入相关性的实证研究
——以 2010-2015 年我国 25 家保险公司为例

骆东方 朱昱荣

骆东方*
研究生
中央财经大学保险学院
北京 102200，中国
电话：18810481178
Email：leastttkx@163.com

朱昱荣
研究生
中央财经大学保险学院
北京 102200，中国
电话：18911392349
Email：594089881@qq.com

关键词：保险公司；广告费用；保费收入；面板数据；回归分析

摘要： 近年来，我国保险业不断发展，保费收入持续增长。但在大数据时代下，若继续主打已经遭遇信任危机的传统营销模式---个人代理制度，无疑会面临后续力不足、见效慢、缺乏竞争力等问题。而广告作为一种营销手段，相比传统价格战或者人海战术具有覆盖面广、传递速度快、形式新颖等优点，若能在市场营销中充分发挥其作用，无疑会为企业注入新的竞争优势。对保险公司来说，注重广告的营销力量不仅会提升品牌信赖度，更为重要的是能通过向消费者传递保险信息以刺激保费收入的增长。

当然随着市场经济的发展，信息的重要性日益体现，我国的保险公司已经逐渐发现广告的力量，保险广告也不再是凤毛麟角，但从广告数量、质量以及创新度来说都远远落后于保险发达地区。并且，由于信息披露制度的不完善，相关广告费用的数据也仅在少数保险公司的报表中体现。因此文章以我国 25 家保险公

司为例，分析广告费用与保费收入之间的相关性，以凸显广告对保费收入的重要性，期引起保险公司的重视。

本文利用 2010 年至 2015 年期间我国 25 家保险公司相应的保费收入和广告费用的样本数据，运用面板数据分析方法来研究保险公司广告投入费用与保费收入的相关性，实证的结果表明了广告费用与保费收入之间存在正相关的关系。

Corn Drought Index Insurance Purchase Intention Based on the Empirical Analysis of Liaoning Province

JIANG Yinghong

Graduate Student
School of Insurance
Central University of Finance and Economics
Beijing 102206, China
Phone: 15600918259
Email: 15600918259@163.com

Keywords: Insurance innovation; Corn drought index insurance; Purchase intention; Logistic model empirical analysis

Abstract.: Agriculture is of vital significance for China's economic, politics, social development and civilization progress. Under the commodity economy, as the fundamental of other industries, its own vulnerability and the fluctuation in production bring huge risks to the security and stability in reproduction. As the world entered the stage of accelerated industrialization and post-industrial age, the contradiction between environmental problems and economic development becomes increasingly sharp. Since the reform and the opening-up, the party and the government turned its focus to economic construction, making "three rural problems" as a task of top priority. As a risk management tool, agricultural insurance can effectively manage and control various risks occurred in agricultural production, therefore been widely used in the risk management of agricultural production in not only China but also around the world. However, over the years, many problems have exposed in the practice of agricultural insurance, such as market failures, adverse selection, difficulties in claim and huge operating pressure, making it less effective as a risk management tool.

According to international experience, as a new type of agriculture insurance, weather index insurance can improve the objectivity and scientificity in the process of agricultural insurance claims, effectively reducing the market failure and adverse selection problem. As a result, this insurance product has been widely used around the world, especially in some developing countries, in recent years. China also have established various weather index insurance pilots and achieved success on the whole. But there still exists some problems. As one of China's main production areas of high-quality corn, the stability and safety of corn production in Liaoning is high related to the sustainable development of numbers industries of China. However, Liaoning province, in the meantime, is also one of the areas with high drought risks, whose outbreak frequency and intensity surpassing the vast majority areas in China. At the same time, since the operation of agricultural insurance in Liaoning province, more and more problems come to surface. Therefore, the exploitation of corn drought index insurance, which can manage the drought risk effectively in corn production as well as been widely accepted by insurance companies and farmers, bring positive effects for sustained and healthy development in Liaoning province economy and the stability of farmers' production and living.

Exploiting new insurance products demand not only design efforts but also loading attention to farmers' actual insurance demand and influence factors. Therefore, from the perspective of farmers' actual insured will, the author carries out empirical research about famers' purchase intention for the new agriculture insurance on the basis of field research to farmers in Liaoning, figuring out farmerreal cognitive situation and demands about the corn drought index and drought risk insurance, which helps to understand the main factor affecting the purchasing intention and put forward the corresponding countermeasures and suggestions for Liaoning government when carrying out the policy in the future.

1. 研究背景与意义

1.1 选题背景

随着世界进入加速工业化阶段与后工业化阶段，环境问题与经济发展之间的矛盾日益尖锐，频频发生的恶劣天气给我国的农民生产生活与粮食安全带来了巨大威胁。辽宁省是我国主要的粮食产区及最大的玉米产区，其生产的稳定性关系到我省整体的经济稳定，关系到全国的粮食安全与多条产业链的生产经营。然而，辽宁省以旱灾为首的灾害爆发频率与严重性却不容乐观。2014 年辽宁省遭遇了 63 年一遇的严重干旱，据不完全统计，全省总面积 6275 万亩农作物中受灾面积 2927.5 万亩，干枯和重旱面积 1870.5 万亩，其中干枯面积 707 万亩。全省粮食因灾减产 100 亿斤左右。本次旱灾中，由政府牵头开辟理赔绿色通道，各大保险公司累计赔付 9.3 亿元，使受灾地区的生产得以恢复，群众的生计总体上得以保障。可以看出，农业保险对于辽宁省而言在保障受灾农民的利益、维护社会上稳定起着举足轻重的作用。

1.2 研究意义

“气候知识服务气候行动”是 2015 年世界气象日的主题，它与中国此前“新国十条”所要求的从开发天气指数保险角度实现农业保险多样化的发展不谋而合。从 2004 年开始至今，中央一号文件和政府工作报告连续 11 年提到要加快发展农业保险，保障粮食安全，促进社会主义新农村建设。对于辽宁省而言，新常态下的保险创新，一方面转变农业保险经营模式刻不容缓。根据国外发展中国家的成功经验，天气指数保险的推广与实施，在成功控制承保风险的同时，还能大大降低保险公司的经营成本，从而促进农业保险经营效率的提高，并有效地弱化市场失灵问题。①另一个非常重要的方面是，农民对风险抱有的侥幸心理、对保险风险分散机制了解的缺乏，导致其自身投保积极性始终不强，最后损失惨重。近年来的国际实践经验表明，以天气指数保险为代表的农业保险创新，不单单需要宏观上政府与保险公司在资金、技术上的努力，更大程度上是需要在微观上挖掘农民投保需求的影响因素。因此，本文将对影响辽宁省农民购买玉米干旱指数保险意愿的因素进行研究，探索农民对干旱风险与干旱指数保险的理解，进而寻找影响其购买需求的最重要的因素，同时提出相应对策与建议。

1.3 天气指数保险的概念与优势

天气指数保险是针对特定农作物、特定的区域设计的，以气象站提供的天气变量为依据，以保险合同规定的天气事件为赔付条件，不与农民的实际生产与损失直接挂钩的农业保险。②与传统农业保险相比，天气指数保有着独特优势：

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①魏华林.天气指数保险与农业保险可持续发展[J].财贸经济,2010,(3):5-11

②吴珊.天气指数保险及其定价研究[D].西南财经大学硕士学位论文.2014,4:1-75

1.对保险人而言：首先，天气指数保险理赔的依据是由气象站客观观测的数据，天气指数保险使保险公司理赔更加便捷，承保成本得以降低。其次，现行的农业保险中普遍存在的道德风险与逆选择问题，将在天气指数保险中实现有效地弱化。第三，天气指数保险在费率上的科学厘定、在灾害区域和级别上的细致划分，以及在数据采集、观测上的客观公正无不体现着科学性与合理性。

2.对投保人而言：首先，天气指数保险通常与农业信贷产品绑定，使其能够提升对目标客户的吸引力，并且能有效地增强农业供应链的稳定性。其次，天气指数保险保单设计较为客观与科学，因此保单条款一般通俗易懂，且同种保单与相同的气象站相关，保险产品的价格也相同③。

2. 国内外干旱指数保险试点的经验比较与启示

2.1 国外干旱指数保险试点的经验与比较

天气指数保险推广最成功的当属印度、马拉维、埃塞俄比亚和墨西哥四国。从应用层面上看，以这四个国家为典型的干旱指数保险可以分成两大类：

1.基于微观家庭层面的印度、马拉维型干旱指数保险：微观家庭层面的干旱指数保险的投保人大多是信贷评级较低、融资困难的农户。印度在推广干旱指数保险时使用的银保互动模式，将农业保险与农业信贷绑定，在保障农民生产的同时促进了农业金融服务，并降低了总的经营、成本；更重要的一点，在发展基础硬件支持的同时，印度始终以农户的需求作为第一要务，简化保单设计，从而获取了更大的市场，这些思路非常值得我们学习与借鉴。

2.基于宏观国家层面的墨西哥、埃塞俄比亚型干旱指数保险：宏观国家层面的干旱指数保险主要是为分散当地农户所遭受的十分严重的旱灾风险而产生的。这个层面上的干旱指数保险通常由政府建立灾害救济计划，风险则通常向国际再保险市场转移。墨西哥的干旱指数保险主要用来为灾后重建基金——FONED 计划充当“最后保险人”作用，从而对灾后重建计划的偿付能力与可持续性进行更直接、更迅速地保障。

2.2 我国干旱指数保险试点的运行与反思

2008 年国元农险在我国安徽省进行了天气指数保险产品的研发工作，在安徽省长丰县进行了水稻干旱高温指数保险的试点。在此次试点中，共签订 1270.78 亩水稻种植天气指数保险合同，累计参保农户 482 户，保险金额 381234 元④。具体合同如下表：

③黄亚林.干旱地区天气指数农业保险的国际借鉴.[J].农业经济,2012,(12):60-62
④于宁宁.农业气象指数保险研究[D].山东农业大学硕士学位论文.2011,5:1-71

表 1 长丰县水稻干旱高温指数保险合同[5]

纯风险保费		4.0%	保险价值		300'/亩
天气指数	触发值	退出值	最大赔付	指数风险发生概率	赔付标准
高温(℃) (July30 th－Aug15 th)	8	20	240	80%	20('/℃)
干旱 I(mm) (May15 th－Aug31 st)	230	100	150	50%	1.2('/mm)
干旱 II(mm) (Sep1 st－Oct15 th)	15	0	100	33%	6.7('/mm)

国元农险在安徽几个试点的干旱指数保险领域尽管取得了成绩，但在实际运行中存在的问题值得我们反思：

1.政府对干旱指数保险的财政支持还不到位。由于干旱指数保险未正式划分进政策性农业保险范畴，而农民在总保费中所负担的比例较低，剩余全部由保险公司自行承担，导致保险公司背负了巨大的承保压力，公司经营积极性下降，保险经营、理赔质量必然随之下降，最终将导致农民购买保险的意愿降低。

2.干旱指数保险的设计仍需完善。一方面，在费率厘定上要兼顾可购性与盈利性，因为农民整体文化水平较低，对保险合同具体内涵不甚了解，其购买意愿往往在保费较低时能得以提升。另一方面，上述保险公司为提高盈利水平，将干旱指数保险的赔付线设置得过高，导致长期以来很少出现赔付的案例，这将在很大程度上破坏农民的投保的积极性。

3.干旱指数保险的销售渠道过于狭隘。以安徽省为例，干旱指数保险的销售仍主要以村委会集体购买为主，虽然减少了交易成本，但这种单一集中的购销方式会对干旱指数保险的全面推广造成阻碍。

4.干旱指数保险相应的技术支持与科普仍存在欠缺。一方面，这两个保险在实施过程中均遇到了目标区域内有效气象站数量不足的问题，技术支持上的缺位最终会导致理赔上的障碍。另一方面，农民购买干旱指数保险后仍然对自己手中的保险产品一知半解，缺乏对产品设计原理的认知，这也将导致其需求不足，购买意愿难以提升。

3. 辽宁省玉米干旱风险的评估

3.1 辽宁省玉米产业地位及干旱风险评估

辽宁省是我国最优质玉米的产区之一，玉米产业发展迅速，但干旱问题始终困扰着政府与农民，辽宁的中西部地区历来更是有“十年九旱”之说。国内曾有研究表明，按照脆弱性、危险性、暴露性及防旱抗旱能力这四大因子可以把辽宁省的玉米干旱灾害风险在空间上划分为四级区域：

[5]陈盛伟.农业气象指数保险在发展中国家的应用及在我国的探索[J].保险研究,2010,(3):82-88



图 1 辽宁省玉米干旱灾害风险分区[⑥]

从图 1 中可以看出，辽宁省玉米旱灾风险从空间上呈现由东向西增强的趋势，干旱风险较严重的区域集中在辽西、北部的朝阳市、阜新市铁岭市、沈阳市、锦州市，那么这几个地区的农民对干旱指数保险的购买意愿极有可能非常大；而东南部的丹东市、葫芦岛市、营口市等旱灾风险较低，相应地该区域内的农民对干旱指数保险的需求可能相对较低。

3.2 辽宁省传统农险对旱灾管理的欠缺性分析

自 2008 年辽宁省农业保险正式试点以来，业务规模、保费规模迅速增长，合规合法程度不断提高，并逐步实现了由粗放型向精细型经营的转变⑦，但是针对旱灾，现行的农业保险还存在着诸多问题和不足：

1.政府补贴方面:首先，辽宁省频发的旱灾给各级政府，尤其是欠发达地区的政府带来了巨大的财政压力，一旦赔付不及时就会造成农户对政府的管理产生质疑，从而拒绝续保或不再进行农险的购买。其次，政府以财政作支撑承担损失，将会导致道德风险，农民长期有政府的补贴作保障，自己将不再对自己的玉米等作物进行有效、合理的旱灾风险防范，这会产生巨大的管理成本。

2.保险公司经营方面：辽宁省当前应对旱灾的方式是通过保险公司建立风险准备进行风险的分摊。一方面，旱灾成灾率高、农作物生长周期长、灾后勘察难度大，使保险公司承担了巨大的经营成本和管理成本，从而承保的积极性低下、保险产品供给不足、创新乏力，进而农民投保的有效需求不足。另一方面，辽宁省的保险公司在旱灾巨灾风险的分散方面经验不足，渠道不多，再保险市场分保成本高，这些经营压力与经营风险都形成了其良性发展的阻碍。最后，保险公司

⑥刘琳, 徐宗学等. 辽宁省农业干旱灾害风险评价及分区[J]. 水电能源科学, 2013, (1):1-4
⑦王志刚.辽宁省农业保险的现状特点、现存问题及其未来机遇[J].农业展望.2012,(11):22-25

作为理性的经济体，自然就会以较低的赔付标准和较高的理赔条件将一部分成本转嫁给农民，这就造成了费率制定的不合理，保险公司承保积极性下降的同时挫伤了农民投保的积极性。

4. 影响农民玉米干旱指数保险购买意愿因素的实证分析

4.1 模型建立

本文研究的样本数据来自辽宁省玉米干旱风险分区中的中、高风险区：阜新市、朝阳市、沈阳市和铁岭市辖区内的共 9 个村庄，每村随机调查 30 户，累计发放问卷 270 份，经过初步筛查，得到有效问卷 225 份。其中，92 名被调查农民表现出了显著的购买意愿，剩余 133 名处于观望态度或没有购买意愿。

选取的变量有：购买意愿（Y）农民的基本信息（性别（X1）、年龄（X2）、文化程度(X3)）、家庭经济状况（家庭年收入(X4)、是否务工(X5)）、玉米生产特征（玉米种植面积(X6)、受灾频率(X7)）、农业保险相关问题（对农业保险的态度(X8)、对政府补贴的态度(X9)）及对干旱指数保险的认知情况(X10)。

农民是否愿意购买玉米干旱指数保险，最终选择的结果只有两种：愿意购买或不愿意购买。因此，以购买意愿作为被解释变量，其是一个二分变量，将“愿意购买定义为 y=1，“不愿意购买”定义为 y=0，则概率分布为：

$$Y=\begin{cases} p & y=1 \\ 1-p & y=0 \end{cases}$$

对于二分变量的显著性分析，通常构建 Logistic 模型进行回归分析，其形式如下：

$$Y=B_0+B_1X_1+B_2X_2+B_3X_3+...+B_{11}X_{11}+u$$ ，其中 u 为随机扰动项。

下面对选取的 10 个解释变量进行赋值：

表 2.解释变量明细表

变量名称	变量赋值	影响方向预判
性别（X_1）	男=1，女=0	负相关
年龄（X_2）	30 以下=1,30-45=2, 45-60=3,60 以上=4	待定
文化教育水平(X_3)	小学=1，初中=2， 高中或中专=3，本科或大专=4	正相关
家庭年收入(X_4)	2 万以下=1,2-4 万=2, 4-6 万=3,6 万=4	待定

务农收入比重(X_5)	20%以下=1,20%-50%=2, 50%-80%=3，80%以上=4	正相关
玉米种植面积(X_6)	10 亩以下=1,10-20 亩=2, 20 亩以上=3	正相关
玉米遭受旱灾频率(X_7)	从不=1，偶尔=2，经常=3	正相关
对农业保险态度(X_8)	不重要=1，不太重要=2， 重要=3，很重要=4	正相关
对政府补贴的认识(X_9)	不重要=1，不太重要=2， 重要=3，很重要=4	待定
对玉米干旱指数保险的认知(X_{10})	从未听说=1，不太了解=2， 比较了解=3，很了解=4	正相关

4.2 Logistic 计量模型结果与分析

4.2.1 回归结果分析

利用 SPSS 16.0 对上述调查数据进行回归分析，回归结果如下：

表 3 Logistic 模型回归结果

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	X1	4.133	.706	34.292	1	.000	62.355
	X2	-.983	.444	4.907	1	.027	.374
	X3	.659	.556	1.406	1	.236	1.933
	X4	.146	.454	.104	1	.747	1.158
	X5	2.093	.361	33.593	1	.000	8.111
	X6	-.006	.461	.000	1	.989	.994
	X7	.676	.421	2.581	1	.108	1.965
	X8	-.403	.364	1.227	1	.268	.668
	X9	1.123	.307	13.347	1	.000	3.075
	X10	.919	.461	3.986	1	.046	2.508
	Constant	-12.486	3.811	10.732	1	.001	.000

表 3 显示，模型整体统计显著性为“极显著”（Sig<0.01），拟合优度较高，具备统计学意义。其中性别（X1）、务农收入比重（X5）的显著性分析为“极显著”（Sig<0.01），年龄（X2）、对政府补贴的认识（X9）、对玉米干旱指数保险的认知度（X10）的显著性分析为“显著”（Sig<0.05）。并且，年龄（X2）的系数为-0.983，说明其对购买意愿有负面影响。因此，根据系数(B)，可以得出回归方程：

$$Y=-12.486+4.133X_1-0.983X_2+2.093X_5+1.123X_9+0.919X_{10}$$

表 4 Logistic 模型最终拟合优度检验

Classification Table[a]

Observed			Predicted		
			Y		
			0	1	Percentage Correct
Step 1	Y	0	115	18	86.5
		1	18	74	80.4
	Overall Percentage				84.0

a. The cut value is .500

表 4 显示，选择“不愿意购买”的农民被正确地预测，正确率为 86.5%；选择“愿意购买”的农民被正确预测，正确率为 80.4%，总的判断正确率为 84.0%。

综上所述，本次 Logistic 模型拟合优度较高，得到的回归方程可以在现实中应用。

4.2.2 显著性因素分析

①性别：结果显示，性别的系数为 4.133，对玉米干旱指数保险的购买意愿有正相关的影响作用，男性总体购买意愿要高于女性。

②年龄：年龄的系数为-0.983，对于玉米干旱指数保险的购买具有负相关影响作用，说明随农民的年龄增长，购买意愿将呈总体下降趋势。原因一方面来自于年轻人对于新事物的接受能力更强，另一方面则是因为年轻人相对财富积累不足，对于风险的抵御能力更差，因此对干旱指数保险的需求更大。

③务农收入比重：务农收入比重的系数为 2.093，说明其对农民的购买意愿起着正相关的作用。务农收入占比重越大，说明其对玉米旱灾的承受的风险越高，购买干旱指数保险的需求就越强。而家庭年收入未呈现显著性的原因也恰恰是由于年收入高的未必务农收入比重高，年收入低的很可能务农收入比重很高。

④对政府补贴的认识：系数为 1.123，说明越认为政府补贴重要的农民，其购买意愿越强。一方面，更依赖政府补贴的农民其收入普遍不是很高，有补贴的保费对其更有吸引力；另一方面，认为政府补贴不重要的农民，原因主要是政府补贴程度还很低，对于相对较高的保费政府补贴作用微乎其微，因此购买意愿较低。

⑤对玉米干旱指数保险的认知度：系数为 0.919，越了解此产品的农民购买意愿越强。农民的认知度上一定程度上还是受到文化教育水平的影响的。但此次分析中，文化教育水平这一因素的显著性水平为 0.236，在 0.05 的显著性水平上不显著，原因一方面是文化教育水平较低的农民，其在长期农业实践过程中可能形成了自己的一套比较可靠的认知体系或经验，因此有着自己总结的风险抵御方式；另一方面，文化教育水平较高的农民，很可能走出玉米耕作甚至走出农业生产从事其他行业工作，因此干旱风险对其影响并不是很大。

⑥受灾频率、玉米种植面积以及对农业保险的态度这几个因素在本次分析在0.05显著性水平上没有显著性，对玉米干旱指数保险的购买意愿没有明显影响，故在此不再赘述。

5. 研究结论与对策建议

5.1 研究结论

本文通过对辽宁省玉米干旱风险分区中的中、高风险区内的 9 个村庄 225 份调查问卷的分析发现，133 名被调查农民没有玉米干旱指数保险的购买意愿，占样本总数的 59.1%，总体购买意愿不强。通过 SPSS 软件进行 Logistic 回归分析，得出农民对玉米干旱指数保险的购买意愿主要受性别、年龄、务农收入比重、政府补贴作用以及对玉米干旱指数保险认知程度几个因素的影响。从整体上看，辽宁省农民对于这一新兴产品的购买意愿不强的原因主要在于：

1. 农民观念依旧保守，保险保障功能宣传不到位。一方面，新型玉米干旱指数保险试点在全国范围内早已开始运行，辽宁省农民对其认知度的低下显现出对此新产品宣传的不到位；另一方面，对农业保险的态度、以及商业保险购买人数较少，体现了农民整体对保险这一风险管理工具的认可度和功能的认知度不高，农民固有的“靠天吃饭”的小农观念依然很强，说明基层政府、保险公司对保险保障功能宣传的缺位。只有让农民真正了解保险的功能，才能更好地引导农民的购买需求。

2. 政府补贴与管理水平不足。一方面政府在现行的政策性农业保险中支持不到位，保费补贴形同虚设，没有根本性作用；另一方面，政府在现行的农业保险中没有很好的起到“最后保险人”的作用，对保险公司查勘、理赔的效率与保险金额赔付的管理不强，打击了农民购买保险的积极性，这将影响到玉米干旱指数保险的推广。

3. 现行保险费率设计不够科学，商业保险公司服务认可度不高。一方面，现行的保险费率设计不够科学，保险赔付标准不足以抵偿种植成本，购买意愿低下；另一方面，从购买过商业保险的农民的反馈来看，大家普遍对商业保险公司的理赔服务不满意，理赔满、不透明，这一因素也将影响未来商业保险公司对玉米干旱指数保险的推广。

5.2 对策建议

1. 加大玉米干旱指数保险的宣传力度和农民教育工作。根据调研结果的反馈来看，我省如要推广玉米干旱指数保险，对这方面信息的普及是刻不容缓的。一方面，各级政府应定期通过电视、广播、报纸，或下乡召开座谈会、发放宣传单等形式，对玉米干旱指数保险为农民答疑解惑、进而宣传推广，提高农民对该产品的认知程度，提高对农民对农业保险重要性的认识。农村留守妇女较多，因

此妇联在这一点上的作用不容忽视。另一方面，应继续加强农村文化教育建设，加大教育投入，提高农民整体的文化教育水平和风险识别能力，并鼓励文化水平较高的年轻人参加玉米干旱指数保险产品设计的相关征求意见会，在提高认知度的同时积极参与具体保险条款的设计工作。

2. 加大必要的基础设施建设力度，积极组织专家实地考察与调研。根据墨西哥等国推行干旱指数保险的经验启示，在玉米干旱指数的测定过程中，气象站的有效建设与合理分布至关重要，玉米干旱指数保险的技术支持离不开气象站，而国元农险试点中气象站不足也产生了一些不良影响。因此，在硬件上，辽宁省政府应在区域合理划定的基础上，积极投入资金进行气象站的定点建设，使干旱指数的测定更有保障，并且尽可能降低测度盲区。软件上，政府应安排保险内含气象指数设计的相关研究人员、农业专家、气象专家及保险公司人员等对辽宁省内的水土情况、气象情况、以及农民对该保险的真实需求情况与诉求进行深入考察与调研，在集体数据整合的基础上，为指数保险的合理设计提供真实有效的资料。

3. 加强对玉米干旱指数保险的资金支持力度，实施价格补贴政策。结合墨西哥和埃塞俄比亚的推广经验启示，以及安徽省国元农险试点中财政支持不到位的问题，我们可以认为，在旱灾较为严重的情况下，政府的对保险在资金上的支持是非常必要且关键的。加大资金支持力度一方面可以缓解保险公司在推广初期的承保压力，提高保险公司供应玉米干旱指数保险的积极性，另一方面，在合理的价格补贴政策下，可以实现对农民参保有意识的引导，从而有效地提高农民的购买需求。

4. 加快玉米干旱指数保险的产品设计与创新。国元农险试点的问题启示我们，在玉米干旱指数保险的产品设计中一定要注意以下两个方面：一方面，要借鉴国际先进经验，因地制宜的进行费率设计，在维护保险公司盈利性的同时兼顾农民对保费过高及赔付线过高的顾虑，提高农民参保的积极性。另一方面，在保险合同设计上应注意简化条款，玉米干旱指数保险作为一种新型风险管理产品，其保险合同简单化将更利于推广。

5. 积极推进银保合作，扩展玉米干旱指数保险的销售渠道。安徽省试点单一渠道销售遇到的障碍告诫我们，应该充分学习与借鉴印度和马拉维干旱指数保险的成功经验，加快促成保险公司与农业信贷机构合作。一方面，实现银保合作，拓宽了玉米干旱指数保险的销售渠道，并且由金融机构分散了保险公司的经营成本。另一方面，农民在参加保险的同时，农业贷款也提供了保障，有利于农业保险放贷规模的扩大，加快农民致富，进而反作用农业保险的快速发展，而且，银保合作减少了农业信贷机构的经营成本，有利于提高其经济效益，从而更好地促进农村小微金融的发展。

6. 加快建立旱灾巨灾风险分散机制，努力实现多渠道的再保险安排。根据

国际上干旱指数保险的成功范例，在产品不断推广与完善的过程中，将干旱巨灾风险进行再保险至关重要。因此，在条件成熟时，辽宁省的保险公司应积极与中国再保险公司及国际再保险市场合作，进行辽宁省玉米干旱指数保险的再保险安排。同时，加快研究建立旱灾巨灾风险基金，实现巨灾风险证券化，通过资本市场等多渠道实现玉米干旱指数保险的再保险。

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玉米干旱指数保险购买意愿研究

——基于辽宁省的实证分析

姜缨红

研究生
中央财经大学保险学院
北京102206，中国
电话：15600918259
Email：15600918259@163.com

关键词:保险创新；玉米干旱指数保险；购买意愿研究；Logistic 模型实证分析；

中文摘要:农业对于中国的济、政治、社会发展和文明进步有着至关重要的意义。商品经济下，农业作为各个产业的基础，其自身的脆弱性和生产的波动性会对整个再生产过程的安全与稳定埋下巨大的风险。随着世界进入加速工业化阶段与后工业化阶段，环境问题与经济发展之间的矛盾日益尖锐。改革开放以来，党和国家将工作重心转到经济建设上来，同时更是将“三农问题”作为工作任务中的重中之重。农业保险作为一种风险管理工具，能够有效管理、控制农业生产中所遇到的各类风险，因此一直以来被中国乃至全世界广泛应用于农业生产风险管理中。不过，多年以来，农业保险在实践中暴露的市场失灵现象和逆选择，以及理赔难、经营压力大等问题，使农业保险这一工具的实际运行效果并不尽如人意。因此，开发一种能够有效克服这些问题的，使农业保险更加有效的风险管理工具，则显得尤为必要。

国际经验表明，天气指数保险作为一种新型农业保险，可以提高理赔的科学性与客观性，有效地减少以往农业保险理赔中的逆选择问题，并有效减弱市场失灵。因此近年来该产品在全世界范围内，尤其是一些发展中国家得到了广泛应用。近年来，我国也进行了不同类型天气指数保险的试点，总体上取得了成功，但也存在着一些问题。辽宁省作为中国优质玉米的主产区之一，其玉米生产的稳定性与安全性关系到中国诸多产业的持续发展。然而，辽宁省也是中国干旱风险的高发地区之一，其干旱风险的爆发频率与强度在国内均属前列。同时，辽宁省的农

业保险自运行以来，暴露的问题越来越多。因此，开发能够有效管理辽宁省玉米生产干旱风险，同时能够为保险公司和农民广泛接受的玉米干旱指数保险，对于辽宁省经济持续健康发展与农民生产生活的稳定，具有非常积极的意义。

新型保险产品的开发，不仅需要产品设计上的努力，更需要在了解农民的真实投保需求及影响因素。因此，笔者从农民实际投保意愿的视角出发，在实地对辽宁省农民调研的基础上，对玉米干旱指数保险的购买意愿进行实证研究，了解农民对干旱风险与干旱指数保险的真实认知情况及诉求，找出影响其购买意愿的最重要的因素，同时为辽宁省为未来开展此项业务提出相应对策与建议。

Study on the Cohesion between Social Health Insurance and Commercial Health Insurance under the New Medical System Reform

QU Ying

School of Insurance
Central University of Finance and Economics
Beijing 102206, China
Mobile: (86)18811386233
Email: quying196@email.cufe.edu.cn

Keywords: Social health insurance, Commercial health insurance, Cohesion, insurance requirements model, cross-analysis theory.

Abstract. With the development of reform and opening up, Chinese living standards increase year by year and the health care spending has witnessed a rise as well. In the past five years, total medical and health expenditure growth rate is much higher than GDP growth rate. Faced with rising medical costs, more and more people choose to purchase insurance to reduce their health risks probability. Social health insurance covers widely and provides the most basic health care; commercial health insurance has features such as flexible buying terms, high level of security, diverse choices and so on. From international experience, we learn that governments around the world are committed to building a multi-level medical security system, our country is no exception. In January 2009, Executive meeting of the State Council adopted a project on Deepening Medical Health System Reform, which indicates the beginning of a new round of medical care reform. The project proposed to construct a medical care system with basic health care as the main body and other health insurance as supplement.

Chinese scholars studying the cohesion between social health insurance and commercial health insurance are mainly based on qualitative research, and their researches are focused on the theoretical analysis or comparative study about foreign operate mode. This paper analyzes and confirms the feasible cohesion using quantitative method.

Firstly, the dissertation describes the policy framework of new medical system reform and its effects to health insurances. Then based on data from CHARLS（China Health and Retirement Longitudinal Study）, the paper analyzes the correlation between social insurance and health insurance needs under the New Medical System Reform, using insurance requirements model, cross-analysis theory and multiple linear regression analysis. Negative correlation suggests that health insurance is complementary to the coverage, residents choose one between social medical insurance and health insurance; positive correlation is shown to be complementary to the depth of insurance, and residents participating in social medical insurance buy extra commercial health insurance to shift more risk. Empirical analysis shows that social health insurance promotes commercial health insurance virtually, whose effect is related to average income of family. The results confirm that the cohesion between social health insurance and commercial health insurance

is feasible. Thirdly, on account of previous analysis and realities, the dissertation provides appropriate ways to build the cohesion between them. Lastly, the paper gives its conclusion and advice from product innovation, professional management and other aspects.

1．引言

改革开放以来，随着国民收入的攀升，人们对于健康保障的需求不断增加，医疗卫生费用同样上涨。近五年来，我国医疗健康总支出逐年增长，其增长速度已经超过GDP的增速，面对日益增长的医疗健康费用风险，越来越多的人选择购买保险转移风险。当前，我国的健康保险分为两大类：社会医疗保险提供最基本的医疗保障，覆盖范围广泛、保障程度相对较低；商业健康保险作为社会医疗保险的补充，保障水平更高、覆盖人群有限。从国际经验来看，各个国家都致力于建立多层次的医疗保障体系。我国在2009年1月，通过了《关于深化医药卫生体制改革的意见》和《2009-2011年深化医药卫生体制改革实施方案》，新医疗体制改革正式实施。

新医改提出构建多层次医疗保障体系的改革方向。指出充分发挥商业健康保险在医疗保障体系中的补充作用，提倡有资质的商业保险机构参与社会医疗的委托管理，明确了商业健康保险与社会医疗保险在多层次医疗保障体系中的关系和职能，为建立两者之间的衔接机制指明了方向。

本文的创新与贡献在于（1）系统阐述了新医改的政策框架及其影响（2）运用保险需求模型、交叉分析理论和多元线性回归模型，对大样本微观数据进行定量分析，证明了建立衔接的可行性（3）结合实证分析结果和实际情况，提出衔接可行途径和相关建议。

2.新医改政策

2.1 新医改出台背景

2.1.1医疗保障体系初具规模

1998年医疗改革以后，国家陆续出台指导意见和相关文件，逐步构建了我国城镇职工基本医疗保险、城镇居民基本医疗保险、新型农村合作医疗和医疗救助系统“四位一体”的社会医疗保险体系。商业健康保险自上世纪八十年代开始经营以来，保费规模迅猛增长，覆盖人群不断扩大，成为居民规避风险的有力手段。

2.1.2居民医疗负担日益加重

随着人们生活水平的提高，健康保障需求快速增长、医疗卫生支出逐年上升。根据统计数据显示，自1999年到2008年，我国医疗卫生总费用每年以超过10%的增速上升，2007年卫生总费用突破亿元大关。其中超过40%的医疗费用需要个人承担，与发达国家15%~20%的水平相比，还存在着一定的差距。该阶段，我国居民医疗健康风险没有得到有效分散，日益加重的医疗负担迫切要求建立多层次的医疗保障体系。

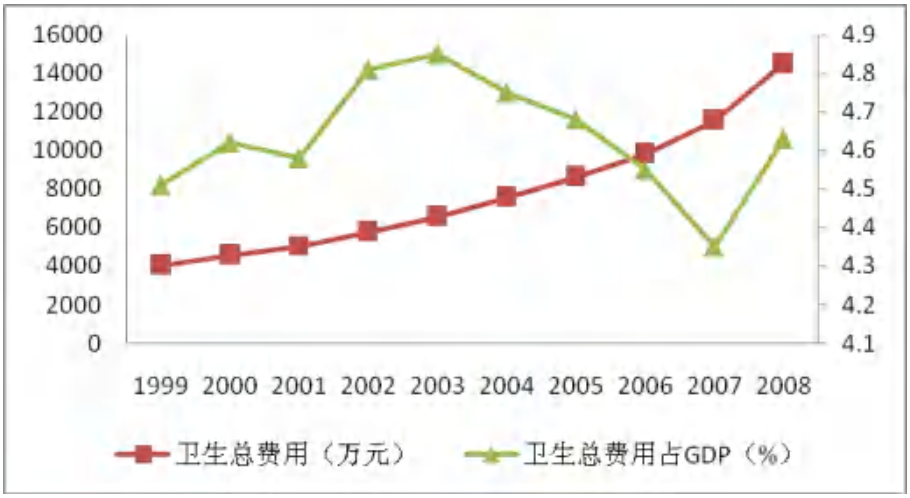


图1：全国医疗卫生总费用

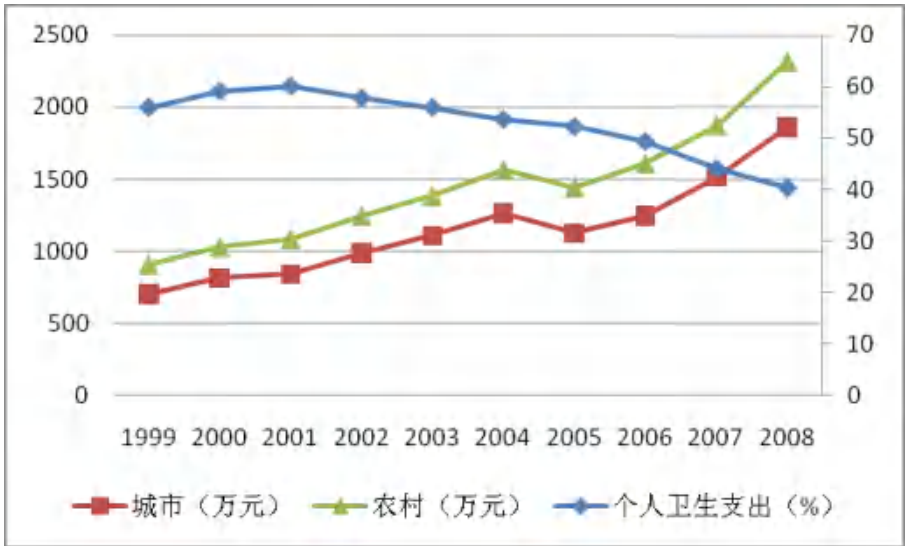


图2：城镇、农村人均医疗费用

数据来源：2011年中国卫生统计年鉴。

注：①数据系核算数；②按当年价格计算；

③2001年起卫生总费用不含高等医学教育经费,2006年起包括城乡医疗救助经费。

2.2 新医改政策框架及其影响

国务院常务会议于2009年1月，通过了《关于深化医药卫生体制改革的意见》和《2009~2011年深化医药卫生体制改革实施方案》，从公共卫生服务体系、医疗服务体系、医疗保障体系、药品供应保障体系四个方面提出了深化医药卫生体制改革的相关意见。其中医疗保障体制改革与保险产业密切相关。

2.1.1明确保险定位，指明发展方向

新医改明确提出“以基本医疗保障为主体，其他多种形式补充医疗保险和商业健康保险为补充，构建多层次医疗保障体系”，这与国际上的普遍做法相保持一致。

从国际经验来看，在众多发达国家及地区，由全民公费医疗制（英国模式）或者社会医疗保险（德国模式）构成公共医疗保障体系，作为医疗健康保障体制的主体。其中，商业健康保险扮演着主要的补充角色，在满足个人多样化的保险需求、分担医疗健康费用风险、约束医疗机构的诊疗和用药行为、提高医疗体系的整体效率等方面发挥着积极作用。多层次医疗保障体系的提出，明确了商业健康保险与社会医疗保险的关系和职能，为建立两者之间的衔接机制指明了方向。

2.1.2基本医疗保障体系城乡一体化

新医改指出坚持“广覆盖、保基本、可持续”的原则，全面实施城镇居民基本医疗保险和新型农村合作医疗制度，完善城镇职工基本医疗保险制度与城乡医疗救助制度，实现基本医疗保障体系城乡一体化。

新医改后，社会基本医疗保险拓宽了其保障广度与深度。从覆盖率来看，截至2014年底，我国城乡基本医疗保险覆盖率超过95%，基本实现“广覆盖”的目标。从保障水平来看，居民医疗费用的自付比例逐步降低，大病医疗保险“封顶线”从原城乡居民年收入的4倍提高至6倍，2014年新型农村合作医疗和城镇居民基本医疗保险的财政补助标准提高到每人每年320元。

2.1.3鼓励商业健康险发展空间

新医改提出充分发挥商业健康保险的补充作用，鼓励商业保险机构开发创新产品，提倡有资质的商业保险机构参与社会医疗的委托管理。

商业健康保险在医疗保障体系中的定位与职能更为清晰，发展环境得到了进一步优化，实现了稳步发展。一是保险业务增长迅速。据保险统计数据报告显示，2015年健康险业务原保险保费收入2410.47亿元，同比增长51.87%；健康险业务赔款和给付762.97亿元，同比增长33.58%；二是市场主体数量增加。截止2015年初，全国有100余家保险公司开展商业健康保险业务，其中包括四家专业健康保险公司，推出产品2300多个。三是产品种类日益丰富，保险产品涵盖医疗保险、疾病保险、护理保险和失能收入损失保险等多个方面，满足不同人群多样化的健康需求。

3.相关性实证分析

在医疗保障体系中，社会医疗保险属于强制保险，商业医疗保险则是相应的补充保险。在研究两者的相关性时，更多的表现为已有的社会医疗保险对于商业健康保险的促进或者抑制作用。所以为了探索建立两类保险衔接的可行性，本文构建了一个多元线性回归模型，模型以样本数据的商业健康保险保费支出为被解释变量，采用包括社会医疗保险保费支出在内的各类影响因素作为解释变量，得出一系列的解释系数。如果相关系数为负，则社会医疗保险对于商业健康保险具有抑制作用，反之，则表现为促进作用，此时，建立衔接具有现实意义与可行性。

已有的实证研究表明，不同的收入水平对商业健康保险需求的影响分为不同阶段，各个阶段表现出不同的促进或者抑制作用。根据交叉分析理论，影响健康保险需求的各种因素还可能会产生交叉项，造成某种因素的影响程度的缩小或增加，因此在不同的收入条件下，对于商业健康保险和社会医疗保险的实证分析，得出的结论可能不同。基于上述考虑，本文以可支配收入作为交叉项，探索不同的收入组别下，商业健康保险与社会医疗保险的相关性。

实证分析的研究思路是：从保险需求模型出发，以商业健康保险作为被解释变量，构建回归方程，分析其中社会医疗保险与商业健康保险的相关性。并且，运用交叉分析的相关理论，探索在不同的收入组别下，两类保险之间的相关性。

3.1 样本数据来源与CHALRS原始数据处理

本文实证分析中的数据来源于中国健康与养老追踪调查(China Health and Retirement Longitudinal Survey, CHARLS)2013年全国追踪调查。CHARLS项目是由中国疾病预防控制中心和北京大学联合开展的跨学科研究，收集中国45岁及以上中老年人家庭和个人的高质量微观数据。CHALRS项目自2008年启动以来，先后进行了2008年浙江甘肃两省预调查，2011年全国基线调查，调查对象覆盖我国30个省级行政单位范围内的150个县级单位，450个村级单位，约1万户适龄家庭中的1.7万人口（家庭至少有一名年满45岁的人，包括其配偶），在总体上代表了中国中老年人群。其后样本数据每两年进行一次追踪调查，CHALRS2013年全国追踪调查是对2011年全国基线调查的后续追踪调查，也是目前为止CHALRS项目最新的数据结果。问卷设计参考了欧美等国家的国际经验，具有高质量与可靠性，得到学术界广泛的认可和应用，国内外学者应用统计数据进行实证研究，取得了众多学术成果。

由于charls数据之间存在的相关性，部分2013年全国追踪调查的数据来源于2011年全国基线调查数据库，需要对两者进行匹配，找出实证分析所需数据。并且由于原始数据信息冗杂，数据量庞大，众多数据与本文所研究课题无关，所以在进行相关实证分析以前，需要对于原始数据进行筛选合并等处理。

3.2 观察数据统计描述

经过前期的数据处理后，将性别、健康状况、教育程度商业健康保险保费支出、社会医疗保险保费支出和家庭人均可支配收入中的缺失数值剔除。同时删去可支配收入为负值的数据，最终剩余8,539个有效数值，样本数据整体基本符合正态分布。

此次研究所选样本性别比大致相当，其中46.46%的人认为自己健康状况好或者一般，35.37%的人自评健康状况不好，12.3%的人自评健康状况很糟糕，说明人们对于自身健康风险存在较大担忧，健康保险潜在需求巨大。另外，相较于社会医疗保险的保费支出，商业健康保险保费支出明显偏低。这说明，当前我国商业健康保险向有效需求的转化率并不高，商业健康保险对于健康风险的分摊作用尚不明显，这与商业健康保险发展历程较短，以及人们尚未健全保险意识有一定的关系。

表1：数据样本的统计特征描述

变量	均值	标准差	最小值	最大值
商业健康保险保费支出（元）	48.96	513.90	0	22000
社会医疗保险保费支出（元）	189.267	969.92	0	37000
家庭人均可支配收入（元）	10491.85	12961.70	2	202000
性别	男		4,130（48.4%）	
	女		4,409（51.6%）	

健康状况（自评）	很好	498（5.8%）
	好	1,096（12.8%）
	一般	2,871（33.6%）
	不好	3,020（35.4%）
	很不好	1054（12.4%）
教育程度	初中毕业及其以下	7,027（82.3%）
	高中毕业至中专毕业	1,198（14.0%）
	大专毕业至本科毕业	307（3.6%）
	硕士毕业及以上	7（0.1%）

3.3模型初设

3.3.1选取因变量与自变量

因变量Y：商业健康保险保费支出（y）。随着近年来我国居民生活水平的提高，人们对于商业健康保险的潜在需求不断增加，我国商业健康保险市场的潜在需求十分巨大。但受到种种因素的限制，保险的潜在需求向有效需求的转化仍然有着一段差距，因此本文的实证分析从保险的有效需求出发，以居民商业健康保险年均保费支出作为因变量。

自变量X_1：社会医疗保险保费支出（insurance）。据统计，我国社会医疗保险覆盖率达到95%以上，该样本数据中绝大部分居民也都享有社会医疗保险，与宏观情况基本一致。基于此，社会医疗保险的选择与否对于商业健康保险的影响并不显著，无法从统计上得到两者的相关性。所以选择社会医疗保险保费支出作为自变量的衡量指标。

X_2：家庭人均可支配收入（income）。居民收入水平对于保险保费支出具有重要影响，一方面高收入水平的人更有可能将潜在需求转化为有效需求，随着可支配收入的提高，居民更加关注于自身的医疗保障，更倾向于购买商业保险。另一方面，可支配收入的增加提高了居民的消费水平，居民购买力上升，商业保险保费支出增加。需要特别指出的是，徐美芳（2007）在实证研究中提出，健康保险需求与个人收入水平并没有显著关系，而与家庭其他成员的收入水平有着显著的关系。本文综合考虑认为，我国传统上以家庭为生活主体，收入高的成员能够为低收入成员购买保险，因此采用家庭平均收入作为衡量指标。

X_3：教育水平（educ）。针对不同教育水平的居民，其对于保险产品的认识与理解不同，这种基于保险意识的差异，会影响到居民对于保险的购买以及消费数额。另外，高教育水平的人通常有着较高的收入水平，他们对于保险产品的购买能力较强。

X_4：健康状况自我评价（health）。健康状况自我评价属于个体的主观认识，个人对于自身健康风险的认知不同，所造成的保险有效需求也会有所不同。

X_5：性别（gender）。早期的实证研究发现，性别差异对我国健康保险发展的影响不显著。然而，近些年来，随着中国人口老龄化的加快，人均寿命延长，其中女性平均寿命高于男性3—5年，女性患慢性病的概率也远高于男性。女性群体对于健康保障的需求要多于男性，因此本文将性别也作为研究变量之一。

3.3.2模型初步回归

模型初步设定时，将所有自变量社会医疗保险保费支出（insurance）、家庭人均可支配收入（income）、教育水平（educ）、健康状况自我评价（health）、性别（gender）都带入回归方程中，其中商业健康保险保费支出、社会医疗保险保费支出和家庭人均可支配收入均取对数值，达到度量单位的一致。用OLS对参数进行估计，得到的回归模型如下：

$$LnY = -0.415+0.0236\ln X_1+0.0322\ln X_2+0.199X_3+0.0437X_4-0.0489X_5 \quad (1)$$

标准差	(0.0823)	(0.00520)	(0.00814)	(0.0439) (0.0227)	(0.0227)
t值	（4.54）	（3.96）	（4.54）	（1.92）	（-2.15）
P>|t|	（0.000）	（0.000）	（0.000）	(0.055)	（0.031）

R^2= 0.0076；修正的R^2 = 0.0071；F=13.14；Prob > F=0.0000

上述回归模型中，虽然R^2数值较小，修正后的R^2仅为0.0071，但是观察其F统计量，等于13.14数值较大，说明多元回归模型呈现整体显著性。观察自变量的统计数值，其中$\ln X_1$、$\ln X_2$与X_3，X_5的p值明显小于0.05，X_4变量的p值略高于0.05，说明上述五个变量在统计上具有显著性，对于$\ln X_1$能够产生较为明显的影响。说明模型初设自变量的选取基本合理。下一步，按照收入水平高低分组，对模型进行交叉分析。

3.4 模型修正设定

根据交叉分析理论，回归方程中各自变量的交叉项对于因变量可能产生影响，需要在回归模型中加入交叉项进行多元回归。由以往的研究经验可知，上述自变量中收入变量产生显著影响，本文所做的实证分析主要针对收入变量进行交叉分析研究，

由计量经济学交叉项回归的相关理论，按照家庭人均可支配收入将样本数据分为四个档次：以平均收入为中线，划分为两大组别，再平分组中人数，得到四

组数值。定义3个虚拟变量，将收入按高低排序，用虚拟变量表示序列信息，然后将虚拟变量带入回归方程中，并加入虚拟变量与其余自变量的交叉项。然而，笔者在经过数据回归后发现，回归方程的R^2值较小，方程的拟合度较差，并且各自变量的p值均高于0.05，无法很好地解释因变量。因此，在原有分析的基础上，简化分析模型。按照收入水平对样本数据进行分组，分别在不同收入水平的组内，构建多元回归模型，分析商业健康保险与社会医疗保险之间的关系。

3.5 数据分组

样本数据中有效数据为8539个，求出其平均值为10491元，计数后我们得到家庭人均可支配收入小于10491的人数为5544，大于平均值的人数为2995。考虑到样本容量的大小，本实证分析最终选择按收入水平分为三组，其中大于平均水平的人群为总体样本1，小于平均收入的人群中收入大于另一半的为总体样本2，其余的人群为总体样本3。按照总体样本1、2、3的顺序依次对于样本进行回归分析。

3.6 数据回归及结果分析

模型回归方程的设定如下，其中因变量商业健康保险保费支出（Y）、自变量社会医疗保险保费支出（X_1）、家庭人均可支配收入（X_2）、教育水平（X_3）、健康状况自我评价（X_4）、性别（X_5）：

$$LnY=a+b\ln X_1+c\ln X_2+dX_3+eX_4+fX_5 \quad (2)$$

stata软件中，对于不同收入组别的charls数据进行回归分析，结果如下表。可以看到，虽然三个回归方程中R的平方项数值不是很大，但是其F统计量数值均较大，说明回归方程整体拟合度较好。根据布劳殊一培干一戈弗雷(BPG)检验法，收入在0—0.425万元，0.425—1.05万元，1.05万元以上的组别其1/2(ESS)数值分别为5.07，13.32，25，故回归结果满足同方差假设。从回归系数的p统计量来看，大多数自变量的p值小于0.05，其余自变量的p值保持在0.09以下。

表2：样本数据回归结果

	收入<0.425(万元)	0.425<收入<1.05(万元)	收入>1.05 (万元)
常数项	-0.297	0.553	-1.324
	(0.132)	(0.644)	(0.487)
社会医疗保险保费支出	0.012	0.023	0.034
	(0.008)	(0.009)	(0.010)
家庭人均可支配收入	0.017	-0.10	0.135
	(0.013)	(0.072)	(0.049)
教育水平	0.198	0.348	0.129
	(0.093)	(0.084)	(0.068)

健康状况自我评价	0.066	0.059	0.006
	(0.031)	(0.038)	(0.047)
性别	0.007	-0.073	-0.082
	(0.031)	(0.038)	(0.047)
R^2	0.0047	0.012	0.008
调整R^2	0.0030	0.0096	0.0066
F	2.80	5.91	4.98
Prob > F	0.0157	0.0000	0.0002
1/2(ESS)	5.07	13.32	25
样本数量	3,000	2,542	2,993

在低收入组中，教育水平的系数较大，说明该变量对于因变量具有重大影响。由于其p值较大，高于一般的0.05水平，剔除教育水平后再次做回归分析，发现回归的R的平方和F数值都下降，说明教育水平对于保费支出具有一定的解释意义，故方程中保留该项；在中等收入组中，人均可支配收入与教育水平的系数都较大，且两个变量的p值都高于0.05。在多元回归中做逐步分析，认为可支配收入和教育水平均留在原方程中；在高收入组中，各个自变量对于因变量均能够很好的解释。

最终，商业健康保险保费支出的最优拟合结果如下。

低收入组：$\ln Y=-0.297+0.012\ln X_1+0.017\ln X_2+0.198X_3+0.066X_4+0.007X_5$

中等收入组：$\ln Y=0.553+0.023\ln X_1-0.10\ln X_2+0.348X_3+0.059X_4-0.073X_5$

高收入组：$\ln Y=-1.324+0.034\ln X_1+0.135\ln X_2+0.129X_3+0.006X_4-0.082X_5$

（Y）商业健康保险保费支出

（X_1）社会医疗保险保费支出

（X_2）家庭人均可支配收入

（X_3）教育水平（中专及其以下=1，大专及以上=2）

（X_4）健康状况自我评价（很不好、不好 =0，一般、好、很好=1）

（X_5）性别（女性=0，男性=1）

根据上式可知商业健康保险保费支出的影响因素为：自变量社会医疗保险保费支出、家庭人均可支配收入、教育水平、健康状况自我评价、性别。各因素对于保费支出的影响效果如下：

（1）社会医疗保险保费支出（X_1）。对于商业健康保险的保费支出的影响程度较大，在三个组别均呈现正相关的关系。在实际情况中，社会医疗保险的推广宣传有利于人们认清自身的健康状况，意识到潜在的医疗健康费用风险，增强人们的保险意识，从而推动保险市场（包括社会医疗保险和商业医疗保险）的发展。另外，随着收入的提高，社会医疗保险对于商业健康保险的促进作用增强。低收入人群对于保险产品的需求有限，在购买了相应的社会医疗保险后，选择购买较少数值的商业健康保险作为补充，商业健康保险与社会医疗保险保费之间的相关性较小。在中高收入人群中，其消费约束曲线外移，购买能力上升。在参与社保保障了基本健康风险以外，选择购买额外的商业健康险转移更多的风险，两类保险保费之间的相关性增大。

（2）家庭人均可支配收入（X_2）。在不同收入组别中，家庭人均可支配收入对于商业健康保费支出的影响出现抑制和促进两种情况。高收入水平下，家庭人均可支配收入对保费支出具有促进作用，商业健康保险需求随着收入的提高显著增加。中等收入水平下，家庭人均可支配收入呈现抑制作用，这与样本数据涵盖了农村地区有着一定的关系。农村地区的数据样本较多集中在中等组别，同时农村地区涉及商业健康保险产品相对较少，随着收入的提高，人们参与社保的积极性增加，对于商业健康保险的保费支出产生挤出效应。

（3）教育水平（X_3）。在三个组别当中，教育水平与商业健康保险的保费支出均呈现正相关关系。一般来说，教育水平较高的社会成员对于自身健康风险的意识越强，作为风险厌恶者，更有可能购买商业健康保险抵消相应的风险。

（4）健康状况自我评价（X_4）。在三个组别当中，健康状况自我评价对于商业健康保险保费支出的影响效果并不明显，其回归系数均在0.07以下。在实际情况中，由于道德风险的存在，健康状况糟糕的人群更倾向于购买保险，而健康状况良好的人则倾向于风险自担，健康状况自我评价与商业保费之间负相关。另一方面，由于消费预算约束的存在，保险的潜在需求向有效需求的转化率并不高。所以分析认为，两方面的作用存在相互抵消，可以认为该项与商业健康保险保费支出相关作用不显著。

（5）性别（X_5）。在低收入组别中，男性相较于女性对于商业健康保险的有效需求更大。低收入家庭中，男性作为主要经济来源收入，对于医疗健康保障的需求更为迫切。高收入组别中，女性对于商业健康保险的需求更大，这与女性更长的平均寿命与更高的慢性病患病率有一定的关系。

4.衔接的可行途径

4.1基本医疗保障有限，商业保险有效补充

在我国，社会医疗保险只提供最基本的医疗保障，将医疗服务设施、失能收入损失以及特殊的诊疗费用等医疗支出剔除在外。同时，社会保险对居民用药及治疗范围也进行了限定，指定医院机构治疗，指定药店拿药，且提供药物与医疗服务需满足指定范围。据统计，我国城镇职工基本医疗保险实际报销水平通常在50%左右, 新型农村合作医疗的实际报销比例为40%左右。商业健康保险针对基本医疗没有覆盖到的保障范围，能够利用自身业务的灵活性，积极研发补充医疗保险产品，满足大众多样化的保险需求，扩充医疗保险市场。”

4.2发挥技术资源优势，探索委托式经营管理

医疗健康保障体系的发展离不开政府的支持，而各种医疗机构、医疗服务设施由于其运行周期长、费用支出大，政府在财政方面的压力较大。积极探索委托经营管理模式，能够吸引社会资本参与投资、建设和运营，并且充分发挥商业保险公司在管理、人才、技术等方面的比较优势，实现社会医疗保险和商业健康险的共赢局面。以“湛江模式”为例，当地由政府主导引入商业保险机构参与社会基本医疗保障建设。依托商业保险公司在管理技术、人力成本、办公平台等方面既有的资源，政府改进管理效率的同时，节约了管理成本，相关投入减少约800多万元。在不增加财政负担的前提下，大幅提高参保人医疗保障水平。湛江地区人均住院费用由2007年的8 851元降至2009年的3 543元，人次治疗成本下降约60%。

4.3 管理式医疗模式，服务中高端人群

管理式医疗模式下，保险公司通过重组、收购、控股健康管理机构或加强与其合作的方式, 为客户提供一体化的健康服务。主要通过实施健康教育、健康咨询、预防保健等干预措施, 达到促进健康的目的。健康管理属于更高层次的健康保障模式, 商业健康保险公司可以针对中高端客户, 推出健康管理,突出健康保险专业化管理特色。目前，我国的商业健康保险公司积极开发高端医疗产品，推动高端医疗市场的发展，国内高端医疗保费在20亿元左右，保险潜在需求巨大，市场前景良好。

5. 结论与相关建议

通过实证分析知，社会医疗保险与商业健康保险之间的互补作用大于替代效应，社会医疗保险的发展能够有效促进商业健康保险，两者之间建立有效衔接具有一定的现实意义和可行性。此时商业健康保险是对医疗体系中保险深度的补充，居民通过购买额外的商业健康保险来转移更多的健康风险。并且，在不同的收入水平下，社会医疗保险和商业健康保险之间呈现不同程度的相关关系。高收

入水平下，两类保险的相关性更为强烈。此外，家庭人均可支配收入、教育水平和性别对于商业健康保险的有效需求都有不同程度的影响，健康自我评价水平对于保险有效需求的影响不明显。

结合实证分析与实际情况，本文认为应当从保险产品创新、建立信息共享机制等方面着手，建立商业健康保险和社会医疗保险的衔接，促进我国医疗保障体系的长期发展。

5.1加大保险产品创新力度

实证分析显示，我国商业健康保险与社会医疗保险具有正的相关性。针对社会医疗保险没有覆盖到的保障范围，商业保险公司应当加大其创新力度，满足不同人群的补充医疗保险需求。运用自身业务的灵活性，开拓和创新补充医疗保险产品，如社会医疗费用自付部分的补充保险、长期护理保险、团体健康保险等。此外，当前我国商业健康保险产品的同质化现象较为严重，各类产品险种单一，对于保险潜在需求者的吸引力不大，健康险的多元多样化将是未来的发展趋势之一。

5.2整合医疗资源，建立健全信息共享机制

社会医疗保险和商业保险在医疗服务设施、医疗人才等方面进行资源的整合，能够有效提高资源的利用效率，降低保险经营成本。同时需要健全信息共享机制，在互联网迅猛发展的今天，大数据技术在健康保险的风险前期测量、保险费率精算定价等方面都有应用。社会医疗保险作为强制保险，对于普通居民的健康医疗信息有较好的掌握，商业医疗保险则在中高端人群方面有着比较优势。两类保险应当建立健全信息共享机制协同发展。

5.3进行专业化经营，加强人才培养

健康保险由于其定价基础与保险责任的特殊性，需要专业化的经营管理，由混业经营向分业经营方向发展。社会基本医疗保险与商业健康保险，应当树立专业化的经营理念与经营策略，建立专业的精算体系和核保核赔体系,以保证健康险业务的正常运转。同时，要注重对于专业化人才的培养，充分利用各种渠道加快培养建设；规范从业人员的服务标准，提高体系人员素质，打造专业化的医疗保险服务团队。

5.4政策支持，健全相关法律法规

保险市场的发展，离不开良好的政策环境和法律环境。一方面政府可以从税收优惠、财政补贴等方面进行政策支持；另一方面需要完善我国医疗保障制度相关法律法规体系，充分发挥政府的法律、财税支持与监管职能，提供良好的制度环境。

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新医改背景下社会医疗保险与商业健康保险的衔接思考

瞿莹

中央财经大学保险学院保险学专业
北京102206，中国
地址：海淀区学院南路39号
电话： (86)18811386233
邮箱地址：quying196@email.cufe.edu.cn

关键词：社会医疗保险；商业健康保险；衔接；保险需求模型；交叉分析理论。

摘要.改革开放以来，我国国民收入水平逐年上升，健康保障的需求也在不断增长。近五年来，医疗健康支出总的增长速度已经超过 GDP 的增速。面对日益增长的医疗费用，越来越多的人选择购买保险来转移健康风险。健康保险分为两类：社会医疗保险提供最基础的医疗保障，覆盖范围广泛；商业健康保险作为补充保险，有着购买方式灵活、保障水平更高、选择多样化等特点。从国际经验来看，各个国家都致力于建立多层次的医疗保障体系，中国也不例外。2009 年 1 月，国务院常务会议通过了《关于深化医药卫生体制改革的意见》，这标志着中国新医改已经拉开了帷幕，新医改提出“以基础医疗保险为主，其他保险作为补充”的改革方向。

国内的学者，在研究社会医疗保险和商业健康保险之间的衔接时，大多采用定性分析进行理论上的探讨，或者比较研究国外的运行体制。本文则关注于定量分析，在实证分析的基础上探讨两者之间衔接的可行性。

本文首先系统阐述了新医改的政策框架和产生影响。然后运用保险需求模型、交叉分析理论和多元线性回归模型，以 charls（中国健康与养老追踪调查）提供的数据作为样本，分析新医改后社会医疗保险和商业健康保险之间的相关性。负相关意味着，商业健康保险是对覆盖人群的补充，未曾购买任何保险的居民将在商业健康保险和社会医疗保险之间抉择；正相关意味着，此时商业健康保

险是对医疗体系中保险深度的补充，参加社会医疗保险的居民通过购买额外的商业健康保险来转移更多的健康风险。实证分析得出，在不同的收入组别下，社会医疗保险对于商业健康保险均产生不同程度大小的促进作用，两者之间建立衔接具有可行性。在实证分析的基础上，本文探讨了衔接的可行途径。最后，给出本文的结论，并提出相关建议。

The Origins of Insurance of Agricultural Future Prices and its Inspiration to China: An Analysis Based on Agricultural Future and Income Insurance

SUN Rong, XU Bin

SUN Rong
Professor
School of Insurance
Southwest University of Finance and Economic
RoomA612, Zhizhi Building,
No.555 Liutai Road, Wenjiang District, Chengdu, Sichuan Province
Phone: (86)13688409637
Email: sunrong@swufe.edu.cn

XU Bin*
Ph.D. Candidate
School of Insurance
Southwest University of Finance and Economic
RoomA612, Zhizhi Building,
No.555 Liutai Road, Wenjiang District, Chengdu, Sichuan Province
Phone: (86)18010627599
Email: 28512969@qq.com

Key words： Farm Bill; Agricultural Commodity Futures; Revenue Insurance

Abstract. Under the context of agricultural modernization, this article tries to trace the origin of the trial insurance on future products in Dalian. The focus of this study is to analyze an equivalent products in the U.S.- revenue insurance, especially the federal law that governs this production and its acception in U.S. The experience for developing security network for farmers in U.S are also summarized. In the end, policy suggestions are provided on applicability of U.S experience in China , taking into account of the its current status of agriculture.

1. 问题的提出及研究背景

农业作为国民经济的基础性产业，其发达程度制约着其他行业的生存和发展。特别是对中国这样的人口大国，农业的生产情况还关系到社会的稳定及国际贸易形势。因此，中国政府一直非常重视农业的发展，近十余年来，政府更是将农业问题作为历年的一号文件发布，以体现对农业的重视程度。虽然政府对农业的补贴力度逐年加大，农民的平均收入却增长缓慢，农民生活水平距离“2020年实现全面建成小康社会”的战略目标依然相距甚远。所以，仅靠高投入、高补贴形式的支农惠农政策，并不能从根本上解决“三农”问题。在此形势下，转变农业生产方式，以农业规模化带动集约化和现代化成为必然趋势，其具体表现即是新型农业经营主体规模的发展。

2016 年度的中央一号文件已经发布，其中关于农业保险，除了“扩大农业保险覆盖面、增加保险品种、提高风险保障水平”的表述外，还增加了“积极开发适应新型农业经营主体需求的保险品种”、“探索开展重要农产品目标价格保险”和“稳步扩大“保险＋期货”试点”等内容，体现了政府对农业保险发展要适应农业现代化改革和农业供给侧改革的要求。具体来看，农业现代化在现阶段的任务是逐步推进农业的适度规模经营。而农业属于经营风险较大的行业，其经营的规模化也意味着风险的规模化，新型农业经营主体面对这种风险的积聚必然会对风险保障提出更高求。“保险+期货”试点下的农产品期货价格保险与目标价格保险是实现更高层次保障的收入保险、收益保险的基础和要件，能够提升现有农业保险体系的保障水平，有必要积极推动其发展。然而，相对于我国现有的农业保险产品，上述新险种无论在产品设计和经营上都较为复杂，贸然开展可能会使保险公司承担较大风险。

作为世界上农业现代化最发达的国家之一的美国，其农业政策体系已经较为完善，特别是其农户收入保障政策和相关工具的使用对保持农户收入稳定和农产品市场稳定发挥了重要作用。更为重要的是美国联邦农作物保险体系经历了由“产量保险”向“收入保险”的转变而逐步走向成熟，其发展经验对我国农业转型期农户收入保障政策和农产品期货价格保险工具的设计有重要借鉴意义。

通过对美国农业保险相关文献的查阅，我们发现美国并无真正意义上的农产品期货价格保险。因而本文的研究围绕农产品期货价格保险在美国农作物保险体系中的类似产品——农作物收入保险展开。分析了农作物收入的保险承载主体美国农业法案的整体架构和最新进展，与农作物收入保险联系紧密的农户收入保障政策、以及为农作物收入保险经营提供支持的农产品期货市场和农作物保险计划等农业风险管理工具。期望通过美国相关领域的发展经验的借鉴，不断完善我国“保险+期货”的模式，建立和发展我国的农产品期货价格保险，稳步推进我国农产品价格机制改革和农业现代化建设。

2. 农产品期货价格保险解构

农产品期货价格保险是在政府鼓励农产品经营企业充分利用期货市场的价格发现功能和风险对冲机制以及保险公司探索试点目标价格保险的双重背景下，由保险实务领域主导开发的创新型产品。目前，农产品期货价格保险仍处于试点和探索阶段，现有研究主要针对其业务操作和功能进行介绍，并无规范的定义。本文试图从农产品期货价格保险的承保和赔付流程，对该产品的特征进行分析和归纳。

农产品期货价格保险的操作主要分为三步：一是保险公司根据投保农产品历史价格波动率、投保时间段、国家托市政策等要素，同时参考场外看跌期权报价，设定目标价格范围和对应保险费率，再由投保主体选择目标价格和投保产量。二是保险公司为防范价格暴跌导致保费不足以赔付的风险，需通过购买场外看跌期权产品进行再保险以对冲风险。三是在保险合约到期时，根据当时的市场价格，由保险公司确定是否对投保主体进行赔付以及是否利用场外期权从期货市场摊回损失。

由上述农产品期货价格保险的经营流程，可以得出该保险产品具有下述特点。首先，保险合约中目标价格的确定利用了期货市场特定时期的合约价格，是期货市场价格发现功能的体现；其次，与农户直接参与期货市场不同，在期货价格保险中，是否选择在期货市场中进行套期保值操作由保险公司决定，农户只根据市场价格和目标价格之前的差异获得赔偿；再次，农产品期货价格保险从名称上看是一种价格保险，但其在合约中约定了产量，最终得到的赔偿是价格差异与约定产量的乘积；最后，农户可以在一定范围内选择投保目标价格和投保产量以满足自身的风险管理需要。

上述这些特点与传统农险的特点明显不同，与独立的期货、期权合约也存在差异，在现行美国农作物保险体系中，与其运行特点最为相近的保险产品即是收入保险。本文将对美国收入保险进行分析，以总结出可供我国农产品期货价格保险借鉴的发展经验。

3. 美国联邦农业法案的整体架构及最新进展

美国的收入保险依托于美国农业法案，在对其进行深入分析之前，有必要对美国农业法案的整体架构有大致了解。

美国的农业问题通常是通过一系列的“计划”进行处理，这些计划包括初级商品补贴（Commodity Support）、营养协助计划（Nutrition Assistance）、农作物保险(Crop Insurance)和保护储备计划(Conservation Reserve Program)等。并且这些计划都会通过一定的立法程序以法律的形式加以确定，在明确的时间区间内保证实施。通过定期对现有法典条文的增删修补，体现历届美国政府对农业政策的导向。由于该法律修订过程是对美国农业政策的调整，所以被称为美

国农业改革法案，该法案颁布周期约为 5 年。

农业法案的出台最早可追溯到 1933 年美国罗斯福总统执政时期。早期的农业法案是在农产品生产过剩和农产品价格不断下降的背景下提出来的，其主要政策目标是增加农民收入，此时的农业法案以“农产品计划”为核心。其后数十年中，农业法案针对农产品生产过剩情况经历了数次调整，并于 1949 年通过立法，施行永久性农业法案。但这一阶段的农业法案依然面临农产品价格高时，支持政策对农业和农民收入影响不大；但在农产品价格低时，政策实施成本过高的问题[1]。至上世纪八九十年代农业法案开始向市场化的方向进行改革，主要表现在开始采用市场手段实施“销售贷款补贴”解决农产品储备问题，以及采用农产品“基期”面积计算补贴，实现与农民生产决策脱钩。1996 年至今，美国农业政策已表现出明显的市场化特征，初步形成以农产品计划和农作物保险计划双核心构成的农民收入“安全网”。

2008 年颁布的农业法案已于 2012 年底失效，在政府财政赤字压力巨大、农业经营风险不断增大以及 WTO 规则限制的背景下，亟需通过新的农业法案对现有农业政策进行调整。由于农业是存在着巨大生产和经营风险的产业，世界各国政府大多采取财政补贴的形式对其发展进行支持。美国农业补贴政策的目标是，在农产品生产过剩的背景下为农业提供支持和保护，提高农场主抵御自然风险和市场风险的能力，保持美国农产品的出口竞争优势[2]。因此，美国农业法案的修订和改革实质上是对补贴数额和补贴规则的调整和优化。新的农业法案经过参众两院的审议，最终于 2014 年 2 月正式通过并实施，有效期直至 2018 年，被称为《2014 年农业法案》或《2014 年农场法案》。新法案在农产品计划（Crop Commodity Programs）、农作物保险（Crop Insurance）、营养计划（Nutrition）和保育计划（Conservation）方面作出了显著的调整，改革的整体特点是联邦政府对农业的补贴形式发生了较大变革，补贴结构也进行了微调（见图 1），削减财政对农业的不合理支出，更加倾向于通过市场手段支持农业发展[3]。其中，涉及对农民收入的支持和保障以及农业风险管理的新政策主要分布在农产品计划、农作物保险计划两个部分。

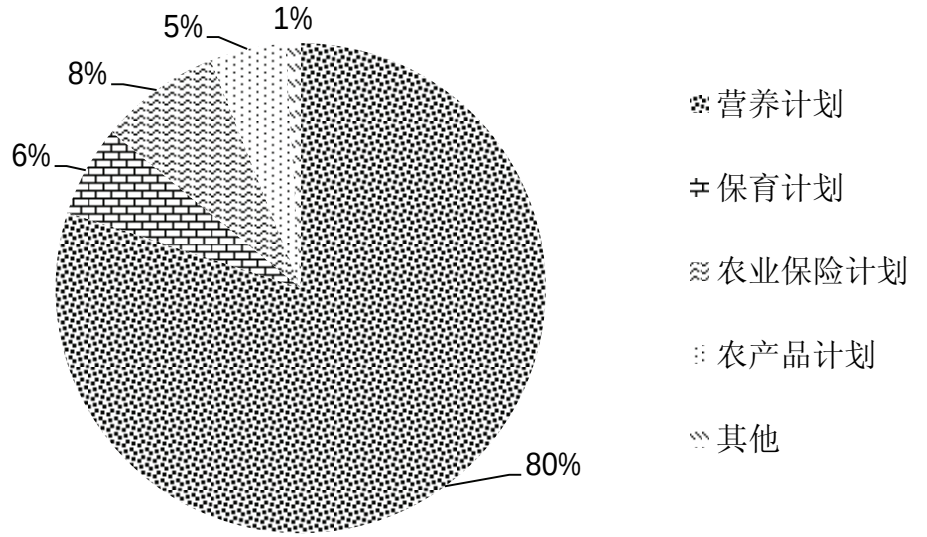


图 1:2014 农业法案财政支出预算图

数据来源：美国国会预算办公室

3.1 对农产品计划的调整

2014 年农业法案在农产品计划的第一部分废除了三项原有补贴计划，即直接支付计划（DP，Direct Payments）、逆周期支付项目（CCP，Counter-Cyclical payments）和平均作物收入可选项目（ACRE，Agriculture Crop Revenue Election），这被认为是此次农业法案中最为重要的变化之一。

直接支付计划（DP）原本是根据农作物种类，按照预先确定的农作物面积、产量和补贴率向农业生产者发放固定补贴。逆周期支付计划（CCP）是在农业部认定项目所覆盖的某种农产品的实际价格低于目标价格时，对该农产品的生产者按照产量和种植面积进行支付。平均作物收入可选计划（ACRE），作为 DP 和 CCP 项目的替代项目，选择该项目的农户将不再享有 CCP 项目的支付，并且将减少 20%DP 项目的支付和 30%的商品贷款补贴率（Commodity loan rates），但可在所在州实际农业收入和农场实际农业收入低于项目保证值时得到支付。

作为上述计划的替代，2014 年农业法案在农产品计划部分新增了价格损失保障（PLC，Price Loss Coverage）和农业风险保障（Agriculture Risk Coverage）计划，农业生产者可以选择其中一项加入。

价格损失保障计划（PLC）与逆周期支付类似，它为种植小麦、饲料谷物、水稻、油菜、花生等计划中所包含的农作物的农民提供补贴。当这些农产品的市场价格下跌至事先预定的参考价格之下时，补贴程序即被触发，其支付机制如下图：

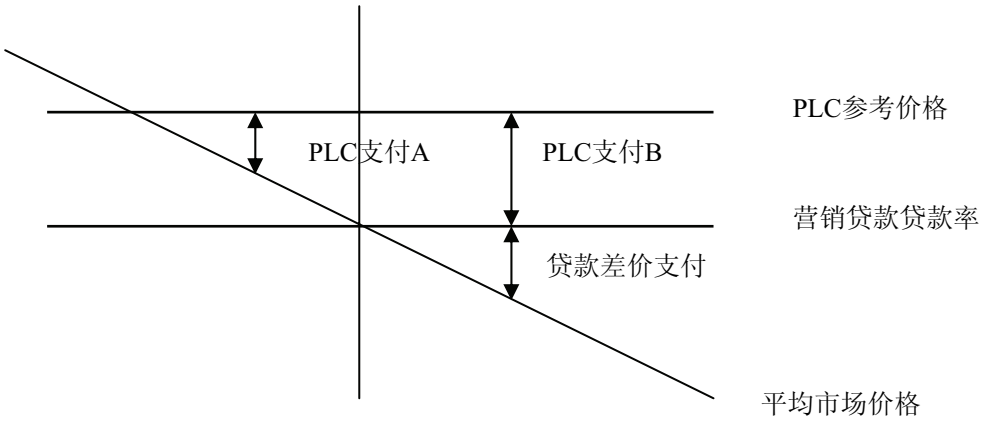


图 2：PLC 计划支付机制

补贴率的计算需要考虑农产品市场平均价格与参考价格、农产品营销贷款[1]价格的相对大小。当市场价格低于 PLC 参考价格，但高于营销贷款价格时，农户收到 PLC 支付 A；当市场价格低于营销贷款价格时，农户收到的 PLC 支付 B 和贷款差价支付之和。价格损失保障计划的补贴数额计算方法如下：

PLC 补贴数额=补贴率×（基期面积×85%）×亩均单产

对某个农场基期面积和亩均单产的确定，农业生产者有一次机会进行选择，即确定是否采用 2008 至 2012 年度的种植面积和 2009 至 2012 年度的作物产出对原有数据进行更新。同时，农业生产者也可以选择所种植的农作物种中的某几种参加该保障计划。但是，上述两种选择一旦做出，在 2014 年农业法案的有效期内不得更改。

农业风险保障计划（ARC）共有两种形式供农业生产者选择，即县域[2]农业风险保障（County-based ARC）和独立农场农业风险保障(Individual ARC),两者在补贴数额的核算上存在一些不同。

县域农业风险保障以某个郡的农作物收入低于该郡基准收入的86%作为触发条件，具体计算方法如下：

县域 ARC 补贴数额=（86%×县域亩均基准收入- 县域亩均实际收入）×基准面积×85%

其中，县域亩均基准收入采用县域奥林匹克单产（Olympic yield）与全国奥林匹克均价（Olympic average of national price）或参考价格中较高者的乘积[3]。

独立农场农业风险保障的触发条件与上述类似，当某个农场所有保障范围内农作物所产生的实际收入低于 ARC 预先设定的保障收入（该农场基准收入的 86%）

[1]农产品营销贷款政策是美国农业贷款政策的一部分，农产品生产者可按各类农产品的贷款率（实质上是预定价格）进行贷款。

[2]国内研究基本都将county做“县”翻译，需要明确的是该含义与国内的县略有不同，其区域大于市，但由于其总量上与中国的县数量相近（美国共有3144个县，中国则有2856个县），译为“县”也较为合适。

[3]奥利匹克单产采用五个年度的单产中去掉最高值和最低值后中间三年的单产平均值，奥林匹克全国均价计算方法与此类似。

时，农业生产者将得到补贴。农场的基准收入是农场中所有保障范围内农作物以种植面积为权重，采用奥林匹克平均的方法计算的加权平均值。具体计算方法如下：

独立农场 ARC 补贴数额=（86%×独立农场基准收入- 独立农场实际收入）×基准面积×65%

3.2 对农作物保险计划的调整

2014 新法案在保留 2008 年农业法案中农作物保险部分的所有项目的基础上，增加了补充保险选择（SCO，Supplemental Coverage Option）和叠加收入保险计划（STAX，Stacked Income Protection Plan）两个保险项目，为不同农作物的生产者提供更完善的收入保障，并且联邦政府为其分别提供 65%和 85%的保费补贴。

补充保险选择计划为陆地棉以外4的农作物生产者提供附加的风险保障，前提是该农业生产者参保了产量、损失保险或其他基础保险项目（Underlying Policy or Plan of Insurance）[4]。农业生产者在参与该计划时可选择保障水平，但不得超过独立农场产量保险项目保险金额的 85%或区域产量保险项目保险金额的 95%。SCO 提供的保障水平还取决于投保农户选择的基础保险项目的保障水平，SCO 项目提供期望收入的 86%与基础保险项目保障水平之间的差额[5]。根据农业生产者投保的基础保险项目和保障程度的不同，补充保险选择计划的赔偿金额有不同的计算方法，即 A 和 B：

A：（86% - 基础保险计划的最高保障比例）× 预期独立农场收入

B：（86% - 实际县域收入/预期县域收入）× 预期县域收入

虽然补充保险选择计划是由农业生产者自愿选择参保，但其参保资格仍受到一定限制，如已加入农业风险保障计划的农户不得参保。

叠加收入保险计划是专门针对陆地棉的生产者而设计的，其赔付条件是参保者所在地区的陆地棉种植收入低于预期收入的 10%时，该计划为陆地棉生产者提供不超过县域收入 30%的保障，是一种浅层次的保障计划。由于其是附加性质的保险计划，其保障水平可以与基础保险项目叠加，叠加后的保障水平可达到 70%~90%，不过保费也会随之提高。其赔偿金额也随基础保险项目选择的不同而不同，具体计算方法如下：

A: min{20%，90% - 基础保险计划的最高保障比例} × 预期县域收入× 保险乘数

B:（90%-实际县域收入/预期县域收入）× 预期县域收入 × 保险乘数5

3.3 对农业贷款的调整

[4]由于受到巴西诉美国棉花补贴案的影响，陆地棉的补贴政策在此次农业法案中几乎都是单独规定的。
[5]最大值为1.2。

2014 年农业法案关于农业贷款的表述主要分布在农业信贷（Credit）和农产品计划中的市场营销贷款（Marketing Loan）部分。对农业信贷的支持基本维持原法案的规模[6]，营销贷款的内容略有变化。

市场营销贷款实质上是一种不带追索权的贷款，新法案在市场营销贷款方面的政策与原法案基本保持一致，主要变化是调整了陆地棉的贷款价格确定方式，新法案规定的各种农产品贷款率如表 1 所示。

表 1: 2014 农业法案农产品参考价格及贷款率

农产品名称	单位	参考价格（美元）	营销贷款贷款率（美元）
小麦	蒲式耳	5.50	2.94
玉米	蒲式耳	3.70	1.95
高粱	蒲式耳	3.95	1.95
大麦	蒲式耳	4.95	1.95
燕麦	蒲式耳	2.40	1.39
籼米	美担	14.00	6.50
粳米	美担	14.00	6.50
花生	吨	535.00	355.00
大豆	蒲式耳	8.40	5.00
其他含油种子	美担	20.15	10.09
干豆	美担	11.00	5.40
扁豆	美担	19.97	11.28
小鹰嘴豆	美担	19.04	7.43
大鹰嘴豆	美担	21.54	11.28

数据来源：2014 农业法案

陆地棉的贷款率则根据之前两年的调整的世界普遍价格(Adjusted Prevailing World Price)确定，但最终贷款率不得低于 0.45 美元每磅，不得高于 0.52 美元每磅。

进行上述调整主要是为了适应农业和美国整体经济的新形势和新变化，主要可以概括为以下几点。一是美国联邦政府在现阶段面临巨大的财政赤字压力。2008 年世界金融危机后，美国经济增长面临巨大压力，2009~2012 财年的财政赤字均在 1 万亿美元以上[7]，有必要采取手段削减政府开支，降低财政赤字。根据美国国会预算办公室（CBO，Congressional Budget Office）估计，未来十年 DP、CCP 和 ACRE 三项支持计划的废除，将合计削减商品计划开支 143.07 亿美元[8]。即使有新的 PLC、ARC 和 SCO 等项目作为上述项目的替代，2014 年农业法案在整体支出预算上仍是减少的，有效保证了财政赤字的降低[9]。二是农业生产和经营的自然和市场风险增大。农业生产是受自然条件影响很大的产业，而进入新世纪以来，频发的自然灾害给农业生产造成了巨大威胁。根据灾害流行病学研究中心（CRED）的数据，2001~2010 年世界各国报告的自然灾害比前 10 年增加 26%，其中，与农业紧密相关的洪涝灾害增加 71%[10]。仅依靠政府固定数额的补贴已经不足以抵消灾害的影响，需要更有效的自然风险管理手段。与此同时，世界农产品市场也处于剧烈的波动之中。据世界粮农组织价格指数显示，粮食价格平均每 17 个月就要经历一次大幅波动，美国作为世界主要农产品生产、出口

国受波动影响更为剧烈[10]。政府需要利用较确定的支出转移这种风险，农作物保险计划无疑是最合适的工具。因此，在 2014 年农业法案中，农作物保险计划得到了补充和加强，并在农业风险管理体系中的占据重要地位。三是 WTO 规则和国际农产品贸易摩擦限制了原补贴规则的运行。

从整体上分析，2014 年农业法案的调整更趋向于利用市场手段支持农业生产，并注重维持市场的公平性，政策执行成本更低，更具针对性。首先，取消直接支付，代之以 ARC、PLC 和 SCO 等保障或保险计划，使补贴对市场的扭曲作用更小。在这种补贴机制下，只有真正受到风险侵害，收入遭受损失的农民可以得到补贴，而那些虽然拥有土地，但已不从事农业生产的个体将不再得到补偿。其次，在存在直接补贴政策时，其他项目补贴额的计算都要基于直接支付的数额或利用有效价格6进行计算，政策操作较为繁琐。新法案取消了直接补贴后，各项目补贴额的计算更为直观，操作也更为简单，降低了政策的执行成本，有利于农业生产者对自身的保障程度进行有效估计。最后，美国政府所担忧的农业风险增大和 WTO 补贴规则限制都通过加强农作物保险体系和增加对农作物保险计划的预算等方式得到较好的解决，在不违反 WTO 规则的情况下，改变补贴结构和方式，利用价格损失保障计划、农业风险保障计划等构筑了更为牢固的农业安全网。

4. 美国“期货+保险”的创新——收入保险产品的演进过程

美国不仅农业发展水平较高，其商品经济、金融市场的发展也都处于发达和领先的阶段。因此，商品流通和金融领域中的风险管理手段被广泛的应用于农业风险管理之中，并且取得了较好的效果。其中，农产品期货和农产品价格保险是在农业领域应用较早，具有特色和借鉴意义的农业风险管理技术。

4.1 对农产品期货的应用

美国农业生产者对农产品期货的利用具有其独特的优势。其一，美国是世界上最早建立期货交易所的国家，自 1848 年芝加哥期货交易所成立以来，美国期货市场已经历经 160 余年的发展，各项交易规则和管理制度都已经臻于成熟，非常适合农产品期货的发展。具体来看，美国农产品期货市场产品丰富，目前有玉米、豆粕、小麦等 30 多种农产品的期权和期货合约上市交易，大部分农产品都可以在交易所内找到对应的产品；其二，美国期货市场参与主体非常广泛，农产品现货经营企业、个人或机构投资者以及代表农产品生产者利益的中介机构等都可以借助期货市场实现其目标。这种套期保值者与风险投机者共存的市场容易产生活跃的的交易，有利于期货市场价格发现功能的实现；其三，美国期货市场能够与现货市场实现良好对接。期货合约到期前如果未进行平仓操作，到期后

[6]一般是平均市场价格与直接支付之和。

就要进行实物交割。而期货市场中的期货合约都是标准化的，对农产品而言，期货合约除了规定农产品的交易规模以外，还要对农产品的质量标准加以限制。美国规模化的生产方式使农产品品质较为均一，便于实现与期货合约对决，减少后期现货交割阶段出现纠纷的可能性。

美国农户对农产品期货市场的利用由来已久，近年来运用农产品期货和期权进行套期保值的农户比例已经达到较高水平。由于期货市场的交易对保证金和交易技术都有要求，美国农户对农产品期货市场的应用可以概括为两种方式，即直接参与和间接参与。

直接参与方式即是农户作为期货市场主体直接与对手方进行交易。采用该方式进行交易的农户主要是少数大型农场的农场主，故以这种方式参与期货市场的比例并不高。大农场主生产规模大、资金相对充足，自身对价格风险的规避需求强烈，又能够满足期货交易的条件，各种农业服务机构为其提供了交易信息和期货交易知识培训，主客观上均具有直接参与期货市场交易的条件。

相对于少数大农场主，规模中小型的家庭农场经营者是美国农业生产者的主要构成，他们参与农产品期货市场主要采取间接的方式。这些中小规模的农业生产者农产品产量较小，不能适用期货市场的交易规模限制，或者资金规模有限可能无法满足农产品价格剧烈波动时追加保证金的需要。因此，当其直接参与农产品期货市场时，可能无法完全规避价格波动的风险或者有面临较大损失的可能性，即使有农业服务部门提供相关信息知识，农户出于自身经济性的考虑也不会选择直接参与期货市场交易。针对中小型农业生产者的经营特点，间接参与方式较好的满足了其规避市场风险、套期保值的需要，有 52%以上的农场主通过这种方式参与农产品期货市场[11]。间接参与方式的最简单描述就是农户通过与各种农业合作社或其他中介机构签订合约，由其代理参与农产品期货市场交易。这些合作社或中介机构或代表农业生产者代销农产品，或从生产者处购买商品进行转售。无论是哪种情况，他们都会在与农业生产者签订远期合约后，按照合约中的数量和价格在农产品期货市场上建立头寸进行套期保值操作。农业生产者在此过程中不仅有效转移了市场风险，还能根据“惠顾比率”（Patronage Rate）最大程度的获得期货市场上的收益[12]。中小型农业生产者通过间接参与农产品期货市场能获得较高收益，这是也合作社等中介机构在美国农产品期货市场中非常活跃的原因。

4.2 对产量保险的应用

美国农作物保险体系经过 70 多年的发展，目前已经成为世界上农作物保险产品最丰富、保障层次最多样化的国家，其中尤以农作物收入保险发展最好，其 2015 年度保费收入占农作物保险保费总收入的 80%以上7。不过，农作物收入保

[7]数据来自美国农业部农业风险管理局，由作者计算整理得出，
https://www3.rma.usda.gov/apps/sob/current_week/insplan2015.pdf。

险并不是在美国农作物保险开办之初就出现的保险产品，而是在 1996 年以后才逐步发展起来的新险种，美国早期的农作物保险是以产量保险为主体而发展的。有学者指出，美国农作物保险在以产量保险为主的发展阶段并不成功，农户参保率不高，保险公司不愿经营，直至农作物收入保险发展成熟之后，农作物保险体系才得到各参与主体的认可[13]。虽然如此，农作物产量保险却为收入保险的发展积累了经验和数据，奠定了发展基础，有必要对其进行简单分析。

农作物产量保险即是以产量的变化作为赔付触发条件的保险，其中农作物巨灾保险（CAT，Catastrophic Coverage）、产量保障保险（YP，Yield Protection）最为人熟知。农作物巨灾保险是产量保险中最基本的形式，也是整个农作物保险体系最基础的“安全网”。参与农作物巨灾保险的被保险人在发生损失时可以获得以正常产量 50%以上和参考价格的 55%计算的赔偿，参保农户享受全额保费补贴，仅需缴纳管理费，但农作物巨灾保险的保障程度偏低，单独投保该险种的农户比例很低。产量保障保险是产量保险类产品中最有典型意义的险种，它本质上是一种多风险农作物保险（MPCI，Multiple Peril Crop Insurance）。产量保障保险需要农户在投保时确定产量保障水平和价格保障水平。其中产量保障水平在实际历史产量（APH，Actual Production History）的基础上确定，从 50%至 85%，每 5%为一档；价格保障水平根据期货市场特定合约均价确定，从 55%至 100%，每 5%为一档。之所以称为产量保障保险，其触发条件保证产量低于实际产量，确定价格只是为了将赔付转化为货币支付。产量保险还包括如团体风险保险计划等一些形式，但只是在产量与价格的确定方面存在差异，赔付的触发条件都是一致的。如前文所述，产量保险并没有取得理想的效果，有学者分析的一种原因是，农场主进行农业生产的目的是收入最大化而并非产量最大化，产量保险的目标与农场主生产的目标并不一致[14]。这就会对政策参与主体的行为产生扭曲，无法达到相应的政策效果。虽然，农作物产量保险存在一定不足，但其数十年的发展，为农作物产量的估量积累大量数据和经验，为农产品收入保险的试点奠定了基础。

4.3 对收入保险的应用

在美国，农作物收入保险凭借其贴近农业生产者风险保障需求、不易引起农作物过量生产等优点，在近些年中的发展迅猛。该类保险保障责任范围内因素导致的农作物产量减少、价格波动或二者共同导致的投保人实际收入低于保证收入的部分，它与产量类保险最大的不同是其赔付的触发条件是收入，而非产量。根据保险保障的是某种农作物产生的收入还是整个农场所有农作物的收入，以及产量的确定基础是农场单产还是区域单产这两个条件，可以将农作物收入类保险进行以下划分。

表 2：美国农作物收入类保险的类型

	以农场平均单产为基础确定产量	以区域平均单产为基础确定产量
针对某农作物收入	收入保障保险（RP）	区域作物收入保险（ARP）
针对整个农场收入	以调整总收入为基础的农场收入保险（AGR）	

农作物收入类保险中最基本、最具代表性的险种是收入保障保险（RP，Revenue Protection），其具体的保险责任是保障被保险人因灾害而导致的产量下降或因收货价格偏离预测价格两种因素引起的收入损失风险。是否达到“保证收入”是收入保障保险的触发条件，而“保证收入”数值的大小取决于投保人选择的实际历史产量保障水平和预期价格、收获价格中的较高者两个因素。具体的计算公式如下：

单位面积保证收入= 农场历史平均单产 × 保障水平 × max｛预期价格，收获价格｝

其中，历史平均单产根据农场的历史平均产量确定，预期价格和收获价格则由期货市场上对应合约的价格决定8。

与收入保障保险类似，区域作物收入保险（Area Revenue Plan）的赔付触发条件也是“保证收入”。不同的是，区域作物收入保险的保险责任是当区域内平均实际单产低于投保人所选择的“保证收入”水平时给予被保险人赔偿，与投保农作物是否发生实际损失无关。该险种在一定程度上避免了收入保障保险因历史产量数据不完整、不准确等原因引起的道德风险，也是收入类保险中非常重要的一个险种。

除了上述两个险种外，还有一种处于试点阶段的收入类农作物保险——调整的总收入保险（AGR，Adjusted Gross Revenue）。与上述险种的区别在于，它不针对某种特定的农作物估计价格或估计产量，而是对整个农场的收入提供保障。农场的调整总收入数据来自美国国内税务局的税务申报表以及农场的年度报告[15]。其承保的风险内容与收入保障保险基本相同，也是农作物收入保险体系组成部分。

上述各种农作物收入保障工具相互之间看似是平行运作的关系，而事实上，早期保障工具的发展是为新保障产品的出现创造了必要条件。农产品期货市场相对联邦政府主导的农作物保险而言是先形成的市场。农产品期货市场的发展和成熟为农产品价格的形成良好的机制，在此机制下得出的价格能够有效地反映市场供求关系。而产量保险的开展除了引起农户对自身农作物产量的关注外，更重要的是积累了不同规模农场的产量数据9。这些长区间的数据基本上避免了人为因

[8]不同种类的农作物所采用的期货合约时间也不同，例如玉米的预测价格采用芝加哥期货交易所12月份期货合约在次年2月份各交易日的平均价格，收获价格则采用12月份期货合约在次年10月份各交易日的平均价格，以对应不同农作物的收获期。

[9]更早期、更具体的数据仍来自美国农业统计局（NASS），这里仅指适用于农作物保险中预测产量确定的数据

素对产量的影响，能够反映不同地块的生产能力和风险程度，便于对其产量进行预测。农作物收入类保险之所以能够得到参与主体各方的肯定，很大程度上得益于其产量和价格的有效估计降低了农作物保险经营中的道德风险，提高了农作物保险与农业生产者经营目标的契合度。

5. 美国“期货+保险”类产品的经验总结

整体而言，美国“期货+保险”类产品是基于美国农业经营模式而设计的，具有鲜明的特色，不一定适合其他国家。但是，该类产品能够在美国得到较好的发展，必然是其满足了农业生产中风险管理的需要。其中，有一些共性因素可供我国农产品期货价格保险的深化试点过程中进行借鉴。

5.1 产品定位注重与农业政策的顶层设计相配合

美国人均耕地面积大、农业技术水平高且自身也是世界头号经济强国，这是其农业发展得天独厚的优势。但是，美国能在世界农产品市场上占据如今的重要地位却是和其对农业政策顶层设计的一贯重视密不可分。美国利用农业法案制定其农业政策已有 80 余年，所涉内容巨细无遗，公开透明，且最终以法律形式加以确认，体现其效力上的权威性。关于农作物保险的内容是农业法案中的一个重要章节，每种新类型农作物保险的产生都会在其中明确其适用对象和赔付机制，并由相关农业经济研究部门对其进行研究，衡量其对其他农业政策的影响和对整体农业财政预算的影响。新法案需经参众两院各利益相关方代表审议通过后方可颁布，在保证各方面利益的基础上实现农业在未来数年的发展目标。收入保险的出现是为了满足农业生产者在产量增加时总收入因价格的下降而下降的风险保障需要，同时保障了产量风险和价格风险，因此也必然会对产量保险和一些农产品价格支持政策产生一定替代。但是，由于其对农业生产的整体支持效果更好，近年来支持力度逐渐加大，并对相关政策进行调整，使其保障内容相互配合，不至过度重叠。

5.2 风险保障程度的阶梯性和可选择性

美国的农作物保险（特别是收入保险）能够在其农业风险管理体系中占据重要地位，固然与美国农产品市场和金融市场的发达程度有关，但更重要的原因是各种农作物保险产品的保障程度都可以根据农业生产者需要，由其自主选择。其阶梯性体现在，农作物巨灾保险（CAT）为农户提供最低一级阶梯的保障，其余保险产品则在此基础上以价格或产量的 5%的水平逐级提高保障程度。可选择性则建立在阶梯性之上，农业生产者根据自身风险承担能力和风险偏好水平选择保障水平，并缴纳相应保险费，充分实现自主选择。在这种保障的机制下，不同类型的农户都可以获得适合自身的农业风险管理组合，避免了同一费率和保障程度条件下的保险需求和供给不匹配的问题，有助于实现整体农业生产的稳定。

5.3 产品的设计注重信息搜集和积累机制

保险产品的设计和开发一般都对历史数据具有较高的要求，美国农业长期而全面的数据系统是美国农作物保险产品能够达到预期效果的重要基础。美国设有国家农业统计局，定期会对农业基础信息进行调研，其早期的农业数据就相对丰富。在农作物保险的发展过程中，美国经历了从“产量保险”向“收入保险”的转变，而后者的成功很大程度上得益于产量保险产品经营过程中所积累的产量数据，保险公司可以借此评估农户的正常收入水平。在收入保险的经营中，保险公司也通过机制设计促使农户主动申报产量和收入水平。在这种机制下，农户通过申报信息获得更高的保障水平，保险公司也能利用信息更精确的评估风险，进而实现“双赢”。

6. 对我国农产品期货价格保险发展的政策建议

如前所述，“农产品期货价格保险”试点是基于我国农业经营现状和期货市场发展阶段而进行的创新性尝试，其出现实质上实现了农户借助保险公司以利用期货市场分散农产品价格风险的功能。该功能与美国农产品收入保险存在一定程度的相似性，即同时利用农产品期货市场的价格发现功能和保险市场的风险保障功能。因此，本文在借鉴美国收入保险发展经验，并根据我国所处的农业发展阶段的基础上，对我国农产品期货价格保险的进一步试点提出以下政策建议。

6.1 产品设计应注重发挥各类市场优势

我国农产品期货价格保险是将农产品期货市场功能与保险市场功能相结合的产物。农产品期货市场的功能优势在于价格发现。从美国的发展经验看，农业经营的市场化是其长期发展趋势，农产品期货市场强势有效，价格形成也趋于市场化。而在我国，大量的补贴和政府的托市收购政策对市场价格产生了巨大的扭曲，造成农产品供求双方的经营困境10。因此，市场化的农产品价格形成机制对我国农业的可持续发展非常必要。我国国内期货市场交易量和交易次数已经显著增加，其价格发现职能逐渐凸显。有研究表明，我国期货市场的有效性已具备开展收入保险的条件[16]。然而，期货市场产生的价格往往波动剧烈，我国农业经营主体的规模有相对较小，单个主体往往并不具备利用期货市场规避价格波动的能力。此时，保险市场风险转移优势就能够得以发挥，利用保险公司和农业经营者较密切的关系，设计符合其需求的期货价格保险合约，可以在促进市场价格形成机制建立的同时降低农户收入风险。

6.2 扩大产品保障水平的可选范围，满足不同类型农户的收入保障需要

[10]具体例子如临时收储政策短期内抬高了农作物价格，造成农作物加工企业成本高企、原材料缺乏，而农户则因为临时收储的地方限额不得不四处奔波，售卖农产品。

目前，农产品期货价格保险尚处于试点初期，现有合约[11]的内容中所包含的目标价格范围较小，投保农户或农业合作社可以选择的范围较窄。在当前农产品期货价格保险的业务量不大的情况下，合约双方可针对保费和保障水平进行一定程度协商，但不利于该产品的大范围推广。现阶段，我国农业生产方式正处于从传统分散的小农经营模式向规模化经营模式过渡的转型期，各种规模的农业生产者并存，这就决定了对此类农业保险的保障程度的需求具有多样性，期货价格保险产品也必须适应这种多样化的需求特点。在美国农作物保险的发展历程中，通过选择目标价格或目标产量的百分比来实现保障水平的多样化被证明是一种较为成功的经验。因此，在农产品期货价格保险的设计中，采用不同目标价格百分比对应不同保费水平的机制可能会吸引更多的农业生产主体购买此类保险，从而增加该保险产品的覆盖范围。

6.3 在产品经营过程中逐步建立农户数据库

美国发展经验表明，农业数据的质量优劣是决定一类保险产品成功与否的关键因素，美国收入保险的良好发展势头得益于其对各农场历史产量数据的较准确掌握。我国农产品期货价格保险其实也是针对农业生产者产量数据缺乏，不足以开展收入保险条件下的创新。但从更长远的角度看，农业生产者的生产经营数据对农业保险的可持续发展具有重要意义。一方面，当前农产品期货价格保险的目标价格是根据历史数据计算的，保障产量由合约双方协议确定，并未加以限制。农业生产者在价格有保障的情况下，有扩大生产规模的激励，在未来农产品期货价格保险承保规模逐步扩大的趋势下，可能会给保险公司带来较大的经营风险。通过对参保主体产量数据的跟踪，可以防范生产规模盲目扩大的潜在风险。另一方面，我国农业保险体系的转型升级仍需要发展保障程度更高的产量、收入保险，投保农户数据库的建立能够为此类保险产品的开发奠定必要基础。

6.4 积极争取中央补贴，增加期货价格保险的潜在参保主体的积极性

我国传统农业保险保费补贴政策采取的是统一补贴率政策，这种政策与保障水平高低、农作物品种和农民的种植规模无关，无法取得保费补贴效用最大化[17]。这种补贴的范围也只限于传统农业保险，目前在大连试点的农产品期货价格保险仅由地方政府及监管机构给予支持，支持力度较小。此外，由于此类保险产品的设计和操作都较为复杂，且不易标准化，故保单成本较高，相应的保费更是远高于享受保费补贴的传统农险。在这种补贴机制和保费水平下，农产品期货价格保险的有效需求非常有限，难以大面积推广。因此，必须积极争取中央财政的补贴，设法降低该产品的保费价格，使那些农产品生产效率和商品化率高，对国家粮食安全贡献较大，但资本实力相对较弱的新型农业经营主体能够产生有效需求，提高其参保积极性，从而扩大农产品期货价格保险的承保规模。

[11]中国人保财险大连市分公司分别与锦州市义县桂勇玉米种植专业合作社、义县华茂谷物种植专业合作社以及北京伟嘉集团签订了国内首份农产品期货价格保险合同。

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农产品期货价格保险溯源及其对我国的启示
——基于农产品期货及收入保险的分析

孙蓉, 徐斌

孙蓉
教授
保险学院
西南财经大学
四川省成都市温江区柳台大道555号
电话： (86)13688409637
Email: sunrong@swufe.edu.cn

徐斌*
博士生
保险学院
西南财经大学
四川省成都市温江区柳台大道555号
电话： (86)18010627599
Email: 28512969@qq.com

摘要:本文以我国农业现代化对市场价格形成机制的内在要求为研究背景，对在我国大连试点的期货价格保险产品进行溯源。重点分析了美国农产品期货价格保险的类似产品——农产品收入保险和其承载主体美国联邦农业法案的主要内容和最新进展，总结了美国农户收入保障体系的发展经验。最后，在基于我国当前的农业发展阶段和美国经验适用性的基础上，提出相应的政策建议。

关键词：农业法案；农产品期货；农产品收入保险；

The Influence of Ownership Structure of the Greater China Listed Insurance Companies on Corporate Performance

SUN Yuejun, ZHANG Ciyuan

SUN Yuejun*
Postgraduate
Central University of Finance and Economics
Beijing 102206, China
Phone: 18500326298
Email: syj772@ 163.com

ZHANG Ciyuan
Postgraduate
Central University of Finance and Economics
Beijing 102206, China
Phone: 15856710066
Email: moguwa2013@163.com

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Abstract. With the development of the insurance market, competition among the insurance companies increases fiercely. The competition of the insurance companies is reflected in many aspects, the core of which is the modern insurance company's governance mechanism. Ownership structure is regarded as the basis of corporate governance. It fundamentally determines the company's decision-making mechanism as well as incentive and restraint mechanism, which ultimately influence the company's behavior and business performance. Therefore, ownership structure has an important impact on its business performance.

Comparing to previous researches about insurance company ownership structure and corporate performance, our research has the following innovative points: Firstly, from the perspective of the Greater China region, we choose our investigated subjects from the Chinese mainland; Hong Kong SAR and Taiwan, China's insurance companies and we collect the annual panel data from 2010 to 2015. Therefore, the research results would be more inclusive. Secondly, we use fifteen indicators to measure the performance of listed insurance companies through statistical methods. In this case, we overcome the possible bias of previous studies which use the stock price changes to measure the performance of the company. Thirdly, in terms of the explanatory variables, we analyze the influence on the corporate performance from the following two aspects: the ownership structure and the board structure.

This paper is mainly divided into four parts: the first part is a literature review, analysis and summary of the relevant research results. The second part is the data source and theoretical research. In order to ensure a more accurate measurement of business performance, we collected 15 indicators, such as net assets income rate, capital utilization rate and so on. Through the factor analysis method, we propose five dimensions of the insurance company performance evaluation index, which are profitability, capital management, managing ability, risk management ability and development potential. The third part is empirical research. This paper uses the panel data to analysis the influence of ownership structure on corporate performance. The results are as following: Firstly, two variables, the biggest shareholder's equity ratio and corporate performance, have a positive relation, significant at 1% level. The ratio of former five shareholders' shareholding and the ratio of the first major shareholder holding shares and the sum of the second to fifth major shareholders holding shares have a negative correlation with operating performance, significant at 1% level. It indicates that the concentration of power and the fixed large shareholders play a positive role in the sustainable management of the enterprise, and will give the investors a positive suggestion. Equity balance of the company's governance plays a positive role; the more decentralized equity distribution is more conducive to the company's business. The type of actual controller and business performance has a positive relation, significant at 1% level. This result may be interpreted as the insurers who are controlled by government have better resources in China and it cause that the governance of State-owned insurance company is better than private insurance companies. The proportion of Independent directors and operating performance has a positive relation, significant at 5% level. The impact of the executive stock ownership rate on the company's business is not significant. The reason may be the sample size is not large enough. However, it can reflect the current status of China's insurance companies from on the other hand, hat is to say, due to the imperfection of the reward and punishment system, the impact of the executive stock ownership rate on the company's business can be ignored. In the last part, we analyze the results of empirical research, and put forward some concrete suggestions on how to establish a more reasonable equity structure.

1. Introduction

With the development of the insurance market, the insurance companies are facing fierce competition as the main part of the market. The competition of the major insurance companies is reflected in all aspects, the core of which is the modern insurance company's governance mechanism. It is generally believed that corporate governance includes internal governance and external governance. More and more scholars believe that the internal governance is the core, and the arrangement of the ownership structure is the key foundation of the governance mechanism. A good ownership structure can optimize the composition of the board of directors, influence shareholders' behavior, stimulate and restrict managers effectively and promote the company to form the governance structure of mutual checks and balances, so as to improve the operating performance of the company and maximizeof the value of the company.

2. Related work

Foreign insurance companies have many arrangements of property right, such as joint-stock system, mutual system, Lloyd, etc. So researches on the ownership structure mainly concentrated in comparison to the influence on the operating performance of the joint-stock and mutual system insurance companies.

Spiller.R (1972) believes that it's the separation of ownership and operating rights of the joint-stock insurance company, share ownership plays a great role in promoting the company's performance. Jensen and Meekling (1976) believe that the increase of the proportion of the internal shareholders of the control right of the company's equity can effectively produce management incentives, reduce agency costs and improve enterprise value. Mayer and Smith (1981) think that one needs to use the form of joint-stock companies and give CEOs high salaries if you want to improve the efficiency of enterprise management, considering the relationship of the ownership structure and executive payment. Mayers, David and Clifford Smith, Jr. (1986) by using the data of 30 mutual life insurance companies which are transformed from the joint-stock system shows that the premium incomes' growth rate remained unchanged, management turnover decreased, so the conversion improves the efficiency of insurance companies on average. M. Carson, D. Forster and J. McNamara (1998) using probit model, analyzing respectively the free cash flow, earnings distribution, assets, operating expenses and losses. The results show that the joint-stock insurance company capital requirements is higher than a mutual insurance company and it's helpful to improve the enterprise performance since the cash flow and joint-stock system have very high correlation.

n addition, some scholars have studied that the ownership structure has little effect on the performance of the company. J. McNamara and s. Ghon Rhee (1992) shows that joint-stock companies have no significant effect on the premium incomes, cash values, the refund rate and business expenses through the investigation of 33 life insurance companies.W. Pot- tier and W. Sommer (1997) using agent theory to investigate the

operational, financial and organizational structure of the life insurance company equity system of the decision factor. It is concluded that the joint-stock companies are more in the form of group, the improvement of performance is not significant. Mutual companies generally have higher ratings, the more they are older, the more likely they are to adopt the form of mutual. C. Lai Gene and Limpaphayom Piman (2003) test the impact of the property rights structure of non life insurance companies in Japan on performance, incentive problems, and financial decisions. The cost and free cash flow of joint-stock companies is lower than mutual insurance companies, but the investment benefits of mutual system is higher than the joint-stock companies,and it's financial risk is lower. Jeng Gene, C. Lai Vivian and McNamara J. (2007) use enterprise value added method and financial intermediation method to empirically test the change of the operating efficiency of life insurance companies in the United States from 1980 to 1999. The result of the test of the value added method is the high efficiency of the pre stock. The result of the test by the financial intermediary method is opposite, but the final conclusion is that there is no significant improvement in the efficiency of the stock.

it's relatively late for the domestic insurance companies to carry out the reform of the shareholding system, so the studies on the relationship between ownership structure and performance of insurance companies is relatively late.

On the one hand, some scholars think that the ownership structure and firm performance have positively relationship: Tang Ruolan (2001) of the state-owned insurance company property right reform suggested that the vague property rights caused by declining competitiveness, the state shares should occupy a considerable proportion in order to carry out shareholding system reform.Yao Shujie (2005) uses a set of data of the 22 Chinese insurance company in 1999 ~ 2002 and the DEA method to evaluate their efficiency scores. The empirical results show that: domestic joint-stock companies, joint ventures and foreign insurance company subsidiary is more efficient than the state-owned insurance company.Mao Ying, Shu Tingfei (2008) found that in the framework of the theory of equity balance, the high concentration of equity is a wildly existed drawback in currently China's Insurance Group, and they put forward to make the ownership structure diversified and pay attention to group company status. Li Shuangjie, Yang Yi (2008) analysis the performances of 35 domestic insurance companies though the input oriented data envelopment analysis model.The results show that in order to improve and develop the governance structure of state-owned insurance companies, we should continue to actively promote with conditional state-owned insurance company reorganized and listed on the stock market.Xiao Xia Xie, Li Jinn (2009) analysis the relationship of the listed insurance company equity structure, the board of directors' characteristics and the operating performance though the multiple regression model and draw the following conclusion: Government Shareholding, executive shareholding ratio and insurance company performance is positive relationship, namely government shareholding ratio increased and managerial ownership will be conducive to improve the performance of the insurance company; foreign strategic investors is not conducive to improve the

performance of the insurance company.

On the other hand, some scholars believe that the property rights structure and corporate performance have negative or less relevant: Huawei (2006) believes the structure of property rights of insurance institutions has no effect on the cost efficiency and profit efficiency.Unilaterally changing insurance property right structure cannot effectively improve the efficiency. The corporate governance structure, organization, marketing system, asset scale and product diversification is the main factors of the influence on the efficiency of China's insurance industry. Chunghwa Li, Xiao Qin Wei, (2007) study showed that the relationship between corporate performance and ownership structure of Listed Companies in 2003 ~2005 is poorly steady, mainly due to a single stock structure and relatively concentrated ownership in China. Lu Yuan (2009) using a network data analysis pointe out that the share governance mechanisms of Chinese funded insurance companies have yet to fully play its role, the ownership structure and governance remains in the structure the changes, the interaction mechanism of the property and control rights have not into the optimization of governance mechanism deeply.

Through the above overview of the literature we can see that abroad studies is mainly concentrated on the effect of different arrangements of the property right system on the performance of insurance companies.The research on the relationship between the governance structure and performance of insurance companies in China starts late, and it mainly concentrates on the influence of ownership structure on performance, and does not consider the influence of board characteristics on performance.Board of directors play a guiding and monitoring role in the day-to-day operations of the company, and the board of directors structure to a large extent is determined by the ownership structure, only if taking the board of directors into consideration, the study on relationship between ownership structure and performance can better reflect the relationship. In addition, the current domestic researches' objects are China's listed insurance companies in mainland, due to the influence of the special situation of China, the study only on mainland insurance companies is rather one-sided, and there will be no strong reference.

So from the perspective of the Greater China region, this article selects Chinese mainland, Hong Kong SAR and Taiwan, China listed insurance companies, combines with the characteristics of the board of directors, and analyzes the relationship of their ownership structure and the performance empirically, so as to provide suggestions for further improvement of the governance structure of insurance companies in our country.

3. Assumptions on the Relationship between Ownership Structure and Operating Performance

3.1 The hypothesis of the relationship between ownership concentration and operating performance.

Equity concentration ratio refers to the proportion of large shareholders holding

company shares and their mutual relations. Equity concentration is an important indicator to measure the distribution of the company's equity, and also an important indicator to measure the strength of the company's stability. For China's current listed insurance companies, frequent changes in the major shareholders not only affect the continuing effectiveness of the business, but also have a negative impact to the outside investors.

Assumption 1: The largest shareholder shareholding ratio (S_1) was positively correlated with business performance;

Assumption 2: The ratio of the first largest shareholder and the proportion of the second to fifth largest shareholder (Z_5) is negatively correlated with business performance;

Assumption 3: The sum of the proportion' square of the top five major shareholders (H_5) is negatively correlated with business performance.

3.1.1 *The hypothesis of the relationship between the actual controller's property and business performance.*

For the influences of Government Shareholding Ratio on the business performance of enterprises in our country,there are mainly two different views. Some people think that with the strength of a strong government support, it's easy to enhance the company's capital strength, gain the relevant policy supports and promote the rapid growth of the company. Another thinks the government shares will bring multiple principal-agent problem, leading politicians to achieve personal goals regardless of the loss the interests of the company, so the management efficiency is lower. It is not conducive to the development of the enterprise. Considering the history of China's insurance industry, in order to obtain the huge success of the insurance industry, It is necessary to have strong capital strange support, so in the current stage, the state as the actual controlling person has a positive impact on business performance.

Assumption 4: The state as the actual controller (G) has a positive impact on the business performance.

3.1.2 *The hypothesis of the relationship between executive incentive and business performance.*

Incentive mechanism, as an important aspect of internal governance, will certainly have a great impact on enterprise performance. The equity incentive in our country is usually used as an important incentive measure by the listing Corporation, especially for the top executives. According to the principal-agent theory, the contradiction between the owner and the operator is mainly some aspects of the problem of the conflict of interests, if allow the operator to hold company shares, its operating performance and its own interests and is closely related to. This reduces the and conflict of interests between the owner and the is the improvement of supervision cost and reduce enterprise performance.

Assumption 5: Executive stock ownership (E) and business performance are positively correlated.

3.1.3 The hypothesis of the relationship between the characteristics of the board of directors and the operating performance.

The board of directors as one of the core mechanisms of Modern Corporation governance, its governance efficiency directly affect the performance of the company. The independent directors and the internal directors are not the same, the latter may be more directly subject to the controlling shareholder and the company's managers, therefore, the existence of independent directors are more conducive to the board of directors of the company's independent judgment. Therefore, the board of directors of the higher proportion of independent directors, the board function can be effectively played, and then improve the operating results of the insurance company.
Assumption 6: The proportion of Independent directors(I) and operating performance were negatively correlated.

4. Factor analysis of comprehensive performance

4.1 Introduction

Many scholars use earnings per share, return on total assets or return on net assets to measure business performance, this paper argues that these single financial indexes cannot include the amount of information, and also easy to be manipulated, so it's different to fully reflect the real business performance of the listed insurance companies.In fact, business performance is not only reflected in profitability, but also reflected in the capital management ability, operation ability, risk management ability and development potential. Therefore, it's necessary to find a method to estimate the company performance comprehensively. Compared with a single index, a comprehensive index is hard to be manipulated and has great advantages.

4.2 Data

Considering the development level of China's capital market and the characteristics of insurance companies, this paper selects 15 indicators which can fully reflect the operating performance of insurance companies.Table 1 shows the structure of comprehensive index system.

Table 1. comprehensive index system

index	expressions	
Return on total assets	Net margin/average assets×100%	profitability
Net assets income rate	Net margin /average net assets×100%	profitability
Net rate of return on investment	Net investment amount/average investment assets×100%	profitability
Investment assets to total assets ratio	average investment assets / average assets×100%	profitability
Net profit growth rate	Net profit margin /net profit in last year×100%	profitability
Turnover rate of net	Operating income / average shareholders' equity ×100%	Operating

assets		
Turnover rate of total assets	Operating income / average total assets ×100%	Operating
Operating income growth rate	(ending operating income - initial operating income) / early operating income ×100%	Operating
Capital utilization ratio	Insurance revenue / owner's equity ×100%	Capital management
Asset liability ratio	Average Liabilities / average assets ×100%	Capital management
Premium retention ratio	Net premium / insurance business income ×100%	Capital management
Operating ratio of liabilities	Liability / owner's equity ×100%	Capital management
Premium income growth rate	(ending premium income - initial premium income) / premium income ×100%	Development potential
Total asset growth rate	(total assets at the beginning of the period) / total assets at the beginning of the period ×100%	Development potential
Growth rate of net assets	(net assets at the end of the period) / net assets at the beginning of the period ×100%	Development potential

Based on the 15 indicators listed in Table 1, this paper uses factor analysis to evaluate the comprehensive performance of listed insurance companies. There are only four listed insurance companies in mainland China which are Chinese Pacific Insurance (Group) Limited, Xinhua Life Insurance Company Limited, China Life Insurance Company Limited and China Ping An insurance (Group) Limited, and in addition to China Ping An insurance (Group) Limited, the remaining three corps are state-owned enterprises, so this paper selects the representative Chinese life insurance Limited, Xinhua Life Insurance Company Limited and China Ping An Group Limited as well as the other two representative listed life insurance companies in Hong Kong SAR and Taiwan, China which are AIA (Hong Kong) Limited and Cathay life insurance company Limited.

In order to make comprehensive and accurate analysis results, this paper selects recently five-year financial data of the five listed insurance company.

4.3 Model and Results

Table 2. Factor characteristic value and contribution

factors	Initial eigenvalue		
	score	Explained variance %	accumulation %
1	4.816	32.108	32.108
2	2.778	18.518	50.626

3	1.861	12.407	63.032
4	1.315	8.766	71.798
5	1.153	7.687	79.485
6	0.902	6.015	85.501
7	0.603	4.02	89.52
8	0.574	3.826	93.346
9	0.4	2.668	96.015
10	0.304	2.028	98.043
11	0.172	1.149	99.192
12	0.071	0.474	99.667
13	0.03	0.2	99.867
14	0.015	0.097	99.964
15	0.005	0.036	100

Table 2 shows characteristic factor value and contribution rate which calculated by SPSS20.0. The first 5 mainly factors have the cumulative contribution rate by 79.485%, that is they together explain the 83.842% this five listed life insurance companies' comprehensive performance index of the variance, embodies the most information of original data, so choose the five common factors instead of the original 15 indicators.

Table 3. Rotated Component Matrix

	Main factors				
	1	2	3	4	5
Return on net assets	-0.004	0.028	0.263	0.188	-0.07
Investment assets ratio	-0.128	0.319	-0.076	0.105	-0.006
Growth rate of net assets	-0.058	-0.066	-0.056	-0.038	0.716
Turnover rate of net assets	0.111	0.284	-0.041	-0.291	-0.274
Turnover ratio of total assets	-0.014	0.302	-0.061	-0.162	0.091
Premium retention ratio	0.013	0.276	-0.129	0.183	-0.039
Premium income growth rate	-0.056	-0.077	0.364	-0.09	-0.076
Total assets revenue growth rate	0.019	0.008	0.108	-0.052	0.383
Return on total assets	-0.268	0.025	0.205	-0.013	-0.07
Capital utilization ratio	0.156	0.106	0.124	-0.191	-0.066
Asset liability ratio	0.286	-0.077	-0.021	0.207	0.015
Operating ratio of liabilities	0.253	-0.048	0.117	-0.016	-0.079
Net rate of return on investment	0.039	-0.041	0.015	0.627	-0.085
Net profit growth rate	0.19	-0.118	-0.206	0.106	0.025
Operating income growth rate	0.026	-0.187	0.338	0.145	0.16

In order to explain the economic significance of the extracted factor, the factor is carried out with the orthogonal rotation of Kaiser standardization, and the factor load

matrix (see Table 3) is obtained.The main factor F_1 mainly explains the rate of return on net assets, the operating ratio of liabilities and the utilization of capital, which can represent the ability of capital management.The main factor F_2 mainly explains the investment assets ratio, total asset turnover ratio and premium retentions ratio, which can represent the operating capacity.The main factor F_3 mainly explains the total assets rate of return, net investment income and asset liability ratio, which can represent the risk management ability.The main factor F_4 mainly explains the net profit growth rate, the growth rate of operating income and net asset turnover, which can represent the profitability.The main factor F_5 mainly explains the growth rate of the net assets, total assets growth rate and the growth rate of premium income, which can represent the development potential.

Table 4. Main factors characteristic value and contribution

Main factors	Extraction square and loading			Rotating square and loading		
	score	Explained variance %	accumulation %	score	Explained variance %	accumulation %
1	4.816	32.108	32.108	3.485	23.231	23.231
2	2.778	18.518	50.626	3.071	20.471	43.702
3	1.861	12.407	63.032	2.463	16.42	60.122
4	1.315	8.766	71.798	1.518	10.119	70.241
5	1.153	7.687	79.485	1.387	9.244	79.485

Take the data of standardized variables into the factor score function and get the five main factors' score of the listed insurance companies, then weight and aggregate the proportion of each factor rotation after the variance contribution rate of five main factors accumulated variance contribution rate as the weights (see Table 4), we can get the comprehensive score P which reflects the performance of the listed life insurance companies.

$$□ = (□_1 \times 23.23\% + □_2 \times 20.47\% + □_3 \times 16.42\% + □_4 \times 10.12\% + □_5 \times 9.24\%)/79.49\% \quad (1)$$

5. Regression analysis of ownership structure and comprehensive performance Index

Due to the small number of listed insurance companies and only five-year data, the time sequence effect is not significant. So this paper make the five-year original sample data mixed become cross-sectional data. Finally, we get 175 observations. Based on the prior assumptions, we establish the following regression models:

$$□ = □ + □_1 \times □_1 + □_2 \times □_5 + □_3 \times □_5 + □_4 \times □ + □_5 \times □ + □_6 \times □ \quad (2)$$

The definition and description of each variable are shown in table 5.

Table 5. Definition and description of variables

Variable name	Variable definition	Variable description

S_1	The largest shareholder equity ratio	The proportion of the largest shareholder of the total share
H_5	Ratio of the top five shareholders	Share of the top five shareholders and the proportion of the total share
Z_5	The ratio of the first major shareholder holding shares and the sum of the second to fifth major shareholders holding shares	The share of the first major shareholder and the ratio of the last four shareholders
G	Actual controlling person	Dummy variable: if it is state-owned, it is recorded as 1; if it is private, it is recorded as 0.
I	Independent directors accounted for the total number of directors	The number of independent directors is the ratio of the total number of the board of directors
E	Proportion of the number of senior executives	The ratio of the number of senior executives to the total number of board of directors
P	Comprehensive performance index	According to the factor analysis method to calculate the score

Table 6 shows the regression result of the equity structure and the comprehensive performance though SPSS20.0.

Table 6 Regression result

	Non standardized coefficient		standardized coefficient	t	Sig.
	B	Standard error			
constant	3.044	0.65		4.683	0
S_1	0.202	0.062	9.522	3.256	0.003
H_5	-0.105	0.024	-5.966	-4.424	0
Z_5	-0.033	0.01	-5.719	-3.259	0.003
G	1.246	0.321	1.31	3.877	0.001
I	0.005	0.002	1.078	2.034	0.044
E	-0.011	0.007	-1.076	-1.722	0.099

The regression results from the equity structure of table 6 and the comprehensive performance can be seen, the coefficients of S_1, Z_5, H_5, G and I all passed the T test with a significant level of 5%, and the F statistic also passed the test, which showed statistical significance, that is to say the largest shareholder, the actual holding of state-owned, independent directors accounted for a positive correlation between the total number of directors of the board of directors and the overall performance of P, The top five shareholders ratio, the largest shareholder and the second to the fifth largest shareholder of total holdings ratio was negatively correlated with the comprehensive performance P; The coefficient of I do not pass the T test, which shows that there is no significant correlation between the proportion of the number of executives shareholding and the overall performance, so we refuse to the assumption.

6. Conclusion

Firstly, the largest shareholder shareholding ratio exhibits a positive correlation with the operating performance, while the former five shareholder shareholding ratio and the ratio of the first major shareholder holding shares and the sum of the second to fifth major shareholders holding shares have a negative correlation with operating performance. This result is consistent with our hypothesis, which indicates that the concentration of power and the fixed large shareholders play a positive role in the sustainable management of the enterprise, and will give the investors a positive suggestion. Equity balance of the company's governance plays a positive role; the more decentralized equity distribution is more conducive to the company's business.

Secondly, the operating performance of the state-owned insurance companies is better than the private insurance companies, which is due to the late start of China's insurance industry, while the support of the national strength can help insurance companies to gain greater market advantage and profit. As far as the current stage is concerned, the state as the actual controlling person has a positive impact on the business performance and private insurance companies are at a disadvantage.

Thirdly, the proportion of independent directors plays a positive role to the company's operating performance, which is in line with our expectations. Independent directors as the company management advice often have more clear and accurate judgment， because they are not controlled directly by shareholders and they can put forward beneficial suggestions on the company's business which are good for the company's business development and operation. Therefore, the board function can effectively play with the higher proportion of independent directors, and then it will improve the operating results of the insurance company.

Fourthly, the impact of the executive stock ownership rate on the company's business is not significant. The reason may be the sample size is not large enough. However, it can reflect the current status of China's insurance companies from on the other hand, hat is to say, due to the imperfection of the reward and punishment system, the impact of the executive stock ownership rate on the company's business can be ignored.

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Using a Parallelogram Framework to Calculate the Pension Liabilities of Social Pooling Accounts Held by Urban Chinese Employees

SHI Chenxi, YANG Zaigui

SHI Chenxi *
Ph.D. Candidate
School of Insurance
Central University of Finance and Economics
Beijing 100081, China
Phone: (86) 18201361516
Email: shichenxi1990@163.com

YANG Zaigui
Professor
School of Insurance
Central University of Finance and Economics
Beijing 100081, China
Phone: (86010) 6228 8162
Email: yangzg@cias-cufe.org

Key words: basic pension insurance; pooling account; pension; actuarial accrued pension liability

Abstract: In this paper, a parallelogram pension calculation framework is proposed to model the liabilities of urban enterprise employees' pooling accounts in China. Two important parameters in these models -- the growth rate of wages and of age-linked benefits -- were used -– along with age and gender -- to actuarially estimate pension liabilities. The results indicated that in early 2015 the actuarial accrued pension liabilities of Chinese urban enterprise employees' social pooling accounts were 72.13 trillion CNY. Women's pension actuarial accrued liabilities accounted for 61.31% of the total which presented a significant gender difference. As a result of the estimation and a sensitivity analysis, some policy recommendations were proposed to reduce the future pension burden and narrow the gender differences in the overall redistribution of funds. These solutions include deferring retirement – especially for women -- as well as improving the return on investment for the pension funds. Also, the contribution rate could be reduced while the replacement rate could be increased.

1. Introduction

In November 2013, establishing a more equitable and sustainable social security system and the principle of actuarial balance were written into the Decision on Some Major Issues Concerning Comprehensively Deepening the Reform proclaimed by the Central Committee of the Communist Party of China. Actuarially assessing the country's old-age insurance system was deemed necessary for managers to find potential risks from a long-term vision, as well as understanding the future financial situation. Reform options established on the principle of actuarial balance are expected to be more affordable, sustainable and fair (Boado-Penasd et al., 2008; Vidal-Melia and Boado-Penas, 2013; Sin, 2005). Social pooling accounts in the old-age insurance system for enterprise workers plays a role in intergenerational support. This system provides a monthly payment to current pensioners derived from contributions collected from current workers. Increases in life expectancy aggravate the burden on current contributors and increase pension expenditures in social pooling accounts which eventually will lead to fiscal unsustainability. By studying the current social pooling accounts, the Chinese government can become better equipped to make logical policy proposals. Actuarial accrued pension liabilities represent the present value of pension benefits deserved in the future, based on workers' payment periods (including the deemed payment period). This parameter can be accurately reflected in all participants' pension benefits and contributions. Research on the actuarial accrued pension liabilities is propitious to policymakers to understand the financial dynamics of the pension system, find the root of the solvency crisis, and draft relevant reform -- which should improve the long-term fiscal sustainability of the pension system.

Many domestic scholars have studied pension insurance and actuarial valuations. Wang (2002) estimated the level of China's pension debt by calculating the actuarial present value of pension benefits which contain pension benefits deserved by *old people* (those who were already retired before early 1998) and the actuarial present value of pension benefits already received by *middle-aged people* (those who started to work after early 1998). Based on this model and the index adjustment method, Wang later (2006) estimated the historical pension debt of China. Gao (2004), Li (2009), Qi and Tao (2011) calculated the scale of China's implicit pension debt with similar methods. More recently, Wang (2013) estimated the payment gap of pooling accounts under different scopes and methodologies. Wei (2014) made actuarial valuations of the financial sustainability of a basic pension for enterprise employees; however, the calculation models used in his paper were typically expressed by text rather than formulas. All of these researchers found that the actuarial method for calculating pension benefits is helpful to understand the financial dynamics of the pension system. Although those studies have made focused on fiscal balance and implicit pension debt, there still are some points which need to be researched further.

First of all, according to the provisions of the State Council on Improving the Basic

Old-age Insurance System for Enterprise Employees (State Council Document #38 in 2005), some changes occurred in the method of contribution for revenues and pension payments, as well as the age-wise classification of participants. The calculation of pension insurance should consider payment differences in varying age groups. Secondly, prior research related to the calculation of revenues and expenditures of a pension system have focused on implicit pension debt and the pension gap; however, there is little research on actuarially accrued pension liabilities. Finally, prior research has relied on calculation methods based on traditional actuarial formulas although these formulas are not ideal.

For this study, a parallelogram pension calculation framework was constructed to study urban enterprise employees' social pooling pension accounts. These accounts clearly divide each worker's life into a working period and a retirement period. Applying the aforementioned creative framework to study the existing basic pension insurance system for urban enterprises resulted in actuarial accrued pension liability models of urban enterprise employees' social pooling accounts. These prospective models were used to calculate the actuarial present value of pension benefits determined by an old system and the present value of future retirement benefits, determined by the length of contributory service under the new system. These models considered contribution revenues during the working period and pension payments during the retirement period. These formulas are clear and easy to understand. In addition, the growth ratio of working-age wages and the growth ratio of age-linked benefits were calculated according to the relationship between wages and pensions and the age and gender distribution. The value of these parameters should improve the precision of the final results.

2. Parallel quadrilateral frame

The length of the contribution period and payment period were divided by entry age, retirement age and ultimate age. As shown in Figure 1, a two-dimensional coordinate system was established with year on the horizontal axis and age on the vertical axis. Based on this two-dimensional coordinate system, a parallelogram pension calculation framework[1] was constructed. The two axes intersect at the origin point of time and retirement age. In this study, e represented entry age, r represented retirement age and ω represented terminal age. An entry line was represented by a diagonal across both point (t, e) and point $(t\text{-}r+e,r)$. Parallel to the entry line was a diagonal across the original point (t,r) which represented the retirement line. Similarly, a diagonal crossing point (t,ω) which also was parallel to the entry line was the final death line. These diagonals together with lines parallel to the horizontal axis crossing point (t,e) and point (t,ω), respectively, constituted two parallelograms. A

1 In this paper, the parallelogram pension calculation framework presented in the literature by Yang (2015) was used. Yang's study, titled "Actuarial Accrued Liability of the Basic Pension for Government and Public Institution Employees" was presented at an international conference in Beijing in 2015 (Population Aging: New Challenges for Public Policy).

parallelogram located in the second, third and fourth quadrants indicated a working-period (contribution period). A parallelogram located in the first, second and fourth quadrant indicated a retirement-period (payment period). This creative framework was used to determine the accrued pension liabilities of urban enterprise employees' social pooling accounts.

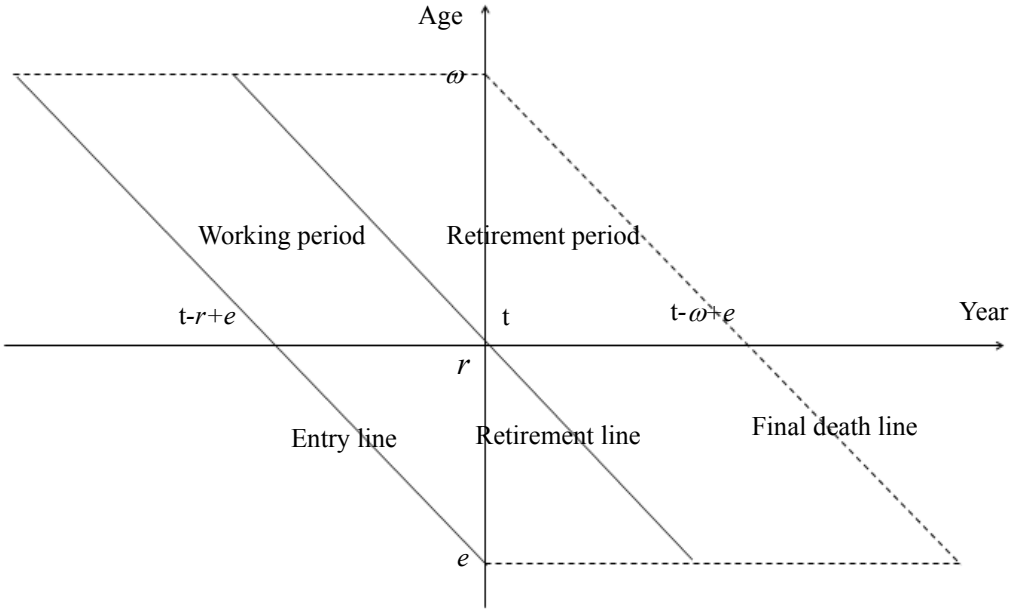


Fig.1. Parallelogram framework for pension measurement

At the measurement time *t*, the actuarial accrued pension liabilities of urban enterprise employees' social pooling accounts can be calculated by using the prospective method which can be expressed as:

Accrued pension liability at the beginning of year *t* = present value of future pension benefits – present value of future pension contributions

According to the *Labor Law*, the retirement age for men in China is 60. Women may retire at 50, but women in managerial positions may retire at 55. In this study, a retirement age of 60 was assumed for men, while a retirement age of 52 was assumed for women. The terminal age was 105. Pension payments and contribution revenues occur at the beginning of each year.

There are some symbols that need to be explained. $L_{t,x}$ denoted the number of *x*-year-old participants at the beginning of year *t*. *LM t,x* denoted the number of *x*-year-old male participants at the beginning of year *t*. *LF t,x* denoted the number of *x*-year-old female participants at the beginning of year *t*. $B_{t,x}$ denoted pension benefits deserved by *x*-year-old participants at the beginning of year *t*. ${}_nP_x$ represented the probability of an *x*-year-old person surviving to age *x+n, while* i_y, v_y, ρ_y and g_y denoted the interest rate, growth rate of pension benefits, and growth rate of wages, respectively. The discount rate was $1/(1+ i_y)$. To simplify some calculations later on, let $V_y =(1+ \rho_y)/(1+ i_y)$, $U_y=(1+g_{y-1})/(1+ i_y)$.

3. The model of accrued pension liabilities based on the parallel quadrilateral framework

3.1The actuarial present value of social pooling account pension benefits deserved in the future from social pooling account by *old people*

In this paper, employees who were already retired before the implementation of State Council Document #26 in 1997 are referred to as *old people* **(**including *old men* and *old women***)**. The age interval of *old people* is [$r+t-z$, ω] at the measurement point of year t, assuming that the system began operating at the beginning of 1997 and z stands for that year.

As shown in figure 1, *old men* had an age interval of [78, 105] when setting the estimation point at 2015. With age 105 set as the terminal age, participants are expected to die at that age. The actuarial present value of pension benefits from social pooling accounts deserved by 105-year-old *old men* at the beginning of 2015 was $LM_{2015,105}B_{2015,105}$. At the beginning of 2015, 104-year-old *old men* received pension benefits for that year, and they will receive pension benefits in 2016 -- as long as they survive to age 105. The actuarial present value of pension benefits deserved in the future from social pooling accounts was:

$$L^{M}_{2015,104}B_{2015,104}(1+p_{104}\frac{1+\rho_{2015}}{1+i_{2015}}) = L^{M}_{2015,104}B_{2015,104}(1+p_{104}V_{2015})$$

Similarly, at the beginning of 2015, the actuarial present value of pension benefits deserved in the future for 78-year-old *old men* from social pooling accounts was:

$$L^{M}_{2015,78}B_{2015,78}(1+p_{78}V_{2015}+{}_{2}p_{78}V_{2015}V_{2016}+\cdots+{}_{27}p_{78}\prod_{k=0}^{26}V_{2015+k}) = L^{M}_{2015,78}B_{2015,78}\sum_{n=0}^{27}\frac{{}_{n}p_{78}}{V_{2014}}\prod_{k=0}^{n}V_{2014+k}$$

Therefore, at the beginning of 2015, the actuarial present value of pension benefits deserved in the future by x-year-old *old people* from social pooling accounts was:

$$L_{t,x}B_{t,x}\sum_{n=0}^{\omega-x}\frac{{}_{n}p_{x}}{V_{t-1}}\prod_{k=0}^{n}V_{t-1+k}$$

The actuarial present value of pension benefits deserved in the future from social pooling accounts by all *old people* at the measurement point t is:

$$PVB^{O}_{t} = \sum_{x=r+t-z}^{\omega}[L_{t,x}B_{t,x}\sum_{n=0}^{\omega-x}\frac{{}_{n}p_{x}}{V_{t-1}}\prod_{k=0}^{n}V_{t-1+k}]$$

It was assumed that pension benefits for pensioners with similar ages would grow at rate b every year, and b represented the growth rate of age-linked benefits. Thus:

$$B_{t,x} = (1+b)^{x-r}B_{t,r},\quad x\in[r,\ \omega] \tag{2}$$

$$B_{t,r} = R\cdot S_{t-1,r-1} = R\cdot(1+s)^{r-1-e}S_{t-1,e} \tag{3}$$

R represented the replacement rate. $S_{y,x}$ stood for the contributory wages of x-year-old contributors in year y, while *s* stood for the growth rate of working-age wages.

3.2 The actuarial present value of social pooling account pension benefits deserved in the future by *retired middle people*

In this paper, employees who were already contributing to the old-age insurance system before the implementation of State Council Document #26 in 1997 and were retired before the measurement point t are referred to as *retired middle people* (including *retired middle men* and *retired middle women*). The age interval of *retired middle people* is [*r*, *r*+*t*-*z*-1] at the measurement point of year *t.* Their pension benefits from social pooling accounts consist of two parts: (i) a basic pension; (ii) a transition pension.

BRMB t,x represented the basic pension benefits deserved by *x*-year-old *retired middle people* in year *t* while *BRMT t,x* represented the transition pension benefits deserved by x-year-old *retired middle people* in year *t*. The annual growth rate was assumed to be the same (ρ_y).

For example, in figure 1, *retired middle men* had an age interval of [60, 77] when setting the estimation point for 2015. The actuarial present value of pension benefits deserved in the future from social pooling accounts by 77-year-old *retired middle men* at the beginning of 2015 was:

$$L^{M}_{2015,77}(B^{RMB}_{2015,77} + B^{RMT}_{2015,77}) \cdot (1 + p_{77}V_{2015} + {}_2p_{77}V_{2015}V_{2016} + \cdots + {}_{28}p_{77}\prod_{k=0}^{27} V_{2015+k})$$

……

The actuarial present value of pension benefits deserved in the future from social pooling accounts by 65-year-old *retired middle men* at the beginning of 2015 was:

$$L^{M}_{2015,60}(B^{RMB}_{2015,60} + B^{RMT}_{2015,60}) \cdot (1 + p_{60}V_{2015} + {}_2p_{60}V_{2015}V_{2016} + \cdots + {}_{45}p_{60}\prod_{k=0}^{44} V_{2015+k})$$

Therefore, the actuarial present value of pension benefits deserved in the future from social pooling account by x-year-old *retired middle people* at the beginning of year *t* is:

$$\begin{aligned} &L_{t,x}(B^{RMB}_{t,x} + B^{RMT}_{t,x}) \cdot (1 + p_x V_t + {}_2p_x V_t V_{t+1} + \cdots + {}_{\omega-x}p_x \prod_{k=0}^{\omega-x-1} V_{t+k}) \\ &= L_{t,x}(B^{RMB}_{t,x} + B^{RMT}_{t,x}) \sum_{n=0}^{\omega-x} \frac{{}_np_x}{V_{t-1}} \prod_{k=0}^{n} V_{t-1+k} \end{aligned}$$

The actuarial present value of pension benefits deserved in the future from social pooling accounts by all *retired middle people* at the measurement point *t* is:

$$PVB^{RM}_t = \sum_{x=r}^{r+t-z-1} \left[L_{t,x}(B^{RMB}_{t,x} + B^{RMT}_{t,x}) \sum_{n=0}^{\omega-x} \frac{{}_np_x}{V_{t-1}} \prod_{k=0}^{n} V_{t-1+k} \right] \quad (4)$$

The pension benefits from social pooling accounts deserved by *retired middle*

people increases at the growth rate of pension benefits based on their pension benefits deserved at retirement age. As long as the length of the contribution period increases one year, benefits from the basic pension portion will enhance one percentage point of the mean value of last year's local average economy wage and the individual's indexed average contributory wage. Benefits from the transition pension portion equal the product of the indexed average contributory wage, accrual factors and the length of the contribution period. The accrual factor typically ranges from 1% to 1.4%, and this study assumed an accrual factor of 1.2%.

The basic pension benefits and transition pension benefits deserved by a 77-year-old *retired middle man* in 2015 were, respectively:

$$B_{2015,77}^{RMB} = B_{1998,60}^{RMB}\prod_{k=1998}^{2014}(1+\rho_k) = \frac{\overline{S}_{1997}}{2}(1+\frac{1}{1998-1997}\cdot\frac{S_{1997,59}}{\overline{S}_{1997}})(1998-1997)\%\prod_{k=1998}^{2014}(1+\rho_k)$$

$$B_{2015,77}^{RMT} = B_{1998,60}^{RMT}\prod_{k=1998}^{2014}(1+\rho_k) = \varepsilon[(60-20)-(1998-1997)]\frac{\overline{S}_{1997}}{1998-1997}\cdot\frac{S_{1997,59}}{\overline{S}_{1997}}\prod_{k=1998}^{2014}(1+\rho_k)$$

……

The basic pension benefits and transition pension benefits deserved by a 60-year-old *retired middle man* in 2015 were, respectively:

$$B_{2015,60}^{RMB} = \frac{\overline{S}_{2014}}{2}\left(1+\frac{1}{2015-1997}\sum_{k=1}^{2015-1997}\frac{S_{2015-k,60-k}}{\overline{S}_{2015-k}}\right)(2015-1997)\%$$

$$B_{2015,60}^{RMT} = \varepsilon[(60-20)-(2015-1997)]\frac{\overline{S}_{2014}}{2015-1997}\sum_{k=1}^{2015-1997}\frac{S_{2015-k,60-k}}{\overline{S}_{2015-k}}$$

Therefore, the basic pension benefits and transition pension benefits deserved by the *x-year-old retired middle people* in year *y* are, respectively:

$$\begin{aligned}B_{t,x}^{RMB} &= B_{t-(x-r),r}^{RMB}\prod_{k=t-(x-r)}^{t}\frac{1+\rho_k}{1+\rho_t}\\ &= \frac{\overline{S}_{t-(x-r)-1}}{2}\left(1+\frac{1}{t-(x-r)-z}\sum_{k=1}^{t-(x-r)-z}\frac{S_{t-(x-r)-k,r-k}}{\overline{S}_{t-(x-r)-k}}\right)[t-(x-r)-z]\%\prod_{k=t-(x-r)}^{t}\frac{1+\rho_k}{1+\rho_t}\end{aligned} \tag{5}$$

$$\begin{aligned}B_{t,x}^{RMT} &= B_{t-(x-r),r}^{RMT}\prod_{k=t-(x-r)}^{t}\frac{1+\rho_k}{1+\rho_t}\\ &= \varepsilon\left[r-e-\left(t-(x-r)-z\right)\right]\frac{\overline{S}_{t-(x-r)-1}}{t-(x-r)-z}\sum_{k=1}^{t-(x-r)-z}\frac{S_{t-(x-r)-k,r-k}}{\overline{S}_{t-(x-r)-k}}\prod_{k=t-(x-r)}^{t}\frac{1+\rho_k}{1+\rho_t}\end{aligned} \tag{6}$$

3.3 The actuarial present value of social pooling account pension benefits deserved in the future by *working middle people*

In this paper, employees who were already contributing to the old-age insurance

system before the implement of the State Council Document #26 in 1997 and who retired after the measurement point t are referred to as *working middle people* (including *working middle men* and *working middle women*). The age interval of *working middle people* is [*e*+*t*-(*z*-1), *r*-1] at the measurement point of year *t*. Their pension benefits from social pooing accounts also are composed of two parts: a basic pension and a transition pension. As for a *x*-year-old contributor in year *t, BWMB t+(r-x),r* represented the basic pension benefits deserved in the year in which he reach his retirement age while *BWMT t+(r-x),r* represented the transition pension benefits deserved when he is *r*-year-old.

So in Figure 1, with *working middle men* as an example, their age interval is [39, 59] when the setting measurement point is 2015. The actuarial present value of social pooling pension benefits deserved in the future by 59-year-old *working middle men* at the beginning of 2015 was:

$$L^{M}_{2015,59}\cdot {}_{59}p_{59}v_{2015}(B^{WMB}_{2016,60}+B^{WMT}_{2016,60})\,(1+{}_{60}p_{60}V_{2016}+{}_{2}p_{60}V_{2016}V_{2017}+\cdots+{}_{45}p_{60}\prod_{k=0}^{44}V_{2016+k})$$

……

The actuarial present value of social pooling pension benefits deserved in the future by 39-year-old *working middle men* at the beginning of 2015 was:

$$\begin{aligned}&L^{M}_{2015,39}\cdot {}_{21}p_{39}\prod_{j=0}^{21-1}v_{2015+j}(B^{WMB}_{2036,60}+B^{WMT}_{2036,60})(1+{}_{60}p_{60}V_{2036}+{}_{2}p_{60}V_{2036}V_{2037}+\cdots+{}_{45}p_{60}\prod_{k=0}^{44}V_{2036+k})\\&=L^{M}_{2015,39}\cdot {}_{21}p_{39}\prod_{j=0}^{21-1}v_{2015+j}(B^{WMB}_{2036,60}+B^{WMT}_{2036,60})\sum_{n=0}^{45}\frac{{}_{n}p_{60}}{V_{2014+21}}\prod_{k=0}^{n}V_{2014+21+k}\end{aligned}$$

Therefore, the actuarial present value of pension benefits deserved in the future by x-year-old *working middle people* at the beginning of year *t* is:

$$L_{r,x}\cdot {}_{(r-x)}p_{x}\prod_{j=0}^{(r-x)-1}v_{t+j}\cdot(B^{WMB}_{t+(r-x),r}+B^{WMT}_{t+(r-x),r})\cdot\sum_{n=0}^{\omega-r}\frac{{}_{n}p_{r}}{V_{t+r-x-1}}\prod_{k=0}^{n}V_{t+r-x-1+k}$$

The actuarial present value of social pooling account pension benefits deserved in the future by all *working middle people* at the measurement point *t* is:

$$PVB^{WM}_{t}=\sum_{x=e+t-(z-1)}^{r-1}[L_{t,x}\cdot {}_{(r-x)}p_{x}\prod_{j=0}^{r-x-1}v_{t+j}\cdot(B^{WMB}_{t+r-x,r}+B^{WMT}_{t+(r-x),r})\cdot\sum_{n=0}^{\omega-r}\frac{{}_{n}p_{r}}{V_{t+r-x-1}}\prod_{k=0}^{n}V_{t+r-x-1+k}]\qquad(7)$$

Computational methods of basic pension benefits and transition pension benefits from social pooling accounts for *working middle people* are the same as those used for *retired middle people*. The basic pension benefits and transition pension benefits earned by a 59-year-old *working middle man* in 2015 were, respectively:

$$B^{WMB}_{2016,60}=\frac{\overline{S}_{2015}}{2}\left(1+\frac{1}{2016-1997}\sum_{k=1}^{2016-1997}\frac{S_{2016-k,60-k}}{\overline{S}_{2016-k}}\right)(2016-1997)\%$$

$$B_{2016,60}^{WMT} = \varepsilon[(60-20)-(2016-1997)]\frac{\overline{S}_{2015}}{2016-1997}\sum_{k=1}^{2016-1997}\frac{S_{2016-k,60-k}}{\overline{S}_{2016-k}}$$

……

As for a 39-year-old *working middle man*, his basic pension benefits and transition pension benefits earned at retirement age will be, respectively:

$$B_{2036,60}^{WMB} = \frac{\overline{S}_{2035}}{2}\left(1+\frac{1}{2036-1997}\sum_{k=1}^{2036-1997}\frac{S_{2036-k.60-k}}{\overline{S}_{2036-k}}\right)(2036-1997)\%$$

$$B_{2036,60}^{WMT} = \varepsilon[(60-20)-(2036-1997)]\frac{\overline{S}_{2035}}{2036-1997}\sum_{k=1}^{2036-1997}\frac{S_{2036-k,60-k}}{\overline{S}_{2036-k}}$$

Therefore, the basic pension benefits and transition pension benefits earned by the *x*-year-old *working middle people* are, respectively:

$$B_{t+(r-x),r}^{WMB} = \frac{\overline{S}_{t+(r-x)-1}}{2}\left(1+\frac{1}{t+(r-x)-z}\sum_{k=1}^{t+(r-x)-z}\frac{S_{t+(r-x)-k,r-k}}{\overline{S}_{t+(r-x)-k}}\right)\left[t+(r-x)-z\right]\% \quad (8)$$

$$B_{t+(r-x),r}^{WMT} = \varepsilon\left[(r-e)-(t+r-x-z)\right]\frac{\overline{S}_{t+r-x-1}}{t+(r-x)-z}\sum_{k=1}^{t+(r-x)-z}\frac{S_{t+(r-x)-k,r-k}}{\overline{S}_{t+(r-x)-k}} \quad (9)$$

3.4 The actuarial present value of social pooling account pension benefits deserved in the future by *new people*

In this study, employees who began contributing after the implement of the State Council Document 26 in 1997 are referred to as *new people* (including *new men* and *new women*). The age interval of *new people* is [*e*, *e*+*t*-*z*] at the measurement point of year *t*. They can receive pension benefits from social pooling accounts only when the length of the contribution period is greater than 15 years.

So in Figure 1, with *new men* as an example, 38-year-old *new men* in 2015 will reach their retirement age in 2037. The actuarial present value of social pooling account pension benefits deserved in the future was:

$$L_{2015,38}^{M}\cdot{}_{22}p_{38}\prod_{j=0}^{22-1}v_{2015+j}B_{2037,60}^{NB}(1+{}_{60}p_{60}V_{2037}+{}_{2}p_{60}V_{2037}V_{2038}+\cdots+{}_{45}p_{60}\prod_{k=0}^{44}V_{2037+k})$$

……

The actuarial present value of social pooling account pension benefits deserved in the by 20-year-old *new men* at the beginning of 2015 was:

$$\begin{aligned}&L_{2015,20}^{M}\cdot{}_{40}p_{20}\prod_{j=0}^{40-1}v_{2015+j}B_{2055,60}^{NB}\left(1+{}_{60}p_{60}V_{2055}+{}_{2}p_{60}V_{2055}V_{2056}+\cdots+{}_{45}p_{60}\prod_{k=0}^{44}V_{2055+k}\right)\\&=L_{2015,20}^{M}\cdot{}_{40}p_{20}\prod_{j=0}^{40-1}v_{2015+j}B_{2055,60}^{NB}\sum_{n=0}^{45}\frac{{}_{n}p_{60}}{V_{2014+40}}\prod_{k=0}^{n}V_{2014+40+k}\end{aligned}$$

Therefore, the actuarial present value of social pooling account pension benefits deserved in the future by *x*-year-old *new people* at the beginning of year *t* is:

$$L_{t,x}\cdot {}_{(r-x)}p_x\prod_{j=0}^{(r-x)-1}v_{t+j}\cdot B^{NB}_{t+(r-x),r}\cdot\sum_{n=0}^{\omega-r}\frac{{}_np_x}{V_{t+r-x-1}}\prod_{k=0}^{n}V_{t+r-x-1+k}$$

BNB t+(r-x),r stands for basic pension benefits which will be received in the year of *t+r-x* by *x*-year-old *new people* at the measurement point *t*.

The actuarial present value of social pooling account pension benefits deserved in the future by all *new people* at the measurement point *t* is:

$$PVB^N_t=\sum_{x=e}^{e+t-z}[L_{t,x}\,{}_{(r-x)}p_x\prod_{j=0}^{r-x-1}v_{t+j}\cdot B^{NB}_{t+(r-x),r}\cdot\sum_{n=0}^{\omega-r}\frac{{}_np_r}{V_{t+r-x-1}}\prod_{k=0}^{n}V_{t+r-x-1+k}] \quad (10)$$

Assuming that employees contribute every year during their working period, their contribution periods would be the same (*r-e* years) when they reach retirement age.

As for a 38-year-old *new man* in 2015, his basic pension benefits earned at retirement age will be:

$$B^{NB}_{2037,60}=\frac{\overline{S}_{2036}}{2}\left(1+\frac{1}{60-20}\sum_{k=1}^{60-20}\frac{S_{2037-k.60-k}}{\overline{S}_{2037-k}}\right)(60-20)\%$$

……

As for a 20-year-old *new man* in 2015, his basic pension benefits earned at retirement age will be:

$$B^{NB}_{2055,60}=\frac{\overline{S}_{2054}}{2}\left(1+\frac{1}{60-20}\sum_{k=1}^{60-20}\frac{S_{2055-k.60-k}}{\overline{S}_{2055-k}}\right)(60-20)\%$$

Therefore, the basic pension benefits earned at the retirement age for the *x*-year-old *new people* is:

$$B^{NB}_{t+(r-x),r}=\frac{\overline{S}_{t+(r-x)-1}}{2}\left(1+\frac{1}{r-e}\sum_{k=1}^{r-e}\frac{S_{t+(r-x)-k,r-k}}{\overline{S}_{t+(r-x)-k}}\right)(r-e)\% \quad (11)$$

3.5 The actuarial present value of future contributions

Since *old men* and *retired middle people* were already retired, they won't need to contribute further. Therefore, urban enterprises only need to contribute to the old age insurance system for *working middle people* and *new people*.

The term *c* represented the required contribution rate, which is 20% according to State Council Document #38 from 2005. According to Figure 1, taking male employees as an example, 59-year-old male employees at the beginning of 2015 need their enterprises to contribute to the old-age insurance system every year based on last year's average contributory wage until they reach their retirement age. The actuarial present value of future contributions is equal to $LM\ 2015,59\cdot cS_{2014,58}$. As for 58-year-old male employees at the beginning of 2015, enterprises needed to contribute at the beginning of that year and next year if these employees still are working. The actuarial present value of future contribution equals:

$$L^{M}_{2015,58} \cdot cS_{2014,57}(1+p_{58}\frac{1+g_{2014}}{1+i_{2015}}) = L^{M}_{2015,58} \cdot cS_{2014,57}(1+p_{58}U_{2015})$$

As for 20-year-old male employees in 2015, the actuarial present value of future contribution equals:

$$L^{M}_{2015,20} \cdot cS_{2014,19}(1+p_{20}U_{2015}+\cdots+{}_{39}p_{20}\prod_{k=0}^{39-1}U_{2015+k}) = L^{M}_{2015,20} \cdot cS_{2014,19}\sum_{n=0}^{39}\frac{{}_{n}p_{20}}{U_{2014}}\prod_{k=0}^{n}U_{2014+k}$$

Therefore, for *x*-year-old employees in the year *y*, the actuarial present value of future contribution equals:

$$L_{t,x} \cdot cS_{t\text{-}1,x\text{-}1} \cdot \sum_{n=0}^{r-1-x}\frac{{}_{n}p_{x}}{U_{t-1}}\prod_{k=0}^{n}U_{t-1+k}\ ,\ \ x\in[e,\ r\text{-}1]$$

At the measurement point *t*, the actuarial present value of future contributions contributed by enterprises for all male and female employees is:

$$PVC_{t} = \sum_{x=e}^{r-1}[L_{t,x} \cdot cS_{t\text{-}1,x\text{-}1} \cdot \sum_{n=0}^{r-x-1}\frac{{}_{n}p_{x}}{U_{t-1}}\prod_{k=0}^{n}U_{t-1+k}]\ ,\ \ x\in[e,\ r\text{-}1] \qquad (12)$$

$$S_{t,x} = (1+s)^{x-e}S_{t,e}$$

Hence, the actuarial accrued pension liabilities are:

$$AL_{t} = PVB^{O}_{t} + PVB^{RM}_{t} + PVB^{WM}_{t} + PVB^{N}_{t} - PVC_{t}$$

4. The assignment estimates

4.1 Actuarial basis

4.1.1 The growth rate of working-age wages

The growth rate of working-age wages can be calculated according to the average contributory wage and the wage of newcomers. The value of *s* has been assumed to be 1% in previous studies (Wang 2002; Zhou 2004). In this study, the parallelogram framework was used to calculate the value of *s* according to the age-wise and gender-wise distribution of contributors. The average contributory wage equals the sum of contributory wages of all age groups divided by the total number of contributors. Taking the difference in retirement age between men and women into account, contributors ranged in age from 20 to 51 are both men and women employees; however, contributors ranged in age from 52 to 59 are only men employees.

$$\overline{S}_{2014} = \frac{L_{2014,20}S_{2014,20} + L_{2014,21}S_{2014,21} + \cdots + L_{2014,51}S_{2014,51} + L^{M}_{2014,52}S_{2014,52} + \cdots + L^{M}_{2014,59}S_{2014,59}}{L_{2014,w}}$$

Rearranging it results in the following formula:

$$\frac{\overline{S}_{2014}}{S_{2014,20}} = l_{20/w} + l_{21/w}(1+s) + \cdots l_{51/w}(1+s)^{31} + l^{M}_{52/w}(1+s)^{32} + \cdots + l^{M}_{59/w}(1+s)^{39} \quad (13)$$

Where $l_{x/w}$ denoted the proportion of the number of x-year-old employees to the number of all employees in 2014. $lM\ x/w$ denoted the proportion of the number of x-year-old male employees (x) to the number of all male and female in-work employees (w) in 2014. If the age-wise and gender-wise distribution of contributors was the same to the age-wise and gender-wise distribution throughout the nation -- including the urban population -- then $l_{x/w}$ and $lM\ x/w$ can be calculated according to the age-wise and gender-wise population distribution provided by the 2014 China Population and Employment Statistical Yearbook. This resource reported that the average annual wage from private enterprises was 51,483 Chinese yuan (CNY) in 2013, and the average contributory wage was about 69.8% of the average economy wage[2]. Based on the average economy wage for a particular year, the contributory wage of that year can be calculated. Therefore, the value of average contributory wages was 35,935 CNY in 2014. Zhilian Zhaopin, a famous hunter in China, disclosed that the monthly wage for new employees ranged from 2,500 to 3,500 CNY. $S_{2014,\ 20}$, newcomers' contributory wage, was approximately 25,128 CNY, when assuming their average monthly wage was 3,000 CNY. Substituting relevant parameters' values into formula (13) and repeatedly computing with Excel, we calculate that s ≈ 1.964%.

4.1.2 The growth rate of age-linked benefits

To calculate the pension benefits deserved by x-year-old participants in year y, it was assumed that pension benefits grow at rate b every year for the different ages in the same year. Average pension benefits in 2015 were equal to the sum of pension benefits earned by all age groups' pensioners divided by the total number of pensioners.

$$\overline{B}_{2015} = \frac{L^{F}_{2015,52}B^{F}_{2015,52} + \cdots + L^{F}_{2015,105}B^{F}_{2015,105} + L^{M}_{2015,60}B^{M}_{2015,60} + \cdots + L^{M}_{2015,105}B^{M}_{2015,105}}{L_{2015,\,r}}$$

Based on formula (3):

$$B^{M}_{2015,60} \Big/ B^{F}_{2015,52} = \frac{R\quad S_{2014,59}}{R\quad S_{2014,51}} = (1+s)^{8}$$

Rearranging it yields:

$$\frac{\overline{B}_{2015}}{B^{F}_{2015,52}} = l^{F}_{52/r} + l^{F}_{53/r}(1+b) + \cdots + l^{F}_{105/r}(1+b)^{53} + (1+s)^{8}[l^{M}_{60/r} + l^{M}_{61/r}(1+b) + \cdots + l^{M}_{105/r}(1+b)^{45}] \quad (14)$$

2 The average pension entitlement for employees in enterprise was 1,856 CNY in 2013 and the replacement rate of pension was 67.5% in 2014 according to the 2014 Annual Development Report of Chinese Society. Then the average contributory wage can be calculated to equal 32,995 CNY which represents approximately 69.8% of the average economy wage.

Where, *BF* 2015,*x* denoted the pension benefits earned by *x*-year-old female pensioners in 2015. *BM* 2015,*x* denoted the pension benefits earned by *x*-year-old male pensioners in 2015. *lF x/r* denoted the proportion of the number of *x*-year-old female pensioners to the number of entire pensioners. *lM x/r* denoted the proportion of the number of *x*-year-old male pensioners to the number of entire pensioners. If the age-wise and gender-wise population distribution in 2015 were the same as that in 2014, then *lF x/r* and *lM x/r* can be calculated according to the age-wise and gender-wise population distribution provided by the China Population and Employment Statistical Yearbook. The average pension benefits for men and women were 1,856 CNY in 2014 according to China's Human Resources and Social Security Yearbook. Taking an annual adjustment rate of 10% into account, average benefits of urban enterprise pensioners in 2015 can be calculated (B_{2015} = 26,949 CNY). Assuming the value of the pension replacement rate is 44%[3], based on formula (3), *BF* 2015,52 = 20,205 CNY. Substituting relevant parameters' values into formula (14) and repeatedly computing with Excel, we calculate that $b \approx 1.939\%$.

4.1.3 The value setting of other parameters

According to the 2014 China's Social Insurance Development Annual Report, the number of participants in basic pension insurance system reached 34,124 million by the end of 2014. $L_{2015,x,}$, the number of participants age *x* in 2015 in urban enterprises, was estimated according to the age-wise and gender-wise population distribution provided by the 2014 China's Population and Employment Statistics Yearbook. The number of pensioners aged 95 and older was estimated based on the number of pensioners aged 94 and the benchmark mortality table. To simplify the calculation of the above models, it was assumed that the interest rate, growth rate of benefits, growth rate of wage, etc., were constant over time. Applying research by Wei (2014), the interest rate was set equal to the average yield rate of Chinese 20-year-old term government debt, i.e., i = 4.08%. It was assumed that the growth rate of wages equaled 5.5% and ρ equaled 4.2%, considering that the previous growth rate was declining after China's economic entry into the "new normal." This paper estimates the actuarial accrued pension liabilities of urban enterprise employees' social pooling accounts in 2015, i.e., t = 2015. After these parameters were fixed, formulas (1), (4), (7), (10), (12) were simplified:

$$PVB^{O}_{2015} = B_{2015,r} \sum_{x=r+18}^{105} \left[L_{2015,x} (1+b)^{x-r} \sum_{n=0}^{105-x} {}_{n}p_x V^n \right] \quad (1')$$

$$PVB^{RM}_{2015} = \sum_{x=r}^{r+17} \left[L_{2015,x} (B^{RMB}_{2015,x} + B^{RMT}_{2015,x}) \sum_{n=0}^{105-x} {}_{n}p_x V^n \right] \quad (4')$$

$$PVB^{WM}_{2015} = \sum_{x=39}^{r-1} \left[L_{2015,x} \cdot {}_{(r-x)}p_x V^{r-x} \cdot (B^{WMB}_{2015+r-x,r} + B^{WMT}_{2015+(r-x),r}) \cdot \sum_{n=0}^{105-r} {}_{n}p_r V^n \right] \quad (7')$$

3 Based on the estimation results of pension replacement rate of different types of social pension insurance made by Wang (2009), the pension replacement rate of enterprise employees was 44%. Zhang (2010) found that the pension replacement rate of basic insurance was equal to 40%. Therefore, it was assumed that *R* equals 44%.

$$PVB_{2015}^{N} = \sum_{x=20}^{38} [L_{2015,x\ (r-x)}\, p_x v^{r-x} B_{2015+(r-x),r}^{NB} \cdot \sum_{n=0}^{105-r} {}_n p_r V^n] \quad (10')$$

$$PVC_t = c \cdot S_{2014,19} \sum_{x=20}^{r-1} [L_{2015,x} (1+s)^{x-20} \sum_{n=0}^{r-x-1} {}_n p_x U^n] \quad (12')$$

4.2 The scale of actuarial accrued pension liabilities

4.2.1 Actuarial present value of pension benefits deserved in the future by *old men*

According to formula (3), *BF 2015,60* was calculated to equal 23,607 CNY and *BF* 2015,52 was calculated to equal 20,205 CNY. Substituting relevant parameters' values into formula (13) and computing with Excel provided the actuarial present value of pension benefits deserved in the future by *old people*. The results are shown in table 1.

Table 1: The actuarial present value of future pension benefits deserved by *old men* in 2015.

age	Number of people		*PVB* deserved by *old people*	
	Male	Female	Male	Female
70		998337		4.42E+11
71		1033814		4.44E+11
72		1032395		4.30E+11
73		978470		3.94E+11
74		829464		3.23E+11
75		875585		3.29E+11
76		788310		2.85E+11
77		828754		2.89E+11
78	629371	747156	1.81E+11	2.50E+11
79	565511	651367	1.56E+11	2.09E+11
80	598860	656334	1.58E+11	2.02E+11
81	436373	490299	1.10E+11	1.45E+11
82	367547	420054	8.89E+10	1.18E+11
83	367547	425020	8.49E+10	1.14E+11
84	283820	299430	6.26E+10	7.68E+10
85	241957	297301	5.09E+10	7.26E+10
86	170292	217832	3.41E+10	5.06E+10
87	127009	201512	2.42E+10	4.45E+10
88	105723	151844	1.92E+10	3.18E+10
89	95789	135524	1.65E+10	2.69E+10
90	68117	105723	1.12E+10	1.99E+10
91	42573	85856	6.63E+09	1.53E+10
92	36897	54635	5.46E+09	9.20E+09
93	29801	41154	4.18E+09	6.55E+09
94	11353	24834	1.51E+09	3.74E+09
95	11043	25663	1.40E+09	3.65E+09
96	7514	17966	9.03E+08	2.41E+09
97	4895	12039	5.59E+08	1.53E+09
98	3037	7677	3.30E+08	9.19E+08
99	1784	4630	1.84E+08	5.23E+08
100	986	2621	9.69E+07	2.80E+08

101	509	1381	4.75E+07	1.39E+08
102	243	671	2.15E+07	6.33E+07
103	106	297	8.82E+06	2.59E+07
104	42	118	3.14E+06	9.07E+06
105	15	0	8.37E+05	0.00E+00
Sum	4208714	12444069	1.02E+12	4.34E+12
	16652783		5.36E+12	

The actuarial present value of pension benefits deserved in the future by *old people* is about 5.36 trillion CNY. The actuarial present value of pension benefits deserved in the future by *old people* is about 1.02 trillion CNY. The actuarial present value of pension benefits deserved in the future by old women is about 4.34 trillion CNY. The average actuarial present value of pension benefits deserved in the future by old women is 1.44 times that of old men.

4.2.2 Actuarial present value of pension benefits deserved in the future by *retired middle people*

Substituting relevant parameters' value into formula (5'), (6'), (4') and computing with Excel provides the actuarial present value of pension benefits deserved in the future by *retired middle people*. The results are shown in table 2.

Table 2: The actuarial present value of future pension benefits deserved by *retired middle people* in 2015.

age	Number of people		*PVB* deserved by *retired middle people*	
	Male	Female	Male	Female
52		1664604		6.32E+11
53		2127231		7.56E+11
54		1966163		6.51E+11
55		2468525		7.61E+11
56		2671456		7.64E+11
57		2549413		6.75E+11
58		2576376		6.29E+11
59		2623207		5.90E+11
60	2245726	2279784	5.71E+11	4.70E+11
61	2162709	2186833	5.10E+11	4.13E+11
62	1905851	1939200	4.15E+11	3.34E+11
63	1798709	1849087	3.61E+11	2.89E+11
64	1707177	1719240	3.15E+11	2.44E+11
65	1453158	1519856	2.46E+11	1.94E+11
66	1348855	1444644	2.08E+11	1.66E+11
67	1314796	1369432	1.85E+11	1.41E+11
68	1162953	1149471	1.49E+11	1.05E+11
69	1072130	1087740	1.24E+11	8.80E+10
70	935897		9.76E+10	
71	989822		9.28E+10	
72	909643		7.64E+10	
73	891195		6.68E+10	
74	771281		5.13E+10	

75	798244		4.70E+10	
76	765605		3.97E+10	
77	669815		3.04E+10	
Sum	22903566	35192263	3.59E+12	7.90E+12
	58095829		1.15E+13	

The actuarial present value (2015) of pension benefits deserved in the future by *retired middle people* was about 11.5 trillion CNY. The actuarial present value of pension benefits deserved in the future by *retired middle men* was about 3.59 trillion CNY. The actuarial present value of pension benefits deserved in the future by *retired middle women* was about 7.9 trillion CNY. The average actuarial present value of pension benefits deserved in the future by *retired middle women* was 1.43 times that deserved by *retired middle men.*

4.2.3 Actuarial present value of future benefits and contributions of *working middle people*

Substituting relevant parameters' value into formula (8'), (9'), (7'), (12') and computing with Excel provided the actuarial present value of future benefits and contribution of *working middle people*. The results are shown in table 3.

Table 3: The actuarial present values of future pension benefits and contributions of *working middle people* in 2015.

Age	Number of people		*PVB* deserved by *working*		*PVC* from *working middle*	
	Male	Female	Male	Female	Male	Female
39	4102618	3939422	1.29E+12	1.41E+12	6.86E+11	3.94E+11
40	4240271	4060045	1.32E+12	1.44E+12	6.84E+11	3.80E+11
41	4363733	4170026	1.34E+12	1.46E+12	6.77E+11	3.62E+11
42	4328255	4047983	1.31E+12	1.40E+12	6.45E+11	3.24E+11
43	4731280	4490742	1.42E+12	1.53E+12	6.74E+11	3.27E+11
44	4150158	4028825	1.23E+12	1.35E+12	5.64E+11	2.65E+11
45	4385729	4106166	1.28E+12	1.36E+12	5.66E+11	2.39E+11
46	3376749	3168851	9.78E+11	1.04E+12	4.12E+11	1.60E+11
47	3679017	3554846	1.05E+12	1.15E+12	4.23E+11	1.52E+11
48	3862081	3732233	1.09E+12	1.19E+12	4.15E+11	1.29E+11
49	3771259	3585356	1.06E+12	1.13E+12	3.77E+11	9.43E+10
50	4456684	4200536	1.23E+12	1.31E+12	4.10E+11	7.46E+10
51	3150402	2952438	8.64E+11	9.09E+11	2.65E+11	2.66E+10
52	1755427		4.77E+11		1.33E+11	
53	2311005		6.21E+11		1.55E+11	
54	2024346		5.39E+11		1.18E+11	
55	2588439		6.83E+11		1.28E+11	
56	2736025		7.16E+11		1.10E+11	
57	2515355		6.53E+11		7.69E+10	
58	2563604		6.60E+11		5.31E+10	
59	2539480		6.50E+11		2.67E+10	
Sum	7163191	50037469	2.05E+13	1.67E+13	7.60E+12	2.93E+12
	121669385		3.72E+13		1.05E+13	

The actuarial present value (2015) of pension benefits deserved in the future by *working middle people* was about 37.2 trillion CNY. The actuarial present value of future contributions from *working middle people* was about 10.5 trillion CNY. The average actuarial present value of pension benefits deserved in the future by *working middle women* was 1.17 times of that earned by *working middle men*, which showed a modest gender difference. Since the actuarial present value of future contributions from *working middle women* was 0.55 times that of *working middle men*, there were gender differences in the actuarial present value of pension liabilities.

4.2.4 Actuarial present value of future benefits and contributions of *new people*

Substituting relevant parameters' values into formulas (11'), (10'), (12') and computing with Excel provides the actuarial present value (2015) of future benefits and contributions of *new people*. The results are shown in table 4.

Table 4: The actuarial present value of future pension benefits and contributions of *new people* in 2015.

Age	Number of people		*PVB* deserved by *new*		*PVC* from *new people*	
	Male	Female	Male	Femal	Male	Female
20	3659150	3352624	1.46E+12	1.55E	9.23E+11	6.52E+11
21	3782611	3425708	1.49E+12	1.56E	9.41E+11	6.53E+11
22	3952194	3427836	1.54E+12	1.54E	9.70E+11	6.40E+11
23	4858999	4368700	1.87E+12	1.93E	1.18E+12	7.99E+11
24	4937759	4370828	1.88E+12	1.91E	1.18E+12	7.81E+11
25	4084170	4116100	1.53E+12	1.78E	9.58E+11	7.18E+11
26	4354509	4497128	1.61E+12	1.91E	1.00E+12	7.65E+11
27	4013215	4051531	1.47E+12	1.70E	9.09E+11	6.71E+11
28	3595290	3624382	1.30E+12	1.50E	8.00E+11	5.83E+11
29	3590323	3532850	1.28E+12	1.45E	7.83E+11	5.52E+11
30	3437060	3495953	1.21E+12	1.41E	7.34E+11	5.29E+11
31	4060045	4152996	1.41E+12	1.66E	8.49E+11	6.07E+11
32	3646378	3568327	1.25E+12	1.40E	7.45E+11	5.03E+11
33	3482472	3505887	1.18E+12	1.36E	6.95E+11	4.75E+11
34	3767711	3727976	1.26E+12	1.43E	7.33E+11	4.85E+11
35	3600966	3420741	1.19E+12	1.29E	6.82E+11	4.26E+11
36	3398035	3253287	1.11E+12	1.21E	6.26E+11	3.86E+11
37	3745005	3485310	1.21E+12	1.28E	6.69E+11	3.92E+11
38	3770549	3707399	1.20E+12	1.35E	6.52E+11	3.94E+11
Sum	7373644	71085562	2.65E+13	2.92E	1.60E+13	1.10E+13
	144822003		5.57E+13		2.70E+13	

The actuarial present value (2015) of pension benefits deserved in the future by *new people* was about 5.57 trillion CNY. The actuarial present value of future contributions from *new people* was about 2.7 trillion CNY. The average actuarial present value of pension benefits deserved in the future by *new women* is 1.15 times of that deserved by *new men*, which is only a small gender difference. Since the actuarial present value of future contributions from *new women* is 0.71 times of that

from *new men* the actuarial present value of pension liabilities exhibited a modest gender difference.

4.2.5 Actuarial accrued pension liabilities of social pooling accounts

Based on the data from table 1 to table 4, the scale of the actuarial accrued pension liabilities of China's enterprise employees' social pooling accounts was calculated. The results are shown in table 5.

Table 5: The present value of future benefits and contributions and the actuarial accrued pension liabilities (trillion)

	PVB				*PVC*	*AL*
	old people	*retired m-people*	*working m- people*	*new people*		
Male	1.019	3.585	20.47	26.45	23.62	27.9
Femal	4.341	7.901	16.69	29.23	13.94	44.2
Sum	5.360	11.49	37.16	55.68	37.56	72.1

4.3 Sensitivity analysis

In order to more fully understand the influence of parameters' changes to actuarial accrued pension liabilities of social pooling accounts, eight groups were created for a sensitivity analysis. These eight categories included the retirement age, contribution rate, interest rate, growth rate of wages, growth rate of wage-linked benefits, accrual factor, replacement rate and growth rate of age-linked benefits. The results are shown in table 6.

Table 6: Elasticity of actuarial accrued liabilities with respect to some parameters.

Parameter changes	Rate of Change	ΔAL	ΔAL/AL	Elasticity
Retirement age：Δr=1	1.766%	-3.961E+1	-5.491%	-310.97%
Contribution rate：Δc=0.2%	1%	-3.756E+1	-0.521%	-52.08%
Interest rate：Δi=1%	24.51%	-8.966E+1	-12.431%	-50.71%
Growth rate of	0.909%	6.603E+11	0.915%	100.71%
Growth rate of	23.81%	1.587E+13	22.01%	92.44%
Accrual factor：Δε=0.012%	1%	1.551E+11	0.215%	21.5%
Replacement rate：ΔR=4.4%	10%	5.360E+11	0.743%	7.43%
Age-linked-benefit：Δb=0.0193	1%	2.399E+10	0.033%	3.3%

The data shown in table 6 seem to indicate that the actuarial accrued pension liabilities of social pooling accounts had an inverse relationship with the change of retirement age, contribution rate and interest rate, but showed same changes as a result of the growth rate of wages, growth rate of benefits, accrual factor, replacement rate and growth rate of age-linked benefit. Of all the parameters studied, retirement age had the most significant effect on actuarial accrued pension liabilities, while growth rate of age-linked benefit had the weakest influence on actuarial accrued pension liabilities. The impact of the other parameters (from strong to weak) were growth rate of wages,

growth rate of benefits, contribution rate, interest rate, accrual factor and replacement rate, respectively. Delaying retirement age -- implying that the contribution period would be extended and the pension payment period would be shortened-- seemed to reduce actuarial accrued pension liabilities. Moreover, increases in retirement age are likely to drop the elderly population's dependency ratio and ease the burden on working participants. If the retirement age for men and women employees increased by one year, the elderly population dependency ratio of urban enterprises in 2014 would have changed from 28.07% to 26.22%.

Increases in the growth rate of wages should enhance the actuarial present value of future benefits and contributions at the same time. The annual contribution is calculated on the basis of last year's average economic wage, but pension benefits increase with each year. Thus the increases in actuarial present value of contributions are more obvious than the enhancement in future benefits. Therefore, increases in the growth rate of wages will enhance actuarial accrued pension liabilities. Increases in the growth rate of wage-linked benefits are likely to augment the present value of future pension benefits and eventually increase actuarial accrued pension liabilities. The elasticity of actuarial accrued pension liabilities with respect to the growth rate of wage-linked benefits is lower than the elasticity of the actuarial accrued pension liabilities with respect to the growth rate of wages because the effect of the growth rate of wage-linked benefits on actuarial accrued pension liabilities is less than the effect of a growth rate of wages. If the effect of interest rates on actuarial accrued pension liabilities is the same as the effect of the return on a pension fund, the elasticity of the actuarial accrued pension liabilities with respect to interest rates would be the same as the elasticity of the actuarial accrued pension liabilities with respect to the return on the pension funds. Increases in return on a pension fund will reduce the actuarial accrued pension liabilities. The accrual factor and the growth rate of age-linked benefits, directly influences the actuarial present value of pension benefits while the contribution rate influences the actuarial present value of contributions. Increases in the accrual factor, replacement rate and growth rate of age-linked benefits are likely to enhance the actuarial accrued pension liabilities; however, increases in the contribution rate will reduce the actuarial accrued pension liabilities.

5. Conclusions and recommendations

In this paper, the parallelogram pension calculation framework was used to study pension liabilities in China. Based on this creative framework, the actuarial accrued pension liabilities of urban enterprise employees' social pooling accounts were calculated. The results showed that in early 2015, the actuarial present value of future pension benefits was about 109.7 trillion CNY, the actuarial present value of future contributions was about 37.56 trillion CNY, and actuarial accrued pension liabilities was about 72.13 trillion CNY. There were gender differences in the actuarial present value of future pension benefits for contributions as well as liabilities. Pension

benefits earned by current contributors represented 76.64% of total pension liabilities. It appears that a pension payment crisis can be avoided only if preventive measures are taken. The results of a sensitivity analysis showed that the scale of the actuarial accrued pension liabilities decreased when parameters -- such as retirement age, contribution rate, and return rate on pension fund – increased. However, the scale will increase when parameters -- such as the growth rate of wages, the growth rate of wage-linked benefits, the accrual factor, the replacement rate and the growth rate of age-linked benefits -- increase. Actuarial accrued pension liabilities are more sensitive to changes in the retirement age, growth rate of wages, growth rate of wage-linked benefits and returns on pension funds. Thus the results of this study suggest that some policy recommendations should be made in order to reduce the future pension burden and narrow gender differences in the social pooling accounts.

1. A deferred retirement policy should be implemented. As mentioned, pension benefits earned by current contributors represent 76.64% of the total pension liabilities. An effective way to control the scale of actuarial accrued pension liabilities is to delay the retirement age so that it is more in line with life expectancy. The retirement age ranges from 65 to 67 years old in most Westernized countries in addition to some African countries. The current statutory retirement age was based on the State Council Document #104 in 1978. At that time, China's average life expectancy was less than 68 witch was much lower than it is now. According to the sixth census, the average life expectancy of China reached 74.83 years in 2010, and yet the retirement age in China is 60 for men and 50 for women (or 55 for professional women). However, delaying the retirement age would be a complex solution and may cause instability. Therefore, the government may wish to adopt an elastic retirement delay to enhance the flexibility of the pension scheme and avoid unstable factors caused by excessive adjustment. An elastic retirement delay could allow retirees to work in accordance with their own circumstances. Under this scheme, older workers could engage in non-full-time work or a full-time job and still receive a portion of their pension entitlement. This should provide a smooth transition period, promote human resources and reduce the government's fiscal burden.

2. Delaying the retirement age for women employees should be considered a priority. The calculations showed that there is a significant transfer of basic pension funds from men to women. Because of the differences in retirement age and life expectancy (with women typically living longer than men[4]), the pension benefits earned by women is higher than it is for men; however, women make lower contributions to the pension program than men. Therefore, increasing the retirement age for women is especially important. Drawing lessons from other countries' experiences, gender differences in retirement age can be reduced through delaying the retirement age for both men and women, as in Poland and Italy[5].

4 According to the 2015 World Health Statistics Report, the average life expectancy for men was 74-year-old and the average life expectancy for women was 77-year-old.

5 In July 2012, Poland released a reform bill which changed the retirement age for men from 65 to 67 and the

3. Low returns on pension funds restrict the financial sustainability of the pension system and also reduce people's enthusiasm to participate in it. The Basic Pension Insurance Fund Investment Management Approach issued by the State Council, adopted in 2015, allows pension funds to be invested in capital markets. The 13th Five-year Plan for the Development of National Economy and Social Development Formulated by the Central Committee of Communist Party of China (hereinafter referred to as the 13th Five-year Plan) also proposed widening investment channels for social insurance funds, strengthening risk management and improving return on investment.

4. Contribution rates can be reduced and the replacement rate can be raised appropriately. Sensitivity analyses showed that variables such as the growth rate of wages, wage-linked pensions, the accrual factor and the replacement rate would have only a slight impact compared with the effect of delaying retirement. If a delayed retirement scheme can be enacted in a timely and appropriate manner, and the return on pension funds can be improved gradually, the contribution rate can be reduced from the current level of 20%, and the replacement rate can be improved, which will not causes the growth of the actuarial accrued pension liabilities. Furthermore, improving the replacement rate is consistent with the adjustment policy of improving pension benefits during the last 11 years.

5. Establishing a reasonable adjustment for the basic pension is one of the proposals in the 13th Five-year Plan. The existing basic pension adjustment accommodates retirees' annuity treatment based on a certain percentage of last year's local average economy wage. Increases in the growth rate of wage-linked pensions will increase the actuarial accrued pension liabilities. Changes in the accrual factor and the age-linked benefit growth rate will affect the actuarial accrued pension liabilities as well as the living standard of participants and economic development in general. If the adjustment policy includes only a single measure, greater inequality could result. Therefore, the pension adjustment mechanism should consider many factors with respect to each parameter. In order to ensure a healthy and sustainable pension insurance system, a key step is to establish a pension adjustment mechanism in line with the level of economic development and income by combining various adjustment methods, such as gradually raising the retirement age, increasing revenue and reducing expenditures.

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retirement age for women from 60 to 67, by delaying the retirement age of three months every year. Likewise, Italy unified the retirement age at 66-year-old for both men and women.

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我国城镇企业职工统筹账户养老金的精算应计负债

—基于平行四边形框架的测算*

石晨曦，杨再贵

石晨曦*
博士生
中央财经大学保险学院
北京，100081
电话：18201361516
邮箱：shichenxi1990@163.com

杨再贵
教授
中央财经大学保险学院/中国精算研究院
北京，100081
电话：(86010) 6228 8162
邮箱：yangzg@cias-cufe.org

关键词：基本养老保险；统筹账户；养老金；精算应计负债

摘要：本文根据养老金测算的平行四边形框架，考虑我国企业职工基本养老保险不同年龄参保人群的养老金构成不同，用未来法建立统筹账户养老金应计负债的精算模型。通过养老金与缴费工资间的关系、人口的年龄性别分布情况估计工龄工资增长率及同年度养老金随年龄增长率，依据基准精算假设，测得 2015 年初企业职工统筹账户养老金精算应计负债为 72.13 万亿元，其中女性统筹账户养老金精算应计负债占 61.31%，性别差异明显。基于测算和敏感性分析，为减轻未来养老金支出负担、缩小性别差异、使企业职工基本养老保险健康可持续发展，可适时适度延迟退休、重点和优先考虑提高女职工退休年龄、努力提高养老保险基金的投资收益率，在此基础上还可适当下调缴费率而适当上调替代率。

Modernizing the Insurance Solvency Regulation in Emerging Market: A Comparison of C-ROSS to Solvency II

SHI Xin

MSc Student
Cass Business School
City University London
London EC1Y 8TZ
Phone: 4407421317222
Email: xin.shi.2@cass.city.ac.uk

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Abstract. The aim of this paper is to conduct a comprehensive and structured comparative assessment of C-ROSS and Solvency II in order to detect similarities and differences as well as the benefits and drawbacks of both regimes. The paper takes a closer analysis on the unique feature of qualitative assessment in C-ROSS, where SARMRA grade directly links to capital charge in Pillar I. Furthermore, the paper discusses the current Solvency II equivalence determination and its impact on C-ROSS.

1. Introduction

China's insurance market has undergone four consecutive years of rapid growth since 2012. The year 2015 saw the fastest growth since the international financial crisis, with national premium income hitting RMB 2.4 trillion, 20% higher than the previous year. However, there has been dissatisfaction that the old regime based on Solvency I, has not coped well with changing conditions in Chinese insurance and financial markets, and where minimum capital requirements are set by fixed ratios that largely

fail to reflect the risk that insurers are running. In fact, the similar concern in European insurance market has led the European Union (EU) to initiate a major project (Solvency II) to develop a new regime since 2002.

Departing from the three mutually-interactive pillar structure of Basel II – financial requirements, supervisory assessment and supervisory reporting and public disclosure – Solvency II emphasises the importance of realistic balance sheet valuation as the foundation for the development of a risk-based capital regulatory framework. [1]

China Insurance Regulatory Commission (CIRC) has been following closely developments in other parts of the world for a number of years, with a view to modernise its regulatory regime and to adapt it to the latest developments. Among the three main options, which are following reforms carried out in the EU with Solvency II, the United States of America with the National Association of Insurance Commissioners' (NAIC) Solvency Modernisation Initiative, or developing a new solvency regime that serves the practical needs and characteristics of China's insurance market, CIRC chose the third one by launching the China Risk Oriented Solvency System (C-ROSS). It follows the risk-oriented framework in line with the international standards but also recognises the current development stage of the China insurance industry.

When EU frameworks face the additional complexity of being applicable to countries with a concomitant increase in the number of stakeholders.[2] C-ROSS, in contrast, benefits from its reduced geographical scope and centralized decision making process. It was developed in an aggressively short period of time, going from project start in 2012 to implementation in 2016, 10 years faster than Solvency II.

2. The key comparisons between C-ROSS and Solvency II

Although it is widely perceived that C-ROSS is another edition of Solvency II, given it adopts the three pillars approach and solvency capital requirement (SCR), the differences derived for the characteristics of emerging market realities are significant.

Table 1. The Characteristics of the Emerging Market and the Variations in Solvency regime

Mature Market	Emerging Market
The base of market: assumption of complete market ⇩ Market value/Fair value	Assumption of incomplete market ⇩ Book value(market value/amortised cost/historical cost)consistent with accounting

Low growth rate and stable regime ⇩ Quantitative models	High growth rate and volatility in regime ⇩ Quantitative model and Qualitative Model
Stronger awareness of risk management ⇩ Self Assessment	Weak awareness in risk management ⇩ Regulation Assessment/integrated Assessment
Sufficiency in expertise ⇩ Standard Formula+Internal model available	Lack of expertise ⇩ Standard Formula

Source: CIRC internal training material

2.1 The valuation of the assets and liabilities

In both of the C-ROSS and Solvency II, the solvency requirements are quantified as the Solvency Ratio, which derived by the formula as follow:

$$\text{Solvency Ratio} = \frac{\text{Actual Capital}}{\text{Minimum Capital}}$$

First of the main variations is the method of the assets and liabilities valuation in calculating Actual Capital. The assumption of an incomplete financial market explains that the valuation of the assets is mainly based on book value.

C-ROSS technical provisions, Solvency Regulatory Standards No. 1 Actual Capital Article 12 states as the follows:

Except the following items, admitted assets of an insurance company shall be recognized at book value:

i. Long-term equity investments in its subsidiaries;

ii. Reinsurance reserve receivable of life insurance business;

iii. Other items specified by the CIRC.

In other words, asset valuation follows China GAAP accounting value basis, under which the assets are categorised as trading or available for sale are held on a fair value basis and the other asset are held on a book value basis.

In contract, Solvency II introduces a new basis of preparation for an insurance company's balance sheet, which is based on the principle of market-consistent valuations. Essentially, this means that the value of assets and liabilities reflect the current value at which they could be traded in financial markets, rather than their original accounting value[3] . The advantage of market- consistent valuation is that it reflects the insurer's solvency in a more accurate way. However, the basic assumption is that many assets are traded in sufficiently deep and liquid markets that provide readily available prices. In China, such a financial market is incomplete with higher volatility.

2.2 Method to calculate MC and risk factors

Considering the limitation of expertise, C-ROSS employs a series of prescribed formulas in calculating MC and prohibits the internal model currently. The rationale of calculating is similar to Solvency II, following the basic formula as the follows:

$$MC=EX\times RF$$

MC denotes minimum capital;

EX denotes risk exposure; e.g. the credit risk exposure EX of an asset (liability) equals the admitted value of the asset (liability), unless otherwise specified; when the admitted value is negative, EX=0;

RF denotes risk factor, $RF = RF_0 \times (1 + K)$;

RF_0 denotes base risk factor;

K denotes characteristic factor,

$$K = \sum_{i=1}^{n} K_1 + K_2 + K_3 + \cdots + K_n$$

One of the variances is about the foreign related undertakings. Capital charge on overseas asset is slightly different from the domestic assets under credit risk, e.g. risk factor for term deposit in overseas bank is 0.05 while in state-owned bank is 0. The overall capital charge is not prohibitively high, whereas the capital charge varies more significantly between domestic and offshore reinsurance undertaking. Such discrimination does not exist under Solvency II.

2.2.1 Characteristics under C-ROSS in reinsurance

For the counterparty default risk of reinsurance receivables of a P&C and a life insurance company (including a health insurance company and a pension insurance company), EX equals Max (net value after offsetting the debtors and liabilities against the same counterparty as agreed in the contract provided that the offset can be made automatically, 0); and the EX of reinsurance reserve receivables also equals Max (admitted value of reinsurance reserve receivables with the same counterparty, 0). The RF_0 value shall be determined as follows:

Table 2. Risk Factors of Insurer's Ceded Out Business

Reinsurer's Solvency Adequacy Ratio			**RF0**
Domestic reinsurers(include the local branches established by overseas reinsurer)	200% or above		0.005
	[150%-200%]		0.013
	[100%-150%]		0.047
	[50%-100%]		0.261
	Below 50%		0.745
Offshore reinsurers	Solvency Adequacy level meets the regulatory requirement	With collaterals	0.087
		Without collaterals	0.588
	Solvency ratios at all tiers cannot meet regulatory requirements		0.867

Source: CIRC

The RF_0 of domestic reinsurer can be as minimum as 0.005, whereas an offshore reinsurer is 0.087 even meet the regulatory requirements with collaterals. In case of without collaterals, ceded out business to an offshore reinsurer is charged more than to an insolvent domestic reinsurer.

The impact of domicile is also prominent in risk factors. Depending on whether the domestic reinsurer is a domestic independent legal entity, Ki value is set and determined as follows:

$$K1 = \begin{cases} 0, & \text{Domestic independant legal entity} \\ 0.05, & \text{No domestic independant legal entity} \end{cases}$$

$$K2 = \begin{cases} -0.1, & \textit{Overseas reinsurer whoes parent company is a domestic} \\ 0, & \text{Others} \end{cases}$$

The different risk factors reflect the regulators intention in reposition of reinsurance undertaking with five main characteristics: localizing the business undertaking, specializing of the reinsurance, normalizing the capital tools, encouraging the primary insurer cede out the tail risk, globalizing the domestic risk. To a certain extent, CIRC encourages to scatter the domestic risk by means of retrocession from a domestic reinsurer to the foreign reinsurer rather than to cede out to a foreign reinsurer directly from a primary insurer. The consideration behind the scene is to mitigate the risk of the numerous new insurers without reinsurance expertise to deal with the offshore reinsurers and to introduce more advanced reinsurance technique to China reinsurance industry by those foreign reinsurers seeking to set up local branches. It will be more obvious if we look at the RF_0 on reinsurance assets ceded by reinsurers to overseas counterparties, which are far lower than primary insurer cede out business.

2.2.2 Counterparty default risk under Solvency II

Under Solvency II, the counterparty default risk is calculated based on the estimated loss-given-default (LGD) of an exposure and the probability of default (PD) of the counterparty for this exposure. [4]

LGD is defined as 50 percent of the sum of the best estimate recoverables from the reinsurance contract (or special purpose vehicle (SPV) in the case of an ILS) and any other related recoverables plus the risk mitigating effect on underwriting risk of the reinsurance in consideration, less the risk-adjusted value of any collateral in relation to the reinsurance.[5] This is shown in the formula below.

$$LGDi = (50\% *(Recoverables_i + RMre,i – Collaterali),)$$

Although domicile is not a risk factor under Solvency II, it is criticised as too complex and centred on the rating. The risk-mitigating effects are also difficult to determine. In contrast, the calculation of counterparty default risk under C-ROSS is more straightforward and well-defined.

2.3 The SARMRA and IRR

Both the Pillar II in C-ROSS and Solvency II set qualitative regulatory requirement. However, when comparing the Own Risk and Solvency Assessment (ORSA) in Solvency II and Solvency-Aligned Risk Management Requirement and Assessment (SARMRA) of C-ROSS, it reveals some key differences.

ORSA is an insurer's self assessment while SARMRA is conducted mainly by the regulators annually. The impact of SARMRA score is direct and well defined, leading to add-on or reduction on Minimum Capital (MC) according to the insurer's risk management performance.

Minimum control risk capital is based on the following equation:

$$MC_{Control\ risk} = Q \times MC_{Quantitative\ risk}$$

Where MC Control risk denotes minimum control risk capital; *MC Quantitative risk* denotes the sum of minimum quantitative risk capital; Q denotes risk factor and it can be calculated by the equation:

$$Q = -0.005S + 0.4$$

Where S means the score given by the regulator

It can be easily calculated that a score of 80 (under centesimal system) is a break even. For example, $MC_{Quantitative\ risk}$ of insurance company A is RMB 1 billion:

Where S=90, Q= -0.05, $MC_{Control\ risk}$ = -50 million;

Where S=80, Q= 0, $MC_{Control\ risk}$ =0

Where S=70, Q=0.05, $MC_{Control\ risk}$ = 50 million

Every 1 mark increasing in SARMRA score will result in a RMB 500,000 reduction in MC.

In contrast, under Solvency II any capital add-ons are totally discretionary elements. However, ORSA gives insurer more room to use internal models, which are not allowed in SARMRA

In Pillar II, another import measurement is integrated risk rating (IRR) which reflects the profile of all risks. It derives from the Category Supervision System (CSS) which has been practiced for many years, where the insurers are classified to four types A, B, C, D (risk increasing from A to B) based on a series of assessment by CIRC. The pitfall of CSS is that there is no binding regulatory measure in accordance with the final grade and sometimes the local bureau of CIRC's rating to the branch of an insurer conflicts with the rating to the its legal entity conducted by the headquarters of CIRC. IRR tried to offset these pitfalls by building an integrated rating system connecting both quantitative risk and qualitative risk.

In IRR, the weighted average method is adopted, in which the weight for quantifiable risks (Pillar I) is 50%, and the weight for unquantifiable is 50%. CIRC will assess the quantifiable risks of an insurance company according to the level and variation characteristics of their core solvency adequacy ratio and comprehensive solvency adequacy ratio. In terms of the unquantifiable risks, CRIC will give a score to the four types of unquantifiable risks respectively, i.e. operational risk, strategic risk, reputation risk and liquidity risk. The scores are based on an assessment of risk factors such as external environment, distributional characteristics, expected loss, historical data and daily regulatory information, and the comprehensive score for unquantifiable risks will by calculated by a weighted average method. Instead of rating the branch as a whole under CSS, local bureaus of CIRC are only responsible to rate some items under operational risk and reputation risk, which will be integrated to the score to the legal entity.

Table 3. Integrated Risk Rating Grade under C-ROSS

Category	Quantitative Risk	Qualitative Risk
A	Solvency adequacy ratio meets requirement	Very low operational risk, strategic risk, reputation risk and liquidity risk
B	Solvency adequacy ratio meets requirement	Relatively low operational risk, strategic risk, reputation risk and liquidity risk
C	Solvency adequacy ratio does not meet requirements	Or solvency adequacy ratio meets requirement but risk level is high for one or several in its operation, strategy, reputation and liquidity risk.
D	Solvency adequacy ratio does not meet requirements	Or solvency adequacy ratio meets requirement but risk level is serious for one or several in its operation, strategy, reputation and liquidity risk.

Source: CIRC

It is noticeable that under Solvency II, factors are applied to obtain the operational risk charge, while in C-ROSS operational risk is categorised as unquantifiable risk and there is no capital requirement for it in Pillar I .[6] Instead, it is captured in IRR and also indirectly charged through the SARMRA in the form of requirement for risk control.

To sum up, the greater emphasis under C-ROSS on qualitative aspects is designed to adapt to the higher volatility of emerging market and make the assessment more flexible. But meanwhile it will require considerable investment on behalf of CIRC in high quality staff in order to make the regime operational and effective.[7]

3. Solvency II equivalency

The Solvency II Directive recognises the fact that the insurance industry is a global industry. To avoid unnecessary duplication of regulation, the European Commission may decide about the equivalence of a third country's solvency and prudential regime.[7]

There are three distinct areas for equivalence assessment under Solvency II: Reinsurance, Solvency Calculation and Group Supervision. By evaluating the third country's solvency supervision regime in three areas, EU makes an equivalence decision with different degree.

Table 4. Type of Solvency II Equivalence

Full equivalence	Temporary equivalence	Provisional equivalence
Can be determined for all 3 areas	Can be determined (if progress is being made towards full equivalence) for reinsurance (Art. 172.4) and third country groups operating in the EEA (Art. 260.5)	Can be determined (if progress is being made towards full equivalence) for EEA groups operating in the third jurisdiction (Art. 227.5)
For unlimited period	For limited period (until 31/12/2020 with the possibility to extend by 1 year)	For limited period (10 years, renewable for further 10-year periods)

Source: EIOPA

Among the top 20 largest insurance market, 14 of them are under Solvency II or recognised as a certain type of equivalence. For China, the benefits of being confirmed as Solvency II equivalence are significant and also reciprocal to the EU insurers. After receiving equivalence, EU insurers can use C-ROSS rules to report on their operations in China, while Chinese insurers are able to operate in the EU without complying with all EU rules. Back to 2012, as the beginning of setting C-ROSS framework, China has expressed an interest in being covered by the transitional provisions. When the framework released in 2014, it is perceived that China is a candidate for provisional equivalency under Solvency II [8].

Table 5. Solvency II Equivalence of the World's Twenty Largest Insurance Markets

Rank	Country(District)	Area of Solvency II Equivalence	Type of Equivalence
1	United States	Group Solvency Equivalence and Reinsurance	Provisional equivalence
2	Japan	Reinsurance Equivalence	Temporary equivalence
		Group Solvency Equivalence	Provisional equivalence
3	United Kingdom	Solvency II	
4	P.R.China	None	
5	France	Solvency II	
6	Germany	Solvency II	
7	Italy	Solvency II	
8	South Korea	None	
9	Canada	Group Solvency Equivalence and Reinsurance	Provisional equivalence
10	Australia	Group Solvency Equivalence and reinsurance	Provisional equivalence
11	Bermuda	Full Equivalence	
12	Netherlands	Solvency II	

13	Taiwan	None	
14	Spain	Solvency II	
15	India	None	
16	Switzerland	Full Equivalence	
17	Russia	None	
18	Brazil	Group Solvency Equivalence and Reinsurance	Provisional equivalence
19	Ireland	Solvency II	
20	South Africa	None	

Source: EIOPA

From the comparison have been conducted so far, we see a similar framework with different technical standards under two regimes. The methodology in calculating SCR is compatible with the same rationale. Looking ahead, equivalence will provide a further catalyst for regulatory harmonisation worldwide, which may eventually allow groups to apply similar capital rules across all their operating territories.

4. Conclusion

Firstly, C-ROSS and Solvency II are no doubt built on a similar risk-oriented framework. However, the characteristics in C-ROSS are designed to reflect the realities of emerging market by reshaping different technical standards and approaches. In Pillar 1, the technical standards in valuation of assets and liabilities do not follow the market value. Due to the lack of financial resource and insufficient expertise, composite factor method is employed in most of the business lines with different risk factors in Solvency II, and no internal model is permitted in SCR calculating currently. The capital charge for offshore reinsurers under counterparty credit risk in C-ROSS actually reflects the intention to encourage foreign reinsurers to establish locally in order to improve the expertise of reinsurance market, but the outcomes are uncertain for now.

Secondly, although in both regimes Pillar 2 involves qualitative conditions of risk management and additional supplementary capital may be required if a supervisory review determines it is needed, C-ROSS has a greater emphasis on the qualitative assessment and links the Pillar I and II by a well-defined MC add-ons result from the grade of SARMRA. More flexible regulatory policies can be applied to the four category assessed by IRR. However, those qualitative approaches require considerable investment in high quality staff, and incompetent regulators may distort the efficiency

of the regime. Thirdly, C-ROSS is perceived as a candidate for Solvency II equivalence. Such a determination may benefit to both of the jurisdictions and contribute to regulatory harmonisation worldwide.

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Pricing Research on Reverse Mortgages in China

WANG Haiyan, LIU Ke, XIANG Yuanyuan

WANG Haiyan*
PhD, Associate Professor
School of Economics and Management
Tongji University
Rm. 816, Block A, Tongji Plaza, No. 1500 Siping Rd.
Shanghai 200092, China
Phone: (86)139 1728 3932
Email: wanghaiyan@tongji.edu.cn

LIU Ke
Master Candidate
School of Economics and Management
Tongji University
Rm. 816, Block A, Tongji Plaza, No. 1500 Siping Rd.
Shanghai 200092, China
Phone: (86) 177 1709 6447
Email: 245942836@qq.com

XIANG Yuanyuan
Master Candidate
School of Economics and Management
Tongji University
Rm. 816, Block A, Tongji Plaza, No. 1500 Siping Rd.
Shanghai 200092, China
Phone: (86)151 2103 3486
Email: 252723713@qq.com

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Abstract. With the rapid development of economy and the improvement of the medicare level, China has quietly stepped into the aging society with a comparatively low per capita income, which

will undoubtedly bring huge pressure on the supply of pension resources. Under this condition, it seems urgently to broaden the sources of pension fund. Therefore, this paper focuses on the risks and the pricing of reverse mortgages in China.

This paper contains four parts. For the first part, we have reviewed the existed achievements on risk management and pricing models for reverse mortgages and categorized these models into four: payment factor model, actuarial model, option pricing model and single (multi)-factor volatility model. Based on the introduction of the participators and operation pattern for reverse mortgages, we analyze its feasibility in China by comparing the market conditions and barriers.

For the second part, the various influence factors are considered, such as loan interest rates, real estate price and the life expectancy of borrowers. Based on the existing research, we also compare the three pricing models: payment factor model, actuarial model and option pricing model. According to the actual situation in China, we establish the benchmark pricing model for reverse mortgages under different operation pattern, which is a static model without taking the fluctuation of affecting factors into account.

The third part will analyze the three major risk factors' volatility and their impact on the benchmark pricing model. Then the dynamic pricing model, which distinguishes the different modes of payment (lump sum payment) and interest reckon (fixed and floating interest rate) has been built. In detail, we select the ARIMA(Auto-Regressive and Moving Average Model) model and Grey Model to simulate the mortgage house price, then the ARIMA model is selected after the comparison of their prediction accuracy; For the simulation of loan interest rate volatility, we compare the Vasicek model, CIR model and jump diffusion model, considering the interference of other factors out of the market, we select a pure variable volatility jump-diffusion model to forecast the mortgage interest volatility. The life expectancy of the borrowers is calculated by the actuarial method.

In the end, as the fourth part, we will provide groups of the empirical pricing outcome of reverse mortgages with the Monte Carlo simulation based on the actual data in China, which can provide guidance for the future business operation of reverse mortgages.

1．引言

随着我国经济的高速发展和医疗水平的显著提高，老龄化已成为困扰社会稳定和经济发展的一项不容忽视的问题，传统的养老资金来源，如基本养老保险金、家庭资助和养老储蓄，将随着人口和家庭结构的变迁而显得不堪重负。当前，反向抵押贷款作为一种有效的补充养老新思路为人们所热议。所谓反向抵押贷款，就是拥有独立房产的老人作为借款人，将其持有的房产抵押给贷款机构，一次性领取或以年金的形式定期领取贷款的业务。合同生效后，借款人逐步将其房产所有权转移给贷款机构，继续享有居住权；贷款合同直到借款人去世或永久搬离抵押住房时结束；贷款支付额以抵押住房的评估现值为基础，剔除折旧和预支利息的折损，按生命表中各年龄人口的平均余命进行分摊。作为一项复杂的金融产品，定价问题是反向抵押贷款研究的关键问题，直接关系到老年客户参与的热情和金融机构承办该业务的积极性。

自20世纪70年代美国推出住房反向抵押贷款产品以来，定价的实证研究就已陆续展开。总结国内外学者的研究成果，主要的定价方法包括：支付因子模型，保险精算模型，期权定价模型，单（多）因素波动定价模型，等。

支付因子模型最早由 Chinloy and Megbolugbe（1994）提出。该模型考虑房产价值波动率、利率、死亡率和通货膨胀率等因素的影响，计算出不同的贷款支付系数，将抵押房产的市场公允价值乘以支付系数，从而得到最终的贷款额度。美国现行反向抵押贷款产品 HECM（Home Equity Conversion Mortgages）的定价即以支付因子模型为基础，考虑房产价值波动率、死亡率和调整精算系数的影响来计算支付因子，但是忽略了利率和通货膨胀率的波动。由于该模型的计算依赖于历史数据，因此对像我国这样尚未开展反向抵押贷款业务的国家不适用。

保险精算模型则由 Tse（1995）提出。该模型从保险精算的角度，基于贷款机构经济利润为零的假设，实质是损益平衡定价模型 MBA（Mean Breakeven Annuity）。此后，Mitchell and Piggott（2004）在此基础上构建了简单的一次性支付模型 LS（Lump Sum）；Baer 等（2006）在不考虑贷款机构经济利润的前提下，根据房产价值波动率、利率波动和预期余命不确定性三个关键因素构建了精算定价模型，并运用蒙特卡罗模拟进行定价；Szymanoski（2007）以美国 HECM 产品数据为基础，研究上述三个因素对定价的影响，发现抵押房产价值可以用随机过程来合理预测。我国的学者也对该模型有所改进：邹小芃和张晶（2006）考虑了共有拥有房产的问题，设计了单生命和双生命的反向抵押贷款精算模型；肖隽子（2006）改进了前者的双生命模型，提出了基于平均余命的保险精算定价模型；路静、高鹏和董纪昌（2009）在 Mitchell 等人的模型基础上，考虑了借款人居住房屋的机会成本；柴效武，王卉卉（2010）对模型参数的设置进一步考虑初始费用和房屋的折旧问题，并利用相关参数和上海市数据，得出不同性别的被保险人获得的年金金额。与支付因子模型相比，保险精算定价模型不依赖于历史数据，更适用于尚未开办反向抵押贷款业务的国家。

期权定价模型考虑了反向抵押贷款产品的借款人在贷款到期时拥有住房赎回权的情形，这可以看作欧式看跌期权。代表有：Bardhan，Karapandza 和 Urosevic（2006）在风险中性的

前提下提出 BKU 定价模型，以及 Ma，Kim 和 Lew（2007）将抵押房产变现花费的时间纳入模型中，从而对 BKU 模型作出完善。范子文（2006）假设借款人在每个支付期初都会根据利率的调整情况来判断是否提前赎回，因此，定价时应充分考虑此期权的价值，规避风险损失。王薇（2009）分别采用保险精算和期权定价方法对上海住房公积金管理中心以房养老项目进行定价，并区分可赎回和不可赎回贷款，实证结果证明存在显著的期权费。陈近（2010）则认为真正的反向抵押贷款赎回权应该是合同到期之前，借款人通过偿还已获得的贷款本金和利息收回房产抵押权，结束贷款业务。他建议采用剥离式赎回权的产品设计，将此赎回权独立于不可赎回的反向抵押贷款产品进行单独定价。

单（多）因素波动定价模型则注重选取影响定价的主要因素来构建模型。胡斌（2003）认为房地产价格波动是影响定价的最主要因素；石卉（2008）通过构建包括土地价格、国民生产总值和人均可支配收入等的多因子分析模型，对南京市未来的住房价格进行预测，并据此建立基于房价波动的反向抵押贷款定价模型；周佳（2009）选取了全国房地产市场数据和以上海、北京为代表的地方房地产市场数据，根据数据的平稳性选择 ARIMA 模型对未来的房价进行预测，进而确定反向抵押贷款产品的价格；奚俊芳（2007）在寿命精算基础上构建反向抵押贷款一次性支付和年金式支付定价模型，并且首次提出递增式年金支付模式。陈珊、谭激扬和杨向群（2007）假设贷款利率波动服从 Markov 链，据此推导出不同支付方式下的定价公式。刘綦铭（2010）认为在我国利率不完全市场化的环境下，利率波动服从单纯跳跃过程，可视为几何布朗运动与泊松过程的有机结合，通过讨论利率波动对反向抵押贷款定价的影响构建定价模型。陈近（2010）对各种影响因素进行仿真模拟，进而得到未来现金流的各种情境，根据无风险利率进行折现，取均值作为反向抵押贷款的最终定价。其中，构建了扩散跳跃利率波动模型和服从布朗运动的房价波动模型。在此基础上，柴效武和杨梦（2012）分别引入 CSV 模型和小波神经网络模型预测预期余命和房价波动，从而构建多因素波动定价模型。

本文将结合最新的死亡率数据、基准贷款利率数据和房地产价格指数数据，探讨在构建定价体系的总体思路中，如何充分反映利率波动、房价波动和预期余命不确定性风险，使得产品定价既不影响潜在的市场需求，又能合理补偿贷款机构所承担的风险。

2. 反向抵押贷款定价的影响因素

2.1 抵押房产价值

反向抵押贷款的支付额是以抵押住房的评估现值为基础确定的。由于“无追索权”条款的限制，如果贷款到期时抵押房产的变现价值小于贷款支付额的终值，贷款机构只能自行承担损失，无权向借款人追偿。抵押住房价值的确定主要包括两类风险：评估风险和波动风险。所谓评估风险主要是考虑住房的物理性、功能性和外部性折旧问题，此外，对于土地使用权剩余年限不同的抵押住房，要考虑不同的评估标准。所谓波动风险则来自于房价走势的不确定性。如果抵押住房评估价值过低，就意味着借款人获得的贷款养老资金不足；反之，贷款机构就会因支付超额贷款而面临资金无法完全回收的风险。

2.2 贷款利率

在反向抵押贷款业务中，利率风险是指由于市场利率的变化偏离预期值，使得贷款机构利润减少甚至遭受损失的可能性。贷款利率可以采取固定和浮动利率两种形式。由于浮动利率随行就市，避免了贷款支付额无法调整带来的损失。因此，采用固定利率会使长期贷款面临更大的利率风险。

此外，反向抵押贷款业务中还隐含着不同的期权。比如住房赎回权条款相当于贷款机构出售了一份欧式看跌期权。当合同到期时，贷款支付额的终值是一定的，可以看成标的资产的执行价格；而抵押住房的未来价值随着房地产市场的走势而上下波动，视为标的资产的市场价格。当抵押住房的最终价值大于贷款支付额的终值时，借款人就会选择执行其住房赎回权，以货币来偿还所获得的贷款总额。在这个过程中，贷款机构没有损失，只是潜在收益减少；而当抵押住房的最终价值小于贷款支付额的终值时，借款人会放弃住房赎回权。此时，由于“无追索权”的限制，贷款机构会面临两者差额的损失。又比如，借款人提前还款的权利使得反向抵押贷款业务可以被视作一份可赎回债券，相当于借款人拥有多份美式期权。当市场利率下降时，借款人随时可能执行其赎回权，并以更低的券面利率订立新的反向抵押贷款合同，以降低资金成本。

2.3 预期余命

在合同有效期内，借款人可以定期获得贷款，额度由如下简化的定价模型来确定：

$$\text{每期贷款支付额}=(\text{抵押住房价值}\div\text{借款人预期余命})\times\text{给付系数}$$

如果借款人的实际余命长于预期余命值，由于社会伦理和合同条款的限制，贷款机构仍要向借款人支付贷款。这种由于寿命的不确定性而使贷款蒙受损失的可能性，即为长寿风险。此外，对于房产夫妻共有的情况，一般规定合同有效期以最后生存者的实际寿命为准。而夫妻双方最后生存者的寿命一般大于任何单独一方的实际寿命。因此，贷款机构为非单身老人提供反向抵押贷款的长寿风险更大。

除此三大主要因素之外，影响反向抵押贷款定价的因素还有道德风险、流动性风险和政策变动等，这里不再赘述。

3. 反向抵押贷款定价的基准模型

根据资产定价的基本公式，资产价值等于未来可能产生的现金流贴现到期初的净现值。实际操作中，一般有三种计算方法：第一种方法是对未来现金流进行风险调整，即确定性等价法；第二种方法是设定风险调整的折现率；第三种方法是风险中性定价法。考虑到我国尚未形成反向抵押贷款的标准化公开交易市场，且影响定价的主要因素描述性较强，本文将采用风险中性定价法进行研究，不对未来现金流进行风险调整，也不考虑折现率的风险溢价，而是综合分析对定价产生影响的主要因素，模拟各个变量在贷款期间的可能性游走路径，计算各场景下的现金流情况，用无风险利率进行折现，最后取其加权平均值作为资产的最终价

格。定价基准模型将抵押房产价值、贷款利率和借款人预期余命三大风险因素视为常量考虑。本文将构建反向抵押贷款一次性支付的定价基准模型。

3.1 模型参数说明

x：借款人年龄为 x 岁，假设其在生日当天申请反向抵押贷款；

T：借款人预期余命，遵循经验生命表的概率分布；

M：借款人的最大余命，根据中国人寿保险业经验生命表最大年龄为 105，M=105-x+1；

${}_{t|}q_x$：x 岁的借款人在申请反向抵押贷款后第 t 年死亡的概率，假设贷款在其死亡后的第一个生日到期；

H_0：抵押房产初始评估价值；

r：折现率。由于本文采用风险中性定价法，折现率采用无风险利率；

i：抵押房产价值年增值率；

m：反向抵押贷款年利率；

f：贷款费率。反向抵押贷款申请过程中各项费用与抵押房产初始评估价值的比率，包括房屋的评估费用、修缮费用以及贷款机构开办新业务的成本等；

d：抵押房产年折旧率。由于无追索权条款的限制，理性的借款人对其抵押房产会实行消极维护，在一定程度上加速房屋折旧；

LS：一次性支付方式中反向抵押贷款的支付额；

3.2 一次性支付定价模型

一次性支付，是指合同生效日，贷款机构将贷款总额一次性发放给借款人。贷款合同直到借款人去世到期，贷款机构获得抵押房产的完全产权，将其变现回收资金。

定价公式表示为：

一次性贷款支付额终值 = 合同到期时抵押房产变现价值 + 贷款初始费用终值

假设借款人去世后的第一个生日为贷款到期日，则贷款的一次性支付额为：

$$\mathrm{LS}(T)=\frac{H_0\times(1+i)^T\times(1-d)^T+H_0\times f\times(1+r)^T}{(1+m)^T} \tag{1}$$

4. 反向抵押贷款定价风险因素模拟分析

4.1 抵押住房价值波动的预测模拟

本文将房价波动归结为长期趋势波动、循环波动和社会心理预期。长期趋势波动可以理解为价值波动，从长期来看，房价有不断上涨的趋势,影响房价趋势波动的因素主要为宏观经济形势、人口因素和城市化进程；循环波动影响因素则表现为，在供需关系作用下，房价围绕价值上下波动形成循环运动，主要的影响因素为人均可支配收入和产业政策等；社会心理预期则是在普遍社会心理预期的情况下，房价很可能背离其内在价值，甚至脱离供求关系而波动。本文假定续期采用无偿形式，选取 2005 年 1 月——2014 年 12 月中国房地产指数系统（CREIS）上海二手房销售价格指数月度数据进行分析。本文分别采用了比较成熟的预测方法——自回归移动平均模型（ARIMA）和灰色理论预测模型（GM）进行预测，在对预测结

果进行比较后决定采用前者。

首先，在 ARIMA 模型下，本文经过平稳性处理及对滞后期阶数（p,q）的识别，得到较为合适的 ARIMA（4,1,1）模型，经过残差序列相关性检验确定，残差序列不存在序列相关性，模型拟合结果较好，因而得到房价波动 ARIMA 预测模型如下：

$$dh_t = 39.04 + 1.36dh_{t-1} - 0.47dh_{t-2} + 0.40dh_{t-3} - 0.36dh_{t-4} + \varepsilon_t - 0.98\varepsilon_{t-1} \qquad (2)$$

其次，

灰色预测模型是将原始数据构成的原始序列经过累加变为生成序列，通过建立微分方程对生成序列的变化过程进行拟合和预测，经过逆还原得到灰色系统本身的发展趋势。灰色模型的适用性检验指标分别为小误差概率 P、后验标准差比值 C 和关联度 ŋ。根据以上数据，运用灰色模型 GM（1,1）进行预测,得到各检验指标如表 1 所示。由此可以判断 GM（1,1）模型检验通过，可以对抵押房产价格波动进行预测。

表 1　CREIS 上海二手房销售价格指数 GM（1,1）参数估计表

参数	小误差概率 P	标准差比值 C	关联度ŋ
估计值	1	0.5980	0.6106

数据来源：Matlab 运算结果

基于上述两种预测模型对数据进行模拟，拟合结果见图 1 所示。两种模型拟合情况都较好，进一步获得拟合误差的相关数据（见表 2）后，我们得出结论：对抵押房产未来价格波动采用 ARIMA 模型进行预测较优。

表 2　ARIMA（4,1,1）模型与 GM（1,1）模型拟合效果对比

模型	残差均值	残差标准差	变异系数	误差概率（10%水平）
ARIMA（4,1,1）	199.8691	150.5745	0.7534	0.1417
GM（1,1）	224.2790	168.2092	0.7502	0.2333

于是 ，对于一次性支付的反向抵押贷款产品，将房产增值率修正为动态参数，则改进的定价基准模型为：

$$\mathrm{LS} = \frac{H_0 \times \prod_{j=1}^{T}(1+i_j)^T \times (1-d)^T + H_0 \times f \times (1+r)^T}{(1+m)^T} \qquad (3)$$

4.2 利率波动的预测模拟

由于中国人民银行规定，基本贷款利率调整后，商业银行对已发放的住房抵押贷款自下一年 1 月起依据新的贷款利率计算还款额度。因此，住房抵押贷款利率呈阶梯跳跃状。本文的研究基于反向抵押贷款浮动利率定价方式与住房抵押贷款相一致，即阶梯跳跃式浮动利率。因而采用跳跃扩散模型进行预测。又由于基准贷款利率由中国人民银行制定并会保持一段时间，没有跳跃扩散模型的漂移过程，因此可以将基准贷款利率波动看作一个单纯的可变波动率跳跃过程：

$$dr_t = K_t dp \quad (4)$$

其中，dp 表示强度为λ的泊松过程，与维纳过程相互独立，λ表示单位时间内利率的平均跳跃次数；$K_t \sim N(\alpha,(\sigma r_t)^2)$；$\lambda = \frac{n}{N}$，$n$ 代表利率跳跃次数，N 代表样本数据总量。

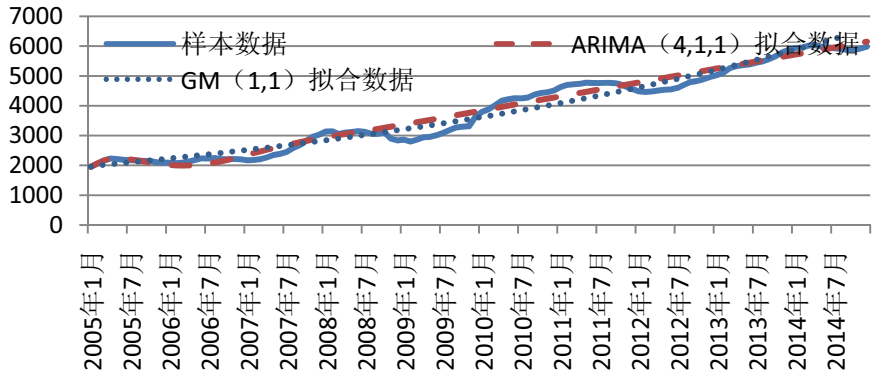


图 1 原始数据与模型拟合数据比较

本文选取中国人民银行公布的1991年5月至2014年12月人民币基准贷款利率月度数据。由于反向抵押贷款期限较长，本文选取 5 年以上基准贷款利率数据。样本总量为 284，差分序列共 283 个数据，其中非零数据为 32 个，代表跳跃次数。参数估计值如表 3 所示。由此可得，反向抵押贷款未来利率波动服从上述单纯可变波动率跳跃过程，其中 $K_t \sim N(0,(0.0963r_t)^2)$，dp 服从强度为 0.1127 的泊松过程。

表 3 人民币基准贷款利率单纯跳跃模型参数值

参数	λ	dr_t/r_t标准差	σ
估计值	0.1127	0.0323	0.0963

由于我国尚缺乏反向抵押贷款业务的历史数据。为了简化定价模型，本文考虑将允许提前还贷的赎回权单独剥离出来，与无赎回权的反向抵押贷款产品分别定价。

4.3 预期余命的估计

本文根据保监会发布的《中国人寿保险业经验生命表 2000-2003》中养老金业务板块数据，对借款人的预期余命进行预测。反向抵押贷款定价模型中的死亡率无法从经验生命表中直接查询，但可以通过相关关系计算获得预期余命的概率。

根据${}_Tp_x$的含义，可知：

$${}_Tp_x = p_x \times p_{x+1} \times \cdots \times p_{x+T-1} = (1-q_x) \times (1-q_{x+1}) \times \cdots \times (1-q_{x+T-1})$$

则有

$$\begin{aligned} {}_{T|}q_x &= {}_Tp_x - {}_{T+1}p_x \\ &= (1-q_x) \times (1-q_{x+1}) \times \cdots \times (1-q_{x+T-1}) - (1-q_x) \times \cdots \times (1-q_{x+T}) \\ &= (1-q_x) \times (1-q_{x+1}) \times \cdots \times (1-q_{x+T-1}) \times q_{x+T} \end{aligned} \quad (5)$$

4.4 一次性支付反向抵押贷款定价的动态模型

反向抵押贷款定价的动态模型同时考虑了抵押房产价值波动、利率变化和预期余命三个因素。在区分固定利率和浮动利率的不同情况下，考虑将允许提前还贷的赎回权单独剥离出来，作出无赎回权及有赎回权情况下的定价。

4.4.1 固定利率情况下的一次性支付定价

在固定利率情况下，不存在利率波动；此前的定价公式仅考虑单个借款人的情况，而实际操作中贷款机构提供的是标准化合同，因此应结合社会平均余命水平进行定价。对于年龄相同的借款人，已经得到每一固定余命 T 下的贷款额度 $\mathrm{LS}(T)$。因此，在不考虑提前还贷的赎回权时，一次性支付反向抵押贷款的定价为

$$\mathrm{LS}=\frac{H_0\times\prod_{j=1}^{T}(1+i_j)\times(1-d)^T+H_0\times f\times(1+r)^T}{\prod_{j=1}^{T}(1+m_j)} \tag{6}$$

对赎回权定价时，考虑利率波动和房产增值两个主要因素。其基本原理是：根据第 t 年的抵押房产评估值和预期房产增值率重新计算期末贷款总额，按照第 t 年的贷款利率水平，判断借款人在第 t 年申请新的反向抵押贷款是否获得额外收益。如果新贷款额度扣除前期费用后，依然大于原贷款的当期总额，借款人会选择提前还贷。

原贷款的当期总额 $I_t=\mathrm{LS}\times(1+m)^t$，新贷款的一次性支付额为 $\mathrm{NLS}=\sum_{k=1}^{M-t}{}_{k|}q_{x+t}\times\mathrm{NLS}(k)$，即

$$\mathrm{NLS}(k)=\frac{H_0\times[\prod_{j=1}^{k}(1+i_j)\times(1-d)^k+\prod_{j=1}^{t}(1+i_j)\times(1-d)^t\times f\times(1+r)^{k-t}}{(1+m)^{k-t}} \tag{7}$$

当 $\mathrm{NLS}_t-H_0\times\prod_{j=1}^{t}(1+i_j)(1-d)^t\times f>I_t$ 时，借款人会选择提前还贷。若借款人在第 t 年选择提前还贷，则行权价值的现值为 $V_t=\mathrm{NLS}_t-H_0\times\prod_{j=1}^{t}(1+i_j)\times(1-d)^t\times f-I_t$。则赎回权价格为行权价值的现值：

$$P_t=\frac{\mathrm{NLS}_t-H_0\times\prod_{j=1}^{t}(1+i_j)\times(1-d)^t\times f-I_t}{(1+r)^t} \tag{8}$$

在每一个预期余命 T 水平下，可以得到不同的赎回权价格，取其均值作为 $P(T)$。反向抵押贷款赎回权的最终定价为 $P=\sum_{T=1}^{M}{}_{T|}q_x\times P(T)$。

4.4.2 浮动利率情况下的一次性支付定价

在不考虑提前还贷的赎回权时，同时加入利率的变化和预期余命的影响，一次性支付反向抵押贷款定价为

$$\mathrm{LS}=\sum_{T=1}^{M}{}_{T|}q_x\times\frac{H_0\times\prod_{j=1}^{T}(1+i_j)\times(1-d)^T+H_0\times f\times(1+r)^T}{\prod_{k=1}^{T}(1+m_k)} \tag{9}$$

对赎回权定价时，原贷款的当期总额 $I_t = \mathrm{LS}\times\prod_{j=1}^{t}(1+m_j)$，新贷款的一次性支付额 NLS_t 为

$$\mathrm{NLS}_t = \sum_{k=1}^{M-t} {}_{k|}q_{x+t} \times \mathrm{NLS}(k)$$

$$\text{其中，}\mathrm{NLS}(k) = \frac{H_0 \times [\prod_{j=1}^{k}(1+i_j)\times(1-d)^k + H_0 \times \prod_{j=1}^{t}(1+i_j)\times(1-d)^t \times f \times (1+r)^{k-t}}{\prod_{a=1}^{k}(1+m_a)} \quad (10)$$

当 $\mathrm{NLS}_t - H_0 \times \prod_{j=1}^{t}(1+i_j)(1-d)^t \times f > I_t$ 时，借款人会选择提前还贷。赎回权价格与式（7）一致，即

$$P_t = \frac{\mathrm{NLS}_t - H_0 \times \prod_{j=1}^{t}(1+i_j)\times(1-d)^t \times f - I_t}{(1+r)^t}$$

在每一个预期余命 T 水平下，运用单纯跳跃模型对利率波动进行预测，取不同预期余命和不同利率波动路径下赎回权价格的平均值，即为赎回权的价格 $P(T)$。一次性支付的反向抵押贷款赎回权的最终定价为

$$P = \sum_{T=1}^{M} {}_{T|}q_x \times P(T) \quad (11)$$

5. 反向抵押贷款定价实证分析

5.1 参数设定

本文假定定价的时间节点在 2015 年 1 月，参数当前数据均取 2015 年 1 月的数据，历史数据均截止到 2014 年 12 月。

固定参数包括：

H_0：抵押房产初始评估价值。本文选取的历史数据为上海二手房销售价格指数。为了保持一致性，设定抵押房产初始值为 300 万元，并分别取 200 万元和 400 万元两个数值作敏感性分析。

r：年折现率。本文选取人民银行 2014 年 11 月 22 日公布的 3 年期人民币存款基准利率作为年折现率，为 4%；

f：贷款费率。由于我国尚未开展反向抵押贷款业务，故借鉴美国 HECM 业务的经验，设定费率为 6%；

d：抵押房产年折旧率。我国的土地使用年限为 70 年，以此作为住宅的使用寿命，则年折旧率为 1.43%（直线折旧法）。然而考虑到住宅用地的价格逐年攀升，因此对年折旧率作适当调整，取 1.2%。

变动参数包括：

i：抵押房产价值年增值率。根据 4.1 节的讨论，得到抵押房产价格公式为式（2）。由于样本为月度数据，需要进一步转换得到抵押房产年增值率为

$$i_t = h_{t*12} / h_{(t-1)*12} - 1$$

m：反向抵押贷款年利率。反向抵押贷款的期限长达几十年，以 2015 年 1 月作为时间节点进行定价，因此贷款利率的初始值设为央行规定的 5 年期人民币贷款基准利率 6.15%。

根据 4.2 节的讨论，我国贷款利率波动类似于一个单纯的可变波动率跳跃过程 $dr_t = K_t dp$，其中 $K_t \sim N(0,(0.0963r_t)^2)$，$dp$ 服从强度为 0.1127 的泊松过程。

与房价波动预测模型一样，利率波动模型也以月度数据为基础，需要转换成年利率。

$_{T|}q_x$：x 岁的借款人预期余命为 T 的概率。4.3 节已计算得到来反映不同年龄借款人剩余寿命为 T 的概率。

5.2 一次性支付——固定利率计息的反向抵押贷款定价结果

以 60-80 岁的借款人为例，申请一次性支付——固定利率计息的反向抵押贷款的额度如表 4 所示。

表 4 男性借款人反向抵押贷款额度与借款人年龄关系图（固定利率）

年龄	反向抵押贷款额度（万元）	贷款比例
60	103.6173	34.54%
61	107.6011	35.87%
62	111.9962	37.33%
63	116.2859	38.76%
64	120.7693	40.26%
65	125.2790	41.76%
66	130.0702	43.36%
67	134.9473	44.98%
68	139.5629	46.52%
69	144.8064	48.27%
70	149.9470	49.98%
71	154.7437	51.58%
72	159.7588	53.25%
73	165.0612	55.02%
74	169.9896	56.66%
75	175.1203	58.37%
76	180.6465	60.22%
77	185.5018	61.83%
78	190.7447	63.58%
79	195.8821	65.29%
80	200.9431	66.98%

从上述结果可知，通过申请反向抵押贷款，老年人在保留住房居住权的同时，可以获得额外收入，在很大程度上提高了老年人的医疗和生活水平，改善晚年生活。借款人年龄与反

向抵押贷款一次性支付额成正比。究其原因，借款人年龄越大，剩余寿命越短，意味着贷款期限越短，贷款到期时抵押房产价值的贴现值越大，贷款机构的风险越小。

以 80 岁男性借款人为例，设定抵押房产的初始评估值为 300 万元，房屋年折旧率为 1.2%，前期费率为 6%，年折现率为 4%为参照组，分别调整贷款利率、贷款费率和房屋折旧率作敏感性分析，详见下表所示。对比上述三者的变化幅度可知，定价结果对贷款利率的敏感性高于对贷款费率和房屋折旧率的敏感性。

表 5 贷款利率敏感性分析

年龄	参照组		*m*=5%		*m*=7%	
	贷款额度	贷款比例	贷款额度	贷款比例	贷款额度	贷款比例
80	200.9431	66.98%	218.933	72.98%	189.3994	63.13%

表 6 贷款费率敏感性分析

年龄	参照组		*f*=5%		*f*=7%	
	贷款额度	贷款比例	贷款额度	贷款比例	贷款额度	贷款比例
80	200.9431	66.98%	198.3346	66.11%	203.4078	67.80%

表 7 房屋折旧率敏感性分析

年龄	参照组		*d*=1%		*d*=1.5%	
	贷款额度	贷款比例	贷款额度	贷款比例	贷款额度	贷款比例
80	200.9431	66.98%	203.8521	67.95%	196.3855	65.46%

赎回权定价过程较为复杂，Matlab 运行时间较长。笔者受限于电脑性能，仅以 80 岁男性借款人为例进行实证定价，结果为 76251 元，占抵押房产现值的 2.54%。结合美国 HECM 业务的经验，此结果是合理的，对借款人而言也具有较高的接受性。

5.3 一次性支付——浮动利率计息的反向抵押贷款定价结果

以 60-80 岁的借款人为例，申请一次性支付——浮动利率计息的反向抵押贷款的额度如表 7 所示。与固定利率定价相比，浮动利率计息方式下的反向抵押贷款提供给借款人的一次性支付额更高。这是因为浮动利率的环境下，贷款机构的一部分利率风险由借款人分担，理应获得相应的风险溢价。

表 8 男性借款人一次性支付——浮动利率计息反向抵押贷款额度

年龄	反向抵押贷款额度（万元）	贷款比例
60	112.0896	37.36%
61	118.3267	39.44%
62	119.0524	39.68%
63	124.9806	41.66%
64	128.9314	42.98%

65	133.0986	44.37%
66	137.7202	45.91%
67	140.7963	46.93%
68	143.9497	47.98%
69	150.6028	50.20%
70	155.6867	51.90%
71	159.921	53.31%
72	163.4786	54.49%
73	170.0157	56.67%
74	173.7303	57.91%
75	178.9762	59.66%
76	182.079	60.69%
77	189.1506	63.05%
78	192.7155	64.24%
79	197.8014	65.93%
80	202.8709	67.62%

以 80 岁男性借款人为例，设定抵押房产的初始评估值为 300 万元，房屋年折旧率为 1.2%，前期费率为 6%，年折现率为 4%为参照组，分别调整贷款利率、贷款费率和房屋折旧率作敏感性分析，详见表 9、表 10 和表 11。

从上述三张表可知，反向抵押贷款一次性支付额与贷款利率和房屋折旧率成反比，与贷款费率成正比。对比三者的变化幅度可知，定价结果对贷款利率的敏感性高于贷款费率和房屋折旧率。

和上述固定利率计息情况相同，由于赎回权定价过程复杂，本文仅以 80 岁男性借款人为例进行实证定价，结果为 85832 元，占抵押房产现值的 2.86%，比固定利率下的定价结果稍高。对比无赎回权的反向抵押贷款在不同计息方式下的定价结果可知，此结果是合理的。

表 9 贷款利率敏感性分析

年龄	参照组		*m*=5%		*m*=7%	
	贷款额度	贷款比例	贷款额度	贷款比例	贷款额度	贷款比例
80	202.8709	67.62%	220.4523	73.48%	190.9896	63.66%

表 10 贷款费率敏感性分析

年龄	参照组		*f*=5%		*f*=7%	
	贷款额度	贷款比例	贷款额度	贷款比例	贷款额度	贷款比例
80	202.8709	67.62%	200.1598	66.72%	204.5457	68.18%

表 11 房屋折旧率敏感性分析

年龄	参照组		*d*=1%		*d*=1.5%	
	贷款额度	贷款比例	贷款额度	贷款比例	贷款额度	贷款比例
80	202.8709	67.62%	205.8047	68.60%	199.4615	66.49%

6. 结论

我国就反向抵押贷款的定价问题展开研究，主要结论如下：

影响反向抵押贷款定价的主要因素包括抵押房产价格、贷款利率和借款人预期余命等，结合现实情况，可采用风险中性定价方法进行反向抵押贷款定价；

通过实证结果对 ARIMA 模型和 GM 模型进行比较，发现 ARIMA 模型拟合度更高，以此对房价波动进行模拟和预测；

在我国的市场环境下，基准贷款利率由人民银行制定并会保持一段时间，从波动特征来看更符合跳跃式的浮动利率。因此，可采用可变波动率的单纯跳跃模型对利率波动进行模拟和预测；

由于我国尚未开办反向抵押贷款业务，缺乏历史数据，因此选择传统的保险精算方式计算借款人预期余命的概率。

借款人年龄与反向抵押贷款一次性支付额成正比。定价结果对贷款利率的敏感性高于对贷款费率和房屋折旧率的敏感性。

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中国实施住房反向抵押贷款的定价研究

王海艳 刘珂 向媛媛

王海艳*
副教授
同济大学经济管理学院
四平路1500号同济大厦A楼816室
上海200092，中国
电话: (86) 139 1728 3932
Email: wanghaiyan@tongji.edu.cn

刘珂
研究生
同济大学经济管理学院
四平路1500号同济大厦A楼816室
上海200092，中国
电话: (86) 177 1709 6447
Email: 245942836@qq.com

向媛媛
研究生
同济大学经济管理学院
四平路1500号同济大厦A楼816室
上海200092，中国
电话: (86) 151 2103 3486
Email: 252723713@qq.com

关键词: 反向抵押贷款；定价；养老

中文摘要. 随着经济的高速发展和医疗水平的显著提高，我国已经悄然步入老龄化社会，且带有明显的“未富先老”特征，这无疑给养老资源的供给带来了巨大压力。在这样的情况

下，拓宽养老资金来源，显得刻不容缓。因此，本文围绕住房反向抵押贷款的风险及定价问题展开研究。

本文主要分为三部分。第一部分，对中外学者有关反向抵押贷款的风险管理及定价模型进行了梳理，总结了现有的定价方法包括：支付因子模型，保险精算模型，期权定价模型以及单（多）因素波动定价模型。在介绍反向抵押贷款的参与主体与运作模式的基础上，通过比较市场条件和发展障碍对反向抵押贷款进行了可行性分析。

第二部分，本文综合考虑贷款利率、抵押房产价格和借款人预期余命等主要影响因素，对反向抵押贷款的三种定价方法：支付因子模型、保险精算模型和期权定价模型进行了比较。进而，结合中国的实际情况，构建不同运作模式下反向抵押贷款定价的基准模型，即不考虑影响因子动态波动的静态模型。

第三部分，详细分析上述三大影响因素的波动及其对基准定价模型的影响，构建区分支付方式(一次性支付方式)和计息方式（分别为固定利率和浮动利率）的反向抵押贷款动态定价体系。其中，抵押房产价格波动的模拟选用 ARIMA（Auto-Regressive and Moving Average Model）模型和灰色模型，通过预测精度的比较选取最优的 ARIMA 模型；对于贷款利率波动的模拟，在对比了 Vasicek 模型、CIR 模型和跳跃扩散模型之后，考虑到市场因素之外的干扰，选用单纯可变波动率的跳跃扩散模型；借款人预期余命则通过保险精算的方式计算概率。

最后第四部分，本文结合当前实际数据，运用蒙特卡罗方法进行数值模拟，获得反向抵押贷款产品的实证定价结果，为将来反向抵押贷款业务的顺利开办提供一定的借鉴。

Path & Optimization of Asset and Liability Management for Life Insurance Industry under the System of "C-ROSS"

WANG Lingzhi *

Post Doctorate
China Pacific Insurance (group) Co., Ltd.
Shanghai 200120, China
Phone: (8621) 33961136
Email: wanglingzhi-001@cpic.com.cn

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Abstract. China risk oriented solvency system ("C-ROSS") has been carried out formally since 2016 after a year of transition. The restriction on investment variety and ratio will be relaxed under the C-ROSS. Along with the expansion of investment channels for insurance funds, self-determination on asset allocation for managers is improved. The risk oriented Solvency System take the capital as a constraint, there is a great difference in capital occupation for different assets. Under the "C-ROSS", how to balance the income, risk and capital occupation in the asset allocation is worth considering. Firstly, this paper analyzed the impaction of C-ROSS on the assets and liabilities for insurance company; Secondly we made the constraints on the capital occupation, liquidity and characteristic of liability; Thirdly, we choose 12 assets as the investable assets and studied the asset allocation strategy under constraints; At the last, we got the Pareto optimal solution for different risk attitude by use of the genetic algorithm.

1. 引言

2012年以来，中国保险业进行了大幅度的市场化改革，保监会颁布一系列改革方案，如保险公司补充资本的办法、并购重组的方法、资金运用大幅放开、第二代偿付能力监管标准、车险费率市场化改革、寿险产品费率改革等。改革力度之大、变化之快前所未有，新国十条进一步打开了保险业发展的空间，保险业无论从增长速度、业务创新、结构调整都在发生巨大的变化。保险业的监管环境发生重大变革，保监会从顶层设计、政策引导、市场约束等方面推动行业健康发展，保险业正在走向市场化道路。随着我国中产阶级的崛起，人们对保障、传承和财富管理的需求更加旺盛，大资管时代悄然来临。保险业的资产负债管理模式正在从"负债驱动资产"转向"资产、负债双轮驱动"的模式。保险公司的资本管理、战略资产配置将更为重要，保险业的资产负债管理将关系到行业地位和发展。

偿二代体系下，保险监管正在走向以偿付能力为核心的泛监管模式，重点监督保险公司的财务安全和资本充足。在资金运用方面，投资范围和比例的限制正在放宽，通过对偿付能力的监管，一旦偿付能力不达标，将对公司的承保、投资等各方面造成直接影响，而卓越的资产负债管理可以为公司资产端带来超额利润，投资反哺承保，提高企业的整体竞争力。这就要求保险公司在进行投资决策时，必须考量资本充足率和偿债能力，选择与负债更匹配的资产配置结构。

"偿二代"实施后，投资监管将进一步放松，原则上只要能够保证偿付能力充足性，就可以自行决定资产配置的品种和比例，但是配置到不同的资产，需要的资本金不同，如何在偿付能力风险最小、资本金约束下寻求最高的投资收益是本研究亟需解决的问题。关于保险业资产配置的研究文献包括：投资研究是保险业资产负债管理的重要组成部分，国内外诸多学者对保险业资产配置等展开研究。如：Barbrain & Devolder（2005）、Baccinello等（1977）、Grosen（2000）、Ronald（2009）、David（2010）等。国内不少学者从资产负债匹配、投资组合和投资风险控制三个策略的角度研究了保险公司的投资策略（陈友平，2002)，在资产负债匹配管理框架下对保险公司的投资组合收益进行了归因分析（秦振球、俞自由等，2003)，在资产负债框架下对保险人的投资策略进行了研究（戴成峰，2007)，投资渠道多样化在给保险公司带来收益的同时，也增大了投资风险和资产错配风险（刘妍芳，2010），王丽珍等（2012）分析了政策约束下基于风险调整报酬率的保险投资策略，段国圣（2013）对保险投资新政下的资产配置进行了研究，指出保险公司应根据对未来宏观经济和资本市场趋势变化的判断分析，寻找在不同宏观周期下预期表现相对优异的大类进行资产配置。

本研究的主要创新点在于，以往关于保险资产最优配置主要是考虑风险、收益和流动性的平衡，本研究则是在新的监管框架下，考虑到各项资产的资本占用，并将最低资本占用作为优化目标或约束条件，优化资产配置策略，以平衡保险资产的风险与收益；在优化资产配置过程中，本文采用了通过优化方法，得出了不

同风险容忍度下的帕累托最优解，对于保险公司的资产配置策略具有一定的指导意义。

以下是本文的结构安排：第二部分是偿二代体系下，保险资产配置品种的遴选，第三部分是各类资产的风险、收益、资本占用情况；第四部分建立了最优资产配置的模型，确定了最优化的目标和约束条件；第五部分则是优化模型求解，采用了自适应的遗传算法，得出了模型的最优解；第六部分是本文的研究结论及配置策略建议。

2. 偿二代下保险业的资产负债管理与约束

2.1 偿二代对寿险业资产端的影响

风险导向的“偿二代”以三支柱为主要监管框架，采用国际上比较成熟和使用的计量模型和方法确定资本要求，对不同风险、不同业务规定不同的资本要求，将显著提高风险的敏感性。2012年出台的保险资金运用新政拓宽了投资渠道和产品，新的监管体系为险资投资非标资产、海外投资、创投基金、私募股权基金等提供了政策支持。有利于扩大保险公司操作空间，优化资产配置，提高投资收益，改善保险公司经营状况，促进保险行业平稳增长。投资新政在提供更多配置选择的同时，也对资产负债管理提出了挑战。然而，不同的投资渠道需要的资本金存在明显差异，这就要求在制定最优化的战略资产配置时将投资策略和资本需求相结合，围绕资产和负债，在一定的约束条件下，平衡风险和收益原则，实现保险公司价值管理、偿付能力管理的目标。

2.2 偿二代对负债端的影响

偿二代体系下，定价利率逐渐放开，公司通过调整产品开发、销售和投资策略，以保持和提升竞争力。产品创新要求保险公司加强资产负债管理，保单的内嵌选择权对负债方的偿付金额和偿付时间产生较大影响，增加了负债方变动路径的复杂性，加大了自身负债的价值与不稳定性，也对保险公司建立有效的资产负债管理提出了更高的要求。对偿付能力的要求是监控保险公司资产负债风险状况的最重要工具，能够对企业在经营管理中的决策行为形成有效约束，以风险为导向的第二代偿付能力监管体系也将对企业资产负债管理能力提出更高的要求。

2.3 偿二代对资产负债管理的影响

经典的马克维茨方法单纯是从资产方的风险收益特征出发解决投资组合的最优化配置问题。具体到保险公司来看，单方面从评估资产方状况的角度出发设计投资策略忽略了公司价值与资产负债双方的联动性。另外，保险企业的投资行为受到负债特征、投资比例监管和偿付能力要求等多方约束，面临更为多样和复杂的风险因素。因而，保险公司可以根据马克维茨的思路，结合具体要求改进投

资目标函数与风险刻画方式，使用一种整合的视角将资产和负债双方联系起来加以考虑，在此基础上得到适合公司运营特点的有效投资组合。

2.4 资产负债管理的约束条件

（1）最低资本占用。资本约束反映了保险公司在资产配置中可承受风险的程度。保险公司在制定资产配置策略时，不仅要考虑投资组合内部的收益与风险的平衡关系，还要考虑资本的约束。

（2）保险公司的偿付能力充足率。

$$\text{偿付能力充足率} = \frac{\text{实际资本}}{\text{最低资本}} = \frac{\text{认可资产-认可负债}}{\text{风险资本要求}} \tag{1}$$

其中，认可资产是指处置不受限制，并可用于履行对保单持有人赔付义务的资产，认可负债是指保险公司无论在持续经营状况还是破产清算状况下均需要偿还的债务。偿二代对认可资产进行了分级，采用市场公允价值为认可价值，而不再通过打折体现风险，这样一来会释放资本金。认可资产扣除认可负债即为实际资本，这也说明在偿二代下，保险公司的利润不再是各个年度分摊，而是在期初计提，利润视为公司的实际资本；

偿二代监管以风险为导向，最低资本的确定也以保险公司的风险划分为基础。根据其业务特点将风险划分为五大类，包括保险风险、市场风险、信用风险、审慎资本要求、调控性资本要求。并对各个子风险进一步细分，针对每一种子风险所需要的最低资本数额，考虑到风险分散效应，即可得到保险公司的最低资本要求。据测算，寿险公司保险风险、市场风险、信用风险的最低资本占比分别为22%、66%、12%；

（3）账户特征约束。在公司层面，基本无法做到资产负债匹配，保险公司不同产品线具有不同的负债特点，可采用“分账户”的方法，将产品线与投资品种的期限、流动性、收益要求进行匹配，以降低市场风险资本要求。分账户的方法，考虑到账户对收益的要求，现金流的要求，风险承受能力等，使得不同类型的资产和负债之间的关系更加明确，可以更精确的指导公司的投资策略和投资收益分配。

3．偿二代下资本占用、负债特征与资产的遴选

3.1 各类资产的最低资本要求

各类资产的市场风险最低资本采用综合因子法计算。各类资产（负债）的市场风险最低资本计算公式为：$MC_{市场} = EX \times RF$，其中，$MC_{市场}$代表市场风险的最低资本，EX为风险暴露，市场风险的风险暴露等于该项资产的认可价值。RF为风险因子，$RF = RF_0 \times (1+K)$；RF_0为基础因子；K为特征因子。

利率风险：债券类资产、资产证券化产品和利率类金融衍生品需要计提利率风险最低资本；利率风险暴露EX为其认可价值；基础因子

$$RF_0=\begin{cases}D\times(-0.0019\times D+0.0214) & 0<D\le 5\\ D\times(-0.0007\times D+0.0154) & 5<D\le 10\\ D\times 0.0084 & D>10\end{cases}$$

保险公司利率风险最低资本为各项资产的利率风险最低资本算术加总。

权益价格风险：上市普通股票的权益价格风险暴露EX为其认可价值；基础因子RF_0赋值如下：

$$RF_0=\begin{cases}0.31 & \text{沪深主板股}\\ 0.41 & \text{中小板股}\\ 0.48 & \text{创业板股}\end{cases}$$

对于股票基金的权益价格风险暴露EX为其认可价值；对普通股票基金，基础因子RF_0赋值为0.25，混合基金的风险因子为0.2，货币市场基金基础因子为0.01，可转债的基础因子为0.18.对于未上市股权，适用穿透法，即明确其基础资产，根据基础资产的风险暴露和风险因子计算其最低资本要求，若无法采用穿透法时，风险因子为0.31；优先股，上市公司公开发行的，风险因子为0.06；由银行保险机构发行的不带强制转换为普通股条款的，风险因子为0.12；

境外资产：境外固定收益类资产价格风险暴露EX为其认可价值，基础因子RF_0赋值如下：

$$RF_0=\begin{cases}0.0762 & \text{发达市场}\\ 0.2139 & \text{新兴市场}\end{cases}$$

境外权益类资产价格风险暴露EX为其认可价值，基础因子RF_0赋值如下：

$$RF_0=\begin{cases}0.3 & \text{发达市场}\\ 0.45 & \text{新兴市场}\end{cases}$$

保险公司应对其持有的外币计价投资资产与负债计算风险最低资本。包括外币房地产、固定收益类资产、权益类资产等。

基础因子RF_0=0.035，根据币种设定特征系数k_1 $=\begin{cases}0 & \text{美元或汇率挂钩}\\ 0.05 & \text{欧元、英镑}\\ 0.12 & \text{其他货币}\end{cases}$

市场风险最低资本汇总：

各类市场风险的最低资本采用相关系数举证进行汇总，计算公式为：

$$MC_{市场}=\sqrt{\mathrm{MC}_{向量}\times M_{相关系数}\times \mathrm{MC}_{向量}^{\mathrm{T}}} \quad (2)$$

其中，$MC_{市场}$代表市场风险的最低资本，$MC_{向量}$为一个行向量，由（$MC_{利率}$，$MC_{权益价格}$，$MC_{房地产}$，$MC_{境外固收}$，$MC_{境外权益}$，$MC_{汇率}$）组成；

表1市场风险最低资本相关系数矩阵

	$MC_{利率}$	$MC_{权益价格}$	$MC_{房地产}$	$MC_{境外固收}$	$MC_{境外权益}$	$MC_{汇率}$
$MC_{利率}$	1	-0.14	-0.18	0	-0.16	0.07
$MC_{权益价格}$	-0.14	1	0.22	0.06	0.50	0.04
$MC_{房地产}$	-0.18	0.22	1	0.18	0.19	-0.14
$MC_{境外固收}$	0	0.06	0.18	1	0.04	-0.01
$MC_{境外权益}$	-0.16	0.50	0.19	0.04	1	-0.19
$MC_{汇率}$	0.07	0.04	-0.14	-0.01	-0.19	1

3.2 资产端遴选

根据其风险情况和资本占用情况，本研究初步假设，保险公司投资的品种包括：权益类（沪深主板股、混合基金、货币市场基金、未上市股权），固定收益类（优先股、固定收益类资产），房地产、美元计价的房地产，境外固收（发达市场固定收益类资产），汇率风险（境外固收、境外房地产）。根据各类资产的属性以及过去5年里各类资产的风险收益特征，以及偿二代最低资本下的风险因子，和变现的难以程度进行汇总，同时，也结合最新保险资金运用监管政策，对各类资产的比例情况进行统计，汇总结果如下表：

表2 各类资产的风险收益特征

资产类别	波动率（%）	收益率（%）	基础风险因子	流动性成本	比例限制[1]
股票	31.92	10.00	0.31/0.41	1%	权益资产上限30%
混合基金	23.48	7.66	0.2	0.5%	
非上市股权	40.64	14.00	0.28	8%	
优先股	10.24	8.00	0.06	5%	
存款、货币基金等	4.55	3.6	0.01	0.1%	无上限
债券类（T<5年）	4.86	3.47	D*（-0.0019*D+0.0214）	2%	固定收益类资产比例无上限
债券类（5年<T<10年）	4.74	4.52	D*（-0.0007*D+0.0154）	3%	
债券类（10年以上）	8.35	6.46	D*0.084	5%	
协议存款	0	3.30	0	3%	

[1] 保监发[2014]13号，中国保监会关于加强和改进保险资金运用比例监管的通知，2014年2月

不动产	16.00	7.00	0.08	10%	房地产类
基础设施股权	33.63	10.00	0.12	8%	上限30%
境外投资固收类	6.25	5.45	0.0762+0.035	5%	境外投资
境外投资房地产	22	10	0.08+0.035	10%	上限15%

3.3 负债端特征

寿险负债具有长期性和复杂性，其负债端的长期性决定了寿险资产负债管理的必要性，在资产配置时应注重总量、结构、期限上的匹配。资产负债管理决策受到产品的业务规模、账户特性、产品期限等特征制约。因此需要对保单数量、保单结构、死亡率、投资收益率、分红政策等，相关的随机变量主要包括保费收入、赔款及费用支出、精算准备金、分红险保单红利等。

传统寿险：在保险期间内现金流比较稳定，该类产品承保利润较大，内含价值相对较高，受死亡率影响显著，对利率的敏感性不高，该类产品应注重与资产的期限匹配，提高固定收益类资产的配置比例，对资产收益率要求较低。

分红型保险：在分红险中，保单条款通常赋予保单持有人一定的选择权，这对分红水平及负债特征均有一定影响。这些选择权包括：如保证最低收益率、退保权等。目前分红险占寿险市场的主导地位，投保人对保障利益和红利分配要求较高，负债成本高；只有提高资产配置的收益才能提高分红水平；

万能险：万能险的缴费比较灵活，对资产负债匹配时需要注重保持一定的流动性。

投连险：此类产品与传统产品有很多不同特性，此类产品受保单退保了影响更多。更多考虑的是保费持续率，即某一类特定投保群体中选择继续支付续保保费的保费规模用该群体需要继续缴纳的保费总数之比。一般，保费的持续率会随着保单年度的增加而增加，在一段时间后达到平衡。投连险而言，在资本市场火爆，投资收益高涨的时候，客户的保费持续率也将大大提高，并且客户积极追加保险费的情况也会涌现。客户行为与市场波动紧密挂钩，受未来市场环境影响较大。

在产品假设过程中，假设保险公司保费收入中，传统险占比30%（其中5年以下占比5%，5~15年占比10%，15年以上占比15%），分红险占比50%（这里假设分红险中保障型分红险占比25%，投资型分红险占比25%），万能及投连险占比20%（万能占比15%，投连险占比5%）2。保险公司很难在全局范围实现资产负债匹配管理，因此，通常做法是采用分账户的方法，即不同的产品对应不同的资产配置组合。这里以一类分红两全保险为例，缴费周期是整个保险期间，满期给付和死亡给付是固定金额，而退保给付是精算准备金的一定比例，分红保单保证收益率2.5%，且每年将可分配利润的70%分给投保人。

[2] 以上假设基于保险市场产品结构的整体情况综合分析得出。

4. 最优化资产配置策略模型的构建

4.1 偿付能力充足率对股市波动的敏感性分析

从530到826以来，股市发生了剧烈波动，531到612股市上涨了11%，在刚刚过去的几个月内，中国股市连续出现暴跌。截止到8月26日股票已经下跌至2927点，相较于年内最高5178点已经有相当一段距离了，大盘整体跌幅超过40%。首先，我们对几个关键时刻点上，偿一代与偿二代体系下偿付能力的情况进行了比较，如图1所示：

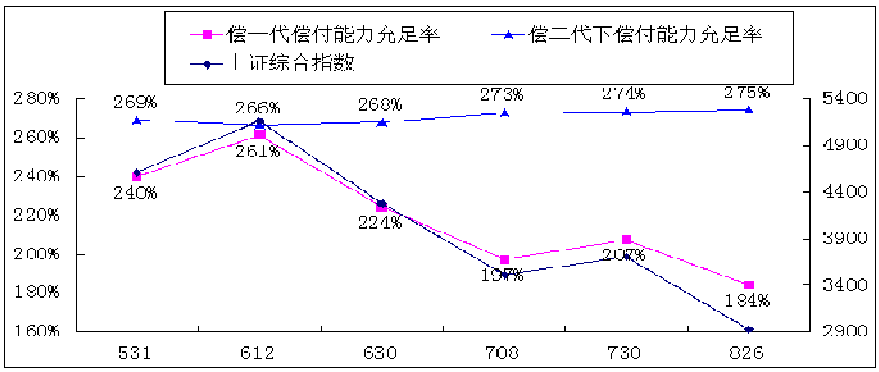


图1 偿一代和偿二代下寿险公司的偿付能力充足率对比

从531到826期间，股市最大波动幅度超过40%，偿一代偿付能力充足率上下波动区间有80个百分点，而偿二代下偿付能力充足率上下波动区间只有8个百分点。偿二代敏感性低的原因是实际资本和最低资本两方面因素的综合结果，一方面偿二代下实际资本受股市波动影响小，另一方面，偿二代下最低资本具有逆周期效果。

偿一代和偿二代偿付能力充足率变化方向出现差异。偿一代下，偿付能力充足率随股市波动而正向波动，在531到612期间，股市上涨，偿付能力充足率提高了22个百分点；在612到826期间，股市大幅下跌，偿付能力充足率也随之下降了80个百分点，826当天的偿付能力充足率为184%，为测试期间最低水平；偿二代下，在531到612期间，股市上涨，实际资本上升，偿付能力充足率却下降了3个百分点；在612到826期间，股市大幅下跌，实际资本下降，偿付能力充足率却提升8个百分点，826当天的偿付能力充足率为274%，为测试期间最高水平。

偿一代下，由于偿付能力充足率受权益波动影响重大，权益配置对偿付能力影响是公司资产配置的重要风险约束。由于偿付能力充足率对股市波动反映过于敏感，导致在股市下跌之后，保险公司不得不减仓，将浮亏变成实际损失，导致结果是追涨杀跌，这样的交易策略更容易造成系统性风险。

而偿二代下，保险公司已经计提了很高的最低资本，这部分最低资本就是为了弥补股市下跌的潜在损失的，所以，偿付能力充足率不应随股市波动变化太敏感。在股市下跌后，股票的投资价值提高，偿二代引导险资进行反向操作，与巴菲特的投资理念更吻合，也更有利于市场稳定发展。

4.2 资产配置时重点考虑资本占用，而非偿付能力充足率

由4.1的分析可以发现，“偿二代”下偿付能力充足率对资产价格的波动并不敏感，因此在决定资产配置时，资本占用就显得非常重要。该策略目标设定为把保险资金分配到可获得的各项资产，以期在满足各种约束的前提下，最大化预期收益。实际上，资产配置与资本约束之间存在重要的双向影响机制，资产配置策略会影响保险公司的利润形成及资本积累，而资本充足度也会反过来影响最优资产配置策略。

模型的目标函数：

$$\begin{cases} MaxE\left(\sum_{i=1}^{n} x_i \cdot R_i\right) - \frac{1}{2} A\sigma_p^2 \\ MinC_{SAA} = \sqrt{\sum_i \sum_j \rho_{ij} X_i k_i X_j k_j} \end{cases} \tag{3}$$

设每项资产的占比为 $x_i, i = 1,...,12$ ， $\sum_i x_i = 1$

组合收益率 $\mathrm{R_p} = \sum_{i=1}^{12} R_i x_i$ ，组合方差

$$\sigma_p^{\ 2} = (x_1, x_2, ...x_n)\begin{pmatrix} \sigma_{11} & \cdots & \sigma_{1n} \\ \sigma_{21} & \ddots & \sigma_{2n} \\ \sigma_{n1} & \cdots & \sigma_{nn} \end{pmatrix}(x_1, x_2, ...x_n)^T$$

权益类资本占用：

$$MC_{权益} = 0.31 \cdot x_1 + 0.2 \cdot x_2 + 0.01x_3 + 0.28x_4 + 0.12x_5 + 0.06x_6$$

这里假设保险公司配置到5年期以内的债券，平均期限为3.5年，则基础因子为0.0516，配置到5~10年期债券，平均期限为8年，则基础因子为0.0784；配置到10年以上的债券，平均期限为15年，则基础因子为0.126.

利率风险资本占用 $MC_{利率} = 0.0516 \cdot x_7 + 0.0784 \cdot x_8 + 0.126x_9$

房地产风险资本占用为 $MC_{房地产} = 0.08(x_{10} + x_{12})$

境外固定收益资本占用为 $MC_{境外固收} = 0.0762x_{11}$

汇率风险资本占用 $MC_{汇率} = 0.035(x_{11} + x_{12})$

境外投资不超过15%，权益类投资不超过30%，不动产投资不超过30%。

常用的解多目标规划的方法，包括目标权重法（将多个目标进行加权转化为单目标）、约束法（选出一个主目标函数，将其余目标函数转换为约束），保险资产在进行资产配置时，希望组合的风险尽可能低，资本占用尽可能低，收益尽可能高。而这三个目标很难同时达到，因此，在求解过程中，这里分别考虑以最低资本占用为约束，风险和收益加权的目标函数法，以及，收益为约束条件下，最低资本占用的情况。

5. 偿二代下保险资产配置策略的优化

5.1 以资本占用为约束，风险和收益加权目标函数法

本研究将首先在考虑流动性约束、最低资本占用、比例约束下，计算保险公司的最优资产配置结构，得到长期均衡市场假设下保险公司资产配置的有效前沿。由于多目标规划下没有唯一的最优解，因此模型给出的是一组Pareto最优解。对于不同的资产配置方案，都有不同的目标组合，决策者需要根据自己的偏好进行选择。

目标函数：

$$Min \quad f(x) = (1-\lambda)\sigma_p^2 - \lambda E(R) \tag{4}$$

目标函数是组合方差与组合收益率的函数，其中参数λ的取值和风险偏好有关，风险容忍度越高，λ取值较大，否则λ就取值较小，$\lambda \in [0,1]$。

约束条件：

$$\begin{cases} x_1 + x_2 + x_3 + x_4 \le 30\% \\ x_8 + x_9 + x_{10} \le 30\% \\ x_{11} + x_{12} \le 15\% \\ \sum_{i=1}^{12} x_i = 1 \\ \sum_{i=1}^{12} x_i \cdot LC_i < 5\% \\ \sqrt{X'UX} \le 0.25 \end{cases} \tag{5}$$

表3最低资本占用约束下，不同风险偏好的最优配置组合 （单位：%）

方案	$\lambda = 0$	$\lambda = 0.1$	$\lambda = 0.3$	$\lambda = 0.5$	$\lambda = 0.7$	$\lambda = 0.9$	$\lambda = 1$
股票	2.04	3.13	4.52	6.61	12.27	15.76	18.05
基金	3.59	4.69	5.60	6.41	3.53	2.36	2.26
非上市股权	4.66	5.77	6.68	7.51	4.68	3.54	3.33
流动性资产	11.15	6.16	5.70	5.61	5.30	3.75	1.18
债券类（T＜5）	28.42	27.57	24.07	18.12	16.11	12.43	11.49
债券类（5<T<10）	19.88	19.35	18.27	16.92	19.44	21.54	21.05
债券类（T>10）	19.20	18.28	16.50	15.22	12.06	11.79	10.42
不动产	4.17	4.40	5.21	7.81	9.46	10.18	10.74
基础设施	5.14	8.31	9.92	11.31	12.79	13.83	16.11
境外房地产	1.75	2.35	3.54	4.50	4.37	4.82	5.37

表3给出了最低资本占用约束下，不同风险态度的最优资产配置情况，在风险偏好情况下，最优资产配置情况。风险偏好不同，资产配置策略有较大差异。

5.2 满足收益率要求下，资本占用越低越好

偿二代下，偿付能力充足率受资产价值波动影响较小。为此，在研究资产配置的时候，忽略资产价值波动，仅考虑收益和风险资本占用两个因素。下面将在不同收益率目标下，求解资本占用最低的资产配置策略。

表4 约定收益率下，最低资本占用的配置策略 （单位：%）

收益率	5.00	5.20	5.40	5.60	5.80	6.00	6.20
股票	1.92	2.92	4.21	6.03	10.81	13.46	12.97
基金	3.39	4.38	5.22	5.84	3.11	2.01	1.62
非上市股权	2.56	3.56	4.21	6.53	7.60	9.16	7.72
优先股	4.57	4.23	4.65	4.62	4.58	4.25	3.86
流动性资产	10.54	5.75	5.31	5.11	4.67	3.21	16.29
债券类（T<5）	26.83	25.75	22.44	16.53	14.19	10.62	8.26
债券类（5<T<10）	18.77	18.08	17.03	15.43	17.12	18.41	15.14
债券类（T>10）	18.13	17.08	15.38	13.88	10.62	10.07	7.49
不动产	2.93	3.84	5.22	7.49	8.33	8.70	7.72
基础设施	4.85	7.76	9.25	10.32	11.26	11.81	11.58
境外固收	3.85	4.11	3.85	4.11	3.85	3.85	3.47
境外房地产	1.65	2.19	3.30	4.11	3.85	4.12	3.86

6．研究结论

投资渠道进一步放开，新的监管体系为险资投资非标资产、海外投资、创投基金、私募股权基金等提供了政策支持。如何在偿付能力约束下，考虑到各类资产对风险资本和偿付能力充足率的影响寻求最优资产配置，是寿险投资环节的关键。不同的投资渠道需要的资本金存在明显差异。这就要求在制定最优化的战略资产配置时将投资策略和资本需求相结合，围绕资产和负债，在一定的约束条件下，平衡风险和收益原则，实现保险公司价值管理、偿付能力管理的目标。

由于新监管规则中风险因子具有规模累退效应，“偿二代”更有利于大型保险公司释放资本，偿付能力充足率普遍提高。资本金充足的大型险企，在资产配置和产品创新上有更大的发挥空间，有能力以低费率等方式参与竞争，并以大范围资金运用取得超额收益，实现良性循环。但是对于中小型险企，资本金显得非常珍贵，因此，在资产配置策略时，以资本占用最小为目标函数，也十分合理。本研究中，在既定收益率下，最低资本占用的配置策略，可为中小企业的资产配置提供参考。

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“偿二代”体系下寿险业的资产负债管理：路径与优化

王灵芝

博士后
中国太平洋保险（集团）股份有限公司
上海 201620，中国
电话：（8621）3396 1161
Email: wanglingzhi-001@cpic.com.cn

关键词：偿二代； 战略资产配置； 多目标规划； 资本占用； 偿付能力充足率

中文摘要. 中国以风险为导向的偿付能力监管体系（简称“偿二代”）在经过一年的过渡期之后，于2016年开始正式实施。偿二代下，品种监管和比例限制将进一步放松，伴随着险资投资渠道的拓展，保险资产配置的自主性将会提高。以风险为导向的偿二代主要通过资本占用实施约束，不同资产的风险因子有较大差异。因此，在偿二代下，在资产配置时应如何平衡收益、风险和资本占用值得认真研究。论文首先分析了偿二代的实施对保险公司资产、负债的影响，然后确定了资本占用、流动性及负债特性的约束条件，经过比较和遴选，选取了12项可投资资产，然后在不同的目标函数下，采用遗传算法，对模型进行了求解。多目标规划下，最优解并不唯一，论文给出了不同风险态度下对应的帕累托最优解。

Research on Integrating Services into Insurance

WANG Xujin　　WANG Haofan

WANG Xujin
Professor
Risk Management and Insurance Department
Beijing Technology and Business University
Phone:（086）13611282321
Email: wangxujin@foxmail.com

WANG Haofan
Product developer
Actuarial & Product development Department
PICC Property and Casualty Company Limited
Phone:（086）15011235307
Email: wanghaofan@picc.com.cn

Keywords: Insurance Services, Combined Ratio, Loss Ratio，Professionals

Abstract: Integrating services into insurance is an important step in the development progress of insurance company. This article includes three parts. The first part is the definition of integrating services into insurance. The second part discuss the urgency of Integrating services into insurance from the aspect of the comprehensive insurance demands, of market competition, of combined ratio optimization, of the development of integrated insurance, and of market segmentation. The third part describe the approaches of Integrating services into insurance, include implementing marketization, supplying professionals, improving insurance awareness, optimizing investment return, enhancing risk management, channel diversification and market segmentation.

保险作为风险管理的一种重要手段，是社会发展的稳定器、经济增长的助推器，通过其风险管理功能的发挥，有效转移风险，促进社会稳定和经济增长。那么，如何赢得客户信赖，以获得更多的保费收入，在高回报的投资收益率下获得高的保险盈利，从而更好地做好保险承保服务呢？保险服务化则是保险公司价值成长的最为重要一环。本文拟就保险服务化的内涵、紧迫性和实现路径做如下探究。

1. 保险服务化的诠释

现代的保险已不是停留于传统的承保和理赔业务，即便是承保和理赔业务也应赋予新的内涵，这就是保险服务化。对于保险服务没有既定的定义，本文认为，保险服务是围绕着保险承保、理赔、防灾防损及其附加服务活动的总称。保险服务化则是以客户服务为中心的理念，从环节上来说，它包括售前、售中和售后等一系列保险服务；从内容上说，不仅包括基本服务，也包括附加服务；不仅包括初级服务，也包括了高级服务。如健康险的附加体检服务和延伸优惠健身或保健服务；车险附加安检服务和延伸优惠汽车保养服务等，延伸服务是有偿服务，仅仅有优惠而已，但这些均使保险消费者得到实惠、感觉到购买保险的附加价值。我国目前售前和售中服务虽然有一定改善，但售后服务以及延伸服务有待加强。从以下产险经营的资料可分析之。

表 1　2006-2015 年我国产险综合成本率、赔付率和费用率状况单位：%

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
综合成本率	102.7	114.2	106.7	104.5	97.3	95.26	97.23	99.5	99.31	98.6
赔付率	52.75	51.81	60.7	54.79	45.08	61.22	61.25	64.15	62.56	60.35
综合费用率	49.55	62.39	46	49.71	52.22	34.04	35.98	35.35	36.75	38.25



图 1　2006-2015 年产险综合成本率、综合赔付率和综合费用率

从上图表可知，我国产险的综合成本率有所改善，就总体而言，综合成本率逐步降低，从 2006 年的 102.7%、2007 年的 114.2%降低到 2013 年的 99.5%、2014 年的 99.31%、2015 年的 98.6%，近两的承保利润分别为 0.5%、0.69%，同时，综合赔付率有所上升，分别由 2006 年的 52.75%、2007 年的 51.81%上升到 2013 年的 64.15%、2014 年的 62.56%、2015 年的 60.35%；综合费用率逐步降低，分别由 2006 年的 49.55%、2007 年的 62.39%下降到 2013 年的 35.35%、2014 年的 36.15%、38.25%。综合赔付率上升说明保险消费者得到更多实惠，综合费用率下降说明保险经营管理也得到较大改善。

从以上图表还可看出，我国财产保险的综合费用率大部分年份低于综合赔付率。不过，2007 年、2010 年分别为 62.39%、52.22%，分别高于综合赔付率 10.58%、7.14%，说明综合费用率偏高。从 2011 年到 2015 年，综合赔付率和综合费用率则逐步趋于稳定，分别为 61-64%、35-38%左右。但相对国外非寿险市场来看，我国产险的综合费用率偏高。以下列表为例1：

表 2 部分国家非寿险公司收益率　　单位：%

	美国	加拿大	英国	德国	法国	日本
	94-04	94-04	94-04	94-04	95-04	96-04
综合成本率率	106.2	103.1	104.2	99.8	105.2	99.4
综合赔付率	79.8	73.3	73.0	72.3	81.9	61.3
综合费用率	26.4	29.8	31.2	27.5	23.3	38.1
投资收益率	16.2	13.8	16.8	15.4	13.4	4.7
其他费用/收入	0.0	0.4	-0.5	-0.3	-0.3	-0.8
综合利润率（税前）	9.2	10.4	12.8	12.7	7.0	4.4

从上表可知，国外非寿险公司一般承保亏损，投资盈利，通过投资盈利弥补承保亏损综合盈利。上述国家中除德国、日本有些将部分承保费用计入了投资费用，有的则将部分投资收益计入了承保利润而导致综合成本率小于 100%以外，其余国家均出现承保亏损，而绝大部分国家的非寿险综合赔付率在 70%以上，法国甚至达到 81.9%；综合费用率则除日本在在 38.1%、英国 31.2%以外，其余国家在 20%多，法国则则只有 23.3%。这说明由于市场竞争的需要，综合赔付率较高，管理水平较高，保险服务做得好，导致保险继续率较高，从而大大降低了佣金支出，进而降低了综合费用率。

2. 保险服务化的紧迫性

无论寿险还是非寿险公司，保险服务化都是非常紧迫的任务，保服务化不仅可以赢得客户信赖，提高保单继续率，降低综合费用率；还有利于避免争夺老客户从分配上增加公司业务，更有利于挖掘新的客户资源，既挖掘了市场潜力，也提高了保险销售人员的收入水平，还提升了保险公司的盈利能力。随着我国保险条款费率的市场化，保险服务化更显得紧迫。

首先，保险服务化是保险需求综合化化的要求，在大数据时代，以客户为中心的互联

[1]应该指出，财产保险只是非寿险的主要方面，非寿险包括财产保险、意外伤害保险和健康保险。

网保险，客户提出了一站式服务，保险套餐或保险超市的需求应运而生，要留住客户，就不能停留在传统的简单承保与理赔，而应当通过更多的保险附加服务。

其次，保险服务化是保险竞争激烈化的要求。在保险条款费率市场化的条件下“低费率、高赔付、高费用”保险费率有可能会有所降低，赔付有可能增加，导致综合赔付率会上升；另一方面，未来劳动力成本仍然居高不下，导致新单佣金会居高不下，同时由于竞争的需要，必须做好保险服务，尤其增加附加服务，则有利于留住客户。

第三，保险服务化是降低综合费用率的要求。在保险条款费率市场化的条件下，综合赔付率将会上升，同时由于寻找新的客户，这样新保单的佣金往往比较高。而保险服务化，则有利于提高继续率，在一定程度有利于降低综合费用率。

第四，保险服务化是保险功能全面化的要求。随着人们生活水平的提高，人们的保险需求不仅是经济补偿或保险金给付，而且有保值增值的附加需求，如机动车的保养需求，健康险的保健或体检需求等，与之相适应的要求保险功能全面化，这就加剧了保险服务化的需求。

第五，保险服务化是保险市场细分的要求。由于保险消费客户的需求不同，对于保险高等消费群和一般消费群应该区别对待，对于一般消费群，应该满足保险保障的一般要求，并附之以一般保险服务，如在一年未发生保险事故的情况下，赋予一定的附加服务；对于高端消费群，则赋予以一定优惠有偿较高端服务，如国外的健康保险费率并不低，但是风险服务做得好，投保人买了这个保险会感到物有所值。前者有利于客户觉得保险重要，后者有利于客户觉得物有所值，二者均有利于留住客户，并挖掘客户潜在需求。

3. 保险服务化的路径

实现保险服务化的路径较多，概括起来主要为：

第一，经济基础市场化。即夯实市场经济基础，市场化是保险服务化的制度基础，充分提高保险公司对市场的反应能力。市场经济是商业保险的基础，商业保险的发展水平又是市场经济制度完善程度的标志。市场经济的基本要素包括私有财产制度、契约自由和自我负责。这既是市场经济的基础，也是完善公司治理结构的前提。只有解决了所有者缺位的问题，才有可能自我负责、增加投资者的动力，才有可能面对让保险公司成为市场的真正主体，才有可能面对市场，发挥保险公司在应对重大事件及时调整保险条款的能力，才可能根据市场需要完善保险条款和费率，提供优质的保险服务。

第二，专业人才是保险服务化的人才保障 。人才是保险的第一生产力，保险行业的兴衰，最关键的取决于人才，保险服务化的水平和程度，更取决于人才。若专业人员的技术没有跟上，在保险条款费率没有市场化的条件下，承保得越大，将会赔得越多；在保险条款费率市场化的条件下，则承保得越多，亏损会越多。因为市场化之后，保险公司的主要利润来源将是投资收益，单个的员工技术有限，影响的将是个案，高管的技术和理念，则影响一个公司。因此，在投资收益为一定的条件下，人才的竞争直接决定着公司的经营技术水平和服务能力，进一步严重影响到公司的竞争力。对于保险人才的保障，一是培养人才；二是用好

人才；三是留住人才。在留住人才方面，应该完善股权激励、企业年金、司龄工资、同等条件下本单位员工优先提拔等制度，这些制度有利于调动员工的工作积极性，留住人才，从而促进保险公司可持续发展以及提升保险业的竞争力。

第三，保险条款费率基础科学化是保险服务化的技术保障。我国在寿险费率基础方面已形成有效的机制；在车险费率基础科学化方面，应该建立机动车辆碰撞研究中心，由中国保险行业协会负责组织，各产险公司为会员，用汽车碰撞的数据为车险费率提供定价依据，这样既为车险定价提供了数理基础，也将提升保险行业在国民经济各部门中的影响力，还将大大提升保险业在全社会的公信力。费率科学化有利于为车险费率竞争确立底线，也有利于确立保险服务化的水平和程度。

第四，保险专业化是保险服务化的重要手段。只有专业化才能精细化，但目前专业化的难度很大，最难的是健康险，其根源在于经营环境，社会保险覆盖面过窄，导致商业保险对社会保险难于发挥补充作用；医院太强势，医患联手骗赔，导致保险公司承保健康险越多就会亏得越多。因此，保险专业化对提高保险服务质量非常重要。

第五，保险意识整体化是保险服务化的社会基础。整体化的保险意识包括消费者的投保意识、保险公司的保险功能意识和政府的保险认知意识。保险人保险功能意识要通过开展合理有效的承保、及时公平的理赔和积极有效的防灾防损等工作来体现，让国民知晓参加保险的必要，同时通过有效安全的保险投资，给保险人带来丰厚的投资收益。具体而言，主要包括：产品合理、服务到位；政府的认知意识则体现为能从战略高度全面正确地理解保险社会发展稳定器和经济增长推动器功能，为发挥保险功能的发挥提供政策环境。投保率提高了，规模大了，才可能做到精细化，服务化便有社会基础。

第六，投资收益水平是保险服务化的经济保障。在实现保险费率市场化后，由于竞争的原因，承保一般很难实现盈利，往往会出现承保亏损，需要通过投资盈利来弥补并实现最后综合盈利。尤其是保险服务化的实施，一方面会由于继续率的提高减少降低佣金支出；另一方面则有可能附加服务的增加，会增加营业费用，因此确保保险投资稳健十分重要。承保和投资是保险的两个车轮子，承保带来保费收入，为保险投资提供资金来源；投资带来投资收益，提高保险公司的盈利能力和偿付能力，从而便于更好地做好承保服务。因此，保险投资水平是保险服务化的经济保障。基于国内资本市场状况和保险公司的投资能力，应当从保险投资监管和经营两方面进一步完善保险投资。在监管方面，应在进一步放松保险投资方式的同时，调整投资比例；在经营方面，则应进一步完善投资决策程序、提升投资经营技术能力、控制投资风险。在保险条款市场化的条件下，竞争会加剧，由于竞争，综合成本率有可能超过 100%，承保会亏损。因此只能通过投资盈利，最终实现综合盈利。1975 年至 2004 年美国、英国、法国、意大利等国的经验均证明了这一点。

第七，风险管控是保险服务化的重要防线。 保险公司经营中的风险分为经营风险和法律风险，经营风险主要有承保、理赔和投资风险；法律风险分为法律纠纷风险和合规风险。对保险交易过程中带来的法律纠纷风险，要通过完善保险经营来解决，如保险法第 17 条中保险人的告知和 19 条格式条款的处理问题，这就可通过给投保人选择的方式予以解决。保险公司的风险管控主要在于：建立有效的公司治理机制和经营管理制度；具备合适的人才队

伍；严格遵循保险监管规定和公司制度。只有有效管控公司的风险，才能保证公司的稳健经营，才能实现保险服务化。

第八，保险渠道多元化和保险客户的细分化也将助推保险服务化。渠道多元化方面，尤其互联网保险将提升保险服务的空间和效率；客户细分化将满足不同客户的保险服务需求。

总之，保险服务化将促进保险公司经营的增效升级，促使保险公司从“分蛋糕”向“做蛋糕”的经营模式转变，进一步挖掘保险市场潜力，从而提生了保险公司的价值成长，也将促进保险业的繁荣。

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保险服务化研究

王绪瑾　王浩帆

王绪瑾
教授
风险管理与保险学系
北京工商大学
海淀区阜成路 33 号，100048
电话：82572744
手机：13611282321
Email: wangxujin@foxmail.com

王浩帆
业务主办
精算部产品研发处
中国人民保险公司
手机：15011235307
Email：wanghaofan@picc.com.cn

关键词：保险服务，综合费用率，赔付率，专业化

摘要：保险服务化是保险公司价值成长的最为重要一环。本文包括三部分：保险服务化的诠释；保险服务化的紧迫性；实现保险服务化的路径。保险服务化的紧迫性在于：保险服务化是保险需求综合化化的要求；是保险竞争激烈化的要求；是降低综合费用率的要求；是保险功能全面化的要求；是保险市场细分的要求。实现保险服务化的路径主要在于：经济基础市场化；专业人才是保险服务化的人才保障；保险条款费率基础科学化是保险服务化的技术保障；保险专业化是保险服务化的重要手段；保险意识整体化是保险服务化的社会基础；投资收益水平是保险服务化的经济保障；风险管控是保险服务化的重要防线；保险渠道多元化和保险客户的细分化也将助推保险服务化。

Insurance Serves in International Trade Integration of Beijing, Tianjin and Hebei Region

XU Shan

School of Economics
Beijing Technology and Business University
Beijing 100048, China
Phone: (86)18800113310
Email: moyinshanshui@163.com

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Abstract. This article aims to study the feasibility of jointly coordinated development between the integration of the insurance and the integration of international trade among Beijing, Tianjin and Hebei, and make recommendations on the coordinated development between regional insurance integration and regional international trade integration. The passage compares various economic indicators, sums up the current state of international trade Beijing, Tianjin and Hebei, points out the strengths and weaknesses and predicts growing trends of international trade in these three regions. On this basis, the passage makes empirical analysis on whether insurance services can promote the development of the international trade integration among Beijing, Tianjin and Hebei or not. Combined with the latest policy of regional insurance, the passage draws a conclusion that regional insurance services can promote the development of the integration of international trade in Beijing, Tianjin and Hebei.

1．绪论

1.1 研究背景和意义

1.1.1 研究背景

（1） 我国国际贸易产业转型发展

从2015年全年宏观经济形势来看，我国经济保持了总体平稳、稳中有进、稳中有好的发展态势。具体数据分析如下表所示：

表1 2015年全年国内生产总值数据表

	生产总值（亿元）	同期增长（%）
全年国内生产总值	676708	6.9
一季度	---	7.0
二季度	---	7.0
三季度	---	6.9
四季度	---	6.8

(数据来源：中国经济网)

分产业看,2015年全年第一产业、第二产业和第三产业生产总值均有所增长，其中第三产品涨幅最大。具体数据分析如下表所示：

表2 2015年全年三大产业国内生产总值数据表

	生产总值增加值（亿元）	同期增长（%）
第一产业	60863	3.9
第二产业	274278	6.0
第三产业	341567	8.3

(数据来源：中国经济网)

其中，2015年全国国际贸易总体情况有所下滑，全年全国进出口总额、出口额均有不小程度的下滑，出口额与同期相比略微下滑。贸易逆差增长幅度巨大。具体数据分析如下表“”所示：

表3 2015年全年全国进出口额数据表

	总额（亿元）	同期增长（%）
进出口	245849	-7.0
出口	141357	-1.8
进口	104492	-13.2
贸易顺差	36865	56.7

(数据来源：中国经济网)

由此可见，2015年我国的国际贸易的发展正处于关键时期，国际贸易总体有所下降，国际贸易行业结构的转型升级迫在眉睫。此外，我国的国际贸易发展的并不均衡，总体而言，东南沿海部国际贸易发展的比较好，相比而言，京津冀地区的国际贸易发展相对滞后。

（2） 我国保险业全面加速发展

2015 年是《国务院关于加快发展现代保险服务业的若干意见》(以下简称"新十条")全面落地的一年,全行业主动适应经济发展新常态,着力服务经济社会发展新需求,保险市场呈现出稳增长、调结构、惠民生、防风险的发展态势。 全年实现原保险保费收入 24282.5 亿元,同比增长 20.0%, 增幅较上年提高 2.5 个百分点;赔款和给付支出 8674.1 亿 元,同比增长 20.2%,增幅较上年提高 4 个百分点;保险深 度为 3.5%,比上年提高 0.3 个百分点。由此可见，我国的保险市场在2015年发展十分迅速，保险行业的整体发展前景很好。

（3） 我国区域化进程明显加快

2015年是我国区域经济发展较快的一年，各地方省份凭借其自身优势，与周边省份、地区建立起联系，从而达到共同发展的目的。本文着重介绍和研究京津冀国际贸易一体化的发展情况。

京津冀一体化由首都经济圈的概念发展。 国家发改委在2011年就开始启动首都经济圈的规划和编制工作，在2012年的区域规划审批计划当中，首都经济圈的发展规划更是位居首位，但进展一直较慢。2015年4月30日，中央政治局召开会议，审议通过《京津冀协同发展规划纲要》，京津冀区域一体化发展进入高速发展阶段。此外，《"十三五"时期京津冀国民经济和社会发展规划》已于2016年2月印发实施，这是全国第一个跨省市的区域"十三五"规划，对于打破三省市"一亩三分地"思维定式，进一步增强发展整体性和协同性具有重要意义。

1.1.2 研究意义

可预测，在未来几年的经济发展中，区域经济一体化发展定将成为国家宏观经济发展的重要基石和重点。其中，京津冀区域一体化更将成为重中之重，所以本文将对京津冀区域一体化进行研究。 经济学上常把投资、消费、出口比喻为拉动GDP增长的"三驾马车"。也就是说，京津冀地区的国际贸易的发展无疑将是京津冀区域一体化不可或缺的重要发展组成部分。但是现实情况是，对于我国东南沿海地区，京津冀地区的国际贸易发展相对滞后。所以，探索如何促进京津冀地区国际贸易一体化健康积极地发展无疑具有重要的现实意义，而本文也将重点研究探索这一问题。

一直以来，国际贸易保险的健全和发展是国际贸易发展的基石和保障，也是国际贸易发展的重大推动力。没有了国际贸易保险的保障，国际贸易发展无法持续长久。但在中国，国际贸易保险的发展相较于西方发达国家，还有着不小的差距。因此，如何提高国际贸易保险水平，又是国际贸易发展过程中的必须解决的问题。

此外， 由于京津冀地区的国际贸易主要是进出口业产品，产业转型尤为重要和紧迫，许多京津冀进出口企业转型升级压力增大。加之国际贸易市场竞争日益加剧，国际贸易市场波动频繁等原因，京津冀地区国际贸易行业和进出口企业正面临着越来越大国际贸易风险。这种情况下， 保险业服务于国际贸易行业，无疑可以为京津冀地区国际贸易的发展提供了新的契机，帮助进出口企业合理规

避风险，降低京津冀地区国际贸易行业的波动性和风险性，促进该地区国际贸易行业的可持续发展。

不仅如此，国际贸易行业和保险业的合作，也反过来使得京津冀地区的保险业面临着巨大的发展机遇，使得京津冀地区的保险业具有更大发展潜力和发展空间。由此可见，保险业和国际贸易行业的合作，将会带来一个多赢的局面。本文从保险业服务于国际贸易的角度，研究国际贸易保险将如何促进京津冀国际贸易一体化的发展，探索保险业和国际贸易行业如何协同发展，相互促进，从而探索一种新的不同行业合作协调发展的模式。

1.2 研究方法

关于京津冀国际贸易保险服务于国际贸易一体化的研究，涉及保险学、国际贸易等多个领域，需要运用的研究方法也较为广泛。本文采用的研究方法主要有：比较研究法和实证分析法。

比较研究法：对北京、天津和河北三个地区的基本状况进行对比分析，对三者的差异有一个直观上的了解。主要是通过查阅现有资料，对三个地区的国际贸易情况和国际保险情况做一个定性比较。

实证分析法：将理论和实际情况联系起来，具体分析京津冀地区的国际贸易合作的现状和存在的问题。特别是从国际贸易保险的角度，分析了具体的国际贸易保险政策将如何促进京津冀国际贸易一体化进程。

此外，本文还运用了定性与定量相结合，宏观微观相结合，总结归纳和具体分析等方法进行研究。

1.3 研究创新点

尽管关于区域保险一体化和国际贸易一体化的研究十分充分，但是，从保险行业发展角度对区域国际贸易发展的促进作用的研究相对较少。传统的分析区域保险业一体化和区域国际贸易一体化的文章大多都各自为政，停留在对经济增量的分析上，并没有将保险业和国际贸易行业互相联系，对比分析，也没有深入挖掘导致该行业经济增量的其他行业的因素。本文以京津冀国际贸易一体化发展为对象，从京津冀保险一体化的角度，分析保险行业对京津冀国际贸易一体化发展的促进作用。

本文研究的创新点有以下三点：

第一，从京津冀经济圈入手，研究区域内保险行业和区域内国际贸易行业的发展差异和区域内协调发展，相互促进的可行性。京津冀经济圈是我国区域经济发展的领头军，研究其发展状况、发展结构，有助于其进一步完善发展，也有利于其他地区的发展借鉴。

第二，突破以往区域经济研究各自为政的传统方法，将”区域保险一体化”和”区域国际贸易一体化”相结合，从京津冀保险一体化的角度，分析保险行业对

京津冀国际贸易一体化发展的促进作用，以及国际贸易发展对保险行业的反作用。从而使得对国际贸易发展的研究更加深入和综合。

第三，研究得出我国区域保险业和区域国际贸易发展可以协调发展，互相促进的结论，从而为今后国家在制定区域协调发展的相关政策，提供跨行业综合发展的建议。

2．京津冀区域国际贸易现状分析

改革开放以来，京津冀地区整体的国际贸易有了较大的发展，尤其近几年发展速度明显加快。但是，在京津冀地区国际贸易整体发展的情况下，各个地区的发展速度和发展现状存在着较大的差异。

2.1 天津国际贸易先天优势明显，发展迅速

2.1.1 先天优势：我国北方第一大港---天津港

自1978年改革开放至今，天津港发展迅速，已经成为我国北方第一大港。

表4 2001-2014年天津港吞吐量和集装箱吞吐量情况

	吞吐量（亿吨）	集装箱吞吐量（万标箱）	成就
2001	1.00		成为我国北方吞吐量第一大港
2004	2.00	380	吞吐量跻身世界前十港口，集装箱位列十八
2005	2.40	480	
2006	2.58	595	
2007	3.00	710	
2008	3.55	850	
2009	3.80	870	
2010	4.00	1000	
2011	4.50	1150	
2012	4.76	1230	
2013	5.00	1300	我国北方第一个5亿吨港口
2014	5.30	1400	再次位列世界港口集装箱吞吐量前十

(数据来源：中国海关总署网)

2015年天津港主动抓住“一带一路”建设和京津冀协同发展建设的历史机遇，充分利用自贸区的优势，大力发展国际贸易和国外贸易，使得当年的天津港的吞吐量和集装箱吞吐量均比去年同期有所增长，如图所示：

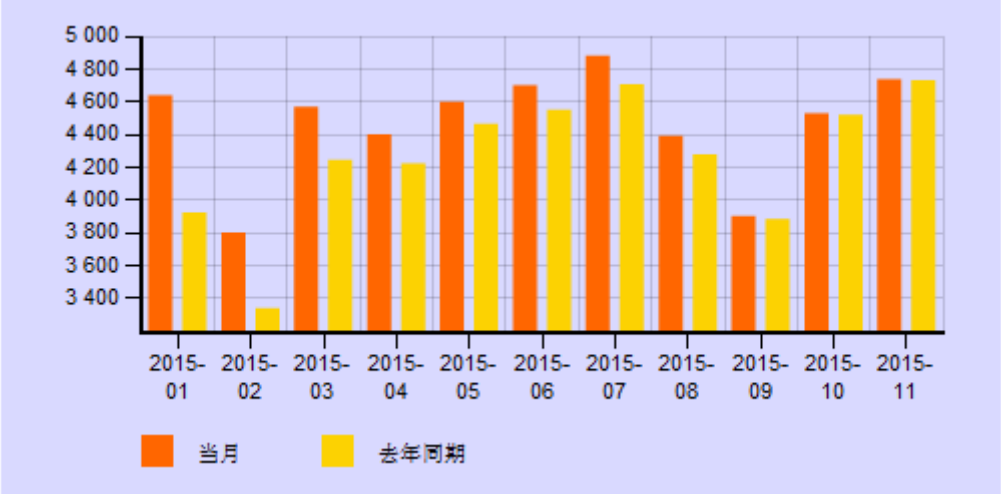


图1　2015年天津港吞吐量同期比较图
(数据来源：中国海关总署网)

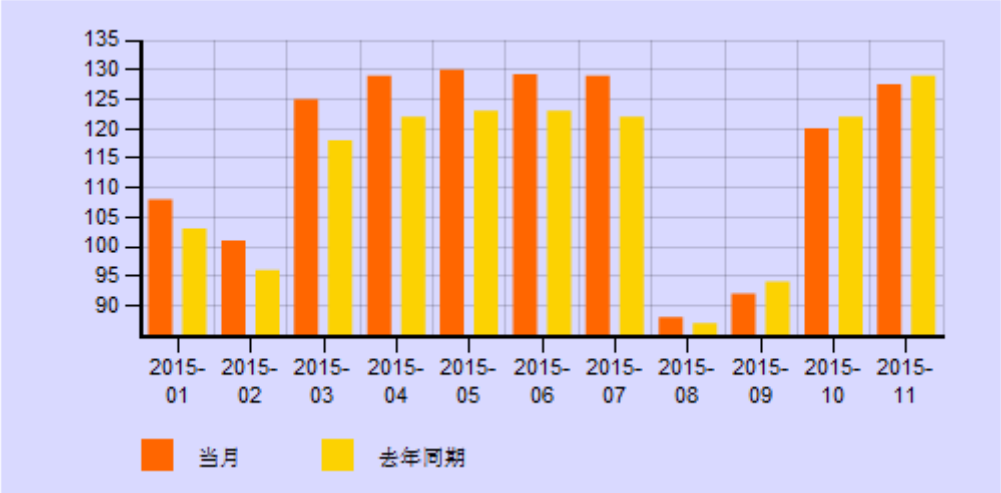


图2　2015年天津港集装箱吞吐量同期比较图
(数据来源：中国海关总署网)

2.1.2 地理优势，区位优势，政策优势

天津是中蒙俄经济走廊主要节点、亚欧大陆桥最近的东部起点。2014年，国际政府提出“一带一路”政策，而天津正处于“一带一路”交汇点，其地理区位优势凸显。

此外，天津还具有政策区位优势：

1984年，天津被国务院批准为对外开发的港口城市以来，给天津的国际贸易发展提供了巨大的机遇。

2014年12月12日，中国政府决定在天津滨海新区设立中国（天津）自由贸易园实试验区。天津自贸区是我国北部地区的第一个自贸区，其目标是与京津冀区域一体化协同发展。

进出口齐头并进，跻身全国前列

从2010年至2014年，天津市的进出口总额持续上升，其中进口额，出口额同步上升，齐头并进。由于国际市场疲软，全国国际贸易行业进出口数据下降等因

素的影响，天津市在2015年，出口额和进口额双双下降。具体数据分析如下列图表所示：

表5 2010-2015天津市进出口情况数据表

	进出口总额(亿美元)	同期增长(%)	出口额（亿美元）	同期增长(%)	进口额（亿美元）	同期增长(%)
2010	822.01	28.8	375.17		446.84	
2011	1032.7	25.8	445.2	18.8	587.5	31.7
2012	1156.2	12.0	483.1	8.6	673.1	14.3
2013	1285.2	11.2	490.2	1.5	795	18.1
2014	1339.1	4.2	526	7.3	813.2	2.3
2015	1143.4	-14.6	511.83	-2.7	631.64	-22.3

(数据来源：中国海关总署网)

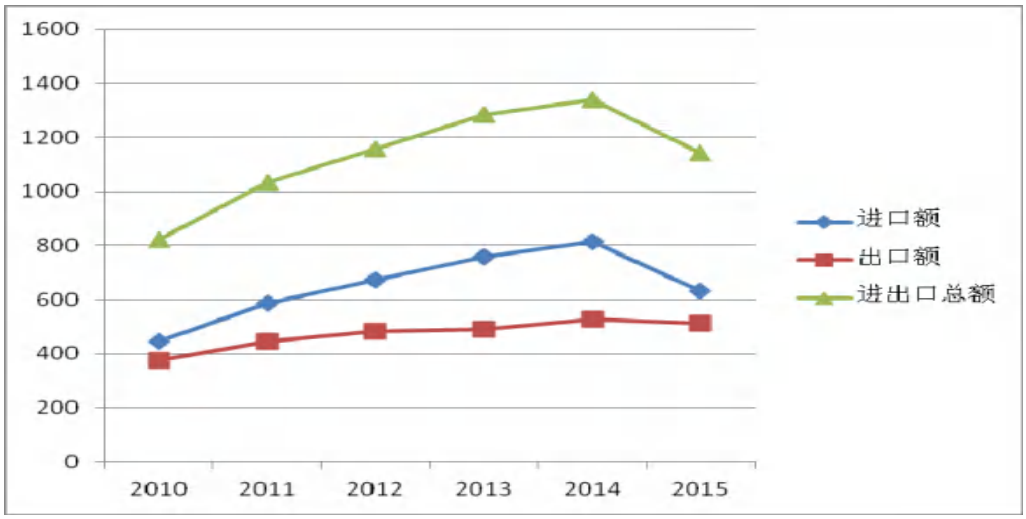


图3 天津近六年进出口贸易额趋势图
(数据来源：中国海关总署网)

2.2 北京科技、服务业发展打造非港口贸易中心

2.2.1 进出口额逐年增长（1978-2013）

北京进出口额从1978年至2013年总体上呈现上升趋势：

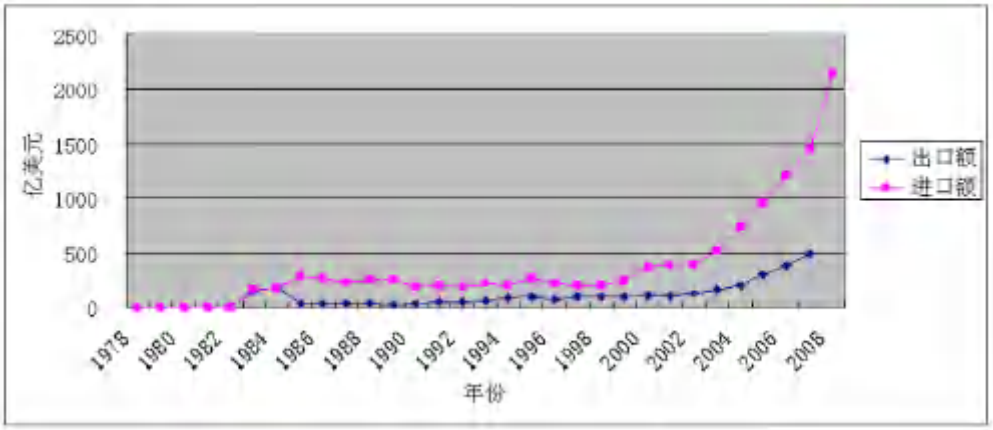


图4 1978-2008北京市进出口额情况图
(数据来源：中国海关总署网)

表6 2009-2013年北京市进出口额情况表

	进出口总额（万亿美元）	同期增长（%）	进口总额（万亿美元）	同期增长（%）	出口总额（万亿美元	同期增长（%）
2009	2148	-20.9	1664	-22.3	484	-5.9
2010	3014	40．3	2459	47．8	555	14．7
2011	3895	29.1	3305	34.2	590	6.5
2012	4079.2	4.7	3482.7	5.3	596.5	1.1
2013	4299.4	5.4	3668.4	5.3	631.0	5.8

(数据来源：中国海关总署网)

可以从图表中看，1978年到2008年期间，北京市的进口总额总体增长趋势十分明显。1978年全市进口总额是1227万美元，1983年进口总额猛增到159.12亿美元。直至到2004年进口总额达到740.06亿美元。从2004年制2008年，全市进口额出现了一个飞跃式的大幅增长。

在2009年，由于受到经济危机的影响，北京的进口总额有所下降。但从2010年到2013年，进口额总体稳定增长。

而对于出口情况而言：北京市的出口总额总体增长趋势比较平稳。1978年北京市的出口总额是2.85亿美元，到2004年出口总额增长到205.69亿美元。从2004年制2008年，全市出口额涨幅明显逐年提升。同样在2009年，北京的出口总额有所下降。从2010年到2013年，出口额同步总体稳定增长。

相比之下，北京市的进口总额要大于出口总额，特别是在2004年之后，北京市的进出口总额都有了大幅度的增长，其中以进口总额的增幅最大。贸易逆差由2004年的534.37亿美元扩大到20013年的3037.4亿美元。

2.2.2 进出口贸易结构改善（2014-2015）

在经济危机后时代的世界市场持续疲软，外需不足的世界背景和中国整体经济涨速减缓，国际贸易总额下降的国家背景下，经历了逐年增长的北京市进出口贸易，于2014开始出现一定幅度的回落。

从进出口总额，进口额，出口额和贸易逆差情况来看，2014、2015年北京市国际贸易总量结构得到改善，2014,、2015年进出口额同步出现一定程度的下降，同时贸易逆差也出现了大幅度的下降，贸易逆差逐渐缩小。具体数据分析如下表所示：

表7 2014、2015年北京进出口额数据表

	进出口总额（万亿元）	同期增长（%）	进口总额(万亿元)	同期增长（%）	出口总额（万亿元）	同期增长	贸易逆差(万亿元)	同期增长（%）
2014	2.6	-4.4	2.2	-4.7	3829	-2.3	1.8	-5.2
2015	1.98	-22.3	1.64	-24.2	3395	-11.3	1.3	-26.9

(数据来源：中国海关总署网)

从贸易方式来看，2014北京市国际贸易方式结构得到改善，一般贸易出现负增长而加工贸易出现的正增长。具体数据分析如下表所示：

表8 2014年北京国际贸易方式数据表

	一般贸易进出口（万亿元）	同期增长（%）	加工贸易进出口（万亿元）	同期增长（%）
2014	2.00	-6.9	2912	1.5

(数据来源：中国海关总署网)

从进出口企业类型来看，2014、2015北京市国际贸易主体结构得到改善。国有企业比例持续下降，而民营企业不断上升。民营企业的发展，给北京市国际贸易带来了活力和创造力。具体数据分析如下表所示：

表9 2014、2015年北京进出口主体数据表

	国有企业进出口额（万亿元）	同期增长（%）	外商投资企业进出口（万亿元）	同期增长（%）	民营企业进出口（万亿元）	同期增长（%）
2014	1.7	-2.6	0.4878	5.1	0.1375	9.9
2015	1.4	-17%	0.4051	-16.9%	0.1555	13.1%

(数据来源：中国海关总署网)

从主要贸易伙伴上看，2014、2015北京市国际贸易伙伴结构得到改善。欧美，沙特等主要贸易伙伴的双边贸易额总体呈下降趋势，这意味着北京国际贸易市场的集中度的下降，市场更加分散，市场范围更广。具体数据分析如下表所示：

表10 2014、2015年北京进出口贸易伙伴数据表

	欧盟贸易额（亿元）	同期增长（%）	美国贸易额（亿元）	同期增长（%）	沙特阿拉伯贸易额（亿元）	同期增长（%）	瑞士贸易额（亿元）	同期增长（%）
2014	2884	12	2135	-2.9	1697	-14	---	---
2015	2532	-12.2	1977	-7.7	---	---	1060	-8.4

(数据来源：中国海关总署网)

从主要进出口商品情况来看，2014 机电产品和高新技术产品是北京国际贸易主要进出口商品。从这一点可以看出北京的国家贸易处在一个相对较高的层次。但是近两年的高新技术产品的连续下滑，值得相关部门的警惕，尽快出台相关政策，逐步提供高新技术产品的贸易量。具体数据分析如下表所示：

表11 2014、2015年北京主要进出口商品数据表

	机电产品贸易额（亿元）	同期增长（%）	高新技术产品贸易额（亿元）	同期增长（%）
2014进口	4791	7.8	1809	-0.3
2015进口	4097	-14.4	1623	-10.1
2014出口	2328	-3.7	1152	-8.9
2015出口	1953	-16.1	873	-24.2

(数据来源：中国海关总署网)

2.2.3 未来发展的方向--高科技贸易

技术发展，有效配置资源将北京打造成一个非港口式贸易中心。当世界市场疲软，进出口贸易额持续下滑的情况下，北京的未来出路仍旧应寄托于科技发展和服务业的发展。

北京聚集了全国最好的高校群体，聚集了大量的高级知识分子，高级技术人员。充分利用北京的技术人才资源，打造北京高科技进出口贸易，将成为北京进出口贸易未来的发展方向。

举例而言，北京的软件出口量一直处于全国领先地区，且优势明显。2005年北京的软件出口量占全国软件总出口量的37.3%。而随着全球服务业外包的趋势不段加强，软件外包的国际市场会越来越来，显然北京的软件出口具有极大地增长潜力。而包括软件出口在内的高科技产品出口必将极大地促进北京进出口贸易的发展。

2.3 河北进出口总额较低，结构相对单一

2.3.1 进出口总额较低

河北省作为国内沿海经济大省之一，相比其他沿海经济大省而言， 其进出口的总量相对较低。从全国角度而言，其进出口水平也仅处于中等行列。

如下图所示，2015年，河北省的外贸进出口总额排在全国第十。对比其他沿海城市，广东省的外贸进出口总额是河北省的14.5倍数，江苏省是其7.2倍，上海市是其5.3倍，浙江省是其4.5倍。由此可见，河北省和其他沿海经济大省相比，其外贸水平还有着不小的差距。

表12 2015年全国各地外贸进出口总额排名表

排序	地区	金额（亿美元）	排序	地区	同比增长（%）
	全国	39569		全国	-8
1	广东省	11658.6	1	贵州省	53.4
2	江苏省	5810.4	2	河南省	12.5
3	上海市	4230	3	湖北省	9.2
4	浙江省	3595.7	4	陕西省	7.9
5	山东省	2795.4	5	江西省	4.1
6	福建省	1479.2	6	湖南省	3.7
7	北京市	1307.9	7	广西	3.4
8	天津市	1190.6	8	安徽省	-1.4
9	辽宁省	1071.2	9	云南省	-4.5
10	河北省	802	10	江苏省	-4.6
11	河南省	770.1	11	青海省	-4.8
12	重庆市	587.2	12	浙江省	-4.9
13	四川省	472.2	13	山西省	-5.4
14	广西	464	14	广东省	-6.1
15	湖北省	446.1	15	上海市	-6.5
16	安徽省	426.2	16	海南省	-8.4
17	江西省	407.1	17	北京市	-8.6
18	陕西省	298.8	18	内蒙古	-9
19	湖南省	293.3	19	福建省	-10.1
20	新疆	270.7	20	宁夏	-14.2
21	吉林省	200.3	21	辽宁省	-14.6
22	云南省	190.2	22	河北省	-14.9

（数据来源：国家商务网）

2.3.2 对外贸易结构相对单一

（1） 贸易方式结构单一：加工贸易占主导地位

一般贸易在河北的对外贸易中占主导地位，而加工贸易只所占比例很少。一直以来，一般贸易都占河北对外贸易总额的80%以上。不过近几年河北加工贸易发展迅速，所占比重逐渐上升。其中，在加工贸易内部，进料加工贸易所占比重远远高于来料加工贸易比重；形成这样局面的主要原因是由于河北省的国际贸易主要产品是传统资源型产品。

（2） 贸易所有制结构单一：民营企业占主导地位

而在对外贸易所有制结构上，进出口结构较为单一。一直以来，民营企业在河北省国际贸易中起主导作用。举例而言，2015年河北民营企业进出口额占总进出口额的55.5%，国有企业和外商企业进出口额所占比例不到一半。且2015年国有企业和外商投资企业进出口额都存在一定程度的下滑。具体数据分析如下表所示：

表13 2015年河北国际贸易主体进出口额数据表

民营企业进出口额（亿元）	同期增长（%）	外商投资企业进出额(亿元）	同期增长（%）	国有企业进出口额（亿元）	同期增长（%）
1771.4	---	866.6	-14.3	554.4	-24

(数据来源：中国海关总署网)

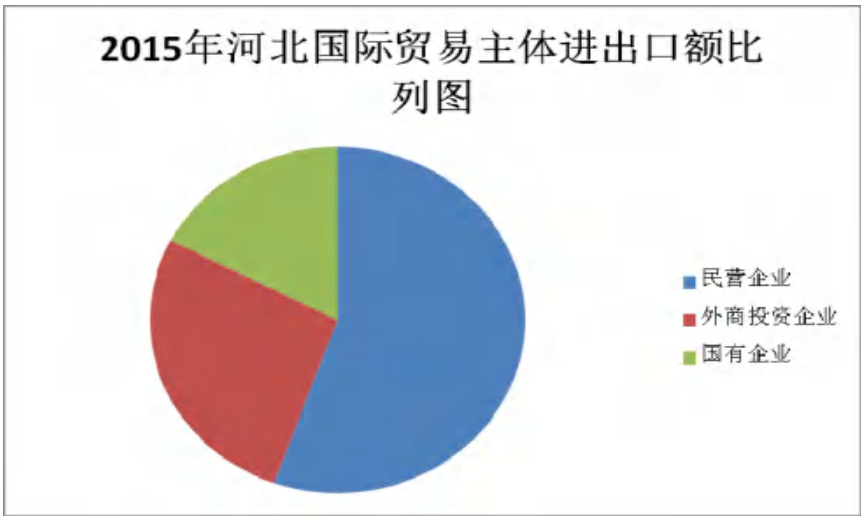


图5 2015年河北国际贸易主体进出口额比例图
(数据来源：中国海关总署网)

民营企业的增多可以提高对外贸易整体活力，但同时也加大了贸易风险。所以，逐步实施发展外贸主体多元化战略，才能促进河北省国际贸易行业健康长久发展。

（3） 贸易商品结构单一：中低端产品占主导地位

2015年河北省主要出口产品为钢材，机电产品，劳动密集型产品。具体数据如下表所示：

表14 2015年河北国际贸易主要出口商品出口额数据表

钢材出口额（亿元）	机电产品出口额（亿元）	劳动密集型产品出口额（亿元）	高新技术产品额（亿元）	农产品出口额(亿元）
611.2	545.2	427.1	146.5	102.7

(数据来源：中国海关总署网)

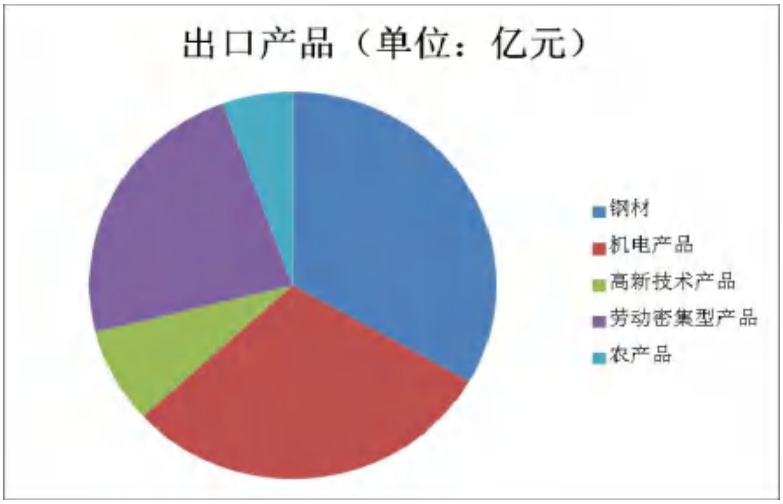


图6 2015年河北出口产品比例图
(数据来源：中国海关总署网)

从图中不难分析出，在2015年河北省出口产品中，原材料和中低端产品（机电产品和劳动密集型产品）产品占据主导地位，而高新技术产品所占比例较小。

进口方面，2015年河北省主要进口产品为铁矿砂，机电产品，农产品。具体数据如下表所示：

表15 2015年河北国际贸易主要进口商品进口额数据表

铁矿砂进口额（亿元）	机电产品进口额（亿元）	农产品进口额（亿元）	煤及褐煤进口额（亿元）	高新技术产品进口（亿元）
609.3	171.1	159.9	32.4	24.4

(数据来源：中国海关总署网)

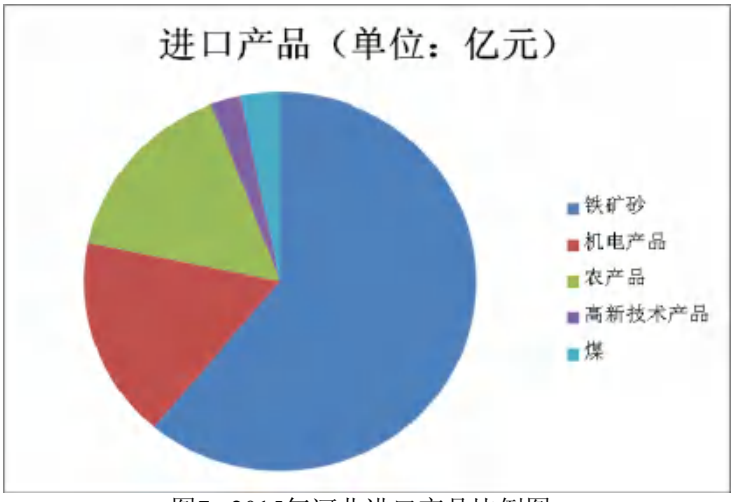


图7 2015年河北进口产品比例图
(数据来源：中国海关总署网)

同样，从图中可以看出，在2015年河北省进口产品中，原材料（铁矿砂和煤）进口占据主导地位，其次是机电产品，而高新技术产品所占比例十分小。

总的来说，河北省国际贸易以原材料和中低端产品为主导的商品结构。这样相对单一和商品结构使得河北省的人才和技术资源没有得到有效发挥，从而也制约了河北省国际贸易的发展。

（4） 贸易市场结构单一：亚欧美市场占主导

河北的国际贸易市场长期高度集中在亚洲，欧洲，美国三大市场。

2015年澳大利亚、欧盟和东盟为河北省前三大贸易伙伴。其中，亚洲，欧洲，美洲市场占了河北国际贸易总市场的70%以上。具体数据如下表所示：

表16 2015年河北国际贸易主要进出口国家进出口额数据表

进出口国家	双边贸易总额（亿元）	同期增长（%）
澳大利亚	469	21.7
欧盟	412.7	12.3
东盟	355.9	4.1
美国	351.6	6.9
韩国	200.4	6.4
巴西	190.2	38
俄罗斯	158	20.6
日本	137.3	12.3

(数据来源：中国海关总署网)

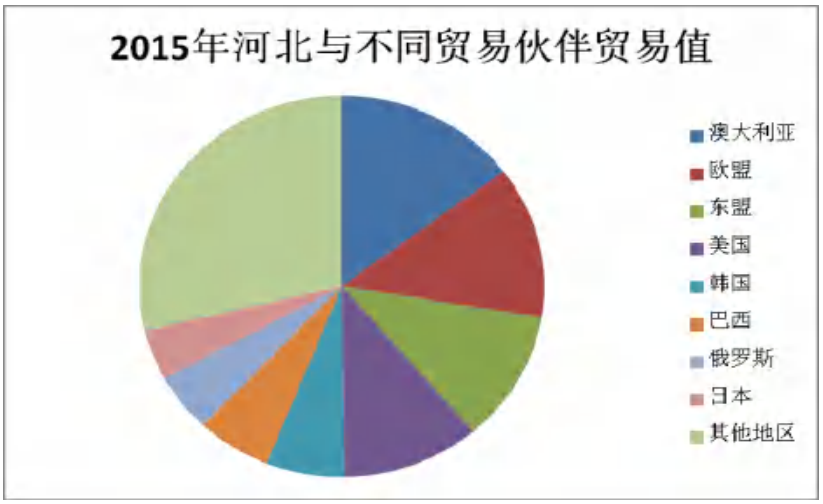


图8 2015年河北与不同贸易伙伴贸易值
(数据来源：中国海关总署网)

3．保险服务促进京津冀地区国际贸易一体化分析

3.1 京津冀地区统一的保险体系促进三地国际贸易总体协调发展

在京津冀区域经济一体化趋势下，京津冀地区国际贸易一体化也得到了巨大的发展。而国际贸易保险的一体化发展必将成为国际贸易一体化进程的基础和重点。

2015年12月4日，中国保监会发布《关于保险业服务于京津冀协同发展的指导意见》。该指导意见中提出，要坚持政策引导，市场主导，推动行业有效合作，创新保险茶农和服务，满足京津冀协同发展对保险业的现实需求。

应用到国际贸易行业，保险业改革应该重点做到以下几点：

第一，打破区域界限，尊重市场和国际贸易规律，建立统一的国际贸易风险预估平台、风险申报平台、专业审单平台。

第二，按照相同国际贸易风险在不同口岸、地区相同处理的原则，建立顺畅完善的国际贸易风险协调机制。

第三，在国际贸易业务统一规范的前提下，搭建起实现“一个网络、一个平台、一套风险评定标准和一套理赔标准“的国际贸易保险业务平台

第四，推广电子保险业务，促进国际贸易风险信息、保险信息在京津冀不同地区的即时交互流通。实现不同进出口产品，不同进出口市场，不同行业的保险信息集成，数据共享的模式。

第五，全面建设京津冀三地保险理赔通赔通付制度，对于一个地区的国际贸易保险业务，也可在其他两个地区进行理赔。

3.2 京津冀地区保险服务促进国际贸易行业多方面协调发展

具体解决保险业如何促进京津冀地区国际贸易一体化的问题，可以从以下几个方面进行分析：

3.2.1 保险促进京津冀国际贸易人力资源共享

北京在高科技产品出口方面做的最好，而天津在运输设备和电子类产品出口做的比较好。而河北则在初级工业产品和劳动密集型产品的出口表现突出。

所以一方面要加强三地之间的人才交流，尤其要加强河北的人才引进，使得河北能有效借力于北京天津的知识人才储备，提高现有出口产品的附加值，提升中低端工业产品的科技含量，促进进出口贸易的可可持续发展。另一方面也要加强人力资源的流动，尤其是北京和天津应充分利用河北的劳动力优势，降低生产成本，增加自身的利润空间。

要想实现京津冀地区人力资源的共享和高效率用政府需要出台相关保障这部分流动性人才权益的政策。这样才能达到人力资源“引得来，留得住，干得好“的效果。中国保监会发布的《关于保险业服务于京津冀协同发展的指导意见》鼓励保险机构在天津，河北和北京统筹实行养老保险、医疗保险的制度的统一和统筹规划。并明确指出要积极争取将京津冀三省市共同纳入个人税收递延型养老保险试点和个人税收优惠型健康保险区域范围。通过这一系列的保险服务一体化措施，将免去京津冀地区流动人口的后顾之忧，促进三地之间的人才和人力资源的交流。

3.2.2 保险促进京津冀国际贸易公司跨区域合作

对于河北而言，其外贸注意以中小型民营企业为主。相比大型的跨国外资公司和国营企业，民营企业在把握机会，抵御风险，科技创新方面有着一定的弱势。

所以大力引进跨国外资公司和国营公司入驻河北，将会大幅度提升河北的国际贸易竞争力。

但是如何引进跨国外资公司和国营公司，对于河北政府而言，将会是一个不小的难题。相比较北京天津而言，河北的投资环境，市场，技术发展，人才资源等都处于一定的弱势地位。这就使得这些公司在入驻河北时会承担更大的投资和运营风险。

而政府和保险业可以根据实际情况，通过提供相关的保险业务，有效的降低和预防这些公司所面临的投资和运营风险，免去他们的后顾之忧，从而吸引这些公司入驻河北，带动河北国际贸易主体的结构升级。此外，政府还应该出台保险政策共享机制，促进保险业提供保险业务共享平台，试点"一地承保，三地理赔"的模式。通过这种方式，吸引北京天津的跨国公司，国企在河北设立分公司。

3.2.3 保险促进京津冀地区国际贸易物流一体化

《关于保险业服务于京津冀协同发展的指导意见》中提出，政府鼓励保险机构发挥保险资金优势，加快建设三地一体化的机动车保险电子保单机制和机动车交通事故快处快赔机制。

三地一体化的机动车保险政策，将促进京津冀地区物流一体化的发展，从而促进京津冀地区国际贸易的交互。由于京津冀三地的贸易流向有相互重叠的方向，比如欧洲，美国，澳洲，韩国日本等贸易流向。所以综合交通体系的保险建设有助于国际贸易物流资源的共享，从而提升物流资源的效用。

除了航空、陆地交通资源的共享外，京津冀地区的国际贸易应该充分利用该区域的港口资源。例如北京想要扩大国际贸易流量，就必须发展自己的出海口。但是北京并不是沿海城市，所以只能寻求和沿海城市的合作。1993年，北京于唐山市签订了联合建港的协议，正式启用"京唐港"。不仅如此，京津冀地区还有其他的港口，比如天津港，秦皇岛港口，唐山港，黄骅等港口。为了促进这些港口的联合发展，资源共享。在保险方面，保险行业和机构应该针国际贸易港口业务，使用统一的业务平台，运行"相同的业务在不同的港口相同处理"的模式。从而消除港口之间的不良竞争，促进不同港口的业务合作和资源共享。

3.2.4 保险促进京津冀地区国际贸易科技发展一体化

科技发展的相对落后造成了河北省国际贸易竞争力不足，所以提高河北科技水平，缩小京津冀地区之间的科学技术差距，是实现京津冀区域国际贸易一体化的重要环节。

在科学技术创新的过程中，特别是将科学技术转化为生产力的过程中，由于外部环境的不确定性和活动本身的不确定大型，导致科研开发项目的终止，失败，未达到预期效果的风险，就是科技风险，科技保险可以防范，规避，转移科技风险。

所以为了鼓励科学技术创新，加快科学技术公司的发展壮大，政府应该大力支持科技保险的的发展，完善科技保险体系，促进保险业和保险机构出台相关

科技保险的新产品和新政策。帮助科研机构，科技型公司合理有效的规避和转移风险。

作为科技保险的首批试点城市，北京、天津两地相继出台了扶持科技保险的相关政策。政府不仅对参保企业进行相应的财政补贴，还对科技研发类的公司的新产品、新技术和新工艺的研发费用进行税前扣除。这就使得企业对科技保险的认知度和接受率逐渐上升。而相比之下，河北的科技保险体系的发展就存在着不小的差距。

所以，河北省应该向北京、天津学习，改革科技保险体系，促进科技研发公司的科技投保率，降低该类公司研发科技的风险。鼓励保险机构不断改善科技保险产品，提供更加有效的科技风险防范方式。北京和天津两地以方便应该大力支持河北省的科技保险体系改革，提供经验和技术人才。另一方面，两地也应该继续完善科技保险体系，促进产品的技术创新和升级，提高京津冀地区整体的国际贸易竞争力。

4．结论

第一，本文以京津冀区域一体化发展为背景，研究区域内国际贸易行业的发展现状和发展差异，从保险促进国际贸易一体化的视角，分析京津冀三地国际贸易也互相促进协调发展的可行性。

第二，本文突破传统的从单一行业入手研究区域经济的方法，将保险和国际贸易这两个不同的行业形结合，分析保险业对国际贸易一体化的作用。打破了对国际贸易研究的局限性，不仅从内部研究国际贸易，更从外部行业，研究国际贸易的发展。从而使得丰富了研究国际贸易行业的方法和思路。

第三，通过对京津冀区域一体化保险业新政策和京津冀三个地区国际贸易发展现状的研究，得出保险业可以促进国际贸易一体的发展的结论。从而为今后京津冀地区政府制定相关政策，促进国际贸易业一体化发展时，提供不同行业综合发展，协调发展，共同发展的建议。

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保监会 2016 年《关于保险业服务于京津冀协同发展的指导意见》

保险服务于京津冀国际贸易一体化研究

许珊

北京工商大学经济学院
北京100048，中国
电话: (86)18800113310
Email: moyinshanshui@163.com

关键词: 京津冀 区域一体化 国际贸易 保险一体化

中文摘要. 本文旨在研究京津冀保险行业一体化和对京津冀国际贸易一体化共同协调发展的可行性，并提出区域保险一体化和区域国际贸易一体化协调发展的相关建议。本文首先通过各个经济指标的数据对比分析，总结出京津冀区域国际贸易现状，比较出京津冀三地国际贸易现状的优劣势，并得出京津冀三大地区的国际贸易发展趋势。此外，在此基础上，对保险服务促进京津冀地区国际贸易一体化进行了实证分析，结合京津冀地区保险的最新政策，分析得出保险对京津冀地区国际贸易一体化具有促进作用。

Based on Factor Analysis of Shaanxi Insurance Industry Core Competitiveness Evaluation Research

YAN Weizhong, Zhang Zidi

YAN Weizhong
Professor
School of statistics
Xi 'an University of Finance and Economics
Xi'an 710100, Shaanxi
Phone: 13991233973
Email: 1535233369@qq.com

ZHANG Zidi *
Postgraduate
School of statistics
Xi 'an University of Finance and Economics
Xi'an 710100, Shaanxi
Phone: 13720619519
Email: 565809224@qq.com

Keywords: Core competitiveness of insurance industry, Factor analysis, Countermeasures and suggestions.

Abstract. With the deepening of enterprise reform, the speeding up of the marketization and the development of economic globalization, the insurance business competition has been transformed into the core competence with resource, ability, technology insurance enterprises as the main content of the insurance industry. This article from the risk management ability, profitability, scale and market share, solvency ability, innovation ability, human resources, brand seven aspects to construct core competitiveness evaluation index system of the insurance industry, using factor analysis method respectively to evaluate the property insurance and life insurance, and according to the results of the analysis are proposed. Shaanxi property insurance and life insurance to improve the core competitiveness of the proposal.

1. Research Background and Significance

The insurance industry is an important part of the financial industry.In recent years, the rapid economic development of shaanxi, the insurance industry has appeared the trend of rapid development, rapid growth of market main body, business scale and depth of coverage and the safeguard has been gradually strengthened. Shaaanxi only have the People's Insurance Company of china alone carry on insurance business between 1980 and 1992, by the end of 2011, has been developed to various 2505 insurance institutions, insurance premium income scale is also growing fast, from 11618340000 yuan in 2006 increased to 34372090000 yuan in 2011, an average annual growth of more than 20%. The insurance premium income of Shaanxi Province during the period from 2007 to 2008 growth 44.7%, 2010 is 30 yi yuan mark a breakthrough. This paper according to the characteristics of the insurance industry in Shaanxi, combineing core competitiveness research of results,defineding to the concept and content of insurance core competitiveness, building insurance core competitiveness evaluation indicators system, using the method of factor analysis to evaluate the shaanxi insurance industry core competitiveness , Analyzed the main factors influencing the shaanxi insurance enterprise core competitiveness and the problems existing in the development of insurance industry, put forward to enhance the core competitiveness of insurance enterprises measures.

2. Domestic and International Literature Review

The study of insurance core competitiveness abroad were analyzed from the macro, meso and micro three levels, use core competitiveness theory and research methods, applied the latest theory to the study of insurance core competitiveness, such as <International Core competitiveness analysis of the insurance industry>written by J.David Cummins.

The study of insurance core competitiveness started late domestic, mainly from the 2002's, and it is still in its infancy, and has not formed a larger mainstream thinking.

3. Construct the evaluation index system of the core competitiveness of the insurance industry

Insurance core competitiveness refers to a country's insurance industry as a national industry, in an open market economy, domestic and international insurance withstand the test of competition and the ability to provide insurance services.

Insurance core competitiveness is a complex multi-system, it is essential to design and build the index system to make scientific and comprehensive Evaluation. Insurance core competitiveness evaluation index system manifestations Insurance is a data core competitiveness, is the basis for a comprehensive evaluation of the core competitiveness of the insurance industry

This article argues that the comprehensive evaluation of the core competitiveness of the insurance industry in the design of the index system should follow the following principles ： 1. Scientific principles; 2.Operability principles; 3.Comparability principle; 4.Hierarchical structure principle.

Table 1 The insurance industry core competitiveness evaluation index system

risk management ability	current ratio, debt management rate, asset-liability, Ratio premium, retention ratio, Reserve adequacy ratio.
profitability	Assets profit margins, Profit growth, Return on equity, Per capita profit margins
scale and market share	Premium income, Total assets, Market share ,Insurance density Insurance penetration
solvency	Insurance loss ratio, Liquidity ratios, The total amount of compensation
innovation ability	Development of new insurance rates, The rate of new insurance premiums High technical personnel proportion
Human resource ability	Professional staff ratio ,Investment in staff training rate, Human resource profit margins
Brand ability	Brand awareness, Brand reputation, Customer loyalty

4. Shaanxi insurance industry core competitiveness empirical analysis

4.1 Data source

The index data of the core competitiveness of the insurance industry in Shaanxi province are from "Shaanxi Insurance" 2012.

In order to eliminate the dimensional difference may bring some unreasonable influence, The data were normalized before carrying out the factor analysis ,so that the average number of each variable is 0, the variance is 1, data standardization formula are :

$$x_{ij}^{*} = \frac{x_{ij} - \overline{x_j}}{\sqrt{\mathrm{var}(x_j)}} (i = 1,2,3,\ldots n;\ j = 1,2,3,\ldots p) \quad (1)$$

$$\overline{x_j} = \frac{1}{n}\sum_{i=1}^{n} x_{ij} \quad (2)$$

$$\mathrm{var}(x_j) = \frac{1}{n-1}\sum_{1}^{n} (x_{ij} - \overline{x_j})^2 (j = 1,2,3,\ldots p) \quad (3)$$

4.2 The empirical analysis method

This article selects the factor analysis method to evaluate the property insurance and life insurance respectively. The idea of the factor analysis method is make the original variables grouped according to correlation , The high correlation between the variables in a group, the correlation between different groups of variables is low, and each variable represents a common factor, with aggregate variable to represent evaluation results.

4.3 The selection of indicators

As some indicators data are not available, so only select some indicators index system for analysis. In this paper, property insurance and life insurance are selected seven indicators for analysis, the selected indicators are: x1 represents reserve adequacy ratio; x2 represents Premium income ; x3 represents insurance density; x4 represents insurance penetration; x5 represents the insurance loss ratio ; x6 represents the rate of new insurance premiums; x7 represents customer loyalty.

4.4 The empirical analysis of Shaanxi province property insurance company core competition

The data for each variable input SPSS20.0 statistical software for factor analysis. Specific steps are; The original data standardization, and calculate correlation coefficient. According to correlation coefficient matrix, calculation characteristic value and variance contribution rate of the correlation coefficient. Secondly, according to the cumulative variance contribution rate is more than 85% to establish the factor loading matrix, to carry on maximum variance factor loading matrix orthogonal rotation, so that the factor variable is more explanatory.Thirdly, calculate each factor score and ranking.

$$F_1 = -0.08ZX_1 + 0.274ZX_2 + 0.273ZX_3 + 0.274ZX_4 + 0.08ZX_5 - 0.088ZX_6 + 0.2372ZX_7 \quad (4)$$

$$F_2 = -0.504ZX_1 + 0.016ZX_2 + 0.016ZX_3 + 0.016ZX_4 = 0.504ZX_5 - 0.071ZX_6 - 0.029ZX_7 \quad (5)$$

$$F_3 = 0.055ZX_1 - 0.039ZX_2 - 0.309ZX_3 - 0.040ZX_4 - 0.055ZX_5 + 1.035ZX_6 - 0.032ZX_7 \quad (6)$$

F1 is a property company influence score, F2 is the ability to pay property insurance company; F3 is a property and casualty insurance company's new product promotion ability score.

Table 2 Property insurance core competitiveness factor score and ranking

Insurance Company	F1	Ranking	F2	Ranking	F3	Ranking
People's Insurance	3.40242	1	0.33559	8	-0.47542	13
Ping An Insurance	2.24126	2	-0.64213	17	0.09822	8
China Pacific Insurance	0.15042	3	-0.1828	14	1.00277	5
China United Property Insurance	-0.01537	4	0.556	6	0.87606	6
China Continent Insurance	-0.04735	5	0.1211	11	1.07921	4
Yong An Insurance	-0.04768	6	-0.45821	15	1.91023	1
An Bang Insurance	-0.28731	7	0.87133	3	-1.30848	19
Tai Ping Insurance	-0.35047	8	0.79394	4	0.08204	9
Tian An Insurance	-0.36067	9	0.06977	12	-0.19853	11
Alltrust Property Insurance	-0.36924	10	1.13724	2	-0.02785	10
An Cheng Property Insurance	-0.38204	11	0.70085	5	-1.0265	17
Du-bang Insurance	-0.38492	12	1.54324	1	-1.49203	20
Sunshine Insurance	-0.39277	13	0.53759	7	1.41152	2
Bohai Property Insurance	-0.39308	14	0.30133	9	-0.64502	14
Huatai Insurance	-0.39573	15	-0.46805	16	-0.87086	16
China Export Credit Insurance	-0.4187	16	-0.89377	18	-1.22803	18
Yingda Taihe Property Insurance	-0.42108	17	-1.51655	19	-0.23715	12
China Life Property and Casualty Insurance	-0.46443	18	-2.93735	20	-0.75055	15
Sinosafe Insurance	-0.46798	19	-0.01564	13	0.56583	7
Bank of China Insurance	-0.59526	20	0.1465	10	1.23455	3

Fourth, according to each factor score and ranking in table 2, with characteristic root weight, according to the formula (7) weighted comprehensive on three factors,

concluded the core competence of property insurance companies in Shaanxi (table 3). Composite scores calculation formula is:

$$Y = \frac{\lambda_1}{\sum_{I=1}^{7}\lambda_I} F_1 + \frac{\lambda_2}{\sum_{I=1}^{7}\lambda_I} F_2 + \frac{\lambda_3}{\sum_{I=1}^{7}\lambda_I} F_3 \quad (7)$$

Table 3 Property insurance core competitiveness comprehensive factor score and ranking

Insurance Company	Composite scores	Ranking
People's Insurance	1.944426608	1
Ping An Insurance	1.069415048	2
China United Property Insurance	0.278630031	3
China Pacific Insurance	0.160609257	4
China Continent Insurance	0.153665377	5
Alltrust Property Insurance	0.139987032	6
Sunshine Insurance	0.132648221	7
Yong An Insurance	0.085044203	8
Du-bang Insurance	0.062450452	9
Tai Ping Insurance	0.059291936	10
An Bang Insurance	-0.065595684	11
Bank of China Insurance	-0.124557341	12
An Cheng Property Insurance	-0.133791709	13
Sinosafe Insurance	-0.191796798	14
Tian An Insurance	-0.206619859	15
Bohai Property Insurance	-0.212533967	16
Huatai Insurance	-0.480901782	17
China Export Credit Insurance	-0.672169109	18
Yingda Taihe Property Insurance	-0.734165904	19
China Life Property and Casualty Insurance	-1.264029659	20

The score of table 3 is standard score, negative points below the national average; positive fraction is higher than the national average. From table 3 can be see, there are 20 property insurance companies, higher than the national average have 10 companies,10 companies below the national average.

From table 3, People's Insurance Company; Ping An Insurance Company; China United Property Insurance Company ranking as the top of three, while China Export Credit Insurance Company; Yingda Taihe Property Insurance Company; China Life Property and Casualty Insurance Company ranking last. In 20 insurance companies, People's Insurance property company scale was ranked no. 1, compensation ability ranked eighth, new product promotion ability ranked 13th, which ranked it can be seen that People's Insurance property company should strengthen the promotion of new products. Property insurance business has been a long time operation and development of ping an insurance company, in recent years, the scale of Ping An Insurance business has increased steadily, in Ping An Insurance company ranking, the company scale was ranked no. 2, the compensation ability ranked no. 17,new product promotion ability ranked eighth, ping an insurance to enhance the core competitiveness of insurance must improve the company's ability to pay.

4.5 The empirical analysis of Shaanxi province life insurance company core competition

The data for each variable input SPSS20.0 statistical software for factor analysis. Specific steps are; The original data standardization, and calculate correlation coefficient. According to correlation coefficient matrix, calculation characteristic value and variance contribution rate of the correlation coefficient.

Secondly, according to the cumulative variance contribution rate is more than 85% to establish the factor loading matrix, to carry on maximum variance factor loading matrix orthogonal rotation, so that the factor variable is more explanatory .

Thirdly, calculate each factor score and ranking.

$$F_1 = -0.0029ZX_1 + 0.255ZX_2 + 0.260ZX_3 + 0.260ZX_4 + 0.029ZX_5 - 0.025ZX_6 + 0.261ZX_7 \quad (8)$$

$$F_2 = -0.348ZX_1 + 0.058ZX_2 + 0.005ZX_3 + 0.005ZX_4 + 0.348ZX_5 - 0.333ZX_6 - 0.012ZX_7 \quad (9)$$

F1 is a property company influence score; F2 is the ability to pay property insurance company and new product promotion ability score.

Table 4 Life insurance core competitiveness factor score and ranking

Insurance Company	F1	Ranking	F2	Ranking
China Life Insurance	3.86908	1	-0.05257	5
China Pacific Insurance	0.59087	4	-0.25451	7
Ping An Insurance	0.81274	2	-0.19096	6
Tai Kang Life Insurance	0.04004	5	-0.38604	11
New China Insurance	0.63355	3	-0.43724	13
Hua Xia Life Insurance	-0.40756	12	-0.37016	9
Jia He Life Insurance	-0.37929	10	-0.49938	19
Ping An Life Insurance	-0.07268	6	3.56978	3
Tai Ping Life Insurance	-0.48812	16	-0.44895	14
PICC Life Insurance	-0.14878	7	-0.46014	16
Union Life Insurance	-0.48928	17	-0.45221	15
Sunshine Insurance	-0.45484	14	-0.47443	17
PICC Health Insurance	-0.3432	9	1.67587	1
Happy Life Insurance	-0.393	11	-0.43173	12
Ying Da Life Insurance	-0.45603	15	0.10115	4
Min Sheng Insurance	-0.52739	19	-0.37113	10
Generali China Life Insurance	-0.4144	13	0.87872	2

China Post Insurance	-0.29944	8	-0.54689	20
Sino Life Insurance	-0.51297	18	-0.48973	18
Great Eastern Insurance	-0.55927	20	-0.35945	8

Fourth, according to each factor score and ranking in table 4, with characteristic root weight, according to the formula (10) weighted comprehensive on three factors, concluded the core competence of property insurance companies in Shaanxi (table5). Composite scores calculation formula is:

$$Y = \frac{\lambda_1}{\sum_{I=1}^{7} \lambda_I} F_1 + \frac{\lambda_2}{\sum_{I=1}^{7} \lambda_I} F_2 \tag{10}$$

Table 5 Life insurance core competitiveness comprehensive factor score and ranking

Insurance Company	Composite scores	Ranking
China Life Insurance	2.31432907	1
Ping An Life Insurance	1.37138515	2
PICC Health Insurance	0.45726689	3
Ping An Insurance	0.41481986	4
China Pacific Insurance	0.25571634	5
New China Insurance	0.20903181	6
Generali China Life Insurance	0.09826164	7
Tai Kang Life Insurance	-0.1288809	8
Ying Da Life Insurance	-0.2351342	9
PICC Life Insurance	-0.2722197	10
Hua Xia Life Insurance	-0.3927326	11
China Post Insurance	-0.3975423	12
Happy Life Insurance	-0.4083546	13
Jia He Life Insurance	-0.4269001	14
Sunshine Insurance	-0.4626065	15
Min Sheng Insurance	-0.4654402	16
Tai Ping Life Insurance	-0.4725910	17
Union Life Insurance	-0.4745835	18
Great Eastern Insurance	-0.4800507	19
Sino Life Insurance	-0.5037564	20

The score of table 5 is standard score, negative points below the national average; positive fraction is higher than the national average. From table 5 can be seen, there are 20 property insurance companies, higher than the national average have 7companies, 13companies below the national average.

From table 5 can be seen, China Life Insurance Company，Ping An Life Insurance Company，PICC Health Insurance Company ranking as the top three. China Life Insurance has a unique position in the 20 insurance companies in our country, China Life Insurance Company rank NO.1 in the scale of company, payment capacity and the ability to promote new products ranked NO.5. In Ping An Insurance company ranking, the company scale was ranked NO.6, the compensation ability and new product promotion ability ranked NO. 17, ping an insurance to enhance the core competitiveness of insurance must improve the company's ability to pay and new product promotion ability.

5. The core competitiveness of the insurance industry in Shaanxi conclusion and suggestion

5.1 Property Insurance company's advice

(1)The insurance company should keep the advantage, make up the disadvantage, and pay attention to the balanced development. Profit is the ultimate goal of insurance companies, operating ability and capital operation ability is directly related to its final profitability, solvency and risk management ability is the foundation of its steady management, growth ability and the ability of business development is the guarantee of sustainable development in the future of the company, the lack of any one aspect ability will affect the development of property insurance, which requires insurance companies to pay attention to balanced development, especially pay more attention to the weak link, timely rectification and improvement.

(2) Avoid over-concentration of insurance operations, encourage more insurance companies to carry insurance in favor of a stable livelihood. The rapid development of the national economy, driven by the rapid growth of automobile manufacturing and consumer spending. So Motor vehicle insurance to become the most important insurance for most property insurance companies, accounting for over 60% of the company's premium income, operating over a single type of insurance is not conducive to the stable development of the company, property insurance company may try to carry out other types of insurance in favor of the people's livelihood.

5.2 Life insurance company's advice

(1) To improve the life insurance company solvency. The main reason for the poor solvency of life insurance companies in China is the rate of return on investment is too low, reinsurance business conduct not good, life insurance reserves extraction without planning, So the life insurance company should scientific and reasonable to extract the reserve, strengthen investment management, reduce the surrender rate, reasonably determine the reinsurance share and improve the external supervision mechanism to enhance our country's life insurance company solvency.

(2) Speed up product innovation ability. The quality of insurance products and services are the most directly reflect the core competitiveness. People choose insurance companies often depends on the different products, But the insurance products of the intangible and dependence make the insurance product comparison is different from other tangible products, Customers can only according to the understanding of the insurance company credibility, as well as services provided by the insurance company can determine whether or not to buy finally. Therefore, improve the core competence of insurance company must accelerate product innovation ability.

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An Exploration of Asset and Liability Management Model of Chinese Insurance Companies under the New Normal

YANG Xinyue

School of Insurance
The Central University of Finance and Economics
Beijing 102206, China
Phone: 18811386199
Email: yangxinyuemii@163.com

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Abstract. China's economy has entered a period of new normal. Meanwhile, the State Council of China issued No.10 National Notice, which means the environment that the insurance industry faces is undergoing enormous changes. The insurance asset management has reached a new era. In that context, it is becoming more and more important for the insurance companies to choose the proper model of asset and liability management. The insurance company can only achieve its strategic objectives by making the most suitable choices to prevent and control the risks.

This paper is divided into four parts. By adopting the methodology of combining document research, empirical research, model construction, induction and deduction together, we show that a combination of asset-oriented and liability-oriented asset and liability management model is expected to have a broader range of applications under the new normal.

First, the paper systematically reviews the theoretical documents and summarizes the methods about asset and liability management. We point out that the insurance company should have a dynamic simulation and scientific management of its whole balance sheet through an integrative application of multiple approaches.

Second, this paper compares the asset-oriented and liability-oriented asset and liability management models, based on the deep analysis on the asset and liability management model of traditional insurance companies. We argue that both models have embodied the thought of asset and liability match. They are suitable for different economic conditions and it is hard to tell which is better. When making the strategic

choice, insurance companies should take various factors into account, such as the macro-environment, the company's scale and market shares, the development goals and so on.

Then the paper explores and summarizes the valuable experience and inspiration of the foreign insurance companies. There is a difference in the development stage of the insurance industry home and abroad, so the foreign successful asset and liability management models do not necessarily apply in China. We should carefully analysis their successful experiences and improve the efficiency of insurance funds. At the same time, however, we must also clearly understand the differences.

By analysis and comparison, we conclude that under the condition of imperfect insurance market and financial market, it is more proper for the insurance companies to apply a combination of asset-oriented and liability-oriented asset and liability management model. Under the new normal, Chinese insurance companies should prevent the mismatch of asset and liability, strengthen the portfolio management and meet the demand when designing the products and developing business. Since China's insurance industry is on its characteristic way, the insurance companies are supposed to learn from the international experience and strive for innovation and steady development.

1. 引言

2014年，中国经济进入新常态，国务院颁布保险业改革发展“新国十条”。我国保险业面临的行业环境正在发生巨大变革，保险资产管理也迈向大资管时代。在“新国十条”引导下，保险业将进一步打开发展空间，逐步走向费率市场化与投资自主化的发展道路。新常态下，保险公司对于资产负债管理模式的选择将更为重要。保险公司唯有根据自身情况选择恰当的资产负债管理模式，防控风险，增加盈利，才能最终实现公司的战略目标，确立行业地位。

当前，为适应日益复杂的保险需求，我国保险产品的创新性逐步增强。保险资金投资方式与渠道日益多元化，保险公司资产与负债对利率等经济指标的变动更为敏感。资产负债管理着眼于资产与负债关系的协调安排以及对风险的量化与控制，对保险公司的可持续发展而言至关重要。

传统的保险公司采用负债驱动式的资产负债管理模式，这一模式的主要理念是资产安排与管理应当根据负债组合状况做出调整，即保险公司充分考虑市场需求，以保险产品为出发点，通过销售保险产品取得保费收入，而后根据负债状况设计资产组合，确定投资计划。在这一过程中，保险的投资理财功能弱化，并且受制于负债端，保险资金投资较为保守。近些年来，随着安邦保险集团在国内外频繁收购与投资，其采用的资产驱动负债模式引人关注，但同时也引发了业界对其负债端承压能力的质疑。

新格局下，保险公司亟待探索适合自身的资产负债管理新模式，适时做出转变，理清保险公司多项目标之间的优先顺序，在控制风险的同时将收益最大化，借力于新常态，把握机遇，实现跨越式发展。

2. 国内外文献综述

资产负债管理理论于20世纪起源于西方发达国家，并且随着国际环境与风险因素的变化得到不断发展与完善。

资产负债管理理论经历了两个主要阶段：基础理论与现代理论阶段。在基础理论阶段，Macaulay(1938)和Hicks(1939)分别提出久期概念并阐释其含义，Koopmans(1942)提出现金流匹配思想，Redington(1952)提出资产负债利率免疫方法等。现代理论阶段的开端是Markowitz(1952)提出资产组合理论，他认为通过构造多样化的资产组合可以降低风险。随后资产组合理论经历了静态与动态两个阶段。静态理论阶段的成果主要有：Artzner(1997)提出一致性风险度量模型以克服VaR方法的局限性，Follmer和Schied(2002)引入凸风险测度将其推广，Krokhmal(2002)提出线性规划的方法以同时得到资产组合的VaR值与实现最佳CVaR值的资产组合比例。在动态理论阶段，借助于计算机资源与数据挖掘技术，投资者更加关注跨期投资策略，考虑未来不确定性对资产负债管理产生的影响。Samuleson(1969)，Merton(1969)等学者对动态资产配置进行研究，Luenberger(1998)

对比了单期与多期投资策略，重新调整了各个期间最优资产组合。20世纪90年代以来，资产负债管理理论被广泛应用于银行、保险公司等机构，Phibrick和Painter(2001)详细分析了动态财务分析的模型框架及其运用的五大步骤，Ferstl和Weissensteiner(2011)在资产负债管理中应用随机线性规划，以期解决动态配置与可预测效应的收益问题，Rao(2013)运用多阶段随机优化决策支持系统来处理保险公司的资产与负债不匹配问题。

国内的资产负债管理理论研究起步较晚，但发展态势良好。整体来看，国内资产负债管理研究主要以寿险、养老金等长期业务为出发点，介绍国外资产负债管理理论的技术与方法，进而深入探索其在中国本土的应用。李秀芳（2002）和刘汉民（2009）在介绍资产负债管理理论的基础上，提出了适合我国寿险公司资产负债管理的模式与方法，之后不断有学者在此基础上发表学术论著。陈迪红（2004），傅强（2013）等人对研究了动态财务分析方法及其应用。樊帆（2003），陈森（2011），李涛（2012）等人对非寿险公司的资产负债管理进行了探索性的研究。

3. 资产负债管理方法

3.1 缺口分析方法

缺口分析方法是一种静态的资产负债管理技术，包括到期缺口分析与持续期缺口分析。缺口 GAP 可表示为

$$GAP = RSA - RSL \tag{1}$$

其中 RSA 为利率敏感性资产，RSL 为利率敏感性负债。持续期缺口较到期缺口的改进之处在于考虑到资产与负债现金流的发生时间与不同期限利率变化所引起的差异。缺口分析方法计算简单，操作方便，但将问题过于理想化，不能准确把握利率对利差收益影响的程度。

3.2 现金流匹配

现金流匹配是通过构造恰当的投资组合，使各个时期的现金流入与流出保持一致，从而可以完全消除利率风险。但是对保险公司而言，试图追求资产与负债现金流的完全匹配是不现实的，因为短期内很难找到满足保险产品期限与金额的投资组合。同时，追求资产负债现金流的完全匹配也会在很大程度上限制保险公司的投资自主性与灵活性。近年来，随着保险产品的多样化发展，保单持有人逐步开始享有各种行使时间不确定的选择权，这必将影响保险公司未来负债的现金流支出，使现金流的完全匹配更加难以实现。

3.3 免疫

免疫是另一种控制利率风险的方法，与现金流匹配不同的是，免疫着眼于匹配资产和负债对利率的敏感性，使保险公司收益不会在利率波动时减少。判断投资组合是否免疫下三个条件：资产的现值不小于负债的现值；资产与负债的久期相同；资产的凸度不小于负债的凸度。满足免疫条件的资产组合无论利率如何波动，盈余都不会减少。免疫对于资产与负债现值的匹配简化了计算过程，可有效控制利率风险。

3.4 风险价值

风险价值是指在特定持有期与置信水平下，资产组合可能发生的最大损失，可用公示表达为：

$$\Pr(\Delta P < VaR) = 1 - \alpha \tag{2}$$

即投资组合在一定持有期内的损失额ΔP在给定置信水平α下的损失上限为VaR。

风险价值方法下，我们通常假设市场是有效的，且市场波动随机，不具备自相关性。风险价值法可以通过设置VaR上限控制公司风险，防止过度投机。但是这一方法主要用于衡量市场风险，可能会忽视信用风险、操作风险等其他种类的风险。

3.5 动态财务分析

动态财务分析(Dynamic Financial Analysis, 简称为DFA)，是一种整体性的财务建模方法，它通过动态模拟公司未来运营环境与经营结果，得出公司未来运营受外部环境因素与内部战略决策的影响程度。与静态的、传统意义上的资产负债管理技术相区别，动态财务分析强调随机性与动态性，模拟不确定条件下公司的未来经营状况。它将整个保险公司视作一个整体，对于保险公司的资产负债管理有很强的参考价值，是国际上非寿险公司通常采用的资产负债管理方法。

操作流程与结构框架

动态财务分析模型框架包括初始条件、情景生成器、财务计算器、优化程序与结果分析五个部分。保险公司应当根据企业所处的经济环境与资产负债状况确定合适的动态财务分析流程，确保建立的模型符合自身财务与经营状况，从而有效利用这一技术降低公司资产负债管理风险，提高整体效益。

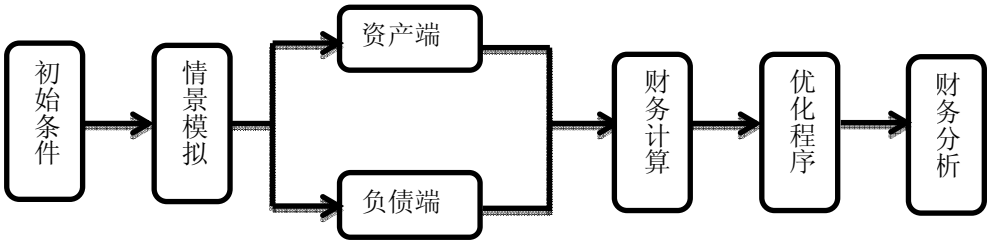


图1 动态财务分析流程图

3.5.1 主要变量及其逻辑关系

保险公司的财务状况受利率、通货膨胀、经济环境、承保周期等诸多因素影响，保险事故发生的时间、频率与赔偿额度等具有不确定性。动态财务分析的各个影响变量之间具有复杂的因果关系，具体可以分为随机因果关系与确定因果关系两种。随机因果关系通过估计参数，模拟随机变量的分布，得到可能出现的结果；确定因果关系则通过保险公司内部数据资料与管理人员来确定未来可能状况。Kaufmann, Gadmer, Klett(2001)在Introduction to Dynamic Financial Analysis中介绍了模型变量间的逻辑关系，本文结合我国经济运行现状与保险公司业务特点，对各主要影响变量及其逻辑关系进行了完善，结果如图2所示。

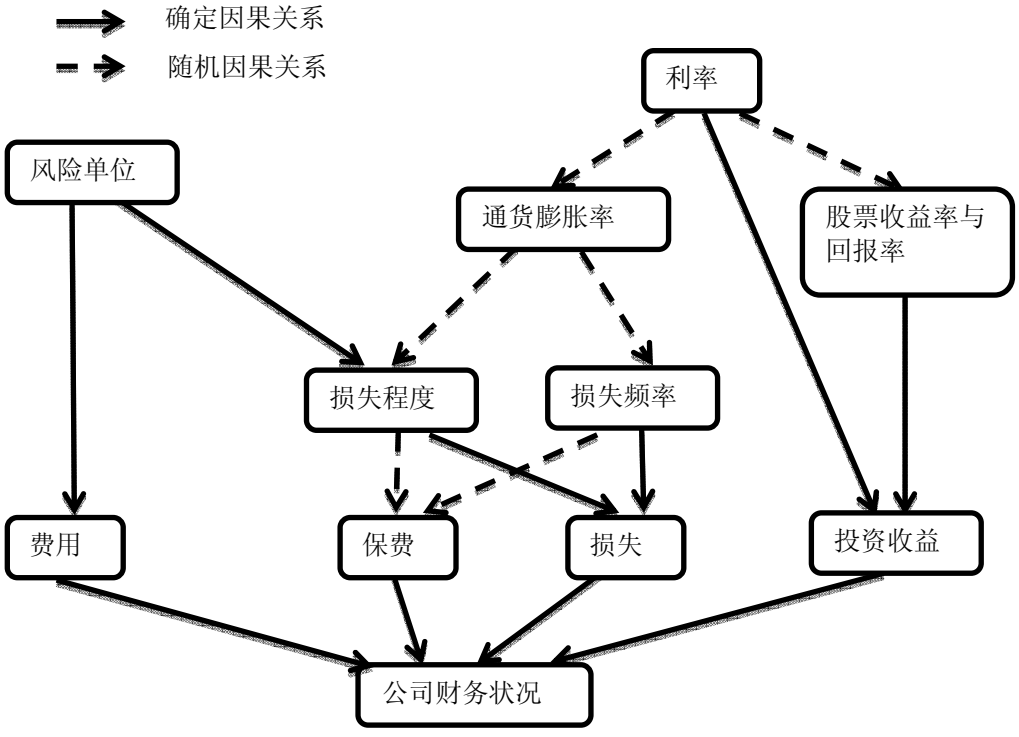


图2 动态财务分析主要变量及其逻辑关系示意图

3.5.2 动态财务分析在财产保险公司的应用

财产保险公司通常采用动态财务分析技术来进行资产负债管理，这是由于相对于寿险公司而言，财险公司通常对内外各种影响因素的变动更为敏感，面临的风险也更加多样（风险分类如图3所示）。采用动态财务分析技术，我们可以综合考虑各种因素及其相关关系，做出合适的资产负债规划与安排。

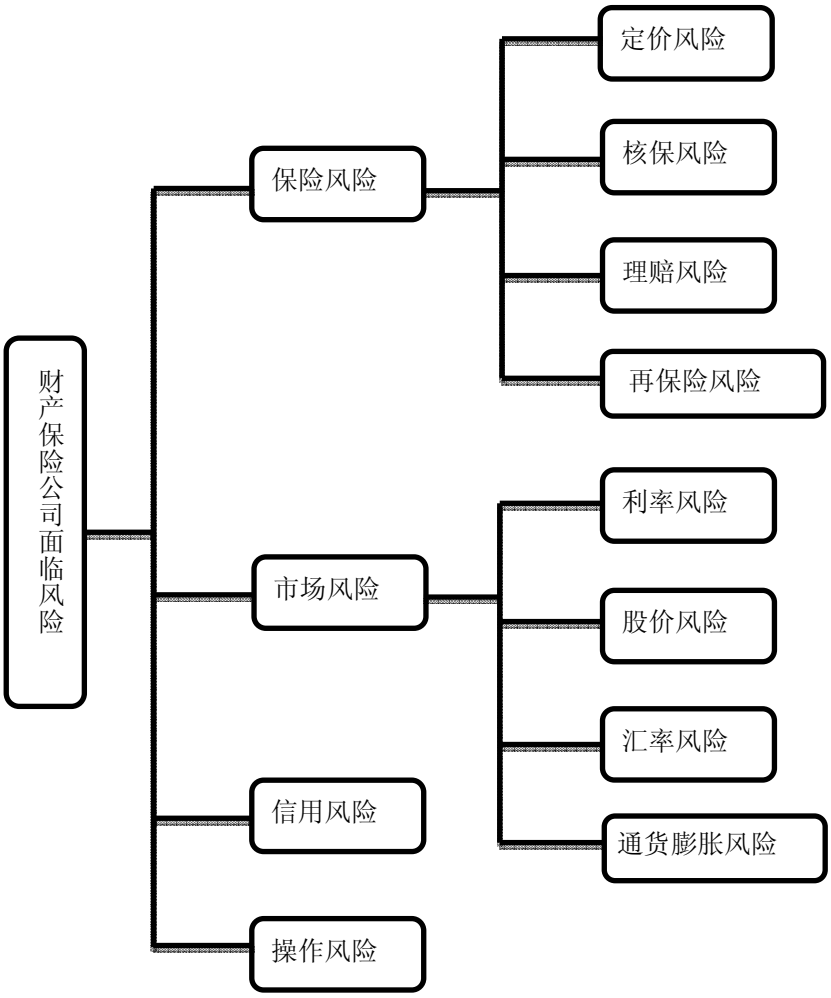


图3 财产保险公司面临主要风险分类

记财产保险公司在时刻t权益资本为 EC_t ， E_t 为保险公司收益，则有：

$$EC_t = EC_{t-1} + E_t \tag{3}$$

其中，EC_t 由承保收益 U_t 和投资收益 I_t 两部分组成。若以 tr 表示保险公司税率，则保险公司收益 E_t 可以表示为：

$$E_t = I_t + U_t - \max\{0, tr(I_t + U_t)\} \tag{4}$$

设保险公司配置于无风险资产（收益率为 R_{1t} ）和风险资产（收益率为 R_{2t} ）的比例分别为 a_{t-1} 和 $1 - a_{t-1}$ ，则保险公司总体投资收益率 R_t 为：

$$R_t = a_{t-1}R_{1t} + (1 - a_{t-1})R_{2t} \tag{5}$$

若 P_{t-1} 为保费收入，θ 为可投资资金占总资金比例，则投资收益率 I_t 与可表示为：

$$I_t = \theta R_t(EC_{t-1} + P_{t-1}) \tag{6}$$

在保险公司的保费收入预测中，Eling和Toplek(2009)，张琳和唐林娟（2012），等学者均认为财产保险市场存在承保周期，借用其向量自回归模型估计承保周期，得到保费水平为：

$$\prod_t = a_0 + a_1 \prod_{t-1} + a_2 \prod_{t-2} + \alpha_t \tag{7}$$

此外，考虑到保险公司成本 E_t^C 可用综合费用表示，设其综合费用为索赔金额C的固定比率k，即有：

$$E_t^C = kC_t \tag{8}$$

4．保险公司资产负债管理模式

依据主导因素的不同，现阶段保险公司的资产负债管理模式主要有两种，分别是负债导向型的资产负债管理模式和资产导向型的资产负债管理模式，目前前者占据主导地位。资产负债管理模式的选择取决于公司所处的行业背景，公司规模，管理模式，业务特点等诸多因素。

4.1 负债导向型的资产负债管理模式

负债导向型的理念是根据负债的特点确定资产组合，安排资产的期限、结构比例与流动性等。在这一理念下，投资标的的选择与配置基于负债状况，保险公司以市场对保险产品的需求为出发点，通过销售保险产品取得保费收入，所进行的资产配置首先应当满足负债偿还要求，其次保证保险公司经营所需流动性，在此基础上尽可能提高盈利水平。

4.2 资产导向型的资产负债管理模式

资产主导型的管理模式强调资产配置的重要性，保险公司首先在投资端确定质量好、收益高的投资项目，然后再通过负债端的保费收入来筹集资金。在这种模式下，保险产品的设计和定价要考虑到投资端的资产状况与投资组合的回报率，这便要求保险公司的产品开发部门更多地与投资管理部门沟通交流，在满足资产要求的同时，设计出符合市场需求的保险产品。

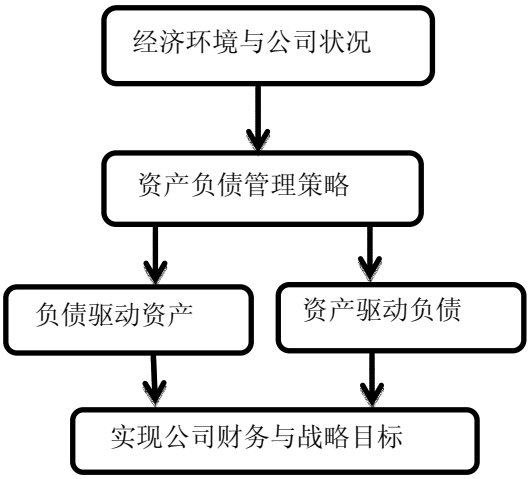


图4 保险公司资产负债管理结构模式图

4.3 两种资产负债管理模式的比较

负债导向型和资产导向型的资产负债管理模式都体现了资产与负债相匹配的管理思想，适用于不同的环境，二者出发点不同，并无优劣之分，且各自有不同的优缺点。保险公司在战略选择的过程中，应当具体分析行业背景，自身条件，公司发展目标等诸多因素，选择合适的管理模式，并以此确定公司发展规划与业务流程。

在负债驱动资产的管理模式下，保险公司更加重视承保业务，相对弱化投资业务。这一模式的优点是有利于保险公司开拓市场，开发出前景良好的保险产品，但投资端的资产组合可能不尽如人意，甚至无法与负债相匹配，这可能给保险公司带来潜在风险。

资产驱动负债的管理模式与负债驱动资产的管理模式相反，强调以投资业务为主，承保业务为辅。在这种管理模式下，保险公司可以灵活地进行资金配置与项目投资，但其开发的保险产品可能无法与市场需求相契合，导致业务拓展局面尴尬。

5. 国外保险公司资产负债管理模式启示

5.1 国外保险公司资产负债管理

20世纪80年代，世界现代保险资产负债管理得到实质性发展。国际性的金融危机频繁发生，呈现出长期性和复杂性的显著特点。1982年，墨西哥触发了震惊全球的拉美债务危机，1990年日本泡沫经济崩溃，经济增长停滞，进入“零增长阶段”。1997年至1998年爆发亚洲金融危机，2007年至2011年爆发美国次贷危机及全球金融危机，世界各国经济增速放缓甚至衰退。在2008年的国际金融危机中，保险公司难以独善其身，同样受到了波及与影响。

日本大和生命保险是典型的因资本运作不当而倒闭的保险公司。大和生命放弃了谨慎的资产负债管理方式，大肆投资高风险的房地产与债券市场，试图追求高回报，却因过分逐利而忽视控制风险。同时，大和生命保险不断扩张规模，负债日益增加，偿付能力急剧下降，资产与负债的不匹配使其最终在金融风暴的冲击下不堪一击，宣布破产。

欧洲在金融危机后加快了“偿付能力Ⅱ”的制定，在2011年3月即完成了第五次量化影响研究（QIS5）。欧盟旨在其内部建立协调一致的偿付能力监管体系，以风险度量为基础，全面评估保险公司的风险，进而完善风险防范机制。在该监管体系下，保险公司风险面临风险定量要求、风险定性要求与风险披露要求等。同时，该体系强调各国家和地区依据各自实际经验确定风险收益特征，促使保险公司降低杠杆化程度，资产负债管理稳健有序进行。

美国保险业一向有着较为稳健的收益率，这得益于高效与多样化的投资组合，即使在金融危机期间也未受太大影响，2009-2013年美国寿险资金投资收益率基本稳定在5%左右。较为引人瞩目的AIG被美国政府接管事件，缘起于其下属

公司在金融衍生产品领域(主要为CDS)的巨额亏损，同样也是因资产与负债的不匹配影响到集团整体的财务稳健性。

5.2 启示

我们应当从世界各国保险公司的资产负债管理经验中吸取教训，将资产与负债合理匹配，防范金融风险，维护我国金融保险体系的健康和可持续发展。

5.2.1 理性选择资产负债管理模式

从国际经验来看，保险公司应当采用何种模式进行资产负债管理，至少需要综合考虑当前监管环境与自身发展状况两个方面的因素。若监管体制尚不健全，则投资可能面临较大风险，无法与负债相匹配；若公司发展规模较小，产品开发技术尚不成熟，则在产品开发阶段可能无法洞悉市场需求，难以设计出具有销售潜力的保险产品，业务增长速度受限。

保险公司在选择资产负债管理模式时，应当理性看待监管体制，对自身发展阶段科学定位，做出理性抉择。数据共享与信息交互平台

5.2.2 正确对待金融创新，完善投资渠道

新格局下，保险公司的资金运用水平愈发对其行业竞争力产生重要影响，丰富的金融衍生工具拓宽了保险资金运用渠道，从而将风险分散，但同时也带来潜在的安全隐患。金融创新产品的高额利润背后蕴藏着高风险，保险公司在分散风险的同时可能将风险转嫁，甚至通过杠杆操作将风险放大。金融创新产品成为风险传递的链条，市场整体风险不断累积加剧。

在全球化进程继续加快的经济背景下，中国的保险公司开始涉足海外投资，这是对完善投资渠道的重要探索。然而，我们应当意识到：资金迈入国际市场的过程应谨慎有序，国内保险公司应借鉴学习发达国家模式，同时吸取其经验教训，稳健中求发展，安全下求创新。

5.2.3 建立全面而灵活的金融监管机制

在国际化的发展趋势下，保险公司面临的风险日益多元化，这便对保险业的监管者提出了更高的要求。全面而灵活的监管机制对保险业的良性发展至关重要。监管机构应当正确配置监管资源，监管者一方面要注重对保险公司业务开拓的全面覆盖，另一发面，要严格规范保险公司在其他金融产品上的探索。监管者在全面监管的过程中要同时注意对市场主体活力的激发，提高保险公司与保险业的市场运行效率。

我国保险监管机构应在“偿二代”监管体系下，落实以资产负债管理为核心的动态偿付能力监管，而非仅依赖于偿付能力额度等静态指标计算，这样才能最大程度上降低保险业资产负债错配风险。例如，监管机构可以根据保险公司负债的不同性质与风险程度，适度开放投资渠道，同时限制投资组合的投资比例，达到资产与负债的合理匹配以及风险防控。

6．我国保险公司资产负债管理模式的探索

影响资产负债管理的因素众多，选择合适的管理模式对我国保险公司的发展尤为重要。恰当的资产负债管理模式保证了公司经营管理的稳健性与收益性，确保了公司战略的正确方向。保险公司对于资产负债管理模式的探索，应当综合考虑本公司的实际业务结构、资产与负债特点、公司战略目标、监管体系等多重因素，通过合适的资产负债管理模式实现资产负债管理的安全性、收益性、流动性等目标，控制公司经营风险。

6.1 负债导向型的资产负债管理模式

传统的保险公司通常采用负债驱动资产式的资产负债管理模式。传统保险产品的赔付时间、金额具有不确定性，保险公司为保证产品质量与企业信誉，需要及时对被保险人做出经济补偿。在未来负债偿还不确定的情况下，保险公司通常根据负债情况合理配置资产，确保债务发生时能够及时履行。

负债导向型的资产负债管理模式有利于推动保险公司承保业务的快速发展。新常态下，我国保险业仍继续保持较快的发展速度，2015年原保费收入2.4亿元人民币，较2014年增长20%。但与发达国家相比，我国的保险深度与保险密度仍处在较低的发展水平上，这也预示着，在未来一段时间内，我国保险业仍将保持较快的发展速度，保险公司也将逐步完善保险产品，增加保费收入。保险公司在保费规模扩张的同时，也将面临保险责任以及保险负债的扩大，这便对其资产管理的有效性提出了更高的要求。

投资产品多元化为负债导向型的资产负债管理模式提供了便利。近年来，保险公司对于投资的管理与风险控制愈发重视，监管部门也逐步放宽了保险公司的投资渠道。投资产品的多元化，不仅使资产与负债在流动性匹配上成为可能，也大大提高了保险资金收益率，确保了负债导向型资产负债管理模式的可行性。

6.2 资产导向型的资产负债管理模式

选择资产导向型模式的保险公司更加注重投资的可靠性与收益性，强调公司根据自身的投资渠道与品种来安排保险产品的销售。这种以负债配合资产的管理模式能够控制资金闲置给公司带来的或有损失与风险。

资产导向型的资产负债管理模式对保险公司提出了更高的要求，保险公司要根据投资能力开发保险产品，确定销售规模。首先，保险公司要有敏锐的市场洞察力，把握良好的投资机会；其次，公司还需要在满足资产要求的基础上，研发具有市场竞争力的保险产品，从而进一步扩大资产规模。倘若保险公司不能在产品端满足客户的需要，则这种管理模式将很可能约束保险公司的发展，甚至使公司经营困难，规模萎缩。

6.3 资产导向型与负债导向型相结合的资产负债管理模式

通过比较分析，我们认为，在保险市场和金融市场尚不完善的国家和地区，保险公司采用资产导向型与负债导向型相结合的资产负债管理模式较为恰当。中国当前面临新常态这一经济发展格局，保险公司应当尽力规避资产与负债不匹配的情况，加强对投资组合的管理，同时在产品设计、业务开发时尽可能满足市场需求。在资产导向型与负债导向型相结合的资产负债管理模式下，保险公司既可以保持较快的业务增长速度，从而提升公司实力，又能够充分发挥投资分析优势，在金融产品创新的浪潮中拓宽投资渠道，保证公司收益水平。

我国保险业的实际情况与国外存在差异，因此国外成功的保险资金管理模式在我国未必适用。我们要分析国外的成功经验，提高我国保险资金运用效率，但也必须认识到各个模式在不同金融环境下的适用差异性。

中国保险业的发展道路独具特色，我国保险公司基于国际经验，在摸索中图发展，在稳健中求创新。资产负债管理模式的探索，对保险公司而言是个富有战略意义的命题，我国保险公司唯有实事求是、胆大心细，选择适合自身的管理模式，才能在新常态的格局下稳步向前。

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新常态下中国保险公司资产负债管理模式的探索

杨心悦

中央财经大学保险学院
北京102206，中国
电话: 18811386199
Email: yangxinyuemii@163.com

关键词: 新常态; 保险资金; 资产负债管理模式; 动态财务分析

中文摘要. 中国经济发展进入新常态，国务院颁布保险业改革发展“新国十条”，我国保险业所处行业环境发生巨大变革，保险资产管理迈向大资管时代。在此背景下，保险公司对于资产负债管理模式的选择将更为重要。保险公司唯有根据自身情况选择恰当的资产负债管理模式，防控风险，增加盈利，才能最终实现公司的战略目标。

本文主要分为五个部分, 我们综合运用文献研究、实证分析、模型构建和归纳演绎等方法，创新性地进行了我国保险公司在资产负债管理模式方面的探索，认为资产导向型与负债导向型相结合的资产负债管理模式在新常态的经济形势下应当得到更为广泛的应用。

文章首先系统梳理了国内外资产负债管理理论文献，总结了缺口分析法、现金流匹配、免疫、风险价值法、动态财务分析等资产负债管理方法。我们创新性地指出，在新常态的经济形势下，保险公司应当综合应用多种方法，对公司整体资产负债状况进行动态模拟与科学管理。

其次，本文在对传统保险公司资产负债管理模式深入分析的基础上，进行了负债导向型与资产导向型资产负债管理模式的横向对比。我们认为，二者都体现了资产与负债相匹配的管理思想，适用于不同的环境，并无优劣之分。保险公司在战略选择的过程中，应当具体分析行业背景，自身条件，公司发展目标等诸多因素，选择合适的管理模式，并以此确定公司的发展规划与业务流程。

随后，本文探讨并总结了国外保险公司资产负债管理模式的发展经验与启示。我国保险业的实际情况与国外存在差异，因此国外成功的保险资金管理模式

在我国未必适用。我们要分析国外的成功经验，提高我国保险资金运用效率，但也必须认识到各个模式在不同金融环境下的适用差异性。

通过比较分析，我们认为，在保险市场和金融市场尚不完善的国家和地区，保险公司采用资产导向型与负债导向型相结合的资产负债管理模式较为恰当。中国当前面临新常态这一经济发展格局，保险公司应当竭力规避资产与负债不匹配的情况，加强对投资组合的管理，同时在产品设计、业务开发时尽可能满足市场需求。中国保险业的发展道路独具特色，我国保险公司应当基于国际经验，在摸索中图发展，在稳健中求创新。

Research on the Development Strategy of Chinese Insurance Broker Company-- Based on SWOT-AHP Method

YUAN Jia, JIANG Yinghong

YUAN Jia
Graduate Student
School of Insurance
Central University of Finance and Economics
Beijing 102206, China
Phone: 18810481529
Email:18810481529@163.com

JIANG Yinghong*
Graduate Student
School of Insurance
Central University of Finance and Economics
Beijing 102206, China
Phone: 15600918259
Email: 15600918259@163.com

Keywords: insurance broker; SWOT-AHP; development strategy

Abstract: With the continuous development of the insurance industry, underwriting technology is becoming increasingly complex, and competition has become more sharp, insurance intermediary has played an important role in the insurance sales process as a professional third party,. The development of insurance broker is relatively slow due to a late start, as which has a large gap with the other agencies in number of institutions and the market share, and most of the operating income generates from the original premium business. However, in the insurance market of developed countries in Europe and America, insurance brokers play an important role in the recruitment, risk assessment and product innovation. So this article studies the development strategy of Chinese insurance broker company with the SWOT-AHP method based on the traditional SWOT strategy analysis method.

1.文献综述

1.1保险经纪市场研究

国内学术对保险经纪公司的发展战略主要集中于以下几个方面：一是将保险经纪公司纳入保险专业中介市场进行研究，如韩家川、李伟乐（2015），高舜嘉、张林涛（2008）和孙维峰、张秀娟、阴慧芳（2008）；二是从不同的方面论述保险经纪公司的发展方向，虽然出发点不同，但是得出的结论都集中于建议保险经纪公司注重吸纳人才、拓宽业务渠道、建立诚信合作，相关的文献有陈阳（2013）、张建军（2010）。

1.2 SWOT-AHP方法

韩家川、李伟乐（2015）、张建军（2010）都使用了SWOT分析法对于我国保险经纪公司发展进行了研究，但主要集中于定性研究，SWOT-AHP方法加入了层次分析法，对SWOT方法进行了改进，结合了定性分析和定量分析，适用于对多种产业进行战略分析，如地方经济发展战略（奉钦亮、覃凡丁、陈建成（2011）和林文树、周沫、吴金卓（2014））、物联网产业（高锡荣、陈玉宝、杨宇（2014））

2.中资保险经纪公司发展SWOT模型

2.1优势（S）

2.1.1少数具有大股东背景，专业化优势明显。

中资行业领先者中，许多都是行业性保险经纪公司，如2014年保费收入位列第一的华润保险经纪公司由华润集团全资持有，其业务包括日用消费品制造、基础设施、公共事业和地产等领域，带动了大量的保险业务；航联保险经纪有限公司则是由国航、南航和东方航空等13家大型国企联合投资，因此航联承保了大部分的航空保险业务；上海海宁保险经纪有限公司（原深圳海宁保险经纪有限公司）由中国海运集团承办，专业经营海上保险相关业务。除此之外，亦有靠专业化服务获取市场规模的非行业性保险经纪公司，如北京联合保险经纪有限公司，专注于教育行业风险管理，2014年的保险业务收入位列第二。

2.1.2外资进入壁垒较高,具有本土优势

截止2014年底，我国共有保险经纪公司445家，而外资参与的经纪机构不到1/20。主要原因是我国对外资从事商业保险经纪存在诸多限制。一是投资比例，外资加入时最高投资比例不能超过50%， 5年后才可设立独资公司；二是资产限制，加入首年年末，公司总资产要求为5亿美元，之后逐年降低（加入1年后要求为4亿美元，2年后为3亿美元，4年后为2亿美元）；三是地域限制，加入首年，业务经营只能在上海、广州、大连、深圳和佛山开展，加入4年后取消地域限制。

相比之下中资保险经纪公司的进入门槛比较低，在业务拓展方面受限较少，主要表现在：2013年我国保险经纪机构相比上年只增长了4家，但分支机构增设较快，比上年增长了147家，截至2013年底，我国保险经纪公司分支机构数量达861家，其中主要是中资保险经纪机构。由此可以看出中资机构短期内仍具有本土优势。

2.2劣势（W）

2.2.1缺乏专业人才，业务结构单一

从下图可以看出，保险经纪公司业务收入中原保费业务占98%，而再保险业务和咨询业务仅占2%，说明我国的保险经纪公司的经营只局限保单业务的招揽，在风险管理、保险咨询方面几乎没有发展。而实际上，国际领先的保险经纪公司如Marsh、Aon、韦莱等都是专业致力于风险管理、保险经纪和保险方案设计的公司，它们拥有先进的数据处理分析技术，同时积累了大量的风险管理经验，这些公司在中国的分支机构也凭借它们专业的技术优势占领了相当的市场份额。专业人才紧缺是我国保险行业面临的共同问题，尤其是在保险中介行业，由于保险行业进入门槛不断降低，从业人员的基本专业素质难以保证，而数据处理、信息技术方面的人才亦十分紧缺，这既不利于保险经纪公司的现有业务的发展，更会对今后拓展业务形成巨大障碍。

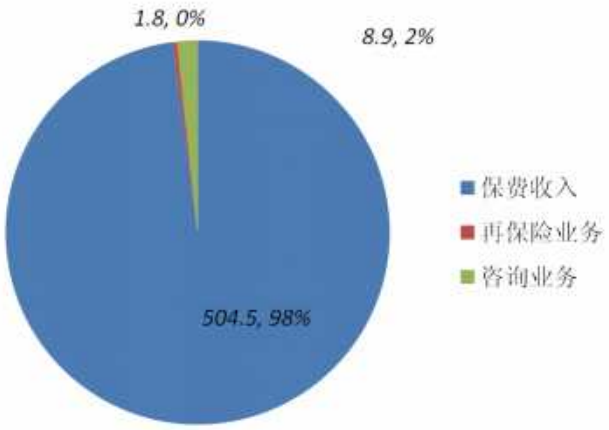


图1 2014保险经纪业务结构分布图

2.2.2 行业整体发展缓慢，呈现被边缘化趋势

2014年我国保险行业累计原保费收入20234.81亿元，通过保险专业中介机构实现保费收入1472.4亿元，占全部原保费收入的7.3%，同比增长了28.2%，而保险经纪机构实现保费收入504.5亿元，仅占全部保费收入的2.5%，与上年持平[1]。可以看出我国保险经纪机构的发展远远落后于专业中介市场的发展，市场份额一

[1] 数据来源：《中国保险年鉴》（2015）

直停滞不前，无论是在保费规模还是市场份额上保险专业代理机构都呈现较大优势，而服务模式与代理机构差异较小，因此呈现出被边缘化的趋势。

2.2.3规模较小，经营能力较弱

目前，我们国家的很多保险经纪人都卡在注册资本下限的门槛线上，大多数公司的注册资本都在0.5~2千万之间，因此大多数公司的规模都很小，难以招揽到大客户。同时由于寿险业务严重萎缩（2013年下降32.64%），财险业务增长速度虽然增长13%，但与专业代理机构（43%）相比，差距较大，说明我国保险经纪公司经营稳定性欠佳。

2.3机遇（O）

2.3.1宏观环境良好

政策方面，国家高度重视保险业的发展，从“国十条”开始明确保险在国计民生中的重要地位后，又连续出台了多项利于商业保险发展的政策，包括放开万能险最低保证利率、商车费改全面试点和商业健康保险个税优惠等，都为商业保险的发展打开了市场化的大门，保险经纪公司无疑将获益于保险市场的发展。

2.3.2市场需求不断增加

从现实状况来看，随着我国人口老龄化加剧，养老成本逐步增加，使年金、终身寿险的需求量增加；癌症等大病的年轻化与心血管疾病、高血压等慢性病的普遍化使大病保险、各类防癌类保险需求量增加；长期护理保险、收入保险、信用保证保险将来也是需求量很大的产品类型，因此长期看来市场需求量会不断增加；另一方面随着保险产品多元化、产品定价市场化发展，市场上的保险产品将呈现多样化趋势，对产品的选择问题将越来越需要由专业保险中介来解决，因此保险经纪公司应该抓住机遇，发展专业化的保险方案策划服务。

2.3.3创新经营模式

互联网时代几乎颠覆了人们的生活方式，也颠覆了传统的经营模式，在十几年前一个保险公司要想积累上万客户量往往需要数年的时间加上许多营销员的不断努力，然而现在一个优秀的公众号在短时间内就可以获得几十万人的关注。对我国保险经纪公司来说，可利用互联网发展网络保险平台，以第三方的形式连接客户与众多保险产品，发挥保险中介的职能，如英大长安保险经纪公司旗下的网络保险平台——长安e家，为客户提供保险产品比价、网上购买、免费体检、保险规划和维权等售前售后服务，值得中小型保险经纪公司学习推广。

2.4挑战（T）

2.4.1替代品威胁

就目前保险经纪公司的主营业务原保费业务来说，保险经纪服务面临多种替代产品的挑战。首先专业中介市场中保险经纪公司最大的竞争者是保险专业代理机构，2014年，全国保险专业代理机构实现代理保费收入967.9亿元，同比

增长34.7%，占全国总保费收入的4.8%，；全国保险经纪人实现保费收入504.5亿元，同比增长17.2%，占全国总保费收入的2.5%，与上年持平。可以看出，无论是在保费收入规模还是在增长率上，保险代理人都远远超过保险经纪人。其次，以银邮类机构、汽车企业和运输类机构为主要代表的保险兼业代理机构所代理的保费占据了很大的份额（2013年占总保费34.19%），虽然增长速度有所放缓，但留给保险经纪公司，但依然形成了较强的替代效应。最后，各类网络保险产品比价平台如慧择网和保险公司的网上直销平台也会对保险代理业务产生影响。

2.4.2来自外资保险经纪公司的挑战

目前参与我国保险经纪市场外资不多，但是凭借其专业的技术水平和人才优势，如达信、韦莱、中怡等保险经纪公司牢牢把握住了市场上的中高端客户，对中资公司来说，想要突破中高端市场比较困难，同时随着2014年国家发改委开始就《外商投资产业指导目录》进行修订，我国将逐渐放开外资对保险经纪公司的投资，市场的开放必将引起更加激烈的竞争，中资保险经纪公司的经营将会更加艰难。

2.4.3与保险公司的合作瓶颈

保险经纪公司要发展原保费业务，与保险公司的合作至关重要，但是其中还存在着很多问题。首先保险经纪人与保险公司发展的步调并不一致，在很多保险公司已经在全国范围内建立起庞大的销售网络之后，保险经纪人才开始发展，这样保险经纪人已经无法再为保险公司节省更多成本；其次在营销模式方面，保险经纪人的代理模式创新力也不足，所以从现实情况来看，我国保险经纪公司处于明显的劣势。

3.可选择发展策略

3.1 SO策略

SO策略结合了优势与机会，即要抓住外部机会发挥自身优势进行发展。行业性保险经纪公司除了发展股东业务以外，还应该利用自身的资源优势，多元化发展以扩大业务规模，具体来说先以横向并购为主，在保险经纪行业内部进行整合，减少现有的对手数量，提高行业整体水平；接着在整个中介市场中进行混合并购，吸收优秀的代理资源和销售人才，组建综合的保险中介集团；最后立足于整个国际市场，近年来国内已经有许多行业都开始着手进行国际并购，未来几年实力强劲的中资保险经纪公司完全有可能通过兼并外资保险经纪公司来打开海外市场，提升中国保险经纪人的国际影响力。而规模较小的保险经纪公司则应借助良好的市场发展趋势，在提高营业收入的同时，加强公司治理，控制经营成本，扩展分支机构以在更大的范围内形成规模效应。

3.2 WO策略

WO策略是机会与劣势相结合的策略，当企业在面对某些市场机会，如互联网保险平台时，由于缺乏相关的技术人才或准入资格，即不具备相关的资源优势，就难以抢占先机。因此在针对经营创新问题时，可以考虑以合作方式进行交叉销售，或者以参与或者购买的形式进入互联网平台的经营；在面对团体客户或者具有长期合作潜力的客户时，可以采取收取更优惠的手续费的形式增加对客户的吸引力，并且在保险理赔和客户维权方面提高售后服务质量以加强客户黏性。

3.3 ST策略

ST策略用于以内部的优势减轻外部的威胁，首先对于行业性保险经纪公司来说，由于其股东背景和资源优势，其余的保险代理机构较难瓜分他们的主要业务，如英大长安的电网业务、航联的航空保险业务等。然而行业性保险经纪公司只占少数，大多数保险经纪公司都是非行业性公司，且规模小，业务结构较差，更容易受到替代品的威胁。同时外资保险经纪公司主要看中的是我国的中高端市场，在风险管理和保险咨询方面的业务较多，我国的保险经纪公司的优势难以发挥作用。

3.4 WT策略

WT策略采取的是主动减轻内部的劣势，同时规避外部威胁的方法。保险经纪公司应从以下几个方面减少劣势：一是积累专业人才，作为知识密集型行业，实现专业化、差异化经营是避免与个人代理人、专业代理人和代理机构同质化经营的最有效的可持续发展道路。保险经纪人应该具有比保险代理人更高的专业素质，除了熟悉市场行情、风险控制以外，还要具有一定的精算知识，具备为投保人制定合适的保险方案，为客户进行风险评估，制定理财规划的能力。因此保险经纪人应从加强自身的修炼开始，不断创新，向专业化发展；二是要重视宣传，提高社会认知度。在规避威胁方面，应增增强自身实力吸引保险公司。双方合作需要以诚信为基础，由于缺乏严格的监督制度，保险经纪人在合作中经常出现一些违规操作。因此保险经纪人应做到“中立”，不偏袒任何一方，对投保人和保险人都要诚信以待，以保障保险主体双方的利益。

4.中资保险经纪公司战略发展的SWOT-AHP模型

按照层次分析法将中资保险经纪公司的优势（S）、劣势（W）、机会（O）挑战（T）构建出各指标的层次结构如图所示

表1　　中资保险经纪公司战略SWOT层次结构

系统层		变量层
中资保险经纪公司战略SWOT分析	优势（S）	少数具有大股东背景，专业优势明显（S1）
		外资进入壁垒较高，具有本土优势（S2）
	劣势（W）	缺乏专业人才，业务结构单一（W1）
		行业整体发展缓慢，呈现出被边缘化趋势（W2）
		规模较小，经营能力较弱（W3）
	机会（O）	宏观环境良好（O1）
		市场需求不断增加（O2）
		创新经营模式（O3）
	挑战（T）	替代产品威胁（T1）
		来自外资保险经纪公司的挑战（T2）
		与保险公司的合作瓶颈（T3）

接下来利用“yaahp”软件根据决策目标、中间层要素和备选方案建立层次结构模型，如下图所示

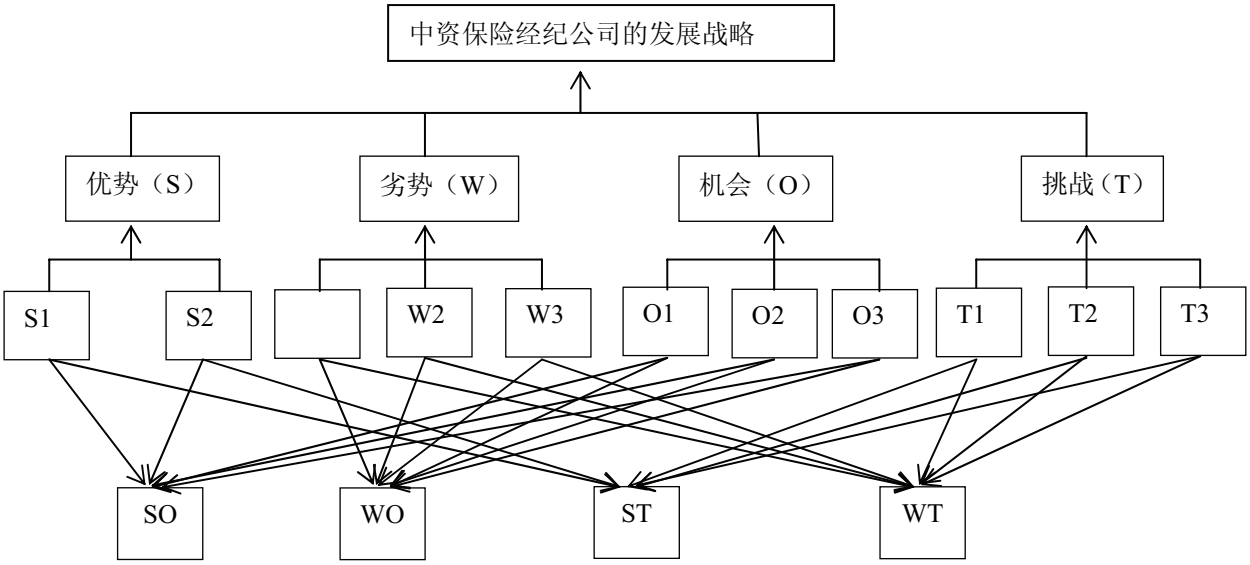


图2 中资保险经纪公司战略决策层次结构模型

通过对不同层次结构的比较矩阵进行打分，并经过CR一致性判断，当一致性比例小于0.1时，通常被认为通过了一致性检验，首先将S、W、O、T两两对比，通过在“同样重要”、“十分重要”、“比较重要”、“稍微重要”、“绝对重要”中进行选择，获得这四个因素的判断矩阵，并通过一致性检验

表2　　组间判断矩阵

一致性比例：0.0039；对"中资保险经纪公司发展战略"的权重：1.0000

发展战略	优势（S）	机会（O）	劣势（W）	挑战（T）	Wi
优势（S）	1.0000	0.5000	0.3333	0.5000	0.1223
机会（O）	2.0000	1.0000	0.5000	1.0000	0.2270
劣势（W）	3.0000	2.0000	1.0000	2.0000	0.4236
挑战（T）	2.0000	1.0000	0.5000	1.0000	0.2270

接着再构造出优势、劣势、机会、挑战四组的判断矩阵以及每个因素的权重（Wi）。

表3 优势组的判断矩阵

优势（S）一致性比例：0.0000；对"中资保险经纪公司发展战略"的权重：0.1223；

优势（S）	s1	s2	Wi
s1	1.0000	0.2500	0.2000
s2	4.0000	1.0000	0.8000

表4 劣势组的判断矩阵

劣势（W） 一致性比例：0.0516；对"中资保险经纪公司发展战略"的权重：0.4236；

劣势（W）	W1	W2	W3	Wi
W1	1.0000	3.0000	2.0000	0.5278
W2	0.3333	1.0000	0.3333	0.1396
W3	0.5000	3.0000	1.0000	0.3325

表5 机会组的判断矩阵

机会（O）一致性比例：0.0825；对"中资保险经纪公司发展战略"的权重：0.2270；

机会（O）	O1	O2	O3	Wi
O1	1.0000	0.2000	0.2500	0.0936
O2	5.0000	1.0000	3.0000	0.6267
O3	4.0000	0.3333	1.0000	0.2797

表6　　挑战组的判断矩阵

挑战（T）一致性比例：0.0370；对"中资保险经纪公司发展战略"的权重：0.2270；

挑战（T）	T1	T2	T3	Wi
T1	1.0000	5.0000	3.0000	0.6370
T2	0.2000	1.0000	0.3333	0.1047
T3	0.3333	3.0000	1.0000	0.2583

最后计算出四种备选方案（SO、WO、ST、WT）各自的权重，得出以下结果，如表7所示，也就是说中资保险经纪公司的战略选择为：WT策略>WO策略>SO策略>ST策略。（“>”意味着“优于”）

表7　　方案层中要素对决策目标的排序权重

备选方案	权重
WT	0.3205
WO	0.2729
SO	0.2323
ST	0.1743

5.结论

本文首先对我国保险经纪公司分析了其自身的优势、劣势，以及面临的挑战和机遇，得出了相应的四个备选战略方向，并通过AHP软件进行因素比较分析，从结果可以看出，由于优势并不明显，同时面临的威胁和挑战较多，目前我国中资保险经纪公司在行业环境中处于劣势状态。其发展战略应该优先选择劣势-威胁策略（WT策略）和劣势-机会策略（WO策略）。所以保险经纪公司应该主动克服自身劣势，把握市场机遇，加强与保险机构的合作，在现有业务基础上不断扩大市场份额和业务范围。

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中资保险经纪公司发展战略研究
——基于SWOT-AHP方法

袁嘉 姜缨红

袁嘉
研究生
中央财经大学保险学院
北京102206，中国
电话：18810481529
Email: 18810481529@163.com

姜缨红*
研究生
中央财经大学保险学院
北京102206，中国
电话：15600918259
Email: 15600918259@163.com

关键词：保险经纪公司；SWOT-AHP；战略分析

中文摘要：随着保险业的不断发展，承保技术日趋复杂化，竞争也日趋尖锐化，保险中介作为专业的第三方，在保险的销售过程起到了重要作用。保险经纪公司作为专业保险中介的“后起之秀”发展相对缓慢，不仅大部分营业收入来自原保费业务，而且无论是在机构数量还是在市场份额方面都与其他代理机构有着较大差距。反观欧美发达国家的保险市场，保险经纪人在业务招揽、风险评估、产品创新方面都有不可代替的作用。因此本文运用SWOT-AHP方法，在传统SWOT战略分析方法基础上，加入定量条件，对我国保险经纪公司的发展战略进行研究。

Discussion on the Insurance Model of Folk Capital Participate in the Transformation of Scientific and Technological Achievements Financing

ZHANG Daijun, BAO Beilu

ZHANG Daijun
Professor
Zhejiang University of Finance & Economic
Hangzhou 310018,China
Phone:(0571)87557108
Email:zdj0303@126.com

BAO Beilu
Graduate Student
Zhejiang University of Finance & Economic
Hangzhou 310018,China
Phone:17816854340
Email:372573630@qq.com

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Abstract. Firstly this paper expounds the scale and characteristics of folk capital, and then using the financial and insurance theory interpretation of scientific and technological achievements into the theoretical mechanism of financing, respectively from the folk capital supply and technology achievements transformation financing needs two angle analysis both the supply and demand relationship and preconditions. Also according to the financing and insurance demand early in the scientific and technological achievements transformation, given subsidies from the government science and technology enterprises in its performance and the key high-tech enterprises project financing insurance pricing investigation, empirical and Simulation in the enlightenment and guiding ideology, infrastructure, investment fund and the compensation fund, rights and interests of safeguard measures, the convertible premium and expand the scope of services and give private capital involved in transformation of scientific and technological achievements and suggestion of the goal of financial and insurance services.

1. 民间资金参与科技成果转化融资可行性分析

1.1 民间资金概述

何谓民间资金，目前人们对它并没有给出一个较为一致性的表述。如果仅仅基于货币资金的层面来量化国家或地区民间资金，通常的做法是依据普遍认同的金融与经济的相关性指标，再由已知官方统计出的货币基金供给量和GDP指标推出为GDP贡献的民间资金的规模。当然不同的统计口径所计量的民间资金规模也有所不同。例如，2015年温州民间资金的规模有说700亿左右，有说1100亿左右。无论如何统计或计量的规模有多大，没有纳入国家正规金融统计范围的货币资金是一种现实存在，目前也没有一个精确的计量手段统计出民间资金的规模到底有多大。据现有的研究结果，正规金融越发的，民间资金活动的空间就越小。反之，正规金融越落后，民间资金活动的空间就越大。不可否认的是民间资金活动游离于正规金融体系之外所形成的融资功能是对正规金融应发挥的融资功能的一种替代，包括其自身循环所可能形成“派生存款”的效应。显然，民间资金的何去何从对社会经济发展的影响是不可忽视的。

民间资金活动自身具有根植性、趋利性、无序性等特征。所谓正规金融制度也都是由民间金融活动逐步养生而成的，没有天生的正规金融。但现实中，并不存在完美的正规金融体系，民间金融活动也并非天然的排斥正规金融。认知局限是人类社会系统性风险，信息不对称不可能借助现实的金融制度完全消除，但在相对有限的区域内融资双方知根知底具有一定的先天优势，因此姻缘、血缘、亲缘或邻里之间形成的借贷、众筹或互助等融资方式存在一定的信用基础，这方面体现了民间资金活动具有一定的根植性特征。正规金融准入或服务体系难以全面覆盖社会经济的各领域，同时正规金融也面临脱媒金融活动的挑战，民间资金活动的趋利性可以通过其众所周知的规避金融监管的金融冒险或创新活动的典型事例得以印证。民间资金活动相对于国家长远发展而言，比较注重短期投融资效益，急功近利的心态比较重，追逐社会投资时尚或热点，且在货币市场或资本市场上呈现较显著的羊群效应，总体上会形成一种无序性的特征。

1.2 科技成果转化及其融资需求

所谓科技成果转化是科学发现与技术发明的成果转化为现实生产力的经营管理活动，它不仅有助于企业形成增效的核心驱动力，同时也是一国或地区经济实现可持续发展或转型升级的驱动力。科技成果走出实验室能否转化成功虽然受到企业经营管理理念与能力、有关科技政策、组织服务体系、科技成果转化机制、转化方式与途径以及转化过程中的目标设定等诸多方面的制约。不可否认的是，由于科技型其轻资产或无法达到传统金融准入资质要求的条件，科技资源与金融资源两者的有效深度融是制约科技成果成功转化最主要的原因之一。企业科技成果转化需要一定的软件和硬件的投入。鉴于科技创新的特殊性，科技成果转化期

间，其人员和相关设施等方面的科技投入几乎没有什么可以借鉴的经验，而且人员开支和设备购置安装等方面的投资金额相对较大，如果不实施成果转化，前期研发投入或技术市场转让的支出将变成沉淀成本，如果实施转化又面临资金不足的窘境。从另一个角度讲，由于科技成果转化过程不确定性，风投或私募资金也会顾忌科技成果转化金融市场建设的滞后性或不完备性，有力投而心生恐惧，因此也会形成科技成果转化融资需求的缺口。另外，科技创新外部性是科技成果转化要求政策引导或扶持的合理诉求，相关政策制定的滞后性或不完备性，也会导致科技成果转化需求得不到应有的满足。

1.3民间资金与科技成果转化融资两者之间的供求关系

民间资金在融入社会经济活动中除了所具有的根植性、趋利性和无序性的一般特征之外，不同类型的民间资金的融资活动也存在一定程度的个性化特征，由传统的用于“养儿防老”或“婚丧嫁娶”到现代的小额贷款、P2P、众筹、融资担保、保理等民间金融方式，不同的民间资金活动方式，无论出于何种目的，注重民间财富管理将成为民间资金的主旋律。理好财，理好社会民众的每一分钱，追求优化现金流，实现财务自由化无疑成为现代人财富管理的最终目标。科技成果转化是营造企业发展核心驱动力，是社会财富创造的第一推动力。因此，满足科技成果转化融资，实现企业或个人财富倍增，这和民间资金所追求的目标是一致的。从现实中民间资金活动的总体趋势上来看，更多的民间资金与满足中小企业融资需求相对应，似乎人们普遍认为民间资金与中小企业融资需求“门当户对”，主张动员民间资金参与设立民间金融服务组织，专注于服务地方小微企业，切实解决民间金融“两难”问题。但是，民间资金和小微企业两者同正规金融及其服务对象相比较，均存在相对的先天不足，若缺乏正确引导，两者相互之间的融合难免产生“怪胎”。引导民间资金参与科技成果转化融资，尤其是参与小微企业科技成果转化融资是切实解决小薇企业融资“两难”问题着力点和有效举措，它不仅有助于融资双方共享科技成果转化所取得的成效，同时也有助于明确民间资金融资取向，满足其趋利性要求，克服民间资金活动无序性的弱点，无疑也是一项利国利民的正确引导。

科技与金融的深度融合不仅仅是有助于社会财富增长效应，同时也是社会治理优化的有效途径。科技成果转化融资是科技金融重要组成部分，其正的外部性已形成共识。另外，科技创新活动不同于一般的随机事件，本身活动缺乏可资鉴成熟经验，对其风险管理要求较高，而民间金融主体通常也不具有对其风险管控的认识水平与能力，因此如果科技金融服务体系不够健全和政府引导或扶持政策力度不够，民间资金与科技成果转化融资的对接会存在难于逾越的鸿沟。

2. 科技成果转化融资保险的理论机理与实证启示

2.1 理论机理

所谓科技成果转化融资风险是指基于科技成果转化融资过程的视角来审视所面临或承担的所有风险，这些风险并不包括科技活动全过程中的所有风险。科技成果转化融资风险在一定程度上又与科技企业自身运作、战略管理、财务、政策法规以及灾害风险息息相关。因此解决科技型中小企业成果转化过程中的融资问题，有必要认清科技成果走出实验室到正式投产运营过程中所存在的科技风险。

科技成果转化融资保险是保险机制介入满足科技成果转化过程融资需求的一类科技保险活动。根据融资方式划分可以将其分为信贷融资保险、债权融资保险、股权融资保险及其衍生融资保险。目前国内试点推行的中小企业贷款保证保险正是融资保险服务中最基本的典型模式。在科技成果研发初级阶段，不确定性相对较大，不太适合可保风险的要求。在科技成果走出实验室之前的融资需求可以利用内源融资方式或借助天使投资或风投模式来实现。走出实验室或经过专家评估验的科技成果要比其研制的初期阶段更可靠一些，其转化的风险相对会低一些。然而，这并不能说明这一阶段就适合保险机制介入。因为在这里我们有必要清楚的认识到科技成果转化的外部性和相应的政策导向性，或者说这里所说的融资保险属于科技保险范畴，其政策属性已被学界广泛认同。只有政府在科技成果转化引导政策落实到位，包括保险公司在内的融资保险其他主体方能权衡是否可以参与其中。

由金融在企业资源配置中特殊地位，意味着科技成果转化融资保险注定是科技成果转化保险中不可忽视的重要内容。科技成果转化过程中或许没有外部融资主体介入，也就不存在外部融资组织介入的融资保险问题了。但从广义的层面，科技成果转化失败，必然会导致内源融资或外源融资主体的经济损失。因此，这里的科技成果转化融资保险是科技成果转化保险的核心，甚至是其全部。从狭义的层面来认识，科技成果转化融资是涉及科技型企业、银行或社会资本或其它金融机构、保险等相关资源的相互融合，是“科、投、贷、保”相互联动的一种创新融资服务模式，是风险、收益、损失在社会经济中得到更加合理的分配或分摊。因此，科技成果转化融资所承保的风险是包括政府在内的所有相关主体在合理扮演好各自角色的基础上保险公司愿意承保的风险。显然，我们这里所说的融资保险所承保的风险并非科技成果转化所面临的所有风险，他所扮演的真正角色就是借助现代保险服务技术促进科技成果转化融资风险得到更合理、更有效的集中、分散或损失分摊，以及融资与防损等保险衍生职能的有效发挥。

2.2 实证启示

为深入了解科技型中小企业风险暴露情况，作者组织走访杭州高新园区，对科技型中小企业开展《关于科技成果转化融资保险问题问卷调查》，其中一部分是关于科技成果转化企业科技风险认知情况调查。本次问卷共涉及8个行业，129家中小科技型企业，将各种风险的重要程度和发生频率的得分，分别从高到低排序，就得到了风险重要程度排序和风险发生频率排序，调查结果显示：风险的重要程度和发生频率都处于较高水平、财务风险突出、科技成果转化过程中面临着更多的是关键技术泄密风险、知识侵权风险、数据损失或损毁风险等无形资产相关的风险。再根据调查结果得出的风险的重要程度及风险发生频率，筛选整合科技成果转化过程战略风险、运作风险、政策法律风险、财务风险、灾害风险这5大类风险中起主要作用的几小类风险作为融资风险与科技保险内在联系结构分析的观测变量，运用结构方程实证分析方法，验证科技型中小企业成果转化对其融资保险需求有何依赖，实证结果显示：除战略风险和灾害风险外，科技成果转化过程中的其他各类风险与科技保险需求都具有正向关联、科技保险对战略风险及灾害风险不具备统计上的显著性、利率变化对科技型中小企业财务的影响是财务风险中最为重大和显著的。

为明确政府补贴与科技型企业经济与社会效益的关系，以在创业板上市的268家被认定为高新技术企业的企业为样本，设置了入产出指标体系，利用数学包络方法出样本企业的综合效率值和纯技术效率值，发现综合效率有效的企业不足10%。对纯技术有效和纯技术无效的企业进行Logistic回归，研究发现政府补助比重对企业绩效有着显著的正向促进作用。同时，企业总资产规模对其绩效有显著正面影响，而企业国有持股比重对绩效有显著负面影响。另外，企业规模和所处地区会影响政府补助的效果。因此，政府应继续加大对高新技术企业的扶持和资助，同时在考虑具体投向时，应注意企业规模、所有制和所处地区等因素的影响。

融资项目损失保险是对科技保险产品的一种丰富和创新，能够满足高新技术企业对于融资项目保险的需求。本文通过收集重点高新技术企业融资项目投资损失次数和损失额度的具体数据作为实证研究的对象。通过文献和精算的相关知识选择合适的保险费率计算模型，从而计算出重点高新技术企业融资项目损失保险的保费。并且，在整个实证研究过程和最终计算结果的基础上，提出一些促进科技保险创新推广的对策建议。

3. 民间资金参与科技成果转化融资保险目标模式的选择

3.1 指导思想

由理论分析和调查实证结果可清楚的认识到民间资金参与科技成果转化融资保险并非属于个体的或孤立的问题，是涉及民间资金融资主体、科技成果转化

主体、银行等金融中介、保险机构、政府等多个主体，其目标模式的选择，需遵循权责匹配或风险、收益或损失合理配置的基本原则，构建民间资金参与科技成果转化融资保险目标模式。

民间资金参与科技成果转化融资保险服务体制机制建设问题是科技资源、金融资源和保险资源深度融合的具体体现，是满足推进企业创新发展的融资需求，是实现财富倍增的安全网和稳定器，是形成与提升经济社会核心驱动力重要举措，更是引导民间资金阳光化、规范化的融入“双创”的发展浪潮，是营造让创新成果惠及民众的社会经济治理的有效模式。

3.2 基础建设

政府搭台建立和完善科技成果转化项目信息库和科学技术交易市场，建立科技成果转化融资保险项目运行情况信息发布和相关信息的管理制度；建立健全专家项目评审制度，确认可转化科技成果入库条件、验收规程和入库成果的审定；建立融资中介、保险等科技成果转化融资协商制度，共同确认科技成果转化融资保险项目的融资条件和核保标准，并拥有最终确认科技成果转化融资保险项目一票否决权。相关主体要形成常态化的沟通机制和建立纠纷调节机制。要鼓励建立融资保险战略同盟，优化科技成果转化融资服务流程，提升服务效率。

明确针对民间融资主体参与科技成果转化融资保险项目补贴对象、类型和补贴标准。建立民间资金参与科技成果转化融资备案制度，维护好民间融资主体合乎法规的应得权益。

3.3 投资基金的设立

设立适合民间资金参与科技成果转化投资基金，根据不同民间投资主体风险偏好和财富管理目标要求，推出由股权、基金、债权及其衍生科技金融产品设立不同科技成果转化融资产品组合，供民间融资主体选择。注重开发优先股或其他适合保守型民间投资主体的科技金融产品。对由企业承担的保费部分，可以利用期权方式面向风险偏好高的民间投资主体进行融资。

3.4 补偿基金的设立

在政府设立的科技成果转化引导基金中设立一项有关民间资金参与科技成果转化融资保险服务补偿基金。对参与科技成果转化融资保险服务的保险机构，在业务上要单独核算，运用超赔再保险方式，进行分层赔款补偿设计，对超过一定赔付率或超过一定金额的保险赔款由政府所设立的补偿基金按照实现确定的比例予以补偿。

3.5 权益维护的保障措施

针对自然人和小微科技型企业民间融资主体适当给予一定倾斜政策，在制度设计上要有防止相对弱势的民间融资主体利益不被侵犯的相关规则。

对实施科技成果转化融资保险服务项目保费补贴方面，要有理有据，既要符合相关融资保险企业的客观要求，也要通过制度设计挤出企业寻租政府或政府绑架企业的空间。同时也要借助共保机制，强化企业风险管理意识，提升企业风险管控能力。

3.6 创新“可转化保费”保险制度模式

根据企业科技成果转化中的财务轻资产特点和现金流相对不足的实际情况，由企业承担的保费除了借助证券化方式由民间投资主体投资外，这方面的理念也可以在企业与保险公司双方关系的建立上得以贯彻，即保险公司在企业投保时可以对其所应缴纳的保费暂时不交或少交为代价获得企业一份债权或期权，在科技成果转化期间发生保险事故，保险公司将履行理赔义务，科技成果转化成功之后企业需要要根据实现承诺支付保费对应的本金和利息或给予保险公司一定数量的股份。

3.7 拓展服务范围夯实保险定价基础

为突破地方科技成果转化融资保险项目总体数量过少的局限性，需要通过跨行政区域联合推广，夯实保险定价基础，在条件比较好的地区可建立科技成果转化融资保险服务专门机构或组建相关主体发展战略同盟，并赋予将民间资金参与科技成果转化融资相关业务做精做实，做出成效。

4. 对策与建议

4.1 建立和完善政策法规

政府在科技成果转化融资保险服务体系建设中具有不可替代的作用。政府如何在具体运作模式选择与运行中履行好自己的职责，主动处理好政府与市场的关系，在其相关领域必须制定科学、合理、可行的政策举措和相应的制度保证。政策法规的建设与完善将有助于政府有限资源更加有效地服务与科技、金融、保险资源的有效融合，使得借助现代保险服务治理科技创新活动有根有据。同时，可利用制度约束力，阻止那些想以科技成果转化的名义套期公共资源的行为。

4.2 建立和完善科技成果转化融资保险服务项目评估体系

科技成果是否能够被专家认同是民间资金参与科技成果转化融资保险服务模式的形成与发展重要前提。不同领域的科技成果转化融资保险项目，必须有相关领域科技专家、金融与保险专家形成的评估团队来讨论确认是否适合融资保险项目中的可转化科技成果。对相对比较成熟的科研项目，应有专业权威的认证标准。对一些尚不具备统一认证口径的科技成果,对其基础性或创新平台的相关指标也需通过专家团队把好关、负好责。

4.3 做好人才队伍和诚信建设

高新技术领域的发展，关键是“高人”的形成与发展。谁赢得了科技成果转化融资保险服务领域的“高人”，谁就拥有超越他人的先发优势，往往也是不可替代的优势，即“高人”在哪里，优势就在那里。所谓高人，并不一定意味是多么高的学历背景，主要在科技、金融、保险领域有理论功底、有实务经验、有良好业绩表现、有口碑的优秀人员，都可以视为相关领域中的“高人”或者说是与众不同的特殊人才。注重培养、引进、用好科技、金融与保险人才，树立德艺双馨的标榜，营造尊重科学和实效的科技创新氛围，要将人才队伍和诚信建设视为创新发展主体的生命，而不仅仅视为可以开发利用的资源。

4.4 不断探索创新模式和注重推广成熟经验

科技创新社会发展永恒的主题。科技、金融、保险资源融合发展受限于人们认知的局限。随着对传统与新知识不断的融合以及认知技术和能力的不断提升，更加具有契合行的科技成果转化融资保险服务发展规律被认知、被发现，相应的创新模式也会不断涌现。基于保险大数法则的保险生存之根、发展之本，客观上需要对人们形成共识的科技成果转化融资保险服务模式予以推广，并在推广中对其不断完善。

5.结语

2015年5月1日国内开始实施存款保险制度、国内硅谷中关村信用评估机构针对关于科技型企业轻资产特点给出的融资资质的信用评级标准和国内宁波等地区推行的中小企业贷款保证保险以及2016《政府工作报告》明确提出，要实现成套设备出口融资保险应保尽保，在十三五发展规划中强调要加快国内保险再保险发展。用好保险资源正当时。将现代保险风险管理技术、风险保障和融资功能在民间资金参与科技成果转化融资领域得意充分发挥，是时代对现代保险服务的呼唤，是国内保险业实现经济效益和履行社会责任的必然选择。在现代保险创新发展中既要注重发挥保险自身固有的服务功效，也要力求保险服务创新发展经久不衰。

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民间资金参与科技成果转化融资保险服务模式的探讨

张代军 包蓓露

张代军
教授
浙江财经大学金融学院
杭州30018，中国
电话: (0571) 87557108
Email: zdj0303@126.com.

包蓓露
硕士生
浙江财经大学金融学院
杭州30018，中国
电话: (0571)87557108
Email: 372573630@qq.com

摘要：阐述民间资金规模及特点，分别从民间资金供给和科技成果转化融资需求两个角度分析两者供求关系建立可能性和前提条件，运用金融及保险相关理论诠释科技成果转化融资保险深度融合的理论机理，根据前期有关科技成果转化融资与保险需求、政府补贴科技型企业与其绩效及重点高新企业项目融资保险定价相关调查、实证或模拟结果所给出的启示，并就指导思想、基础建设、投资基金和补偿基金设立、权益维护保障措施、可转换保费及服务范围拓展等方面给出民间资金参与科技成果转化融资保险服务的目标模式及其相关建议。

关键词：民间资金；科技成果转化；融资保险

The Mode Analysis of S&T Achievements Transformation Insurance Leading Fund

ZHANG Daijun，LIU Xinlong

ZHANG Daijun
Professor
School of finance, Zhejiang University of Finance and Economics
Hangzhou 310018, China
Phone: (0571)87557108
Email: zdj0303@126.com.

LIU Xinlong
Master Candidate
School of finance, Zhejiang University of Finance and Economics
Hangzhou 310018, China
Phone:15869145498
Email:lxl458838418@163.com

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Abstract: In recent years, our country is facing the difficulty of industrial restructure while economic development entered bottleneck and technological innovation is becoming a important power to stimulate national economic. But there are a series of problems in the process of technological innovation so that many science and technology enterprises can hardly get loans from banks. In August 13,2015 China State Council issued “Some opinions on accelerating the development of modern insurance services”(“Insurance state ten” for short) which proposed definitely Insurance will play an important role. Technological innovation has the characteristics of high-risk, which has a natural combination with the function of insurance. However, insurance has not play a part in every stage of S&T achievements transformation because small science and technology enterprises have huge financial pressures and business owners are not aware of such insurance. This article proposes a guidance

fund for S&T achievements transformation insurance(hereinafter to be referred as "the Fund") in order to further protect business owners' rights and interests. It bases on government guidance and private capital's participation ,and equipped the professional risk management techniques of insurance companies. It aims at declining business owners' risks when they failed in the process of by S&T achievements transformation because the insurance can spread risks to the whole society so that it can reduce the influence of Market Failures. Meanwhile, if a science and technology enterprise have been insured, the insurance will reduce the loss which caused by the failure of S&T achievements transformation and make the company easier to gain loan from banks.

At first, this paper analyses the Fund's organizational structure and mechanism which involve the necessity and disadvantages of government investment; if insurance companies take part in it will increase efficiency; designing "transformable premium"(premium exchanges stocks when S&T achievements transformation is achieved);how to attract private capitals and etc. And I analyse venture capitalists' expected return by setting three endings which are publicly listed, being merged and bankruptcy liquidation. Otherwise, in empirical aspect, this paper builds random effects model to analyse if insurance plays a role in S&T achievements transformation can promote success rate, and makes the conclusion compare with uninsured companies. Finally ,exploring the utility change between building the Fund and only venture capital investment leading fund based on above conclusion.

1. 引言

伴随着我国产业结构的进一步转型升级，科技类企业的发展逐渐受到了全社会的关注和重视。自2006年《国家中长期科学和技术发展规划纲要》等文件发布以来，国务院又继续出台了一系列政策支持和引导民间的科技产品研发和转化，其中就包括了设立创业投资引导基金和科技成果转化引导基金等政策性基金。然而，科技类企业以其独有的特性，导致此类基金并不能完全满足此类企业的需要。因为科技成果转化融资相较于其他项目融资具有更高的风险，导致此类融资一直难以吸引到更多的民间资金参与，相比于大量的科技成果转化融资需求，基金的使用一直处于捉襟见肘的状态。根据实际调查发现，多数科技型中小企业获得的贷款融资远远达不到自身的需求水平。科技型中小企业难以获得科技成果转化融资，使得很多优质成果无法转化或不能成功转化为切实的提高国民经济水平和社会生产力的产品。而对科技型企业投保可以大大分散和降低其在科技创新活动中的风险。本文着重研究了以科技成果转化融资为标的的信用保证保险，并借鉴科技成果转化引导基金的组织结构及其运作机制，探讨设立科技成果转化融资保险引导基金的组织结构，并通过模型分析该基金如何吸引民间资本融资。以期对现实中的科技成果转化融资保险发展有所启发。

2. 科技成果转化引导基金发展概况

2.1 科技成果转化引导基金成立背景

科技成果转化引导基金在为中小企业提供资金支持方面得到了广泛的认同和研究。创业投资不仅为高科技迅速、高效地实现产业化提供了及时而有力的资金支持，而且已经成为各国经济实现快速与可持续发展不可或缺的重要力量。通过设立引导基金，支持本国高新科技与战略新兴行业的科技成果转化转化，已经被众多国家采用实施。国发2006[6]号文件《国家中长期科学和技术发展规划纲要》中明确提出，支持鼓励企业成为科技创新主体。为贯彻落实这一发展方针，财政部、科技部联合设立了国家科技成果转化引导基金，并号召地方设立下级基金，旨在充分发挥财政资金的杠杆和引导作用，带动民间资本对科技成果转化投融资热情，完善投融资体系。引导基金遵循“引导性、间接性、非营利性、市场化”原则，主要用于支持转化利用财政资金形成的科技成果。

2.2 科技成果转化引导基金的制度设计

国家科技成果转化引导基金引导基金是由科技部与财政部牵头成立，并对基金运作过程中的发展方向及各项制度进行规划。其作为“母基金”，自身并不进行投资，其主要作用是引导社会资金进入转化投资领域，其支持科技成果转化的方式主要依靠设立创业投资子基金、贷款风险补偿和绩效奖励等。引导基金下分基

金理事会以及委托管理机构。理事会主要负责进行基金日常运作过程中的各个事项进行审议和决策，其下又有秘书处负责理事会日常工作；委托管理机构则负责基金的日常管理工作，主要包括基金设立申请的受理以及托管银行招标等。

2.3 我国科技成果转化引导基金发展情况

科技成果转化引导基金在我国发展时间较短，导致各地基金普遍规模较小。而且受地方经济发展影响，引导基金发展也及不均衡，在经济发达的地区普遍规模更大、发展更快，而在经济不发达地区，由于地方政府对引导基金认识不够和财政资金的紧缺，导致引导基金难以得到发展。

表1 部分地区引导基金发展情况

地区	基金概要	投资定位
北京	以首都科技发展集团以及北京大学等技术源头单位，与深创投等金融资本用友等产业资本、区县政府等四类主体合作，共设立了6支子基金。	重点投资于重大科技创新和科技成果转化项目。
上海	由上海市政府设立，主要资金来源为本市重大项目专项资金，民间资本无偿捐赠及基金自身各项收益等。由上海创业接力科技金融集团有限公司负责管理。	以节能环保、新一代信息技术、生物、高端装备制造、新能源、新材料和新能源汽车等七大战略性新兴产业，以及文化创意、高技术服务业等产业领域为主。
陕西省	由省政府财政拨款5亿元，与社会投资人以有限合伙制、公司制等形式共同发起创立，同时率先建立科技保险风险补偿机制，由财政补贴资金。	60%以上优先投资于陕西科技型中小企业，并无明确的行业侧重点。
山东省	由省政府出资设立，通过注资参股方式，与其他符合条件的社会资本、地方政府资金等资本共同构成，资金规模为2.4亿元。山东省经济开发投资公司负责管理、省金融办负责指导监管。	主要投资于电子信息、生物与新医药、资源与环境、高端装备制造、新能源及节能、新材料等高新技术领域，以及轻工、纺织、机械、化工、冶金、建材等优势传统产业的升级改造。
广东省	省级引导基金首期初期7.5亿元，并面向社会征集参股子基金。且引导基金将按比例将财政资金所属收益让利于其他投资方与管理方。	重点投资于计算与通信集成芯片、移动互联关键技术与器件、云计算与大数据管理技术、新型印刷显示与材料、可见光通信技术及标准光组件、智能机器人、新能源汽车电池与动力系统、干细胞与组织工程、增材制造(3D打印)技术。
江苏省	江苏省引导基金针对不同学科，不同层次的科技成果细分为自然科学基金、重大科技支撑与自主创新、重大科技成果转化、科技服务平台、苏北科技富民强县等五个部分。五部分资金由省财政部、省科技部以及各资金独自成立的基金委员会共同管理。	各基金分别侧重于不同领域的前沿技术，关键性技术和重大科技转化项目的投资。
贵州省	省财政预算拨款10亿元，联合其他社会资本和社会捐赠共同设立。由贵州贵民投资公司发起设立贵州省科技成果转化基金创业投资公司，负责基金的日常事务管理；委托贵州省贵鑫瑞和创业投资公司负责基金投资业务。	在新材料、先进制造、生物医药、节能环保、电子信息、新能源、现代服务业、现代农业、大数据产业等战略新兴产业及特色优势产业领域进行重点投资。
湖南省	省本级财政出资6000万元，长沙、湘潭、株洲三个高新区累计投入财政科技专项资金约4亿元。其中科技成果转化引导基金规模3亿元，并与国家开发银行等7家银行开展科技金融战略合作。	集中投向国家重点支持的高新技术领域和战略新兴产业领域。
云南省	资金来源于省级财政拨款和投资收益，与其他符合条件的社会资金、投资机构、地方政府等	主要投向云南省高原特色农业、新材料、生物医药、节能环保、高端装备制造、新能源、新

	其他投资者共同发起设立若干创业投资子基金以及用于风险补偿。	能源汽车、光电子与信息以及现代服务业等领域。
青海省	青海省转化基金为有限合伙制，由青海省国有科技资产经营管理有限公司、湖南湘商资本管理有限公司、北京凯邦资本管理有限公司共同发起设立，其中产业投资基金总规模10亿人民币，首期5亿人民币。	重点投资于战略性新兴产业、循环经济和高新技术改造提升传统产业领域，和具备原始创新、集成创新或消化吸收再创新属性的行业

3. 科技保险市场现存问题分析

3.1 科技保险市场存在外部性

外部性是指个人消费者或生产者的经济活动对社会上其他人的福利产生了影响，造成私人成本与社会成本、私人利益与社会利益的差异。对投保人而言，科技成果转化过程的投保费用由其独自承担，但取得的成果却不可避免的被全社会共享，这意味着其边际私人成本大于边际社会成本，边际私人收益小于边际社会收益，造成双重外部性。对保险人而言，由于自身保单易被模仿，且承保之后科技成果转化失败造成的损失由其全部承担，但收益却依然有社会共享，因此导致保险人的边际私人成本大于边际社会成本，边际私人收益小于边际社会收益。保险人和被保险人同时具有双重外部性导致了科技保险市场严重失灵，资源达不到有效配置。

3.2 科技成果转化过程的弱可保性

风险可保性是指此类风险或同质风险中包含大量个体，使保险人可以利用保险精算原理和大数法则合理计算保费，建立保险基金来对少数出险单位进行补偿。这样的风险对保险人来说就是可保的。但科技成果转化过程中存在的风险具有以下特点：（1）差异性强。科技成果转化过程中的风险在起因、性质和扩散路径等方面都具有各自的特点，无法找到大量风险同质的单位，无法有效利用大数法则的原理分散风险；（2）不确定性高。科技风险本身的复杂性导致在项目开始进行时无法对整个项目可能产生的风险的发生时间和影响规模进行有效预估；（3）损失程度普遍较大。科技风险普遍集中度高且具有连锁性质，当某个风险发生之后极可能诱发后续的一系列风险，从而导致整个科技成果转化过程受到影响，甚至直接导致项目的失败。如此高风险高损失的性质导致了科技成果转化过程的弱可保性。

3.3 科技保险供需同时不足

对科技企业而言，首先，科技保险尚属于一种新事物，没有得到多数企业认可，加上对科技保险的相关条款及其优惠政策不了解，导致企业普遍投保积极性不高；其次，部分企业缺乏风险管理意识，高估自身的抗风险能力，或抱有侥幸心理，不愿耗费成本在保费支出上；第三，很多科技企业属于中小微企业，自身财务状况较差，现金流紧张，加上科技类保险保费相对较高，企业投保会大大减少投资产品开发的资金，因此无力涉及科技保险。

对保险人而言，由于科技企业出险后损失不确定性大，加上我国科技保险业务尚处于起步阶段，没有大量历史数据支持，导致保险公司难以合理计算保费，进一步的，就难以推出符合市场需求且涉及面更广的保险品种。目前我国开发出的产品研发责任险、关键研发设备险、高管人员和关键研发人员团体健康险和意外险等20个左右的险种，普遍是在传统保险的基础上加以改造，难以适应科技行业的风险特质。

4. 科技成果转化融资保险引导基金模式探究

4.1 科技成果转化融资保险引导基金概述

由于科技成果转化融资相较于其他项目融资具有更高的风险，导致此类融资一直难以吸引到更多的民间资金参与，相比于大量的科技成果转化融资需求，基金的使用一直处于捉襟见肘的状态。根据实际调查发现，多数科技型中小企业获得的贷款融资远远达不到自身的需求水平。科技型中小企业难以获得科技成果转化融资，使得很多优质成果无法转化或不能成功转化为切实的提高国民经济水平和社会生产力的产品。而难以获得贷款融资的主要原因是科技型中小企业的轻资产特性造成的，由于投资方担心其在转化失败后的面临的巨大损失，因此不得不提高投资门槛。而保险的介入则可以有效的解决此类问题。对科技企业的科技成果转化过程提供保险，如通过信用保证保险等一系列的保险行为，可以为其提供多方面的保障，分散企业科技成果转化失败的风险，以此来降低融资门槛。同时，开展科技企业保险业务也为当前保险行业的发展注入新鲜血液，拓宽了保险业务范围，为改善当前保险行业严重同质化，主营业务范围传统单一的现状，和提高保险业在国民经济中的地位都具有重要作用。然而，由于科技成果转化过程具有高风险、高损失的性质，保费普遍偏高，科技企业在成果转化过程中的现金流紧张，造成了他们无力独自负担高额的保费。本文提出的科技成果转化融资保险引导基金一方面可以通过引入保险提高科技成果转化效率，另一方面又可以提高科技企业投保率。该基金是以科技成果转化引导基金为模板，通过政府财政资金出资牵头成立，并融入保险公司和民间资本，成立子基金，以政策化、系统化、专业化地为科技成果转化提供高效的保险保障。

4.2 科技成果转化融资保险引导基金运行机制

本文所设计的科技成果转化融资保险引导基金（下称保险基金）是以科技成果转化引导基金（下称引导基金）为蓝本，参照其部门设定和运行机制。相比较于引导基金，保险基金可由财政部、科技部和保监会共同发起设立母基金，同时设立引导基金管理委员会作为引导基金的监管机构和最高权力机关，负责有关引导基金重大事项的决策和协调，包括资金筹措、合资合作方选择、管理制度、运行方式、绩效奖惩等。组织保险行业专业人士、风险管理专家和政府部门有关人员等设立引导基金理事会，负责对项目投资及退出、监管处理等提出决策建议，

对基金操作主体提交的投资方案进行审核，并通过吸引民间资本设立旗下营利性子基金，交由民间基金管理公司管理，母基金负责设立监管部门监管基金运作。

引导基金以阶段性保险补贴和亏损补偿的方式参与科技成果转化保险过程，所缴保费视为“可转化保费”，在保险标的项目转化成功后可将保费转化为部分股权。

4.3 对民间资本的激励机制

公共资本介入创新创业活动的目的是为了增加对早期创新项目的投资，以及对民间资本参与投资发挥引导作用，各基金的主体依然是民间资本。那么，如何吸引更多的民间资本参与到科技成果转化融资保险引导基金中，就成为了决定引导基金规模、效率和社会影响力的重要因素。本文通过借鉴王利明《引导基金对私人资本、创业投资企业和创业投资家的激励机制研究》一文中提出的不同补偿机制的分类和激励强度的比较，将转化结果分为上市、并购和破产清算等三种情况，并探讨这三种情况导致的最终收益率的变化，将不同激励方式下投资净收益率 $\tilde{r}$ 的期望μ和方差 σ^2 的表达式进行进一步的补充。

4.3.1 不同补偿机制的基本假设

引导基金其下的子基金是吸纳民间资金的主体，而子基金作为投资于创新创业领域的商业性基金，其本质是创造了一种风险资产。对投资者而言，投资于此类基金是根据其自身的投资组合来决定的。因此，子基金的预期收益与风险的比例要达到投资者的预期，才能吸引民间资金的进入。所以分析不同的补偿机制的激励强度，可以转化为分析它们对投资者预期收益率的影响。

综上所述，本文作出如下假设：

①引导基金（公共资本）、私人投资者和创业投资企业三方决定共同成立一家子基金，私人投资者的出资比例为α，公共资本所占比例为1 −α，创业投资企业投入其专业技能，资本投入忽略不计。基金期末收益一个固定的比例作为创业投资企业的报酬，剩余收益在公共资本和私人资本之间进行分配，出于分析的简便，下文将对创业投资企业的报酬进行归零处理；

②假定一个代表性私人投资者拥有的初始资金为w= 1，其投资于子基金的资金为x（0 <x<1），则投资于无风险资产的资金为1 − x。该投资者风险规避，具有绝对风险规避系数为ρ的 CARA 型效用函数 $U(w)=1-e^{-\rho w}$ 。投资者所面临的投资机会包括：投资于无风险资产获得净收益率 r_f；投资于子基金，其净收益率为随机变量 $\tilde{r}$，μ 表示 $\tilde{r}$ 的数学期望，σ^2 表示方差。$\tilde{r}$ 的分布函数为 $F(r)$，密度函数为 $f(r)$。

③假设投资标的的转化结果为上市、被其他企业兼并收购和破产清算三种，成功上市概率为 p_1，投资者通过保费转化股权得到的期望收益率为 r_1；被其他企

业兼并收购的概率为 p_2，股票溢价收购使投资者获得的期望收益率为 r_2；转化失败后进行破产清算的概率为 p_3，对投资者造成的损失为 r_3（$r_3<0$）。其中 $p_1+p_2+p_3=1$，且 r_1、r_2、r_3 分别服从 $N(\mu_1,\sigma_1^2)$、$N(\mu_2,\sigma_2^2)$ 和 $N(\mu_3,\sigma_3^2)$。则无政府补贴情况下，投资净收益率 $\tilde{r}$ 的数学期望为：

$\mu = p_1\mu_1 + p_2\mu_2 + p_3\mu_3$，

方差为：

$\sigma^2=p_1(r_1-\mu)^2 + p_2(r_2-\mu)^2 + p_3(r_3-\mu)^2$。

④为吸引更多的私人资本投入子基金，引导基金中的公共资本可以对私人资本进行直接补偿。根据市场普遍存在的补偿方式和前人的研究，本文所考虑补偿方式包括以下两种：

1）亏损保底：公共资本承诺，若子基金亏损，则私人资本只承担一个保底亏损额，折算成收益率为–γ (γ >0)，超过部分由公共资本承担；若子基金盈利，则双方按其投入比例共享。

2）亏损补偿：若子基金投资亏损，则私人资本的承担的比例β小于其投资比例α；若子基金盈利，则双方按其投入比例共享。

4.3.2 亏损保底模式下的投资最优解

当公共资本承诺在子基金发生亏损时，私人资本的保底收益率为–γ，则此时私人投资者的收益率将会从 r_3 变成为一个服从在–γ处截尾的正态分布 η_1。此时，

$$E(\eta_1)=\mu_3+\sigma_3\frac{\varphi[(\gamma+\mu_3)/\sigma_3]}{\Phi[(\gamma+\mu_3)/\sigma_3]}>\mu_3 \quad (1)$$

$$Var(\eta_1)=\sigma_3^2\{1-(\frac{\gamma+\mu_3}{\sigma_3})\frac{\varphi[(\gamma+\mu_3)/\sigma_3]}{\Phi[(\gamma+\mu_3)/\sigma_3]}-\frac{\varphi^2[(\gamma+\mu_3)/\sigma_3]}{\Phi^2[(\gamma+\mu_3)/\sigma_3]}\}<\sigma_3^2 \quad (2)$$

其中，φ 和 Φ 分别为标准正态分布的分布函数和密度函数。

则投资者的收益率的数学期望为：

$$\mu^* = p_1\mu_1 + p_2\mu_2 + p_3\{\mu_3+\sigma_3\frac{\varphi[(\gamma+\mu_3)/\sigma_3]}{\Phi[(\gamma+\mu_3)/\sigma_3]}\} \quad (3)$$

方差由于 r_1、r_2、r_3 不相互独立，在此简化为 σ^{*2}，并可知 $\sigma^{*2}<\sigma^2$。根据投资者追求确定型财富最大化原则[1]，可得最优解为：

$$x_1=\frac{\mu^*-r_f}{\rho\sigma^{*2}},(\mu^*>r_f-\sigma_3\frac{\varphi[(\gamma+\mu_3)/\sigma_3]}{\Phi[(\gamma+\mu_3)/\sigma_3]}) \quad (4)$$

小结：在亏损保底模式中，投资收益率的数学期望提高，方差降低，说明该模式可以在提高私人投资者期望收益率的同时，降低投资失败可能带来的损失。该模式的优点在于在投资成功时，引导基金可以最大限度的保有其收益；缺点在

[1]参考王利明博士论文《引导基金对私人资本、创业投资企业和创业投资家的激励机制研究》的分析

于当投资失败时，公共资本的损失可能会无限大，对财政资金来说是一个不容忽视的巨大隐性风险。

4.3.3 亏损补偿模式下的投资最优解

假设共同资本投资发生亏损时，私人资本承担的亏损比例为β，小于其在子基金中的投资比例α；若子基金盈利，私人资本以α的出资比例获得其收益。设$\tau = \beta / \alpha$，此时r_3服从一个新的正态分布η_2。则发生亏损时，r_3的数学期望变为：

$$E(\eta_2) = \tau\mu_3$$

方差变为：

$$Var(\eta_2) = \tau^2\sigma_3^2$$

则私人投资者投资收益率的期望为：

$$\mu' = p_1\mu_1 + p_2\mu_2 + \tau p_3\mu_3 \tag{5}$$

方差同样简化为σ'^2。此时私人资本投入的最优解为：

$$x_2 = \frac{\mu' - r_f}{\rho\sigma'^2}, (\mu' > r_f) \tag{6}$$

小结：在亏损补偿模式中，公共资本的补贴同样使私人资本投资的期望收益率提高，风险降低。但与亏损保底模式不同的是，此时私人投资家也承担了发生高额损失的风险。因此，该模式更有利于发挥私人投资家的能动性，激励其发挥自身资源和优势，鉴别投资标的的资质，有利于引导基金自身的审核和投资业务。

4.3.4 两种激励模式的比较

由于引导基金投资收益分散于公共资本和私人资本，因此私人投资者福利的增加必然导致公共资本福利的减少。决策者在制定私人资本激励机制时必然会使每种激励模式下私人资本期望收益率相同，因此，本文通过比较两种激励模式下私人投资者承受风险的变化，来比较两种模式的激励强度。

由于r_1，r_2在这两种激励模式中的分布未发生变化，因此将此处对整体投资收益率方差的分析简化为对r_3的方差变化的分析。

由$\mu^* = \mu'$可得约束条件

$$p_1\mu_1 + p_2\mu_2 + p_3\{\mu_3 + \sigma_3\frac{\varphi[(\gamma + \mu_3)/\sigma_3]}{\Phi[(\gamma + \mu_3)/\sigma_3]}\} = p_1\mu_1 + p_2\mu_2 + \tau p_3\mu_3 \tag{7}$$

解得：

$$\tau = 1 + \frac{\sigma_3}{\mu_3}\frac{\varphi[(\gamma + \mu_3)/\sigma_3]}{\Phi[(\gamma + \mu_3)/\sigma_3]} \tag{8}$$

令

$$\frac{Var(\eta_1)}{Var(\eta_2)}=\frac{\{1-(\frac{\gamma+\mu_3}{\sigma_3})\frac{\varphi[(\gamma+\mu_3)/\sigma_3]}{\Phi[(\gamma+\mu_3)/\sigma_3]}-\frac{\varphi^2[(\gamma+\mu_3)/\sigma_3]}{\Phi^2[(\gamma+\mu_3)/\sigma_3]}\}}{\tau^2}<1 \quad (9)$$

解得：

$$\gamma>-\mu_3-\frac{2\sigma_3^2}{\mu_3}-\sigma_3(1+\frac{\sigma_3^2}{\mu_3^2})\frac{\varphi[(\gamma+\mu_3)/\sigma_3]}{\Phi[(\gamma+\mu_3)/\sigma_3]} \quad (10)$$

4.3.5结论

由（10）可以看出，在两种模式中，私人投资者承担的风险根据γ和τ的取值不同变化率也不同。当$\gamma>-\mu_3-\frac{2\sigma_3^2}{\mu_3}-\sigma_3(1+\frac{\sigma_3^2}{\mu_3^2})\frac{\varphi[(\gamma+\mu_3)/\sigma_3]}{\Phi[(\gamma+\mu_3)/\sigma_3]}$时，$Var(\eta_1)<Var(\eta_2)$。此时亏损保底的激励模式使得私人投资者在取得相同的期望投资收益率的同时，面临的风险更小，因此对私人投资者的激励强度更大。当$\gamma<-\mu_3-\frac{2\sigma_3^2}{\mu_3}-\sigma_3(1+\frac{\sigma_3^2}{\mu_3^2})\frac{\varphi[(\gamma+\mu_3)/\sigma_3]}{\Phi[(\gamma+\mu_3)/\sigma_3]}$时，$Var(\eta_1)>Var(\eta_2)$。此时亏损补偿模式能够在使私人投资者获得相同期望收益率的同时，面临更小的风险，因此此时亏损补偿模式对投资者产生了更强的激励。在实际操作中，政策制定者应充分考虑科技成果转化失败的概率，以及失败时面临的期望损失，以此来对私人投资者的亏损上限γ和亏损补偿比例τ做出理性预期，选择具有更强激励强度的激励措施。

5、结语

本文通过总结整理过去收集的资料及产生的部分想法，提出设立科技成果转化融资保险引导基金的构思，并对如何吸引民间资本的激励措施进行了模型分析，以期能对该引导基金乃至其他类型的保险引导基金在加强市场资金吸引力方面给出一定的启发。本文旨在为我国参与科技成果转化的相关人员和企业提供更为系统和完善的风险补偿手段和保险保障，以进一步完善我国科技成果转化引导体系，提高我国科技成果创新成功率。

附注:此文为 2015 年度浙江省软科学研究计划重点项目"民间资金参与科技成果转化融资的保险制度优化设计"(项目编号：2015C25044) 的研究成果。

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科技成果转化融资保险引导基金模式探究

张代军 刘鑫龙

张代军
教授
浙江财经大学金融学院
杭州30018，中国
电话: 13750815909
Email: zdj0303@126.com.

刘鑫龙*
硕士研究生
浙江财经大学金融学院
电话:15869145498
Email: lxl458838418@163.com

关键词：科技成果转化融资保险、引导基金、效用分析。

中文摘要．近年来，随着我国经济发展进入瓶颈期，产业结构面临转型升级，科技创新逐渐成为带动国民经济发展的重要动力。然而，科技研发中产生的一系列问题导致此类中小型企业一直以来都难以获得贷款融资。2015年8月13日国务院发布《关于加快发展现代保险服务业的若干意见》（简称“保险新国十条”）明确提出了今后保险业在社会发展中将扮演的重要角色。科技创新以其高风险的特性，与保险的职能具有天然的契合性。然而保险行业在科技成果研发转化的各个阶段都没有发挥出其应该发挥的作用。究其原因，就是科技型中小企业资金压力大，或企业所有者对于此类保险认识不足引起的。本文提出的科技成果转化融资保险引导基金，是基于政府引导，民间资本参与，并具备保险公司专业化风险管理技术的一种新型政策引导基金，目的在于进一步保障科技型中小企业所有者的权益，通过政策性保险的形式将科技成果转化过程中存在的风险向全社会分散，削弱由科技成果转化对全社会的正外部性导致的市场失灵，降低转化失败导致的所有者权益过度损失。同时，通过对科技成果转化过程提供保险，可以降低转化失败之后企业的损失，降低企业获得贷款融资的门槛。

本文首先对科技成果转化融资保险基金建立的组织结构和运行机制等进行了理论分析。其中包括政府出资进行引导的必要性和其中存在的缺陷；保险公司参与带来的效率提高；通过设计可转化保费（在科技成果转化成功后将保费按出资规模转化为股权），吸引民间资本参与投资等。其中在对吸引外部投资进行的理论分析中，通过对企业公开上市、被兼并收购、以及破产清算这三种结局产生的剩余价值以及所占比重进行讨论，分析风险投资者获得的期望回报，以此作为吸引风投资金的主要因素。此外，在实证分析方面，本文通过建立随机效应模型，分析保险介入科技成果转化融资过程对科技型中小企业进行科技成果转化产生的影响，并与无保险介入的企业进行对比，研究保险对科技成果转化过程是否具有促进作用，并以此结论为基础，探究设立融资保险基金的效用变化，并与如今单独实行的科技成果转化引导基金政策进行横向对比。

The Analysis of Property Insurance Company's Profitability and its Impact Factor

ZHANG Fangjie, HAN Lin, ZHANG Jichao

ZHANG Fangjie
Associate Professor
School of Economics
Shandong University
Jinan250100, China
Phone: (8610) 88364625; 18615203276
Email: zhangfangjie@sdu.edu.cn

HAN Lin *
Postgraduate Student
School of Economics
Shandong University
Jinan 250100, China
Phone: 15508690976
Email: 290131517@qq.com

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Abstract: With the development of insurance markets, Property insurance company'sface a lot of competition and challenges. Based on the particularity of property insurance company, design anappropriate analysis system of property insurance company profitability is necessary. This paper improved Du Pont Analysis Systemaiming to examine the profitability by ROA. The factors in new Du Pont Analysis Systemlikerate of return on investment, equity multiplier, total assets turnover, etc. are significantlyrelated to ROA, which means these factors can evaluate the profitability of property insurance company effectively. Empirical results also show the degree of influence for each factors which provides a good reference.

1. Introduction

Insurance industry in China has already made great advancements as a rising industry, since the recovery of the insurance industry in 1979. By the end of 2014, Insurance density in China is 1479 yuan/person, insurance depth is 3.18%. The contribution of the insurance industry to GDP has increased continuously, the importance of insurance industry to national economy is more and more great. In last decade, china insurance industry has been developing rapidly, especially the property insurance company, which is due to the great development of commercial motor vehicle insurance. In 2014 the total profit of China insurance industry is 99,142 million yuan, in which the property insurance companies got 34,998 million yuan, rose by 7.58% year-on-year. But in recent years, the ratio of the property insurance premium to the entire insurance industry premium income has decreased year by year, the growth rate is also lower than that of life insurance. Underwriting profit decreased year by year since 2008, the underwriting profit of 2013 is 2,200 million yuan, fell 1.3% year-on-year. In 14 property insurance products, there are 10 products profits while 4 products have a deficit. [1]The problems in the management of property insurance companies, especially the problem of profitability, has become an important research topic in recent years. To find out the suitable analysis framework of the insurance company's profitability and to study the influencing factors and improving methods of profitability of property insurance company has important practical significance.

Business property insurance company is characterized by wide diversity of insured object, universality of underwriting risk, short-term of underwriting period and sociality of underwriting responsibility. At the same time, the property insurance company's insurance business is mostly short-term and there are uncertainties as to the sources of its expense margin, mortality margin, interest margin, the property insurance company also has a higher degree of liquidity than life insurance company. At present, the profit of Chinese property insurance company mainly comes from the investment income, some companies' underwriting profit are even negative (as shown in Table 1), which makes property insurance company's management has its particularity.

There are many methods to evaluate profitability, such as factor analysis method, DuPont System analysis method, the Monte Carlo method and others. In this paper, the DuPont analysis method is adopted to build evaluation system of profitability, but because of the particularity of insurance companies' operating liabilities, its cost, profits and the calculation method of capital using were different with the general business, so DuPont analysis system needs some improvement in order to evaluate the property insurance company's profitability better. At the same time, this paper tries to make an empirical analysis on the relationship between the profitability of Chinese property insurance company and its influence factors according to the data of China's property insurance company, strive to evaluate various indicators effectively, to provide a feasible and reliable basis for the construction of the profitability evaluation system.

[1]Data coms from China Insurance Yearbook 2014

Table I.Profit of Property Insurance Companies in 2013/million yuan

Company Name	Operating Profit	Investment Income	Underwriting Profit
PICC Property Insurance	13224.13	10598.48	2625.65
China Property & Casualty Reinsurance Company LTD.	1539.6	1476.31	63.29
CPIC Property Insurance	3587.26	3364.72	222.54
Ping An Property Insurance	7941.53	5462.2	2479.33
Tai Ping Property Insurance	268.11	358.38	-90.27
Yang Guang Property Insurance	340.46	981.95	-641.49
Huang Tai Property Insurance	298.07	237.14	60.93
Tian An Property Insurance	376.8	327.91	48.89

2. Literature Review

DuPont analysis was first proposed by Pierre DuPont and Donaldson Brown who are from DuPont Co. in 1919, such a system based on rate of assessment can evaluate company's profitability well, so it is widely used in manufacturing. Descendants of the DuPont system make a series of improvements on it, for example, Harvard professor Palepu (2001) proposed the Palepu Victor comprehensive financial analysis system, mainly replaced Rate of Return on Equity by sustainable growth rate as the core of analysis system, and included the rate of dividend distribution, with full consideration of the enterprise's sustainable development ability. The improvement of DuPont system for insurance company is mainly made by Barry D. Smith(1999) who adjusted DuPont analysis formula according to the liability management of insurance company. He redefines each ratio to make it a special title and meaning of the insurance industry.

There are many Chinese articles are related to the deficiency and improvement of DuPont Analysis System, they mainly focused on introducing or improving related factors like cash flow, variable cost and other aspects. Zheng Hongtie(2001) and Ye Chunhui(2010) advocated to introducing cash flow information into the DuPont system. Zheng Hongtie adopted ROE, ROA and total cash debt to measure operating capacity, profitability and solvency while Ye adopted net cash recoveries, debt coverage ratio, assets cash recoveries instead. Hong Aimei(2011) introduced cash flow into traditional DuPont analysis system by adding cash index to make it can analysis enterprise's operational risk and financial risk as a whole. On this basis, Sun Xiaochun (2012) also classified the costs according to their characters, so that it is more conducive to guide enterprises manage their accounts and improve their financial management.

In terms of profitability analysis, Negru T (2010) deemed that both the profit system and the product profit level of an insurance company can be quantified. And two insurance companies and their products can be evaluated by profit analysis conducted by a profit test, the Intrinsic Value Method and sensibility analysis on influential

parameters. Qi J. (2012) has predicted the profitability of Chinese insurance companies in the following five years by utilizing a Monte Carlo Simulation, discovering that the investment business will become a new potential profit driver. Bian-Bian J I and Sun X (2014) et. al have analyzed, by using grey correlation analysis model, the effect of exogenous factors on profitability of non-life insurance companies under the context of foreign insurance companies pouring into Chinese Market, and have pointed out that segmentation of the insurance market is a major factor and insurance density and depth is the secondary factor.

Domestic scholars Zhu Xiangjun and Liu Lingling (2010) selected ROA, ROE and underwriting profit margin indexes in analyzing profitability of property-casualty insurance companies, and objectively analyzed the profit situation of 7 property-casualty insurance companies in last ten years. Zhang Yong and Du Tongchao (2011) utilized the dynamic financial analysis theory in studying increasing profitability of property insurance industry, and noted that it is should to enhance the management of claim, and management of investment, such as stock right, fund, debt and so on, increasing profit by a two-pronged approach. Zhao Meng (2014) selected altogether eight indexes, such as investment asset ratio, profit per capita and so on, to conduct finance analysis on 46 property insurance companies in China, which has a practical meaning.

Currently, domestic literature and Foreign literature on the profitability evaluation of insurance company are of great amount, mainly analyzing problem in management and method for increasing profitability. However, researches on profitability system analysis are few, and lack support of demonstration results. The following chapter will improve the Du Pont System and related indexes will be redefined with measured its validity and importance based on empirical results, thereby providing companies and nation with feasible reference.

3. Construction of evaluation system of property insurance company's profitability

3.1 DuPont Analysis

DuPont analysis is a system of comprehensive financial analysis for enterprise, it is based on ROE. This formula is first used by DuPont Corporation. After improvement and development, the system overcomes the defect that single index can only analysis one certain aspects of enterprise, contacting profit, assets, equity and other financial indicators can not only analyze the business situation, but also reflect the various factors effect on the financial condition and the degree of the effect.

As the core index of DuPont analysis system,ROE(return on equity) is also known as rate of return on common stockholders' equity. ROE is not only a measure of profitability of shareholders' equity, but also a measure of how well a company uses investments to generate earnings growth, it is a better measure index than pure net profit growth rate. At the same time, the system is a multi-layered financial ratio analysis system, return on asset and equity multiplier are factors related to return on equity directly. The reason is that the rising of the index financial leverage will rise risk degree at the same time and there are many limitations on it. So the key to rise return on equity is to rise return on asset. Equity multiplier reflected the relationships

between asset, debt and common stockholders' equity, it is a measure of the extent of the company's liabilities. Equity multiplier is positively related to the asset liability ratio, that is, the higher the asset liability ratio, the greater the equity multiplier, the greater the risk, and vice versa. In fact, the relationship between the various levels can continue to be broken down, and gradually covering all aspects of enterprise operation. For example, the following formula shows the way to break down ROE into three important components.

$$\text{ROE}=\frac{\text{Net income}}{\text{Sales}}\times\frac{\text{Sales revenue}}{\textit{Total Assets}}\times\frac{\textit{Total Assets}}{\textit{Shareholder}\ \text{Equity}} \qquad (3\text{-}1)$$

The original formula is break down into the product of net interest rate, total assets turnover and equity multiplier, so that we can analyze the difference of the three between enterprises.Formula 3-1 shows the how tobreakdown ROE. Total assets turnover reflected the degree of operation capability, net interest rate reflected profitability, combination the two reflected the operation capability and profitability of enterprise comprehensively.

3.2. Construction of DuPont analysis system of property insurance company

3.2.1. Expansion of DuPont system

The core index of DuPont analysis system is the return on equity(net interest rate of equity), and the key of the construction of index system is how to break down the driving factors that effected on return on equity scientifically and rationally. In 1999, the famous American scholar Barry D. Smith has made a corresponding adjustment to the DuPont financial analysis system, so that it is in accordance with the property insurance company's operating characteristics. The following formula (3-2) is an improved version of the formula (3-1).

$$\textit{ROE}=\frac{(\text{Underwriting profit}+\textit{Investment return})}{\text{Premium income}}\times\frac{\text{Premium income}}{\textit{Total Assets}}\times\frac{\textit{Total Assets}}{\textit{Shareholder}\ \text{Equity}} \qquad (3\text{-}2)$$

At the same time, define the four ratios in the formula (4-2) , and we obtain the formula (3-3).

$$\textit{ROE}=(\frac{\text{Underwriting profit}}{\text{Premium income}}+\frac{\textit{Investment return}}{\textit{Total Assets}}\times\frac{\textit{Total Assets}}{\text{Premium income}})\times\frac{\text{Premium income}}{\textit{Shareholder}\ \text{Equity}}$$

ROE=（underwriting profit margin + rate of return on investment× investment returns multiplier）× Kenney coefficient （3-3）

In this paper, we refer to Barry D. Smith's thinking of improving DuPont analysis system, introduce the "earned premium" as an important indicator into analysis system. After the "new insurance guidelines" issued in 2006, original financial statements of insurance companies changed in the format, it made the indicatorearned

premium received additional significance. The indicator "Premium income" is only concerned about the size and the market position of insurance company, the comparison of the premium income is likely to cause deviation of concern, resulting in business management problems. While the indicator "earned premium" have deducted the portion unearned premium reserve and improved the quality of income indicators. Also in 2008, the Ministry of Finance promulgated "enterprise accounting standards Interpretation No. 2" and issued in 2009 " Treatment provisions on accounting related to insurance contract" changed the provisioning approach of unearned premium reserve, and the calculation to earned premium also changed. After the introduction the index earned premium, the DuPont analysis system can be broken down further.

$$\text{ROE}=\left(\frac{\text{Underwriting profit}}{\text{Earned premium}}+\frac{\textit{Investment return}}{\textit{Total Assets}}\times\frac{\textit{Total Assets}}{\text{Earned premium}}\right)\times\frac{\text{Earned premium}}{\textit{Shareholder}\ \text{Equity}}$$

$$=\left(\frac{\text{Underwriting profit}}{\text{Earned premium}}+\frac{\textit{Investment return}}{\textit{Total Assets}}\times\frac{\textit{Total Assets}}{\text{Earned premium}}\right)\times$$

$$\frac{\text{Earned premium}}{\text{Premium income}}\times\frac{\text{Premium income}}{\textit{Total Assets}}\times\frac{\textit{Total Assets}}{\textit{Shareholder Equity}}$$

= (underwriting profit margin + rate of return on investment × investment returns multiplier)× ratio of earned premium × asset turnover × equity multiplier (3-4)

Breakdown net profit margin in formula 3-1 into two important components, underwriting profit margin and rate of return on investment, and replace premium income by earned premium; replace Kenney coefficient by the product of asset turnover and financial leverage (equity multiplier) and replace the income index in asset turnover by earned premium; thefinancial leverage index has not been replaced. The core formula in this system is formula 3-4. In this system, underwriting profit margin and rate of return on investment can reflect the profitability, asset turnover reflect the operating capacity and equity multiplier reflect solvency, the system analysis the operating conditions of property insurance companies from three aspects, and as a result, get the impact of each indicator on return on equity.

3.2.2. Description of Index

(i)Return on equity (ROE)

ROE(return on equity) is also known as net interest rate of equity. ROE is a measure of how well a company uses investments to generate earnings growth, it is the most representative index of corporate profitability. ROE can be broken down to reflect operation capability and solvency at the same time, so this index has a very good comparability and comprehensiveness. The higher the return on equity is, the better the profitability of corporate capital is and more competitive it is.

$$\text{ROE}=\frac{\text{Net income}}{\text{Shareholder Equity}}\times 100\%$$

(ii) Underwriting profit margin (UPM)

Underwriting profit is the main profit of the core business of insurance companies--insurance. Underwriting profit margin is the ratio between Underwriting profit and earned premium, it reflects the profitability of insurance business of insurance company. Underwriting profit margin can also measure the quality of company's insurance business. It is worth noting that after the implementation of the new insurance standards, underwriting profit doesn't appear in profit and loss statement. According to the formula, underwriting profit= Operating profit + return on investment + changes in fair values.

$$\text{Underwriting Profit Margin} = \frac{\text{Underwriting Profit}}{\text{Earned Premium}} \times 100\%$$

(iii) Rate of return on investment (ROI)

Rate of return on investment reflect the profitability of the investment, which is the ratio between return on investment of insurance company and assets. It is a measure of the ability insurance company manages its assets. Compared with return on equity, this ratio should not be too low or too high, the formermeansthe failure of investment, the later indicate company manipulate profits.

$$\text{Rate of Return on Investment} = \frac{\text{Return on Investment}}{\text{Total Assets}} \times 100\%$$

(iv) Investment returns multiplier (IRM)

This coefficient was defined by Barry D. Smith, which is the ratio between earned premium and total assets. It reflects the potential investment scale of an insurance company.

$$\text{Investment returns multiplier} = \frac{\text{Total Assets}}{\text{Earned Premium}} \times 100\%$$

(v)Earned premium ratio (EPR)

Premium income is the insurance premium paid by the applicant, which is the main funding source of the insurance company. Premium income can be used to pay the payment between insurance period, it can also be used for investment. On the basis of premium income, adjust the part unearned premium reserve so that we get earned premiums. Ratio between earned premium and premium income reflects the property insurance company's service quality and operating condition.

$$\text{Earned premium ratio} = \frac{\text{Earned Premium}}{\text{Premium Income}} \times 100\%$$

(vi)Total assets turnover (TAT)

The total asset turnover shows how much total assets investment required by each yuan of premium income, and it reflects the speed and efficiency of the total assets of the insurance company. Total asset turnover is an indicator of operating capacity. Operating capacity is the guarantee of profitability, and also the basis of solvency.

Therefore, the property insurance companies should analysis this indicator carefully, making company funds under smooth operation can ensure good operation of the company.

$$\text{Total Assets Turnover} = \frac{\text{Premium Income}}{\text{Total Assets}} \times 100\%$$

(vii) Degree of financial leverage (equity multiplier, EM)

Equity multiplier can reflect the most basic financial position, that is, ratio between assets, liabilities and owner's equity. As to property insurance companies, it can reflect the conditions of operation on borrowings. At the same time, the index can reflect the enterprise's financial policy, if net interest rate of total assets unchanged, the higher the equity multiplier, the better the profitability, bringing the greater risk. Enterprises tend to the practice, but lenders will oppose it. Although the property insurance company is in debt management, it should also make use of this index to balance the relationship between high profit and high risk, to manage the risk of enterprise and the risk of the insured well.

$$\text{Equity Multiplier} = \frac{\text{Total Assets}}{\text{Shareholder Equity}} \times 100\%$$

4. Empirical analysis of the factors impacting on the profitability of Chinese property insurance companies

4.1 Sample selection

4.1.1 Data sources

Considering that the property insurance company's business cycle is short, we can use the data in recent years to assess the profitability of them. In this paper, we adopted data from "China Insurance Yearbook" and selected23 main Chinese property insurance companies between 2009 - 2013, which accounted for more than 90% of total property insurance business in China. In addition to the three giants PIPCproperty insurance (1950), CPICproperty insurance (1991) and Ping Anproperty insurance (2002), it included 14 in small and medium-sized companies and 6 foreign capital property insurance companies. Due to the establishmentof new property insurance company by Anbang in 2011, its financial index got adjustment, financial data is quite different from before, so data of Anbang in 2011were excluded.

4.1.2 Analysis of data

First make the statistical analysis for the data of 23 property insurance companies between 2009 and 2013.Observe the relationship between trends of property insurance company profitability and each factor.

Table II. Profitability of Chinese property insurance company 2009-2013

Year	ROE	UPM	ROI	IRM	EPR	TAT	EM
2009	0.0814	-0.0755	0.0332	4.1583	0.7393	0.5360	4.2663
2010	0.0791	-0.0568	0.0241	2.9521	0.8212	0.5923	5.4169

2011	0.0691	-0.0300	0.0234	2.7747	0.8192	0.6776	4.4642
2012	0.0838	-0.0051	0.0284	3.9301	0.8432	0.5802	3.8628
2013	0.0612	-0.0544	0.0453	3.2540	0.7750	0.6120	3.7231

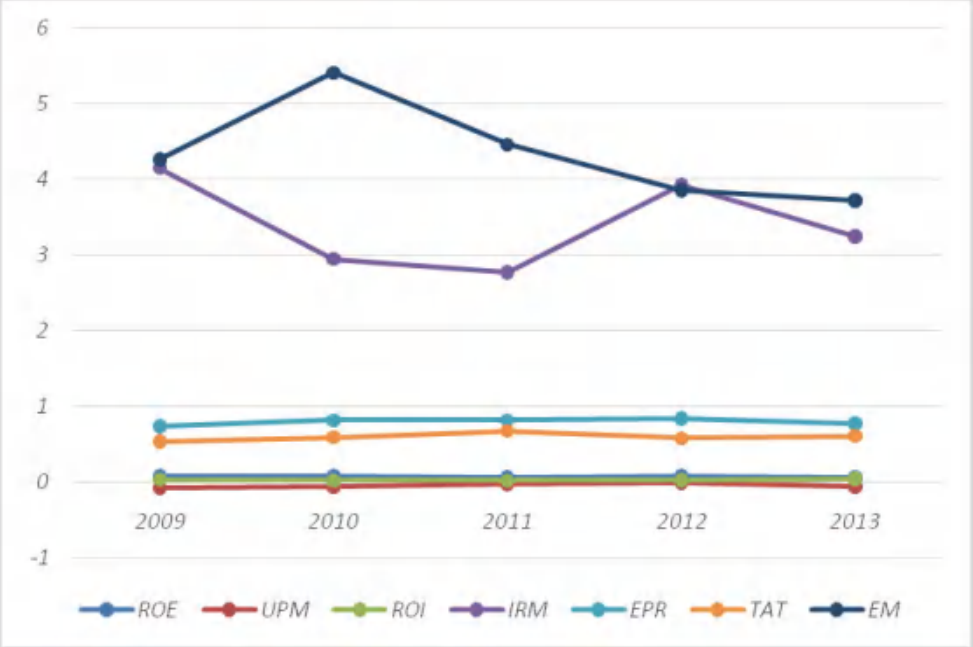


Figure 1. Profitability of Chinese property insurance company

Table II reflects the overall profitability of Chinese property insurance market from 2009 to 2013. The data in the table are all average. As can be seen, the return on equity has not changed a lot in a few years,2012 is the year property insurance companies attain maximum profit, but in 2013 the profit declined. In China Insurance Yearbook 2014, it is mentioned that underwriting situation of property insurance market in 2013 is worse than last year, there are still 4 insurance products of 14 had a deficit. In recent years, the underwriting profit margins are always minus. In 2013, there are only 25 insurance companies of 64 showed a profit, the underwriting profit margins declined 82.4%. Property insurance companies' underwriting income is still relatively weak, they still rely on investment income to make up for underwriting losses. On the other hand, return on investment is relatively stable, after the 2008 crisis, the domestic economic situation improved, especially in 2013, investment income reached a peak. Investment income coefficient changed little, floated up or down between 3 and 4. Earned premium ratio is also stable, which shows that the property insurance companies are mature in dealing with premium income and earned premium. Assets turnover reached the peak in 2011, in that year the company funds was used efficiently, it shows the high operation capability of company. Equity multiplier has a downward trend, indicating that in recent years, the insurance company can be in a good structure of assets and liabilities, the financial risk is low, the future net cash flow can be guaranteed. Figure I shows the situation how seven indexes changed. The investment return coefficient and the equity multiplier are the two had great variation and the other indexes are relatively stable.

4.1.3 Statistical description of variables

The data of 23 insurance companies for five years constitute a short panel data, from the point of view of the descriptive statistics of the data, they are all positive except underwriting profit margin, underwriting profit margin'sabsolute value of coefficient of variation is the maximum, indicating that this index fluctuate harder, earned premium rate and the total assets turnover have the smallest dispersion degree.

Table III. Statistical description of variables

Variables	Average	standard deviation	Coefficient of variation	Max	Min
ROE	0.0711	0.1258	1.7693	0.4683	-0.4944
UPM	-0.0248	0.1896	-7.6451	0.7076	-0.9818
ROI	0.0275	0.0141	0.5127	0.0910	0.0054
IRM	3.0837	2.8313	0.9182	19.4827	0.5588
EPR	0.7911	0.2946	0.3724	2.2645	0.2573
TAT	0.5902	0.1887	0.3197	0.9858	0.0925
EM	3.9759	2.6509	0.6667	16.6000	-8.5850

4.2 Data stationary test

We use Stata to inspect if our panel data is balance or not. Panel variable shows company(strongly balanced), time variable is year 2009 to 2013. The results proved to be panel data.

Then, we use panel unit root test to inspect panel data sequence of each section. There are many testing method such as LLC,Fisher-ADF,Fisher-PP, IPS etc. We chose LLC and IPS to test our balance panel data. If passed one of them, we can say our variable is stationarydiscrete-time sequence. The results are as follows.

TableIV. Unit root test results

Variables	LLC	IPS
ROE	-15.696*** （0.0000）	-2.691*** （0.001）
UPM	-28.436*** （0.0000）	-3.721*** （0.000）
ROI	-12.032*** （0.0000）	-2.278** （0.021）
IRM	-162.122*** （0.0000）	-10.835*** （0.000）
EPR	-15.729*** （0.0000）	-2.035* （0.09）
TAT	-13.317*** （0.0000）	-7.271 （0.790）

EM	-13.237*** （0.0000）	-2.368** （0.011）

***p<0.01,**p<0.05,*p<0.1

In Table IV, the result of LLC testing shows that seven variables are all significant at 1% level. Only TAT didn't pass the IPS test, but we charge it is also stationary because it passed the LLC test. Overall, the seven variables are all stationary series.

4.3 Model Constructing

In order to test the degree of influence each indicator make on the main index of property insurance company -- return on equity, we set variable ROE as explained variable and UPM， ROI， IRM， EPR， TAT， EM as explanatory variables. Because the data has two dimensions -- time and individual, we use i to represent the individual and t to represent the time, establish the following model.

$$ROE_{it} = \alpha + \beta_1 UPM_{it} + \beta_2 ROI_{it} + \beta_3 IRM_{it} + \beta_4 EPR_{it} + \beta_5 TAT_{it} + \beta_6 EM_{it} + \epsilon_{it}$$

In the formula, "it" represents the ith individual in the period t, and there are total five periods and 23 individuals.αrepresents the intercept , $\beta_1$representsthe effect of UPM on ROE, $\beta_2$represents the effect of ROI on ROE, β_3 represents the effect of IRM on ROE, $\beta_4$represents the effect of EPR on ROE, β_5 represents the effect of EPR on ROE, β_6 represents the effect of EM on ROE, ε_{it}represents the random error.

4.4 Empirical results

In this section, we conduct an empirical test for the effect of the factors we select on ROE of property insurance company. Using STATA processing panel data and applying fixed effects regression, we found the Prob> F= 0.0031, strongly rejected the original hypothesis. Fixed effects regression is obviously better than the mixed regression. In the Houseman test, the p value was 0.0163, which rejected the original hypothesis, so we adopted Fixed effects regression model. Specific regression results are as follows.

Table V.Regressions Result

Variable	Symbol	Regression coefficient	P
UPM	+	0.134**	0.036
ROI	+	1.88***	0.001
IRM	+	0.173**	0.015
EPR	+	0.126***	0.008
TAT	+	0.204**	0.039
EM	+	0.806*	0.089
_cons	+	-0.247***	0.006

***p<0.01,**p<0.05,*p<0.1

In the regression results, Prob> F= 0.0003 showed that there was a significant correlation between the explanatory variables and the explained variables in the model, and the changes of the six indicators could well reflect the net interest rate.

Analyzed from the direction the ROE was influenced, the regression coefficient of six indicators are all positive said that they presented a positive correlation with return of equity, which is consistent with the theoretical hypothesis. Analyzed from the degree the ROE was influenced, the regression coefficient of ROI is biggest of all, which showed that the change in the investment rate caused the biggest change in the net interest rate of interest. The second biggest regression coefficient is EM's. Its value is 0.806. However, the p value of EM is the biggest of six indicators, so it is least significant. The degree of effect of TAT on ROE ranked third, but much weaker than the first two. From the point of view of significant degree of explanatory variables, ROI and the EPR are the highest, they are both significant at 1% level. And then underwriting profit rate, investment profit multiplier and total assets turnover are significant at 5% level, at last, equity multiplier is significant at 10% level. The ordinal arrangement of the degree of the sport indexes upon physiological indexes is as follows: rate of return on investment, equity multiplier, total assets turnover, investment returns multiplier, underwriting profit margin, earned premium ratio.

5. Policy Suggestions on Improving Profitability of Property Insurance Companies

5.1 Policy Suggestions at the Level of Property Insurance Companies

Improve underwriting and claims service quality, and improve property insurance companies' underwritingprofits. Such profits of China's property insurers have been negative for many years, which is in direct relation to the quality of underwrite and claims service. The empirical results also show that underwriting profit is an important factor affecting the profitability of insurance companies. As underwriting business is these companies' main business, they should give top priority to raising the business's profit level. Improvement in underwriting and claims service quality improvement can not only reduce the loss ratio, but also control the underwriting risk, thereby reducing such companies' business risks and improvingtheir profitability.

Maximize asset utilization levels, and improve investment profitability. China's property insurersstill lag relatively far behind their foreign competitors inasset utilization and asset operation capacity, with the former's investment income multiplier equivalent to that of America a decade ago. Therefore, the asset utilization and investmenthas much room for improvement. Given theproperty insurers' current underwriting losses are mainly compensated with investment income, it is of great importance to improve the investment rate of return of funds, and all the more so sincefunds of insurance companies are mostly short-term liquidity and have higher requirements for the funds management level. Insurance companies are companies that manage risks, and thus they need to pay extra attention to the field where the funds are invested and the level of risk.

Large insurance companies can set up a special asset management company, while small-and medium-sized ones can seek the help of professional asset management companies. There are altogether 12 such companies in China, according to the

Insurance Association, which can provide better advice for insurance companies regarding risk management and professional operation of funds. From the viewpoint of investment channel, the channels to utilize insurance companies' funds should extend, the forms of financial products diversified, and meanwhile, risks prevention and control given extra attention to while making investment on the securities, bonds and real estate markets that are opened up by the state, ashighyield means highrisk. Nevertheless, reasonably arranging investment structure and funds management ways, in light of the funds characteristics and investment experience of the company in question, can ensure steady growth in investment yields.

Optimize management, and seek new profit growth points. Of the domestic Chinese-funded property insurers, some have the state-owned shares account for too high a proportion, leading insufficient vitality in internal management and lack of competition and incentive mechanisms. Such companies should change economic thinking, accelerate the process of marketization and establish a reasonable corporate governance structure. Although the overseas-funded insurers have the same legal status as Chinese-funded ones, they are yet to form the samesize and visibility. Such companies should approach the problem from the perspective of improving market share and forming an economy of scale, which means establishing a stable customer base.

5.2 Policy Suggestions at the Regulatory Level

Strengthen solvency monitoring and control financial risks. Property insurance companies' solvency is a prerequisite for stable operation and performance of insurance liability. Besides, solvency regulation is essential to ensuring the healthy development of the industry,and a pivotal means to ensure steady stability in national economy. In order to ensure the stable development of such companies in China, we must strengthen solvency regulation; in terms of investment, we should strengthen the stock and fund investment management, establishreporting mechanisms, and prevent property insurance companies from investment concealment and misstatement. In addition, we should strengthen companies' risk management, control, and assessment; improve the transparency of corporate finance; ensure accuracy and authenticity of companies' financial data; regularly disclose financial data and information on indicators; regularly review assessments. Finally, regulators should promote transparency of regulation, while advancing the rates' market process, improve market mechanism, and pay attention to the relevance between property insurance market and other financial markets.

Create a healthy business environment, and improve profitability stability. The development of China's property insurance industry will not sustain without the guidance and regulation of insurance regulators. A stable and healthy industry environment is a fundamental guarantee for property insurance companies to improve. Only in a good business environment, canthese companies advance steadily in business operation and capital investment. That said, regulators have the responsibility to build a healthy industry environment for these companies to make profits. As these companies in China largely rely on investment earnings, regulators shouldadopt appropriate measures to control investment risk, guide insurance companies to invest in the stable-performing financial sectors, ensure a stable stream of earning, such as establishing early warning mechanisms and guiding the diversification ofinvestment. While relaxing the investment channels, regulators

should carry out dynamic monitoring on the investment environment and execute review and proper punishment in case of investment not in compliance with regulations.

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The Study on Solvency Capital Requirement of Small and Medium-Sized Property Insurance Company in China under the System of Composition by the C-ROSS

ZHOU Haizhen, ZHOU Xinting

ZHOU Haizhen
Associate Professor
Zhejiang University of Finance and Economics
Hangzhou310018, China
Phone: 15957120135
Email: zhouhaizhen@zufe.edu.cn

ZHOU Xinting*
Graduate student
Master of Insurance
Zhejiang University of finance and economics
Phone:17816854339
Tao Li Yuan, Zhejiang University
Email:zxt123love @163.com

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Abstract. In the first quarter of 2016, the second generation of solvency regulation system was officially being into effect. The implement of the c-ross is to scientifically accurate measurement of risk and increases sensitivity to risk.solvency capital requirement should be calculated based on the risks faced by insurance companies. As we all know, the solvency capital requirement impose a direct impact on capital efficiency and business practice. In this context, it's meaningful to do some research on the solvency capital amounts. Underwriting risk which served as the main risk module of the non-life insurance will be measured as a starting point, then analysis on the status quo of China's non-life insurance industry is done to explore its constraints and make some recommendations.

1.导论

1.1 研究背景

2014年8月13日,《国务院关于加快发展现代保险服务业的若干意见》即"国十条"正式发布。作为"顶层设计"，新"国十条"描绘了保险业全面发展的蓝图，将保险业提高到国家战略产业的高度，同时也阐明了现代保险服务业在整个经济和社会发展中的地位，指出保险业是现代经济的关键行业，是风险管理的基本方式。同时近几年"放开前端，稳住后端"的市场化改革也在稳步推进，保险市场的产品也从传统型向多元化发展，其中万能险，分红险，投连险，变额年金的出现极大的丰富了产品市场，自2013年下半年以来,监管部门在保险资金的投资范围和比例限制各方面也实行了逐步松绑。随着保险行业的持续发展和市场化改革，作为以规模为导向的偿一代监管体系已经无法满足监管要求。

2012 年我国保监会发布了《中国第二代偿付能力监管制度体系建设规划》，成立了由中国保监会正、副主席领导的制度建设小组负责具体工作。计划用 3 至 5 年时间,形成一套既与国际接轨、又与我国保险业发展阶段相适应的偿付能力监管制度。2013 年保监会发布了《中国第二代偿付能力监管制度体系整体框架》(保监发[2013] 42 号)对我国第二代保险监管制度的目标、原则、监管方式以及技术细节进行了详细阐述。2015 年 2 月，中国保监会公布了保险公司偿付能力监管规则共计 17 项，目标是基本建成以风险为导向、符合中国市场化改革需要的第二代偿付能力监管体系（以下简称" 偿二代")，我国保险业监管进入了一个新的历史篇章。2016 年 1 月 1 日正式实行偿二代监管标准，结束偿二代试运行的过渡期。

保险监管的普遍共识是要制定全行业的统一标准，特别是用于监管保险公司偿付能力的最低资本标准。问题在于对我国这样的新兴保险市场，保险机构之间的经营和风险状况差异非常大，因此本文对占据保险公司数量 90%的中小型保险的偿付能力进行研究既不失时效性,也更具针对性。

1.2 研究价值

偿二代确立了"三支柱"的监管体系。其中，第一支柱是定量资本要求，主要防范能够量化的风险，通过科学地识别和量化各类风险，要求保险公司具备与其风险相适应的资本，这为偿付能力的监管提供了直接的参考标准。因此，偿付能力资本要求的设定，直接影响到保险公司的风险能否被全面反应，保险企业的冗余资本能否被释放，资本运用的有效性能否得到提升。

由于保费风险是保险公司特有的风险，也是主要的风险，所以本文选择该项风险作为偿付能力资本要求研究的风险参考。当前，国内的财险企业的分类主要是以市场份额为依据，大型财险公司是指市场份额高于 10%的企业，中小型财险公司是指该数据低于 10%，根据实际情况我们把平安、太平洋和人保这 3 家公司以外的其他企业统称为中小型财产保险企业。本文选取占据保险公司数量 90%的中小型保险作为研究的主体，分析统一的行业监管标准中偿付能力资本要求设定的合理性。

1.3 文献综述

1.3.1 国外研究现状

欧洲最早的偿付能力研究工作是由 campagne（1948）和 pentikanen（1952）

开始的。Pentikanen(1952）首次提出偿付能力溢额的概念，它是保险公司的认可资产和认可负债的差额，是一个实际值。最低资本要求（实际资本 / 最低资本），即偿付能力充足率的确定，但是我们还必须弄清的一个问题是，实际可利用的资本和监管当局要求的最低资本之间的区别，前者是一个 Pentikanen (1952)定义的真实值，而后者则是监管当局出于保护保单持有人利益的一个要求值。理论上的资本要求，一般都是监管当局要求的最低持有资本数量，一旦实际资本低于这个最低要求，则监管当局将进行监管干预。对监管者来说，最低资本要求的设计工作是尤其富有挑战性的问题，那么，监管当局是如何设计这个理论上的最低要求“值” 呢? 里程碑的工作是 Campagne(1961)做出的。campagne（1961）所运用的数据是欧洲国家 1952-1957 年非寿险公司的保单年度数据，并假设费用率为常数 42％，赔付率服从 Beta 分布，利用在险价值（VaR）方法估计出欧洲国家赔付率大于 83％的概率不超过 0.03%，则综合成本率为 42％＋83％ ＝125％，即公司需要保费收入的 25％作为额外资本准备，以保证公司未来一年偿付能力充足的概率不低于 99.97%。欧洲 Solvency 0 正是基于 campagne（1961）的研究报告，经过协商与妥协，最终使用 99.5%和 99.2％的置信水平确定的。欧洲 Solvency Ⅰ即借鉴了这种做法，在 Solvency 0 的基础上加入了信用保险和巨灾风险的分类，而我国偿二代和欧洲 SolvencyII 则是更加细致地对风险进行分类并分别设定风险因子。在欧洲推出 Solvency 0 之后的一段时间内，又有很多文献(Daykin，1984;Kastelijn＆Remmerswaal，1986;Pentikainen，1982;Norberg＆Sundt，1985)继续深入对最低资本要求进行研究，直到 20 世纪 90 年代，这些研究(Daykin，1984;Daykin＆ Hey，1990)渐渐形成了一个趋势，即在设计最低资本需求时应该将保险公司面临的各种风险考虑进去。这种考虑最低资本需求的思想被称为“基于风险(Risk Based)” 或者“风险导向(RiskOriented)” (IAA，2004;Sandstrom，2005)。目前欧盟推出的 Solvency II 就是基于这样的原理来计算资本需求。

1.3.2 国内研究现状

国内学者对我国现行的监管标准也进行了一些研究。占梦雅（2006）对偿一代非寿险业最低资本要求的合理性进行了研究，认为偿一代规定中的第二项（近三年平均综合赔款 7000 万元以下部分的 26％和 7000 万元以上部分的 2 3 ％）几乎不起作用。任燕燕、张晓、郭金龙（2009）基于 2001-2006 年的数据，用比率法对我国最低资本标准进行了研究，认为现行最低资本的要求过低。任燕燕（2009）所利用的比率法与 campagne 模型框架其实是一样的，只是将 campagne 模型中的Ｂeta 分布换成了正态分布，并且将置信水平设置为 99.99％，由此得出我国偿一代最低资本标准要求过低的结论是显而易见的，因为 99.99％的置信水平设定得过高。张昌磊(2009)基于 2009 年以前的各家非寿险公司数据， 根据欧盟 Solvency 0/I 的方法进行分析，也认为可以适当向上调整最低偿付能力资本比率系数以降低保险公司由于业务快速发展所产生的破产风险。但是张昌磊(2009)的结论是在用综合成本率替代 Campagne(1961)所用到的损失率而得， 因此也不是一个“原原本本” 的检验。

林悦好、王海燕(2011)借鉴 Solvency II 的理论，也得出了现行监管标准要求过低的结论。然而该研究并不是基于现行监管理论基础进行检验的，我们可以将林悦好、王海燕(2011) 的研究理解成是 Solvency II 在中国的一次定量测试。周县华、王云波（2014）完全按照 campagne 模型以及欧洲 Solvency 0 的 99.5%和 99.2％的置信水平对我国偿一代标准进行验证，认为偿一代的最低资本要求在所验证的区间内偏低，但是在可接受的范围内。但是周县华（2014）所验证的标

准是自留保费或已赚保费的 18%与 16%，而我国偿一代规定的是自留保费减营业税金及附加后 1 亿元以下部分的 18%和 1 亿以上部分 16%，自留保费减去营业税金及附加后，实际中最低资本占自留保费的比例是没有那么高的，因此他的结果也是值得商榷的。2014 年 4 月 25 日，中国保监会发布了偿二代征求意见稿，迄今才一年多时间，国内学者对我国偿二代最低资本要求的研究还比较少。

1.3.3 文献评述

综上所述，目前国内学者对我国偿二代规则的研究较少，而对偿一代与偿二代的比较研究几乎没有。总结目前这些在中国的研究，主要存在的问题:一是研究数据都是 2009 年以前的，但是中国财政部和保监会在 2009 年进行了准备金评估方法的改革(《企业会计准则解释第 2 号》)，利用新的最佳估计加显性风险边际的方法替代原有的保守的规则导向方法。与新的方法相比，2009 年以前的数据并不能准确地反映保险公司的赔付率和盈利水平。二是关于置信水平的基准问题，国内的一些研究都没有考虑到目前保费参数 18% 和 16% 所对应的置信水平，从而使得保费参数比较缺乏一个统一的比较基准。这导致的一个结果是，有些研究会用到 99.99% 的置信水平(任燕燕、张晓、郭金龙，2009)，而有些研究会用到 99. 5% 的置信水平(张昌磊，2009)，其实这种不同标准的"比较"本身就是有问题的。本文将尝试对偿二代下非寿险业保费风险最低资本进行验证，并对偿一代与偿二代的最低资本标准在同一情景下进行对比。

1.4 研究思路

本文通过阅读我国《第二代偿付能力制度体系框架》的基本原则和技术指导,明确了中小型财险企业偿付能力资本要求的计算方式和适用对象,通过梳理主流偿付能力监管制度及改革内容寻找经验借鉴。在规范分析的基础上确定了保费风险模块的风险衡量指标，确定指标之后，通过对比偿一代最低资本和偿二代下保费风险最低资本要求率的数值，描述性分析两代监管制度的差别。接着对我国偿二代非寿险保费风险展开了实证分析，对 38 家中小型财险公司五年赔付率数据拟合 Beta 分布，估计出参数分别计算出不同置信水平下的分位数及其对应的最低资本要求比率，结合前面计算的最低资本要求率分析对应的置信水平。在通过模型确定赔付率后,对影响我国财险业务最低资本要求的非客观因素即费用风险进行探讨,分析我国现阶段偿付能力监管资本要求面临的约束,本文最终可能难以得到一个肯定的具有结论性的结果,但是通过分析和探讨可以发现问题并试图提出一些观点。

1.5 本文的创新点与不足

本文选用了 2011 至 2015 年中小型财险公司的业务数据,考虑到了 2008 年保险年鉴统计口径的更改,数据具有连续性和规范性,因此在样本容量和数据时效性以及质量上有一定的新颖性。目前分析财险企业偿付能力最低资本的文献也不少，但单独把中小型财险公司提取出来分析的还较少。在保费风险的分析中,通过区别客观赔付风险和可控费用风险,使得监管资本可以通过费用因子进行调节,增强其灵活性和适应性。本文还将各公司偿一代最低资本和偿二代保费风险最低资本进行计算对比，整体上判断两代监管制度的区别。在分析赔付风险时，本文采用赔付率拟合 beta 分布的方法，关于赔付率的计算，本文选用了已赚保费作为分母，相对于净自留保费，已赚保费更能反映实际赔付率和保费风险情况。本文的不足在于量化风险时只是考虑的保费风险，还有准备金风险，巨灾风险，信

用风险和市场风险都没有纳入分析范围内。于数据来源的限制，本文并没有对分险种的保费风险风险因子分别进行验证，只是对总体的保费风险进行了研究，对于具体险种的保费风险的风险因子验证问题我们还将继续研究。

2.我国偿付能力监管制度

我国借鉴了欧盟最低资本的计算方法和美国的财务指标预警机制,理论上是合理有效的监管体系,但我国保险业规范发展的时间不长,当时借鉴的制度是否适合我国保险业实际情况还难以得到实践的检验。

2.1 偿一代监管体系最低资本规定

(1)《保险公司偿付能力监管规定》对最低资本的要求《规定》第四条要求财产保险公司应具备的最低偿付能力额度为下述两项中数额较大的一项:

a.最近会计年度公司自留保费减营业税及附加后 1 亿元人民币以下部分的18%和 1 亿元人民币以上部分的 16%。

b.公司最近 3 年平均综合赔款“金额 7000 万元以下部分的 26%和 7000 万元以上部分的 23%。

(2)保险法对资本的要求

2009 年 10 月 1 日起修改施行的《保险法》第一百零二条规定经营财产保险业务的公司当年自留保险费,不得超过实有资本金加公积金总和的四倍。第一百零三条规定保险公司对每一危险单位,即对一次保险事故可能造成的最大损失范围所承担的责任,不得超过其实有资本金加公积金总和的百分之十,超过的部分应当办理再保险。

2.2 偿二代监管体系

2.2.1 监管要素

监管要素是偿付能力监管的三支柱，是偿付能力监管的重要组成部分。三支柱分别从定量资本要求、定性监管要求和市场约束机制三个方面对保险公司的偿付能力进行监督和管理，主要规范偿付能力监管的内容、原则、方法和标准。

1.第一支柱定量资本要求

第一支柱定量资本要求主要防范能够量化的风险，通过科学地识别和量化各类风险，要求保险公司具备与其风险相适应的资本。在第一支柱中，能够量化的风险应具备三个特征：第一，这些风险应当是保险公司经营中长期稳定存在的；第二，通过现有的技术手段，可以定量识别这些风险的大小；第三，这些风险的计量方法和结果是可靠的。

2.第二支柱定性监管要求

第二支柱定性监管要求，是在第一支柱的基础上，进一步防范难以量化的风险，如操作风险、战略风险、声誉风险、流动性风险等。

3.第三支柱市场约束机制

第三支柱市场约束机制，是引导、促进和发挥市场相关利益人的力量，通过对外信息披露等手段，借助市场的约束力，加强对保险公司偿付能力的监管，进一步防范风险。其中，市场力量主要包括社会公众、消费者、评级机构和证券市场的行业分析师等。

2.2.2 最低资本

1.最低资本，是指保险公司为了应对市场风险、信用风险、保险风险等各类风险对偿付能力的不利影响，依据监管机构的规定而应当具有的资本数额。

2.确定最低资本时，必须处理好风险防范与价值增长的关系，建立恰当的最低资本标准，既能有效防范风险，又能避免资本冗余。偿二代的最低资本应当是集中反映不同利益诉求、兼顾各方利益的均衡、公允的资本。

2.3 我国偿付能力监管制度改革总结

从规模导向转变为风险导向，是偿二代区别于偿一代的最重要特征。偿一代下保险公司资本计量主要取决于保费规模，同样保费规模的不同业务资本要求层面没有区分。而在偿二代监管体系下，每个业务都有对应的风险因子，根据风险因子计算各业务的资本，这样有利于各业务风险的识别，避免保险公司一味追求规模，有利于保险公司根据风险类别优化业务结构，有利于经营稳健的保险公司释放在偿一代体系下过于保守的冗余资本。另外最低资本风险范围有所增加，偿一代主要考察保险风险，偿二代则包含了保险风险、信用风险、市场风险三类可量化的风险以及操作风险、战略风险、声誉风险、流动性风险等难以量化的风险。偿二代还将保险公司风险管理水平评估结果与控制风险最低资本要求挂钩，根据风险管控能力不同，保险机构最低资本要求可能减少也可能增加，偿二代的监管机制有助于保险公司提高风控管理的能力。

3.偿付能力计算的理论基础

3.1 破产概率理论

偿付能力资本是为防止非预期损失造成偿付危机而准备的资本,通常以流动性好安全性高的资产形式存在,其最终目的是防止公司遭遇不利冲击造成经营中断或失去偿债能力,风险资本量化原理源于破产概率模型,对保险公司而言,偿付能力资本设置原则就是保证赔款及费用之和高于保费收入及偿付能力资本之和的概率不超过某个概率,其原理可用以下公式进行说明: Pr{L+E < P+RM}>l-a,其中 A 为赔付支出,E 为费用，f 为费用，p 为保费，RM 为偿付能力资本要求,a 为破产概率。为了保证保险公司破产概率低于 a,公司需要持有蕭数量的资本用于防范赔款和费用支出大于保费的风险,破产概率 a 越小,资本要求率越高。破产概率模型为我们设置偿付能力资本提供了基本分析思路,现在所有的风险量化管理依然采用这种思想,只是在风险拟合模型上有着不同选择。

3.2 Campagne 模型

Campagne(1961)的主要依据是破产概率理论，其基本原理是综合考虑保险公司面临的全部风险，通过制定一个偿付能力资本限制，使保险公司破产的概率保持在一个很小的水平之下。Campagne 模型可以表述为以下形式: P(X+E)＞P+msm×P)≤ε其中，X 为保险公司的赔付，E 为费用，P 为净自留保费，msm 为最低资本占净自留保费的比例，ε为破产概率。我国偿二代保费风险可以简要描述为保费收入不够赔付和费用支出的风险，Campagne 模型正是衡量了这样一种风险。本文关于净自留保费的定义与保监会 2003 年《保险公司偿付能力额度及监管指标管理规定》相一致，即:净自留保费(P)=原保费收入+分保费收入－分出保费。

上式经过进一步变形，可以表示成以下形式：P(LR＞1+ msm－ER)≤ε。其中，

LR 为赔付率，ER 为行业平均费用率。Campagne(1961)假设赔付率服从 Beta 分布，主要是基于如下考虑:一般来说，赔付率是在(0，1)区间内分布的，而在随机变量大于 0 同时又小于 1 的分布中，Beta 分布通常与赔付率的真实分布比较接近。

关于赔付率和费用率的统计有两种计算方法：以净自留保费为分母和以已赚保费为分母，本文采用的是以已赚保费为分母的计算方法，已赚保费为所有保单自留保费在统计区间内生成的满期保费，更能反映公司的实际赔付率与承保风险状况。

4.中小型财险公司保费风险最低资本实证分析

偿二代采用定量监管要求、定性监管要求和市场约束机制三支柱框架。其中，作为第一支柱的定量监管要求，是测度可量化为最低资本的固有风险，包括保险风险、市场风险和信用风险三大可量化风险，据此确定保险公司需要具备的资本。本文即是对偿二代可量化风险保险风险中的保费风险进行实证研究，

偿二代中关于非寿险业保费风险的解释：由于保险事故发生的频度及损失金额存在不确定性，导致保费可能不足以支付未来的赔款及费用，从而使保险公司遭受非预期损失的风险。根据保费风险的定义，我们在本章的实证分析中区分了客观风险和非客观风险,赔付风险来自客观的承保标的,但费用风险与公司的经营行为相关性大。本章首先考虑客观的赔付风险,并在最后一节结合费用分析保费风险偿付能力资本额度。

4.1 数据来源

首先我们将保费收入低于 500 亿的保险公司定为中小型财险公司，根据 2012 年各公司的保费收入情况，目前财险市场上只有三家是大于 500 亿的，这三家的保费规模共占据了市场份额的 70%，剩余 30%由中小型财险公司占有。本文选用了 38 家中小型财险公司 2011 年到 2015 年的经营数据，数据来源主要是《保险年鉴》，由于 2016 版的《保险年鉴》还未出版，所以 2015 年的经营数据是从各公司网站披露的年报得出来的。中国保监会在 2009 年年发布《关于保险业实施〈企业会计准则解释第 2 号>有关事项的通知》，要求保险公司在编制财务报表时按照新的企业会计准则编制，所以选用 2011 年到 2015 年的数据保证了统计上的一致性。有些新成立的公司数据不足五年，本文未予选择，另外有些赔付率，费用率大于 1 的数据本文也予以剔除，最后剩下 38 家财险公司作为研究样本。

赔付率和费用率的计算所需要的数据来自于各保险公司的损益表，包括已赚保费、分出保费、赔付支出、摊回赔付支出、提取为巨额赔款准备金、弹回未决赔款准备金、手续费及佣金、业务及管理费、营业税金及附加、分保费用。

4.2 最低资本要求的计算

偿二代保费风险最低资本的计算中风险因子是分险种给定的，计算各险种的最低资本时需要用到各险种的净自留保费，这个数据在《保险年鉴》和公司年报上是没有给出的，本文利用各险种业务的规模占总公司业务规模的比例来估计分险种的情况，由此计算各业务类型的净自留保费。

其中：

各业务类型的分保费收入（或分出保费）≈各业务类型的保费收入 / 公司总保费收入×公司总的分保费收入（或分出保费）。

各业务类型的净自留保费＝各业务类型的保费收入＋各业务类型的分保费收入－各业务类型的分出保费。根据《保险公司偿付能力监管规则第 4 号：保费风险最低资本（非寿险业务）》中的规定，保费风险最低资本以各业务类型的净自留保费为风险暴露，利用规定中给定的风险因子对各业务类型的保费风险最低资本进行计算，最后加总得出保险公司总的保费风险最低资本。

4.3 偿一代最低资本和偿二代保费风险最低资本对比分析

偿一代关于非寿险业最低资本计算的规定是：使用以下（1）、（2）中的较大值作为最低资本要求:（1）会计年度自留保费减营业税金及附加后 1 亿元以下部分的 18%和 1 亿元以上部分的 16%；（2）近三年平均综合赔款 7000 万以下部分的 26%和 7000 万以上部分的 23%。有很多研究(占梦雅，2006;任燕燕、张晓、郭金龙，2009)都证实了"规定"中的第二项几乎不起作用，因此，偿一代最低资本的计算标准就是保费规模，风险度量比较单一，单纯以业务规模的百分比来衡量保险公司所面临的风险，结合保费风险的定义可以看出偿一代最低资本要求只是单纯考虑了保险公司的保费风险，本节内容就是基于这点，对非寿险业偿一代最低资本标准和偿二代保费风险最低资本标准进行实证对比分析。

根据前面介绍的偿一代最低资本以及偿二代保费风险最低资本的计算方法，我们选取鼎和财险作为示例进行计算。

（1）偿一代最低资本(单位:万元)

自留保费=原保费收入+分保费收入-分出保费

=266519.1+1288.25-34590=233217.35

自留保费-营业税金及附加=233217.35-14455.67=218761.68

最低资本=10000*0.18+(218761.68-10000)*0.16=35201.87

最低资本占已赚保费的比例=35201.87/228273=15.42%

（2）偿二代保费风险最低资本（单位:万元）

车险分入保费=(车险原保费收入/总的原保费收入)×总的分入保费收入

= (149392.9/266519.1)×1288.25 = 722.1072

车险分出保费=(车险原保费收入/总的原保费收入)×总的分出保费收入

=(149392.9/266519.1)×34590=19388.85

依次算出其他险种的分入保费、分出保费。

再根据: 自留保费=原保费收入+分如保费-分出保费，算出各险种自留保费，如表 1

表 1 各险种保费收入情况

险种	保费收入	分入保费	分出保费	自留保费
车险	149392.9	722.1072	19388.85	130,726.12
企财险	67895.98	326.6042	8811.834	59,410.75
工程险	23271.95	111.9465	3020.334	20,363.56
意外险	14916.12	71.75193	1935.879	13,051.99
责任险	6363.31	30.60982	825.8579	5,568.06

各业务类型的保费风险最低资本计算公式为：

$$MC=EX \times RF \quad (4.1)$$

其中:

MC 为各业务类型的保费风险或准备金风险的最低资本；

EX 为风险暴露；

RF为风险因子，$RF = RF_0 \times (1 + K)$

RF_0为基础因子，K 为特征因子，$\sum_{i=1}^{i=n} k_1 + k_2 + \cdots + k_n$，K∈[0.25, 0.25]，保监会另有规定的除外；

根据《保险公司偿付能力监管规则第 4 号：保险风险最低资本（非寿险业务）》，RF_0的大小是根据各险种自留保费的大小而定，由于k_i值的确定所需要的数据在保险公司的年报无法获得，这里我们就精简公式，只考虑RF_0的取值。例如车险的自留保费在 10 亿～50 亿这个范围，对应的就是 0.0925，同样其他险种对应的风险因子情况如表 2

表 2 各险种风险因子

险种	车险	企财险	工程险	意外险	责任险
风险因子	0.0925	0.39	0.39	0.078	0.145

根据公式 4.1 算出各险种最低资本，最后加总得到鼎和财险偿二代下保费风险最低资本：

$\sum MC$=130726.12×0.0925+59410.75×0.39+20363.56×0.39+13051.99×0.078+5568.06×0.145=45029.57

最低资本占已赚保费的比例=45029.57/228273=19.73%

根据前面的计算方法算出另外 37 家公司最低资本占已赚保费的比例。同时根据表 3 这个数据，做了一些统计量的分析，统计结果如表 4。

表 32015 年各公司最低资本占已赚保费比例

公司名称	偿二代		偿一代	公司名称	偿二代	偿一代
国寿财险	0.1165		0.1613	国元农险	0.2170	0.1538
大地保险	0.1285		0.1609	鼎和财险	0.1973	0.1542
太平财险	0.1073		0.1565	紫金财险	0.1284	0.1605
阳光财险	0.1337		0.1698	浙商财险	0.1418	0.1530
华泰财险	0.1225		0.1531	信达财险	0.1212	0.1425
天安	0.1185		0.7050	中意财险	0.8358	0.1811
华安	0.1243		0.1613	美亚	0.1586	0.1617
永安	0.1183		0.1639	东京海上	0.2172	0.1571
永诚	0.1275		0.1534	太阳联合	0.6584	0.1900
安信农险	0.3188		0.1499	丘博	0.6085	0.1620
安华农险	0.1754		0.1626	三星财险	0.1851	0.1724
阳光农险	0.2290		0.1607	安联	0.3676	0.1633
渤海	0.1420		0.1558	日本财险	0.5575	0.1996
都邦	0.1431		0.1593	利宝	0.1119	0.1568
华农	0.1440		0.1758	安盟	0.2457	0.1624
民安	0.1344		0.1467	现代	0.1640	0.2735
安诚	0.1243		0.1494	爱和谊	0.1998	0.2088

中银	0.2239		0.1295	兴亚	0.8002	0.1726
英大财险	0.2741		0.1519	乐爱金	0.6111	0.1897

表 4 最低资本要求率对比分析

统计量	偿二代	偿一代
加权平均值	0.1407	0.1486
算术平均值	0.2509	0.1800
标准差	0.2009	0.0906
中位数	0.1613	0.1611
最大值	0.8353	0.705
最小值	0.1073	0.1295

根据表 4 可以看出，偿二代下最大值、最小值这两项数据都比偿一代要高，说明在偿二代的监管标准下，整体上企业的最低资本增加了，监管更严了。另外偿二代下的标准差是 0.2009,相比偿一代 0.0906 的标准差要大了很多，这主要是因为偿一代的风险因子单一，风险大小的衡量标准主要是每个公司的保费规模，从偿一代第一项的计算标准：会计年度自留保费减营业税金及附加后 1 亿元以下部分的 18%和 1 亿元以上部分的 16%，可以看出，最低资本占已赚保费比例大小的差异主要来自营业税及附加，而营业税金及附加占已赚保费的比例比较稳定，所以偿一代下的标准差较小，数据较稳定。偿二代在计算保费风险最低资本时，将险种进行了分类，不同的险种对应不同的风险因子，由于每个公司经营的险种的规模存在差异，从而导致了偿二代下最低资本占比率的差异较大。

另外，本文选用了两种均值的算法：算术平均值和加权平均值，这两种算法也表达了不同的含义。加权平均最低资本要求比率是行业所有公司的最低资本要求之和占行业所有公司总的已赚保费的比率，这个比率是对非寿险业偿付能力最低资本监管的一个总体概览。偿一代下最低资本要求率是 14.86%，偿二代下保费风险最低资本要求率是 14.07%，二者相差不多，主要是因为，目前规模较大的财险企业主要经营的险种就是车险，而偿二代保费风险中车险的风险因子较小，导致整体的加权平均值没有比偿一大多少。

再对算术平均最低资本要求比率进行分析，偿一代最低资本要求比率是 18%，偿二代保费风险算术平均最低资本要求比率是 25.09%，后者比前者高出 7 个百分点。这还是仅考虑了偿二代下保费风险，若将其他可量化的风险加入考虑，偿二代下的最低资本要求率可能会更高。这是因为偿二代监管体系在计算最低资本时分险种设立了风险因子，有些险种的风险因子很高，比如农业险、信用保证险以及财产险的风险因子都在 30%以上，总体上拉高了平均最低资本要求比率。

根据表 3，我们对每个公司的最低资本要求率的变化情况进行统计，发现有 17 家公司偿二代下保费风险最低资本要求率比偿一代下最低资本要求率高，21 家降低。

17 家最低资本要求率提高的保险公司中有四家主要经营农业保险，分别是国元农险、安信农险、安华农险以及阳光农险，正是因为他们主营业务的风险因子在偿二代监管要求下较高导致的；除了这 4 家经营业务专业性较强的公司，还有 13 家公司的最低资本要求率也提高了，其中提高 35%以上的 6 家公司是中意财险、太阳联合、丘博、日本财险、兴亚以及乐爱金，我们分析这 6 家公司经营的保险品种，其中有 5 家不经营车险业务，且主营业务是企财险，剩下的中意财险

虽然经营车险但保费规模第一的仍是企财险，偿二代中企财险的风险因子达到了30%以上；最低资本要求提高幅度低于35%的7家公司都有经营车险业务，但总体保费规模较小。

对于21家最低资本要求率降低的保险公司，它们的主营业务都是车险，并且保险规模在20亿以上的有16家，如果把中小型财险公司这个群体按保费收入20亿这个临界点分成中型和小型，那么主要经营车险业务的中型财险公司的最低资本要求率都是降低的。

所以，我们大致可以得出这样的结论：保费规模的大小以及主营业务的不同影响着偿二代下中小型财险公司最低资本的变化。如果保费规模和车险业务规模越大以及风险因子较大的农业险、财产险、信用保证险的业务规模越小，那么偿二代监管体系对该保险公司最低资本的影响就越小。

4.4 中小型财险公司赔付风险分析

下面我们对赔付率进行实证分析，38家中小型财险赔付率的分布直方图如图1所示，从图中我们可以看出赔付率主要集中在50%左右，而偿一代最低资本要求中的第二项标准只有在赔付率达到70%以上或者30%以下才会起作用，因此也证实了前面所说的偿一代基本都是以保费规模作为最低资本测算标准的。

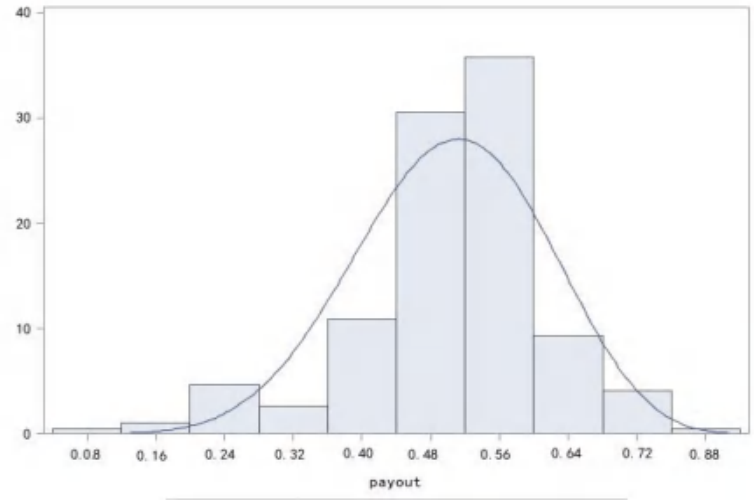


图1 赔付率的分布直方图

我们利用这38家财险公司190个赔付率数据拟合Beta分布，估计出参数a=7.23，b=5.09，并且对Beta分布进行KS检验，检验结果如图2，结果显示显著，拟合效果较好。

單一樣本 Kolmogorov-Smirnov 檢定

		VAR00001
N		193
常態參數[a,b]	平均數	.5838
	標準偏差	.10893
最極端差異	絕對	.125
	正	.076
	負	-.125
測試統計資料		.125
漸近顯著性（雙尾）		.000[c]

a. 檢定分配是常態的。
b. 從資料計算。
c. Lilliefors 顯著更正。

图 2 KS 检验

根据拟合出来的 Beta 分布，我们计算出不同置信水平下的分位数及其对应的最低资本要求比率，结果如表 5 所示，大致可以看出，随着置信水平的提高，即破产概率越低，最低资本要求比率也越来越高，监管也越加严格。

我们将之前计算的偿一代和偿二代最低资本要求比率的均值与这个表格进行对比分析。偿一代下最低资本要求比率算术平均值是 17.84%，对应着 94.2%的置信水平，再回顾一下偿一代关于最低资本计算的第一条标准：会计年度自留保费减营业税金及附加后 1 亿元以下部分的 18% 和 1 亿元以上部分的 16%，所以在偿一代下计算出来的最低资本要求比率正常都在 16%～18% 这个范围，18%这个数值也验证了这点。在偿一代监管标准下，中小型财险公司最低资本要求比率所对应的置信水平大概在 94%左右，就是说中小型财险公司有 6%的可能性面临破产，这个概率相对成熟市场的 0.05%高出了很多。偿二代下保费风险最低资本要求率的算术平均值是 25.09%，对应的置信水平接近 99%，相比偿一代下 94%的置信水平，偿二代的监管标准严格了许多，接近于成熟市场的监管要求，算术平均值较高主要是因为一些专业型和小型财险公司的主营业务品种的风险因子较高导致的。

另外，我们计算出来的偿一代和偿二代下最低资本要求率加权平均值分别是 14.07%和 14.86%，二者相差不大，都接近 92%的置信水平，这主要是因为规模较大的财险公司都是以车险为主营业务，而车险的风险因子较小，整体上拉低了偿二代的最低资本要求率。鉴于目前险种规模上车险占据了 70%左右的份额，我们用加权平均值研究目前的监管制度的合理性更恰当一些。但是，92%的置信水平相对较低，所以偿二代监管标准在车险的保费风险因子设定上可能略显宽松，但考虑到国内保险市场处于发展阶段尤其中小型财险公司，市场尚未成熟，这个标准也是在接受范围内的。

表 5 Beta 分布下不同置信水平对应的最低资本要求比率

置信水平	92%	93%	94%	95.0%	95.5%	96.0%	96.5%	97.0%	97.5%	98.0%	98.5%	99.0%
VaR	71.19%	72.32%	74.71%	75.94%	76.29%	76.36%	76.55%	77.35%	78.07%	78.59%	81.29%	82.23%

msm	14.20 %	15.33 %	17.72 %	18.95 %	19.30 %	19.37 %	19.56 %	20.36 %	21.08 %	21.60 %	24.30 %	25.24 %

4.5 中小型财险公司费用风险分析

保险公司费用开支跟公司经营行为相关性强,除税金及附加外,手续费及佣金,营业费用都是公司可以控制的,严格来说非客观可控的费用波动不能称作风险,如果费用率较高,将直接降低偿付能力充足率,企业可采取外部融资补充资本或者控制费用,但赔付风险是客观、不可控的,唯有补充资本加以防范。因此,本节通过分析中小型财险公司平均费用对保费风险资本要求的影响。

图 3 是我们将中小型财险公司 5 年来的费用率统计情况和大型财险公司的对比结果。

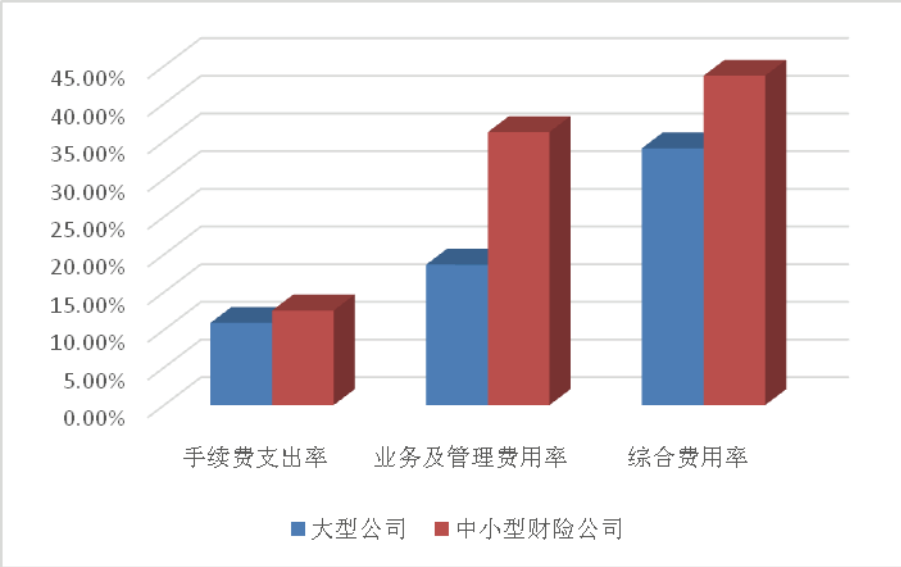


图 3　中小型、大型财险公司综合费用率、业务及管理费用率对比

大型财险公司的手续费支出率是 10.99%,中小型财险公司的综合费用率是 12.86%，中小型财产公司明显高于大型财险公司，大公司成立时间长，在传统渠道上有很强的控制力，而中小保险公司由于成立时间晚，品牌知名度远不及大型公司，再加上新公司成立初期往往只能受限于一定区域经营，局限性大，与大型公司相比，分支机构少，在传统渠道上面往往很难突破大型公司的掌控，只能通过支付高于大型公司的手续费来获取保单，增加了成本。

大型财险公司的业务及管理费用率为 18.65%,明显优于中小财险公司,规模效益在管理成本、费用成本和佣金成本得到了良好的表现。中小型财险公司的业务及管理费用率为 36.23%,许多中小型财险公司成立时间较短，由于前期需要投入极大的资金，包括注册资本金的要求、前期办公场所的租赁。再加上开业前期保费收入相对较少，导致费用率的分母较小，费用率整体较高。

大型财险公司的综合费用率 33.19%，中小型财险公司则是 43.01%，前面在计算 beta 分布下不同置信水平对应的最低资本要求比率时，根据 msm=VaR+ER-1，其中 ER 取的值就是 43.01%，如果中小型财险公司平均费用率降低到大型财险公司的 33.19%，最低资本要求率的计算结果如表 6

表 6 Beta 分布下不同置信水平对应的最低资本要求比率

置信	92%	93%	94%	95%	95.5%	96%	96.5%	97%	97.5%	98%	98.5%	99%

水平												
VaR	71.19%	72.32%	74.71%	75.94%	76.29%	76.36%	76.55%	77.35%	78.07%	78.59%	81.29%	82.23%
msm	4.38%	5.51%	7.90%	9.13%	9.48%	9.55%	9.74%	10.54%	11.26%	11.78%	14.48%	15.42%

偿二代下最低资本要求率加权平均值是 14.86%，在这个表中对应的置信水平就是 98.5%左右，比 92%提高了 6 个百分点，意味着保费风险下的中小型财险公司的破产概率降低了 6 个百分点，所以积极控制费用支出，将有利于降低保费风险。

4.6 保费风险资本额度实证结果

偿一代与偿二代的最低资本要求率的对比发现，偿一代的资本要求确实偏低，鉴于当时中国的保险市场还处于起步阶段，监管也处于探索时期，所以这个资本要求也可以接受。另外考虑到目前中国保险市场上车险占据 70%的份额，而且车险的风险因子较低，所以偿二代保费风险最低资本要求率的加权平均值更有现实意义，但其对应的 92%的置信水平是较低的，如果要求 99%的置信水平，38 家公司中只有 8 家达到了最低资本要求率，可以看出偿二代最低资本的监管标准还是相对宽松的，但是对风险的度量比偿一代更加科学了。

在考虑费用风险时，中小型财险公司的费用率普遍较高，较高的费用率将直接降低财险公司的偿付能力，中小型财险公司外部融资能力不如大型财险公司，在短期内难以调整业务结构的情况下，尽可能控制运营成本降低费用，从而提高偿付能力。经营费用主要来源于中小型财险公司内部运作的各个环节。所以提高管理效率是关键环节,首先要构筑扁平化的组织结构,精简中间职能机构和人员、减少管理层次,同时要给予一线岗位人员较多的自主权和更大的灵活性。其次，有效控制手续费的支出比例,在信息化的今天,要充分利用先进的互联网信息技术,通过网络销售和电话销售的方式,降低保单销售成本。最后,提高对风险的识别和防范能力,强化对保险理赔的管理,避免在业务承保和理赔的环节中逆选择和道德风险的发生。

5.第二代偿付能力监管体系实施后的影响及政策建议

5.1 第二代偿付能力监管体系实施后的影响

5.1.1 激励保险公司进行风险管理

保险业是经营风险的特殊行业,风险管理是保险公司管理的主要目标,新的偿付能力框架将更加鼓励保险公司进行风险管理,今后,偿付能力的管理主要是风险的管理,各保险公司为了保证其偿付能力的充足,必须及时对其保险风险、市场风险和信用风险进行管理,风险管理水平强的保险公司偿付能力充足,保险业务也将随之增多,如此相互影响。这将激励更多的保险公司进行风险管理,进而使整个保险业在风险管理方面更有作为,使保险市场变得更加安全,投保人的利益更能够得到保障。

5.1.2 为市场化改革提供监管保障

市场化改革为保险公司提供了更多的灵活性和自主性,但监管是必不可少的,因此,市场化监管变得很重要,为市场化改革提供了监管保障。市场化改革主要包括投资监管政策的市场化改革和条款费率的市场化改革,前者涉及利率和信用风险,后者涉及保险风险,这些风险的市场价值能准确反映公司所面临的风险,对其的评估和监管能使保险公司在稳定经营的前提下获取更大的价值。

5.1.3 对保险企业管理提出挑战

偿二代相对于偿一代对风险管理和企业管理的要求更高,新的规则要求保险公司的企业战略、经营模式和竞争行为随着市场环境和监管环境的变化而及时调整,要求产品创新能力、定价能力、投资能力和风险管理能力变得更加强大,要求保险公司人员和监管人员主动进行知识更新和创新,对保险人员的理论和技术水平提出了较高的要求,也对保险企业组织架构和管理重点提出了挑战。

5.2 政策建议

5.2.1 应实施有差别的监管

通过风险考察,以风险为依据划分风险群体制定对应的监管对策,通过对行业风险的全面调查和测算摸清行业底细,为监管制度的制定提供参考。其实在欧美监管制度中也存在差别监管。美国的 RBC 制度,除签单保费低于 200 万美元并且只在国内开展业务的保险公司外,适用于所有人身险和财产险公司。欧盟偿付能力 II 考虑到保险公司的规模、性质和其服务内容采取差别监管,如保费收入低于 500 万欧元的公司不需执行偿付能力 II,有成员国特别规定的也可以不采用其标准,强调新的偿付能力制度不能成为中小型财险公司的负担,尤其是专业性保险公司。

5.2.2 区分客观风险和非客观风险

偿付能力管理的最终目的是防止公司破产,因此偿付能力最低资本额度对于应对不利风险冲击确实能起到一定的风险缓释作用,但是公司是可以采用风险控制手段降低非客观性风险。如何准确衡量行业客观风险,并将企业主观风险反应到资本要求中,同时对企业主观风险行为进行有效约束,才能充分体现最低资本要求与风险防范要求的统一。中小型财险公司在成立初期，规模快速扩张、营业管理费用比例过高这类风险,不应该反应到监管最低资本要求中来,因为这会反应到实际资本的减少中去,采用行业平均水平或认可水平即可。

5.2.3 强化第二和第三支柱的作用

最低偿付能力资本要求,是保险偿付能力监管制度中对公司影响最直接的监管要素。过高的要求增加保险公司的资本成本,影响保险业的发展速度和行业吸引力。我国 C-ROSS 始终强调风险和价值的平衡,所以监管资本要求不会与现行标准存在太大的差异。在资本不能大幅增加的情况下,唯有合理控制公司的经营和投资行为以降低风险暴露,这种控制会更多依赖于完善的法规和严格的监管执行来实现。另外一个现实问题是保险业快速发展同偿付能力资本融资压力增加的矛盾。中小型财险公司在市场上的的品牌效应不如大型财险公司，大型公司可以发行次级债融资，而对于中小型财险公司来说盈利能力的改善才是为其持续发展提供源源不断的内部资本的来源。

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偿二代下中小型财险公司偿付能力最低资本要求研究

周海珍 周新婷

周海珍
副教授
浙江财经大学金融学院
杭州310018，中国
电话: 15957120135
Email: zhouhaizhen@zufe.edu.cn

周新婷*
保险硕士
浙江财经大学金融学院
杭州市江干区下沙经济技术开发区
学源街
电话:17816854339
Email:zxt123love@163.com

关键词：偿二代；最低资本；中小型财险；偿付能力

摘要.2016年第一季度，第二代偿付能力监管体系正式实施。中国偿二代建设的目标是要科学准确的计量风险并提高对风险的敏感度，在计算保险公司面临的各个风险模块的资本要求的基础上合理设置资本额度。在此背景下,本文选取中小型财险公司为研究对象，对构成财险业主要风险的保费风险进行计量，并以此为起点探讨我国财险业偿付能力资本标准,结合我国中小型财险公司发展现状,分析作为监管第一支柱的量化要求面临的现实约束,并提出建议。

Chapter 2.Risk Management

Risk Analysis and Countermeasure Research on Public Transport Passengers

----Based on the Perspective of Insurance

FENG Yuchen

School of Insurance
Central University of Finance and Economics
Beijing 102206, China
Phone: 15652126802
Email: fengyc9170@163.com

Keywords: Public transport; Passengers risk; Risk analysis; Insurance

Abstract. With the increase in the number of private cars and seriousness of traffic congestion in our country, public transport plays an increasingly important role in urban development. However, insurance status quo is worrying and the risks in the public transport cannot be insured. This paper analyzes the risks of passengers, the status quo of insurance insured by public transport operators, the problems of insurance in the field of public transport. Suggest that insurance companies should develop new insurance product, the government should increase the intensity of fiscal subsidies, have appropriate policy interventions and legislative guarantee, passengers should improve accident insurance consciousness.

1．引言

随着我国私家车数量的不断攀升、交通堵塞情况的日益严重，公共交通对市民出行和城市发展发挥愈发重要的作用。国务院早在 2013 年就发布了《关于城市优先发展公共交通的指导意见》，明确将公共交通置于优先发展的地位。然而，现有公交车的投保情况令人担忧，乘客在乘坐公交车过程中存在的风险无法得到应有的保险保障。一起起公交纵火案造成的惨重伤亡刺痛着我们的神经，但残酷的现实更让我们无法回避：我国目前公共交通投保情况如何？遭遇突发事故时由谁来承担乘客的赔偿金？能否通过保险，更好地保障公共交通运营过程中乘客面临的风险？

本文的创新点在于：（1）对公共交通运营过程中乘客存在的风险进行了合理划分，有助于运营商和保险公司有效地进行风险管理；（2）通过公交纵火案这类突发事故来反省公共交通的投保现状，通过事故的赔偿情况来体现保险损失补偿的功能；（3）从风险可保性、保费公平性、保险利益等角度，分析现有保险产品在公交领域的问题和争议；（4）细分市场需求，根据公交领域特定风险，尝试开发新型保险产品。

2．乘客风险分析

笔者搜集近年来公交车发生的各种事故，从精算的原理出发，按照风险的发生概率和损失强度，将公交车在行驶过程中乘客存在的风险划分为两大类：

一是因车辆碰撞、倾覆、火灾、自燃等事故造成的人员伤亡；二是车辆刹车、起步、停车、转弯、车门开关过程中发生磕碰、摔倒、挤压造成的乘客人身伤亡和财产损失。

两种风险发生的概率不同，造成的损失不同。公交车每天在市区固定的线路上低速行驶，发生大型交通事故造成群死群伤的概率极低。即使发生交通事故，比如撞伤路人、与其他车辆相撞，车上乘客也一般不会出现大面积伤亡。但是因为公交车本身的运营特点，乘客上下频繁、存在大量的站立乘客以及严重的超载现象，第二种风险经常发生，乘客在公交车上摔倒受伤的报道屡见不鲜。笔者走访了承保北京公交集团的某保险公司北京分公司，了解到保险公司每年对第二种风险的赔付额都在 1500 万元左右。此外据报道，武汉市 2014 年有上千名乘客乘坐公交受伤，平均每天有近 3 名，由此带来了上千万元的医疗费用。而事故的主要原因是急刹车、急加油、急转弯导致车厢的不平稳。

3．公交公司投保现状分析

为了解各地公交公司的投保情况，笔者整理出近几年公交纵火案发生地的公交车投保情况和赔偿情况，包括福建省厦门市、四川省省会成都市、贵州省省会贵阳市、浙江省省会杭州市、广东省省会广州市、四川省宜宾市、宁夏省省会银川市，汇总结果如表 1。

表 1 历年公交纵火案及投保情况盘点

	伤亡情况	交强险	承运人责任险	商业车险
2009 年 6•5 成都公交车纵火案	27 人死亡 74 人受伤	投保	每次事故赔偿 限额 400 万元	三责险，不计免赔险等
2013 年 6•7 厦门公交纵火案	47 人死亡 34 人受伤	投保	赔偿限额为每座位 35 万元	三责险 车损险
2014 年 2•27 贵阳公交车燃烧事件	6 人死亡 35 人受伤	投保	未投保	未投保
2014 年 5•12 四川宜宾公交纵火事件	1 人死亡 77 人受伤	投保	全车责任险最高赔偿限额 145 万	未投保
2014 年 7•5 杭州公交车纵火案	32 人受伤	投保	赔偿限额为每车每次事故 15 万	未投保
2014 年 7•15 广州公交车纵火案	2 人死亡 33 人受伤	投保	投保	未投保
2016 年 1•5 银川公交纵火案	18 人死亡 32 人受伤	投保	赔偿限额每车 150 万 每座位 10 万	未投保

纵观近几年的公交纵火案，几乎全部发生在经济发达的大城市，公交公司的规模和资金实力也相应突出，但是公交车辆的投保情况却不尽如人意。承运人责任险投保情况参差不齐，每次事故的赔偿限额也各不相同。杭州市公交车虽投保该责任保险，但是每车每次事故赔偿限额仅为 15 万元。而其他商业车险投保情况更是不容乐观。经济发达的大城市投保情况如此，经济落后的广大中小城市更是堪忧，除国家强制购买的交强险以外，绝大多数没有购买其他任何保险，公交乘客受到的保险保障微乎其微。

这些纵火案中，作案人通常是一些心怀不满而报复社会，甚至对无辜民众施暴的厌世者。作案人大多被火当场烧死，而人员伤亡、财产损失的赔偿责任全部落在了公交公司的头上。大城市的公交集团经济实力相对雄厚，尚可承担这类事故的赔偿责任，不至于破产。假设类似事故发生在经济欠发达的小城市，这些城市的公交集团大多实力薄弱甚至只是一些皮包公司，受害者及其家属必定很难从公交公司得到应有的赔偿，产生各类赔偿纠纷。

公交车投保情况堪忧的原因，主要在于：

（1）观念问题

公共交通运营商往往主观臆断低估风险，不愿意相信风险的存在。在公交公司看来，公交车司机在上岗前经过了严格的培训，驾驶技术精湛，因此发生重大交通事故的概率极低，发生纵火案等群死群伤的风险也可以忽略。而公交车最易发生的两种事故：与其他车辆的轻微碰撞造成公交车车体轻微损伤，紧急刹车等司机失误操作导致乘客摔倒受伤，这些损失和责任是他们可以负担的，因此购买交强险以外的商业保险是不必要的。同时，由于车险费率较高，每年购买交强险和商业保险的保费对公交公司来说是一笔极大的开支。高昂的保费与被他们低估的事故风险严重不对等，因此绝大多数的公交公司一般只购买法律强制的交强险。但在实际运行过程中，公交车发生事故的风险高出公司预期，交强险远远不能分担他们承担的赔偿责任，公交公司与受害者之间的法律纠纷时有发生，受害

者及其家属很难从公交公司手里得到足够的赔偿。

（2）资金问题

公共交通行业是低盈利行业，成本回收期长，在运营初期甚至有负盈利的现象。可供公交公司投保的交强险、承运人责任险、车上人员责任险、车损险等车险却是统一定价，私家车公交车一并对待，并没有专门针对公交车特点所开发的保险。这就导致现有车辆保险对公交车而言费率较高，保费成本与事故成本不匹配，要投保足够的商业车险将耗费大量资金，公交公司正是因为巨额支出而没有强烈的投保意愿。

（3）市场问题

长期以来，我国车险并未针对不同车型区别化，所有车型均采用统一的保险费率。商业车险的费率也由保险行业协会厘定，保险公司并无车险产品定价权。而公交车有自己的运营特点，因此具有一些独特的风险和一些不会出现的风险，例如车上有大量站着的乘客，这是私家车、长途客运车所不存在的。作为公交公司，若按照现行的保险条款、保险费率投保，就意味着他们承担着与其风险不匹配的保费成本，公交车的独特风险却无法得到保障。作为保险人，保险公司常常在车险业务上遭遇亏损，在面对公交行业这一高危行业时，也持一种消极的承保态度。由此可见，保险产品的设计漏洞和缺乏主动性的保险市场制约着公交保险保障的发展。

4．保险产品问题分析

公交公司的投保现状，实则从侧面反映了现有保险市场上保险产品自身存在的问题。目前，涉及到公交车乘客安全的保险主要有交强险、承运人责任险、车上人员责任险和乘客意外伤害保险四种。然而，这几种保险在公交领域到出现不同程度的“水土不服”：

4.1 交强险

2006 年开始实行的施行的《机动车交通事故责任强制保险条例》，将交强险列为政府强制性保险，公交车和所有车辆一样不买交强险上路即属于违法。然而前些年，合肥[①]、济南[②]、郑州[③]等地却因发生交通事故无处赔偿，接连被爆出公交集团不缴交强险。“合肥公交车：交强险？我不认识！——公交公司内部追偿案引爆公交车未买交强险潜规则”“济南市公交车未上交强险‘裸奔多年’东窗事发”“郑州大批公交车未买交强险便上路，年检过程成迷”的新闻标题着实引人注目。而当被询问为何不如数上缴交强险时，不少公交集团都提到“公交是特殊行业，每年亏损非常大。” 如此不合法的现象果真合理么？没有缴纳交强险，如何通过车辆年检？这些问题都值得我们思考，更令人担忧。

4.2 承运人责任险和车上人员责任险

承运人责任险以承运人在运输过程中的运输责任为保险标的，对于长途客运车辆属于强制保险；车上人员险负责赔偿保险车辆交通意外造成的本车人员伤亡，被私家车广泛投保。但是因为公交车自身的特点，这两种保险在公交领域存

[①] 安徽新闻网 http://ah.anhuinews.com/system/2010/10/26/003399938.shtml
[②] 慧择网 http://www.hzins.com/study/detal-47986.html
[③] 中国广播网 http://china.cnr.cn/yaowen/201112/t20111230_508995832_1.shtml

在以下问题：

（1）投保方式不合理。

承运人责任险和车上人员责任险都是按照座位投保，对于严禁超载的长途客运车辆和私家车而言是合理的，但是对于人满为患、存在大量站立乘客的公交车而言便极不合理。以 2013 年厦门公交纵火案为例，该公交车投保承运人责任险 36 个座位（每个座位责任限额 35 万），但是事故却造成了 47 人死亡、34 人受伤的惨烈后果。36 个座位获得的 1260 万的赔付和 81 伤亡的巨额赔偿之间，必定存在很大缺口。可见，针对道路运输开发的承运人责任险在公共交通领域并不完全合适。

（2）保费与风险不匹配。

一方面，承运人责任险主要是针对道路运输设计，如长途客运、货运车辆。因为长途、高速，发生大型交通事故的概率较高。车上人员责任险作为商业车险的重要组成，被私家车广泛投保。因为行驶速度、路线、区域不定，驾驶人员的驾驶技术参差不齐，私家车发生交通事故的概率也较高。两种责任保险由于承保大型交通事故造成的车上人员人身伤亡，保费都很高昂。而公交车在市区内按照固定路线低速行驶，发生特大交通事故造成车上乘客群死群伤的概率很低。如果公交公司投保了这两种责任保险，实则承担了高于其风险发生概率的保费，违背了保费公平性原则。另一方面，公交公司每年要为前文中提到的第二种风险支付高额的赔偿金，这两种责任保险却无法减轻其赔付压力。

因此，公交公司如果投保这两种责任保险，将导致风险与保费严重不匹配，保费支出与事故成本之间严重不对等。由于承运人责任保险对于公交车来讲不属于强制保险，在权衡事故赔偿金额和保费之本后，公交公司纷纷放弃了对责任险的投保。

（3）免费群体带来保费压力。

公共交通的公益性，决定了公交公司将面临相当数量的免费乘车群体。普通乘客购票乘车，尚可为公交公司投保责任险积累一定的资金来源。但对于免费群体，却间接增加了公交公司的经营压力。加之公交公司一直处于负债经营，主要依靠政府补贴来经营运转，无力承担两种责任保险高昂的保费。

4.3 乘客意外伤害保险

2006 年，建设部等部门发布《关于优先发展城市公共交通若干经济政策的意见》，其中规定：享受免费乘车的老年人、残疾人办理乘车证件之前，需由有关部门为其办理意外伤害险。江西、天津等地政府更是免费为老年人办理人身意外伤害保险，于是越来越多的媒体和舆论开始主张由政府或公交公司为乘客投保意外伤害险。但从法律来讲，这种行为是欠妥的。《保险法》规定：人身保险的投保人在保险合同订立时，对被保险人应当具有保险利益。由于公交公司对乘客并不具有法律上承认的利益，因此该保险合同从法律上讲是无效的。部分地方政府通过行政力量推动公交公司购买意外伤害险，本意是造福民生、为百姓维权，但是会造成消费者概念紊乱，还会误导保险需求，引发道德风险。

另外，即便公交公司为乘客投保意外伤害保险，但是公交公司本身的责任风险没有发生转移，事故发生时仍然需要承担相应的赔偿责任。因此，这种既不经济又不公平的做法，不能够被公交公司认可。

5．对策建议

5.1 开发新型保险产品

针对公交车自身运营特点和风险特点，保险公司应开发新型保险产品，挖掘市场潜力。以北京市为例，2014 年全市公交车数量达 28080 辆，而全国范围内的公交车数量更是惊人，这将是一片巨大的、待开发而又存在潜力的市场。

公交公司普遍认为第一种风险（大型事故造成群死群伤）发生概率极低，可以自留，不愿意购买相应的保险产品；而第二种风险（在刹车、起步、停车、转弯、车门开关过程中存在的风险）发生概率较高，需要以保险的形式转移出去。

所以，保险业应针对第二种风险开发专门的责任保险，转移本应由公交公司承担的经济赔偿责任。通过合理厘定费率、设计条款，保险公司可以达到盈利的目的，公交公司可以有效降低全年的保费支出以及赔偿支出，实现互利共赢。

此外，保险公司也可以根据第一种风险的发生概率，为公交车这一特殊行业厘定费率，开发针对车上乘客群死群伤的责任保险产品。作为上述主险的一种附加险，公交公司可以根据实际情况自愿投保。同时，也可以尝试在公交公司之间建立道路救助基金，以应对公交纵火案这样的群死群伤案件。

5.2 加大财政补贴力度

公共交通是满足人民群众基本出行的公益性事业，承担着重要的社会角色。同时公共交通也是低盈利行业，成本回收期长，在运营初期甚至有亏损的现象。随着公共交通的高速发展，政府需要不断加大财政补贴力度，保证公交企业的保费支出。

公交公司也要持续加大保费投入。通过投保责任保险，公交公司不仅可以有效完善对各种事故的应急善后处理机制，而且可以维持稳定经营、减少公司自身风险，提升管理能力，同时履行公交企业的社会责任、提升公共交通行业的社会责任感，为构建和谐社会做出实际贡献。

因此，可以借鉴农业保险等政策性保险的推广方式——政府相关部门给予高度重视，加大财政补贴力度，公交公司积极配合，增加保费投入，提高客户的保险保障程度。

5.3 适当政策干预与立法保障

2013 年 1 月 5 日，《国务院关于城市优先发展公共交通的指导意见》出台，明确提出将公共交通置于优先发展的地位。但是，《指导意见》主要体现的是基本原则和核心理念，缺乏完善的法律法规来对公共交通的运营、风险管理、保险投保等方面做出详细规定。

因此，基于公交车各种事故频发的现状，政府可以借鉴长途客运车辆投保承运人责任险的方式，强制公交车行业投保新型责任保险，充分发挥保险风险分散和风险转移的作用。确保事故发生时，受伤乘客能够及时获得保险金赔偿。

同时，相关政府部门应该加快立法，为事故赔偿责任的确定提供法律依据。细化公交车管理条例，规范公交企业的经营、管理。

5.4 提高乘客意外险投保意识

现有保险市场有很多种类的交通工具意外险，保障被保险人乘坐飞机、火车、轮船、汽车等交通工具时遭受的意外伤害，但是客户的投保情况不理想。成都、

上海、长沙、江苏等地推出公交车意外伤害保险已有近十年历史，但是购买的人寥寥无几。保险公司受限于成本过高，在开发推广公交意外险时不够积极；乘客缺乏保险意识，主观或者客观地排斥公交意外险。

然而，一起起大型公交纵火案，时有发生的乘客磕碰摔伤案件，都在提醒着我们：不仅公交公司需要投保相应责任险外，乘客也应该为自身购买意外伤害保险。事故发生时，乘客不仅可以得到意外险的补偿，而且有权向公交公司提出赔偿请求。通过乘客意外险和公交公司责任险的有效衔接，更好地保障乘客的权益。

因此，需要持续宣传、积极引导，提高广大乘客的意外险投保意识。保险公司也需要不断投入，借助互联网营销、场景营销等方式，开辟乘客投保的新途径，降低自身的经营、展业成本。经常乘坐公共交通的乘客应该根据实际情况，选择购买一款适合自己的交通工具意外险，为自己的出行保驾护航。

6．保险产品构想与设计

基于以上分析，本文构想与设计“公交车乘客磕碰摔伤责任保险”，对公交车乘客面临的第二种风险加以专门保障，并从保险责任、赔偿限额、保费厘定、风险控制四方面展开详细的描述：

6.1 保险责任

在保险期间内，乘客在乘坐公交车途中，因公交公司指定驾驶员的常规驾驶行为导致的下列乘客小规模伤亡意外事故，按照法律规定应由公交公司所承担的经济赔偿责任，保险公司将进行赔偿

（1）公交车起步、刹车、减速停车、转弯过程中，乘客发生磕、碰、摔、挤、压而遭受的人身伤亡和财产的直接损毁，应当由被保险人（公交公司）应当承担的赔偿责任。

（2）公交车车门在打开及关闭过程中，由车门造成的乘客的人身伤亡和财产的直接损毁，应当由被保险人承担赔偿责任。

其中，乘客是指持有效运输凭证乘坐公交车的人员、按照运输主管部门有关规免费乘坐公交车的儿童以及按照公交公司规定享受免票待遇的人员。

6.2 赔偿限额

公交车乘客磕碰摔伤责任保险的赔偿限额，分为全年整公司累计赔偿限额、每车每次赔偿限额和每人每次事故赔偿限额：

全年整公司累计赔偿限额：由公交公司与保险公司根据前几年出险情况协商决定，与整个公司的公交车数量挂钩，以确定全年整个公司所有车辆发生的所有保险责任内事故的责任赔偿限额。

每车每次赔偿限额：每车每次事故中所有乘客人身伤亡的赔偿限额。

每人每次事故赔偿限额：由公交公司与保险公司协商决定，以确定单起事故造成乘客伤亡时，保险公司的责任赔偿限额。每次事故中，保险人对每一旅客人身伤亡的赔偿金额，应当以保险单明细表中所对应的每人每次事故赔偿限额为限；

6.3 费率厘定

保险公司依据相关精算技术，结合经验数据，坚持充分、公平、合理、稳定灵活以及促进防损的原则，合理厘定费率。费率的主要影响因素有如下：

（1）公交公司的规模、运营情况

（2）公交公司前几年度保险事故发生的频率

（3）保险事故发生造成的人身伤亡情况（医疗费用的支出）和财产损毁情况

（4）公交车型号、载乘人数

（5）公交车线路长度

（6）公交公司（公交车）的安全防范措施以及防灾防损情况

6.4 风险控制

（1）本保险仅保障公交车起步、刹车、减速停车、转弯过程中，乘客发生磕、碰、摔、挤、压，以及公交车车门在打开、关闭过程中，由车门对乘客造成的人身伤亡和财产损毁。这些风险均属于大概率风险，保险公司可以通过大量的经验数据分析，合理厘定费率。特大交通事故（公交车由于碰撞、倾覆、火灾、自燃）造成的群死群伤事件不属于保险责任范围以内，发生事故时保险公司也不进行赔偿。

（2）通过全年整公司累计赔偿限额、每车每次赔偿限额和每人每次事故赔偿限额的设定，对保险公司所面临的风险进行了控制，使得全年的赔偿额控制在合理的范围之内。

（3）通过超额累进免赔率或者比率免赔率的设置，根据保险金请求对大小事故进行了划分。事故保险金请求额越高，免赔率越高，控制了保险公司所需面临的风险。

（4）为了避免繁琐的流程手续，控制保险公司事故勘察、定损、赔偿的费用，设置每人每次事故免赔额。如果保险事故发生时，产生的医疗费用以及财产损失在事故免赔额以下，由公交公司自行赔偿。

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公共交通乘客风险分析及对策研究
——基于保险的视角

冯钰宸
中央财经大学保险学院
北京102206，中国
电话: 15652126802
Email: fengyc9170@163.com

关键词：公共交通；乘客风险；风险分析；保险

中文摘要

随着我国私家车数量的不断攀升、交通堵塞情况的日益严重，公共交通对市民出行和城市发展发挥愈发重要的作用。然而，现有公交车的投保情况堪忧，乘客在公共交通出行中存在的风险无法得到应有的保险保障。本文基于保险的视角，对乘客公交出行过程中的风险、公交公司投保现状及原因、现有保险产品存在的问题进行了详细分析，并且提出了开发新型保险产品、加大财政补贴力度、适当政策干预与立法保障、提高乘客意外险投保意识等对策来改善乘客的保险保障情况。

Research on the Risk of Housing Reverse Mortgage Loan Retirement Pattern

LIU Xie, ZHU Yu

LIU Xie*
Master Candidate
Department of insurance
Beijing Technology and Business University
Building No.4, BTBU
Fucheng Road, Haidian District, Beijing
Phone: 152 1072 4876
Email: lhwz3@163.com

ZHU Yu
Master Candidate
Department of insurance
Beijing Technology and Business University
Building No.3, BTBU
Fucheng Road, Haidian District, Beijing
Phone: 152 1096 0958
Email: zhuyu_email@126.com

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Abstract. With the increasingly aging population and heavy social endowment pressure, housing reverse mortgage can solve part of the elderly pension difficulties and will become a powerful supplement to the social pension. The risk management of housing reverse mortgage Loan is one of the key issues which we need to consider in order to carry out the housing reverse mortgage loan retirement pattern better in the

near future. Existing research mainly focuses on the feasibility and pricing of housing reverse mortgage loan. Based on the risk management perspective, this paper firstly analyzes the various risks of housing reverse mortgage loan retirement pattern. Then we analyze the behavior choice of the risk bearers by utility theory. Finally, some recommendations and measures for risk prevention and reduction are proposed, such as insurance and loan securitization.

1.引言

自上世纪90年代以来，我国65岁及以上的老年人口占比开始出现明显上升，在2000年时该数值增至7%，联合国相关标准表明中国在当时已经步入老龄化社会。国家统计局最新统计数据显示，截至2015年全国60岁及以上人口已达全国总人口的16.15%，其中65岁及以上人口占比达10.47%，我国社会老龄化程度在快速加深，目前已经成为老龄化速度最快的国家之一。

与日本、美国、欧洲等国家或者地区的老龄化情况相比，我国出现老龄化问题的时间虽短，但人口基数决定我国的老龄化人口规模庞大。一方面由于人口自然增长率长期低于预期，1990至2000年之间出生的人群陆续达到工作年龄，劳动力市场逐渐萎缩；另一方面人民生活及医疗条件水平提高，人均寿命不断提高，导致我国面临的老龄化问题更加严峻。

在自身条件上，我国依然是发展中国家，人均GDP较低，地区发展不均衡，社会保障的覆盖程度和保障力度不足，与上述发达国家差距较大，国内的大部分的老年人面临着未富先老的尴尬局面。现在 “4-2-1” 正成为家庭结构主流，两个年轻人要负担起4个老人的养老重任和至少一个孩子的家庭压力，传统的居家养老模式已经悄然发生变化，空巢老人的问题更加突出。面临着近半数的城市老年家庭已经成为空巢家庭的现实，如何有效应对我国日益严重的老龄化问题，探寻多元化的养老模式成为当下的热点。

2．住房反向抵押贷款介绍

住房反向抵押贷款是指老年人将自有房屋的产权抵押给银行、保险公司等金融机构，相应的金融机构对借款人的年龄、预计寿命、房屋的现值、未来的增值、折损情况及借款人去世时房产的价值进行综合评估后，将房屋的全部或部分价值分摊到预期寿命年限中，按月（年）支付现金给借款人。

2.1 国外情况

住房反向抵押贷款制度最早起步于荷兰，在美、英、澳大利亚等国家的发展较快。这其中美国的住房反抵押制度最为完善，影响最为广泛，自19世纪80年代起，逐渐形成以下三种类型产品：房屋价值转换抵押贷款（HECM）、住房保有人计划（Home Keeper）、财务自由计划（Financial Freedom）。HECM是由政府住房与都市发展部主导并进行担保，并根据政策因素对贷款比例按地区和年数进行限制，主要对象是拥有房屋的价值在中等程度的贷款人。Home Keeper是半官方性质，主要是针对不符合HECM的贷款人推出的，较为灵活。Financial Freedom更加强调盈利性，但由于缺少政府介入，因而选择该计划的人数较少。

在上述三种方式中，政府经营主导的HECM项目发展比较成功，业务在21世纪进入爆发式增长阶段，目前覆盖全美各州，在反向抵押贷款市场中占据了

90% 以上的份额。根据美国学者对反向抵押贷款的预期效果推测，80%拥有房屋产权的老年人将从中获益，潜在需求巨大，但美国现实情况并非如此理想，半数以上美国老人将住房视为最后的屏障而不愿选择反向抵押，在全美符合申请住房反向抵押贷款条件的家庭约有 2400 万，实际上仅有 2.1%符合要求的美国家庭参与到业务中，贷款的业务量在 2009 年遭受金融危机影响也曾出现大幅下滑。这主要因为住房反向抵押贷款复杂性和风险程度均高于其他类型的金融产品，加上交易费用较高和遗产赠与动机影响，所以业务总量不是很多。

虽然美国住房反向抵押贷款运行效果不如预期，但仍被证明是一种提高老年人生活质量和收入水平的有效方式，这对于我国缓解养老压力有着一定借鉴意义。

2.2 国内情况

国内的住房反向抵押贷款最早于 2007 年进行尝试，上海公积金管理中心推出了住房自助养老的创新模式，但由于在合同签订之时房屋产权便发生转移，无法被大部分人所接受。之后又有养老服务中心和房地产经纪公司等企业推出了不转移房屋产权的新模式，却因为老人对房产公司的不信任而夭折。2013 年国务院发布意见明确提出“开展老年人住房反向抵押养老保险试点”。2014 年 6 月，在北京、上海、广州、武汉四城市开展反向抵押贷款试点，目前，两年试点已经到期，保监会下发通知扩大试点范围并延长试点期间至 2018 年。试点过程中虽然参保对象与保险公司的积极性不足，参与人数较少，但从试点情况看，业务有效提高了老年人的可支配收入，显著提升了参保老人的养老水平，获得了参保老人的高度评价。

2.3. 住房反向抵押业务现实问题

我国现在基本养老金的覆盖面窄，保障程度低，加上目前家庭养老趋势的弱化，住房反向抵押的有效运用能够帮助老年人利用房产融资养老，提高老人生活医疗水平，改善收入情况，满足老年人居家养老的需求，同时盘活一二线城市的房地产交易市场，改善房地产市场供需不平衡现状，有利于我国金融市场的全面多元发展，但在住房反向抵押贷款业务试点过程中，可以发现存在着需求与供给均不足的情况。一方面，由于传统养老观念的限制，老年人更愿意将房产留给子女，加上获得的业务年金收入达不到期望水平，削弱了积极性，进而影响住房反向抵押贷款业务需求。另一方面，由于该项业务流程复杂，存续期长，涉及房地产、金融、财税等多个领域，缺乏有力的政策和法律支持，贷款机构无法或者难以在较短时间获得收益，承担的风险过高，这些都影响金融机构的供给积极性。反向抵押贷款还具有正外部性，对我国养老事业稳定化和金融产业多元化有促进作用。上述因素导致我国住房反抵押贷款存在明显的市场失灵情况。

接下来，本文将在国内外学者研究基础上从业务自身及借贷双方对住房反抵

押的风险进行分析。

3. 研究现状

国外研究方面： Munnell(2007)研究发现，由于医疗费用高昂且缺乏长期护理保险等因素，半数以上老人将住房视为最后的屏障而不愿选择反向抵押。Wang（2007）等研究认为由于反向抵押风险高于其他类型贷款业务，导致一般私营机构没有动力开展此业务，美国 90%以上的反向抵押贷款产品是由经政府特别授权的金融机构进行运作，因而市场化程度低。Hui Shan(2009)分析认为，有强烈遗赠意愿的老人认为反向抵押减少了其遗产总额，同时复杂的金融产品形式不为其所了解，因而无法接受。

国内研究方面：李伟林（2007）从我国的国情出发，从金融机构的角度对开展住房反向抵押贷款可能面临的风险进行了分析，认为此项业务风险较大，金融机构应谨慎推行，并提出规避相应风险的方法。柴效武(2008)首先对贷款机构所面临的风险进行研究，认为其主要面临住房价值风险、长寿风险、利率风险、流动性风险，并且可能引起道德风险;杨哲（2016）认为以房养老目前仅限于部分金融机构参与，政府未能提供足够的担保和服务，缺少有效的政策及法律匹配。

4 住房反向抵押贷款风险分析

4.1 住房反抵押贷款业务本身的风险

4.1.1 利率风险

利率风险是指由于市场利率变动的不确定性造成反抵押贷款参与者损失的可能性。利率风险是住房反向抵押贷款的业务的主要风险之一，也是影响金融机构未来可回收价值的重要因素。如果住房反向抵押贷款合同采用的是固定利率，当利率上升时，贷款人因为失去其他投资机会，从而承担了更高的机会成本；如果采用浮动利率，当基准利率上升时，由于发放的年金不能减少，应计利息提高，贷款到期时累计本息额超过房产价值的可能性增大，超过期末房产价值的部分就越多,金融机构遭受损失也就越大。无论采取固定利率,还是浮动利率,当基准利率下降时，借款人可能就不愿意承担高于市场利率的合同利率,选择提前偿还贷款本息或者进行重新融资。

我国积极推进利率市场化已经初见成效,目前市场化基本完成，之后利率水平的预估将会更加困难和复杂，在 2015 年一年中，央行进行了 5 次降准降息，贷款利率从 6.15%调整到 4.9%。因为住房反向抵押贷款业务的周期很长，利率风险难以分散，利率的轻微变化都可能会对贷款机构产生重大影响,并最终影响住房反向抵押贷款的运行。

4.1.2 预期寿命风险

预期寿命风险。即在住房反向抵押贷款中，由于借款人的实际寿命比预期平均寿命长，年金的给付总额高于房产的预期价值，贷款人收不抵支的风险。住房

反向抵押合同一般给予借款人不受追索的权利，即贷款机构不能以老年借款人的其他财产来抵充债务，也不能向老年借款人的继承人追偿，从而可能使贷款机构面临损失。

预期寿命和实际寿命的差别是该风险产生的原因。预期寿命通过编制生命表计算，是反应人口健康状况的指标，其受到社会经济、医疗卫生水平的限制。在反向抵押贷款的业务中，金融机构通过生命表测算贷款人的平均预期寿命，但由于业务跨度时间长，人口死亡率随着社会发展不断降低，生命表的修订存在滞后性，这样金融机构面临着定价的风险，同时个人实际寿命虽服从平均预期寿命规律，也有着悬殊个人差异，不断变化的预期寿命和无法准确预测的实际寿命引起住房反向抵押的不确定性。

此外，信息不对称和借款人的逆向选择往往会加重预期寿命风险，但可通过扩大借款人数量和规模、完善产品设计来分散风险。

4.1.3 房价波动风险

住房作为住房反向抵押业务中最主要的抵押物,其价值的波动是贷款机构所面临的主要风险之一。房屋是目前是长期消费品，也是投资品，对房屋自身来讲，房屋的地段位置、周边环境、市政及生活教育配套设施会影响其价格,作为一种长期资产,随着社会经济的发展，周边环境发生变化,原有的配套老化,所处的商业圈转迁等变动也会影响房屋价值。

住房被公认为使用寿命长且能长期保值，但实际情况是我国住房平均寿命住房还不到 30 年，主要由于性能较差如面积小、难以改造等原因无法满足居民的需要，从而出现了功能性折旧；其次在使用过程中,也会因某些自然异常变化,如水灾、火灾、地震等原因或人为的破坏导致损毁。此外，外部环境的变化也会影响房屋价值,比如政治、经济和行业因素等。住房反向抵押贷款业务周期长,可能会经历不同的经济周期。

房地产泡沫由于有限的优质土地供给无法满足社会经济发展的需求而出现。宽松的货币和房屋贷款政策推高房价，受金融危机的影响，泡沫破裂会影响房地产开发商、参与者,还将影响向房地产开发提供各种服务的中介机构、金融机构和相关产业的从业人员,严重时,还可能影响整个国民经济的运行或国家经济安全。在采用固定利率情况下，借款人的风险将全部转移至贷款机构，如果房价大跌，房屋价值将远远低于贷款额度，那么银行将面临大面积的普通房屋贷款违约，这样将面临资金断供，无法支付借款人的款项。在采用浮动利率的情况下，这样风险同时分散给借款人和贷款机构，房产市值缩水，贷款人收到的款项会大幅减少。国家统计局数据显示，2004 年全国商品房销售均价为 2778 元，2014 年为 6324 元，2015 年为 6793 元，房地产的价格近 10 年间一直属于上升时期，特别是 2007 年以来，国内房地产市场一直处于高速增长阶段， 我国目前“北上广深”等一线城市房价的绝对值已经超过了很多国际大都市，三四线城市的已建成

未售出及在建房屋的巨额库存则需要很久的消化时间，这表明价格泡沫与数量泡沫的可能同时存在，在国家对房地产行业宏观调控力度增强、采取限购等政策之下，未来房价继续高速上涨的预期将大打折扣。再加上房地产市场的变数不可控，房价波动将大于宏观经济波动情况，日本上世纪 90 年代楼市危机之后，东京地产价格下跌了 70%，如果国内房价出现类似大幅度下跌，泡沫破裂，将会给住房反抵押政策带来巨大风险。与此同时随着人口老龄化的加剧和家庭人口结构的变化，居民的生育意愿降低，25 至 49 岁的购房适龄人口将逐步下降，同时老年人普遍有将房屋留给子女的传统观念，祖辈和父辈的房产将由第三代继承，按照目前住宅用地供应速度已远超城镇人口增速情况来看，在 20 年之后，中小城市及大城市非繁华区将会有大量房屋闲置，房地产市场将呈现供过于求的情况，这会进一步加剧房价下跌，从而出现房产变现困难的问题。

因此，在房地产行业发展迅速，势头良好的情况下，住房反向抵押贷款业务双方都能从中获益，老年群体能够享受到房屋带来的价值增值，改善晚年生活质量，借贷金融机构能够获得丰厚利润。但若经济下行压力增大，房地产市场降温，参加住房反抵押的老年群体和贷款的金融机构都将面临着巨大的系统性风险，将会给老年人生活带来巨大压力。

4.1.4 房屋价值评估及咨询风险

住房反向抵押贷款以房屋作为抵押物，因为存在价值波动，需要根据现行市场利率和预期利率波动,综合考虑房产的增值折旧因素,得出估算的房产现值,作为年金给付的依据。另外,在合同期末,即金融机构在完成养老年金给付、取得房屋所有权以后,还要进入房屋二级市场进行房屋残值的拍卖、转让等。总体而言，房屋价值的核算显得尤为重要，评估需要考虑到房屋情况和房地产行业周期变化等价值波动因素，因此房地产估值过程中必然涉及第三方评估机构的参与。从 20 世纪 80 年代初至今，我国住房制度改革虽然取得了巨大成就，但由于房地产市场发展的盲目性、不规范性及政府宏观调控和法律法规不健全，导致房地产市场仍存在较多问题，房产评估机制和中介公司缺乏有效的规范和监管。

在美国,不同机构(联邦政府、保险公司、银行)主导的住房反向抵押贷款业务所提供的合同规定差异较大,其中相当多的制度规定很复杂且暗藏风险,这种复杂性超出了一般借款人的专业范畴,难以了解其中的风险。另外,业务推销员一般只介绍业务对于借款人的收益,回避对风险的介绍,导致借款人做出非自身本意的决定。为了克服合同的复杂性,借款人通常需要支付不菲的咨询费用给第三方专业咨询机构。国内咨询公司成长很快，但管理不够规范，针对个人业务的咨询相对较少，借款人的专业咨询需要难以得到满足。

4.1.5 自然风险

自然风险主要是指人为无法控制的自然异常变化(如地震、洪涝、台风等)而带来损失的可能性。这些灾害不可抗拒,一旦受到这些因素影响,房地产变现时价

值低于累计的贷款本息总额的可能性大大增加,贷款机构遭受损失的可能性加大,同时借款人也会承受巨大风险。通过研究我国近年发生的自然灾害情况发现,保险在后期赔付中占据比例微乎其微,且多以人身保险为主,目前巨灾保险产品刚开始在部分地区进行试点,主要是单一灾害指数保险,即保险的赔偿不是基于被保险人的实际损失,而是基于预先设定的外在参数(台风级别等)是否达到触发水平,而大部分情况下一旦发生自然灾害,由于承保的风险过于集中,保险人可能无力承担保险责任。缺乏合适的巨灾保险产品是反向抵押贷款业务中的自然风险较难分散的原因。

4.2 借款人主体导致的风险

4.2.1 逆向选择风险

一般而言,存活寿命与平均寿命相关,又同个体的身体健康状况、既往病史、生存环境及医疗保健条件等有着极为密切的联系,但贷款机构和借款人对这些相关信息资料的掌握程度是不对称的。借款人对自己的身体健康状况、既往病史及医疗保健等信息的更为了解; 金融机构对这些信息的掌握却很不完全,而为了取得对方的准确信息资料将花费高额成本。

在普通寿险业务中,投保人更倾向于证明自己身体是健康的,甚至不惜采用造假等欺诈手段,这样在身体出现问题后可以获得保险金给付。住房反抵押贷款制度下,借款人更愿意让银行或者保险公司相信自己身体情况欠佳,由于金融机构较难估计借款人的预期寿命,因此根据生命表愿意支付给借款人较高的年金,当实际寿命长于预期寿命时,借款人便可以获得超额的收入。因此从自身角度出发,身体越健康的老年人更有可能参加住房反抵押,加上老年人在获得了年金之后,生活水平和医疗水平的提高实际寿命也将延长,这会导致借款人寿命高于平均值。

4.2.2 道德风险

道德风险主要是指借款人将住房抵押给金融机构后,获得相应的年金后,缺乏维护房屋积极性,导致房屋价值贬损。借款人与金融机构签订住房反向抵押合同后,在居住期间对负有修缮、维护责任,由于房屋产权在借款人过世之后进行转移,房屋价值因维护不善而降低的风险由金融机构承担,很可能出现维修带来的效用小于维修成本的情况,借款人便没有足够动力进行房屋的定期修缮维护。

4.3 贷款人主体导致的风险

4.3.1 不道德行为

从美国现行经验看,贷款机构业务人员在展业阶段会从自身利益出发,并未完全告知申请人全部业务费用,许多纠纷的发生是由于申请人对条款了解不深,甚至签订的合同中被强加一些不公平条款,从而损害自身正当权益。

4.3.2 流动性风险

流动性风险是由贷款机构的资金来源与到期支出不能匹配而引发挤兑现象

的风险。在住房反向抵押贷款业务中，贷款机构根据合同约定定期向借款人持续发放贷款，并在老人离世后获得被抵押房产进行拍。贷款机构虽然在借款人去世后能够获得房产的所有权，但房产在合同存续期间仍然由借款人居住而无法变现。正向房屋抵押风险会随时间的推移而变小，住房反向贷款则相反，业务回报周期过长且市场波动大，随着时间的推移，金融机构需要支付的养老金额增加，流动性风险随之增加。

贷款机构要在业务开办之初投入大量资金，并在合同到期前维持不断增加的现金流出，住房反向抵押贷款自身流动性不足，这需要金融机构通过其他业务得到巨额有效的长期资金来源，而目前银行资金来源主要是企业存贷款、居民储蓄等短期资金，开展反向抵押贷款业务之后，会造成银行用短期资金发放长期住房贷款，引发流动性风险。对于保险公司而言，为大量保费找到新的投资途径，但流动性大幅降低，增加保险金给付和公司资金流风险。

国内大部分的金融机构对部门业绩考核按年度进行，而住房反向抵押贷款的收益需要较长周期，也会在较长时间内增加企业的资金流动性风险，对资金充足性要求较高，影响其他业务的发展，因此当期的企业经营人员对这种贷款的开发和推广动力不足，也是目前住房反抵押难以推行的原因之一。

4.4 政策法律的风险

4.4.1 现有土地使用制度不完善

目前，我国仍然执行的是住宅房产使用年限为 70 年的规定。《物权法》、《房地产管理法》中明确规定城市土地归国家所有，土地所有权和使用权分离，虽然《物权法》规定土地使用年限到期之后自动续期，但并未指出自动续期的费用问题，而目前国内部分地区出现一少部分房屋产权到期免费续期的情况，但这些个例没有广泛代表性，当老人年迈将房产抵押时，房屋的使用年限大都已经过半，而当老人身故后，使用年限更是所剩不多。随着使用期限的临近,房产价值的不确定性将大大增加,无形中加大了贷款机构的风险。

4.4.2 城市规划变化引起的风险

我国正处于快速的城市化进程中，因城市建设、规划变化的需要，拆迁和危旧房改造工程同样给住房反向抵押带来不确定性。如果抵押房屋被拆迁，那么将面临回迁或补偿等诸多问题，国家关于房地产的具体政策走向尤其是长达数十年的法规动向,难以准确预测,所以面临的政策风险很难避免。在住房反抵押试点中，保险公司推出的合同约定，贷款人在获悉抵押房屋被征收、征用或拆迁的通知后，应当先与保险公司约定房屋抵押变更和养老金偿还问题进行协商，并达成书面补充协议。并未明确规定如何处理市场价值与拆迁补偿等账面价值的差异形成的盈亏。

4.4.3 驱逐风险

尽管各个国家对住房反向抵押贷款借款人资格规定都有所不同,但都在年龄

等方面对借款人进行了严格限制。住房反向抵押贷款本身的养老属性要求其适用对象必须是特殊的老年群体，同时向特定年龄的居民放款可以整体缩短贷款期限,减少机构贷款风险。在美国,住房反向抵押贷款借款人年龄不得小于 62 岁；房屋可以共有,但共有人的年龄至少要达到 62 岁，如果夫妻双方中的一方因为未达到最低年龄限制无法在反向抵押贷款合同中签字,一旦在合同上签字的一方先过世,借款机构将会要求立刻履行清偿义务,在合同上没有签字的配偶要从金融机构手中付款将房产赎回,否则将面临从所居住的房产中被驱逐的危险。目前我国在试点过程中，约定投保人年龄需在 60 周岁（含）至 85 周岁（含）之间，夫妻双方投保的，那么待被保险人皆身故后，保险公司行使对抵押房屋的处分权。如果夫妻双方其中一方由于年龄限制无法在合同中签字，也有可能面临着被驱逐的风险。

2005 年 1 月 1 日开始实施的《最高人民法院关于人民法院民事执行中查封、扣押、冻结财产的规定》第六条规定：对被执行人及其所扶养家属生活所必需的居住房屋，人民法院可以查封，但不得拍卖、变卖或者抵债。第七条规定：业主抵押自己所有房屋，如果该套房产是属于业主的唯一可以居住房产，而且也有充分证据可证明这一点的时候，那么即使抵押权人向业主追讨欠款，法院也不能拍卖、变卖或者抵债。有学者认为“一旦老人与保险公司签署反向抵押贷款合同，在老人病重时，有子女入住该抵押房屋，并且声称是‘唯一住房’，未来即使老人去世，保险公司也很难将其子女驱离，届时保险公司将无法实现房产价值。”根据北京市及地方法院发布的解释意见，被执行人及所扶养的家属应该定义为被执行人所抚养的未成年子女和丧失劳动能力、无生活来源的成年子女，将上述观点准确描述为成年有收入来源的子女入住老人抵押房屋，声称“唯一住房”是不符合法律规定的，但也可能面临着驱离过程中操作难问题。贷款机构可以借款主体家庭进行审核，面临的被执行人家属入住房屋而无法变现房产的风险将大大降低。

4.4.4 税收政策风险

对借款人而言，若认为住房反向抵押贷款是房屋价值贷款则不需要支付所得税，但若将其认定为房屋销售则需要支付所得税，那么借款人取得的收入就被认为是应征税的收入，这会对借款人产生不利影响。从目前保监会的征求意见稿来看，试点产品分为参与型反向抵押养老保险产品和非参与型反向抵押养老保险产品。非参与型产品，指保险公司不参与分享房屋增值收益，抵押房屋价值增长全部归属于投保人。目前试点推行的均为非参与型产品，税收政策是在我国试点过程中也并未提及，对贷款机构而言，其无法获得房产的增值收益，那么税负政策的优惠与否会影响到金融机构开展业务的利润水平和积极性。

5 住房反向抵押贷款效用分析

接下来以生命周期消费理论为基础，在规避上述大部分风险的条件下，研究贷款人在参与住房反抵押前后的效用变化。目的在于使生命周期内不同时期的消

费水平基本一致，实现贷款人生命周期效用的最大化。

首先做出如下假设:个体寿命为 NL，工作时间为 WL，年收入为 Y，个体从 T 岁开始工作，并拥有一套自有产权住房，价值为 W_h；年收入全部用于消费和储蓄,不考虑储蓄的利率与贴现率;工作期间的储蓄是退休时消费的唯一来源，个体工作与退休期间每年的消费相同;个体从遗产赠与中获得效用函数形式与消费的效用函数形式一致。

5.1 个体未参加住房反抵押的效用

个体生命周期内总效用为

$$U=\sum_{t=T}^{WL}u(C_t^1)+\sum_{t=WL+1}^{NL}u(C_t^2) \tag{1}$$

$$C_t^1=Y-s \tag{2}$$

$$C_t^2=\frac{WL\times s}{NL-WL} \tag{3}$$

C_t^1 和 C_t^2 表示个体在工作和退休期间的平均消费，s 为工作期间年储蓄额，为了对目标函数进行数值估计，设定效用函数为常数相对风险厌恶(CRRA)函数，CRRA 效用函数可以较好地度量在未来时间里使消费平滑的意愿。

$$U(C)=\frac{(C)^{1-\gamma}}{1-\gamma},r=1 \tag{4}$$

γ 为风险厌恶系数，求 s 最优值使个体效用达到最大，对（1）式求微分得到

$$s=Y\times\frac{NL-WL}{NL} \tag{5}$$

$$C_1=C_2=Y\times\frac{WL}{NL} \tag{6}$$

考虑遗赠动机，则个体的效用为

$$U=\sum_{t=1}^{WL}u(C_1)+\sum_{t=WL+1}^{NL}u(C_2)+u(W_h^{'}) \tag{7}$$

$$u(W_h^{'})=\frac{\theta\frac{(W_h^{'})^{1-\gamma}}{1-\gamma}}{(1+\rho)^{NL-WL}} \tag{8}$$

效用折现率 ρ，将遗赠效用进行主观折现，遗赠动机表示个体对于将房屋作为遗产的意愿程度，θ 越大，意愿越强。

5.2 个体参加住房反抵押的效用

房屋价值的贷款总额为$\alpha \mathrm{W_h}(1-\beta)$，其中$\alpha$为贷款比例，$\beta$为业务的费用率

$$U^{'}=\sum_{t=T}^{WL}u(C_{\mathrm{t}}^{'1})+\sum_{t=WL+1}^{NL}u(C_{t}^{'2}) \tag{9}$$

$$C_t^{I'}=Y-s \tag{10}$$

$$C_t^{2'}=\frac{WL\times s^{'}+\alpha W_h(1-\beta)}{NL-WL} \tag{11}$$

同样对$U^{'}$求微分得到

$$s^{'}=Y\times\frac{NL-WL}{NL}-\frac{\alpha W_h(1-\beta)}{NL} \tag{12}$$

$$C_1^{'}=C_2^{'}=Y\times\frac{WL}{NL}+\frac{\alpha W_h(1-\beta)}{NL} \tag{13}$$

对两个(7)(9)两公式对比发现，不考虑住房进行遗产赠与动机时，个体在参加住房反向抵押贷款之后，可支配收入上升，每年度消费额增加了$\frac{\alpha W_h(1-\beta)}{NL}$，总效用增加。

5.3 参数选择与结果分析

根据国家统计局公布的数据和相关文献，假定效用折现率ρ为 4%，常相对风险厌恶系数γ为 0.7；25 岁开始工作，并有一套 80 平米自有产权住房，退休年龄 WL 为 60 岁，寿命 NL 为 75 岁；在退休时房产价值为$\mathrm{W_h}$，死亡时房产价值为$\mathrm{W_h^{'}}$，2004-2014 年我国住宅商品房平均价格上涨率约为 6.98%，结合风险分析部分，本文对房价上涨趋势保持温和上涨态度，将预期上涨率定为 4%；贷款额度为 0.8，住房反抵押业务交易成本为 15%，遗赠动机θ为 3；2015 年全国住宅商品房平均销售价格为6793元，2015年全国城镇非私营单位平均工资为62029元，忽略通货膨胀影响，将其作为平均年收入。

结果表明，住房反抵押贷款可以增加个体在整个生命周期内的消费，从而能够提高其整体效用，而且个体寿命越长，其效用水平越高；将遗赠动机考虑在内，当遗赠动机为 3 时，选择不参加反向抵押贷款的效用比参加贷款业务之后效用更高；当遗赠动机为 2 时，遗赠动机带来的效用基本抵消参与反向抵押贷款带来的

效用增额。这表明遗赠动机越强，该行为带来的效用越大，现有文献中遗赠动机大小受模型设定影响较大，估计我国居民的遗赠动机在 3.7 左右，很可能会使个体参与反抵押贷款之后的效用较未参与时出现下降，如果实施遗产税政策，能够减少遗赠动机带来的效用值，提高住房反抵押的业务吸引力。遗赠动机对个体参与住房反抵押业务得到效用变化带来较大影响，是个体选择参加业务与否的一个关键因素。

在利率和房价增长平稳，未考虑风险因素的情况下，住房反向抵押贷款给借款人带来了明显的效用增加，身体越健康、寿命越长的借款人，其效用增加效果越明显；在考虑遗赠动机之后发现，由于受我国养儿防老传统观念影响，加上遗产税制度并未推行，法律也对成年子女对父母的赡养义务及遗产的继承权有着严格的规定，因此遗赠动机较强是目前许多老年人不选择住房反抵押贷款的主要原因。因此，金融机构应当对目标人群进行科学分类，膝下无子女的老人遗赠动机较弱，着重考虑该类老人作为业务发展对象。

住房反向抵押贷款能够使老年人消费增加，效用提升，研究如何合理分散风险是加快业务发展的核心问题。

6 我国住房反向抵押贷款风险应对

住房反向抵押贷款作为一种创新性的养老业务，承担了社会养老的重要补充作用，但发展过程中业务本身、金融机构、借款人均面临风险，同时还面临着政策法律风险，这直接影响到住房反向抵押贷款各方主体的参与积极性，关系着住房抵押贷款的顺利发展。因此，如何有效控制各方风险，顺利推进住房反向抵押贷款的养老模式，本文建议可考虑从以下几个方面着手。

6.1 政府方面

6.1.1 发挥政府的关键作用，完善相关配套政策

目前住房反向抵押贷款的市场规模小，成本相对较高，风险管控难度大，加上反抵押贷款业务具有正外部性的因素，各方参与积极性低，政府有责任支持该业务的发展。从美国反向抵押贷款的实践来看，美国政府承担的主导地位及扶持政策是反抵押贷款市场能够取得成功的关键。

采取政府主导，市场化运作相结合的办法是我国反抵押贷款业务起步阶段的有效路径。业务开展初期，政府提供低息或无息贷款作为启动资金，并对参与的老年人及开展此项业务的金融机构给予税收优惠；政府向借款人和贷款机构收取不同比例保费建立保险基金，对借贷双方可能存在的损失提供担保，当保险基金金额不足时，无法承担部分由政府进行补贴。

建立法定的贷款免费咨询制度，加强对咨询机构的管理，给予有资质的咨询机构适当补贴，确保咨询内容和流程的可靠性、规范性，从而使得借款人能够获得准确信息，减少不必要的纠纷。

加快房地产税及遗产税的征收调研，增加住房反向抵押贷款的吸引力。利用

大数据进行房产信息完善和共享，明确房产登记细则，落实征税范围与计税制度。健全评估体系，培育有资质的评估机构，制定统一的评估办法和标准。

6.1.2 完善相关法律法规

由于房屋土地使用期限的有限性，未来房屋产权价值评估将面临较大不确定性。虽然 2007 年出台的《中华人民共和国物权法》已经规定“住宅建设用地使用权期间届满的，自动续期”，但如何续期、续期费用多少，仍是未知数。因此，明确土地使用权期满后的具体实施问题，从法律层面上支持和保护双方利益，解决金融机构的后顾之忧，是降低法律风险，促进住房反抵押贷款健康快速发展的重要途径。

6.1.3 加强宣传力度

增加住房反向抵押贷款产品的市场认知度，通过规范引导和信息披露，为公众提供公开、理性的决策信息支持；对开办此项业务的保险公司从内控管理等方面进行严格的资格审核；对合同条款实行审核制，对无追索权、退保损失、房屋优先赎回权、房屋使用权终身制等内容从严把控，规范借贷双方行为，保障住房反抵押贷款的顺利发展。

6.1.4 加强市场监管

住房反向抵押贷款涉及老年人（借款人）、银行、保险公司等多个市场主体。实践中，由于老年人在诸多市场主体中处于相对弱势的地位，在于金融机构以及养老机构接触中，可能受到金融机构夸大收益、隐瞒风险等不规范操作的误导、不到位的服务及不公平的待遇。这些就需要政府加强监管，严厉打击违法违规行为，增强行业自律，为推动住房反向抵押贷款的良性发展保驾护航。

6.2 金融机构方面

6.2.1 优化产品设计，加强风险管理

（1）减少利率风险

住房反抵押贷款目的在于提高老年人的养老保障程度,预定利率和年金给付额都应当保持在一个较为稳定的水平，而住房反抵押贷款业务无论采用固定利率还是浮动利率，都面临着利率风险，由于时间跨度较长,如果采用完全固定的利率,则风险较大。本文建议采用限制浮动利率和利率保险进行风险分散，即将预定利率浮动差额限定在一个范围内,约定按固定期限在基础利率之上根据波动情况进行差额调整,对实际利率超过约定范围部分的风险运用利率保险进行规避。这样既稳定了老年人的年金额，又在一定程度上降低了保险公司经营的风险,有利于住房反向抵押贷款业务的开展。同时金融机构还可以利用利率金融衍生工具来防范利率风险。可供选择的金融衍生工具包括远期利率协议、利率期货、利率期权等，衍生品的出现为特设机构规避利率风险提供了有效的手段,但是金融衍生产品要发挥作用,依托发达的金融衍生品交易市场和规范的法律监管环境。我国目前资本市场机制还不够完善,金融衍生产品不够成熟,所以需大力发展金融衍生品市场。

（2）减少房价波动风险。

可以考虑在不损害投保人利益前提下，设置阶段房价评估条款，即定期或不定期对抵押房产进行评估，从而对支付额度进行适度调整。房地产作为一种特殊商品，由于其地域性强，各区域间房产价格波动关联度小，增加住房反向抵押贷款业务数量和范围能够起到分散房价波动风险的作用。

（3）降低流动性风险。

通过反抵押贷款证券化分摊房价波动风险同样也是控制风险的有效措施之一，即贷款机构将住房反抵押贷款合约打包出售给特殊信托机构（SPV），贷款机构获得了稳定的现金流从而向借款人发放年金。特殊信托机构将购入的合约进行信用增级后以证券形式出售给投资者。这样既减少了房价波动风险，又缓解了金融机构资金流压力。

（4）减少预期寿命风险。

贷款机构可以要求借款人购买两全保险来分散预期寿命风险，若借款人在预期寿命时限生存，承保两全保险的保险公司支付保险金给贷款机构；若借款人在预期寿命时限死亡，则支付保险金给借款人的财产继承者。预期寿命风险和房价波动风险都是非系统性风险，贷款机构可以通过扩大住房反向抵押贷款业务数量进行风险分散，东部发展较快地区的无子女或失独老人是反抵押业务的目标人群。

（5）针对逆向选择和道德风险。

可以选择专业的医疗中介机构对老年人的健康状况进行评估，贷款机构根据评估结果决策贷款额度；对于道德风险，将借款人对房屋的维护修缮义务提前进行约定，并从贷款总额中预留一部分作为维修保证金，之后定期对房屋状况进行检测，如果房屋维护较好，便将费用分期返还。

6.2.2 为老年人提供人性化服务

住房反向抵押业务参与者一般年事已高，可以为这些老年人提供例如免费体检、定期上门进行咨询和医疗协助、在进行房屋评估时安装无障碍设施、推荐给老年人合适的意外伤害和护理保险产品等人性化服务。这样既可以减少道德风险，又利于树立良好口碑，便于推广宣传住房反向抵押业务。

6.2.3 建立业务激励机制

鼓励金融机构对住房反向抵押贷款业务负责人进行激励，调动业务人员推广积极性，有利于金融机构内部引导业务的逐步落实。

6.3 借款人加强维权意识

住房反向抵押贷款业务的流程复杂，反抵押合同条款属于格式条款，一般是由金融机构制定，借款人处于弱势一方，对条款了解程度不深，所以应接受政府提供的咨询教育服务，确保自身的知情权，有效借助住房反抵押业务规避风险，维护自身合法利益，提升收入水平和生活质量，安享晚年生活。

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住房反向抵押贷款养老模式的路径及风险管理研究

刘燮 朱瑜

刘燮*
硕士研究生
北京工商大学保险系
北京市海淀区阜成路11号东区4号楼
电话: 152 1072 4876
Email: lhwz3@163.com

朱瑜
硕士研究生
北京工商大保险系
北京市海淀区阜成路11号东区3号楼
电话: 152 1096 0958
Email: zhuyu_email@126.com

关键词: 住房反向抵押贷款；以房养老；风险识别;风险管理

中文摘要.在我国人口老龄化日益加剧、社会养老压力日益沉重的背景下，住房反向抵押贷款养老模式能够较好地解决部分老年人的养老困难，是我国现阶段社会养老保障体系的一种有力补充。住房反向抵押贷款的风险管理是我国推行住房反向抵押贷款养老模式需要重点考虑的核心问题之一。现有研究主要集中在住房反向抵押贷款的可行性和定价方面，本文从风险管理的视角出发，首先分析了住房反向抵押贷款养老模式存在的各种风险,在此基础上运用效用理论来分析风险主体的行为选择，最后为住房反向抵押贷款的风险防范提出了诸如发展住房反向抵押贷款保险、住房反向抵押贷款证券化等对策性建议。

A Study on Development Strategies of Professional Internet Insurance Company: Comparative Analysis on Key financial indicators of Online & Offline Insurance Companies

KONG Yuehong, CHEN Shiya

KONG Yuehong*
Associate Professor
School of Finance
Hubei University of Economics
Room 301, Qunxian Building, No. 8 Yangqiao Lake Avenue,
Jiangxia District, Wuhan, Hubei 430205, China
Phone: (8627) 8197 3760
Email: 48003500@ qq.com

CHEN Shiya
School of Finance
Hubei University of Economics
No. 8 Yangqiao Lake Avenue,
Jiangxia District, Wuhan, Hubei 430205, China
Phone: (86)132 9668 2185
Email: 1130393780@ qq.com

Keywords: professional Internet Insurance Company, Development Strategy, financial analysis.

Abstract. In the time of Internet+ , the industry of Internet insurance is rapidly expanding. In recent years, Internet insurance has been developing rapidly in China, and has been keeping the fast growth power head. Till now, three main operating patterns are formed, that are network platform operated by traditional insurance companies themselves, network platform operated by the third party and the professional Internet insurance companies. From the point of view of the current market structure, the mode of third party platform is accounting for a dominant position, while the mode of professional Internet insurance company is showing a

new force of sudden rise. Why does the mode of professional Internet insurance company arouse the investors' favor? This argument, taking *Zhongan online* as an example, and comparing it with the traditional insurance company, Beibu Gulf Property & Casualty Insurance Co., Ltd., which was established nearly at the same time with it, finds out that , one hand, professional Internet insurance companies have unique advantages in solvency, profitability, Growth ability and Operational capability; on the other hand, they have weakness on cost management capabilities, investment profitability and business development capabilities and so on. In order to promote the development of professional Internet insurance companies, comprehensive strategies should be taken and put into effect. Professional Internet insurance companies should grasp the opportunity, position themselves precisely in the insurance market, promote themselves internally and externally, carry out the maximum advantage, and continuously improve the market competitiveness.

1.引言

在“互联网+”的时代背景下，互联网保险热潮掀起。近年来中国互联网保险迅猛发展，并保持强劲的增长势头，主要形成了传统保险公司自建网络平台、第三方互联网销售平台、专业互联网保险公司等三种模式。从目前的市场格局来看，第三方平台模式占主导地位，但专业互联网保险公司模式呈现出异军突起之势。2013 年 11 月，国内首家专业互联网保险公司——众安在线财产保险股份有限公司（以下简称“众安在线”）成立。开业至今，其业务规模不断扩大，整体发展态势良好，且在开业次年既实现赢利，打破了国内保险公司平均盈利周期大致需要 7 年的规律。2015 年又有泰康在线等 3 家专业互联网保险公司相继获批筹建和开业。除了这四家已经批准成立的公司外，蚂蚁金服、京东、百度等多家上市公司发布公告，表示要成立互联网保险企业。

专业互联网保险公司缘何倍受各路资本青睐？与其他互联网保险商业模式相比较，专业互联网保险公司究竟具有哪些得天独厚的优势？在突显其优势的同时，这一模式有哪些固有的缺陷或劣势需要克服？互联网保险公司在迎来重大发展机遇的同时，是否面临挑战？本文以众安在线为例，通过将其与同一时期开业的传统保险公司——北部湾财产保险股份有限公司（以下简称“北部湾财险”）的财务状况进行全方面的对比研究[①]，发掘专业互联网保险公司的内在优势与劣势，进而提出促进其进一步发展的战略。

2. 众安在线与北部湾财险基本财务情况的对比分析

2.1 两家公司成立时的基本情况

2.1.1 众安在线成立时的基本情况

2013 年 11 月 6 日，倍受关注的众安在线正式开业，其注册资金 10 亿元人民币，注册地为上海。作为一家财产险公司，众安在线倍受瞩目的原因主要有两点：一是基于其特殊的股东背景：众安在线由阿里巴巴的马云、中国平安的马明哲、腾讯的马化腾联手设立，其中阿里巴巴集团持股比例为 19.9%，成为其最大股东。腾讯控股和中国平安分别持股 15%。二是，众安在线开创了一种全新保险商业模式：众安在线是一家独立的互联网保险公司，力图实现经营环节、经营方式和业务范围全部互联网化。经营环节的互联网化不仅仅体现在销售渠道，而是在线上提供集产品研发、销售、精算、理赔于一体的多样化保险服务；经营方式的互联网化体现在除注册地在上海外，该公司将不设任何分支机构，完全通过互联网进行销售和理赔；业务范围的互联网化体现在，根据中国保监会批准的业务范围，众安在线主要是经营“与互联网直接相关”的企业/家庭财产保险、货运保险、责任保险、信用保证保险等业务。

[①] 本文研究所用数据均来源于这两家公司发布的年报。

2.1.2 北部湾财险成立时的基本情况

北部湾财险于 2013 年 1 月 18 日成立，是首家总部设于广西的全国性法人保险机构，成立时注册资本为人民币 15 亿元由，是由广西金融投资集团有限公司（持股 20%）作为主发起人，联合广东鸿发投资集团有限公司（持股 20%）、广西交通投资集团有限公司（持股 19%）、广西北部湾国际港务集团有限公司（持股 12.67%）、广西长江天成投资集团有限公司（持股 12.67%）等 13 家国有大型及骨干企业集团和民营企业组成，涵盖金融、钢铁、交通、港航、汽车、房地产等多个行业领域。北部湾财险是传统型保险公司，采用传统保险公司的组织架构和运营模式，按现代金融企业制度实行董事会管理、市场化运作，主要经营财产保险业务，包括财产损失保险、责任保险、保证保险、信用保险等业务；短期健康保险业务和人身意外伤害保险业务。

2.1.3 选择两家公司对比的原因

本文选取这两家公司进行对比分析主要基于以下考虑：一是两家公司各自可以作为线上和线下保险公司的典型代表：众安在线作为国内第一家成立的专业互联网保险公司，近年来业务和规模发展迅速，无疑可以作为专业互联网保险公司的代表；北部湾产险无论是从其股东背景、经营业务的范围，还是其运营模式，传承了传统保险公司的基本特点，可以作为新兴传统保险公司的代表。二是，两家公司均在 2013 年成立，虽然在成立具体时间上有十个月的差异，但基于产险公司经营的多是短期险业务，这个差异对成立后第二年经营状况的影响甚微。三是成立时，两家公司的资本实力相当，从注册资本额来看，北部湾产险甚至略胜一筹。

2.2 两家公司基本财务状况变化情况的对比

2.2.1 总资产对比

众安在线的总资产在 2013-2015 年逐年增加，而且在 2015 年总资产达的增长率为 553.7%，北部湾财险的总资产随着业务规模的不断扩大也在不断增长，北部湾财险 2015 年总资产增幅较小；在 2014 年众安在线开拓新业务，在 2015 年保费收入增长迅猛，在 2015 年总资产增幅较大，超越北部湾财险，并与北部湾财险拉开较大距离。（见表 1）

表 1　　众安在线与北部湾总资产对比

	2013 年	2014 年		2015 年	
	总资产（百万元）	总资产（百万元）	增长率（%）	总资产（百万元）	增长率（%）
众安在线	1002.27	1238.96	23.6	8098.82	553.7
北部湾财险	1502.01	2050.69	36.5	2370.73	15.6

2.2.2 营业收入及结构对比

营业收入是保险公司经营活动的收入，是利润的主要来源。众安在线营业收入每年都在增长，且 2015 年大幅增长，主要原因是互联网的普及以及互联网保险产品的创新，使更多的投保人选择在网上投保，众安在线的保费收入增长迅猛，且众安在线在 2015 年公允价值变动收益较高；北部湾财险营业收入也在逐年增长，增长幅度低于众安在线。（见表 2）

表 2　　众安在线与北部湾保险营业收入对比

	2013 年	2014 年		2015 年	
	营业收入（百万元）	营业收入（百万元）	增长率（%）	营业收入（百万元）	增长率（%）
众安在线	13.10	792.07	5946.34	2527.87	219.15
北部湾财险	87.23	606.79	595.62	1121.75	84.87

营业收入结构是营业收入的构成及各构成部分的占比。通过分析营业收入的结构理清两家保险公司的经营收入主要来自哪项收入（如表 3、表 4 所示），通过分析，可以看出两家保险公司的营业收入的主要来源都是保险业务，但就比重而言众安在线的已赚保费占总营业收入的比重小，且众安在线的的公允价值变动收益占比较大，较北部湾财险有较大区别。

表 3　　众安在线营业收入的结构分析　　（单位：百万元）

	2013 年		2014 年		2015 年	
	收入额（百万元）	占比（%）	收入额（百万元）	占比（%）	收入额（百万元）	占比（%）
已赚保费	2.55	19.45	712.18	89.91	1921.49	76.01
投资收益	10.56	80.55	24.34	3.07	24.22	0.96
公允价值变动收益	-		54.84	6.92	567.22	22.44
其他业务收入	-		0.70	0.09	14.94	0.59

表 4　　北部湾营业收入的结构分析　　（单位：百万元）

	2013 年		2014 年		2015 年	
	收入额（百万元）	占比（%）	收入额（百万元）	占比（%）	收入额（百万元）	占比（%）
已赚保费	77.44	88.77	562.26	92.66	1027.24	91.58
投资收益	9.56	10.96	42.27	6.97	76.35	6.81
公允价值变动收益	-		1.81	0.30	18.34	1.64
汇兑收益	-0.05	-0.06	0.14	0.02	-0.28	-0.02
其他业务收入	0.29	0.33	0.30	0.05	0.05	0.00

2.2.3 营业支出对比

营业支出反映了主营业务收入的各项成本，通过分析营业支出结构分析可以了解两家保险公司费用率高的原因，以及经营成果表现与该公司哪项成本控制有关，了解各项支出的控制情况以便清楚为获取更多利润应在哪项成本控制上加强。从表 5 和表 6 可以看出，众安在线和北部湾保险都是在赔付支出以及业务及管理费用支出占营业支出的比重较高，众安在线的赔付支出的成本要高于北部湾财险。众安在线的手续费及佣金支出的占比低于北部湾财险。

表 5　众安在线的营业支出及结构

	2013 年		2014 年		2015 年	
	支出额（百万元）	占比（%）	支出额（百万元）	占比（%）	支出额（百万元）	占比（%）
赔付支出	4.08	8.18	490.54	62.56	1177.00	50.53
提取保险责任准备金	0.79	1.58	63.67	8.12	143.03	6.14
营业税金及附加	0.72	1.44	44.87	5.72	128.99	5.54
手续费及佣金支出	-	-	17.77	2.27	102.33	4.39
业务及管理费用	44.21	88.60	167.29	21.33	777.85	33.40
其他业务成本	0.1	0.20	-	-	-	-
合计	49.9	100	784.14		2319.20	100

表 6　北部湾财险的营业支出及结构

	2013 年		2014 年		2015 年	
	支出额（百万元）	占比（%）	支出额（百万元）	占比（%）	支出额（百万元）	占比（%）
赔付支出	26.69	10.14	246.89	31.52	513.68	42.07
提取保险责任准备金	53.18	20.21	141.92	18.12	171.65	14.06
营业税金及附加	18.31	6.96	45.96	5.87	61.17	5.01
手续费及佣金支出	30.94	11.76	81.69	10.43	95.16	7.79
业务及管理费用	133.67	50.79	265.63	33.91	376.79	30.86
其他业务成本	0.40	0.15	1.19	0.15	0.94	0.08
资产净值损失	-	-	-	-	1.54	0.13
合计	163.19	100	783.28	100	1220.93	100

2.2.4 营业利润对比

营业利润是企业最基本经营活动成果，也是企业一定时期获得利润中最主要，最稳定的来源。众安在线在 2013-2015 年不断增长，在 2014 年扭转盈亏的局面，实现盈利，并在 2015 年，营业利润成倍增长，增长率为 2402%，远远超过北部湾财险；北部湾财险 2013-2015 年持续亏损，但是在 2015 年减亏 7735 万元。

利润总额是企业在生产过程中各种收入扣除各种耗费后的盈利，反映企业在

报告期期内实现的盈亏总额。众安在线的利润总额持续增长的，2014 年比 2013 年增长 177.8%，增长了接近两倍，2015 年比 2014 年增长 866%，增长八倍多，反映众安在线不断增长且增长迅速的趋势。北部湾财险连续三年持续亏损，在 2015 年有转好趋势。

净利润的大小主要由利润总额和所得税费用两个因素。众安在线在 2013-2015 年持续增长，2015 年比 2014 年净利润增长 517%，净利润增长迅猛；北部湾财险 2014 年比 2015 亏损更多，在 2015 年经营情况转好，表明北部湾财险有变好趋势。

表 7　　众安在线与北部湾利润情况对比　　（单位：百万元）

	2013 年		2014 年		2015 年	
	众安在线	北部湾	众安在线	北部湾	众安在线	北部湾
营业利润	-36.79	－175.96	7.94	－176.53	198.67	－99.18
营业外利润	6.88	4.89	0.18	3.13	26.22	1.79
利润总额	-29.91	-171.07	23.28	-173.40	224.89	-97.39
净利润	-29.91	-171.07	27.28	-173.40	168.40	-97.39

3.众安在线发展优势分析

3.1 众安在线的偿付能力优于北部湾财险

偿付能力，是企业偿付债务的能力。保险公司的偿债能力是指保险公司对所承担的保险责任的经济补偿能力，包括短期偿债能力和长期偿债能力。本文用反映短期偿债能力的流动比率、反映长期偿债能力的资产负债率和负债经营率、及主要财务监管指标资本充足率等四个财务指标，对众安在线和北部湾财险两个企业的偿债能力对比分析（见表 8）。

众安在线的流动比率在 2013-2015 年都维持在较高的数值，北部湾财险在 2014 年小于 1，出现短期偿债能力不足，在 2015 年流动比率增大，短期偿债能力提升；综合来看，这 3 年中众安在线的流动比率都高于北部湾财险，说明众安在线的短期偿债能力强于北部湾财险。

众安在线的资产负债率在 15%左右，负债经营率一直低于 1，说明众安在线财务结构比较稳定，风险小；北部湾保险资产负债率、负债经营率都明显高于众安在线，表明众安在线的长期偿债能力优于北部湾财险。

偿付能力充足率即资本充足率，是指保险公司的实际资本与最低资本的比率。通过偿付能力充足率可以判断保险公司的偿付能力是否充足。两家保险公司的资本适足率均高于 150%，为充足 II 类公司，众安在线的偿付能力充足率明显高于北部湾财险。

表 8 众安在线与北部湾财险偿付能力分析

	众安在线			北部湾财险		
	2013 年	2014 年	2015 年	2013 年	2014 年	2015 年
流动比率	53.33	4.27	9.55	3.15	0.99	1.12
资产负债率	2.27%	18.25%	14.33%	71.44%	43.69%	55.23%
负债经营率	0.023	0.223	0.167	2.502	0.776	1.234
偿付能力充足率	44710%	759%	1802%	889.17%	827.83%	488.66%

3.2 众安在线的盈利能力强于北部湾保险

盈利能力是指企业获取利润的能力，也称为企业资金或资本增值能力，盈利能力可以反映经营能力的好坏。本文通过营业利润率、利润率、资产利润率和净资产利润率四个指标对比分析众安在线和北部湾财险的盈利能力。众安在线与北部湾财险四个指标数值见表 9。整体而言，在三年中众安在线的营业利润率、利润率、资产利润率、净资产利润率均高于北部湾财险；就趋势而言，逐年增长。而北部湾财险的四项指标虽有变好的趋势，但均为负数，表明众安在线的盈利能力明显强于北部湾财险。

表 9 众安在线与北部湾财险的盈利能力分析 单位：%

	众安保险			北部湾财险		
	2013 年	2014 年	2015 年	2013 年	2014 年	2015 年
营业利润率	-1444.76	1.11	10.34	-227.23	-31.40	-9.65
利润率	-228.25	3.44	6.66	-196.11	-28.58	-8.68
资产利润率	-	2.43	3.61	-	-9.76	-4.41
净资产利润率	-	2.74	4.24	-	-21.90	-8.79

3.3 众安在线的成长能力快于北部湾保险

企业的成长能力是企业未来发展趋势和发展速度，反映了企业未来发展的前景。本文主要从主营业务增长率、净利润增长率、净资产增长率、总资产增长率四个指标对比分析众安在线和北部湾财险的成长能力。如表 10 所示，众安在线在 2015 年业务增长较快，净利润增长率为 517%，表明公司经营业绩突出，市场竞争能力较强，净资产增长率为 585%，说明企业扩展能力较强；而北部湾财险对比 2014 年，2015 年业务增长放缓，净利润持续三年都为负数，说明北部湾财险的经营存在一定的问题，净资产增长率为负数，表明北部湾财险资产的扩展能力减弱，主要原因之一是 2014 年经营出现亏损，投资者对其信心降低。

表 10 众安在线与北部湾财险的成长能力分析

	众安在线		北部湾财险	
	2014 年	2015 年	2014 年	2015 年
主营业务增长率	5944%	219%	596%	85%
净利润增长率	-	517%	-	-

净资产增长率	3.4%	585%	169%	- 8.09%
总资产增长率	23.61%	554%	36.53%	15.61%

3.4 众安在线的营运能力胜于北部湾保险

企业的营运能力是企业的经营运行能力，是企业营运资产的效率与效益。即企业运用各项资产以赚钱利润的能力。本文主要从应收保费周转率、应收保费周转天数和资产周转率对比分析企业营运资产的效益。如表 11 所示，众安在线应收保费周转率较高，应收保费天数较短，应收保费周转正常，表明众安在线营运资产的效率较高；众安在线的资产周转率较高，反映公司的资产利用效率较高。

表 11　　众安在线与北部湾财险的营运能力分析

	众安在线		北部湾财险	
	2014 年	2015 年	2014 年	2015 年
应收保费周转率	73.08	29.51	32.54	20.63
应收保费周转天数	5	11	11	17
资产周转率	70.68%	54.14%	34.16%	50.74%

4.众安在线发展的劣势分析

4.1 众安在线的成本管理优势未得到充分显现

成本管理就是如何强化成本控制以提高综合盈利能力。本文主要从赔付率、综合费用率、营业费用率、综合成本率四个指标来对比分析众安在线和北部湾财险的成本管理能力。如表 12 所示，2014 年众安在线除赔付率外各项指标均低于北部湾财险，表明众安在线的成本控制较好；但在 2015 年，众安在线的各项指标均增加，且略高于北部湾财险，说明众安在线成本控制能力下降，互联网保险的成本优势并未得到充分发挥。

表 12　　众安在线与北部湾财险的成本管理能力分析　　单位：%

	众安保险			北部湾财险		
	2013 年	2014 年	2015 年	2013 年	2014 年	2015 年
赔付率	191.00	77.82	68.70	103.14	69.15	66.72
综合费用率	1764.55	32.28	52.52	236.22	69.95	51.90
营业费用率	1736.30	23.49	40.48	172.62	47.24	36.68
综合成本率	1955.55	110.10	121.22	339.36	139.10	118.61

4.2 众安在线的投资收益能力未得到有效发挥

本文对于投资效益的评价主要是从投资收益率这一指标说明。投资收益率指标反映保险公司对外投资的效益，可以衡量投资组合的品质，一般认为该指标应该高于银行同期存款利率。如表 13 所示，众安在线的投资收益率较低，且呈现

下降趋势，2015 年的 0.636%低于同期银行存款利率；而北部湾财险投资收益率呈上升趋势，且投资收益率较为合理，综上可看出众安在线的投资收益率低于北部湾财险。

表 13 众安在线与北部湾财险的投资收益分析 单位：%

	2014 年	2015 年
众安在线	3.07%	0.636%
北部湾财险	4.75%	5.41%

4.3 众安在线的业务拓展能力有待进一步提高

从表 14 可以看出，众安在线持续两年保费增长都较快，在 2015 年增长最快的是健康险其次是信用保险，家庭财产保险，其增长都达到了五倍以上。众安在线的保费收入主要是来自其他险种，在 2014 年年报中显示其他险种中主要是退运险，占总保费收入的 77.2%，但在 2015 年年报中虽未显示其他险种的具体情况，但从其实际运营情况来分析，退运险任应占较大比重。但在企业财产保险、船舶保险和农业保险这些手续复杂，核保理赔等手续繁琐的保险，众安在线并没有开办。

从表 15 可以看出，北部湾保险业务的涵盖范围较为广泛，包含了所有基本财产保险的险种，在 2015 年各险种的保费收入的增长除责任保险和农业保险，表现一般，多险种出现负增长。从保费收入结构来看，商业险车险所占的比重较大，企财险所占比重逐年递减，农业保险所占比重上升，意外伤害保险所占比重下降。

表 14 众安在线保费收入总额及结构

	2013 年		2014 年			2015 年		
	保费收入（万元）	占比（%）	保费收入（万元）	增长率（%）	占比（%）	保费收入（万元）	增长率（%）	占比（%）
保证保险	266.59	20.91	10892.94	3986	13.72	45329.01	316.13	19.85
家财险	0.04	0.00	455.46	1049342	0.57	3376.22	641.28	1.48
信用保险			400.27	-	0.50	5172.80	1192.32	2.27
责任保险			1599.27	-	2.01	8120.87	407.79	3.56
意外伤害险			4439.31	-	5.59	28336.56	538.31	12.41
健康险			1.13	-	0.00	1280.18	112790	0.56
其他[②]	1008.09	79.08	61621.26	6012	77.60	136688.6	121.82	59.87
合计	1274.72	100	79409.65	6129	100	228304.2	187.50	100

[②]该公司其他险种主要为退运险，2014 年度退运险保险业务收入金额为人民币 613,144,511 元；2013 年：人民币 10,080,880 元。

表 15　　北部湾保费收入总额及结构

	2013 年		2014 年			2015 年		
	保费收入（万元）	占比（%）	保费收入（万元）	增长率（%）	占比（%）	保费收入（万元）	增长率（%）	占比（%）
交强险	6055.10	18.52	20087.50	231.75	22.04	27146.90	35.14	21.10
商业险车险	12980.05	39.70	37710.9	190.53	41.37	53599.81	42.13	41.66
企财险	5812.14	17.78	7487.99	28.83	8.21	5999.55	-19.88	4.66
家财险	251.22	0.77	3523.98	1302.8	3.87	4617.48	31.03	3.59
工程保险	1208.96	3.70	896.05	-25.88	0.98	550.08	-38.61	0.43
责任保险	627.49	1.92	1951.10	210.93	2.14	5104.70	161.6	3.97
货运保险	224.38	0.69	658.62	193.53	0.72	954.38	44.91	0.74
船舶保险	320.44	0.98	618.15	92.91	0.68	588.70	-4.76	0.46
保证保险						9.00		0.01
农业保险			9058.26		9.94	19242.50	112.4	14.95
意外伤害险	5194.74	15.89	8990.25	73.06	9.86	10672.63	18.71	8.29
短期健康险	22.67	0.07	136.34	501.37	0.15	187.25	37.34	0.15
特殊风险						0.06		
其他险			8.15		0.01	0.48	-94.06	
分保收入			23.59		0.03			
合计	32697.20	100	91150.9	178.77	100	128673.53	41.17	100

5.专业互联网保险公司发展策略

通过众安在线和北部湾财险的对比分析，我们发现专业互联网保险公司的发展在具备明显优势的同时，其内在固有的缺陷也将为其发展带来不确定性。专业互联网保险公司在经营管理方面没有可借鉴的范本，需要结合互联网保险实际，制定合适于其自身特点的经营管理策略。

5.1 实行差异化市场策略，不断提高市场竞争力

随着互联网普及，互联网用户不断增长，网上购物也成为网民日常网络生活的重要组成部分。互联网粘性的不断增加也为保险产品的宣传及销售提供便利。面对我国互联网保险市场的巨大开发潜力，互联网保险公司应结合自身特点，在对市场进行细分的基础上，将自身定位于市场拾遗补缺者，实行差异化的市场竞争策略，以避开与传统保险公司正面竞争，抢占保险市场先机。

5.2 充分利用技术优势，不断提升经营管理效率

近年来传统保险公司通过实现内部管理及联系的网络化，使得公司内部的各

个部门之间信息共享程度增大，实现了公司各部门客户信息的维护及保单处理协同，大大提高了管理效率。而互联网保险公司更应将互联网的作用发挥到极致，除了将企业经营的各个环节和主要经营活动，利用通过互联网在线进行外，还应建立一套完善的数据库，通过计算机来进行数据处理和分析，为保险公司的决策管理工作提供便利，从而不断提高自身的管理水平和员工工作效率，在快节奏的市场条件下占得先机。

5.3 充分发挥财务杠杆效应，不断提高投资收益率

从前文的分析来看，众安在线的负债经营率较低，资本未得到有效利用，财务杠杆效应未得到充分发挥，从而造成其投资收益率较低。一方面，专业互联网保险公司应准确把握保险资金投资监管政策，在政策法规允许的范围内，根据市场对资金的需求和风险状况，不断加大投资的力度。另一方面企业投资能力的提升关键在于人才，专业互联网保险公司应注重专业投资人才的培养和引进，以提升自身投资能力和收益状况。

5.4 准确把握市场需求，加大产品研发力度

专业互联网保险公司应结合互联网低成本、高粘性的特点，开发适合网络群体需要的保险产品。一类是符合互联网小额、海量、高频和碎片化特征的各类简单化创新产品，保费金额较低、需求广泛、与具体场景相结合，尽管每个细分险种的市场空间有限，形成合力则是一个巨大的增量市场。另一类是刚需、标准化程度较高的险种，如车险、理财险等。此类险种在线下就有广阔的市场，由于是刚性需求，消费者可以直接感知、购买需求旺盛。

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专业互联网保险公司发展策略研究
——基于线上和线下保险公司主要财务指标的对比分析[③]

孔月红　　陈诗雅

孔月红*
副教授
湖北经济学院金融学院
湖北省武汉市江夏区杨桥湖大道8号群贤楼301室
武汉430205，中国
电话: 135 4525 7211
Email: 48003500@ qq.com

陈诗雅
湖北经济学院金融学院
湖北省武汉市江夏区杨桥湖大道8号
武汉430205，中国
电话: 132 9668 2185
Email: 1130393780@ qq.com

关键词: 专业互联网保险公司；发展策略；财务分析

摘要：在“互联网+”的时代背景下，互联网保险热潮掀起。近年来中国互联网保险迅猛发展，并保持强劲的增长势头，主要形成了传统保险公司自建网络平台、第三方互联网销售平台、专业互联网保险公司等三种模式。从目前的市场格局来看，第三方平台模式占主导地位，但专业互联网保险公司模式呈现出异军突起之势。专业互联网保险公司缘何倍受各路资本青睐？本文以首家专业互联网保险公司——众安在线为例，通过将其与同一时期开业的传统保险公司——北部湾财产保险股份有限公司的主要财务指标进行对比，研究发现，专业互联网保险公司在偿付能力、盈利能力、成长能力和运营能力等方面具有独特的优势；但同时在成本管理能力、投资收益能力和业务拓展能力等方面存在劣势。专业互联保险公司应综合运用多样化的发展策略，把握机遇，精准定位，内外兼修，实现优势最大化，不断提高市场竞争力。

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The Risk Management of Medical Insurance Relationship

-Based on the Dissipative Structure Theory

LI Bing, LI Xinying

LI Bing
Associate Professor
School of politics and public administration
University of Electronic Science and Technology of China
Chengdu 611731, China
Tel: 13808000750
Email: 1065810507@ qq.com

LI Xinying *
School of politics and public administration
University of Electronic Science and Technology of China
Room 455, complex building, University of electronic science and technology
No 2006, Xiyuan avenue, Chengdu hi-tech west zone
Phone: 18200108614
Email: 156047552 @qq.com

Keywords: Risk management, Medical insurance relationship, Dissipative structure theory.

Abstract. This paper expounds the internal connection between the risk management medical insurance relationship and the dissipative structure by using the dissipative structure theory and methods. It analyses the risk management of medical insurance relationship through deconstruction method, and analyses the three subjects of

medical insurance institutions, the insured parties and medical institutions, and the non-linear relationship among them and their internal entropy transmission process in the whole system. Meanwhile, this paper learns from the medical insurance management experiences from the United States and Germany to, based on the reality of China, explore an effective path to establish the risk management of medical insurance relationship by introducing negative entropy from outside, so as to achieve relative balance of the system. Ultimately, it tries to lower the risks existed in the present medical insurance relationship and proposes suggestions for government in managing the relative interest bodies in medical insurance, reducing risks, achieving pluralistic governance and realizing mutual share and progress.

1. Introduction

The dissipative structure theory, coined by Russian-Belgian physical chemist Ilya Prigogine, points out that an open system which is operating out of, and often far from equilibrium in an environment with which it exchanges energy and matter. When the condition changes reach a certain threshold value, it will shift from the original chaotic state to a steady state in time, space of function. Since 1970s, the dissipative structure theory has been applied not only in natural science research, but also has a wide application in the field of social science with remarkable achievements. Medical insurance relationship management is a complex field, which involves many relationship bodies gaming between each other. It is an integrated social system. To see the evolution process of the system from the perspective of the theory of dissipation structure, its purpose is to constantly create and improve the conditions which form the dissipative structure, so as to help medical insurance relationship to reach dynamic and orderly state, and to reduce the risks that exist in the government's management.

Therefore, in order to construct a reasonable medical insurance relationship and to reduce the risk of management, it requires to design a reasonable mechanism to control the fluctuation caused by conflicts and differences among different factors within a reasonable limits. By doing, it will become a driving force for the development of the society and make the whole system full of vigor and vitality; Conversely, it will lead a series of risk, such as moral hazard, fund management risk, etc. in medical insurance.

2. Analysis on the use of dissipative structure theory on risk management of medical insurance relationship

Prigogine thinks that entropy is a measurement of the chaotic degree of a system. The greater is the value of entropy, the more chaotic is the system. The system can offset the increasing positive entropy within the system by introducing the negative entropy to ultimately reduce the total entropy and make the system from being chaotic to ordered.

In the daily operation of medical insurance, the main bodies, i.e. the government (medical management agencies), medical institutions and the insured parties have their own interests appeal, thus the three main bodies will interact and have interest game, and at the same time, produce positive entropy which is unfavorable in maintaining the medical insurance relationship management.

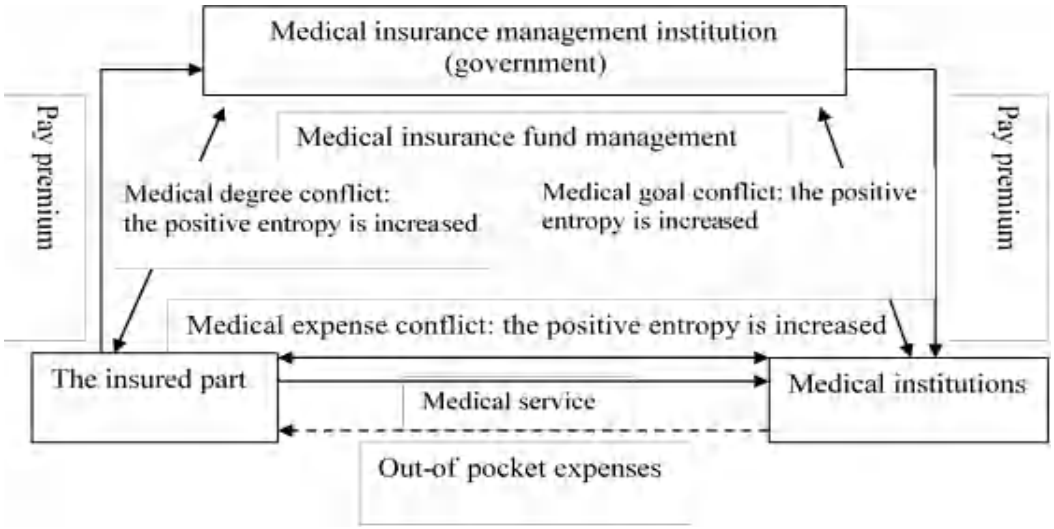


Figure 1 Relationship of Chinese medical insurance elements and the production of positive entropy

First of all, the relationship between the medical insurance management institutions and medical institutions should be a relationship of supervision and cooperation. Government's goal of providing "basic medical insurance" is realized through the work of medical institutions. Meanwhile, the latter is required to accept supervision of the former. However, the two have interest differences. For instance, hospital usually considers more about the normal operation and interests of itself, and less about the medical cost control. But medical insurance management institutions require that hospital must consider the medical cost control. Otherwise, the hospital is considered to violet the rules and will not receive relevant expenses, which will cause contradiction between hospitals and management institutions and even the insured parties, and that will lead to increase of positive entropy. The process of entropy increase reveals the trend of diminishing efficiency in the process of executing the systems, policies and methods of such medical insurance relationship management.

Second, medical insurance management institutions will not only consider to realize the goal of specific and individual basic medical insurance, but more importantly the implementation of the overall goal to ensure the balance of payments of medical insurance fund. Individual insured party, by contrast, purses only the realization of personal goal, and will not proactively consider the balance of payments problems of medical insurance fund. In particular, if there is lack of constraints, the insured party will definitely pursue high quality and adequate medical insurance instead of "basic medical insurance". Even if the insured party knows that they could only have basic medical insurance, there is still a different understanding on "basic medical insurance" between them and the medical insurance institutions.

Finally, the relation between medical institutions and insured parties is the relation of service supply and demand. The insured patients have relatively high requirement for hospital. They require doctors to adopt the most scientific scheme for treatment according to personal condition. However, once the treatment ended, the medical insurance center can only pay relative medical costs in proportion according to the

national directory of diagnosis, thus a large proportion of medical expenses not covered is transferred to the patients. When the medical cost is more than expected, patients are more likely to hold a suspicious attitude to the medical treatment of a hospital. Under such circumstances, the positive entropy brought from the conflict between the insured and medical institutions will further aggravate the imbalance in the medical management system.

The positive entropy flow produced from the internal conflicts among the three main bodies of medical management system is the source of the unsteady management system. As a result, the efficiency of medical relationship management will be decreased and will even bring risks to management. If the system continue to maintain the relatively closed state and does not adjust the system and introduce external mechanism, and not exchange necessary material, energy and information with the external environment, the medical insurance relationship management will fall into a state of disorder; conversely, if the medical insurance management system can input energy and information to itself from the external environment, have corresponding system innovation, management innovation and technological innovation, and break the rigid state internally to increase the management efficiency, then the medical insurance relationship management will return to a harmonious state.

3. The open management mode of medical insurance in Germany and the United States

In the process of the evolution of the system, the negative entropy coming from the external environment is a necessary external condition in maintaining and developing the system.

3.1 Germany's open medical insurance management system

Germany is the first country worldwide to set up the social medical insurance system. In the past over 100 years of reform and development, it has achieved effective governance of overall high efficiency and good social fairness. According to data released by the world health organization, the expenditure of medical and social security accounts for as high as 88.8% in the government's spending on health in 2012. Whether the national health care level or the degree of satisfaction, the comprehensive performance of Germany's medical insurance system ranks top 20 worldwide in recent years [13]. In particular, Germany establishes the governance system in the field of medical insurance, which combines government governance and social governance, has effectively achieved the virtuous cycle operation among the main bodies of the medical insurance field.

The German government's main role is to design the system and related laws. When medical insurance dispute occurs, the government is responsible for regulation and arbitration, but does not have direct control and management over the medical insurance industry. At the macro level, the governance structure of Germany's social medical insurance organization is mainly that the government department set up a federal joint committee which has members such as the federal disease fund

association, the hospital alliance and the statutory medical insurance physicians' association. The federal joint committee, based on reference obtained from policy research institute and consultancy, formulates the kind and standard of medical service that needs the guarantee of disease fund, and approve the disease fund to be the host organization to undertake and manage the statutory medical insurance. Physicians association, hospital alliance and disease fund association is respectively responsible for supervising other members; on the meso-level, the social medical insurance governance is mainly relied on governance of associations, and it is also an important measure for Germany to introduce negative entropy from external environment. The federal joint committee enjoys monopoly of national recognition. It can implement plans through mutual consultations, and it is of constraint force on members of the association; on the micro-level, the internal governance mainly focuses on the internal arrangement of rights structure of disease fund. The disease fund, which manages itself autonomously, has independent organization decision-making right. Generally speaking, its internal structure mainly includes the management committee and the board. Among which, representatives of the management committee are elected by the insured and the employers. The electoral system is one of the core mechanisms of the autonomously managing social insurance institutions. As the center of management institution, it makes decision which makes decision that can affect the funds, and undertakes major leadership and organizational tasks.

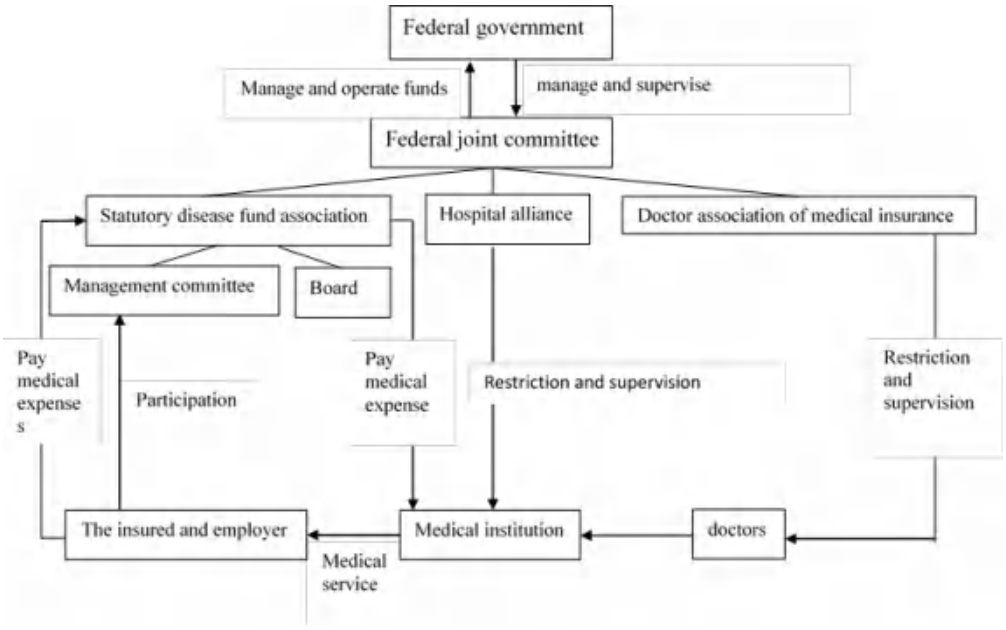


Figure 2 .The structure of Germany's medical insurance relationship mangement

We can found that in the German medical insurance system, in addition to the three main bodies of the insured party, medical insurance management institution and medical institution, there are also external institutions, which are the statutory disease fund, the hospital alliance and the medical insurance doctor association. The negative entropy produced help to promote government regulation separating from

management, which has reduced the positive entropy flow brought from the direct conflict between the medical insurance management institution of the government and the insured as well as the medial institution. Besides, hospital alliance and medical insurance doctor association can reduce the said conflict by supervising hospitals and doctors externally, which will further offset the positive entropy.

3.2 The introduction of negative entropy under the American medical insurance system

The United States is the world's most representative country in implementing medical insurance marketization. Although the medical technology is advanced, the medical capital is abundant, and the per capita medical expenses and medical costs exceed that of other developed countries, the United States has yet to achieve the goal of universal medical insurance. However, things have been improved since the implementation of "Affordable Care Act" by Obama administration in 2010. In particular, the profit allocation mechanism between medicine companies and insurance companies increased, through effective active prevention and intervention, the percentage of doctors to prescribe more effective drugs and treatment by 60%, which lowered the percentage of the comprehensive risks of medical insurance service participants by 50%. [14]

In the United States, personal medical insurance fee is accounted and paid according to the medicine directory stipulated by insurance companies. The Pharmaceutical factory interest group has large political force, and can formulate or amend the medicine directory to favor their own interest by lobbying congress etc. As a result, the increased medical cost makes higher medical insurance fees for the insured parties, giving more profits to medicine manufactories and insurance companies. The inner system positive entropy between the interest appeal of the two parties and the insured parities increased constantly, which will make the system more unbalanced.

To change the situation of ever increasing medical costs and pressure for citizens and enterprises, the Obama administration adopts the medical reform tax mechanism to separate the benefits of medicine manufactories and insurance companies, that is to introduce the negative entropy mechanism from the external environment to control the positive entropy flow generated between medicine manufactories and insurance companies with a reasonable range. The tax increase sets a bar that only high-income people can reach, which in fact increases taxation for the rich people. Of course, in order to preserve their own interests and reduce the limit of tax increase, the high-income people will use their own political strength to force insurance companies to modify medicine directory listing, so as to reduce the cost of medicines. Such interests of the game will eventually reduce the medical insurance cost for individuals and enterprises, which will ultimately ease the medical insurance contradiction in the United States.

To introduce negative entropy from outside and to seek a non-equilibrium restriction mechanism flexibly coordinates the relationship among major interest groups, readjusts the interest structure, and dissolves the resistance to the maximum.

4. To build a harmonious medical insurance relationship management system in China

(1) Openness is the necessary condition for the medical relationship management system to develop in an orderly way. First, the open system of medical insurance relationship management should be future improved. The government should play the dominant role, giving play to macro-control, formulating policies and laws, and performing regulatory functions. In addition, on the premise of ensuring funds safety and effective regulation, the government should give full play to the market adjustment function, and providing the rights of free choices in medical service supply, ways of seeking medical care and participating in medical insurance. In the process of operating medical funds, it can bring the market into full play to add and keep value, so as to realize the government-dominant medical resources distribution and the coordinated development of the market regulation.

(2) Separating government regulation and management, and introducing external negative entropy flow. To separate the government functions as public service purchaser, supplier, policymaker and regulator is the new practice for modern government to reform government public service and management. A medical insurance agency can be set up as shown in figure 3. The agency's positioning should be a public service institution independent of the government. It can be constituted by three parties of the government, insured and medical institutions. The insured party and medical institution will mainly participate in formulating medical insurance fees rules and mechanism, while the government will perform the communicator of interests between the two parties and the regulator of medical fees collecting and settlement. The insured and the medical service provider should be separated, letting the agency to perform the intermediary and bridge between the two. The agency should take advantage of itself in premium actuary and medical cost control to solve the problem of information asymmetry in medical insurance, so as to avoid the risks of contradiction between medical institutions and the insured.

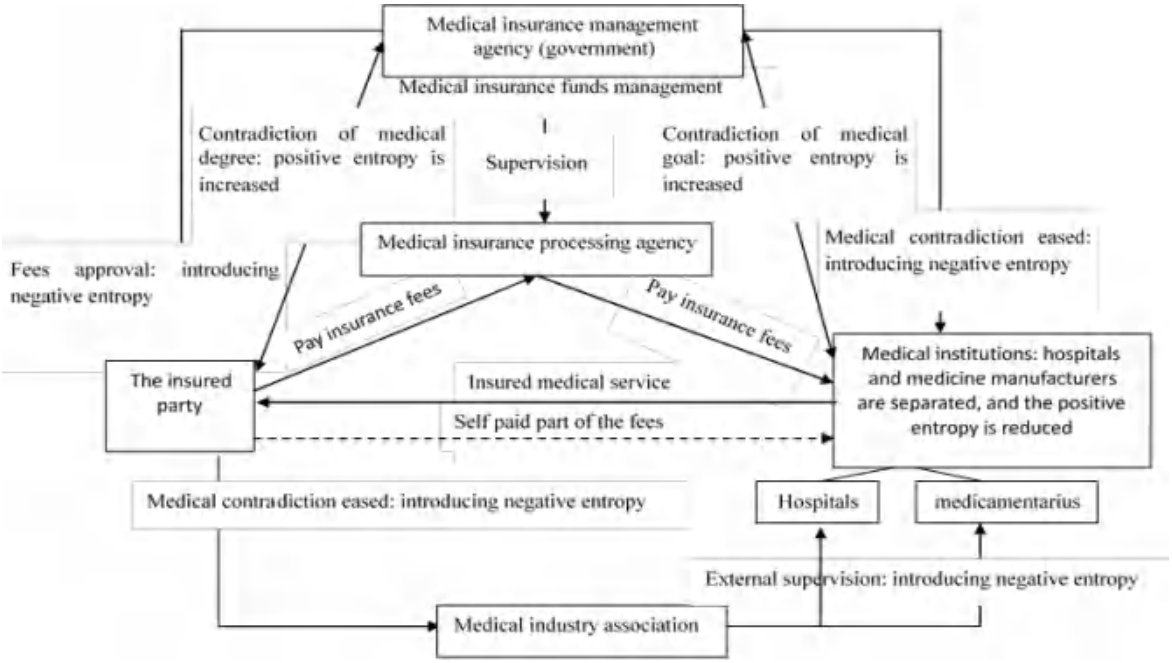


Figure 3 Management flow after introducing negative entropy

(3) The medical insurance management institutions in China should increase the transparency and accountability of the use of insurance premiums, and to set up the "administration of medical insurance premium" to supervise and evaluate the insurance rate adjustment. In addition, supervison can be introduced from outside the management system, that is to learn from the third party supervision model of foreign contires. The medical industry association, the third party organization constituted of medicine manufacturer, hospitals and other medical institutions can be responsible for supervision, which is fair and just. It can introduce negative entropy externally to offset the direct conflict between the insured and medical institutions, and thus reduce the risk of direct conflict between patient and doctors.

(4)To deal with the contradictions, difference and fluctuation in medical insurance relationship management. Negative entropy can be input constantly to offset the power of positive entropy, which can also be reduced by internal optimization, so as to strengthen the forming condition of dissipation structure, improve the power of dissipation management, and play the role of management institutions with efficiency. Public hospitals should phase out the mechanism of "covering hospital expenses with medicine revenue", and promote the pattern of "separation of hospitals and medicine". The government should strengthen its supervision on medical services institution, medicine circulation and price regulation, and to break the monopoly hospitals and medicine. It should urge the hospitals and medicine manufacturers to operate separately, so as to realize the internationally accepted model: "hospital makes prescription, pharmacy sells medicine and the insured buy medicine directly from pharmacy". The interest connection between hospital operation and medicine sales should be cut off to reduce the prices of medicine. When the interests of hospitals and medicine are no longer connected, hospitals will definitely improve its medical service quality and efficiency, so as to ensure its daily operation and interests. Such

practice reduces the positive entropy of the risk generated from medical costs between patients and hospital, which will reduce the entropy value of the whole system. Meanwhile, the government investment department and the supervision department of public hospitals should be separated. The investment department is responsible for financing and ensuring reasonable and effective investment, while the supervision department is responsible for supervising the economic and social activities of various types of behavior subjects, which include economic content of the price, quality, entry and exit of public service products, public welfare service products and commercial service products, and social content which includes safety, health, sanitation, environmental protection etc. Even for the supervision of public service production, it must have in-depth involvement and active intervene in the public service supply, improving the efficiency of resource allocation of public service, including having effective governmental and commercial regulation.

Here, external negative entropy can be introduced with the aid of the open system, that is the insurance management institution which is independent of government. It will formulate and audit the directory listing of basic medical insurance, and hospitals should prescribe in strict accordance with the listing. The insurance management institution can be formed by both the insured and the government, and the same medical institution can partly participated to supervise with an attempt to ensure its basic operation. To separate medicine manufactures and hospitals, and government to establish a model separating regulation and management, then the risks and conflicts in management will be reduced.

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基于耗散结构理论对医疗保险关系的风险管理研究

李冰　李欣颖

李冰
副教授
电子科技大学政治与公共管理学院
成都611731，中国
电话：13808000750
Email：1065810507@qq.com

李欣颖*
本科生
电子科技大学政治与公共管理学院
电子科技大学综合楼 455 室
成都高新西区西源大道 2006 号
电话:18200108614
Email：156047552@qq.com

关键词：风险管理；医疗保险关系；耗散结构理论

中文摘要. 本文运用现代耗散结构理论和方法,阐述其与医疗保险关系风险管理内部存在的联系，对医疗保险关系风险管理作解构分析,以医疗保险机构、参保人以及医疗机构为三大主要关系主体,分析三者在整个系统中彼此之间存在的非线性关系以及内部之间的熵值转换过程。同时，本文借鉴美国、德国在医疗保险风险管理中的经验，结合本国实情，探寻从外部引入负熵，使系统达到相对平衡的状态，构建医疗保险关系风险管理的有效路径，改善当前医疗保险关系中存在的风险，为政府对医疗保险相关利益主体的管理提出建议，减少风险，实现多元治理，使得彼此共享共进。

1. 引言

由比利时科学家伊里亚·普里戈金提出的耗散结构理论指出，一个开放系统在远离平衡的状态下，与外界进行物质和能量的交换，当条件变化达到一定的阈值时，就会从原有的混沌无序状态转变为在时间、空间或功能上的有序状态。自20世纪70年代以来，耗散结构理论不仅应用于自然科学领域中的研究，在社会科学领域中也有广泛应用，并且取得了令人瞩目的成就。医疗保险关系管理是一个较为复杂的领域，其中涉及众多关系主体，彼此之间相互博弈，是一个综合的社会系统。从耗散结构理论的视角审视这个系统的演化过程，其目的就是要不断创造和完善形成耗散结构所需要的条件，从而促进医疗保险关系达到动态有序的状态，减少政府管理中存在的风险。

因此，为了构造合理的医疗保险关系，减少管理的风险，就需要设计出合理的机制，使得由内部各要素之间的矛盾和差异引起的涨落，能够控制在合理的限度之内，这样才会成为社会发展的动力，使得整个体系充满生机与活力；反之，则会带来一系列的风险，诸如医疗保险的道德风险，基金管理风险等。

2. 运用耗散结构理论对医疗保险关系矛盾风险分析

普里戈金认为熵是一个系统无序程度的度量，熵的取值越大，系统就越无序。系统可以通过引入外部负熵，抵消系统内部不断增加的正熵流，最终减少总熵，从而使系统从无序态变为有序态。

在医疗保险的日常运行中，由于以政府（医保管理机构）、医疗机构以及参保人为主体的医疗保险关系系统中各个主体对于自身利益的诉求，三大主体之间就会通过相互作用产生利益的博弈，同时会产生不利于维持医疗保险关系管理秩序的正熵。

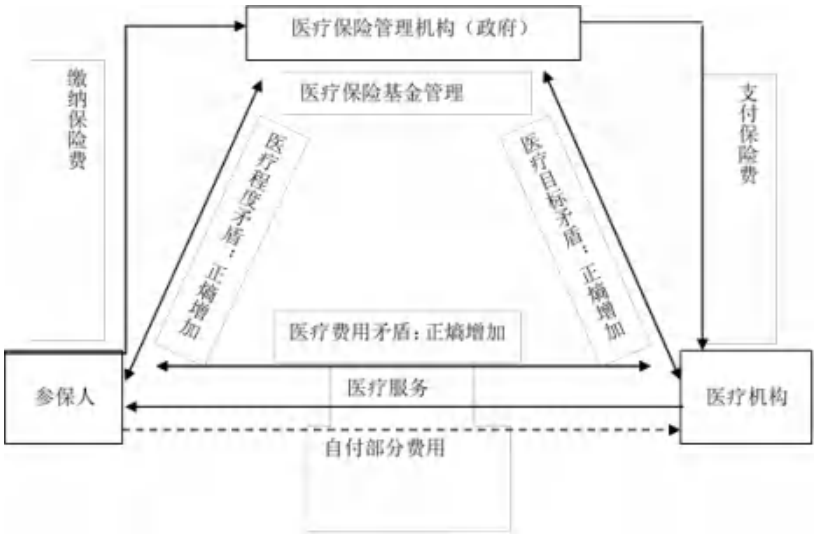


图 1　我国医疗保险要素关系以及正熵产生图

首先，医疗保险管理机构与医疗机构之间的关系应该是一种监督合作关系。政府提供“基本医疗保障”目标是需要通过医疗机构的工作来实现，医疗机构也要接受政府的监督。但是两者之间又存在着利益差异。比如医院通常是考虑医院本身的正常运营和利益，对医疗费用控制则考虑较少，而医保管理机构则要求医院必须考虑控制医疗成本，否则，医院则是违规操作，不予支付相关费用，这样就造成了医院与管理部门乃至参保患者之间的矛盾，即系统内部正熵的增加。正熵增的过程，揭示了此种医疗保险关系管理的制度、政策、方法在执行过程中呈现了效率递减的趋势。

其次，医保管理机构不仅要考虑具体的、单个的参保人基本医疗保障目标的实现，更要考虑整体目标的实现，保障实现医疗保险基金的收支平衡。与此相反，单个的参保人则只追求自身目标的实现，而不会主动考虑医疗保险基金收支平衡问题。特别是，如果约束不力，参保人必然追求高质量的、充分的医疗保障，而不是“ 基本医疗保障”。即使参保人明白自己只能得到基本医疗保障，也与医疗保险机构在“基本医疗保障”的理解上存在着差异。

最后，医疗机构与参保人之间是一种服务供需关系。参保患者对医院的要求相对较高，要求医生根据病情，采取最科学的方案进行治疗。但是一旦结束治疗，由于医保中心只能按国家规定的诊疗目录按比例支付相关的医药费用，许多不予支付的医疗费用自然转到了患者的头上，出现超出预期的医疗费用时，患者更多的是对医院的医疗行为产生怀疑。在此状况下，参保者与医疗机构的矛盾所带来的正熵流也就加剧了医疗管理系统的不平衡。

因此，由于医疗管理体系三大主体的内部矛盾冲突而不断产生的正熵流是管理体系不稳定的源泉，必然导致医疗关系管理效益的降低，甚至带来管理上的风险。如果此时，系统继续处于相对封闭的状态，不及时地进行制度上的调整和外部机制的引进，不与外部环境进行必要的物质、能量和信息交换，医疗保险关系

管理将会持续陷入无序的状态；反之，如果医疗保险管理系统能够从外部环境输入能量和信息，进行相应的制度创新、管理创新和技术创新，打破内部僵化的状态，使管理效率递增，医疗保险关系管理又将恢复和谐状态。

3.德国与美国的医疗保险开放管理模式

在系统的演化过程中，来自外界环境的负熵是系统维持和发展有序结构的一个必不可少的外因条件。

3.1 德国开放式的医疗保险管理体制

德国是世界上首个建立社会医疗保险制度的国家，在过去 100 多年的改革发展中实现了总体效能高、社会公平性好的有效治理。在世界卫生组织公布的数据中，2012 年德国在医疗社会保障方面的支出占政府在整体健康方面的支出高达 88.8%，无论是从国民健康水平还是满意程度，德国医疗保险制度的综合绩效排名近几年都在全球的前 20 位[13]。特别是德国在医疗保险领域建立的政府治理和社会治理相结合的治理体系，有效地实现了医疗保险领域中各大关系主体的良性循环运作。

德国政府的主要作用就是设计制度和制定相关法律，当发生医疗保险纠纷时，承担调节及仲裁的责任，并不直接控制和管理医疗保险行业。德国社会医疗保险组织的治理结构在宏观层面上主要是政府部门设立了成员包括联邦疾病基金协会，医院联盟和法定医疗保险医师协会的联邦联合委员会。联邦联合委员会在参考政策研究所及咨询机构建议的基础上， 制定疾病基金所需保障的医疗服务种类及质量标准，批准疾病基金会作为承办及管理法定医疗保险的主体机构。医师协会、医院联盟和疾病基金协会分别负责监督其成员执行；在中观层面上，社会医疗保险治理主要是基于协会层面的治理，也是德国从外部环境引入负熵的重要举措。联邦联合委员会享有国家认可的垄断地位，通过相互协商实施计划，对所有协会成员具有约束力；微观层面则是进行内部治理，主要关注的是疾病基金内部的权利结构安排。自治管理的疾病基金拥有独立的组织决策权，一般而言，其内部结构主要包括了管理委员会和理事会。其中，管理委员会的代表由被保险人及其雇主选举产生。选举制度是社会保险机构自治管理的核心机制之一，它作为管理机构的中心，有权影响基金的决策，承担主要的领导和组织任务。

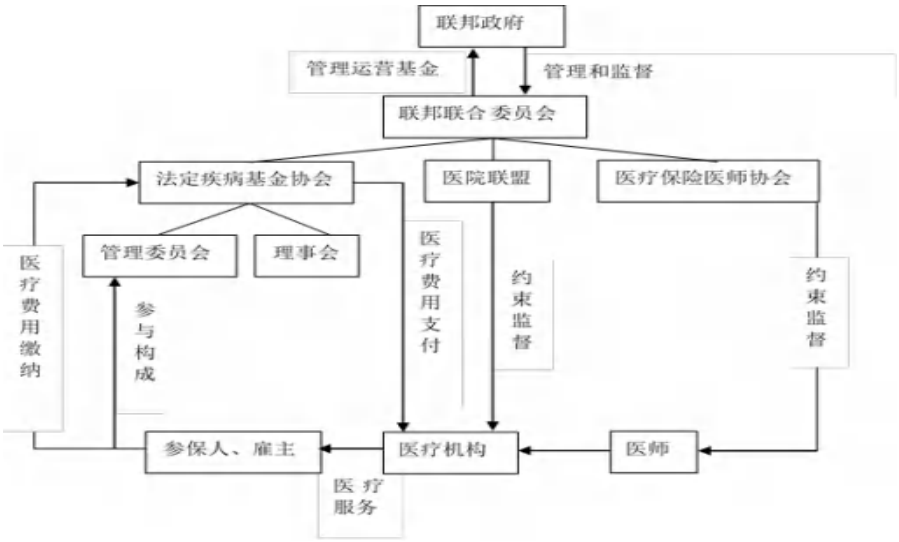


图 2　德国医疗保险关系管理结构

从中我们可以发现，德国医疗保险体制中，除了参保人、医疗保险管理机构以及医疗机构这三大主体之外，法定疾病基金会和医院联盟、医疗保险医师协会，是从外部介入到三者关系之间的机构，其所带来的负熵也就是促使政府的医疗保险管理机构实现管办分离，减少了其与参保人和医疗机构的直接矛盾所带来的正熵流。另外医院联盟和医疗保险医师协会则是通过从外部对医院、医师的监督，减少了其与另外两大主体之间的矛盾，从而进一步抵消了正熵的产生。

3.2 美国医保系统下的负熵引入模式

美国是世界上推行医疗保险市场化最具代表的国家，尽管美国的医疗技术先进，医疗资金雄厚，人均医疗费用和医疗费用均超过其他发达国家，但仍未实现全民医保的目标。但是，自 2010 年奥巴马“平价医疗法案”推行以来，情况有所好转，特别是法案中医药商和保险公司的利益分割机制，通过有效的主动预防与干预，医生能开出更为有效的药物与治疗方法的几率提高了 60%，从而使医保服务的参加者的综合风险低了 50%。[14]

在美国，个人的医疗保险费用主要是根据保险公司规定的医药清单目录进行缴费核算。药厂利益集团拥有着较大的政治力量，能够通过国会游说等使得保险公司根据自身的利益制定或者修改保险医药目录清单，医药费用增高，那么就会使得参保人的费用增多，医保费用随之上涨，从而药厂商和保险公司从中获益，二者的利益诉求与参保人彼此间系统内部的正熵流不断增加，从而使得系统不平衡程度日益加剧。

奥巴马政府为了改变美国医保费用逐渐升高，公民、企业压力不断增加的状况，引入了一种能将药厂商和保险公司利益分离的机制，那就是采用医改税，也就是从外部引入了负熵机制，从而使得药厂商和保险公司之间所产生的正熵流控

制在合理范围之内。增税条件一般设定为高收入阶层符合此条件，变相地向富人增税。当然，高收入阶层为了保全自己的利益，减少增税的额度，就会通过自身的政治力量，迫使保险公司修改医药目录清单，降低药品的费用。这样的利益博弈，最终使得个人和企业的医保费用降低，从而缓和了美国的医保矛盾。

从外部引入负熵，找寻一种非平衡下的制约机制的做法，灵活协调了重大利益集团的关系，重新调整了利益格局，最大限度地化解了阻力。

4. 构建我国和谐的医疗保险关系管理体制

（1）开放是医疗关系管理系统向有序发展的必要条件，首先应该继续完善医疗保险关系管理体制这一开放系统，坚持政府主导，发挥政府的宏观调控、制定政策法律及监管职能，另外在基金安全和有效监管的前提下，充分发挥市场调节功能，在医疗服务供给、就医方式、参保方式等方面给予自由选择权，在医保基金的运营过程中，可以充分发挥市场的作用增值保值，从而实现医疗资源配置政府主导和市场调节的协调发展。

（2）管办分离，从外部引入负熵流，分离政府作为公共服务购买者、供给者、政策制定者和监管者的职能，这是现代国家政府改革政府公共服务与管理的新做法。在此可以设立一个医保办理机构，如图 3 所示，办理机构的定位应当是独立于政府的公共服务机构，它可以由政府、参保人、医疗机构三方共同构成。参保人与医疗机构的加入主要是在制定医疗保险费用条例和机制时发挥作用，而政府在其中就是协调两者之间利益的沟通者和医疗费用收取与结算的管理者，参保人与医疗给付者应当彼此隔离，要让经办机构充当二者的中介与桥梁，通过发挥经办机构在保费精算和医疗费用控制方面的优势解决医疗保险中两个信息不对称问题，从而规避医疗机构与参保人之间的矛盾风险。

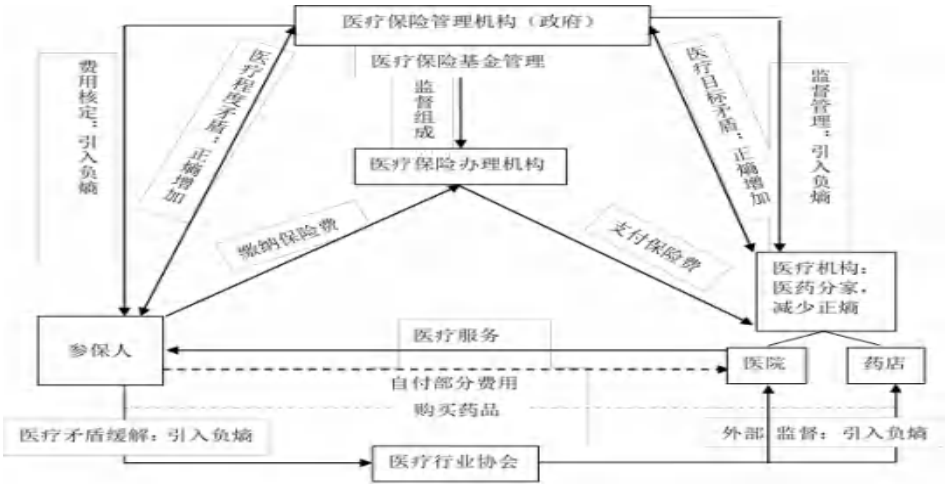


图 3 负熵引入后的管理体制

（3）我国的医疗保险管理机构应该提高保险保费使用的透明度和可问责性，成立“医疗保险费管理局”负责监督和评估保险的费率调整。另外，可以从管理体制外部引入监督，即借鉴国外第三方监管的模式，让医疗行业协会，例如医药、医院等医疗机构组成的第三方组织负责监管，体现公平公正，从外部引入负熵，进而抵消参保人与医疗机构直接产生的矛盾，减少医患间的直接风险冲突。

（4）正确处理医疗保险关系管理存在的矛盾、差异和涨落。不断输入负熵流，抵消熵增力量，另外也可以通过内部优化减少正熵流的产生，从而强化耗散结构的形成条件，增强管理耗散的力量，使管理机构有效地发挥作用。公立医院应该逐步取消“以药养医”机制，促进形成“医药分家”的格局，政府要加强对医疗服务机构、药品流通及价格方面的监管，以此打破医药不分的垄断体制，促使医、药经营分开，以实现“医院出方、药店售药、参保人员直接购药”的国际通行模式。切断医院运行与药品销售的利益联系，从而降低药品价格。当医院利益与医药利益不能进行挂钩时，医院势必会通过提高自身的医疗品质与效益，从而确保其本身的日常运营和利益，此种做法则是减少了患者与医院因为医疗费用而产生的风险正熵值，进而促进了整个系统的熵值下降。同时，公立医院的政府出资部门必须与监管部门分离，出资部门的责任在于筹资和保障出资的合理有效。监管部门的责任在于监管各类行为主体的经济和社会活动，包括公共服务产品、公益性服务产品、商业性服务产品的价格、质量、进入和退出等经济性内容，及安全、健康、卫生、环境保护等社会性内容。即使是对公共服务品的监管，也必须深度介入和积极干预公共服务供给，提高公共服务资源配置的效率，包括进行政府内的有效监管和商业性有效监管。

在此，可以借助开放系统的条件，引入外部负熵，即独立于政府之外的保险管理机构，对基本医保的目录清单进行相应的制定和审核，而医院则应严格按照此清单进行开药治疗，保险管理机构的构成可以是参保人和政府共同形成，同样的医疗机构可以部分介入其中，进行监督，以保证其基本的运营情况，将药商和医院进行分割，政府则建构出管办分离的模式，从而降低在管理中所带来的风险矛盾。

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Risk Prediction of Long Inclined-Shaft Construction in Mine by TBM Based on Chaotic Time Series

LIANG Rong, JIN Cong

LIANG Rong*
Post-doctor
School of Economics and Management
Tsinghua University
Beijing 100084, China
Phone: (8610)62796801
Email: liangrpianpiansh@163.com

JIN Cong
Ph.D. Candidate
School of Mechanics and Civil Engineering
China University of Mining & Technology(Beijing)
Phone: (8610)62344938
Email: 275325048@qq.com

Keywords: Long inclined-shaft, Chaotic prediction, Time series, Phase-space reconstruction.

Abstract. Nonlinear chaotic time series is used to predict risk of long inclined-shaft construction in mine by TBM based on analyzing its character. Phase space of risk time series of construction by TBM is reconstructed; time delay and embedding dimension is also obtained. Maximum Lyapunov index of risk series in long inclined-shaft construction by TBM is obtained by using small data quantity method. It proves that the risk time series in long inclined-shaft construction by TBM has characteristics of chaos. AOLLM-BP prediction model is put forward which can predict the tendency of risk time series changing with time. Simulation experiments show that the prediction model has strong ability and better predictive effect on risk of long inclined-shaft construction in mine by TBM.

1. Introduction

TBM is becoming the world's most advanced tunnel excavation machine, giving priority to TBM in tunnel excavation has became a general trend of tunnel construction development in future[1]. Compared with the traditional drill-blast construction method, TBM has the advantages of efficiency, fast speed, high quality and safety. Its driving speed is generally 4 to 10 times compared to the conventional drill-blast method [1]. In the construction of long inclined shaft, more and more people begin to consider choosing TBM under the appropriate construction circumstances. TBM has the characteristics of poor adaptability when meeting bad engineering geological condition and higher requirement on the quality of construction managers [2]. Geological conditions of long inclined-shaft construction in mine by TBM are complicated and have varieties of construction risk factors. Traditional risk assessment methods such as analytic hierarchy process (AHP) and fuzzy mathematics methods cannot be applied on the entire project. Currently, construction by TBM lacks suitable techniques and methods for complex project and other thorough study on characteristics of risk on construction by TBM such as randomness, dynamic, ambiguity, complexity [3]. Chaos theory is studied on the randomness of system and nonlinear characteristics; it is focused on the uncertainty and regular transformation of system. Chaotic system is sensitive to initial conditions, so it is suitable for short-term constructive prediction. Risk time series of construction by TBM contain not only the risk of information in the past, but also information in future. Therefore, using the theory of chaos to predict risk of time series on construction by TBM has important theoretical significance and engineering practical value.

At present, it has been proposed varieties of prediction methods of chaotic time series based on Taken s embedding theorem and phase space reconstruction such as global prediction method [4-7], local prediction method [8], volterra prediction method and so on. Global prediction method selects all fitting vector in the phase space; local prediction method chooses the adjacent point vector and fits the space trajectory in the phase space; volterra prediction method solves the kernel function and predicts time series through numerical approach to chaotic orbit of the phase space [9]. But previous prediction methods have the disadvantages of limitations to certain extent and lower prediction accuracy. This paper proposes a combined prediction model of AOLLM-BP for predicting chaotic time series. It reduces the problem of lower prediction accuracy and has good predictive effect.

2. Phase Space Reconstruction

2.1 Determination of time delay and embedding dimension

For risk chaotic time series of long inclined-shaft construction in mine by TBM: $\{x_i, i = 1,2,\cdots N\}$, m is the embedding dimension, τ is time delay, m dimensional phase space by method of phase space reconstruction is obtained: $\{X_j, j = 1,2,\cdots, M\}$, phase points are as follows:

$$\begin{cases} X_1=[x(1),x(1-\tau),\cdots,x(1-(m-1)\tau)] \\ X_2=[x(2),x(2-\tau),\cdots,x(2-(m-1)\tau)] \\ \cdots \\ X_N=[x(\mathrm{N}),x(\mathrm{N}-\tau),\cdots,x(N-(m-1)\tau)] \end{cases} \tag{1}$$

where $M=N-(m-1)\tau$ is the number of points in phase space.

The key of phase space reconstruction is to select appropriate time delay and embedding dimension. If the number of embedding dimension $m \geq 2D+1$ (D is the number of dimension of the attractor), the geometrical characteristics of reconstructing phase space attractor can be equivalent to the geometrical characteristics of the prime mover system attractor. Number of embedding dimension should be chosen appropriately [10], which orbit of phase space consisted of $x(t)$ and $x(t+\tau)$ neither compression nor folding. Autocorrelation coefficient of two time series should be relatively appropriate, not too big or too small. Selection of time delay should reduce the relevance of original time series, and information of original motive force system should not be lost. The methods of calculating embedding dimension and time delay are mutual information method and C-C method. C-C method considers interdependence of time delay and embedding dimension, so it can better reflect the reality risk characteristics of inclined-shaft construction in mine by TBM. C-C method uses the following equation to calculate:

$$\overline{S}(\tau)=\frac{1}{16}\sum_{m=2}^{7}\sum_{j=1}^{4}S(m,r_j,\tau) \tag{2}$$

$$\Delta\overline{S}(\tau)=\frac{1}{4}\sum_{m=2}^{7}\Delta S(m,\tau) \tag{3}$$

$$S_{cor}(\tau)=\Delta\overline{S}(\tau)+\left|\overline{S}(\tau)\right| \tag{4}$$

where $S(m,r_j,\tau)=C(m,r_j,\tau)-C^m(1,r_j,\tau)$, reflecting the autocorrelation characteristic of system; r is the size of the neighborhood radius; $C(m,r,\tau)=\frac{1}{M^2}\sum_{1\leq j\leq k\leq M}\theta(r-\|X_j-X_k\|)$ is correlation integral of system, it describes the relevance of all the variables dynamic process in system, reflecting fineness level of attractor geometry structure. $\theta(\bullet)$ is Heaviside function:

$$\theta(x)=\begin{cases} 0, x<0 \\ 1, x\geq 0 \end{cases} \tag{5}$$

G-P algorithm has been used to estimate correlation dimension[11], when $r\to 0, N\to\infty$, the function approximate the following equation: $\log_2 C(m,r,\tau)\to v\log_2 r$. When m increases gradually, correlation dimension of the system is the limit value while v is not increased with m.

The most appropriate number of time delay τ is the first point that $\overline{S}(t)$ equals zero or the first minimum point of $\Delta\overline{S}(t)$, the optimal time delay can be obtained when $S_{cor}(\tau)$ reaches minimum.

2.2 Identification and analysis on chaotic time series of risk

To judge risk characteristics of chaos time series, this paper uses the characteristics of the correlation dimension and Lyapunov index. Lyapunov index can analyze the characteristics of chaos system by judging whether trajectory in phase space have diffuse trend or not, and it describes the sensitivity to initial value of chaotic system. When Lyapunov index is positive, the system is chaotic, corresponding to the chaos orbit; When Lyapunov index is negative, the system is convergent, corresponding to the stable periodic orbit. Lyapunov index is calculated by following equation:

$$\begin{aligned}\lambda(x_0) &= \lim_{N\to\infty}\lim_{\varepsilon\to\infty}\frac{1}{N}\ln\left|\frac{f^N(x_0+\varepsilon)-f^N(x_0)}{(x_0+\varepsilon)-x_0}\right| \\ &= \lim_{N\to\infty}\frac{1}{N}\ln\left|\frac{df^N(x_0)}{dx_0}\right|\end{aligned} \tag{6}$$

Currently, there are several methods of calculating maximum Lyapunov index such as Nicolis method, Wolf method, Jacohian method, small-data method[12], etc. This paper uses small-data method and the steps are as follows:

(1) Calculate delay time τ and embedding dimension *m*, reconstructing the phase space: $\{x_j, j=1,2,\cdots N\}$

(2) Find each adjacent point $X_{\hat{j}}$ in phase space orbit, and limit the short separation as follows:

$$d_j(0) = \min_{\hat{j}}\left\|x_j - x_{\hat{j}}\right\|,\ \left|j-\hat{j}\right| > T \tag{7}$$

(3) Calculate the adjacent point X_j to the distance for discrete time step as follows:

$$d_{j(i)} = \left|X_{j+i} + X_{\hat{j}+i}\right| \tag{8}$$

where $i = 1,2,\cdots,\min(M-j, M-\hat{j})$.

(4) For each i, find all average $x(i)$ of j as follows:

$$x(i) = \frac{1}{q\Delta t}\sum_{j=1}^{q}\ln d_j(i) \tag{9}$$

where q is the number of non-zero of $d_j(i)$. Maximum Lyapunov index is slope of regression straight line calculated by least square methods [14].

3. Combined prediction model of AOLLM-BP

3.1 Weighted first-order local prediction model (AOLLM)

Weighted first-order local prediction model uses last point of the reconstructed phase space as the center point and regards the nearest track point to center point as a relevant point, predicting time series according to the evolution of trajectory. This method has good ability and high accuracy of prediction[15]. The steps are as follows:

(1) Find the adjacent point X_{ki} $(i=1,2,\cdots n)$ of X_k , and calculate the distance d_i between two points.

(2) Determine minimum value d_p among d_i ; calculate the weights of points X_{ki} according to Eq. (10):

$$W_i = \frac{\exp(-(d_p - d_m))}{\sum_{i=1}^{n} \exp(-(d_p - d_m))} \tag{10}$$

(3) Fit first-order local line as follows:

$$X_{ki+1} = ae + bX_{ki} \tag{11}$$

where $i=1,2,\cdots,n$, $e=(1,1,\cdots 1)^T$, a、b are coefficients.

(4) Use the weighted least squares method by the equation: $\min = \sum_{i=1}^{n} W_i (X_{ki+1} - ae - bX_{ki})^2$, both a and b are obtained as follows:

$$\begin{cases} a + b\sum_{i=1}^{n} W_i X_{ki} = \sum_{i=1}^{n} W_i X_{ki+1} \\ a\sum_{i=1}^{n} W_i X_{ki} + b\sum_{i=1}^{n} W_i X_{ki}^{\ 2} = \sum_{i=1}^{n} W_i X_{ki} X_{ki+1} \end{cases} \tag{12}$$

Prediction equation can be obtained by Eq. (15) as both a and b have determined in Eq. (12). Multi-step prediction is find reference vector X_{ki} again based on single step prediction.

3.2 BP neural network prediction model of double hidden layers

BP neural network is a feedback learning neural network. BP network can approximate any nonlinear mapping relationship as long as there are enough hidden layers and number of neurons[16]. BP neural network of double hidden layers is divided into three levels : input layer,two hidden layers and output layer. Firstly, the number of nodes should be determined referring to input layer, hidden layers and output layer. Then, obtain the equations of hidden layers and output layer. In the end, calculate error and correct weights until the error is reduced to an acceptable level.

3.3 Prediction model based on AOLLM-BP

This model consists of weighted first-order local prediction model and BP neural network prediction model of double hidden layers. Firstly, take different length of time series data sequence into weighted first-order local prediction model, the predicted results are used as input vectors of double hidden layer in BP neural network. Then, use actual values as output values and repeat this process. In the end, time samples from 1 to t is established and the time of t+1 could be predicted.

4. Instance analyses

Development of Tai Gemiao mining area which subordinate to Shenhua New Street Energy Company is one of major projects of energy base construction in our country. 1, 2, 3 and 4 of mine are proposed to use main and subsidiary well as inclined shafts, the main and subsidiary inclined shafts are built firstly using TBM as $1^{\#}$, $2^{\#}$ experimental wells. The angle of inclined shaft is 6º, total length is 6314m, and length of construction by TBM is 6109m.

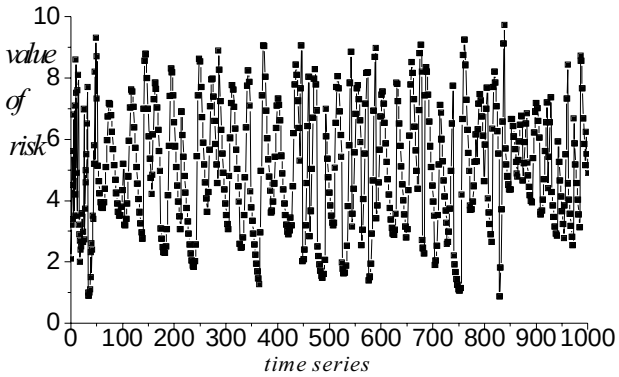


Fig 1 the risk values of time series

This paper collected 1000 groups of risk on construction by TBM of mine inclined-shaft as samples, standardized samples in the interval [0, 10] to generate risk chaotic time series $\{X_i\}$ as is shown in figure 1. 860 data are used to train the model; the other 140 data are used to test the accuracy of model. Parameters of C-C method:

m=2,3,4,5, $\tau = 2,3,\cdots 20$.

Results of $\Delta S(m,t)$ and $Scor(t)$ are obtained using TBM risk time series of construction by TBM , its phase space reconstruction results of risk time series are shown in figure 2. As can be seen from the figure, while τ=9, $\Delta S(m,t)$ obtains the first minimum, so the delay time τ is 9， $Scor(t)$ obtain the minimum while τ=16, the embedding dimension is 5, it is the embedding dimension should be calculate.

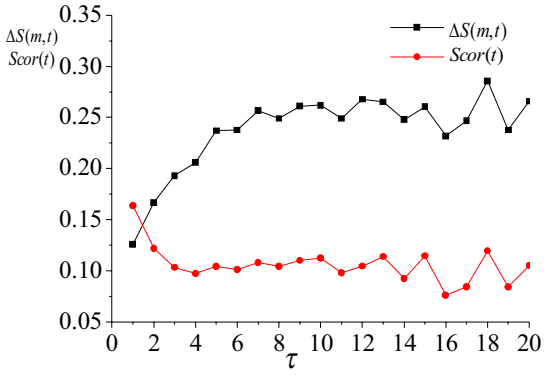


Fig 2 Change curve of ΔS(m,t)、Scor(t) varies with τ

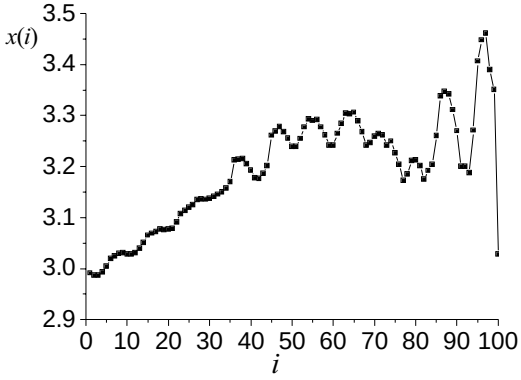


Fig 3 Change curve of time series step i varies with distance of logarithmic average $x(i)$

Maximum Lyapunov index of mine inclined shaft of TBM construction risk time series is calculate by small-data method, logarithmic average distance relationship varies with the steps of time series is shown in figure 3. The maximum Lyapunov index is $0.003>0$, so risk time series of mine inclined wells of TBM construction has chaos characteristics, so we can use the chaos method to predict.

Predicted results are shown in figure 4. From the two figures it can be seen that the model can better used for TBM construction risk of mine inclined wells. The error is about 0.517. The error of using weighted first-order local prediction model is about 0.688. So using Multi-step prediction in 100 steps prediction effect is ideal, more than 100 steps prediction error is a little high, but it is still in the acceptable range.

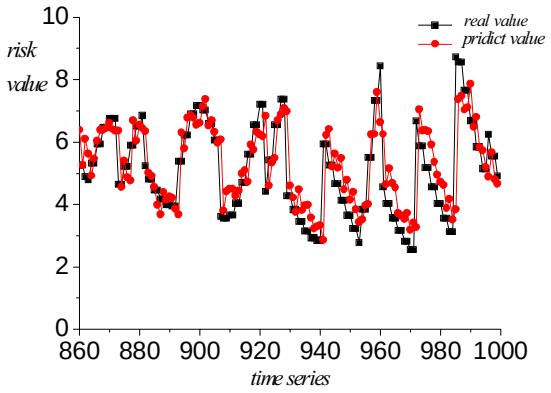


Fig 4 Predicted value and the actual value of risk time series

5. Conclusions

（1）TBM construction risk chaos characteristics of mine inclined well and the development of the risk has the characteristics of sensitive to initial conditions, TBM construction risk of mine inclined-shaft is predicted using chaos forecasting method in this paper. TBM construction risk of mine inclined wells is predicted based on the first-order local prediction method model; it provides an effective method for actual construction.

（2）The model is successfully applied to TBM construction risk prediction of mine inclined-shaft, it is proved that the model is effective and reliable, it is used to provides the beneficial reference to forecast the risk and risk prevention for construction personnel.

（3）Because of intrinsic complexity, in this paper, the predictive model still need to be further improved and optimized in engineering application.

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Study about the Reason for the Absence of Chinese Risk Compensation Mechanism for Earthquake and its improvement

MENG Yinan, WANG Haiyan, CUI Shuo

MENG Yinan
Master candidate
School of Economics and Management
Tongji University
Rm. 816, Block A Tongji Plaza, No.1500,Siping Rd
Shanghai 200092, China
Phone: (86) 136 5187 0742
Email: mengyinan0729@163.com

WANG Haiyan *
Ph.D, Associate Professor
School of Economics and Management
Tongji University
Rm. 816, Block A Tongji Plaza, No.1500,Siping Rd.
Shanghai 20092, China
Phone:（086）139 1728 3932
Email: wanghaiyan@tongji.edu.cn

CUI Shuo
Master candidate
School of Economics and Management
Tongji University
Rm. 816, Block A Tongji Plaza, No.1500,Siping Rd.
Shanghai 200092, China
Phone: (86) 152 1671 8066
Email: 090230@tongji.edu.cn

Keywords: Compensation mechanism, Earthquake, Compensation capacity, Earthquake fund

Abstract. Chinese risk compensation mechanism for catastrophe is sorely missing. Compensation for the damage of catastrophe mainly depends on government finance, however the insurance industry only plays limited role. Recently, the attention on the establishment of risk compensation mechanism for catastrophe has increased. The

central government has proposed “three steps” to establish risk compensation mechanism for catastrophe. Property insurance companies have established mutual insurance organization to insure dwelling house from earthquake. Several places have launched pilot project of catastrophe insurance. This paper takes earthquake as an example, summarize the current status and study the capacity and the capacity efficiency to analyze the reason for the absence of Chinese risk compensation mechanism for earthquake. It is proposed to increase government’s engagement, especially financially. In consideration of the financial pressure of local government, capital injection to the earthquake insurance fund from both local and central government is suggested. The paper calculates the scale of the fund and gets the conclusion that it is feasible to set the risk level of the fund to deal with the catastrophe happened once in a century.

1. 引言

我国幅员辽阔，地质结构复杂多变，是世界上自然灾害最为严重的国家之一，主要灾害有地震、台风、干旱、洪水等。在2014-2015年间，直接经济损失在百亿级的自然灾害多达7次，其中，地震灾害尤为严重，两年间在我国大陆地区共发生5级以上地震25次，6级以上地震5次，云南鲁甸6.5级地震造成直接经济损失201.4亿元，2008年5月12日发生在四川汶川8.0级的大地震，更是造成了69227人死亡，17923人失踪，直接经济损失达到8452亿元人民币，是新中国成立以来破坏力最强的一次地震，此次地震中保险只赔偿了20多亿元，占比是0.2%，大部分由社会捐款、政府拨款和国际援助承担。可见，与巨额损失相对应的，是我国巨灾风险管理能力的缺失；另一方面，保险业在巨灾中发挥的作用也十分有限，保监会主席项俊波曾在2014年“两会”上介绍，在国际上，巨灾保险赔款一般占到灾害损失30%-40%，而我国的比例尚不到3%。

面临这样的现状，积极探寻和建立新的巨灾损失补偿机制已经成为我国经济发展的迫切要求。目前，全球已有多个国家，结合本国实际情况，建立了各种巨灾风险补偿机制。2014年8月国务院颁布《国务院关于加快发展现代保险服务业的若干意见》（新国十条），提出建立巨灾保险制度：研究建立巨灾保险基金、巨灾再保险等制度，逐步形成财政支持下的多层次巨灾风险分散机制；鼓励各地根据风险特点，探索对台风、地震、滑坡、泥石流、洪水、森林火灾等灾害的有效保障模式等。

本文将围绕地震风险，研究地震风险补偿机制缺失的原因，并提出在地震巨灾风险补偿机制中设立地震基金的设想，并进一步提出对于整个机制设立的一些想法。

2. 文献回顾

有关我国巨灾补偿机制现状方面，巨灾风险损失的补偿主要以国家财政救济和社会捐助为主。林光彬（2010）认为，我国保险业在巨灾中发挥的作用十分有限。保险业在机制中的缺失主要是由于巨灾保险的供给与需求不足，国内外学者通过理论和实际的分析，提出了一些原因。主要有以下一些原因限制了巨灾保险产品供给：卓志、丁元昊（2011），张庆洪（2008）等，从不同角度解释了巨灾保险产品风险难以扩散；田玲、骆佳（2012）提出保险公司存在财务和审批方面的约束；李炳圭等（1997），Freeman（2003），丁元昊（2009），田玲、邢宏洋、高俊（2013）等，探讨了巨灾风险的可保性，认为巨灾风险在满足一些条件之后才具有可保性。限制巨灾保险产品需求的因素主要有：LIJiaming，WANGZongpeng（2011）认为巨灾产品本身同时具有私人产品和公共产品的特征，导致私人最佳消费量小于社会最佳规模，即需求不足。田玲，姚鹏（2014）利用RH理论研究了灾后捐助对巨灾保险需求的挤出效用，认为灾后捐助体系的存在会明显地挤出巨灾保险的需求。

关于整体性巨灾风险补偿机制，Lewis和Murdoch（1996）将巨灾风险管理划分为三个部分：自留风险，私人/公共部门的融资部分以及国际援助。姚庆海（2006）提出了我国巨灾损失的整体性补偿机制:被保险人及未投保的个体、原保险人、商业再保险（国内、国际）、资本市场（如风险证券化）、国家、政府作为最终的保险人（再保险人）。

巨灾补偿机制可以大致分为几个层次：灾前防损、原保险、再保险、巨灾基金、资本市场等。灾前防损方面，仲伟(2009)研究了美国洪水保险计划，徐美芳(2008)研究了夏威夷飓风管理基金和加州地震局防灾防损计划，各国都通过机制的设计，与投保人和政府共同进行灾前防损。在原保险层面，国外学术界的主流观点基本趋于一致的是，政府多大程度上参与分散巨灾风险，取决于各国保险市场的发育情况，也取决各国政府的态度和具体的国家情况。可以利用政府补贴、形成共保体、通过资本市场进行风险融资等提高巨灾的可保性。在再保险层面，刘培(2014)认为，我国再保险人才匮乏，缺乏专业的再保险经纪人，再保险需求与供给严重失衡，国内监管理念的缺失，都在一定程度上限制了国内再保险的供给。在巨灾

基金层面，黄小敏（2011）认为，巨灾损失的补偿无法单纯通过再保险加以解决，国外经验表明，建立巨灾风险基金可以保障巨灾风险制度的稳定运行。在资本市场层面，黄小敏（2010）认为在我国保险业还不够发达的情况下，尤其需要借助保险市场以外的力量加以分散，具体来说可以采取应急准备金债券、巨灾债券、互换可买卖期券。

3. 关于地震风险补偿机制缺失的原因分析

3.1 中国地震风险补偿机制现状

2013年，十八届三中全会，中央明确提出了要进一步完善保险的经济补偿机制，建立巨灾保险制度，并确立了巨灾保险制度“三步走”计划：第一步，在2014年底完成巨灾保险专题研究；第二步，在2017年底完成相关立法工作，推动地震巨灾保险条例的出台；第三步，在2017-2020年，全面逐步实施地震保险制度，将其纳入国家综合减灾防灾体系中。在政府的政策支持和指导下，目前我国已有多地建立了巨灾保险制度，既有包括多种巨灾的保险补偿机制，也有只包含地震等单个风险的补偿机制。鉴于整体巨灾保险机制与单个巨灾之间存在很多相通之处，本文先对几个代表性地区的巨灾保险制度进行梳理，再结合我国目前整体巨灾保险制度现状，分析我国地震巨灾补偿机制缺失的原因。

3.1.1 深圳巨灾保险制度

深圳巨灾保险制度于2014年7月9日正式启动，是我国国内首个巨灾保险项目，该巨灾保险制度由“三大支柱”组成，政府巨灾救助保险、巨灾基金和商业巨灾保险。1）政府巨灾救助保险，由深圳市政府全额出资3600万元向中国人民财产保险股份有限公司深圳市分公司购买，涵盖了深圳市所有可能遭遇的15种自然灾害风险，保障范围有普通伤害救助、伤害致残救助和身故救助三大类，包括住宿费、医疗费等十三种费用，赔偿限额为每人每次灾害10万元，总限额为20亿元。深圳是我国第一个建造核电站的地区，巨灾保险还将责任扩展到自然灾害引发的核电站严重事故。2）巨灾基金由深圳政府首次注资3000万元建立，同时可以吸收企业、个人等社会捐助，主要用于承担在政府巨灾救助保险赔付限额之上的赔付。3）商业巨灾保险，由商业保险公司提供巨灾保险产品，居民自愿购买，以满足居民更高层次、个性化巨灾保险需求。同时规定保险公司每年从保费中提取5%用于灾害研究、应急演练等防灾防损事项，并研究建立巨灾数据平台。

值得注意的是，深圳所处区域发生自然灾害形成巨灾风险的可能性较低，作为一线城市，其抗灾及救助能力较强，所以发生系统性风险的可能性极低。但巨灾保险制度真正需要关注的是那些巨灾风险大，抗灾能力低的地区，对于这些地区来讲，深圳项目的可复制性并不高。

3.1.2 宁波市巨灾保险项目

2014年11月6日，宁波市民政局与中国人民财产保险股份有限公司宁波市分公司签署了公共巨灾保险合同，标志着宁波市巨灾保险项目正式落地。与深圳类似，宁波巨灾项目同样包含公共巨灾保险、巨灾基金和商业巨灾保险三部分。在公共巨灾保险方面，由宁波市政府全额出资3800万向商业保险公司购买6亿元巨灾风险保障，与深圳最大的不同在于，除了对居民的人身伤亡抚恤外，还增加了对宁波市行政区域内常住居民的家庭财产损失救助，保障范围涵盖台风、强热带风暴等自然灾害及其引起的人身伤亡及家庭财产损失，赔偿限额分别为每人10万元和每户2000元，两项的总限额均为3亿元，另设灾害期间的见义勇为增补抚恤最高10万元。根据合同条款，按照保险公司3%的预定利润，从保费结余中计提专项风险准备金。巨灾基金方面，由政府初期出资500万元设立，接受社会捐赠，用于赔付保险公司赔偿限额以上的部分。

宁波在2015年经受了“灿鸿”和“杜鹃”两次台风侵袭，发生了巨灾保险项目启动以来的首次赔付，共累计为14万户民众支付理赔款8000万元。在勘察定损方面的做法是，由社区街道、村委会进行登记，再抽取10%进行抽样调查，结果公示三天，若无异议便在三日内支付赔款，有效提高了赔付的速度。虽然2015年的赔款远低于6亿元赔付限额，但考虑到宁波在近十年中，遭遇了五次经济损失达10亿元的台风，有可能超出赔付金额和巨灾基金的总和，因此在制度中建立了动态调整完善机制，保险合同一年一签，根据上一年度的运营情况来调整费率及保额。2016年,宁波巨灾保险又新增突发性重大公共安全事件风险保障,保额为1亿元,总保费增加至5700万元,并细化了理赔触发条件、开始建立远程定损系统;引入第三方机构独立评估巨灾保险保费，使保费更加合理。

3.1.3 云南地震保险专项试点

2015年8月20日，云南大理白族自治州政策性农房地震保险试点启动。大理州人民政府与诚泰财险、人保财险、平安财险、大地财险、中华联合、中再产险6家公司签署战略合作协议和农房地震保险试点协议，同时前5家保险公司签订了试点共保协议。三年试点期间由省、州、县三级政府全额承担保费3215万元，采用震级触发型农房地震指数保险。保险涵盖了大理白族自治州境内和周边发生的

5级及以上地震造成的农房直接损失、恢复重建费用以及居民死亡救助。根据不同的震级，农房的赔偿限额从2800万元到4200万元不等，以0.5级为一档；地震民房灾后重建补助标准为平均每户5.8万元；居民死亡的赔偿限额为每人10万元，总限额为每年8000万元。

在2015年10月30日，昌宁县发生了5.1级地震，造成农房直接经济损失4480万元，理赔共计753.76万元，占农房损失的16.83%，从地震发生到赔付用时18天。

云南作为地震的高发区，有50%的农房为土木结构，抗震性低，此次试点方案从风险最高、损失最大的农房入手，并且是国内第一个震级触发型指数保险，对于其他经济不发达且巨灾风险大的地区具有借鉴价值。与深圳、宁波建立巨灾基金的做法不同，农房地震保险采用共保形式来强化抗风险能力，并引入再保险机制，这也在一定程度上减轻了政府的财政负担。但值得注意的是，在试点期间，整个州的保费由云南省、州、县政府全额承担，如果要在云南全省内推广地震保险，考虑到云南省经济发展程度相对较低，政府财政恐怕难以长久全额承担保费，试点结束后如何继续推行是亟待解决的问题。

3.1.4 四川省乐山城乡居民住房地震保险试点

2015年11月23日，城乡居民住房地震保险试点在四川省乐山市启动。由中国人保财险、中华联合保险和中航安盟3家保险公司共同承办，保险责任涵盖因震级5级及以上地震，及由此在72小时内引起的次生灾害造成的直接损失。保险标的为乐山市居民自有的、用于生活且长期居住的永久性房屋，且分为城市及农村两大类，各按照赔付金额分为三个档次，农村为2万、4万、6万，城市为5万、10万、15万，居民可自行选择是否投保及投保档次。政府对于投保的居民实行60%的保费补贴，对于特定弱势群体实行百分百参保及全额补贴。另外，由四川省财政出资2000万元成立四川省地震保险基金，并将每年保费的20%注入基金。

四川省的居民住房地震保险试点与前几个有很大不同。对保险标的进行更为细化的分类，有利于根据标的不同特性进行制度设计和改进；不实行强制保险而改为保费补贴的方式，鼓励居民进行投保的同时，在一定程度上降低政府的财政负担。

3.2 中国地震巨灾风险补偿机制缺失的原因

从目前已经实施的巨灾保险制度来看，最大的特色在于在整个补偿机制中政府扮演了非常重要的角色，政府除了是机制的制定者外，还在资金方面提供了重

要的支持，除四川外其他三个地区都由政府全额承担保费，并对巨灾基金进行注资，深圳初期投入为6600万元，宁波为4300万元，云南为3215万元，四川政府对地震保险基金投入2000万元。从我国的实际情况来看，如果没有政府的引导、参与和支持，巨灾风险补偿机制很难得到发展，这也是我国补偿机制在此前一直处于严重缺失状态、迟迟难以发展的重要原因。

在缺少政府参与的情况下，巨灾风险补偿机制的重要基础之一——巨灾保险，在需求和供给两方面都存在严重不足。首先从需求方面，我国居民保险意识本身就非常薄弱。虽然地震等巨灾有损失度高的特点，但是由于其发生概率极低，所以风险极易被低估。按照行为金融学理论，当地震没有发生时，人们不会进行成本效益分析，决策往往是非理性的，侥幸心理下往往倾向于不购买保险，特别是在我国居民对地震灾害等风险的认知还缺乏的情况下，对于地震保险产品的需求就更低了。而在巨灾发生后，短时间内可能出现居民对此类保险产品的需求激增，但由于巨灾的小概率性，可能短时间内不再发生类似的事件，随着记忆逐渐淡化，投保人仍然会低估风险，甚至出现退保的行为。另外，一些地震频发的地区居民平均收入水平较低，人们对地震保险产品的可负担性较弱。

其次，从供给方面来看，由于地震风险的分布比较集中，在这些区域的居民对地震保险的需求显著高于其他区域，导致地震风险个体之间不仅不独立，还具有高度正相关性，不符合保险“大数定理”的基本假定，所以对于地震等巨灾保险的可保性始终存在争议，也造成保险公司不愿意承保此类风险。对于保险公司来说，累积的保费收入和盈余本来可以配置在长期投资上获得更高的收益，承保地震风险后，为了能在地震发生后完成巨额的赔偿，就需要使这部分资金保持良好的流动性，这将降低保险公司的盈利水平，也削弱了保险公司进入这一领域的积极性。但是在今年4月，我国财险业在地震巨灾保险方面取得了突破性进展，45家财产保险公司根据“自愿参与、风险共担”的原则发起成立住宅地震共同体，共同应对地震灾害。5月16日，保监会联合财政部印发《建立城乡居民住宅地震巨灾保险制度实施方案》，以地震为突破口的巨灾保险制度即将开展实践探索。以共同体的形式承保地震等巨灾风险，可以实现财险公司间风险共担，增强承保能力，鼓励保险企业承保巨灾风险的效果。考虑到随着巨灾保险制度的逐步发展，更多财险公司会加入到共同体的行列，且承保范围也会从地震造成的住宅损失扩大到地震造成的其他经济损失，再进一步扩展到其他巨灾风险，本文对我国整个财险业的巨灾偿付能力进行了测算。

4. 我国财险业偿付能力测算

本文采用Cummins等人（2002）的保险赔付度量模型，该模型可以用来评估在给定巨灾损失的前提下，单个保险人和整个保险市场赔付能力。

单个保险人的承保能力公式如下：

$$R_i|L = E(L_i) + Q_i - E(T_i|Q_i, L) = [E(L_i) + Q_i]N(-C_i) + \mu_{L_i|L}N(C_i) - \sigma_{L_i|L}n(C_i) \quad (1)$$

其中$E(L_i) = \mu_i$为保险公司i的赔款支出，Q_i为保险公司i的所有者权益，$C_i = \frac{E(L_i)+Q_i-\mu_{L_i|L}}{\sigma_{L_i|L}}$，$\mu_{L_i|L} = \mu_i + \frac{\rho_i\sigma_i}{\sigma_L}(L - \mu_L)$，$\rho_i$是保险公司i的赔付数据与保险业赔付数据的相关系数，σ_i是保险公司i历年赔付数据的标准差，σ_L是保险业历年赔付数据的标准差，L是既定的巨灾损失，$\mu_L = E(L)$为保险业的赔款支出，N(*)为标准正态分布的分布函数，n(*)为标准正态分布的密度函数。

本文选取2005年-2014年间经营的59家财险公司，其中29家有完整赔付数据，这29家公司（FTS，Full Time Series Company）在2014年的赔付数据达到所有财险公司赔付数据的93%，因此具有代表性，剩余30家数据存在缺失（NFTS，Non-Full Time Series Company）。

对于FTS公司，只需计算出相关参数，便可计算承保能力，为了剔除赔付数据中时间趋势的影响，建立关于时间的回归方程：

$$L_i^t = \alpha_i + \beta_i t + \varepsilon_i^t \quad (2)$$

$$L^t = \alpha + \beta t + \varepsilon^t \quad (3)$$

其中L_i^t是财险公司i历年的赔付金额，L^t是保险业历年赔付金额。将两个回归方程残差项的标准差来代替σ_i和σ_L，残差项的相关系数代替ρ_i，将计算出的其他参数及设定的损失值带入公式中，便可得到这29家财险公司的最大承保能力。

对于NFTS公司，利用FTS公司的财务数据估算出σ_i和σ_L。具体做法是建立回归模型：

$$Y = C + a_1E/A + a_2LnE + a_3LnNL + a_4NI/NP + a_5ROA + a_6RR/A + \varepsilon \quad (4)$$

其中E是所有者权益，A是总资产，NL是净赔付支出，NI是净利润，NP是净保费收入，RR是应收保费，ROA=NI/A。数据来自29家FTS2014年财务数据，将Lnσ_i和Lnσ_L分

别作为因变量，利用Eviews计算出回归方程的未知参数。从回归结果可以看到模型结果显著，说明$Ln\sigma_i$和$Ln\sigma_L$可以用公司财务数据来预测。

表1 回归结果

Dependent Variable	$Ln\sigma_i$	$Ln\sigma_L$
Variable	Coefficient	Coefficient
C	-1.489109	-1.636865
E/A	0.101249	-0.647733
LnNL	0.159179	0.374304
LnE	0.861150	0.581704
ROA	0.088457	0.136001
NI/NP	-2.125824	-1.592518
RR/A	3.936771	0.999888
R-squared	0.977315	0.933393
Adjusted R-squared	0.971129	0.915227
F-statistic	157.9706	51.38248

将30家NFTS的财务数据带入计算出的模型中，计算出NFTS的σ_i和σ_L以及其他参数，最后计算出NFTS公司的最大承保能力。所有财险公司的偿付能力加总结果如下：

表2 财险业偿付能力测算结果

巨灾损失金额（万元）	最大赔付金额	赔付效率
200000	202675.3086	101.34%
300000	294682.2637	98.23%
400000	384997.7926	96.25%
500000	470659.5174	94.13%
600000	515418.7212	85.90%
700000	519335.1627	74.19%

从计算结果来看，巨灾损失超过30亿，财险业的偿付能力便会出现短缺，且随着损失的增大，短缺的速度也会加快。从我国近些年的地震损失数据来看，2010年至2014年间，平均每年地震造成的直接经济损失额近360亿元，目前共同体承担的仅是地震造成的住宅损失，估计其金额会在200亿元以下，虽然共同体还没有包含所有财险公司，但是预计共同体的最大赔付金额基本仍能覆盖地震造成的住宅损失。但一旦发生如2008年汶川地震8000亿元以上损失的地震，即使是整个财险业仅承担住宅损失部分，可能也无法完成赔付。再考虑到财险公司的持续经营问题，如果真的按照最大赔付金额进行赔付，势必会严重影响到保险公司日后的经营。综上所述，本文认为尽管我国建立了地震住宅共同体，增强了承保能力，但是我国财险业的赔付能力仍然非常不足。这也间接说明了为何此前我国地震巨

灾风险补偿机制难以发展的原因，由于赔付能力的缺失，以及缺少政策的支持，财险业缺少主动加入这一领域的动力。

但随着政府的加入，我国巨灾补偿机制将以地震为起点，将进入发展期。由政府建立巨灾基金，注入初始资金，形成了多层次的巨灾风险分摊，可以增强保险的承保能力，但这势必给政府财政造成巨大的财政负担。以地震为例，从2015年1月1日至2016年5月25日，我国大陆地区地震风险主要集中在我国云南、四川、甘肃、青海、新疆、西藏等地，基本都是经济相对欠发达区域，政府财政并不充裕。从2015年地方政府收入来看，仅有四川略超全国均值，其他省份的财政收入远低于平均水平；从财政支出来看，全国财政支出与财政收入的比值在1.81，而这些省份的比值都在2以上，其中西藏达到了10倍。值得一提的是，在云南大理的试点其实最初是计划在楚雄州的，考虑到虽然省政府会提供财政支持，但由于地震保险需要在较长时间段对可能发生的损失进行有效分摊，仍需要地方政府有一定的支付能力，大理的财政收入好于楚雄，所以最后将试点放在了大理。目前试点地区仅仅是省级以下的一个城市，如果要在全省推广这种模式，对地方财政将是更大的挑战，所以本文认为如果仅依靠地方政府，想要在全省推广地震保险制度，恐怕难以实现。

5. 我国建立地震风险补偿机制的建议

从以上的讨论可以看到，保险业的偿付能力不足、居民的保险意识不强等问题虽然限制了地震风险补偿机制的发展，但在地方政府的参与下，特别是资金的支持下，注入了新的发展动力，但地方政府的财政压力可能会限制政府的参与程度。如果要将试点推广到更大范围，短期内必然会给地方政府财政造成巨大负担，但这可能是发展初期必然要碰到的困难，本文认为，发展的路径可能是在初期，政府通过提高自身的参与度，从而吸引和鼓励财险业加入进来，保险业与政府各取所长，考虑各方面的发展程度来对地震巨灾补偿机制各层次进行排列，从灾前防损，到共保体承保地震风险，再到再保险、地震保险基金、巨灾风险证券化等方面的设计，随着各层次的发展，政府的角色就可以逐渐淡化和退出。

（1）在灾前防损方面，可以借鉴美国国家洪水保险计划，将灾前防损融入到制度设计中去，该计划中规定只有进行了一定灾前防损措施的社区才可以加入到保险计划中去。但鉴于我国一些地震多发区经济发展水平落后，可以将条件适当放松，比如根据不同房屋的抗震性及灾前防损的实施程度设定不同档次，与起赔额和赔付金额相关联。

（2）在地震共保体方面，积极建立地震数据库，通过国际交流合作吸收国外先进产品开发技术，并与政府协商用保费补贴等措施将更多居民纳入到机制中，也可以帮助提升居民的保险意识。

（3）积极发展我国的再保险市场，目前我国再保险供给严重不足，费率严重偏离国际市场，导致国内财险公司的风险难以向国外分保，只能自留风险，也间接导致财险公司不敢涉足地震等巨灾保险。

（4）建立地震保险基金，作为再保险之后的地震损失补偿层次。

（5）发展地震债券等金融衍生品，比如在2015年7月中再集团在境外市场发行5000万美元的巨灾债券，就是一次很好的尝试，利用资本市场来分散风险。

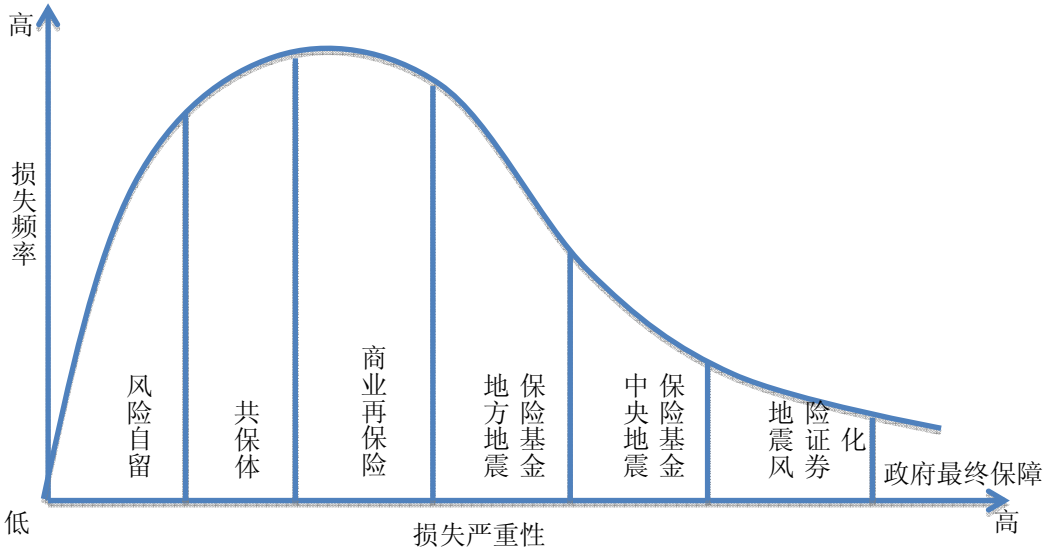


图1 地震巨灾补偿机制层次设计

本文认为，目前地方在财政上遇到的困难可以通过国家财政来得以缓解，具体做法是在地方建立地震保险基金的基础上，在全国范围内也建立这样一个保险基金，巨灾补偿的分担层次是原保险、再保险、地方地震保险基金、全国地震保险基金，基于这一设想，本文对全国基金的规模进行了测算。

6. 地震保险基金规模测算

要计算巨灾基金规模，需要估计地震损失和纯保费规模。

巨灾基金规模公式：

$$SCF_{\alpha} = max\{PML_{\alpha} - (E(S_n) + \sum_{i=1}^{n} Q_i)(1+r); 0\} \quad (5)$$

其中PML_α为最大可能损失值，α =0.01则为百年一遇的地震损失，α =0.001为千年一遇的地震损失。$E(S_n)$为纯保费，$\sum_{i=1}^{n} Q_i$是财险公司的所有者权益。

计算最大可能损失值PML_α：

要计算最大可能损失值，首先要估计出损失的分布函数。本文收集了从1967年-2014年的地震数据，震级在5级以上，对地震损失数据进行物价调整后，取损失额在500万元以上的数据，将损失数据取对数，从QQ图来看数据具有厚尾性，所以本文采用分段拟合的方法来拟合分布。

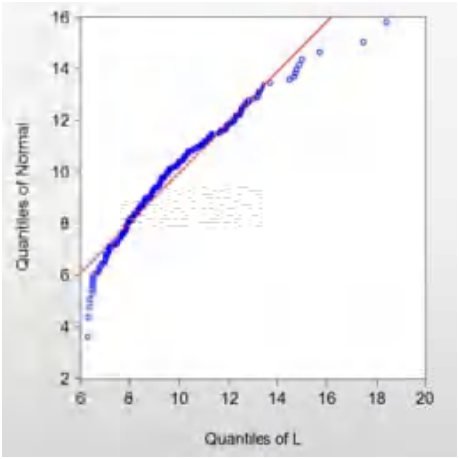


图2　QQ图

运用极值理论中超越阈值法（POT）的GPD分布，对阈值 u 以前的数据采用正态分布拟合，对阈值以后的数据采用GPD分布拟合。

阈值的取：

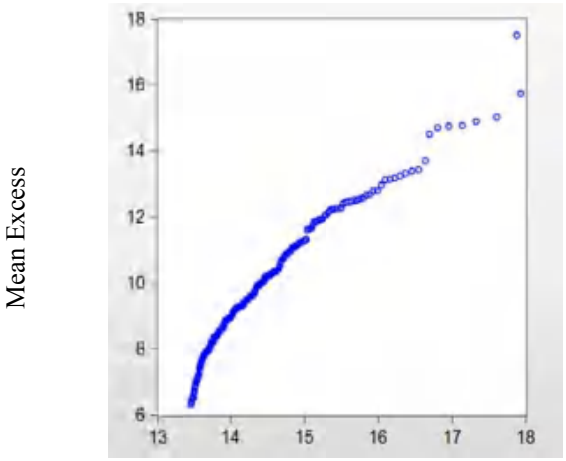


图3　MEF图

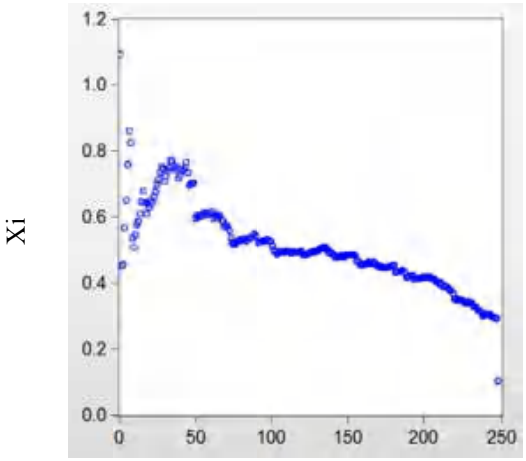


图4　HILL图

结合MEF图和HILL图，选取将阈值选为11.77，即损失值为129808万元。阈值前有202个数据，阈值之后有46条数据。用Matlab对数据进行分段拟合，最终得到整体分布：

$$F(x)=\begin{cases}\int_0^x \frac{1}{\sqrt{2\pi}*1.34x} e^{-\frac{(\ln x-8.92)^2}{2*1.34^2}} & (x<129808)\\ 1-\left(1+\frac{1.4257x}{129808}\right)^{-1/1.4257} & (x<129808)\ (\xi=1.4257 \quad \beta=129808)\end{cases} \tag{6}$$

损失频率分布在阈值前服从$\lambda_1=7.36$的泊松分布，超过阈值部分服从$\lambda_2=0.9184$的泊松分布。

$$PML_{0.01}=\text{ц}+\left\{\left(-\frac{\lambda_2}{\ln(1-\alpha)}\right)^{\xi}-1\right\}\frac{\beta}{\xi}=72748465.77\text{万元}=7274.85\text{亿元}$$

$$PML_{0.001}=1950950359\text{万元}=195095\text{亿元}$$

计算纯保费：

$$E(S_N)=\lambda_1 E(E|_{\{L<129808\}})+\lambda_2 E(E|_{\{L>129808\}}) \tag{7}$$

$$=7.36*16980.73+0.9184*3723954=3545057.526\text{万元}=354.5\text{亿元}$$

计算所有者权益：

$$\sum_{i=1}^{59} Q_i=364894.69\text{百万元}=3649\text{亿元} \tag{8}$$

2014年末一年期存款基准利率水平为3.00%，即r=0.03

$$SCF_{0.01}=7274.85-(3649+354.5*(1+0.03))=3260.715\text{亿元}$$

$$SCF_{0.001}=195095-(3649+354.5*(1+0.03))=191080.865\text{亿元}$$

表3 地震保险基金规模测算结果

承保比例	$SCF_{0.01}$	$SCF_{0.001}$
10%	0	15495.365
25%	0	44759.615
50%	0	93533.365
75%	1442	142307.115
90%	2533.23	171571.365
100%	3260.715	191080.865

从测算结果来看，如果遭遇百年一遇的地震风险，最大损失在千亿级，如果遭遇千年一遇的地震，损失则在万亿级，从我国目前的财政情况来看，2015年全国财政收入为15万亿元，所以将基金建立在应对百年一遇的地震灾害比较符合我国目前的国情。在承保比例上，初期可以选择在75%以下，通过地方政府和中央政府的合理分配来对地震基金进行注资。

7. 结语

结合以上研究，本文认为在巨灾风险补偿机制建立之初，以地震为突破口，由财险公司组成共同体可以提高整体财险业承保能力，但我国财险业的承保能力仍然存在巨大缺口，也是目前我国巨灾风险补偿机制缺失的重要原因。因此从中央到地方政府的参与度要适当提高，从而鼓励保险业和居民参与到地震巨灾风险补偿机制的建设中来，特别是在资金方面，通过建立巨灾保险基金，由地方和中央财政共同注资，目前将基金设定在应对百年一遇的地震灾害，并将承包比例定在75%是较为合理的水平。但本文在基金规模测算时没有加入起赔额的设定，会对规模造成一定影响，另外对于基金资金如何在地方政府及中央政府间分担，以及基金的运作方面，本文没有给出具体的方案，这也将是以后继续研究的方向。

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中国地震风险补偿机制缺失原因及其改进的研究

孟一南 王海艳 崔朔

孟一南
硕士生
同济大学经济与管理学院
上海市四平路1500号同济大厦A座816室
上海200092，中国
电话: (86) 13651870742
Email: mengyinan0729@163.com

王海艳*
博士，副教授
同济大学经济与管理学院
上海市四平路1500号同济大厦A座816室
电话：(86) 13917283932
Email: wanghaiyan@tongji.edu.cn

崔朔
硕士生
同济大学经济与管理学院
上海市四平路1500号同济大厦A座816室
上海200092，中国
电话：(86) 15216718066
Email: 090230@tongji.edu.cn

关键词:补偿机制；地震；赔付能力；地震巨灾基金

中文摘要. 我国巨灾风险管理能力严重缺失，巨灾损失赔偿主要依靠政府拨款，保险业发挥的作用十分有限，但近年对于建立巨灾风险补偿机制的关注度逐渐提高，中央提出了巨灾保险制度“三步走”计划，财险业组成了住宅地震共同体，多地开展了巨灾保险制度试点。本文以地震为例，梳理了目前我国各地试点的巨灾保险制度，结合现状以及对财险业承保能力的分析，得出了我国地震风险补偿机制缺失的原因，提出政府应当提高参与度，特别是在资金方面的支持，考虑到地方政府财政压力的问题，本文提出由地方政府和中央共同注资地震保险基金的想法，并对基金规模进行了测算，得出目前将基金建立在应对百年一遇的地震风险水平具有可行性。

Economic and Non-economic Losses Claim Effects on the Severity of Opportunistic Fraud in Auto Bodily Injury Compulsory Liability (BICL) Insurance: Evidence from China

ZHOU Jiantao, AI Jing, WANG Shanshan, WANG Tianyang

ZHOU Jiantao
School of Economics and Management,
Beihang University,
Beijing, China, 100191
E-mail: zhoujiantaoA1032@buaa.edu.cn

AI Jing
Department of Finance, University of Hawaii
Honolulu, HI 96822 USA
E-mail: Jinga@hawaii.edu

WANG Shanshan
School of Economics and Management, Beihang University
Beijing, China, 100191
E-mail: sswang@ buaa.edu.cn

WANG Tianyang
Department of Finance and Real Estate, Colorado State University
Fort Collins, CO 80523 USA
E-mail: Tianyang.Wang@colostate.edu

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Abstract: Despite the increasing importance of opportunistic fraud activities in liability claims to insurers, relatively little research has been done to understand the causes and impacts of these activities. General damage awards are often argued to be the primary motivating factor for this type of opportunistic fraud. We test this hypothesis using a unique sample of closed claim lawsuit cases in automobile bodily injury compulsory liability insurance during 2007-2012 in China. Our results show that other economic and non-economic losses claim sub-items except medical expense are the significant detecting factors for the severity of opportunistic fraud, especially general damage as well as death or disability damage besides conventional wage loss. We still find the moral hazards of neglecting victim fault and focusing on the non-motorist or pedestrian role in auto accident caused by RTSL. Last, the severity of opportunistic fraud for sprains is not statistically significant, meaning higher possibility of opportunistic fraud for sprains does not imply larger severity of opportunistic fraud. Our findings provide additional insights on ex post moral hazard and have important policy implications to both insurers and regulators.

1. Introduction

Moral hazard has long been recognized as an essential issue in the insurance markets. One particular form of moral hazard is when the insured attempts to manipulate the amount received from an insurance claim, i.e., the ex post moral hazard or insurance fraud. Fraudulent claims significantly increase the cost borne by insurance companies and ultimately crease deadweight losses to the entire society (Meyer et al., 1995; Cummins and Tennyson, 1996). The prior literature of ex post moral hazard primarily focuses on the effects of economic loss claimed on total settlements, such as medical expenses on the soft-tissue injuries (Derrig et al., 1994), sprain and wage claims from the perspective of falsification cost (Crocker and Tennyson, 2002), and medical expenses and wage losses (Doerpinghaus et al., 2008). Although noneconomic losses are more susceptible to such ex post moral hazard, it is rarely studied because of the difficulty in separating economic and noneconomic losses in detecting these fraud scenarios.

Publicly available statistics generally are highly aggregated and presented in a form accessible only to the specialist. The previous studies often utilize and are limited by the Insurance Research Council (IRC) data or similar data from insurance companies, which lack of the noneconomic damages claims data to examine how closely the settlement amount represent the real underlying losses. This is further complicated by the fact that most of these data sets have to resort to the opinions of experts, rather than court decisions, to determine whether a claim constitutes fraud or not.

The primary objective of this paper is to fill the gap in the current literature by making using of a unique data set. This study provides new insights in ex post moral hazard by examining both the economic and noneconomic losses in automobile bodily injury Compulsory liability (BICL) insurance. Automobile liability claims is one of the most common sources of individual liability and the consequences of settlement decisions are far reaching. Auto liability settlement amounts are influenced by many factors such as the claimant's degree of fault in causing the accident, the extent of the claimant's bodily injury, state negligence rules, the attorney involvement and falsified claims from both economic and noneconomic losses due to moral hazards from the claimants. Inflations in the general damage awards have been the primary motivation for opportunistic fraud in liability claims (Cummins and Tennyson, 1996; Crocker and Tennyson, 2002; Loughran, 2005; Asmat and Tennyson, 2014). Noneconomic personal injury protection coverage is most susceptible to moral hazard and has been a major source of premium inflation.

Our empirical work builds upon a unique data set of settled automobile bodily injury compulsory liability (BICL) claims lawsuits during 2007-2012 in China. Our data set has a few advantages over what is used in previous studies. First, litigated claims provide a more objective fraud definition than expert opinions. Second, our data contains a breakdown of different items of claimed losses that include also noneconomic losses. Because our data provides detailed information on the claimed and settled loss amounts, we focus on studying the severity of insurance fraud, rather than the frequency. To our best knowledge, this is the first study that empirically gauges the fraud severity of noneconomic losses. We are able to test whether the economic and noneconomic losses have different impacts on insurance fraud severity, and also identify claimant demographics and claim characteristics that affect the fraud severity.

We classify the court award amount into "insurer payment amount" and "insured defendant motorist payment amount", and then calculate total amount of opportunistic fraud based on the total claim and award amount. Namely, both the claim and award

amount are considered spontaneously to evaluate the severity of opportunistic fraud. Next, we identify opportunistic fraud from two dimensions: the opportunistic fraud aims only at the insurer if the court award amount equals the insurer payment amount; on the contrary, the opportunistic fraud aims at both the insurer and the insured defendant driver if the court award amount is greater than the insurer payment amount. These measures are employed to address three questions: i) to what extent does general damage influence the severity of opportunistic fraud in auto bodily injury compulsory liability claims? ii) does lower probability of opportunistic fraud for death or disability also imply less severity of opportunistic fraud for death or disability damage? iii) does higher probability of opportunistic fraud for sprains suggest larger severity of opportunistic fraud?

This paper contributes to the existing literature in the following four aspects. First, the severity of opportunistic fraud for general damage is the largest among all economic and non-economic losses claim sub-items and much larger than the second largest wage loss claim, adding to the present auto claim fraud literature that general damage amount claimed is not included in the total amount claimed (Crocker and Tennyson, 2002; Loughran, 2005; Doerpinghaus et al., 2008). Second, the severity of opportunistic fraud for death or disability damage is the third largest among all economic and non-economic losses claim sub-items, enriching the current auto claim fraud literature that severity of bodily injury is just dummy variable and death and permanent total disability are ommitted (Crocker and Tennyson, 2002; Loughran, 2005; Doerpinghaus et al., 2003, 2008). Third, RTSL gives rise to moral hazards of neglecting victim fault and focusing on the non-motorist or pedestrian role in auto accident, being possibly the unintended results of the RTSL designer. Last, the severity of opportunistic fraud for sprains is not significant statistically, enriching the present auto claim fraud literature that sprains is either higher possibility of opportunistic fraud or lower insurance payments (Crocker and Tennyson, 2002; Loughran, 2005).

The remainder of this article is organized as follows. Section 2 presents the literature review, auto Bodily Injury Compulsory Liability (BICL) Data from China, and discusses the importance and necessity of quantifying the severity of opportunistic fraud and adding noneconomic losses claimed and other economic losses claim sub-items besides medical expense and lost wage by seeking an independent claims lawsuit sample beyond insurance companies. Section 3 develops specific hypotheses to be tested, measures how economic and noneconomic losses claim sub-items affect insurer payment and insurer fraud amount differently, among

which RTSL, claimant demographics, and other claim characteristics as control variable, and describes the actual lawsuit data on auto bodily injury compulsory liability insurance claims. Section 4 presents empirical test results of the hypotheses and discusses insights. Section 5 concludes the paper and discusses limitations.

2. Literature Review and Auto Bodily Injury Compulsory Liability (BICL) Data from China

2.1 Literature Review

The essential components of fraud are the intent to deceive and the desire to induce an insurer to pay more than it otherwise would. A great deal of research focuses on fraud frequency, assessing and ranking fraud suspiciousness of individual claims, either based on the parametric and supervised methods (Derrig and Ostaszewski, 1995; Artis et al., 2002; Viaene et al., 2002; Caudill et al., 2005), or unsupervised methods for opportunistic fraud detection (Brockett et al., 2002; Ai et al., 2013).

However, higher fraud frequency does not necessarily imply larger fraud severity. The ex post moral hazard often cause the soft insurance fraud, i.e, the opportunistic insurance fraud. It occurs when the claimant takes advantage of a situation which has already taken place and makes an inflated claim, such as exaggerating the severity of an injury and claiming injuries or pain beyond the actual damages. For example, a person being legitimately injured in a collision could pretend that the injuries received were worse and more painful than they actually were and claimed additional monies. Soft fraud is the most common form of auto insurance fraud because it is very easy to commit and difficult to detect. Especially in cases where neck and back injuries are involved, it is often difficult to determine the true extent of the damage. Due to this fact, policyholders often exaggerate their pain or disabilities to receive extra compensation. The excess of legitimate injuries received in unplanned accidents is very easy to do, even without malicious intent, which is why it is so frequent. Therefore, it is very important to analyze the severity of opportunistic fraud.

Empirical estimates of the extent of excess claim are not available. Some previous researches focus on insurance payouts, which are used to imply the excess claim indirectly, but its implication is too coarse and inaccurate. Among these literatures, total damages payments include economic and noneconomic losses, but noneconomic loss is not contained in the total amount claimed. Economic loss is also called special damage in auto insurance. It refers to financial loss and damage suffered by a person resulting from medical expense and lost wage. Extent of bodily injury includes

non-disability, partial disability, total disability, and death. Crocker and Tennyson (2002) eliminate all death and permanent total disability claims because the wage loss settlement amount of death or permanent total disability is much larger than other claims. But fatality and permanent total disability are more severe injuries, more disputable between the claimant and the insured motorist, and more likely to be litigated. Doerpinghaus et al., (2008) find that the payout for permanent disability larger than that for temporary disability after eliminate all death claims. Derrig and Weisberg (2003) find that the presence of independent medical exam (IME) corresponds to higher payout because it can prove the suffered injury more easily, meaning lower fraud probability, so the insurer is willing to give a more generous payout. But it is more valuable for death or disability to be changed to numerical variable for death or disability damages and to evaluate the severity of opportunistic fraud.

Doerpinghaus et al., (2008) find the payout of hospitalization larger than that of outpatient because bodily injury severity of inpatient is more severe than that of outpatient. But inpatient in involved with hospitalization care expenses, which is still involved in the revenue, persons, term, and level of the nursing staff, and there exists a larger potential of opportunistic fraud to exaggerate the claim amount. So it is more meaningful for hospitalization to be changed to numerical variable for hospital care expenses and to evaluate its severity of opportunistic fraud.

Wage loss is easier to falsify by malingering on the part of the injured party than claims for medical expense. Crocker and Tennyson (2002) find that claims involving wage loss receive substantially less generous settlements than claims entailing only medical expense. It is also of interest for economic losses claimed to extend to other claim sub-items such as subsequent treatment expenses, transportation costs, etc.

Noneconomic loss is also called general damage, which is intended to compensate the auto accident injured or the dead victim's dependents for pain and suffering, emotional distress, loss of consortium or companionship, and other intangible injuries. These damages involve no direct economic loss and have no precise value. It is very difficult for insurers or legal courts to assign a dollar value to these losses by their nature. As a result, these awards tend to be erratic and easy to be falsified. On its symbolic function, Jaffe (1953) suggests that noneconomic damages may establish the plaintiff's self-confidence, wipe out his sense of outrage, or may be a consolation or solace from a psychic perspective; Ingber (1985) argues that its symbolic function is served by limiting damages to pecuniary losses that additionally result in nonmonetary harm; Radin (1993) suggests that its compensation can symbolize public

respect for rights and public recognition of the transgressor's fault by requiring something important to be given up on one side and received on the other; Zavos (2009) argues that noneconomic damages symbolically affirm that the plaintiff has been wrongfully deprived of something of value, even though that value can not be expressed at its fair market equivalency. On its appropriate atonement, Blumstein et al. (1991) argue that a series of jury verdicts for similar injuries or losses will lack predictability and consistency, given the minimal guidance they customarily receive from the court; Geisfeld (1995) clarifies the potential award arbitrariness into vertical and horizontal equity, indicating horizontal equity worse than vertical equity; Bovbjerg et al. (1988) propose constructing a matrix that determines the relative ratios for noneconomic damages based on data from past jury verdicts, broken down by the nine-point severity scale (the highest severity is death, and the lowest severity is emotion only)； Zavos (2009) further proposes that the jury selects a point on the severity scale to determine the noneconomic loss. Empirically Crocker and Tennyson (2002) examine the optimal claims settlement strategy for a liability insurer by regressing the total payment amount on the economic damages claimed for bodily injury liability in automobile accidents; Loughran (2005) show that insurers use general damage awards to reduce the incentive to submit exaggerated claims for specific damages for injuries and lost wages in bodily injury claims; and Asmat and Tennyson (2014) estimate the impact of bad faith liability on the total settlement amount relative to the claimed amount of loss, and find the presence of tort liability for insurer bad faith increases settlement amounts and reduces the likelihood that a claim is underpaid. But to date no research estimates the potential of opportunistic fraud for a general damage claimant to exaggerate the amount claimed.

The second branch of related research is on compensation mechanism, which mainly falls into tort and no-fault[1]. The major difference is whether there are restrictions on the right to sue and whether the policyholder's own insurer pays first-party benefits, up to the state maximum amount, regardless of who is at fault in the accident. Under the traditional tort mechanism for compensating victims of auto accidents, a driver can only be held responsible for other parties' damages if the driver is found to be negligent in the context of the accident. Tennyson and Warfel (2008, 2010) find that tort liability for first-party bad faith leads to more paid claims that

[1] Automobile liability accounts for more than half of all property-liability insurance premiums sold in the United States. Furthermore, the topic of sufficient concern that state legislators continue to pass laws modifying rules for compensating individuals injured in automobile accidents. Colorado, for instance, reverted to a tort liability system in 2003 after many years as a non-fault state. Minnesota, is considering a similar change.

contain characteristics often associated with fraud. The no-fault system is intended to compensate bodily injuries more efficiently and lower the cost of auto insurance by taking small claims out of the courts. Each insurance company compensates its own policyholders (the first party) for the cost of minor injuries, regardless of who was at fault in the accident. No-fault liability can lead to greater levels of compensation, but variability in payment is less. Schmit and Yeh (2003) find that New Jersey increases variability in payment after it switched to choice from no-fault. A great deal of research has been reported on various aspects of U.S. litigation patterns, such as changes in numbers of legal claims filed in various courts and jurisdictions, and the effects of various legislative modifications to the civil litigation system (Viscusi, 1991; Reimann, 2003; Browne and Schmit, 2008). But it is too coarse only to explore the relationship between auto compensation mechanism and total payments. Browne and Schmit (2008) find that the claimant fault is positively correlated with probability of hiring attorneys and filing legal claims, where the more the claimant fault, the larger probability the claimant hires an attorney and files a legal claim. Kessler (1995) groups claimant role in accident into automobile driver, passenger in automobile, motorcycle driver, passenger on motorcycle, and pedestrian; Tennyson and Salsas-Forn (2002) group it into passenger, pedestrian, and driver. It is more valuable to combine claimant fault and his or her role in auto accident into auto compensation mechanism, and further to explore the moral hazard caused by the auto compensation mechanism.

The third branch of related research is to investigate whether claimant demographics (namely, gender, age, marital status, and employment status etc.) also affect economic and noneconomic claim moral hazards. The prior literature provides evidence of risk aversion and negotiation differences as a function of gender and age. For instance, women and the elderly are more risk averse for a variety of pure and financial (i.e., speculative) risks (Levin et al., 1988; Powell and Ansic, 1997; Jianakoplos and Bernasek, 1998; Sunden and Surette, 1998; Schubert et al., 1999; Halek and Eisenhauer, 2001). Study also provides evidence that women and the elderly are more conflict averse in dispute settlement with greater negotiation costs and less successful outcomes, resulting in preferences for shorter negotiations with relatively lower payoffs holding other factors constant (Gallos, 1993; Stuhlmacher and Walters, 1999; Graddy and Pistaferri, 2000). But to date no research estimates the potential of opportunistic fraud for the woman or elderly claimant to exaggerate the amount claimed. The married can make claim decisions jointly with his or her spouse. Bair et al. (2012) find the married motorist gains larger payout than the non-married

controlling other factors. Unemployed claimants are more ready to hold out for higher settlements since they have little to lose by waiting. The unemployed receives more payout than the employed (Cummins and Tennyson, 1996; Doerpinghaus et al., 2008). But to date no research estimates the potential of opportunistic fraud for the married or the unemployed claimant to exaggerate the amount claimed.

The forth branch of related research is to investigate whether other claim characteristics (such as attorney, location in city, and sprains etc.) also affect economic and noneconomic claim moral hazards. Claimant bargaining power can be greatly improved when a lawyer is involved, and meanwhile the lawyer may encourage the claimant to inflate the injury extent (Carroll and Abrahamse, 2001). David and Tennyson (1996) find that the insured motorist can gain higher award amount of pain and suffering for the slight auto accident injury when a lawyer is involved, but the lawyer improving the claimant bargaining power and encouraging the victim to inflate injury extent are mixed. In urban locations, people are less likely to know one another and therefore are more likely to make a claim, even if potentially without a merit. Kessler (1995) finds that more fraud occurs in urban areas than in rural areas. Where fraud is more likely to exist, insurers are less generous in their claim payment. Doerpinghaus et al. (2008) find that the payment in the urban area is less than that in a rural area. Sprains is more difficult to prove, and relatively more susceptible to opportunistic fraud. Derrig et al. (1994) find that the auto accident claimant is inclined to claim general damage for strain and sprain if he can get help from a lawyer. Tennyson and Salsas-Form (2002) find that auto accident audit probability is positively correlated with strain and sprain claim. Crocker and Tennyson (2002) report that claims involved sprain injuries receive lower insurance payments than non-sprain claims, and Loughran (2005) sees that sprain injuries receive lower general damages at all levels of special damages. But to date no research estimates the potential of opportunistic fraud for attorney involvement, location in city, and sprains.

We take these studies one step further to test whether economic and non-economic losses claim sub-items affect the severity of opportunistic fraud differently based on our datasets on court award sample of auto bodily injury compulsory liability insurance, among which compensation mechanism, claimant demographics, and other claim characteristics as control variable, and make a contrast between their effects on insurer payment and fraud amount.

2.2. Auto Bodily Injury Compulsory Liability (BICL) Data from China

Our research sample is the automobile bodily injury compulsory liability (BICL) legal claims lawsuit data in China. We begin by providing an overview of the auto insurance system and the structure of the auto insurance market in China. China is the largest emerging auto insurance market with auto accidents increasing significantly. In 2010 alone, more than 390,000 accidents occurred on local roads and highways in China, with over 254,000 injuries, and death toll of more than 65,000 (Statistical Abstract of Traffic Control Department of the People's Republic of China, 2013).

The Road Traffic Safety Law (RTSL) in effect as of May 1, 2004 in China, emphasizes protecting the auto accident victims, especially the non-motor driver or pedestrian in an auto accident more than the motorist, and urges the insurer to pay the auto injured within the auto bodily injury compulsory liability (BICL) limit[2]. A considerable number of auto accident claims disputes ended up being litigated in court, and both economic and non-economic losses were sought by claimants. RTSL is a mixture of tort and no-fault: if the auto accident victim is a non-motor driver or pedestrian, the court mainly applies no-fault and fault is considered secondly; but if the auto accident victim is a motorist, it applies fault completely. RTSL classifies victim role in auto accident into motor driver, and non-motorist or pedestrian, and protects the non-motorist or pedestrian more than the motorist. We expect that RTSL gives rise to moral hazards of claimants neglecting victim fault and focusing on the non-motorist or pedestrian role in auto accident. We anticipate that victim fault is negatively correlated with insurer payment amount, but positively correlated to insurer fraud amount, and that both insurer payment and fraud amount for the non-motorist or pedestrian are larger than that for the motorist.

The claimant may recover for all bodily injuries sustained including economic and non-economic losses from the insurer and the insured injuring motorist. If an auto accident causes the victim personal injury or death, the insurer shall pay indemnity with BICL threshold, which provides the basic compensation for bodily injury and the indemnity limit is the same across China, including the total compensation limit, death or disability limit, medical expense limit, and limit when the insured motorist is no-fault. Death or disability expenses include funeral expenses, death damages, traffic costs for dependents of the dead victim to deal with the funeral, disability damages,

[2] RTSL may affect claimants and judges behavior through victim fault and role in auto accident. Browne and Schmit (2008) include total disability and fatality in injury severity. The claimant is the victim while the injured is subject to temporary disability, or partial disability; but the claimant is the victim's dependents when the injured is subject to total disability or fatality. Our actual claims lawsuit sample encompasses all injury types, especially total disability and fatality, so we use victim instead of claimant in this article.

care expenses, restoration expenses, traffic costs, and lost wages. Death or disability damages amount is calculated in a similar manner and hence considered as the same category. Death damage reflects the amount that the decedent would be reasonably expected to have accumulated during the remainder of his lifetime, which is generally calculated according to 20 years. Disability damage reflects the amount that the disabled would be compensated by the capacity losing severity and disability level. In China, due to the large urban-rural disparity, death or disability damages amount is much different between urban and rural residents[3]. There is incentive for claimants to exaggerate claim amount with the bodily injury severity from lower grade to higher grade. In contrast, the general damages amount is a larger flexible scope, and not subject to the difference across the urban and rural residents[4]. Assuming that normal life expectancy is 80 years old, if the injured victim in the auto accident is above 60 years old, the time span equals 80 minus his or her real age[5]. Assumed that a peasant and a citizen suffer the same bodily injury in an auto accident, death or disability damages awarded for the citizen is much larger than that for the peasant just because of their urban-rural identity difference.

On June 19, 2006, China Insurance Regulatory Commission (CIRC) determined auto BICL indemnity limit of ¥58,000 without deductibles, including death or disability limit ¥50,000, and medical expenses limit ¥8,000. When the insured defendant motorist is no-fault in the auto accident, death or disability limit is ¥10,000, and medical expenses limit is ¥1,600. In 2008, CIRC revised auto BICL indemnity limit of ¥120,000 without deductibles, including death or disability limit ¥110,000, and medical expenses limit ¥10,000. When the insured defendant motorist is no-fault in the auto accident, death or disability limit is ¥11,000, and medical expenses limit is ¥1,000. We classify the sample into the higher policy for ¥120,000 and the lower policy for ¥58,000, and expect that both insurer payment and fraud amount for the higher policy larger than for the lower policy.

[3] The death or disability is divided into 10 grades from level 1 (the most severe, disability damage amount= death damage amount ×100%) to level 10 (the least serious, disability damage amount =death damage amount ×10%) according to the bodily injury severity with the multiplier is gradually reduced by 10% from level 1 to level 10.

[4] In 2012, for Beijing urban resident, death damages amount is ¥658,060 (=¥32,093 of the urban per capita disposable income in previous financial year ×20 years) and the general damages amount is ¥50,000~¥100,000. Similarly, for Beijing rural resident, death damages amount is ¥294,720 (=¥14,736 of the rural per capita disposable income in previous financial year ×20 years) and the general damages amount is ¥50,000~¥100,000.

[5] For example, if an urban victim is 75 years old, death damages amount equals ¥32,093 times 5 years.

There is no systematic study on auto bodily injury liability fraud detection. Empirical auto insurance fraud detection in China focuses on physical damage and fraud frequency. Ye (2010, 2011) detects auto physical damage fraud frequency through logit discrete model and BP neurological network respectively based on Jiangsu, Zhejiang, and Shanghai auto insurance claim data; Liu (2012) finds that the undetected auto physical damage fraud accounts for about 30 percent, among which 90 percent belongs to lower than ¥3150 claim cases based on the closed auto insurance claim cases in Guangdong province during 2010-2011. Zhou et al., (2011) explore the relationship between claim filing characteristics and insurer payment amount (a fraction of total court award amount) based on a closed auto bodily injury claim lawsuit cases in Beijing, but not further estimating its fraud severity.

3. Basic Assumptions, Model Setting, Sample and Data

3.1. Basic Assumptions

We assume that factors related to fraud frequency and claim payments equally influence both insurer payment and fraud amount, which are mainly determined by claim sub-items of economic and non-economic losses.

3.1.1 Economic and Non-Economic Losses Claim Sub-items

According to BICL, the insurer pays the auto accident injured economic and non-economic losses, which include medical expense, subsequent treatment expense, transportation cost, hospital care expense, death or disability damage, general damage, etc., so total amount claimed also includes non-economic loss, which means pain and suffering, loss of companionship, mental anguish, etc.

Crocker and Tennyson (2002) examine the optimal claims settlement strategy for a liability insurer by regressing the total payment amount on the economic damages claimed for bodily injury liability in automobile accidents; Loughran (2005) show that insurers use general damage awards to reduce the incentive to submit exaggerated claims for specific damages for injuries and lost wages in bodily injury claims; and Asmat and Tennyson (2014) estimate the impact of bad faith liability on the total settlement amount relative to the claimed amount of loss, and find the presence of tort liability for insurer bad faith increases settlement amounts. Here non-economic loss claim is measured by the natural logarithm of general damage claimed. We expect that the payment coefficient for LnGeneralDamage is lower than that for LnMedExp, but the fraud coefficient for LnGeneralDamage is larger than that for LnMedExp.

Besides medical expense and wage loss, economic loss amount claimed also includes other claim sub-items such as death or disability damage, hospital care expense, subsequent treatment expense, and transportation cost etc. Medical expense means the really expended amount for the hospital to remedy the traffic accident injury, including medical fee, diagnosis fee, and face lifting fee etc. Medical expenses claim requires the receipts documentation of the specific services and the date and cost of each service received from each licensed practitioner who provides medical treatments, so there is hardly potential of opportunistic fraud. Lost wage means the actually reduced revenue by the auto accident injured because of not being able to engage in his normal work from his or her suffering the auto accident injury to being completely cured. Lost wage claim must also offer the traffic accident injured revenue document before his injury and lost wage documentations, but the documentation only involves a simple form filled out by the victim's employer, which reports the dates of victim employment, absences following the accident, gross earnings, leading to a larger fraud potential than medical expense. Crocker and Tennyson (2002) find that claims involving wage loss receive substantially less generous settlements than claims entailing only medical expense. Medical expense and wage loss claim is measured by the natural logarithm of their claim amount respectively. We expect that the payment coefficient for LnMedExp is larger than that for LnWageLoss, but the fraud coefficient for LnWageLoss is larger than that for LnMedExp.

Death damage means the amount that the decedent would be reasonably expected to have accumulated during the remainder of his lifetime, which is generally calculated according to 20 years. Disability damage means the amount that the disabled would be compensated by his or her capacity losing severity and disability level. We group personal injury severity into non-disability, disability and death. But death has been omitted in the present claim literature (Crocker and Tennyson, 2002; Doerpinghaus et al., 2008) because of their severe nature and rare occurrence. Disability or death damage claim needs disability degree or death documentations. Derrig and Weisberg (2003) find that presence of IME corresponds to higher claim payment because IME reflects lower soft fraud likelihood and the insurer will pay the claimant generously. Death is an objective fact with the death documentation offered by the traffic officer or the hospital, also with lower fraud likelihood. Death or disability is divided into 10 grades from level 1 (the most severe, disability damage amount=death damage amount ×100%) to level 10 (the least serious, disability damage amount=death damage amount ×10%) according to bodily injury severity with the multiplier is gradually reduced by 10% from level 1 to level 10. There is

incentive for the claimant to exaggerate claim amount with bodily injury severity from lower to higher level. Death or disability damage claim is measured by the natural logarithm of death or disability damage claim amount. We expect that the payment coefficient for LnDea/DisaDamage is larger than that for MedExp, but the fraud coefficient for LnDea/DisaDamage is not much larger than that for LnMedExp.

Hospital care expense means that the auto accident injured can hardly take care of himself or herself during his or her hospital treatment, but need others' hospital care, which involves the revenue, persons, term, and level of the nursing staff. Hospital care expense requires hospitalization document and the income, persons, term, and level documentations of the nursing staff. Hospital stay means more severe injury than non-hospitalization, and even many not instant fatalities need also be hospitalized for some time in our sample. Doerpinghaus et al. (2008) find that claimants with injuries resulting in a hospital stay receive higher claim payments than those not hospitalized. But it is easier to exaggerate the amount claimed for hospital care expense, leading to a larger potential of opportunistic fraud. Hospital care expense claim is measured by the natural logarithm of hospital care expense claim amount. We expect that the payment coefficient for LnHospiCare is lower than that for MedExp, but the fraud coefficient for LnHospiCare is larger than that for LnMedExp.

Subsequent treatment expense means a fixed sign of dysfunction left behind after the auto accident injured is treated medically, who is not satisfied with present medical treatment and asks the insured injurer and insurer to continue medical treatment in the future. Namely subsequent treatment expense is not real medical expense at present, but the potential medical expense in the future. Subsequent treatment expense claim requires medical certificate or expert conclusion, which is hardly adopted by the court. Even if the court adopts the medical certificate or expert conclusion, subsequent treatment expense claim amount is easily surpassing its necessary and reasonable limit, so there is larger potential of opportunistic fraud. Subsequent treatment expense claim is measured by the natural logarithm of subsequent treatment expense claim amount. We expect that the payment coefficient for LnSubseTreat is lower than that for MedExp, but the fraud coefficient for LnSubseTreat is larger than that for LnMedExp.

Transportation cost means the actual bus or ship tickets for the auto accident injured and the necessary hospital care staff to have a medical treatment or transfer to other hospitals for medical treatments, which should be consistent with the site, time, persons, and frequency of hospitalization. Transportation cost claim requires the actual bus or ship tickets for the auto accident injured and the necessary hospital care

staff to have a medical treatment or transfer to other hospitals for medical treatments. It is easier to exaggerate the claim amount for transportation cost, so there also is a larger potential of opportunistic fraud. Transportation cost claim is measured by the natural logarithm of transportation cost claim amount. We expect that the payment coefficient for LnTransportation is lower than that for MedExp, but the fraud coefficient for LnTransportation is larger than that for LnMedExp.

In addition, claimant demographics and other claim characteristics as control variables, also affect insurer payment and fraud amount greatly.

3.1.2 Claimant Demographics

Claimant demographics mainly include gender, age, marital status, and employment status. These characteristics may reflect a greater availability of resources, which in turn is likely to encourage greater levels of litigation. Gender and age have been associated with differences in risk-aversion and negotiating preferences and discrimination. Halek and Eisenhauer (2001) report evidence in life insurance purchase decisions of risk aversion differences across gender, age, and marital status. Doerpinghaus et al. (2003, 2008) find gender and age effects in both fault assignment and claim payment in automobile liability claims. Viscusi (1988) identifies gender and marital status effects in pursuing product liability claims. Men generally have higher incomes and married people may have support from the spouse both improving their bargaining power. We expect that both insurer payment and excess claim amount are larger for male than for female, and larger for the married than for the non-married.

Unemployed claimants have lower lawsuit cost because their time cost is nearly zero. There exists the "lottery effect" that unemployed claimants "hold out" for higher settlements since they have little to lose by waiting (Cummins and Tennyson, 1996; Doerpinghaus et al., 2008). In China, the unemployed contains peasants and citizens, the peasant is potential unemployed, but the citizen is publicly non-employed, both having lower time cost. We expect that both insurer payment and fraud amount are larger for the unemployed than for the employed.

Older people (defined as more than 65 years) demonstrate greater financial risk aversion because the cost of risk is greater at older ages due to a shorter horizon with which to recover from adverse circumstances (Fuchs 1982; Posner, 1995). But there is little prior research on the effect of youthful age (defined as less than 22 years) on financial decision making based on his or her relatively less negotiating experience. We group age into the elderly (more than or equals to 60 years), the youthful (less than 18 years), and the middle-aged (more than or equals to 18 years, but less than 60

years). According to Article 11, Chapter II, General Principles of the Civil Law (GPCL) of the People's Republic of China, a citizen who is more than or equals to 18 years old shall have full capacity for civil conduct and may independently engage in civil activities. Here we have a different definition of youthful claimant from the classical literature because there is a large body of young migrant workers who are over or equals to 18 years old in our sample. According to retirement provisions by the State Council of the People's Republic of China, male and female official who are more than or equals to 60 years old，female staff who is more than or equals to 55 years old, female worker who is more than or equals to 50 years old shall retire. We uniformly use age 60 or over as retirement for convenience. Here we have a different definition of elderly claimant from the traditional literature because life and health condition in a developing country, like China, is significantly different from that in a developed country, namely obvious difference of economic development leads to the medical and security condition distinctive gap between them. We expect that both insurer payment and fraud amount are lower for the youthful and elderly than for the middle-aged.

3.1.3 Other Claim Characteristics

Besides the claimant demographics, there are some other claim characteristics, such as lawyer involvement, accident location, sprains, and the elderly who claims sprains.

Claimant negotiating power can be enhanced significantly if a lawyer is involved, meanwhile the attorney may also encourage the auto accident victim to exaggerate the injury extent (Carroll and Abrahamse, 2001). David and Tennyson (1992) find that the insured motorist can gain higher award amount of pain and suffering for slight bodily injury in the auto accident because of the lawyer involvement. We expect that both insurer payment and fraud amount are larger with lawyer involvement than without a lawyer.

In metropolitan locations, people are less likely to know one another and therefore are more likely to make a claim, even if potentially without a merit. Kessler (1995) finds that more fraud occurs in metropolitan areas than in rural areas. Where fraud is more likely to exist, insurers are less generous in their claim payment. Doerpinghaus et al. (2008) find that the payment in the urban area is less than that in a rural area. Beijing is undergoing a rapid urbanization, many local peasants become citizens, and more and more migrant workers across the country flow to Beijing city. There are more frequent population mobility and less familiarity among people in city. We classify accident location in Beijing into urban and rural area and expect lower insurer

payment amount in urban than in rural area, but larger soft fraud amount in urban than in rural area.

Sprains are more difficult to prove than other injuries, and therefore more vulnerable to fraud. Crocker and Tennyson (2002) report that claims involved sprain injuries receive lower insurance payments than non-sprain claims; Loughran (2005) finds that sprain injuries receive lower general damages at all levels of special damages. We expect lower insurer payment amount for sprains than for non-sprains, but larger insurer fraud amount for sprains than for non-sprains.

We still add an intersection between sprains and the elderly. The elderly has greater financial risk aversion (Fuchs, 1982; Posner, 1995); Carroll and Abrahamse (2001) find that the elderly is more likely to submit a claim for soft injury. We expect that both insurer payment and insurer fraud amount are lower for the elderly than for the middle-aged who claims sprains.

In summary, Table 1 presents the dependent and independent variable names and definitions.

Table 1 Variable Name and Definition

Variable Name	Variable Definition
LnInsurerPayment	Ln(insurer payment amount awarded)
LnInsurerFraud	Ln(total claim - total award)*(insurer payment / total award)
lnMedExp	Ln(medical expense claimed)
lnSubseTreat	Ln(subsequent treatment expense claimed)
lnHospiCare	Ln(hospital care expense claimed)
lnTransportation	Ln(transportation cost claimed)
lnWageLoss	Ln(lost wage claimed)
lnDea/DisaDamage	ln(death or disability damage claimed)
lnGeneralDamage	ln(general damage claimed)
VFault	% Victim at fault in accident
NonMotorist	1if victim is non-motorist or pedestrian, 0 else
HigherPolicy	1 if claim apply higher policy for ¥120,000, 0 else
CFemale	1 if claimant female, 0 else
CYouthful	1 if claimant<18 years, 0 else
CElderly	1 if claimant≥60 years, 0 else
CUnemployed	1 if claimant unemployed, 0 else
CMarried	1 if claimant married, 0 else
Attorney	1 if claimant use an attorney, 0 else
LocationCity	1 if accident occurs in city, 0 else
Sprains	1 if victim sprain, 0 else
ElderlySprains	1 if the elderly claims sprains, 0 else

3.2. Theoretical Model

Before developing the empirical model for the severity of opportunistic fraud, we briefly summarize Doerpinghaus et al. (2008)'s model for insurance claim payment, which expresses the claimant's excess demand as the difference between the claimant's and the insurer's perceived value of the claim. Specifically, the claimant's net payment after negotiation in Doerpinghaus et al. (2008) is

$$P_n = P - c(y - x)^2 , \quad (1)$$

Where c is the negotiating cost parameter (such that higher values of c imply higher negotiating costs), and P is the liability claim payment, which is defined as

$$P = x + G(y - x) \quad (2)$$

Where x is the insurer's perceived value of the claim and y is the claimant's perceived value. The quantity (y-x) reflects the claimant's excess demand beyond the insurer's valuation of the claim. The random variable, G , ranges from 0 to 1 and is the settlement multiplier, determined by social, cultural, and legal factors that are beyond the control of the claimant. The claimant's optimal claim value, y, is determined by expected utility maximization, where utility is a function of the net payment, Pn, and Doerpinghaus et al. (2008) define the claimant's expected utility as

$$EU(P_n) = EP_n - rVar(P_n) = x + \mu_G(y - x) - c(y - x)^2 - r\sigma_G^2(y - x)^2 \quad (3)$$

Where r is the claimant's risk-aversion parameter, μ_G and σ_G^2 represent the mean and variance of the settlement multiplier, respectively. The optimal demand for the claimant is $y^* = \frac{1}{2}\frac{\mu_G}{c + r\sigma_G^2} + x$

Doerpinghaus et al. (2008) test empirically whether women, elderly, and youthful (as well as married) claimants receive different payments for similar injuries. Our BICL closed claim litigation cases are generally involved with three parties: the claimant, the insurer, and the insured motorist. The claimant usually litigates both the insurer and the insured motor driver, not distinguishing their respective amount claimed, but the total amount awarded often includes the insurer payment amount and the insured defendant motorist payment amount. That is to say, the insurer payment amount is a fraction of the total amount awarded, slightly different from claimant payment (Doerpinghaus et al., 2008). We explore economic and non-economic losses claim sub-items effects on insurer payment amount.

In addition, we extend the Doerpinghaus et al. (2008) study to continue estimating the excess claims effects and test it with our survey on auto bodily injury compulsory liability insurance claim lawsuit data in China. Present insurance payment researches (Crocker and Tennyson, 2002; Loughran, 2005; Doerpinghaus et al., 2008) detect

inflated claims subjectively based on the Insurance Research Council (IRC) data which originate from the insurers in the United States. Here we substitute the court for the insurer, fairly estimating the claimant's excess demand beyond the court's valuation of the claim. This paper detects inflated claims objectively according to the court award amount as a fair reference point. If the claim amount is larger than the award amount, it is regarded as overstated claims, where total inflated claim amount = (total claim amount − total award amount). We assume that insurer fraud amount is in proportion to the insurer and the insured defendant motorist payments awarded by the court, then insurer fraud amount equals total inflated claim amount times the ratio of insurer payment amount relative to total award amount. In short, insurer fraud amount is determined by total claim amount and total award amount together. Given that the total award amount is comparatively stable, soft fraud severity depends mainly on total claim amount.

We develop a model to estimate insurer payment and insurer fraud amount respectively with our survey on auto bodily injury compulsory liability insurance claim lawsuit data in China as

$$P_i = \beta_0 + \beta_1 * C_i + \beta_2 * L_i + \beta_3 * D_i + \beta_4 * O_i + \varepsilon_i, \text{ where} \qquad (4)$$

P_i = natural logarithm of insurer payment amount, or insurer fraud amount for the *i*th;

β_0 = intercept term;

C_i= measures of amount claimed including economic and noneconomic losses for the *i*th claim;

β_1= a vector of regression coefficients for amount claimed measures;

L_i= measures of RTSL including victim fault and role in auto accident, and BITPCL policy limit for the *i*th claim;

β_2 = a vector of regression coefficients for RTSL;

D_i = measures of claimant demographic characteristics;

β_3= a vector of regression coefficients for claimant demographic characteristics;

O_i= a vector of other claim characteristics associated with the *i*th claim;

β_4 = a vector of regression coefficients for other claim characteristics;

ε_i= the random error term.

3.3. Sample and Data

Based on Article 29 of the Civil Procedure Law of the People's Republic of China, "a lawsuit brought on a tortuous act shall be under the jurisdiction of the people's courts of the place where the tort is committed or where the defendant has his domicile".

Therefore, the claim data is not limited to the district residents. It reflects both the accident places and the residence of the defendant in the entire city of Beijing. Figures released by Beijing's municipal bureau of statistics show that the capital's population grew by almost half a million residents in 2013 to 21.15 million. To put that in perspective, that's only slightly less than the entire population of Australia, or 60% of the entire population of Canada.

We analyze auto bodily injury compulsory liability (BICL) closed claims lawsuit cases awarded by a Beijing district court during 2007-2012 in China to test our hypotheses. Our data include extensive information on each claim case, which makes them uniquely suited to examining the economic and non-economic losses claim effects on insurer payment and fraud amount respectively. Both the claimed amount and the amount paid by the insurer are reported in some detail, such as amount of medical expense, lost wage, death or disability damage, subsequent treatment expense, hospital care expense, and transportation costs, and also reported is the amount of general damage claimed by the claimant and paid by the insurer. Details are provided regarding the circumstances of each accident, including the location, attorney involvement, victim fault, role in auto accident, and different policy limit. The data also contain information regarding the nature of the injuries incurred by the claimant and the extent of trauma suffered. Finally, there are some data on the personal characteristics of the claimant, including sex, age, and marital and employment status.

The initial survey data set of all auto bodily injury compulsory liability closed award claims involving two-party accidents yields 649 cases. First, we eliminate 50 closed award claims in which auto compulsory liability (CL) insurance is not purchased, which reduces our sample to 599 cases. Following Doerpinghaus et al. (2008), we focus on auto BICL claims, thus omitting 95 observations from complete property damage compulsory liability (PDCL), leaving our sample to 504 cases. We further delete 40 auto bodily injury claims in which both BICL and bodily injury selective liability insurance are simultaneously bought by the same injuring motorist because auto bodily injury selective liability insurance with deductibles does not contain general damages. The many differences across non-CL, PDCL, and BICL add-on yield non-comparable liability claims. We delete these 185 unsuitable auto closed award claims from the analysis just to reduce heterogeneity in features of BICL

insurance. The resulting suitable closed award data of auto BICL claims for analysis are 464 cases, which are very rarely received and quite valuable[6].

Our BICL closed award files include summary information on economic and noneconomic losses amount claimed containing total and sub-items, which include medical expenses, subsequent treatment expenses, hospital care expenses, transportation costs, lost wages, death or disability damages, and general damages, greatly increasing the potential of claim fraud. Namely, severity of bodily injury is changed to numerical variable for death or disability damage, and extent of treatment is changed to numerical variable for hospital care expenses. The BICL award data are thus well suited to hypotheses test regarding economic and noneconomic losses claim effects on insurer payment and fraud amount. Victim fault and role in accident, and different policy limit are also reported, making it possible to test whether RTSL gives rise to moral hazards for the auto accident injured, especially the more protected group.

Among the 464 cases for auto bodily injury compulsory liability insurance, there are 58 cases for insurer payment amount being zero. We drop these 58 outlier samples, leaving 406 normal claims, among which there are 161 cases of female, and 245 cases of male; 20 cases of the youthful, 62 cases of the elderly, and 324 cases of the middle-aged; 159 cases of the unemployed, and 247 cases of the employed; 331 cases of the married, and 75 cases of the non-married. There are 63 cases of soft tissue injury, and 343 cases of non-soft tissue injury; 268 cases with lawyer involvement, and 138 cases without lawyer involvement; 390 cases in city, and 16 cases in rural area; 324 cases of policy limit for ¥120,000, and 82 cases of policy limit for ¥58,000; 338 cases of the non-motor driver or pedestrian, and 68 cases of the motorist; 164 cases of non-disability, 208 cases of disability, and 34 cases of death. Table 2 presents the summary statistics for dependent and independent variables for the 406 normal claims, in which LnInsurerPayment mean is 10.1522 and its median is 10.7899.

Table 2 Summary Statistics for Dependent and Independent Variables based on 406 Legal Claim Samples

Variable Name	Mean	Median	Std Dev	Min	Max
LnInsurerPayment	10.1522	10.7899	1.3789	6.4677	12.3844
LnMedExp	7.5110	8.2557	3.1622	0.0000	12.4645
LnSubseTreat	1.8237	0.0000	3.6747	0.0000	12.1498
LnHospiCare	6.3484	7.8320	3.6494	0.0000	12.3543
LnTransportation	5.2826	6.2146	2.6722	0.0000	10.2307
LnWageLoss	7.6067	8.9159	3.3376	0.0000	12.2061
LnDea/DisaDamage	6.6125	10.1903	5.4927	0.0000	13.3526

[6] Kessler (1995) excludes 32 litigated claims from 7385 automobile insurance bodily injury claims, collected by the Insurance Research Council in 1987, in which litigated claims account for only 0.43% of all claims.

LnGeneralDamage	7.5413	9.2103	3.8027	0.0000	13.1224
VFault	0.0889	0.0000	0.1949	0.0000	1.0000
NonMotorist	0.8325	1.0000	0.3739	0.0000	1.0000
HigherPolicy	0.7980	1.0000	0.4020	0.0000	1.0000
CFemale	0.3966	0.0000	0.4898	0.0000	1.0000
CYouthful	0.0493	0.0000	0.2167	0.0000	1.0000
CElderly	0.1527	0.0000	0.3602	0.0000	1.0000
CUnemployed	0.3916	0.0000	0.4887	0.0000	1.0000
CMarried	0.8153	1.0000	0.3886	0.0000	1.0000
Attorney	0.6601	1.0000	0.4743	0.0000	1.0000
LocationCity	0.9606	1.0000	0.1948	0.0000	1.0000
Sprains	0.1552	0.0000	0.3625	0.0000	1.0000
ElderlySprains	0.02710	0.0000	0.1626	0.0000	1.0000

Similarly, among the 464 cases for auto bodily injury compulsory liability insurance, there are 28 cases for the claim amount equaling the award amount and 436 claims in which the claim amount is larger than the award amount. We drop these 28 outlier samples, leaving 436 exaggerated claims, among which there are 180 cases of female, and 256 cases of male; 20 cases of the youthful, 61 cases of the elderly, and 355 cases of the middle-aged; 172 cases of the unemployed, and 264 cases of the employed; 357 cases of the married, and 79 cases of the unmarried. There are 78 cases of soft tissue injury, and 358 cases of non-soft tissue injury; 281 cases with lawyer involvement, and 155 cases without lawyer involvement; 418 cases in city, and 18 cases in rural area; 353 cases of policy limit for ¥ 120,000, and 83 cases of policy limit for ¥ 58,000; 362 cases of the non-motor driver or pedestrian, and 74 cases of the motor driver; 35 cases of non-disability, 207 cases of disability, and 35 cases of death. Table 3 presents the summary statistics for dependent and independent variables for the 436 excess claims, in which LnInsurerFraud mean is 9.4742 and its median is 9.5051.

Table 3 Summary Statistics for Dependent and Independent Variables based on 436 Excess Claim Samples

Variable Name	**Mean**	**Median**	**Std Dev**	**Min**	**Max**
LnInsurerFraud	9.4742	9.5051	1.4457	5.1985	12.9972
LnMedExp	7.3100	8.1277	3.2460	0.0000	12.4645
LnSubseTreat	1.7490	0.0000	3.6023	0.0000	12.1498
LnHospiCare	6.2142	7.7832	3.6757	0.0000	12.7915
LnTransportation	5.2443	6.2146	2.6519	0.0000	10.2307
LnWageLoss	7.5546	8.8378	3.3147	0.0000	12.2061
LnDea/DisaDamage	6.1709	10.0290	5.5687	0.0000	13.3526
LnGeneralDamage	7.3600	8.9872	3.8822	0.0000	13.1224
VFault	0.0883	0.0000	0.1997	0.0000	1.0000
NonMotorist	0.8303	1.0000	0.3758	0.0000	1.0000

HigherPolicy	0.8096	1.0000	0.3930	0.0000	1.0000
CFemale	0.4128	0.0000	0.4929	0.0000	1.0000
CYouthful	0.0459	0.0000	0.2094	0.0000	1.0000
CElderly	0.1399	0.0000	0.3473	0.0000	1.0000
CUnemployed	0.3945	0.0000	0.4893	0.0000	1.0000
CMarried	0.8188	1.0000	0.3856	0.0000	1.0000
Attorney	0.6445	1.0000	0.4792	0.0000	1.0000
LocationCity	0.9587	1.0000	0.1992	0.0000	1.0000
Sprains	0.1789	0.0000	0.3837	0.0000	1.0000
ElderlySprains	0.0252	0.0000	0.1570	0.0000	1.0000

4. Empirical Result

Based on the selected 406 insurer payment and 436 insurer fraud samples, we perform an ordinary least squares (OLS) regression for LnInsurerPayment in section 4.1 and LnInsurerFraud in section 4.2 using model 4, respectively. For both samples, we show the OLS regression results, the justification of the normality assumption via both graphical tools (Scatter plots and Q-Q plots) and various normality tests, and the detailed econometric explanation for the results, respectively.

4.1. Claim Effects on Insurer Payment Amount

We perform an OLS regression for LnInsurerPayment based on model 4, and Table 4 presents results of OLS regression.

As we know, normality assumption is very important for the residuals from a linear regression model. If they are not normally distributed, the residuals should not be used in Z tests or in any other tests derived from the normal distribution, such as *t* tests, *F* tests and chi-squared tests. Thus, before we demonstrate the OLS results in Table 4, we first check the normality assumption for the residuals from model 4. First we show the visual inspection of the distribution of standardized residuals of OLS regression in Figure 1 via scatter plot and normal Q-Q (quantile-quantile) plot. From the scatter plot of the standardized residuals in Figure 1 (Left), which are randomly distributed in the strip region of -2 to +2, and its normal Q-Q plot in Figure 1 (Right) is distributed around a straight line, both of which imply that the normality assumption holds true for model 4. Although from Figure 1, readers can judge the normality assumption by themselves, the visual methods may seem unreliable. As supplementary to the graphical assessment of normality, we perform 10 popular normality tests described in Ghasemi and Zahediasl (2012), i.e., Kolmogorov-Smirnov (KS) test, Jarque-Bera test, Shapiro-Wilk's (SW) test,

D'Agostino Omnibus test, D' Agostino Skewness test, D' Agostino Kurtosis test, Cramer-von Mises test, Pearson Chi-Square test, Shapiro-Francia test, and Energy test, see tests results in the columns 2 and 3 in Table 5. All tests have a p-value far greater than 0.05, especially for the KS and SW tests with the p-value being greater than 0.20, which indicates normal distribution of data.

Table 4 OLS Regression of Dependent and Independent Variable based on 406 Samples

Variable	Estimate	Std.Error	t Statistic	Prob.	
Intercept	7.9804	0.1745	45.7279	0.0000	***
LnMedExp	0.0434	0.0069	6.2969	0.0000	***
LnSubseTreat	-0.0084	0.0058	-1.4587	0.1455	
LnHospiCare	0.0184	0.0065	2.8164	0.0051	***
LnTransportation	0.0254	0.0084	3.0358	0.0026	***
LnWageLoss	0.0196	0.0077	2.5296	0.0118	**
LnDea/DisaDamage	0.1756	0.0055	31.7952	0.0000	***
LnGeneralDamage	0.0232	0.0070	3.3151	0.0000	***
VFault	0.3027	0.1161	2.6072	0.0095	***
NonMotorist	0.0508	0.0603	0.8418	0.4004	
HigherPolicy	0.3245	0.0534	6.0732	0.0000	***
CFemale	-0.0999	0.0432	-2.3116	0.0213	**
CYouthful	-0.2992	0.1179	-2.5375	0.0116	**
CElderly	-0.0609	0.0726	-0.8386	0.4022	
CUnemployed	0.0002	0.0491	0.0034	0.9973	
CMarried	-0.0495	0.0599	-0.8264	0.4091	
Attorney	0.1673	0.0495	3.3771	0.0008	***
LocationCity	-0.1096	0.1073	-1.0219	0.3075	
Sprains	-0.7254	0.0714	-10.1545	0.0000	***
ElderlySprains	0.3055	0.1468	2.0804	0.0381	**
R-squared: 0.9027			Adjusted R-squared: 0.9167		
F-statistic: 235.7 on 19 and 386 DF			P-value: < 2.2e-16		

***significant at 0.01; **Significant at 0.05; *Significant at 0.1

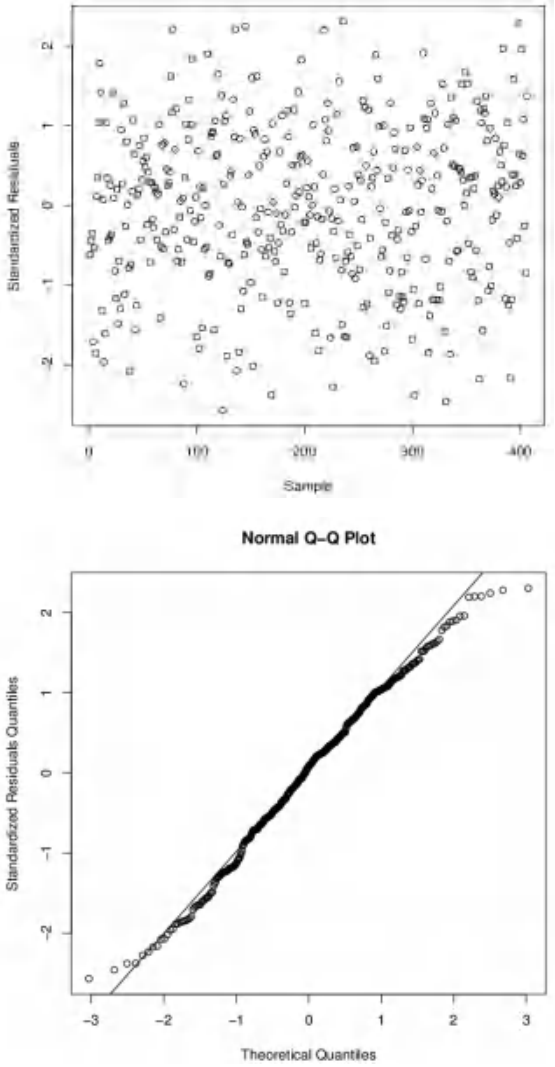


Figure 1 Scatter plot (Left) and Normal Q-Q plot (Right) for Standardized Residual of OLS regression for LnInsurerPayment

Table 5 Normality Test Results for Standardized Residual of OLS Regression for LnInsurerPayment and LnInsurerFraud

Normality Test	**LnInsurerPayment**		**LnInsurerFraud**	
	Test Statistic	P-value	Test Statistic	P-value
Kolmogorov-Smirnov Test	0.0474	0.3552	0.038	0.5548
Jarque-Bera Test	4.5924	0.1006	3.8633	0.1449
Shapiro-Wilk' s Test	0.9949	0.2338	0.9946	0.1247
D' Agostino Test-Ominibus	5.5710	0.0617	4.8678	0.0877
D' Agostino Test-Skewness	-1.4258	0.1539	-1.0601	0.2891
D' Agostino Test-Kurtosis	-1.8810	0.0600	-1.9350	0.0530
Cramer-von Mises Test	0.1086	0.0855	0.0901	0.1529
Pearson Chi-Square Test	27.8125	0.1455	19.8853	0.4651
Shapiro-Francia Test	0.9937	0.1020	0.9957	0.2413
Energy Test	0.7816	0.0803	0.6180	0.1381

Table 4 presents results of the OLS estimation with the dependent variable equal to the natural logarithm of insurer payment amount for 406 samples. The adjusted $\mathbf{R^2}$ is 0.9167.

Here insurer payment amount is similar to insurance payout (Doerpinghaus et al., 2008), but the difference is that insurer payment amount is a fraction of total award amount in this article. The payment coefficient for LnMedExp is 0.0434 and statistically significant at the 0.01 level, which is larger than other claim sub-items except Lndea/ DisaDamage consistent with our hypothesis.

The payment coefficient of LnWageLoss is 0.0196 and statistically significant at the 0.05 level, which is less than that of LnMedExp, reflecting wage loss higher probability of opportunistic fraud than medical expense consistent with our hypothesis. Wage loss is easier to falsify than medical expense, leading to greater reluctance by the court to award a wage loss claim, also consistent with Crocker and Tennyson (2002).

The payment coefficient for LnHospiCare is 0.0184 and statistically significant at the 0.01 level, which is less than that of LnMedExp, reflecting hospital care higher fraud probability than medical expense consistent with our hypothesis. Injuries resulting in a hospital stay mean more severe than without hospitalization. The court will regard hospital care expense as necessary, but hospital care expense is easier to exaggerate the claim amount than medical expense because hospital care expense is involved with the revenue, persons, term and level of nursing staff, leading to greater reluctance by the court to award a hospital care expense claim.

The payment coefficient for LnSubseTreat is not statistically significant, meaning the court awards subsequent treatment claim the least and much less than medical expense, reflecting its higher fraud probability than medical expense consistent with our hypothesis. Subsequent treatment expense claim should offer a medical documentation by the hospital or appraisal conclusion by the expert. Subsequent treatment expense is not real medical expense, but potential medical expense in the future, which is hard to be adopted by the court, leading to greater reluctance by the court to award a subsequent treatment expense claim.

The payment coefficient for LnTransporCost is 0.0254 and statistically significant at the 0.01 level, which is less than that of LnMedExp, reflecting transportation cost higher fraud probability than medical expense consistent with our hypothesis. Transportation cost claim should offer bus or ship ticket invoices to have a medical treatment or transfer to other hospitals for medical treatments. It is not hard for the claimant to collect bus or ship ticket invoices which are not actually involved with

medical services if the claimant colludes with the bus or ship tickets provider, leading to greater reluctance by the court to award a transportation cost claim.

The payment coefficient for LnGeneralDamage is 0.0232 and statistically significant at the 0.01 level, which is less than that of LnMedExp, reflecting general damage higher fraud probability than medical expense consistent with our hypothesis. General damage claim should prove the traffic accident injured or the dependents of the dead victim to suffer mental pain and suffering, mental abnormity, or physiological and psychological damage, namely inactive feeling. It is not hard for the claimant to prove the inactive feeling of general damage, but very difficult to prove general damage claim amount consistent with mental anguish suffered by the traffic accident injured or the dead victim' dependents, leading to larger opportunistic fraud probability for the claimant to exaggerate the mental claim amount. In China, the court still considers the area economic environment, identity, family background, accident fault, and social effects etc. of the traffic accident injured, leading to greater reluctance by the court to award general damage claim, consistent with mental anguish not being easily documented (Crocker and Tennyson, 2002; Loughran, 2005).

The payment coefficient for Lndea/ DisaDamage is 0.1756 and statistically significant at the 0.01 level, which is the largest among all claim sub-items, reflecting its more severe injury severity consistent with our hypothesis. In our BICL sample of 406 cases, all disability damage claimants hold IME and all death damage claimants hold death document by the traffic police officer or the hospital, and they can easily prove the suffered injury, hinting lower fraud probability and more severe injury severity, resulting in greater generosity by the court to award a disability or death damage claim, also consistent with death or disability more severe injury severity (Crocker and Tennyson, 2002; Doerpinghaus et al., 2008).

The payment coefficient of victim fault is 0.3027 and statistically significant at the 0.01 level, meaning that victim fault does not affect the court to reduce insurer payment amount significantly contrary to our hypothesis. RTSL classifies the auto accident injured into the motorist and the non-motorist or pedestrian subgroups, and protects the non-motorist or pedestrian more than the motorist. The court considers victim fault directly when the auto injured is also a motorist; but when the auto injured is a non-motorist or pedestrian, the court first considers the injury severity of the auto injured and make the insured injuring motorist undertake no-fault, and then thinks of victim fault secondly. In our BICL sample of 406 cases, there are 338 cases of non-motorist or pedestrian, namely in most conditions the insured injuring motorist first undertakes no-fault, and then the auto injured applies at-fault indirectly, resulting

in victim fault not affecting insurer payment amount negatively. This is our important finding in this paper, also similar to the bad faith liability effect on insurer payments (Tennyson and Warfel, 2010; Asmat and Tennyson 2014).

The payment coefficient for higher policy is 0.3245 and statistically significant at the 0.01 level consistent with our hypothesis. Higher policy gives the auto accident injured larger economic support than lower policy, also similar to Schmit and Yeh (2003).

The payment coefficient for female is -0.0999 and statistically significant at the 0.05 level, meaning the female claimant receives less payment amount than the male consistent with our hypothesis. The female claimant has weaker bargaining power than the male, leading to greater reluctance by the court to a female claimant, also corroborating the gender effect in both fault assignment and claim payment in automobile liability claims（Doerpinghaus et al., 2003, 2008).

The payment coefficient for the youthful is -0.2992 and statistically significant at the 0.05 level, meaning the young claimant receives less payment amount than the middle-aged consistent with our hypothesis. The young claimant has less negotiating experience than the middle-aged, and more importantly, they are less than 18 years old and generally minors or students in school, not existing wage loss, leading to greater reluctance by the court to award a young claimant.

The payment coefficient for attorney is 0.1673 and statistically significant at the 0.01 level, meaning the claimant receives more payment amount with the help of a lawyer than without a lawyer consistent with our hypothesis. Claimant negotiating power can be enhanced significantly if a lawyer is involved because the attorney is more expert in dealing with the legal system, which may lessen a claimant's risk estimate, and provides a buffer that may lessen negotiating costs to the claimant, leading to greater generosity by the court to award a claim with the help of a lawyer, also consistent with David and Tennyson (1992).

The payment coefficient for sprains is -0.7254 and statistically significant at the 0.01 level, meaning the claimant receives less payment amount for sprains than that for non-sprains consistent with our hypothesis. Sprains are relatively more susceptible to fraud, leading to greater reluctance by the court to award a sprain claim, also consistent with Crocker and Tennyson (2002).

But the payment coefficient for elderly*sprains is 0.3055 and statistically significant at the 0.05 level, meaning the court awards the elderly who claims sprains more strongly than the middle-aged who claims sprains contrary to our hypothesis. There is higher fraud probability for sprains, and the elderly has weaker bargaining

power than the middle-aged, if the elderly claims sprains, the court should award the elderly less than the middle-aged who claims sprains. However the 0.3055 payment coefficient for elderly*sprains proves that the elderly's bargaining power is not inferior but superior to the middle-aged. Modern medical condition improves significantly and life expectancy is significantly lengthened, leading to the elderly's bodily function improving greatly and his or her retiring at 60 years old seeming a little earlier than ever. Sprains is lower injury severity, assuring the elderly enough time and energy on sprains claim lawsuits contrasted with the middle-aged who has to work for a living, and finally win the judge sympathy. It is our important finding in this paper, enriching present pure sprains claim and insurance payments literature (Derrig et al., 1994; Tennyson & Salsas-Forn, 2002).

In short, all payment coefficients of economic and non-economic losses claim sub-items are consistent with our hypotheses, hinting opportunistic fraud severity of other economic and non-economic losses claim sub-items except death or disability damage larger than medical expense, but it is hard to sequence the excess claim severity of these claim sub-items because claim amount is not considered.

4.2. Claim Effects on Insurer Fraud Amount

Our main devotion in this paper is to estimate the severity of opportunistic fraud. We consider also total claim amount and measure the opportunistic fraud amount directly, further enriching present unitary insurance payouts literature (Doerpinghaus et al., 2008). We also perform OLS regression for LnInsurerFraud based on model 4, and Table 6 presents results of OLS regression. Similarly, we verify the normality assumption via graphical methods and normality tests see the scatter plot and normal Q-Q plot in Figure 2 (Left) and (Right) respectively, and the results of normality tests in the columns 4 and 5 in Table5. From these results, the normality assumption holds for the dataset.

The fraud coefficient for LnMedExp is -0.0304 and statistically significant at the 0.05 level, and the fraud coefficients of other economic and non-economic losses claim sub-items are larger than that for LnMedExp. The severity of opportunistic fraud sequence of these claim sub-items is as follows: general damage (0.1525) ＞＞ wage loss (0.0567) ＞ death or disability damage (0.0494) ＞ subsequent treatment expense (0.0338) ＞ hospital care expense (0.0256) ＞ transportation cost (0.0196), further the excess claim severity of these claim sub-items can be divided into three levels: general damage is the largest and much larger than the second largest wage loss claim; wage loss and death or disability damage are the second level; subsequent

treatment expense, hospital care expense, and transportation cost are the third level with relatively lower severity of opportunistic fraud.

Table 6 OLS Regression of Dependent and Independent Variable based on 436 Samples

Variable	Estimate	Std.Error	t Statistic	Prob.	
Intercept	5.9531	0.3853	15.4520	0.0000	***
LnMedExp	-0.0304	0.0154	-1.9685	0.0497	**
LnSubseTreat	0.0338	0.0133	2.5371	0.0115	**
LnHospiCare	0.0256	0.0146	1.7502	0.0808	*
LnTransportation	0.0196	0.0186	1.0558	0.2917	
LnWageLoss	0.0567	0.0175	3.2298	0.0013	***
LnDea/DisaDamage	0.0494	0.0126	3.9362	0.0001	***
LnGeneralDamage	0.1525	0.0153	9.9598	0.0000	***
VFault	2.1089	0.2603	8.1002	0.0000	***
NonMotorist	0.3045	0.1360	2.2384	0.0257	**
HigherPolicy	0.2545	0.1213	2.0977	0.0365	**
CFemale	-0.0523	0.0970	0.5392	0.5900	
CYouthful	-0.3185	0.2701	-1.1791	0.2390	
CElderly	-0.0159	0.1704	-0.0933	0.9257	
CUnemployed	0.2831	0.1096	-2.5833	0.0101	**
CMarried	0.0685	0.1347	0.5086	0.6113	
Attorney	0.2808	0.1134	2.4760	0.0137	**
LocationCity	0.6266	0.2372	2.6419	0.0086	***
Sprains	0.0089	0.1515	0.0588	0.9532	
ElderlySprains	0.3444	0.3393	1.0149	0.3108	
R-squared: 0.5998			Adjusted R-squared: 0.5816		
F-statistic: 32.82 on 19 and 416 DF			P-value: < 2.2e-16		

***significant at 0.01; **Significant at 0.05; *Significant at 0.1

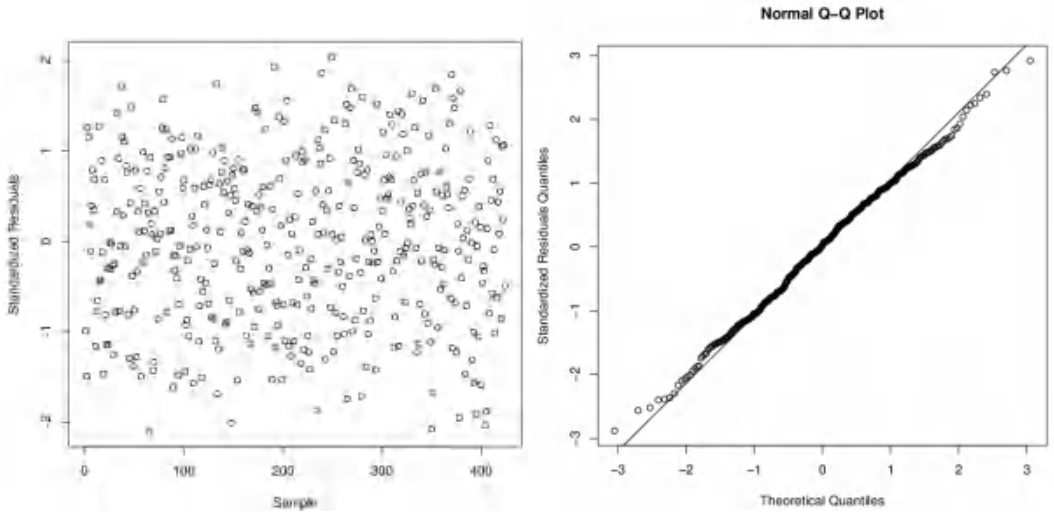


Figure 2 Scatter plot (Left) and Normal Q-Q plot (Right) for Standardized Residual of OLS regression for LnInsurerFraud

The fraud coefficient for LnGeneralDamage is 0.1525 and statistically significant at the 0.01 level, which is the largest, meaning the severity of excess claim for general damage is the most severe among all economic and noneconomic claim sub-items consistent with our hypothesis. Mental anguish such as pain and suffering, losing companionship etc. exists objectively, which is hard to measure in term of money. Short of objective standards, both in death, disability, and non-disability, the claimant can claim general damage, and there is hardly fraud cost. Claimants often neglect the auto accident injured identity, family background, accident fault, and social effects etc., but strongly focus on the auto accident victim and especially the non-motorist or pedestrian role in auto accident, leading to larger claim amount than the court award amount naturally. In addition, mental anguish is not easily documented (Crocker and Tennyson, 2002; Loughran, 2005), and the court awards less general damage than medical expense, further enlarging the difference between total claim and award amount. The 0.0232 payment coefficient for LnGeneralDamage hints its severity of opportunistic fraud larger than medical expense, and its 0.1525 fraud coefficient measures its severity of opportunistic fraud the largest among all economic and non-economic losses claim sub-items directly and more accurately, reflecting its much larger claim amount than the court award amount. There is much larger potential of opportunistic fraud for general damage claim, and it is our most important finding in this paper, also consistent with Crocker and Tennyson (2002) and Loughran (2005).

The 0.0567 fraud coefficient for LnWageLoss is the second largest among all economic and noneconomic losses claim sub-items and statistically significant at the

0.01 level, reflecting the severity of opportunistic fraud for wage loss larger than that for medical expense consistent with our hypothesis. Wage loss is easier to falsify than medical expense, resulting in much larger claim amount for wage loss than for medical expense (Crocker and Tennyson, 2002); the 0.0567 fraud coefficient for LnWageLoss reflects the severity of opportunistic fraud more accurately than its 0.0266 payment coefficient, also consistent with Crocker and Tennyson (2002).

The 0.0494 fraud coefficient for Lndea/ DisaDamage is the third largest among all economic and non-economic losses claim sub-items and statistically significant at the 0.01 level, reflecting the severity of opportunistic fraud for death or disability damage much larger than for medical expense contrary to our hypothesis. The 0.1756 payment coefficient for Lndea/ DisaDamage reflects its lower probability of opportunistic fraud and hints its lower severity of opportunistic fraud because of its more severe injury extent for death or disability, but its more severe injury severity creates the claimant more convincing and reasonable excuse to exaggerate the claim amount, and there exists a larger potential of opportunistic fraud. Death or disability is divided into ten levels from the least to the most severe injury extent, and death or disability damage amount is gradually reduced with the multiplier by 10 percent from level 1 to 10 according to its bodily injury severity. The 0.0494 fraud coefficient for Lndea/ DisaDamage reflects its larger potential of opportunistic fraud more accurately than its 0.1756 payment coefficient, which may emphasize its more severe injury extent but conceal its larger potential of opportunistic fraud. In a word, the largest insurer payment amount but larger insurer fraud amount coexists for death or disability damage claim both because of its more severe injury extent. That is to say, more severe injury extent gives rise to larger potential of opportunistic fraud, and it is our another important finding in this paper.

The 0.0338 fraud coefficient forLnSubseTreat is the fourth largest among all economic and non-economic losses claim sub-items and statistically significant at the 0.05 level, reflecting the severity of opportunistic fraud for subsequent treatment expense larger than for medical expense consistent with our hypothesis. Subsequent treatment expense claim requires medical certificate or expert conclusion, which is hard to be adopted by the court, and even if the court adopts the medical certificate or expert conclusion, there is larger potential of opportunistic fraud for the claimant to claim subsequent treatment expense because it is not present real medical expense, but potential medical expense in the future. The statistically insignificant payment coefficient for LnSubseTreat reflects its higher probability of opportunistic fraud and

hints larger fraud severity than medical expense, and its 0.0338 fraud coefficient measures its severity of opportunistic fraud more accurately.

The 0.0256 fraud coefficient forLnHospiCare is the fifth largest among all economic and non-economic losses claim sub-items and statistically significant at the 0.10 level, reflecting the severity of opportunistic fraud for hospital care expense larger than for medical expense consistent with our hypothesis. Hospital stay means more severe injury than outpatient, and the court will regard hospital care as necessary. But hospital care creates the claimant more reasonable excuse to enlarge hospital care expense claim amount, and there exists larger potential of opportunistic fraud because it is easier to falsify the revenue, persons, term and level of nursing staff. The 0.0256 fraud coefficient for LnHospiCare reflects its severity of opportunistic fraud more accurately than its 0.0184 payment coefficient.

The fraud coefficient for LnTransporCost is not statistically significant, but its severity of opportunistic fraud is still larger than that for medical expense because the fraud coefficient for LnMedExp is -0.0304 and statistically significant at the 0.05 level consistent with our hypothesis. It is easier for the claimant to falsify transportation cost than medical expense, resulting in larger potential of opportunistic fraud for the claimant to inflate transportation cost. The 0.0254 payment coefficient for LnTransporCost reflects its higher probability of opportunistic fraud and hints its larger severity of opportunistic fraud than medical expense, and its statistically insignificant fraud coefficient measures its severity of opportunistic fraud more accurately than its 0.0254 payment coefficient.

The fraud coefficient for victim fault is 2.1089 and statistically significant at the 0.01 level, reflecting victim fault is positively related with its severity of opportunistic fraud consistent with our hypothesis. RTSL protects the auto accident injured, maybe leading to the moral hazard that the claimant focuses on the victim injury severity, but neglects victim fault, seeking higher claim amount with larger fault. The 0.3027 payment coefficient for victim fault can not reflect the negative relationship between victim fault and the court reducing insurer payment amount because the non-motorist and pedestrian accounts for a much larger portion in our sample and the court mainly consider the victim injury extent and then victim fault secondly. But the 2.1089 fraud coefficient measures the moral hazard that the claimant neglects victim fault more accurately.

The fraud coefficient for the non-motorist or pedestrian is 0.3045 and statistically significant at the 0.05 level, reflecting the severity of opportunistic fraud for the non-motorist or pedestrian larger than for the motorist consistent with our hypothesis.

RTSL protects the non-motor driver or pedestrian more than the motorist, maybe inducing the non-motor driver or pedestrian to claim higher amount than the motorist and there exists a larger potential of opportunistic fraud for the non-motor driver or pedestrian. The statistically insignificant payment coefficient for the non-motorist or pedestrian hints there is no radical difference for insurer payment amount between the non-motor driver or pedestrian and the motorist, but its 0.3045 fraud coefficient reflects that its larger potential of opportunistic fraud is mainly because of its higher claim amount.

The fraud coefficient for higher policy is 0.2545 and statistically significant at the 0.05 level, reflecting the severity of opportunistic fraud larger for the higher policy than for the lower policy consistent with our hypothesis. In 2008, CIRC increased bodily injury compensation limit ¥120,000 from ¥58,000, maybe leading to higher claim amount than ever for the same or similar injury. In Table 4 the payment coefficient for higher policy is 0.3245 and statistically significant at the 0.01 level, and in Table 6 the fraud coefficient for higher policy is 0.2545 and statistically significant at the 0.05 level. In a word, larger insurer payment amount and larger insurer fraud amount coexist for higher policy. Namely, higher policy leads to larger potential of opportunistic fraud.

The fraud coefficient for the unemployed is 0.2831 and statistically significant at the 0.05 level, reflecting the severity of opportunistic fraud larger for the unemployed than for the employed consistent with our hypothesis. Unemployed claimants have less opportunity cost, being more ready to spend more time on claim lawsuits for the uncertain award amount because they have little to lose by waiting, also consistent with Cummins and Tennyson (1996).

The fraud coefficient for attorney is 0.2808 and statistically significant at the 0.05 level, reflecting the severity of opportunistic fraud larger with attorney than without attorney consistent with our hypothesis. Claimant negotiating power can be enhanced significantly if a lawyer is involved, meanwhile the lawyer may also encourage the claimant to seek the insurer higher claim amount, and there exists the moral hazard of larger potential of opportunistic fraud. In a word, higher insurer payment amount and larger insurer fraud amount coexist for attorney involvement, and it is also our important finding in this paper consistent with Carroll and Abrahamse (2001) .

The fraud coefficient for city is 0.6266 and statistically significant at the 0.01 level, reflecting the severity of opportunistic fraud larger in urban areas than in rural areas consistent with our hypothesis. There is larger population mobility in urban area than

in rural area, and people in urban area know each other less than that in rural area, leading to larger potential of opportunistic fraud in urban than in rural area.

The fraud coefficient for sprains is not statistically significant, but its payment coefficient is -0.7254 and statistically significant at the 0.01 level, meaning that higher possibility of opportunistic fraud for sprains does not hint larger severity of opportunistic fraud because lower injury severity for sprains limits its potential of opportunistic fraud greatly, leading to its much lower claim amount than non-sprains.

The fraud coefficient for elderly*sprains is not statistically significant, but its payment coefficient is 0.3055 and statistically significant at the 0.05 level, meaning that higher bargaining power for the elderly who claims sprains does not hint larger severity of opportunistic fraud because lower injury severity for sprains restricts the elderly the potential of opportunistic fraud greatly.

In a word, insurer fraud amount reflects the severity of opportunistic fraud more accurately than insurer payment amount, other economic and non-economic losses claim sub-items except medical expense are the distinct estimating factors, and especially general damage and death or disability damage are the most obvious besides the conventional wage loss. RTSL gives rise to moral hazards of neglecting victim fault and focusing on the non-motorist or pedestrian role in auto accident. An attorney can enhance the claimant bargaining power greatly, and meanwhile there exists a larger potential of opportunistic fraud for attorney involvement. The severity of opportunistic fraud for sprains is not obvious because lower injury severity for sprains restricts its potential of opportunistic fraud greatly.

5. Conclusion and Future Research

We propose an empirical model for insurer payment and insurer fraud amount, and conduct the OLS regression based on our survey on the selected 406 normal and 436 excess claim lawsuit cases respectively for auto bodily injury compulsory liability insurance from a Beijing district court in China during 2007-2012. Results of our study suggest that other economic and non-economic losses claim sub-items except medical expense are the significant detecting factors for the severity of opportunistic fraud, yet OLS regression result for insurer fraud amount is more accurate than the OLS regression result for insurer payment amount.

The severity of opportunistic fraud for general damage is the largest among all economic and non-economic losses claim sub-items and much larger than the second largest wage loss claim, being our most important finding in this paper, enriching the

present auto claim fraud literature that general damage amount claimed is not included in the total amount claimed.

The severity of opportunistic fraud for death or disability damage is the third largest among all economic and non-economic losses claim sub-items, being our another important finding in this paper, enriching the present auto claim fraud literature that bodily injury severity is just dummy variable and death or disability is not changed to numerical variable for death or disability damage.

RTSL gives rise to moral hazards of neglecting victim fault and focusing on the non-motorist or pedestrian role in auto accident, enriching the present auto claim fraud literature that either the single law system reform or insurance payments is concerned.

The severity of opportunistic fraud for attorney involvement is larger than that without an attorney, enriching the present auto claim fraud literature that the lawyer enhancing claimant negotiating power and encouraging the victim to inflate the injury extent are mixed.

The severity of opportunistic fraud for sprains is not significant statistically, enriching the present auto claim fraud literature that sprains is either higher fraud probability or lower insurance payments.

Our findings have important policy implications because the present claim fraud literature concerns about lost wages and sprains (Crocker and Tennyson, 2002; Loughran, 2005). Other economic and non-economic losses claim sub-items should also be heeded seriously, especially general damage as well as death or disability damage. The moral hazards of neglecting victim fault and focusing on non-motorist or pedestrian role in auto accident are possibly the unintended results of the RTSL designer. We still should pay attention to the moral hazard of attorney to encourage the claimant to seek higher claim amount.

However, we must be careful in interpreting these results, as we here utilizes a relatively small sample size, which comes from auto bodily injury compulsory liability insurance in China during 2007-2012 instead from a worldwide population. The geographical location may be important, and different results may be found in the different areas. The available data, however, cause us to pause in making in-depth analysis, we encourage future researchers to seek out the similar data from different areas, i.e, Asia, European, or American countries, etc. If such data could be collected, which can be viewed as cluster data, maybe a mixture model will be appropriate and this deserves our further study. In addition, excess claims also exist in other insurances besides auto bodily injury third-party compulsory liability insurance. In the

future, we will continue to survey much more lawsuit data of auto bodily injury third-party compulsory liability insurance and extend the opportunistic fraud severity evaluation to other insurances such as personal accident or health insurance.

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Chapter 3. Property and Liability Insurance

Using DEA to Measure Retention Efficiency of Cross-Strait Non-Life Insurance Companies

CHANG Ya-yin, KAO Tong-liang, CHEN Ying-erh

CHANG Ya-yin
Master
Department of Insurance
Tamkang University
New Taipei City, Taiwan
Mobile: (+886)921010314
Phone: (+886) 2-26215656 ext. 2563, 2564
Email: 143553@mail.tku.edu.tw

KAO Tong-liang*
Associate Professor
Department of Insurance
Tamkang University
New Taipei City, Taiwan
Mobile: (+886)972172361
Phone: (+886) 2-26215656 ext. 2563, 2564
Email: brucekao@mail.tku.edu.tw

CHEN Ying-erh
Assistant Professor
Department of Insurance
Tamkang University
New Taipei City, Taiwan
Mobile: (+886)919013230
Phone: (+886) 2-26215656 ext. 2563, 2564
Email: 143553@mail.tku.edu.tw

Keywords: Non-life insurance Company, Retention, Efficiency, DEA, Tobit regression

Abstract: This study uses the two-stage data envelopment analysis (DEA) method with traditional one-stage DEA method to measure the retention efficiency of cross-strait 36 non-life insurance companies over the period 2008-2013. Findings of this study show that the average retention efficiency of companies in China Taiwan is better than that in Mainland China under the traditional one-stage DEA method. But under the two-stage DEA method, we find that in the second stage, the average retention efficiency of companies in Mainland China is better than that in China Taiwan, although in the first stage, the average marketing efficiency of companies in China Taiwan is better than that in Mainland China. This study further uses Tobit regression model to examine the factors significantly influencing the efficiency above. Seven variables employed to examine the model are time of establishment, written premiums, ratio of college-educated employees, ratio of professional employees, ratio of non-automobile Insurance, financial holding company and ratio of retained premiums. The results reveal that the retention efficiency is significantly influenced by written premiums and ratio of retained premiums, while the marketing efficiency can be influenced by time of establishment and ratio of non-automobile Insurance.

1. 前言

近 10 年来，两岸保险业业务的发展均有不错的表现，尤其大陆保险业伴随着经济的高度发展有相当幅度的业务成长。就 2014 年总保费收入而言，大陆计有 328,440 百万美元保费收入，世界排名第 4，中国台湾计有 95,622 百万美元，世界排名第 11。就 2014 年的保险渗透度言，中国台湾为 18.9，世界排名第一；大陆为 3.2，排名第 44 名，较之 2013 年的渗透度 3.0，排名 49 名，进步了 5 名。就 2014 年的保险密度言，中国台湾为 4,072 美元，排名第 9。大陆为 235 美元，排名第 57，较之 2013 年的第 60 名，进步了 3 名。

台湾地区 2014 年整体保险业保险费收入为 NT$29,033.5 亿元(约 RMB$ 5852 亿元)，其中产险保费收入仅 NT$1,322.2 亿元（约 RMB$266.5 亿元），产寿险保费收入比例为 1:20.96，差异非常大。台湾地区 2014 年整体保险业保险费收入约为 2005 年保费收入 NT$15,762.52 亿元（RMB$3,177.16 亿元）的 1.84 倍。

大陆地区 2014 年总保费收入为人民币 20,234.81 亿元，为 2005 年 4,927.34 亿元的 4.11 倍，保费增长快速。2014 年产险保费收入为 RMB$7,203.38 亿元，寿险保费收入为 RMB$13,031.43 亿元，产寿险保费收入之比例为 1:1.84，可以看出

险保费收入为 RMB$13,031.43 亿元，产寿险保费收入之比例为 1:1.84，可以看出产寿险的发展较为均衡。

若比较两岸 2014 年整体保险费收入，大陆总保费收入约为中国台湾总保费收入的 3.46 倍。若就寿险保费收入言，大陆为中国台湾的 2.33 倍，而就产险保费收入言，则大陆为中国台湾的 27.3 倍，足见大陆产险市场的规模远大于中国台湾的产险市场。

产险公司承保的大量产险业务，同时亦须承负损失的赔偿责任，惟产险公司真正留在手中的业务是自留业，因此各公司在评估其核保利润(underwriting profit)及综合率(combined ratio)时，莫不以自留业务为依归，才能真正呈现产险公司业务经营成果。基于此，本文旨在探讨两岸 36 家产险公司的自留业务绩效，包括台湾地区 14 家产险公司及大陆 22 家产险公司。

本文采用数据报络分析法(Data Envelopment Analysis; DEA)进行效率之评估，并透过 tobit 回归对评估之结果，检验影响两岸产险公司效率值之因素，期能找出关键影响因素，作为产险公司提升其自留效率之参考。

2. 文献回顾

2.1 保险业经营绩效

DEA 是 1978 年由 Charnes, Cooper, Rhodes 三位学者于 European Journal of Operation Research 期刊中，提出的经营效率分析法。而产险业运用 DEA，最早为 Fecher et al.(1993)，运用参数法(随机边界法)及非参数法(数据报络分析法)评估 1984 年至 1989 年法国 84 家寿险业者及 243 家产险业者之生产绩效，研究结果发现，产寿险业之效率值离散程度很大，且效率值和保险公司特性有关，营运规模较大，再保险比率较低的公司，其效率值较高。而 Donni and Fecher(1997)，衡量 OECD 15 家保险公司于 1983 年至 1991 年之生产力和效率，将生产力分为技术进步和效率变动，生产力主要和技术进步有关，且各国保险市场特性和效率水平有关，较高的再保险比率和市占率，其效率值较高。

Noulas et al. (2001) 运用 DEA 衡量 1991 年至 1996 年希腊非寿险业经营之绩效，研究结果显示希腊非寿险业经营非常无效率，且各保险公司效率水平存在很大差异，作者并提出，无效率之保险公司欲继续营运，则降低成本是较为可行的方式。近年有 Cummins and Xie（2008），衡量 1994~2003 年美国产险业者因并购行为对其生产力与效率之影响，结果显示并购可让产险业者公司价值提升，收购公司有较高之收入效率，目标公司亦有较佳之成本配置效能成长。

由上述可知，不同国家，不同环境背景，也会影响其市场特性和效率值间之关系。在过去二十年中，由于获取资料和环境等因素，许多保险业效率研究，局限于特定地区或国家，而 Huang and Eling(2013)则为跨国家之研究，采用投入导向多阶段 DEA，比较 2000 至 2008 年金砖四国(巴西、俄罗斯、印度、中国)产险

业之效率，除了传统可以控制的变量(例如：员工人数、资本、净保费、总投资资产)外，亦将各国环境变量纳入评估 (例如：GDP、存款利率、综合率)，并考虑不同国家的环境因素，研究结果发现环境因素强烈影响保险业经营效率，若消除此因素，印度在纯技术效率部分远低于其他国家，而俄罗斯及中国排名分为第二及第三，巴西则为最有效率。另透过回归分析归纳得知影响产险公司效率因素有资产规模、获利能力、清偿能力与公司股权结构等因素。

相较于国外于1978年提出DEA，国内直到1990年才由高强教授发表于Forest Science 期刊。陈禹廷(2002)运用 DEA 评估 90 年我国 17 家产物保险公司之经营绩效，并针对纯技术相对无效率之产险公司进行差额变量分析，提出产险公司应改善资源分配，使其达到相对有效率。纪琬琪(2003)，运用 DEA 法评估 2001 年台湾地区 24 家产险公司之再保险经营绩效，研究发现具有整体效率的公司有 10 家，但若单就分入或分进业务来看，则仅有 2 家公司有效率。余永赞(2007)评估 2002 年至 2004 年中国大陆本土和外商产险公司效率值，发现外商在技术效率和纯技术效率皆优于本国公司，但规模效率不明显。

黄旭男与高栋梁（2005），将产险业的产出过程分为营销阶段与获利阶段，运用两阶段检视提高对绩效的鉴别力，其研究结果亦指出影响营销效率之因素有外勤人员比率、专业人员比率、自留保费比率、银行存款比率及投资比率等，影响获利效率之因素为公司规模与自留保费比率等。何停好(2006)利用数据报落分析法及修正杜邦方程式，评估中国台湾产险业财务绩效，研究结果发现外商公司财务绩效皆高于本国公司，北美洲为财务绩效最佳之公司，而本国最佳为明台。

近年来有柯文贞(2012)，利用两阶段数据报络分析法衡量 2007 年至 2009 年两岸产险业经营绩效，研究结果发现大陆产险业平均值大于中国台湾，但若细分为两阶段，在营销阶段中国台湾业者效率值大于大陆，而获利阶段则是大陆效率大于中国台湾。另外，回归分析发现，不论以传统一阶段或是分为营销及获利两阶段，影响两岸产险公司经营效率其影响因素均有资产总额，而中国台湾产险业者受市占率、大专人员比率有显著影响。李仪贞(2013)，运用两阶段数据报络分析法，评估中国台湾产险业 2009 年至 2011 年自留业务效率，发现本国产险市场自留阶段效率是成长趋势。而签单保费和公司整体保费自留率对自留效率有显著正影响。

王建伟(2014)，采用投入导向模式评估中国台湾产险业整体经营绩效与个别经营绩效，研究结果发现我国产险业在整体、内部流程、顾客三个构面绩效佳，在平均财务及学习成长构面绩效则较差。此外也发现，我国产险业跨期生产力变动呈现成长趋势，且外部业务员人数与理赔追偿金对于公司整体绩效有显著负影响。

2.2 影响自留额之因素

产险业因承保之风险变异性高，加上近年来巨灾风险之威胁，因此，相当重视风险之移转。通常涉及再保险者，并非原有保险金额之全部，其中原保险人自

己保留的部分，称为自留额，也就是保险公司自行承担之责任额，超过自留部份即安排再保险，将业务分出。至于自留额之多寡，通常依照保险种类、本身财务状况、契约件数、全年保费收入、危险的高低等因素为标准。

Mayers and Smith(1990)，从再保险市场证明公司保险的需求，提出影响再保险之因素有规模大小、业务集中度、地理集中度 、所有权结构、信用评等(A+至C)、险种及是否为子公司或集团成员。

而林文煌 (2002)，提出自留额厘定考虑因素为资本、公积金、特别准备金、未分配盈余、业务量(同质危险保单件数累积越多，越能发挥大数法则)、危险暴露、再保费用与条件和经营策略(因规模小的公司，基于业务需求及管理阶层压力，往往自留额度较高，仅购买较低比例之再保险。规模较大的公司，自留额厘定重点为整体营运利润，平均而言，其自留额度相对较低)。另外，研究结果也显示，长期而言再保比例可适度调降，即自留比例可适度调高，使核保损益更为稳定，产生自留核保利润。

欧金裕(2003)，由于不同部门经理人对于自留有不同的基准看法，因此，分别以股东、核保经理人以及财务管理人不同角度来看待风险自留的差异性，以股东立场，考虑公司资产负债配置和资本投资效益；站在核保经理人的观点，考虑风险组合因素，也就是涵盖愈多个别危险，其累积理赔成本愈接近预期成本；若以财务经理人观点来看，则是考虑公司流动资金，即是否有足够流动资产，应付理赔需求。此外，也考虑到市场费率水平、再保险市场状况、相关法规等外部因素。

詹明华(2008)，则提出下列变量会影响再保险需求：公司规模(规模较大的公司，需额外增加承保能量，再保险需求较大)、总资产报酬率、业务集中度(产险公司越专注于某一险种，越能发挥大数法则，可降低再保险需求)、自留赔款冲击率、财务杠杆、收益波动性及再保险价格。

李珍颖(2012)，分析中国台湾产险业自留决定因素，并从公司本身特定因素及外部总体经济变动两个层面来衡量，研究结果发现资产报酬率、流动比率、业务集中度、投资报酬率、金融控股公司、业务组合与自留比率呈现正相关，其中资产报酬率愈高，表示有更多的能力面临损失冲击和财务压力，因此将提高自留比率以承担风险。而拥有金控背景可以分享集团资源，获得较好之绩效。此外，公司规模、核保风险、市占率对自留比率则有负向影响。

陈芳足(2014)，针对自留额厘订因子进行探讨，并以 OECD 共 30 国之 1999 年至 2008 年之统计数据为样本，分析产险自留比率与影响因子之关联性，研究结果发现外商开放程度愈低，总自留比率愈高，而总资产规模愈大、金融深化度愈高、核保绩效愈佳，则总自留比率愈高。

综上所述，影响自留额之因素可分为财务及业务两大构面，业务方面包含：业务集中度、地理及集中度、经营策略等，财务方面则以资本、总资产报酬率、投资报酬率、收益波动性、再保险价格为主。

3. 评估方法

此处说明本研究使用之实证方法，包含：数据报络分析法（DEA）与 Tobit 回归。

3.1 数据报络分析法（DEA）

3.1.1 评估模式

本研究运用数据报络分析法(Data Envelopment Analysis, DEA)探讨产险公司之经营绩效，此法不需假设任何函数即可将多项投入与产出变量汇总成单一具整体效率的指标，DEA 又可分为投入导向和产出导向，投入导向探讨决策单位是否已经投入极少化从事生产，产出导向则探讨是否以产出极大化从事生产，本研究采用产出导向的 DEA 模式，探讨中国台湾 13 家本土产险公司，在目前的相同投入水平下，产出多少方属有效。

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DEA 中以 CCR 和 BCC 被学界公认为是此领域中最具影响力的两个模式，由于 CCR 模式与 BCC 模式之差异仅是规模报酬为固定或变动之假设，以下先就产出导向 CCR 模式说明，再导引至 BCC 模式。CCR 产出模式系假设有 N 个受评单位（DMU），X_{ik}表示第 k 个 DMU 的第 i 个投入项，Y_{rk}表示第 k 个 DMU 的第 r 个产出项，每个 DMU 均使用 m 种投入，而生产 s 种产出，则第 k 个 DMU 的效率可由以下数学线性规划模式求得。

$$Min \frac{1}{g_k} = \sum_{i=1}^{m} v_i X_{ik} \qquad \text{模式(1)}$$

$$\text{s.t.:}$$

$$\sum_{r=1}^{s} u_r Y_{rk} = 1$$

$$\sum_{i=1}^{m} v_i X_{ij} - \sum_{r=1}^{s} u_r Y_{rj} \geq 0, \ j = 1, \ldots, n$$

$$u_r, v_i \geq \varepsilon > 0, \quad r = 1, \ldots, s, \quad i = 1, \ldots, m$$

而其中 $1/g_k$ 为第 k 个 DMU 的相对效率值，u_r, v_i分别代表第 r 个产出项与第 i 个投入项之权重，n 为受评单位之个数，m 为投入因子之个数，r 为产出项之个数，ε为一极小之正值。各 DMU 的效率值界在 0~1 间，最具效率者的效率值＝1。

若在 CCR 模式（1）中加一项v_0，即为 BCC 模式，v_0可用以判定在产出观点

下，受评单位所处规模报酬的位置，当v_0< 0 时，属规模报酬递增，当其值为 0，属规模报酬不变，当v_0> 0 时，属规模报酬递减。与模式(1)对应之 BCC 原模式则可以下式表示：

$$Min\ \frac{1}{g_k} = \sum_{i=1}^{m} v_i X_{ik} + v_0$$ 模式(2)

$$s.t.:$$

$$\sum_{r=1}^{s} u_r Y_{rk} = 1$$

$$\sum_{i=1}^{m} v_i X_{ij} - \sum_{r=1}^{s} u_r Y_{rj} + v_0 \geq 0, \quad j = 1, \ldots, n$$

$$u_r, v_i \geq \varepsilon > 0, \quad r = 1, \ldots, s, \quad i = 1, \ldots, m$$ v_0无正负限制

在 CCR 模式所求得的生产效率是在固定规模假设下之总效率，但 BCC 模式求得的是纯技术效率，若将 CCR 模式求得的效率值除以 BCC 模式求得的效率值，即可获得受评公司的规模效率。

3.1.2 投入产出变量及数据

产险业的生产过程中，可分为业务活动及投资活动两部分，业务活动中主要系透过业务营销或招揽获取保费收入，营销是否成功，一般使用的衡量指标是以保费收入的成长来决定，接着再透过核保、理赔流程以及再保险安排获取核保利润

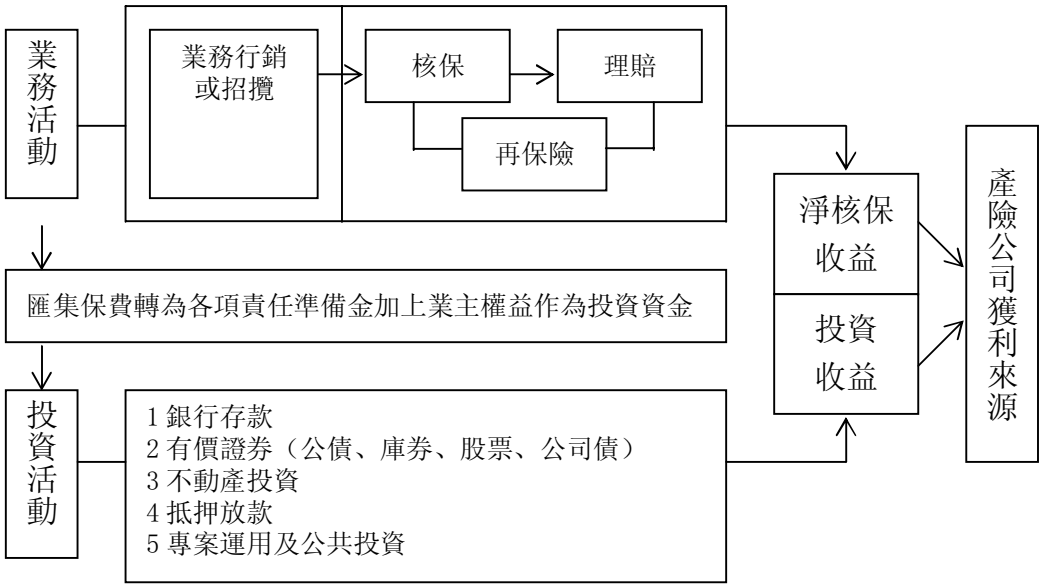


图 3-1 产险公司生产活动及过程

在本文中，我们共分为一阶段及两阶段数据报络分析法，两阶段数据报络分析法中，首先以产险业最主要的投入因素，即营业管理费用和佣金承保费用做为投入变量，以上皆为签单营销过程中所必须投入之成本；而产出变量则是采用保

险公司签发保单所获取之签单保费以及保险业为分散风险，将部份业务分出，再保险公司所获取之再保费收入为产出变数。接着第二阶段再以保险公司实际留在公司内部之自留核保收益及因有再保安排而可获得之再保佣金收入为产出变数，并以签单保费入和再保费收入为投入变量，此为两阶段二投入与二产出之采用变量，至于一阶段数据报络分析法则是将中间的变量删除，直接将营管及佣承费用当成投入变量，自留核保收益和再保佣金收入当作产出变量，相关变量之选取如下：

表 3-1 投入与产出变量说明

		变量名称	说明
第一阶段	投入	营业管理费用	营业费用及其他营业成本
		佣金承保费用	佣金费用：招揽业务所支出费用 承保费用：承保业务时所支付的各项费用
	产出	签单保费收入	即保险公司承保业务所收取之费用
		再保费收入	原保险公司为分散风险，而将业务分出予其他保险公司时，所缴之保费。
第二阶段	投入	签单保费收入	同上
		再保费收入	同上
	产出	自留核保收益	自留保费-自留赔款 ＝（签单保费＋再保费收入－再保费支出）－（签单赔款＋再保赔款－再保摊回款）
		再保佣金收入	产险公司因再保分出而获得之佣金收入。

由下表可知营业管理费用及佣金承保费用在金融海啸期间呈现较少情形，而签单保费收入，亦相对呈现下降情形，此一现象表示各公司在金融海啸期间，对于营运费用的管控较为严格，公司所承保之业务收入亦不如以往。此外，自留核保利益除了在 2009 年及 2010 年呈现下滑现象外，基本上是上升趋势；再保佣金收入则大致上呈现下滑情形。

表 3-2 各年度之投入产出变量总额 单位：新台币千元

年度	营管费用	佣承费用	签单保费收入	再保费收入	自留核保利益	再保佣金收入
2008	22,018,473	14,233,033	104,360,949	8,047,472	35,637,227	7,299,661
2009	21,992,117	12,470,532	100,649,307	7,371,304	33,930,775	6,535,573
2010	22,213,231	12,855,963	103,504,473	6,020,248	32,281,002	5,679,468
2011	22,872,222	13,631,315	110,517,810	5,546,598	35,492,571	6,274,489
2012	23,774,420	14,433,012	117,822,071	6,213,923	38,080,795	6,066,315

2013	25,538,904	15,026,648	122,273,014	6,192,127	42,702,609	5,844,336

若将投入产出资料，进一步加以检验，作相关系数分析，如表 4-3 所示，可知各投入及产出变量间，均具正相关，符合了进行 DEA 研究必须符合之等幅扩张性(isotonicity)的原则，亦即增加某项投入时不应导致某项产出减少，若投入与产出项之间的正向相关性不高时，应将此变数予以删除。由此也可以知道，上述的投入变量以及产出变量的选取并无不当。

表 3-3 各年度之投入产出变量相关系数分析

	营管费用	佣承费用	签单保费收入	再保费收入	自留核保利益	再保佣金收入
营管费用	1					
佣承费用	0.9998	1				
签单保费收入	0.9995	0.9997	1			
再保费收入	0.9998	0.9998	0.9998	1		
自留核保利益	0.9999	0.9998	0.9998	0.9999	1	
再保佣金收入	0.9995	0.9995	0.9989	0.9994	0.9995	1

3.2 回归模型

本文为更深入探讨影响各产险公司分保效益优劣之因素，以 Tobit 回归模型进行分析。由于 DEA 模型估算出的效率值介于区间(0, 1)之间，且有些集中在上界部分，因此，采用普通最小平方回归模型并不适合，而改采 Tobit 回归以处理效率值在 1 截断之情形较为合适。

3.2.1 中国台湾产险公司的回归模型

$$EFF_i = b_0 + b_1 X_{i1} + b_2 X_{i2} + \ldots + b_7 X_{i7} + \varepsilon_i$$

其中 $i = 1, \cdots, 14$，EFF_i 分别表 14 家中国台湾产险公司之营销阶段效率值、及自留阶段之效率值，$X_{i1}, \cdots, X_{i7}$ 表各项回归自变数，b_0 为截距，$b_1, \cdots, b_7$ 表回归系数，ε_i 表随机误差项。应变量采用 14 家产险公司营销与自留之效率值。自变量之采用，则如下说明：

(1) 学士以上占率：学士以上人数除以员工总人数，将专科以下学历排除，衡量教育程度高低对效率之影响，教育程度对于公司经营应占有举足轻重的地位。
(2) 专业人员比重：保险为无形商品，其专业人员，包含核保、理赔以及精算等方面是公司重要的资产，包含前端的危险选择、费率厘订到发生保险事故之赔案处理等方面，员工之专业素质愈高对于业务质量之控管应较佳。
(3) 资产规模：保险公司资产规模会影响风险的承担能力，可运用的资源也相对较多，资产规模较大的公司，其经营效率应较规模小的公司佳。

(4) 签单保费市占率：签单保费占整体市场的比重，比率愈高表示公司之业务愈多，愈容易达到大数法则之危险平均，公司业务质量应较佳。

(5) 保费自留比率：即自留保费除以签单保费和再保费收入之和，其中自留保费为签单保费加再保费收入减再保费支出，表示公司本业经营之最终成果。

(6) 是否为金控背景：本研究采用虚拟变量，即 0 与 1 来区分，拥有金控背景的公司，集团内有较多资源，若妥善运用，对于公司经营层面应有正面影响。

(7) 车险赔款率：车险业务比重约占整体业务五成，为作主要之险种，因此以此变量衡量赔款率之高低对于公司经营效率之影响，应有其意义。

3.2.2 大陆产险公司的回归模型

$$EFF_i = b_0 + b_1 X_{i1} + b_2 X_{i2} + ... + b_7 X_{i7} + \varepsilon_i$$

其中 $i = 1,\ldots,22$，EFF_i 分别表 22 家大陆产险公司之营销阶段效率值、及自留阶段之效率值，$X_{i1},\ldots,X_{i7}$ 表各项回归自变数，b_0 为截距，$b_1,\ldots, b_7$ 表回归系数，ε_i 表随机误差项。应变量采用 22 家产险公司营销与自留之效率值。自变量之采用，如下说明：

(1) 学士以上占率：学士以上人数除以员工总人数。表示公司内部拥有大学学历以上的比例，教育程度愈高，对公司的经营及发展，应有正面影响。

(2) 中级以上专业人员比重：中级加高级专业人员人数除以员工总人数。表示公司内部具有核保、理赔、精算等中级以上专业人才之比例，比例愈高，保险从业人员素质及竞争力愈高，尤其保险为无形商品，专业人员比例应对公司业务质量控管有正向影响。

(3) 高级以上专业人员比重：高级专业人员人数除以员工总人数。表示公司内部具有核保、理赔、精算等高级专业人才之比例，比例愈高，保险从业人员素质及竞争力愈高，尤其保险为无形商品，专业人员比例应对公司业务质量控管有正向影响。

(4) 业务规模：亦即签单保费，业务规模愈大表示公司所承保之业务愈多，但并不代表公司之利润多寡。

(5) 自留保费：签单保费加再保费收入减再保费支出，比率愈高表示保险公司自行承担之责任额愈高，亦可看出其承担风险之能量。

(6) 成立时间长短：采用虚拟变数，0 为 10 年以下，1 为 10 年以上。大陆产险业有历史悠久的公司，近年来随着市场开放，亦有许多新成立的产险公司，历史悠久的公司，在市场地位、品牌及资本等方面应较具有竞争优势。因此，用此自变量来评估是否会影响公司经营效率。

(7) 非车险比重：非车险保费占总保费的比重，因非车险业务如企财险、工程险等之保险金额变异甚大，依赖再保险程度较大。大陆产险业非车险比重约占三成，用此变量评估车险或非车险的业务对于公司分保效率影响较显著。

4. 实证结果分析

4.1. 两岸共同评估之结果

4.1.1 一阶段数据报络分析法

若以中国台湾及大陆产险业者共同评估效率值，亦即 2008 年至 2013 年中国台湾 14 家及大陆 22 家，共 36 家产险公司 216 个受评单位，视为一体进行效率值分析，可以发现中国信保(0.968)效率值仍远高于其他业者，且高于第二名的华南(0.655)及泰安(0.608)幅度相当大。此外，就整体效率值而言，中国台湾产险业者效率值普遍皆高于大陆产险业者。若就各别年度观之，2011 年除中国信保外，台寿保亦为相对有效率之公司，而 2012 年明台达相对有效率。

表 4-1 中国台湾及大陆各产险公司传统一阶段 DEA 之效率值

DMU	公司名称	2008	2009	2010	2011	2012	2013	平均
1	台产	0.532	0.354	0.328	0.335	0.351	0.313	0.369
2	中国	0.704	0.618	0.568	0.508	0.534	0.499	0.572
3	富邦	0.343	0.324	0.248	0.25	0.228	0.235	0.271
4	苏黎世	0.18	0.171	0.151	0.152	0.149	0.136	0.157
5	泰安	0.596	0.624	0.576	0.641	0.645	0.563	0.608
6	明台	0.827	0.59	0.341	0.301	1	0.353	0.569
7	美亚	0.242	0.316	0.381	0.435	0.347	0.284	0.334
8	第一	0.401	0.349	0.27	0.343	0.272	0.278	0.319
9	旺旺友联	0.515	0.497	0.52	0.729	0.708	0.662	0.605
10	新光	0.511	0.405	0.364	0.42	0.378	0.298	0.396
11	华南	0.747	0.742	0.62	0.632	0.567	0.619	0.655
12	国泰世纪	0.187	0.171	0.161	0.163	0.169	0.169	0.170
13	新安东京	0.259	0.255	0.25	0.257	0.242	0.262	0.254
14	台寿保	0.142	0.196	0.533	1	0.7	0.974	0.591
15	人保	0.292	0.378	0.292	0.435	0.284	0.251	0.322
16	国寿	0.298	0.223	0.298	0.248	0.232	0.24	0.257
17	大地	0.249	0.354	0.249	0.207	0.185	0.183	0.238
18	太平	0.178	0.185	0.178	0.166	0.288	0.238	0.206
19	中国信保	1	1	1	1	0.923	0.884	0.968
20	阳光财险	0.252	0.175	0.252	0.065	0.152	0.164	0.177
21	太保	0.369	0.363	0.369	0.342	0.286	0.329	0.343
22	平安	0.303	0.265	0.303	0.28	0.24	0.28	0.279
23	华泰	0.311	0.23	0.311	0.691	0.326	0.352	0.393
24	天安	0.292	0.135	0.292	0.544	0.313	0.155	0.395
25	永安	0.158	0.13	0.158	0.174	0.157	0.14	0.387
26	永诚	0.32	0.422	0.32	0.514	0.369	0.274	0.392

27	安信农险	0.538	0.219	0.538	0.135	0.118	0.19	0.402
28	安华农险	0.219	0.161	0.219	0.259	0.166	0.198	0.393
29	天平汽车	0.438	0.33	0.438	0.277	0.281	0.184	0.385
30	阳光农险	0.289	0.161	0.289	0.525	0.408	0.071	0.387
31	渤海	0.111	0.125	0.111	0.131	0.108	0.133	0.391
32	都邦	0.139	0.156	0.139	0.135	0.117	0.145	0.381
33	华农	0.084	0.13	0.084	0.14	0.149	0.183	0.380
34	民安	0.163	0.14	0.163	0.29	0.211	0.152	0.368
35	安诚	0.202	0.218	0.202	0.16	0.207	0.153	0.377
36	中银	0.217	0.179	0.217	0.223	0.235	0.317	0.382
中国台湾平均值		0.441	0.400	0.379	0.440	0.449	0.403	0.419
大陆平均值		0.292	0.258	0.292	0.316	0.262	0.237	0.373
相对有效率家数		1	1	1	2	1	0	

4.1.2　两阶段数据报络分析法

4.1.2.1 第一阶段－营销效率阶段

就两阶段数据报络分析法营销效率方面，两岸整体而言中国信保仍为效率最佳的　公司，其次为中国台湾的明台产险，进一步可以发现，整体来看中国台湾营销效率值皆高于大陆地区，效率值离散程度较大，中国台湾则是产险公司间效率值差异幅度没有大陆那么悬殊。

此外，中国台湾显然受到 2008 年金融海啸之影响，至 2012 年才逐步回升，而大陆或许幅员广大市场尚在起飞阶段，即使历经金融海啸之冲击，营销效率方面仍持续往上成长。

表 4-2 中国台湾及大陆各产险公司两阶段 DEA 之营销效率值

DMU	公司名称	2008	2009	2010	2011	2012	2013	平均
1	台产	0.493	0.364	0.414	0.469	0.475	0.465	0.447
2	中国	0.57	0.531	0.512	0.488	0.504	0.493	0.516
3	富邦	0.435	0.428	0.396	0.408	0.412	0.422	0.417
4	苏黎世	0.242	0.265	0.241	0.245	0.249	0.214	0.243
5	泰安	0.432	0.563	0.495	0.519	0.538	0.483	0.505
6	明台	0.467	0.388	0.39	0.406	1	0.891	0.590
7	美亚	0.256	0.222	0.276	0.307	0.149	0.14	0.225
8	第一	0.487	0.454	0.44	0.464	0.456	0.448	0.458
9	旺旺友联	0.433	0.421	0.395	0.379	0.439	0.428	0.416
10	新光	0.496	0.439	0.438	0.457	0.477	0.458	0.461
11	华南	0.484	0.491	0.491	0.49	0.508	0.474	0.490
12	国泰世纪	0.354	0.329	0.339	0.338	0.342	0.33	0.339

13	新安东京	0.432	0.429	0.437	0.453	0.437	0.424	0.435
14	台寿保	0.236	0.296	0.309	0.341	0.306	0.357	0.308
15	人保	0.291	0.432	0.418	0.468	0.36	0.337	0.384
16	国寿	0.157	0.301	0.32	0.314	0.313	0.352	0.293
17	大地	0.244	0.573	0.339	0.319	0.295	0.314	0.347
18	太平	0.193	0.242	0.235	0.248	0.282	0.262	0.244
19	中国信保	0.37	1	0.943	1	1	0.807	0.853
20	阳光财险	0.154	0.249	0.299	0.282	0.254	0.266	0.251
21	太保	0.2	0.313	0.349	0.396	0.334	0.35	0.324
22	平安	0.164	0.343	0.364	0.376	0.301	0.344	0.315
23	华泰	0.178	0.242	0.261	0.724	0.266	0.311	0.330
24	天安	0.231	0.271	0.275	0.346	0.257	0.27	0.275
25	永安	0.284	0.287	0.286	0.273	0.251	0.251	0.272
26	永诚	0.158	0.282	0.31	0.451	0.261	0.258	0.287
27	安信农险	0.741	0.283	0.97	0.264	0.256	0.303	0.470
28	安华农险	0.235	0.41	0.35	0.396	0.291	0.278	0.327
29	天平汽车	0.155	0.383	0.421	0.373	0.286	0.264	0.314
30	阳光农险	0.718	0.474	0.626	0.584	0.57	0.554	0.588
31	渤海	0.254	0.173	0.201	0.22	0.201	0.214	0.211
32	都邦	0.26	0.231	0.234	0.234	0.215	0.218	0.232
33	华农	0.143	0.144	0.141	0.182	0.193	0.224	0.171
34	民安	0.12	0.192	0.197	0.256	0.221	0.231	0.203
35	安诚	0.127	0.263	0.272	0.267	0.312	0.223	0.244
36	中银	0.199	0.261	0.282	0.32	0.259	0.363	0.281
中国台湾平均值		0.416	0.401	0.398	0.412	0.449	0.431	0.417
大陆平均值		0.253	0.334	0.368	0.377	0.317	0.318	0.27
相对有效率家数		0	1	0	1	2	0	

4.1.2.2 第二阶段－自留效率阶段

就两岸两阶段数据报络分析法营销效率方面，整体而言中国信保仍表险亮眼，而台寿保则排名第二。就整体效率值来看，显然受到金融海啸之影响。由于自留效率的估算，须等待年度结束后才得以估算，故在时间上落后一年以上应属正常。因金融海啸爆发时间在 2008 年 9 月，延续了一年多，故影响效果呈现在 2010 年，应属合理。而整体效率方面，大陆则是整体平均值高于中国台湾

表 4-3 中国台湾及大陆各产险公司两阶段 DEA 之自留效率值

DMU	公司名称	2008	2009	2010	2011	2012	2013	平均
1	台产	0.374	0.337	0.273	0.242	0.251	0.248	0.288

2	中国	0.475	0.427	0.403	0.377	0.385	0.359	0.404
3	富邦	0.273	0.265	0.262	0.25	0.243	0.263	0.259
4	苏黎世	0.38	0.304	0.313	0.302	0.307	0.328	0.322
5	泰安	0.458	0.374	0.39	0.41	0.4	0.392	0.404
6	明台	0.602	0.522	0.292	0.247	0.148	0.129	0.323
7	美亚	0.353	0.509	0.501	0.522	0.934	0.855	0.612
8	第一	0.283	0.263	0.214	0.245	0.211	0.219	0.239
9	旺旺友联	0.44	0.42	0.447	0.661	0.547	0.518	0.506
10	新光	0.35	0.308	0.275	0.303	0.262	0.242	0.290
11	华南	0.523	0.511	0.426	0.429	0.372	0.432	0.449
12	国泰世纪	0.264	0.262	0.205	0.237	0.242	0.249	0.243
13	新安东京	0.29	0.285	0.271	0.268	0.261	0.293	0.278
14	台寿保	0.286	0.383	0.6	1	0.767	0.928	0.661
15	人保	0.474	0.29	0.33	0.377	0.278	0.254	0.334
16	国寿	0.666	0.293	0.328	0.39	0.378	0.354	0.402
17	大地	0.482	0.29	0.347	0.293	0.251	0.275	0.323
18	太平	0.405	0.298	0.332	0.321	0.348	0.335	0.340
19	中国信保	1	0.707	1	0.599	0.36	0.36	0.671
20	阳光财险	0.781	0.346	0.411	0.079	0.287	0.301	0.368
21	太保	0.62	0.4	0.356	0.344	0.284	0.321	0.388
22	平安	0.87	0.364	0.393	0.353	0.275	0.297	0.425
23	华泰	0.585	0.332	0.398	0.39	0.404	0.388	0.416
24	天安	0.823	0.244	0.823	0.616	0.412	0.273	0.532
25	永安	0.291	0.234	0.263	0.313	0.3	0.266	0.278
26	永诚	0.681	0.496	0.347	0.583	0.495	0.36	0.494
27	安信农险	0.347	0.367	0.265	0.257	0.253	0.343	0.305
28	安华农险	0.515	0.189	0.348	0.275	0.313	0.272	0.319
29	天平汽车	1	0.466	0.425	0.366	0.44	0.545	0.540
30	阳光农险	0.222	0.187	0.254	0.45	0.395	0.052	0.260
31	渤海	0.206	0.238	0.228	0.302	0.293	0.297	0.261
32	都邦	0.469	0.36	0.326	0.281	0.299	0.342	0.346
33	华农	0.196	0.307	0.204	0.379	0.399	0.389	0.312
34	民安	0.524	0.348	0.319	0.446	0.312	0.316	0.378
35	安诚	0.764	0.392	0.356	0.289	0.321	0.331	0.409
36	中银	0.455	0.272	0.321	0.322	0.314	0.412	0.349
中国台湾平均值		0.382	0.369	0.348	0.392	0.381	0.390	0.377
大陆平均值		0.563	0.337	0.381	0.365	0.337	0.322	0.384

整体平均值	0.492	0.350	0.368	0.376	0.354	0.348	0.381

4.2 影响两岸产险业相对效率之因素

本节运用中国台湾 14 家及大陆 22 家产险公司，于 2008 年至 2013 年之营销效率及自留效率为应变量，并检视不同自变量对于其效率值之影响。

4.2.1 台湾地区之产险公司

4.2.1.1 影响营销阶段之因素

由下表可知，就营销效率阶段而言，学士以上占率(X1)、是否为金控背景(X4)、车险赔款率(X5)、签单保费(X6)，对于公司效率值有正影响，以本研究所选取之相关变量来看，学士以上占率愈高，表示公司内部员工有一定的教育程度，对于了解与营销商品层面有正面帮助，而签单保费规模愈大，公司于整体市场的承保的业务已达一定规模，具规模经济，对于品牌知名度有正面帮助，中国台湾产险市场中车险为占比最高之险种，消费者购买保险目的也就是希望保险事故发生时能获取金钱上补偿，若理赔适当地从宽，民众对于保险公司口碑以及后续之业务推广方面有正向影响。此外，拥有金控背景的公司，其资源较多，亦可以透过交叉营销与数据之交互运用，于不同通路上贩卖商品并提供顾客差异化的服务，有助其营销效率之提升。

至于专业人员比重(X2)、资产规模(X3)、整体保费自留比率(X5)对于营销阶段效率值则有负影响，因专业人员比重系指核保、理赔以及精算方面之专业人才，较属于商品设计层面及后续之赔款方面，对于前端之销售人员并无正影响。而自留保费为保险业自行承担之责任额，整体自行承担之保费愈高，必须对相关费用之控管更为谨慎，此结果亦显示中国台湾产险业者对于费用之控管与其相对所收取之保费间是否对价平衡，仍有相当大的进步空间。

表 4-4 影响中国台湾营销阶段效率之因素

变数	参数估计	显著性
R 平方 0.519138，调整后 R 平方 0.04187		
Intercept	0.941456	0.071479
学士以上占率(X1)	0.172437	0.809648
专业人员比重(X2)	-2.07489	0.09872
资产规模(X3)	-1.7E-08	0.18395
是否为金控背景((X4)	0.050507	0.6784
车险赔款率(X5)	2.52934	0.065436
签单保费(X6)	6.25E-08	0.154595
整体保费自留率(X7)	-3.60316	0.06625

4.2.1.2 影响自留阶段之因素

专业人员比重(X2)、整体保费自留比率(X5)、资产规模(X3)、对于自留阶段

效率值为正影响，公司整体员工素质，包含专业人员比例愈高，表示业务质量控管愈佳，其自留效率亦愈高。公司整体保费自留比率愈高，其自留之保费愈高，若加上核保人员良好的危险选择，其自留核保收益较佳。而资产规模愈大，表示公司拥有较丰厚之资源可运用，若妥善运用，其自留效率亦应较佳。

由下表亦可知道，学士以上占率(X1) 、车险赔款率(X3)、签单保费(X7)对于自留效率值为负面影响，近年来各公司拥有大学以上学历之人员比重皆相当高，但对于公司业务选择及费用控管并无正影响，仍须仰赖专业人员，其对于公司的营运、策略拟定等方面扮演相当关键的角色。此外车险为最大宗之险种，其赔款率愈高，当然自留效率亦应愈差。

表 4-5 影响中国台湾自留阶段效率之因素

变数	参数估计	显著性
R 平方 0.532701，调整后 R 平方 0.132159		
Intercept	0.052372	0.931269
学士以上占率(X1)	-0.02242	0.981165
专业人员比重(X2)	3.275887	0.051589
车险赔款率(X3)	-3.80182	0.035837
整体保费自留比率(X5)	5.075719	0.041278
资产规模(X6)	7.44E-09	0.648398
签单保费(X7)	-3.4E-08	0.524065

4.2.2 大陆地区产险公司

4.2.2.1 影响营销阶段之因素

成立时间长短(X1)、签单保费(X2)、学士以上占率(X3)、非车险比重(X5)、是否为金控(X6)对于大陆产险业者之营销效率有正影响，成立时间愈长的公司，其市场利基与地位具有优势，而学士以上比重愈高，表公司内部人员拥有一定的教育程度。此外，亦发现非车险比重愈高，其公司营销效率愈佳，即车险比重愈高，营销效率愈差，因此，增加非车险业务占公司整体业务的比重，对于公司业务之拓展有显著正影响。此外，拥有金控背景的公司，其资源较多，亦可以透过交叉营销与数据之交互运用，于不同通路上贩卖商品并提供顾客差异化的服务，有助其营销效率之提升。而高级以上专业人员比重(X5)、整体保费自留率(X7)比重愈高，其营销效率值愈低，由此可见专业人员比重与营销效率值间并无正相关。

表 4-6 影响大陆营销阶段效率之因素

变数	参数估计	显著性
R 平方 0.759189，调整后 R 平方 0.638783		
Intercept	0.127087	0.09725
成立时间长短(X1)	0.029462	0.560373
签单保费(X2)	8.75E-07	0.933698

学士以上占率(X3)	0.087131	0.616858
专业人员比重(X4)	-0.11998	0.626893
非车险比重(X5)	0.472295	0.002817
是否为金控(X6)	0.02209	0.699057
整体保费自留率(X7)	-1.3E-07	0.98864

数据源：本研究自行整理

4.2.2.2 影响自留阶段之因素

影响大陆自留阶段效率值较显著的为非车险比重(X5)，与中国台湾不同的是大陆非车险比重愈高，其效率值较差。

表 4-7 影响大陆自留阶段效率之因素

变数	参数估计	显著性
R 平方 0.895599，调整后 R 平方 0.843399		
Intercept	0.227812	1.12E-06
成立时间长短(X1)	-0.01822	0.361986
签单保费(X2)	1.13E-05	0.014336
学士以上占率(X3)	0.509934	2.3E-06
专业人员比重(X4)	-0.09092	0.352331
非车险比重(X5)	-0.26238	0.000153
是否为金控(X6)	0.010405	0.6422
整体保费自留率(X7)	-1E-05	0.011677

数据源：本研究自行整理

4.2.3 中国台湾及大陆同时影响因素

4.2.3.1 影响营销阶段之因素

若将两岸数据视为一期共同评估可以发现，成立时间长短(X1)、签单保费(X2)、学士以上占率(X3)、专业人员比重(X4)、非车险比重(X5)对于营销阶段效率有正面影响。此外，亦发现不论将中国台湾与大陆资料分别进行分析，或站在同一基准点共同来看，皆可发现签单保费、学士以上占率、非车险比重对于营销阶段效率都有正面影响。而非车险比重为影响最为显著之因素，亦即车险比重愈高，其公司营销效率值则愈差。

表 4-8 影响中国台湾与大陆地区营销阶段效率之因素

变数	参数估计	显著性
R 平方 0.612189，调整后 R 平方 0.515237		
Intercept	0.147849	0.015942
成立时间长短(X1)	0.079953	0.09292
签单保费(X2)	6.29E-08	0.111203

学士以上占率(X3)	0.02338	0.849085
专业人员比重(X4)	0.034093	0.853534
非车险比重(X5)	0.372858	0.000618
是否为金控(X6)	-0.00429	0.911654
整体保费自留率(X7)	-7.2E-08	0.166464

数据源：本研究自行整理

4.2.3.2 影响自留阶段之因素

签单保费(X2)、学士以上占率(X3)、非车险比重(X5) 对于自留阶段效率有正面影响，此外亦发现，不论分别分析中国台湾与大陆产险业，或将两岸视为一个整体共同进行评估，皆可发现签单保费与整体保费自留率为影响较为显著之因素。若从两岸整体角度来看，签单保费愈高的公司，愈容易达到规模经济。

表 4-9 影响中国台湾与大陆地区自留阶段效率之因素

变数	参数估计	显著性
R 平方 0.284666，调整后 R 平方 0.105832		
Intercept	0.367189	4.01E-06
成立时间长短(X1)	-0.02784	0.59161
签单保费(X2)	9.06E-08	0.04274
学士以上占率(X3)	0.154031	0.266488
专业人员比重((X4)	-0.09986	0.628607
非车险比重(X5)	0.029108	0.789339
是否为金控(X6)	-0.0183	0.671544
整体保费自留率(X7)	-1.2E-07	0.035786

数据源：本研究自行整理

4.3 管理意涵

就上述评估分析，将营销效率与自留效率作组合，可以发现有些公司营销效率与自留效皆佳，有的公司营销效率佳但自留效率较差，有的公司营销效率较差但自留效率则较佳，亦有公司两种效率不佳者。这些不同组合的公司应可采取下列方式改善其营销效率或自留效率。

(1) 营销效率佳且自留效率亦佳者：此类型公司，营销与自留两阶段效率值皆高于同业，可随时根据市场变化与公司业务发展状况，调整其经营政策与营业方针，维持其在同业中拥有之优势。尤其中国信保在两阶段效率值皆远高于同业，值得其他业者学习。

(2) 营销效率较差自留效率佳者：此类型公司，自留阶段效率值皆高于同业，可维持其优势，同时提升营销效率的部分。代表公司对于业务之推广绩效不佳，但其所承保之业务质量皆优于同业。应加强通路推广，赚取保费收入，或降

低营业成本并控管相关费用之支出。

(3) 营销效率佳但自留效率较差者：此类型公司营销效率在同业中为相对有效率，可维持其优势，但自留效率值仍有相当大的改善空间。代表公司业务拓展速度太快，并没有谨慎选择承保之业务，造成自留业务之质量不佳。应提高自留核保收益，无论是增加保费收入或对于业务之选择更为谨慎，应调整公司经营方针，加强本业经营之效率。

(4) 营销效率自留效率均较差者：此类型公司营销与自留两阶段效率值皆低于同业水平，公司应积极改善其经营政策，以达永续经营。

5. 结论

由本文前述分析中国台湾整体效率值优于大陆，中国台湾在传统的一阶段分析中，整体效率值优于大陆，若区分为两阶段，即营销效率与自留效率，亦可得到相同结果。此外，也发现两岸在自留阶段的效率值皆优于营销阶段。

两岸资料共同评估，大陆第二阶段之自留效率值高于中国台湾。由于两岸整体环境背景和产业发产概况不尽相同，因此，本研究亦将两岸数据合并视为一期进行评估，中国台湾整体效率值高于大陆，但若区分为两阶段，则发现大陆自留阶段之效率值稍高于中国台湾，由此可见区分为两阶段更可以看出公司经营上之优劣势与公司较具竞争力之项目，进而可以据此拟定公司之经营策略。

2008 年金融海啸，影响两岸 2009 年后之经营绩效。若以整体效率值之角度观之，可看出中国台湾各产险公司于 2008 年金融海啸发生期间，自留核保利益均呈现下滑现象，对于营运费用的管控也较为严格，且由于自留效率的估算，须等待年度结束后才得以估算，故可看出 2008 年 9 月金融海啸之发生，不会立即反映在保险市场上，延续了一年多，至 2010 年效率值才普遍低于前后几个年度，且并无任何一家公司被当作标竿次数。而大陆产险业者同样也受到 2008 年金融海啸之冲击，整体效率值于 2009 年降 0.033，但其幅度没有中国台湾那么大，至 2010 年即恢复金融海啸前水平，且其两阶段数据报络分析法中之营销效率值更一路呈现上升趋势，由此应可推估，即使在整体金融市场大环境不佳的情况下，其市场由于还在成长阶段，因此，相对中国台湾而言并无那么明显的冲击。

中国台湾车险赔款率愈高，其营销效率较佳，自留段效效率则较差。车险为最大宗之险种，其赔款率愈高，当然整体之自留效率亦应愈差。大陆非车险比重愈高，其营销效率值较佳，自留阶段效率值则较差。增加非车险业务占公司整体业务的比重，对于公司业务之拓展有显著正影响，但自留效率则为负影响。

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运用 DEA 法评估两岸产险业之自留业务效率

中文摘要：本论文运用传统一阶段及两阶段数据报络分析法，衡量两岸 36 家产险公司 2008 年至 2013 年期间之自留业务效率。研究结果发现在传统一阶段数据报络分析法中，中国台湾整体的自留业务效率值高于大陆。惟若改用两阶段数据报络分析法进行评估时，则显示第一阶段的营销效率值中国台湾虽然高于大陆，但在第二阶段的自留业务务效率值，则大陆优于中国台湾。此外，本论文亦运用 Tobit 回归方法探讨影响上述效率值之关键因素，采用的变量包括公司成立时间长短、签单保费收入、教育程度大学以上比率、专业人员比率、非车险业务比率、金控与否及自留比率等七项自变数。结果发现，影响营销效率之因素为成立时间长短(+)及非车险比重(+)，其余变数皆不显著；影响自留业务效率之因素则为签单保费(+)和自留保费比率(-)，其余变数皆不显著。

关键词：产险业、自留业务、经营绩效、数据报络分析法、Tobit 回归

Environmental Liability Risk and Insurance: A Comparative Review

Chris Parsons
Professor in Insurance
Faculty of Actuarial Science and Insurance
Sir John Cass Business School, City of London
106 Bunhill Row
London EC1Y 8TZ

Email: c.parsons@city.ac.uk

Web pages:
http://bunhill.city.ac.uk/research/cassexperts.nsf/(expertsbyName)/80257346003B633B80256D0300537C2E?OpenDocument

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Abstract

The production of material goods and generation of wealth in growing industrial economies requires a balance to be struck between economic development and the alleviation of poverty, and preservation of the environment for future generations. In emerging economies the latter is often sacrificed to the former, but as societies become richer concern for protection of the environment usually grows, and legal regimes to protect the environment tend to strengthen, imposing heavier burdens on polluting firms and exposing them to greater potential tort liabilities and regulatory actions. Insurance is often then considered as a mechanism for spreading risk and funding compensation and remediation.

In this paper we review the development of environmental liability regimes in the US and Europe and compare them with parallel developments in the Far East, and especially China. We also consider the experience of insurers in designing and

developing insurance products for pollution and environmental liability, together with the demand for and barriers to the supply of such insurance. In particular, we assess the viability of compulsory insurance regimes for environmental liability. These have already been introduced in some countries, including China, and are currently the subject of renewed debate at European level.

1. Introduction

Pollution can be defined as the over-production of waste or, perhaps, the result of our failure to adequately contain and control waste. There are three main pathways, or media, through which pollutants may be transmitted, being 1) air, 2) water, and 3) soil or land. The first-mentioned, air pollution, stands out as distinct from the others, as it is the least susceptible to control through mechanism involving tort liability, regulatory action and insurance. The air that we breathe is part of the 'non-owned' environment, so nobody affected by air pollution has proprietary rights that can support an action in tort. In any event, air pollution is usually diffuse; that is, the product of many polluters, such as the drivers of millions of motor vehicles. For this reason identifying and pursuing liable defendants is rarely practicable. Finally, while remediation (clean-up) of polluted land and water can often be achieved, this is less frequently possible for air pollution.

There are many polluting agents but, at the risk of simplification, the most significant in practical terms are hydrocarbons (e.g. petroleum, coal products), heavy metals (such as lead), herbicides, pesticides, fertilisers and solvents. There are, of course, many different ways in which these agents can be released into the environment.[1]

Environmental pollution and contamination is a serious problem, especially for countries that have a history of industrialisation. In many such countries there are thousands of sites that have been contaminated by past industrial activity and which pose a continuing threat to health through, for example, migration of contaminants into water supplies. The cost of cleaning up such sites is often very high, especially if groundwater is affected.[2] For reasons that are obvious, insurance is not an ideal

[1] These include agricultural and storm water run-off, leaking sewer and landfill sites, mining and construction activities, the operation of foundries and other industrial sites, accidental leaks and spills, deliberate discharges and intentional tipping of waste, improper disposal of car batteries, personal care products and household chemicals, vehicle emissions and, of course, the burning fossil fuels.

[2] The average cost of US 'Superfund' clean-ups is around US$30, and the largest around US$2.5 bn. Remediation can take as long as 25 years. The average time for remediation in EU cases is approximately one year, but the process has taken up to six years in some instances.

mechanism for meeting the cost of past pollution damage,[3] and can only be employed effectively as a means of financing future risk. Unfortunately, distinguishing between past and present pollution is not always easy. Furthermore, in recent years insurers (particularly in the USA), have sometimes been held liable for historic pollution through the imposition of retrospective liability on the firms that they insured.

Pollution damage can occur as a result of a single 'accident' or event, such as a fire, explosion, collision of vehicles, sudden bursting of a pipe or breakdown of equipment which, when functioning correctly, prevents the release of pollutants. In other cases the damage is gradual and cumulative, caused by the release of pollutants over a long period of time, in relatively small quantities and, perhaps, within limits allowed by law. In this case there may be no accident as such and the operators of the facility or plant in question may well be aware of the emissions, although they might fail to foresee the harmful effects that ultimately result in a claim.

Based on insurers' past experience, and for other reasons discussed below, the provision of insurance protection against liability for pollution has proved problematic, and insurers remain cautious when contemplating cover. In broad terms, cover for the first type of damage, 'sudden and accidental' pollution, has been quite readily available under public/general liability (PL/GL) polices, though not necessarily in sufficiently large amounts. There is a more limited market for cover in respect of the second, 'gradually occurring' pollution, under policies that give wider cover in a number of other respects.[4] The term Environmental Impairment Liability (EIL) is the term most commonly used for the latter.

2. Evolution of Environmental Liability Regimes in the US and Europe

In emerging and developing economies there is usually little concern for the environment. Industrialisation, typically accompanied by urbanisation, frequently results in a degradation of the natural environment, but this is often seen as a reasonable price to pay for lifting people out of poverty. However, as incomes rise and poverty is reduced, and a relatively wealthy middle class emerges, concern for the

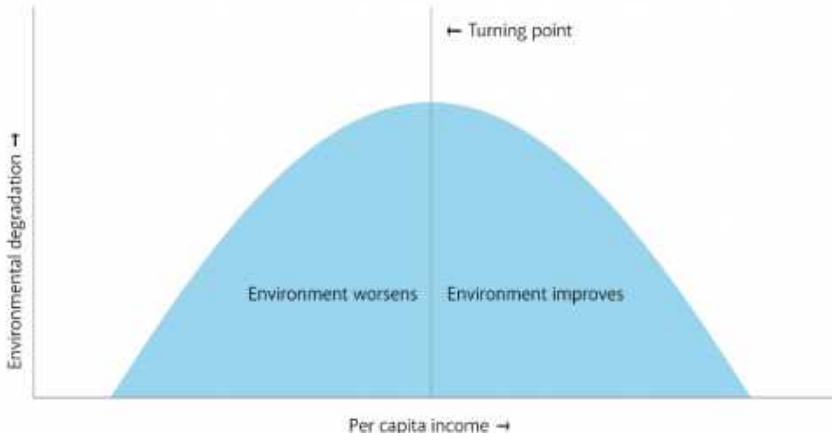
3 However, insurers have sometimes offered cover for historic pollution, or at least the unexpectedly high cost of remedying known pollution, under lines such as 'remediation cost cap' and 'property transfer' policies.

4 For example, for cost of clean-ups mandated by regulatory authorities, including 'own site' clean-up costs, as well as third party (tort) claims for damages.

environment and the damaging effects of industrialisation usually develops, resulting in pressure on governments to better protect the environment.

In recent years this pattern has been formally represented in what has become known as the Environmental Kuznets Curve. This is a development of the curve representing the relationship between economic growth and income inequality postulated by the American economist Simon Kuznets in 1954.[5] From the early 1990s onward the Kuznets Curve became a vehicle for describing the relationship between measurable levels of environmental quality, such as the concentration of sulphur dioxide emissions, and per capita income. Evidence began to accumulate that as countries develop the levels of environmental degradation and per capita income follows the same inverted-U-shaped relationship as in the original Kuznets curve, converting it into the Environmental Kuznets Curve (EKC) shown, here.

Figure 1 – The Environmental Kuznets Curve



This relationship is intuitively appealing. Environmental damage in a rapidly developing economy is always likely to be severe owing to profligate use of natural resources, less efficient and relatively dirty technologies and the high priority given to

[5] In his presidential address to at the sixty-seventh annual meeting of the American Economic Association in December 1954, entitled 'Economic Growth and Income Inequality' Kuznets suggested that as per capita income increases, income inequality also increases at first but then, after some turning point, starts declining and eventually moves back toward greater equality as economic growth continues. This changing relationship between per capita income and income inequality, now observed empirically, can be represented by a bell-shaped curve known as the Kuznets Curve.

increased production at the expense of mitigating the adverse environmental consequences of growth. However, as people become wealthier, purer water, better air quality, and a generally cleaner environment become more valued as people make choices at the margin about how to spend what they earn. Later still, in the post-industrial phase of an economy, better technologies and a shift to service-based activities are likely to enhance the trend. There is some historical evidence to suggest that the inflection or turning point in the EKC is likely to lie between about US$5,000 and US$8,000 in per capita income.

Of course, the environment does not improve of its own accord as incomes rise, but only as a consequence of pressure on governments to regulate polluting firms, protect the environment and give redress to victims of pollution and contamination. In the West, pressure of this sort started to build in the 1960's and early 1970's. This was marked, for example, by the emergence of the 'green movement' as a social and political force.[6] Hitherto, there had been little specific law designed to regulate polluting firms and redress was available to victims of pollution only through the limited mechanisms of common law tort liability, such as the law of negligence. In fact, traditional tort liability is very limited as a tool for controlling and regulating environmental damage. It cannot be used to control damage to the non-owned environment (i.e. general ecological damage), because there is no 'owner' of the damaged property who can bring suit. Also, tort liability is reactive, and can do little to prevent damage that might be caused in future. However, for the first time, governments now began to promulgate specific legal regimes of regulation and civil liability for pollution and environmental damage. For example, the landmark US National Environmental Policy Act 1969 (NEPA) became law on 1 January 1970 and the European Union launched its first environmental programmes in 1973, which culminated eventually in the Environmental Liability Directive of 2004. A series of major environmental disasters around this time gave added urgency to the need for reform. [7]

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6 A number of highly influential activist groups were founded around this time, including Greenpeace and Friends of the Earth (founded 1969-70).

7 Examples include the Minamata Bay mercury poisonings (Japan, 1956), the Torrey Canyon and Santa Barbara oil spills (1967 and 1969), poisonings following the release of toxins from chemical plants at Seveso (Italy, 1976) and the 'toxic suburb' of Love Canal (Niagara Falls, New York, USA). Later major examples include the explosion at the Union Carbide plant in Bhopal (Madhya *Pradesh,* India, 1984), the Chernobyl nuclear reactor fire (Ukraine, 1986) and the Exxon Valdez disaster (Alaska, 1989).

Most of these regimes are based on the 'polluter pays' principle – the simple proposition that incentives on the part of potentially polluting firms to limit the impact of their activities on the environment can be generated only by making them bear the cost of the damage they cause. In Europe, for example, the formal origin of this principle is the 1957 Treaty of Rome, as amended by the Single European Act 1986.[8] Polluters can be 'made to pay' in various ways, for example through systems of emissions trading ('cap and trade'), via tort based civil liability and via regulatory action, which can include criminal penalties for polluting firms (and, perhaps, sanctions against their directors) and remediation (clean-up) orders.

There are a number of potential problems in 'making the polluter pay'. One of them is the problem of causation. Sanctions can be imposed on polluting firms only in cases where there is a clear causal link between the polluter and the damage alleged to have been caused. Pollution damage often first manifests itself many years after the original release, and by this time the pollutants in question have often migrated great distances from their original source. In such a case the link between polluter and victim can be very hard to make. The problem becomes even more difficult if there is more than one potential polluter involved, which is very often the case.[9] One possible solution to the latter problem (multiple polluters) is the legal device of joint and several liability. Under this mechanism any one of a number of polluters can be held liable for the whole of the damage, regardless of how small their own contribution may be. A party who is held fully liable in this way then has the task of identifying and pursuing possible co-defendants. Not surprisingly, joint and several liability is regarded as a harsh measure by industry interests, and by their insurers.

A further difficulty lies in the fact that, in many cases, the original polluter is no longer around by the time the damage becomes manifest, which is often many years after the release of the pollutants concerned. An extra dimension of this problem can

8 Para 2 of Article 130r reads: 'Action by the Community relating to the environment shall be based on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source, and that the polluter should pay.'

9 See, for example, Raffinerie Mediterranee (ERG) SpA v Ministero dello Sviluppo economico (CJEU, Case Nos. C-378/08, C-379/08 and C-380/08, 2010), the first European Court of Justice case involving the 2004 EU Environmental Liability Directive. The Augusta roadstead, in Sicily, had been badly affected by recurring incidents of environmental pollution, generated by a large number of firms operating in the hydrocarbon and the petrochemical sectors established there since the 1960s. A link between the pollution and the activities of the firms was in fact presumed to exist by the Court.

arise from the fact that the pollution damage may, in effect, have been *intentionally* brought about – by parties who calculated that they could make a tidy profit from the activity that caused the damage and then render themselves judgement-proof before the harm was discovered. This 'hit and run' phenomenon has been styled 'looting' by Akerlof & Romer (1993), who analysed the use of strategic bankruptcy as a means of appropriating rents in the context of the US savings and loan crisis. Mason & Swanson (1998) suggest that this phenomenon is one of the primary causes of long-tail insurance risks and provide a number of examples. In particular, they discuss the problems associated with toxic waste disposal sites in the US and elsewhere, where absence of effective regulation encouraged the establishment of firms for the single purpose of providing landfill sites for the disposal of problematic waste. As the authors note:

> 'These firms often existed with few assets other than the land on which the disposal occurred. After years of dumping, and before detection of any leaks, the firm would then dissolve its corporation and disappear, leaving others to incur the deferred costliness of its operation. … This is the essence of looting: operation of a firm in a context in which it is possible to incur benefits today while postponing the associated costliness until the future, with dissolution and liquidation occurring in the interim. The necessary conditions for looting are therefore a) the availability of unlimited liability; b) the capacity to create deferred costliness; and c) the structure that renders liquidation the optimal strategy to pursue.'[10]

3. Evolution of Insurance Cover for Pollution

The evolution of insurance cover for pollution mirrors the evolution of legal regimes to control it – in the sense that, until the late 1960s, the question of pollution was hardly addressed by insurers at all. Insurance policies were usually silent on the question, and damage in the form of pollution and contamination was not mentioned as either included or excluded. This meant that the risk was often insured by default.

[10] Mason & Swanson (1998), p. 183. See also Parsons, C., (2003), 'Moral hazard in liability insurance', Geneva Papers on Risk and Insurance, 28(3), p.447-470 for further discussion of the insurance issues connected with 'looting'.

Property insurance policies covered damage to (material) property and, while cover was often limited to named perils such as fire or explosion, the operation of such perils could quite easily lead to a pollution incident. Cover under liability policies was even wider. Liability cover is effectively 'all risks', because the policy will normally respond to any form of personal injury or damage to property for which the insured is held legally responsible, provided the injury or damage is 'accidental' or not 'expected and intended' by the insured. Coverage was therefore extensive, especially under Public/General Liability insurances (PL, GL or CGL[11] in the USA).

The width of these wordings led to massive, and largely unexpected, claims for pollution, mainly in the USA, from the early 1970s onward, affecting US and European casualty insurers and reinsurers, including Lloyd's, which was very heavily exposed to the USA through both direct insurance and reinsurance. Insurers reacted by cutting down the cover under GL policies, and sought to remove all liability for gradual pollution, often by means of an exclusion that limited cover for pollution to incidents that were 'sudden and accidental.' These exclusions were added to GL policies in the USA from around 1970 onwards, but often at a later date in the UK and Europe, and sometimes not until 1991. A limited market for liability cover in respect of gradual pollution, described earlier as Environmental Impairment Liability (EIL) also developed from the late 1960s onwards, although it collapsed for a period of time in the mysterious and still largely unexplained US liability insurance crisis of the mid-1980s. Insurers have remained very cautious since, with cover restricted to defined and thoroughly audited sites, and subject to low limits and a number of restrictive terms.

4. Environmental Liability and Insurance in Europe

The law on environmental liability in Europe is still something of a patchwork comprising, in differing proportions across member states, a combination of old

[11] CGL originally stood for Comprehensive General Liability (insurance), but the name was later changed to Commercial General Liability (also CGL), partly because an emerging doctrine whereby insurers were expected to 'fulfil the reasonable expectations of the insured' led to concern about the use of the word 'comprehensive', which might imply that there were no exclusions on the cover.

common law liabilities, domestic codes and regulations and pan-European law, contained in a series of EU Directives. The basic framework for the latter is set out in the EU Environmental Liability Directive (ELD) of 2004.[12] Member States were required to implement the ELD by 30 April 2007, but few were able to meet the deadline. Full implementation in the UK, for example, did not take place until 2009.

Summarised briefly, the ELD sets out a framework based on the 'polluter pays' principle for damage to species and natural habitats (1992 Habitats Directive[13] and 1979 Wild Birds Directive[14]), the pollution of waters (2000 Water Framework Directive[15]) and land contamination that creates a risk to human health. Damage to biodiversity (i.e. general ecological damage) is included, so no person or business need prove harm when such damage has resulted. Every member state is required to have a supervising agency for enforcement of ELD provisions. Polluting companies are required to pay the cost of necessary clean-up operations and put in place preventative measures. Liability is strict (i.e. no-fault) for hazardous industries, subject to 'state of the art' & 'permit' defences, which are options that have been adopted in some Member States, including UK. Unlike the US 'Superfund' legislation, there is no retrospective liability. Liability of operators can be joint and several (as in, for example, the UK) or proportionate (as in Italy).

As yet, the effectiveness of the ELD is hard to judge. However, and perhaps significantly, there have been no notified ELD cases in some countries (e.g. Denmark) a few in others (for example, around 15-20 the UK and Italy) while in two EU member states, Poland and Hungary, there have been hundreds. This is partly explained by the fact that, in a number of countries, cases against polluters are more likely to be brought under existing local laws which were already highly developed before the ELD was transposed into local law. However, other factors are likely to be at play, including the level of awareness of environmental responsibilities, the availability of insurance and the resources available to bring action against offending firms. The latter is especially important. It is well understood that, even in wealthy and mature economies, authorities (and especially local authorities) rarely have the means to thoroughly monitor and control the activities of potentially polluting firms.

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12 Directive 2004/35/EC.

13 ***Directive*** 92/43/EEC.

14 Directive 79/409/EEC.

15 ***Directive 2000***/60/EC.

It safe to say that the vast majority of firms, of all sizes, carry GL insurance (or its equivalent) in the larger, more mature economies of Europe and in Northern Europe generally, though in less mature economies, and in Southern Europe, take-up is rather lower. In most cases the insurance will cover liability for 'sudden and accidental' pollutions at least. However, few firms, and very few in the SME sector, carry cover for gradual pollution under what were described earlier as EIL policies. In the UK for example, annual premium income for this line of business was estimated to be in the region of US$50-60 mn. in 2013, while total premium for all lines of liability insurance was in the region of $US 12 bn. at the time, meaning that EIL accounted for only less than half of one percent of the total. Limits on coverage for EIL are also quite low. In Europe, cover of up to €50 mn. is available, but large firms mostly buy cover with limits in the € 0-30 mn. range, and for small firms €1-5 mn. is more usual.

5. Problems in Insuring Environmental Risks

The caution of insurers with regard to environmental risks, mentioned above is well known. Many years ago Carter (1989)[16] noted that the cover available was often proved inadequate in view of the potential size of claims. He pointed out that the insurance market, even then, was able to mobilise large amounts of insurance capacity for oil rigs and aircraft hull and liability risks (up to US $1bn for the former at the time) whereas the London market could offer cover only in the region US $85-170m for sudden and accidental pollution risks, and far less for Environmental Pollution Liability (EIL) insurances covering gradual pollution. The reluctance of insurers to grant large amounts of cover for pollution risks, and especially for gradual pollution, deserves some comment. There are a number of reasons, briefly considered below.

5.1 Latent Damage and Long-Tail Claims

This audience will not need to be reminded of all the problems of product design, pricing, reserving, claims management and moral hazard problems associated with long tail risks. The time periods involved in environmental liability can be very long indeed, longer even than those for disease claims associated with asbestos. In one

[16] Carter, R, L., (1989) 'Liability for Accidental Pollution: Obstacles to the Supply of Insurance', Chartered Insurance Institute, London.

(admittedly extreme) example the period was 117 years. This case concerns pollution originating from a creosote factory opened by the New Orleans and North Eastern Railroad company in the year 1882 in Slidell, Louisiana. The creosote, a highly polluting coal tar product, was needed to treat the timbers of a wooden bridge that was built to carry the new Cincinnati to New Orleans railroad across Lake Ponchartrain. The polluted land was subsequently designated a 'Superfund' site and, in 1999, the Alabama Great Southern Railroad Company, a successor of the New Orleans and North Eastern Railroad company, was required to pay US$13 mn. for its share of the clean-up operation. This case also provides an excellent example of the 'development risk' – the expansion of liability through unpredictable legal change. The original, late nineteenth century, operators of the railway company can scarcely have imagined how legal developments in the late 20th century would impact upon their successors.

5.2 The Uncertainty of the Law

Insurer's experience of the US 'Superfund' legislation, mentioned earlier, periods of rapid expansion in tort law in both the USA and some European countries and uncertainty over the ultimate shape of regulatory regimes such as the 2004 European Environmental Liability Directive have contributed to insurer's risk aversion with regard to environmental exposures. 'Superfund' refers to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). This was Federal law creating a liability regime which, along with taxes on petroleum and chemical industries, was intended to build up a large trust fund that could be used to clean up some 1300 or so designated, heavily polluted sites. CERCLA imposed strict, retrospective and joint and several liability on Potentially Responsible Parties (PRP) who were linked to these sites.[17] A large number of such parties had cover under old US CGL policies which carried no pollution exclusion, or wide liability covers written by European insurers, many in the London market. The resulting claims bankrupted some casualty insurers and weighed heavily on Lloyd's and the

[17] A PRP might be: 1. The current owner or operator of the site; 2. The owner or operator of a site at the time that disposal of a hazardous substance, pollutant or contaminant occurred; 3. A person who arranged for the disposal of a hazardous substance, pollutant or contaminant at a site, or; 4. A person who transported a hazardous substance, pollutant or contaminant to a site, who also had selected that site for the disposal of the hazardous substances, pollutants or contaminants.

London insurance market in particular.

5.3 Distinguishing Accidental from Non-Accidental Pollution

If insurers provide cover for pollution damage that is intended or expected by the insured the latter will have little incentive to take care, creating an obvious moral hazard. Unfortunately, it is often very difficult to distinguish between 'accidental' and 'non-accidental' releases of pollutants, particularly where pollution is gradual and does not arise from a definite incident, such as a fire. Designing policies that clearly and unambiguously exclude non-accidental pollution has proved very difficult and wordings intended to achieve this have sometimes been successfully challenged in the courts.[18]

5.4 The Size Distribution of Pollution Claims

Many classes of liability insurance, such as motor third party and employers' liability or workers' compensation, are characterized by a pattern of high frequency, low severity claims. Environmental Impairment Liability insurance, by contrast, tends to generate relatively few small losses, but creates a potential exposure to infrequent but very large losses. This means that underwriters can have less confidence about loss estimates for environmental risks than for other classes of business and that portfolios of such risks will be subject to greater than normal fluctuations, and require more reinsurance to stabilise them.

5.5 Survey, Risk Assessment, and Claim Transaction Costs

[18] See, for example, *Sunbeam Corporation et al. v. Liberty Mutual Insurance Company et al*., 781 A.2d 1189 (Pa. 2001) where the words 'sudden and accidental' were held to merely reinforce the words 'unexpected and unintended'. US courts have sometimes delivered other unpleasant surprises for insurers. For example, the decision of the Supreme Court of Washington in *Boeing Co v. Aetna Casualty and Surety et al 113 Wash 2589 (1990)* and *AIU Insurance Company et al v. Superior Court of Santa Clara County No SO 12525 (Cal S Ct Nov 18 1990)* confirmed that where a CGL policy purports to cover legal liability for 'damages', such 'damages' include costs incurred in complying with a clean-up order under CERCLA. The English courts, by contrast, have ruled that a regulatory clean up order is not 'damages' but a debt under statute and therefore not insured by a conventional Public Liability policy. See **Bartoline v. RSA Insurance** [2006] EWHC 3598, [2008] Env. LR 1.

Insurance against the risk of pollution can be written successfully only where the insurer has a good picture of the risk, which means that a detailed environmental audit is necessary before cover can be granted. These audits can be properly conducted only by people with advanced and up-to-date scientific knowledge and technical skills. The cost of such audits is bound to be high and must be borne ultimately by those who insure, pushing up the price of insurance cover and weakening demand. Ironically, some would-be insureds resist such inspections, on the grounds that the discovery of a potential pollution risk may expose them to legal action in the future if, having become aware of the risk, they then do nothing about it. In other words, the client may prefer *not* to know that they have a problem, in case this knowledge is later used in evidence against them.

There is also abundant evidence that claim transaction costs for pollution and environmental liability claims are exceptionally high. Pollution-related claims often result in 'fact intensive' disputes about matters such as the nature and timing of the damage, degree of fault on the part of the insured, causation, and the insured's awareness or otherwise of the harm being caused. While transaction costs for liability insurance in general are typically around 50% of premiums, for environmental liability claims they are often very much higher.[19]

5.6 Adverse Selection

In the case of Environmental Liability Insurance in particular, there is likely to be a high level of selection against insurers, with demand for cover concentrated in firms having a known pollution risk. This will be exacerbated if the law mandates insurance for high-risk firms, but not others.

6. Compulsory Insurance

[19] A report for the Rand Institute for Civil Justice on the transaction costs of insurers in major US 'Superfund' cases found an astonishing average transaction cost of 88% of total expenditure by insurers, ranging from 80% to 96%. This means that out of all the huge sums paid by insurance companies, only a tiny proportion - 12% - was actually used to clean up polluted land. Acton, J.P. and Dixon, L.S., (1992) 'Superfund and Transaction Costs: the Experience of Insurers and Very Large Industrial Firms' RAND, Santa Monica, 1992.

At the present time, a few countries worldwide have introduced a system of compulsory insurance for pollution and environmental damage, for some risks at least. The European Union has been contemplating for some time the enactment of a compulsory insurance system to be applied in all Member States. This is discussed later.

6.1 Potential Problems in Compulsory Insurance Regimes

There are a number of potential problems in implementing a regime of compulsory insurance for environmental liability risks. Some are common to all countries while others are likely to affect some only.

6.1.1 The need for clear and predictable rules on civil liability and regulatory obligations

Liability insurance of any sort can only be effective in protecting buyers, and reasonably attractive to insurance sellers, where the relevant liability rules and are detailed and clear, and their implementation through the courts is reasonably predictable. In a number of mature economies this is the case although, as we have seen, even in Europe the law is still a rather messy patchwork across member states of common law rules, local codes and regulations and over-arching EU law – which can make it difficult for insurers to construct international programmes that include environmental liability. Elsewhere, the problems are much greater, because the legal framework for environmental damage is often undeveloped, and regulatory codes frequently lack sufficient detail.[20] A law that requires firms to buy insurance to cover their civil and regulatory obligations in respect of pollution can only create difficulties if neither insurers nor insureds are clear as to what those obligations are.

6.1.2 The nature of the risks insured

Compulsory insurance regimes work best when there are a large number of homogenous risks to insure, loss patterns of high frequency and low severity, and little

[20] This was the case in China, for example, under the original 1989 Environmental Protection Law. However, substantial revisions in 2014, effective from 1 January 2015, and subsequent interpretations of the Supreme Court have given greater clarity and detail.

chance of accumulation or aggregation of risks, resulting in large, relatively stable portfolios for insurers. Third party motor insurance, workers' compensation (WC) and employers' liability (EL) insurance, which are often subject to compulsory insurance laws, fulfil these characteristics quite well whereas, as we have seen, environmental liability risks, which vary enormously in scale and scope and tend to produce volatile claims patterns, do not.

6.1.3 Simple insurance contracts, uniform in coverage, with few restrictions and exclusions

Compulsory insurance regimes, if they are to work properly, must not only identify the parties who are obliged to insure, but must also delineate the scope of the cover required, otherwise firms could obey the letter of the law by buying a policy, but evade its spirit by carrying cover so narrow as to be almost useless. To protect the interest of third parties, such as road or work accident victims, compulsory regimes usually mandate very wide coverage and disallow most, if not all, exclusions. Insurers have little difficulty in meeting these requirements in the case of relatively simple lines such as motor. The complex nature of environmental risks, and the exceptionally hazardous nature of some of them, makes it much more difficult to frame regulations on compulsory coverage. Many existing policies carry a wide range of exclusions. For example, traditional GL policies do not cover gradual pollution and may not cover the cost of regulatory clean-ups, as apart from third party claims for damages. EIL policies do cover both of the latter but, in turn, are likely to carry a number of restrictions, including claims for damage that relate to the use of lead, asbestos or underground storage tanks. Nor is it clear that the 'claims-made' wordings used by most EIL insurers would always be acceptable to regulators because, depending on how the are framed, they may allow insurers to come off cover quite abruptly and may not provide the sort of long term security that is desirable.

6.1.4 A mature and competitive market, with abundant and steady supply

It goes without saying that a system of compulsory insurance cannot work unless there is a number of willing sellers that is sufficient to make the market competitive and enough capacity to fulfil the needs of all firms that are required to insure. While the market for conventional GL insurance is very large in terms of supply, with abundant capacity in most countries, including many emerging markets, this is not the

case with EIL insurance covering gradual pollution. The market for EIL insurance is relatively mature in the USA and a few European countries, with a significant number of players, but available coverage limits are relatively low. Elsewhere, the market is almost non-existent, since insurers lack the data and technical knowledge to underwrite risks with confidence.

It is also the case that the supply of insurance for long-tail lines such as EIL tends to be more fragile and volatile than for other liability lines, drying up more quickly in critical times. This was certainly the case in the most remarkable of such crises, the 1984-86 US liability insurance crisis mentioned earlier, when the market for EIL insurance all but collapsed, along with the supply of cover for a number of other long-tail risks.[21]

6.1.5 Compulsory insurance in Europe

During the development process that led to the introduction of the 2004 EU Environmental Liability Directive (ELD) there was much discussion about the possible introduction of compulsory insurance (or other forms of financial guarantee, such as bonds, bank guarantees, funds or captives) to support liability imposed by the Directive. However, member states were divided on the issue and an earlier published proposal for compulsory insurance was dropped, partly because insurers doubted whether compulsory insurance was practical given that the market was not sufficiently developed in most member states. Also, a requirement to provide compensation for bio-diversity was something completely new to insurers. In the end, the final text of the ELD only provided, in Article14, that: 'Member States shall take measures to *encourage* the development of financial security instruments and markets by the appropriate economic and financial operators to use financial guarantees to cover their responsibilities under the Directive.' Since then a few, mainly smaller, countries of Europe have introduced a regime of compulsory insurance or other financial security, for at least some risks. They are Bulgaria, Czech Republic, Greece, Hungary, Portugal, Romania, Slovakia, Spain.[22]

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21 The crisis has never been explained adequately by insurance economists. There are various theories, involving factors such as a rapid expansion in the scope of tort law prior to the crisis, falling interest rates, collusion by insurers to restrict supply and jack up prices, and theories based on loss shocks and under-pricing. The crisis was confined to the USA, with no parallel in Europe. A good discussion can be found in Priest, G. L., 1987, 'The Current Insurance Crisis and Modern Tort Law', *Yale Law Journal*, 96, pp. 1521-1590.

22 Turkey has also introduced a restricted regime of compulsory insurance for sea pollution caused

An 2010 EU report[23] concluded that it was still premature to introduce any mandatory Europe-wide compulsory regime and a 2014 report,[24] adopted only in April 2016, made no further mention of it, although it noted that there had been a steady rise in the number of European firms buying insurance. An earlier report,[25] commissioned by the EU and published in 2013, examined the feasibility of a Hungarian proposal[26] for a Europe-wide fund or pool to cover environmental and other damage resulting from major industrial disasters. This facility would complement private insurance products by providing funding for losses above the level of €100 million level, that is, above the level for which funding was not otherwise likely to be available. At the time of writing there have been no further developments.

It should be said that, quite apart from the problem of market capacity, most European insurers do not favour any form of Europe-wide mandatory insurance regime given the still somewhat diverse nature of European regulatory rules for environmental damage and differing customer needs.[27]

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by coastal facilities, including refineries, gas terminals, power houses, industrial production facilities and shipyards.

23 Report under Article 14(2) of Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage, COM/2010/0581 final.

24 Report under Article 14(2) of Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage, COM (2016) 204 final.

25 BIO Intelligence Service et al. (2012) 'Study to explore the feasibility of creating a fund to cover environmental liability and losses occurring from industrial accidents', Final report prepared for European Commission, DG ENV

26 This was partly inspired by a major industrial accident that took place at the MAL alumina factory near Kolontár, Hungary on 4 October 2010. A dam wall on one of the 'red mud' ponds at the factory collapsed, resulting in around one million cubic metres of 'red sludge' and alkaline water spilling from the reservoir. A one to two metre high wave of toxic waters and sludge killed ten people, injured several hundred more, destroyed over 300 homes, contaminated a thousand hectares of land, including 400 hectares of agricultural land, and polluted the Torna Creek and other local waterways. The firm carried insurance with a limit that was believed to have been just €40,000, while the total cost of the disaster is thought to have exceeded €115 million.

27 One representative body noted: 'The survey indicates that an EU-wide compulsory insurance system would not benefit the differing needs of customers in different member states. This means that 'one size does not fit all'. Mandatory cover would remove the freedom to contract and has the potential to increase cost and decrease consumer choice. 'Survey of environmental liability insurance developments', Insurance Europe, June 2014.

7. Environmental Liability in China

It is well known that China's push for rapid industrialisation and spectacular economic growth has resulted in significant damage to the environment. The country's heavy dependence on coal is acknowledged as a prime cause, China being the world's largest user of coal-derived electricity. Another key factor is the rapid urbanisation and the energy demands that come with it. Around 56% percent of the population live in or near cities, compared with 26 percent in 1990.

China's National Bureau of Statistics reported an average income of around $9,000 for urban workers in 2014. Of course, there are significant regional variations, with workers in Beijing, for example, earning significantly more than elsewhere.[28] The theory behind the Environmental Kuznets Curve would suggest that, at this level of income improvements in the environment should be starting to show. Indeed, academic studies provide some empirical evidence of this.[29] In any event, there is abundant anecdotal evidence both of public concern about the quality of the environment in China, the greater impact and effectiveness of environmental pressure groups, and of Government commitment to address the problems of pollution.[30]

7.1 Environmental Law in China

The general framework for China's environmental law is contained in Environmental

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28 The National Bureau of Statistics reported an average salary for urban employees in Beijing's public sector of 102,268 yuan ($16 475) in 2014, around 90% higher than the figure for workers in the private sector.

29 For example, recent academic research from Fudan University confirms that the nonlinear relationship between the industrial carbon dioxide emissions and the level of economic development follows the inverted-U shape of the EKC curve. Shanghai, Beijing and Tianjin are reported to have crossed the EKC inflection point and are now in the developmental stage, environmental pollution having reduced since 2005, 2006 and 2008 respectively. However, other areas were reported as being still in the earlier stage of development, with economic growth accompanied by worsening environmental pollution. (Linna Chen & Shiyi Chen (2015) 'The Estimation of Environmental Kuznets Curve in China: Nonparametric Panel Approach', *Computational Economics*, October 2015, Volume 46, Issue 3, pp 405-420.)

30 For example, Premier Li Keqiang in addressing the opening session of the National People's Congress in 2014 said reform was the top priority, describing pollution as 'nature's red-light warning against the model of inefficient and blind development', underscoring the broader message that China must reduce its reliance on coal and shift to a different kind of development.

Protection Law (EPL) of the People's Republic of China 24 April 2014, which came into effect on 1 January 2015, almost 25 years after enactment of the original 1989 Environmental Protection Law, which was first adopted on a trial basis in 1979. [31] The 1979/1989 Law set out key principles for China's pollution control system that were later implemented through a number of media-specific laws. Most have been retained in the 2014 EPL, such as the three 'synchronicities, (which require the design, construction, and operation of pollution control equipment to run concurrently with corresponding stages of an industrial construction project), the application of pollution fees, and requirements for environmental impact assessments.

The 2014 EPL has grown significantly in size, now consisting of 70 articles (as against 47 in the 1989 Law), in seven chapters. The 1979/89 EPL consisted of five substantive chapters addressing Supervision and Management (Chapter 2), Protection and Improvement (Chapter 3), Prevention and Control of Environmental Pollution and other Public Hazards (Chapter 4), and Legal Liability (Chapter 5). The 2014 EPL retains these headings, but has significantly rewritten many of the articles, added new ones, and created a wholly new chapter on Information Disclosure and Public Participation, providing explicit legislative commitment to transparency and public participation.

Notable features include Article 59, which addresses the persistent problem of environmental penalties that are too low to provide an effective deterrent to non-compliance. Similar to provisions in US and European environmental law, Article 59 allows penalties to accumulate day by day after a polluter has received a compliance order. Article 64 confirms that pollution and ecological destruction can give rise to liability under China's Tort Liability Law. Articles 61 and 65 relate to environmental impact assessment (EIA). They articulate specific legislative authorisation for EIA enforcement remedies following a failure to submit proper EIA documentation prior to commencing a construction project, as well as the submission of fraudulent EIA documentation.

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[31] The Swiss Re Centre for Global Dialogue has produced a very good summary of the law. See Tseming Yang. 'The 2014 Revisions of China's Environmental Protection Law', 16 Oct 2014 http://cgd.swissre.com/risk_dialogue_magazine/Environmental_liability/The_2014_Revisions_of_Chinas_Environmental_Protection_Law.html

A perennial problem for China and, indeed, for environmental regimes worldwide, is the problem of enforcement. Lack of resources on the part of local and government agencies with enforcement powers, lack of public awareness (and even lack of trained environmental lawyers) mean that the high aspirations of environmental regimes are often not translated into action. With this in mind, perhaps the most significant advance in the 2014 EPL is its support for the emerging role of environmental public interest litigation. Under the new Article 58, social organisations that are registered at local or higher national level and have engaged in environmental activities for at least five years are given legal standing to bring cases regarding 'environmental pollution, ecological damage, and public interest harm' thus allowing public interest litigation of the type seen in US citizen suits. Furthermore, shortly after the implementation date of the 2014 EPL, the Supreme Court published explicit guidance on procedure for bringing such cases.[32]

Summarising the 2014 amendments, Yang[33] notes:

> *... cause for optimism can be found outside of government, where civic engagement and activity are increasing. The new chapter 5 confirms and enhances the role of civil society entities, which have become increasingly sophisticated over the years. They can be expected to fully avail themselves of the new authorities. Possibly most intriguing, the EPL Revisions' legislative acknowledgment and creation of a formal role for civil society for the first time in the history of China's modern environmental governance system has set the stage for a potential structural transformation of the governance system and the possibility of long-term positive change.*

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[32] On 6 January 2015 the Supreme Court issued its 'Interpretation on Several Issues Regarding the Application of Law in Public Interest Environmental Civil Litigation'. The Interpretation combines court procedural rules with additional rules on liability and other legal standards to put in place a framework for Chinese environmental NGOs to file public interest environmental cases against polluters. It supplements Article 58 of the Environmental Protection Law 2014 and the 2012 Civil Procedure Law, neither of which gave sufficient guidance to local NGOs and courts in relation to these lawsuits. The Interpretation authorises environmental NGOs with a five year track record that are legally registered to sue polluters on behalf of the public, and to seek the equivalent of a permanent injunction, compensation, remediation orders, or an apology, among other measures. It has been suggested that around 700 of the 7,000 or so such groups in China would qualify.

[33] See Yang, footnote 31 above.

7.2 Environmental Insurance in China

Liability insurance, in general, is relatively undeveloped in China. According to Swiss Re, penetration for liability insurance in China was just 0.04% in 2014 compared with 0.12% Japan, 0.36% in the UK and 0.50% in the USA.[34] This is entirely consistent with the pattern found in emerging markets as a whole. There is always growth in product diversity as an insurance market develops, but in the early stages demand for non-life insurance is mainly confined to insurance for large-scale state infrastructure projects and insurance linked to trade and transport (e.g. MAT insurances). Then, somewhat later, demand emerges for property insurance cover for domestic businesses. It is usually later still before demand expands to include basic forms of liability insurance and yet later again before there is demand for more complex liability lines such as D&O insurance and Environmental Impairment Liability insurance.

In fact, liability insurance in China has seen steady growth in recent years, and this is projected to continue in years to come: (see Figures 2 below). At the same time, profitability is good, with loss ratios for liability insurance, at around 40% of premiums, running much lower than loss ratios for non-life insurance generally: (Figure 3 below). Again, this is consistent with the typical correlation we find in emerging markets between strong growth and good profits, with profitability eventually deteriorating as growth slows. The profitability of liability insurance in emerging markets is also boosted when awareness of legal rights and litigiousness are low, as they have been in China in the past.

[34] 'Liability Insurance in Asia', Swiss Re Economic Research and Consulting, September 2015.

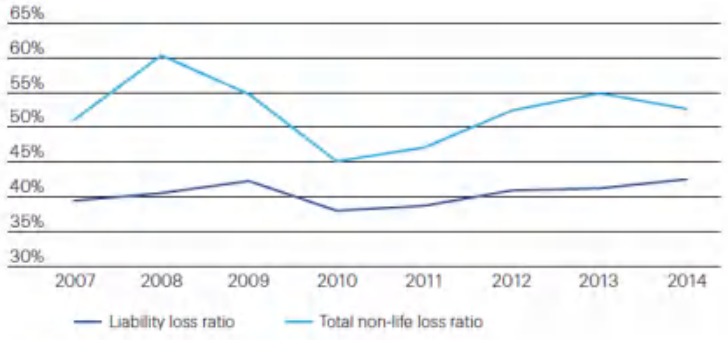
Figure 2
Liability premiums in China (USD billion): 2001–2020F



Note: excludes motor third-party, passenger liability, workers/employee compensation. E = estimates; F = forecasts.

Source: China Insurance Regulatory Commission (CIRC). Swiss Re Economic Research & Consulting.

Figure 3
Loss ratio of liability and total non-life insurance in China (2007–2014, financial year)



Source: CIRC, Swiss Re Economic Research & Consulting.

Article 52 of China's Environmental Protection Law of 2014 echoes Article 24 of the EU Environmental Liability Directive 2004 in stating that 'The State encourages participation in environment pollution liability insurance.' In fact, early experiments with environmental liability insurance in China appear to have been rather limited in terms of success. The process of development has been admirably described by Feng *et al*,[35] who trace its evolution from the early 1990s almost to the present day. The authors note that the first trials of pollution insurance in Dalian, Shenyang, Changchun, Jilin, and some other cities in the northeast of China turned out to be failures. There were hardly any claim payments, and without a detailed framework of law on environmental protection and little legal enforcement demand was small. The few firms that did insure lost interest and the number of insurance contracts decreased year by year, so that the trials came to a halt in the mid-1990s.

[35] Yan Feng, Arthur P.J. Mol, Yonglong Lu, Guizhen He, C.S.A. van Koppen (2104) 'Environmental Pollution Liability Insurance in China: In Need of Strong Government Backing', *AMBIO: A Journal of the Human Environment*, September 2014, Volume 43, Issue 5, pp 687-702.

According to the authors, a new stage began when trials were revived from 2006 onwards, supported by various initiatives at national level. Eight provinces and cities (Jiangsu, Hubei, Hunan, Henan, Chongqing, Shenzhen, Ningbo, and Shenyang) had been chosen for pollution insurance trial applications by the end of 2008. Industries dealing with dangerous chemicals, petrochemicals, dangerous waste treatment, landfills, sewage treatment plants, and various industrial parks were selected as the main targets for the pilot programmes. The revised Tort Liability Law of 2009 assisted the process of development by defining more clearly the liability rules for environmental pollution, providing that the alleged polluter should assume the burden of proving that it is not liable in the case of a dispute, and detailing how liability for pollution caused by several polluters should be addressed. By the end of 2011, 14 provinces and cities (Jiangsu, Hubei, Hunan, Chongqing, Shenzhen, Ningbo, Shenyang, Hebei, Henan, Yunnan, Shanghai, Sichuan, Fujian, and Shanxi) had started applying pollution insurance trials. Local government in some of these pilot areas (Shanghai, Hebei, Henan, Liaoning, Chongqing, and Jiangsu) also launched local legislation on pollution insurance and most issued implementation guidelines, announced principles, and set up work arrangements with industries. Mandatory pollution insurance systems were introduced in some provinces, including Hunan and Jiangsu, requiring companies above a certain size in specific sectors to insure.

The authors report that more than ten insurance companies had entered the Chinese market for pollution with approval of the China Insurance Commission (CIRC) by the end of 2010. However, they also note that insurers had encountered many difficulties with risk assessment, and based classification and pricing on simple indicators such as general industrial categories, firm size and location, with little discrimination founded on actual emissions or specific production processes. They also noted the very high premiums reported by Lin,[36] which apparently varied from 2% to as much as 8%.

These concerns were echoed more recently at the June 2015 opening of the Environmental Pollution Liability Insurance Technical Service Centre in Beijing, which is operated by the private broking firm Strait Unite. Mr. Bie Tao, Deputy

[36] Lin, Q. (2010) 'The role of government in environmental pollution liability insurance' *Popular Business* 320.

Director of the Legal and Regulatory Department of the Ministry of Environmental Protection noted that almost all of the 31 provinces, autonomous regions and municipalities in China had carried out pilot schemes on environmental liability insurance since the first such trial in 2007, but insurance companies still lacked expertise in pricing, underwriting and assessing the risk management capabilities of firms that take up insurance. Officials from the CIRC said that the aim of new Centre aims was to help deal with these questions. The Centre would also provide advice on the design of environmental liability insurance products that are tailored to the needs of firms.

Despite these concerns, measures to introduce compulsory insurance for at least some environmental risks in China have already been introduced via the promulgation, in February 2013, of the Ministry of Environmental Protection (MEP) and the CIRC joint *Guiding Opinions on Pilot Scheme for Compulsory Environmental Pollution Liability Insurance*, which requires compulsory purchase of pollution liability insurance for companies with high environmental risks operating in China. These are firms conducting non-ferrous metal mining and smelting operations, lead battery manufacturing, leather and related products manufacturing and chemical materials and products manufacturing. Insurance is recommended, but not mandated, for a variety of other high risk sectors, including petroleum, gas, mining and chemical industries, waste disposal firms and those discharging dioxins.

According to the *Guiding Opinions*, insurance must cover third-party liabilities arising out of sudden and accidental new pollution, necessary and reasonable expenses incurred by the insured to save any third party's life or to mitigate loss or damage to their property, and necessary and reasonable clean-up expenses incurred by the insured to control the pollution or remediate contaminated waters and land in accordance with environmental legislation. Reports suggest that bespoke environmental impairment liability policies are available in China to cover new pollution conditions up to RMB300 million (US$50 million) for both sudden, accidental and gradual events and that these are deemed to comply with the new mandatory scope of coverage.[37] According to a 2014 press release[38] from the

[37] Zhang, Peter 'Green Insurance now Compulsory in China', *Willis International Alert*, Issue 60, March

Ministry of Environmental Protections, around 25,000 environmental liability insurance products have been bought in China since 2007, while nearly 5,000 firms involved in heavy metal, petrochemical, hazardous chemical, hazardous waste disposal, electricity, medical and pharmaceutical, and printing and dyeing industries were covered by such insurance in 2014.

8. Conclusion

Insurers' historic experiences with pollution and environmental liability insurance in Europe and the USA have not always been happy ones, as portrayed in the earlier sections of this paper. At the same time, the provision of insurance cover against pollution presents a number of technical problems for insurers that are not easy to address. This has led to a great deal of caution on part of insurers where environmental risks are concerned. Uncertainty, together with high risk assessment and claim transaction costs has resulted in high premiums, relatively low limits of coverage (especially for gradual pollution), and restrictive terms in most cases. This, in turn, has weakened demand for cover, with only a very small proportion of European firms obtaining insurance for gradual pollution and regulatory clean-up costs, as apart from third-party claims for 'sudden and accidental' pollution. All this, in turn, has made it difficult to implement systems of compulsory insurance for pollution in Europe, resulting in limited initiatives in a few member states, but no progress at the wider EU level. In effect, there is something of a stand-off, or deadlock, between governments and regulatory authorities, potential insurance buyers and insurance firms.

In China matters have advanced quite swiftly. China has legacy of industrial pollution but not, as yet, a legacy of insurers that have suffered and had to learn hard lessons from it. The insurance market for pollution and environmental liability is still in its infancy but, apparently, maturing quite rapidly. The recent introduction of compulsory cover for at least some risks appears to be a factor that is driving that

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2013.

[38] MEP press release 4 December 2014 http://english.sepa.gov.cn/News_service/news_release/201501/t20150104_293747.shtml

development.[39] There is some evidence from China that the introduction of compulsory insurance can, in itself, help the insurance market mature more rapidly.[40] There is, of course, a potential downside too. The introduction of compulsory insurance for high risk firms only always raises the spectre of adverse selection. Indeed, the types of firms mandated for compulsory insurance in China, such as lead battery manufacturers and firms using powerful solvents, such as tanneries, are exactly those that insurers in Europe most shun. There is a risk that bad claims experience with firms such as these might lead to insurers dropping out of the market rather than moving into it, and a lack of supply that might then undermine the whole compulsory insurance regime. As yet, there has been little claims experience relating to environmental risks in China and, as discussed earlier, loss ratios for liability insurance are extraordinarily low by international standards. It is most unlikely that this state of affairs will continue as the Chinese market continues to mature, and experience has proved that where liability insurance is concerned an element of caution, and an eye to the past as well as the future, is always wise.

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[39] China is not unique in the Far East in introducing compulsory cover. Swiss Re suggest that EIL insurance is also expected to gain traction in South Korea following the introduction by the Ministry of Environment of the Act on Liability and Relief for Damages from Environmental Pollution (Damage Relief Act) on 31 December 2014. From July 2016, businesses and facilities with a high-risk of causing environmental pollution will be required to have insurance. Swiss Re (2015) 'Liability Insurance in Asia', note 33 above.

[40] See Feng et al (2014), 'Environmental Pollution Liability Insurance in China: Compulsory or Voluntary?' *Journal of Cleaner Production*, May 2014. The authors carried out comparative case studies on voluntary insurance systems in Chongqing and compulsory systems in Wuxi and Jiangsu provinces. The results show that in contemporary China, compulsory pollution insurance promotion helps local government to quickly build more quickly a relatively mature system of pollution insurance, but it was too early to draw conclusions on the contribution of pollution insurance to environmental risk mitigation and pollution victim compensation.

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Theoretical and Empirical Analysis of Farmers' Behavior in Participating in Agricultural Insurance in the Undeveloped Poverty Stricken Areas in China*

HAN Jinmian, ZHANG Shan

HAN Jinmian*
Associate Professor
School of Economics and Management
Northwest University
Xi'an 710127, China
Phone: (86) 13279291829
Email: jinmianh@ nwu.edu.cn

ZHANG Shan
Master degree candidate
School of Economics and Management
Northwest University
Xi'an 710127, China
Phone: (86) 15991609750
Email:izhangshan@163.com

Keywords: Agricultural Insurance, Behavior in Participating in Agricultural Insurance, Logit Model, the Undeveloped Poverty Stricken Areas.

Abstract. Chinese Thirteenth Five-year Plan proposes to help the seventy million poor people living in the undeveloped poverty stricken areas out of poverty. The

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undeveloped poverty stricken areas are the poorest areas in China with fragile ecology. The special natural, social and economic features in such areas make the households face a variety of risks. Carrying out agricultural insurance can help the farmers' transfer their risks and stable their lives. However, the activeness of farmers' participation in agricultural insurance is inadequate in these areas. This article, based on the theory of risk management and insurance, analyzes the farmers' behavior in participating in agricultural insurance in the undeveloped poverty stricken areas in China. It explores the factors that affect the farmers' agricultural insurance participation behavior. It takes the farmers' personal characteristics, their family income and capital, as well as their risk awareness as the main variables, and studies their effects on farmers' behavior in participating in agricultural insurance. Moreover, it uses the Logit model to do the empirical analysis based on the questionnaire data in such areas, and lastly it puts forward the conclusion and policy suggestions.

1.引言

让中国连片特困区的七千多万贫困人口脱贫致富，这是十八届五中全提出的“十三五”目标之一。要在五年内实现这一目标，中国的扶贫事业任重道远。众所周知，连片特困区基本覆盖了全国大部分贫困地区和深度贫困群体，这些地区的生态环境十分脆弱，农户常年处于贫困之中，一般的经济增长策略难以带动这些地区的发展，常规的扶贫手段难以奏效，如何找到适合该地区的脱贫手段，因地制宜，帮助贫困群众增加收入与提高自我发展能力，帮助这些地区实现经济又好又快发展，是当下我国亟须解决的问题。

连片特困区农户主要以农业为生计，因此频发的自然灾害对其农业收入会产生巨大的影响。仅靠政府的救助、社会的捐赠，并不能有效转移和分散这些风险。因此，在这些地区开展政策性农业保险就显得势在必行。保险作为一种市场化的风险保障、经济补偿和社会治理机制，其能有效保护贫困地区农户的生产力，分担农户的经济损失，稳定农户的收入，提升其自我发展能力，并且能促进农村金融体系稳定，是实现全面建设小康社会可以利用的重要风险管理工具。政策性农业保险自 2002 年提出以来至今，一直得到各方学者的关注与研究，如何实现其可持续发展，那就需要各方的共同努力与各项制度的协调配合，尤其是必须得到农户的参与。

但是，连片特困区现实的情况是：农业保险的基础很薄弱，不利于保险公司的经营与管理，加之农户长期以来形成的依赖政府的思想，使得连片特困区的农户对于农业保险的参与性并不高。由于我国商业性农业保险市场供给与需求都不旺盛，从而导致农业保险市场失灵，即在中国农业保险处于“供需双冷”状态之下(冯文丽，2004)[1]。因此研究农户参加农业保险的因素是很有必要的。国外对于

农户参保行为因素研究的相关文献有很多。首先从保险需求方面来看，Vandeveer(2001)通过对越南农户参与荔枝保险的分析发现，农户参保行为受到个人特征、家庭特征以及风险相关变量等因素的影响[2]。接着，Elizabeth J. Austin（2001）认为人力资本与农户的情商对于农户参保决策具有一定影响[3]；Andrew Dorward ＆ Maria Maucer(2006)认为农户的文化水平和经营背景是农户生产行为的决定性因素[4]，当然，也有学者（John G. Mcpeak and Cheiyl Ｒ. Doss，2006）认为，农户的年龄以及对于风险的偏好也是重要因素[5]。

近年来，由于国家对农业保险的重视以及相关农业保险政策的普及，国内学者对于农业保险的研究越来越多，有关"农户购买农业保险意愿的影响因素"进行分析的有：宁满秀、刑郦、钟甫宁(2005) 对新疆玛纳斯河流域的棉农参与农业保险的实证研究证明，"农业生产风险的大小"、"棉花专业化生产程度"、"总耕地面积"、"户主务农时间长短"等因素会影响农户对农业保险的需求[6]。同时，他们又对农户支付意愿进行了实证分析，研究表明，农户对棉花保费的支付水平主要受棉花生产波动性高低、自然灾害给棉农带来的经济损失程度、棉花播种面积、农户对农业保险重要性的认知度等因素的影响[7]。张跃华、史清华、顾海英（2007）通过对河南省 622 个农户样本进行实证分析发现，农业风险是农民生产中所面临的主要风险，但是由于农民收人低和保险消费等原因，使得农业保险的商业性市场较小，对农业保险重要性的认知也是影响因素之一[8]。彭可茂、席利卿、彭开丽(2012) 运用 Tobit 模型通过对广东省 34 地农户稻作保险购买行为进行分析表明，农户家庭纯收入、对农业保险的认同等四个因素对支付意愿的影响较为显著，保险免赔率、生产总成本等六个因素对支付意愿有一定影响，而稻作面积、是否参与过其他保险等三个因素的影响甚微[9]。姜岩、李扬（2012）通过对江苏省宿迁市泗洪县和淮安地区金湖县农户调查数据的实证分析发现，保费补贴和风险厌恶对农户参保行为影响显著[10]。杨雪美、冯文丽等（2013）基于河北试点的实证分析，认为农户的风险意识、保险认知与政策性农业保险之间有一定关系，农户的风险意识已经形成，对农业保险也有一定认知，但大多数农户的保险认知被扭曲，导致农业保险覆盖率低下；同时，政府的保费补贴已经不是促使农户购买保险的最主要因素，影响农业保险覆盖率的关键在于是否有合适的保险产品规避农户最担心的农业风险，农业保险是否能够获得农户的认同[11]。

综上，国内文献在理论及研究方法上为本文后续进展提供了较好的基础，然而也存在一定的局限。大多数文献都是针对于局部地区或者某一农作物品种进行研究，而对连片特困区农户的参保行为具有针对性的分析几乎没有。因此，本文以风险管理为切入点并结合保险学相关知识，基于农户对农业保险需求的视角，分不同层次对影响农户农业保险需求及参保意愿的因素进行理论与实证分析，研究连片特困区农户这一微观主体通过参与政策性农业保险来降低农业风险所引起的损失，对于连片特困区农户脱贫具有指导意义。本论文结构具体安排如下：第一，引言。第二，农业保险参保行为的理论分析，具体包括：数学期望理论与农户参保行为、农业保险需求理论、理论分析与研究假设。第三，变量选取与模

型。第四，中国连片特困区农户参保行为实证分析，包括数据来源和描述性统计分析、回归结果及分析。第五，结论及相关政策性建议。

2.农业保险参保行为的理论分析

2.1 数学期望理论与农户参保行为

在“理性小农学说”理论中，美国经济学家舒尔茨认为“理性小农”能够最适度运用生产资源，如此他们就能获得最大化利润[12]。所谓农户的理性行为是指农户在面临多个可供选择的方案时，他们总是会选择能使自己效用最大化的那一种。那么，农户是否愿意通过参与政策性农业保险来获取保费的保障？这将取决于农户在保留性保费支出与真实的保费支出之间做出权衡，如果参保能够最大限度地提高未来的收益，那么农户将会选择参与政策性农业保险；如果参保之后农户不能获得增加的未来收益，那么他们会选择放弃购买农业保险。以上理论可以用以下数学公式表示[12]。

对于未参保农户的期望效用如下：

$$E(U|insu=0)=pU(Wo+Y-C-L)+(1-p)U(Wo+Y-C)$$

对于参保农户的期望效用为：

$$E(U|insu=1)=pU(Wo+Y-C-Q-L+A)+(1-p)U(Wo+Y-Q)$$

其中：

P 为损失发生概率；

Wo 为家庭最初资本；

Y 为家庭年收入；

C 为家庭年支出；

L 为灾害发生所造成的损失；

Q 为购买农业保险的保费支出；

A 为当发生灾害时所获得的保险赔偿。

由以上的公式我们可以得出，只有当$E(U|insu=1)>=E(U|insu=0)$时，参保行为才有可能发生。

上述分析过程表明，参保决策由农户自身决定，但同时也受其他因素的影响。如：家庭特征、农户个人特征等。

2.2 农业保险需求理论

对于农业保险需求的研究主要是基于冯· 诺依曼和摩根斯坦(1947)的期望效用最大化框架而发展起来，借助于风险规避系数，构造了一个分段的伯努利函数，认为农户对于风险的规避先随初始财富的增加而增加，当达到某一点后，再随财富的增加而减少[6]。在中国，农民是参与政策性农业保险的主体，相对于城市居民来讲，他们的收入较低，对于农业保险需求问题的研究常会涉及贫困地区贫困家庭。以下几点分析了农户对农业保险需求意愿。

（1）农户分散风险成本比较。农户可以通过减少货币的支出来管理自身所

面对的风险。如当农户的收入较少时，而对于一些必须支付的货币（如医疗费用、教育费用等），农户会在满足这些必须支付的费用的情况下，少支付或者不支付其他方面的货币支出，这种风险管理原则可以帮助农户获得最大化的收入。例如农户想引入农作物新品种，但种子价格相对较高，这时尽管种植新品种会给农户带来更高的产量和收入，部分农户仍会放弃选择新品种的机会以减少当期的货币支出，这是农民在既有资源和经济条件下的理性选择。

（2）农业保险在农户各种消费支出中的优先次序。农户具有整体风险管理的思维，他们在其日常生活中需要应对的不仅仅是农业风险，还有对子女教育费用的无力支付、对医疗费用无力承担等，农户面临的这些经济困难风险比农业风险对其带来的损失后果更为严重。因此，农户对于农业风险的担心相对较弱，农户会自觉地把农业风险置于整体的经济困难之后进行管理。因为农户资源和能力有限，他会使用优先顺序的管理方法，优先考虑的是教育费和医疗费用开支，其次再考虑农业风险的管理 。

（3）保险与其他风险管理方式之间的替代关系。农户可以选择利用非正式制度来管理风险。在农村地区，多数农户在面对风险和损失时，其最先考虑向邻居、亲朋好友构成的"关系网"相互借贷，这种非正式的相互援助为平滑消费起到了很好的保障作用，帮助农户应对了风险。

（4）运用财务管理方式---保险来应对风险。农户在农业风险发生之前，可以采取多样化的组合策略，如多元化经营是农户应对"事前"风险常用的传统策略之一，农户可以以此来降低收入波动，保证生产资金投入和家庭日常开销的现金需要。农户可以在"事后"采取一系列的财务策略来分散风险。农户在风险发生后通过动用储蓄、减少开支、寻求亲邻借贷来应对困境。动用储蓄和减少开支属于农户的自身"收入平滑"手段，借以度过困难时期。亲邻借贷属于无息贷款，是一种低成本的有效风险管理策略。即使在农业风险范围比较广泛，大多数农户遭受风险的情况下，此措施仍然有效，因为部分农户有其他非农收入。购买保险理论上是风险管理的重要财务手段，因为农业保险作为一种市场化的风险保障、经济补偿和社会治理机制，其能有效保护贫困地区农户的生产力，分担农户的经济损失，稳定农户的收入，是一种重要的风险管理工具。

2.3 理论分析与研究假设

基于以上的数学期望理论和农户的风险管理策略，本文在此基础上提出下面两条假说：

第一：理性人假设。本文认为，农户在决定要不要购买政策性农业保险时，最先考虑的是购买保险后能否获得最大的期望效用。即农户在考虑利用农业保险来风险分散时，需要考虑利用农业保险分散风险的成本与通过其他方法分散风险的成本进行比较，如果采用保险方式分散风险的成本小于农户自己分散风险的成本，那么，农户会选择向保险公司投保来分散风险；反之，农户不会购买农业保险，这是因为农民的行为是一种理性行为。

第二：农户具有厌恶风险的特征，他们对于风险偏好具有一致性。

本文又在以上两条基本假设的基础之上，提出了以下三个问题：

问题一：农户在何种情况下，会选择购买政策性农业保险？

问题二：影响农户购买政策性农业保险的影响因素主要有哪些？

问题三： 在农户选择购买政策性农业保险的时候，哪些因素会对农户的参保行为产生决定性影响，哪些因素会对农户的参保行为影响甚微？

带着以上三个问题，我们对连片特困区农户参保行为进行理论与实证分析，希望能对这三个问题进行很好的解答。

3.变量选择及模型

3.1 变量选择

在现有相关研究的基础上，选取农户的个人特征、家庭特征、对待风险的态度以及对保险的认知四类九个变量进行研究，其对农户参保行为的预期影响如下：

农户个体特征：农户在家庭决策中起重要作用，因此会对参与保险决策产生重要影响。农户个人特征主要包括农户的性别、年龄、受教育水平等，这些因素均会对农户的参保行为产生影响。一般认为，农户的教育程度越高，对于保险信息的获取及理解更迅速有效；年龄在一定程度上表明了被调查者是否具有表达自己行为的能力，年龄越大，务农时间越长，从事农业生产的经验越丰富，越不倾向于参加政策性农业保险来分担风险。而对于年轻的农户一般属于风险偏好型，故更容易参保。性别对农户的参保行为并没有特别准确的描述。因此在本文中，选择了农户的年龄、受教育水平为解释变量。

农户的家庭特征：在一般研究中，农户的家庭特征包括：家庭经营收入、农业收入占比、是否有盈余、是否有银行存款、困难时候亲戚朋友的作用。家庭年收入是支付农业保险能力的反映，故会对农户的参保行为有决定性影响；农业收入占比越高，说明家庭的主要收入来源为从事农业生产，其越有可能参与保险；家庭是否盈余是否有存款也是保费支付能力的体现；如果农户困难时通过向亲戚朋友借款越容易，那他们就会倾向于采用这种借款的方式来帮其渡过难关，就越不太可能参与政策性农业保险来分担风险。

个体对待风险的态度：包括对风险的考虑、风险态度、风险发生的次数。一般认为，对于风险考虑越多的农户，越倾向于购买农业保险，而那些持有无所谓态度的农户则不太会选择通过参保来应对风险。对于风险发生的次数，越多的风险意味着农户从保险公司那里得到的补偿越多，其自身所承担的风险损失就会相对较少，其越有可能参与保险。本文选取风险态度以及风险发生次数为研究因素。

对保险的认知程度：本文选取是否得到保险补偿、认为保险的作用两个变量来反映农民的心理认知状况。一般认为，农户如果能得到保险公司合理的理赔，其对于保险就持更信任的态度，更愿意购买农业保险。而对于农户是否参与新农合，则对于购买保险的意愿表示不确定。因为，如果农户购买了新农合，就不会有多余的资金来参与保险；而对于另外一些农户，他认可新农合，当然也有可能

认可农业保险。当然，认为保险作用更大的农户，就会选择购买农业保险。

3.2 回归模型

农户的参保意愿有“愿意参保”与“不愿意参保”两种情况，被解释变量具有非连续的特点，属于二元选择的问题。故本文采用二元 Logit 回归模型对农户参加政策性农业保险的影响因素进行实证分析。假定农户自愿参与政策性农业保险的概率为 P，其取值范围为[0,1]。当农户自愿参加农业保险时，P 值取 1；反之为 0，概率为（1-P）。

Logistic 模型采用的是逻辑概率分布函数，其中 α 为常数项，参数 βi 为 Logit 模型的回归系数；Xi 为农户参保决策的影响因素，即模型的自变量。

$$Pi = F(Zi) = F(\alpha + \beta Xi) = \frac{1}{1+e^{-Zi}} = \frac{1}{1+e^{-(\alpha+\beta Xi)}} \quad (1)$$

$$\ln \frac{Pi}{1-Pi} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i \quad (2)$$

(2)式即为最终线性回归模型。

4.中国连片特困区农户参保行为实证分析

4.1 数据来源和描述性统计

4.1.1数据来源

本文数据来源于国家社科基金项目“中国连片特困区农户的风险冲击、脆弱性及其反贫困策略研究”调研组于 2015 年与 2016 年在秦巴山区、武陵山区、吕梁山区及燕山-太行山区四个连片特困区调查得到。

本次调查共发放问卷 1259 份 ，收回有效问卷 1176 份 ,问卷回收率为 93.4%。主要调查方法为街头随访、随机入户调查。调查内容包括四大部分: 第一部分为农户家庭的基本情况；第二部分为农户家庭收入、支出调查；第三部分为农户所遇风险冲击及对待风险的态度；第四部分为家庭资本、社会资本、信贷、保险调查。

4.1.2样本的描述性统计分析

表 1：样本的描述性统计分析

变量名称	变量含义	均值	标准差	最小值	最大值
Insure1	是否参保	0.674	0.472	0.000	1.000
hage	户主年龄	48.36	11.34	19	84
hkno	受教育程度	1.833	0.763	0.000	4.000
surp	是否盈余	0.602	0.758	0.000	1.000
leftsave1	是否有存款	0.552	0.478	0.000	1.000
thrisk	对风险考虑	2.538	0.626	0.000	3.000

attrisk	风险态度	1.151	0.718	0.000	3.000
numrisk	风险次数	2.521	1.620	0.000	12.000
insure2	是否得到保险补偿	0.474	0.433	0.000	1.000
insure3	保险作用	1.515	0.744	0.000	3.000

4.2 回归结果及分析

本文使用 Eviews8.0 软件对变量进行分析与处理，得出的结果列于表 2 中。从以下的回归结果我们可以看出：

表 2 计量回归结果

Variable	Coe.	Std.	P 值
constant	-0.942***	1.020	0.006
hage	-0.014***	0.016	0.004
hkno	0.154***	0.039	0.000
surp	0.000	0.000	0.172
leftsave1	0.065*	0.383	0.065
thrisk	0.477***	0.177	0.007
attrisk	-0.098	0.206	0.363
numrisk	0.169**	0.074	0.033
insure2	4.823***	0.671	0.000
insure3	0.324***	0.193	0.000

注: *、**、***表示 10%、5%、1%的显著性水平。

（1）对于农户的个人特征方面：户主年龄（X1）及受教育程度（X2）均通过了显著性检验，且均在 1%的水平上显著。年龄的弹性影响系数为-0.014，这表明，年龄每增加 1%，农户参保的概率下降 0.014%。这种现象的原因可能是年龄越大的农户，务农时间越长，从事农业生产的经验越丰富，越不倾向于参加政策性农业保险来分担风险；还有可能是因为年龄越大的农户，他们承担的责任越多，故而会对风险采取比较保守的对待方式，比如说向亲戚朋友借款或者通过其他非正式保险来应对风险。对于受教育程度这一因素，其弹性影响系数为 0.154，表明随着受教育年限每增加 1%，农户参保的概率增加 0.154%。这是因为受教育程度越高的农户，他对风险的认知水平、对保险的了解程度都会有很好地了解，故越容易参保。这与该论文前期的预期是一致的，也与国内相关学者(彭可茂，席利卿, 彭开丽)的研究结果相吻合[9]。

（2）在农户的家庭特征方面，家庭是否有盈余未通过显著性检验，而家庭是否有存款在 10%的水平上显著。这说明家庭盈余与农户参保行为没有相关性，产生这种现象的原因可能是本文在选取代理变量的有效性方面存在这一定的缺

陷；也有可能是因为农户认为，不管是将钱存在银行，还是投放于保险，都是一种投资方式，那既然选择了在银行存款，那就不太愿意再去将钱投资于农业保险，毕竟银行会支付一定的利息，有固定的现金流入，而保险的不确定性太大，故而会影响农户的投保决策。

（3）在对风险的考虑、风险的态度以及风险发生的次数三个变量中，只有风险的态度未通过显著性检验，而风险态度在 1%的水平上通过检验，风险发生的次数在 5%的水平上通过检验。可见对于风险考虑越多的农户，越倾向于购买农业保险，且其弹性影响系数为 0.477，表明农户对于风险的考虑概率增加 1%，那么他们参保的可能性就增加 0.477%；对于风险发生的次数，越多的风险意味着农户如果参与农业保险，那么他从保险公司那里得到的补偿就会越多，其自身所承担的风险损失就会相对较少，其越有可能参与保险，这与本文的预期是一致的，也与国内学者王敏俊在《影响小规模农户参加政策性农业保险的因素分析》一文中所得的结果一致[13]。而农户的风险态度对参保行为影响并不显著，有可能是因为即便农户对风险很在乎，他们也可以在风险发生时，选择其他方式（比如向亲戚朋友借款、银行借款或者通过引入新技术、多样化种植等）来平滑风险带来的损失，因此其对农户参保行为的影响并不显著。

（4）农户对于保险的作用的认知以及是否得到过保险公司的补偿均通过了显著性检验。这是因为，认为保险作用越大的农户，其更会选择购买保险来分担风险，同时，得到过保险公司补偿的农户，他们会更信赖保险公司，这也会增加他们参保的几率。这与预期结果均一致,也与国内的相关研究结果一致[11]。

5.结论及政策建议

通过分析，我们可以得出以下结论：

（1）农户购买农业保险的行为，取决于他在参保后所获得的期望效应是否大于未参保时候的效用。如果大于，则符合期望效用最大化原理，农户就更倾向于参保。对于风险规避型的农户，他们在购买农业保险之后，自然灾害发生时的货币边际效用若等于不发生自然灾害时货币财富的边际效用的保险金额，是他们需要购买的保险品种

（2）影响农户参加农业保险行为的因素主要有：农户年龄、受教育程度、是否有盈余、是否有银行存款、对风险的态度、对保险的作用的认识及是否获得保险公司的赔偿等。

（3）在影响农户参保行为的因素中，户主年龄、受教育程度、是否盈余、是否有存款、对风险考虑、风险态度、风险次数、是否得到保险补偿、保险作用。在这些因素中，户主年龄、受教育程度、对风险考虑、是否得到保险补偿、保险作用对农户参保行为影响显著，风险次数对农户的参保行为有一定影响，而是否有盈余、是否有存款、风险态度这三项因素对农户参保行为影响甚微。

在此基础上，我们对我国连片特困区农业保险的发展提出以下几点建议：

首先：应该充分发挥政策性农业保险的功能。从本文的研究看，政策性农业

保险在农村正稳步推进，其作为有效分散农业风险的手段，正在得到政府与农户的重视。为了保证其顺利实施，就必须因地制宜，在中国不同地区开展不同的农业保险。例如，连片特困区的致贫因素有很多，应该根据连片特困区风险发生种类结构、地区特点、产业特点，开展保险种类灵活的保险产品，同时根据农户自身对于保险的支付水平，来合厘定保费，不断开发新保险险种，使之推广普及到最需要的贫困地区。

其次，农户对保险作用的认知以及农户是否得到保险公司的补偿，均对农户参保行为有很大影响。这就表明农业保险在连片特困区的开展具有可持续性。那么，可以通过部分群众的模范带头作用来扩大政策性农业保险的普及推广，也可以通过“熟人效应”，即以前从保险受益的群众，通过人传人的方法，来扩大农业保险的普及范围。政府也可以通过“以惠促保”手段干预农业保险市场，提高农户的参保积极性。

最后，农业保险在连片特困区的推广与应用，应该与十三五规划提出的目标相契合，引领各方资金与设施的投入，加强农村地区基础设施建设，促进农民增收，以农户增收带动地区性保险的发展，在以保险的发展来保障农村地区农户的收入，形成一种优势互补的模式。

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中国连片特困区农户农业保险参保行为理论与实证分析

韩锦绵 张珊

韩锦绵*
副教授
西北大学经济管理学院
西安 710127，中国
电话: (86) 13279291829
Email: jinmianh@nwu.edu.cn

张珊
硕士生
西北大学经济管理学院
西安 710127，中国
电话: (86) 15991609750
Email: izhangshan@163.com

关键词: 农业保险;参保行为;Logit 模型;连片特困区

中文摘要.我国十三五规划提出要采取措施帮助连片特困区七千多万贫困人口脱贫。连片特困区属于中国贫困程度严重、生态非常脆弱的山区，特殊的自然、社会、经济特征使得这些区的农户面临着多种风险，开展政策性农业保险，建立农业风险防范机制，有利于增强农户的风险抵御能力，有效稳定农民生产生活，但特困区农户参与农业保险的积极性并不足。本文依据风险管理和保险学相关理论，对连片特困区农户的参保行为进行理论和实证分析，以农户个人特征、家庭收入及资本、个体对待风险的态度以及对保险的认知为主要变量，从理论上分析诸因素对农户参保行为的影响情况。同时基于 14 个连片特困区农户调查问卷数据，借助 Logit 计量回归模型进行实证分析，最终得出相关结论并给出政策建议。

Social Capital, Informal Insurance and Risk Sharing of Rural Households: an Example of the Undeveloped Poverty Stricken Areas in China *

HAN Jinmian, ZHAO Ling

HAN Jinmian*
Associate Professor
School of Economics and Management
Northwest University
Xi'an 710127, China
Phone: (86) 13279291829
Email: jinmianh@ nwu.edu.cn

ZHAO Ling
Master degree candidate
School of Economics and Management
Northwest University
Xi'an 710127, China
Phone: (86) 18292867782
Email: zhaoling10@126.com

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Abstract. The farmers' poverty has been a big concern in China. The majority of them live in the 14 undeveloped poverty stricken areas, which have been considered as crucial battlefields for future poverty alleviation. These areas face harsh living conditions and frequent natural disasters, and the farmers encounter various risk

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shocks. Both formal and informal insurance are applied there for the farmers' risk management. At present, there exist two forms of social insurance: the new rural cooperative medical system and the rural social endowment insurance. The development of commercial insurance has been very slow. Therefore, the informal insurance based on social capital is a major means for the farmers' risk sharing. This paper, in the perspective of social capital, theoretically analyzes the risk sharing mechanism of informal insurance, and through the field survey in such areas in China, it uses the Tobit model and factor analysis method to carry on the empirical analysis. It discusses the effects of four dimensions of social capital, such as social network, participation, trust and reciprocity on the risk sharing amount of informal insurance. Finally, this paper analyzes the indispensability and shortage of informal insurance in such areas, and puts forward policy recommendations for the farmers' risk sharing. It also discusses how the informal insurance cooperates with formal insurance for the farmers' risk sharing in such areas in the current institutional environment.

1.引言

作为一个发展中农业大国，农村贫困问题是我国改革和发展中的关键问题，一直备受学术界和政府的关注。二十一世纪之初，随着《中国农村扶贫开发纲要（2001-2010）》目标任务的完成，中国的绝对贫困人口分布呈现出大分散、小集中态势，向民族聚居区、边远山区、省际交界区、革命老区集中，这些区域被称为集中连片特殊困难区，简称连片特困区。为顺应中国贫困格局的这一变化，2011年，《中国农村扶贫开发纲要（2011～2020 年）》在全国共划分了 14 个连片特困区，作为中国新阶段的扶贫攻坚主战场。这些连片特困区生态系统脆弱，公共服务和基础设施滞后，信息闭塞，工业化、农业产业化、城镇化水平低，民众受教育水平低，缺乏科技人才，水土流失严重，土地贫瘠，自然灾害频发……农户直接面临着资产风险、社会风险、收入风险和福利风险等多样的风险冲击，并以正式保险和非正式保险两种形式分担着风险。

20 世纪 80 年代以来，我国保险业迅速发展。1980 年全国保费收入为 4.6 亿元，2015 年全国保费收入增长到 2.4 万亿元，保险业总资产已达 12.4 万亿元，中国成为全球保险业发展最快的国家。但农村保险的发展速度却尤为缓慢，在很大程度上制约着农村的经济发展。2015 年，我国农业保险保费收入仅为 374.7 亿元，这远远低于城市的保费水平。现阶段，除新农合、农户社会养老保险外的其他社会保险制度较少进入这些连片特困区，商业保险在连片特困区的发展也非常迟缓（叶明华，2015；范文敬，2014）。目前我国保险机构可达 180 家，但是在连片特困区开展业务的只有中国人寿保险公司、平安保险公司、太平洋保险公司、中国人民保险公司等少数保险机构（柯毅萍，2008：刘扬等，2008）。

我国连片特困区正式保险制度安排十分薄弱，再加上农户的保险意识较低，受农村文化环境的影响，农户们在遭受到风险冲击后更倾向于在家庭内部分担，信息闭塞和一些不适当言论的传播也导致了农户对保险的不信任，农村保险有效需求不足（杨思思，2009）。此外，连片特困区农户收入水平较低，但商业保险公司在农村的保险业务价格偏高，农户们缺乏商业保险支付能力。因此，对农户而言，基于社会资本的非正式保险是进行风险分担的主要手段。遭受风险冲击的农户可以利用其所有的社会资本获得馈赠、非正规信贷等形式的非正式保险，从而平滑消费，降低风险冲击造成的损失。在此背景下，本文以社会资本为切入点，利用 2015 年中国连片特困区的农户调查数据，研究社会网络规模、参与、信任、互惠等四个不同的社会资本维度对非正式保险风险分担额度的影响，期望从社会资本的新视角为有效利用非正式保险制度，提高连片特困区农户风险分担效率，推动农村社会保障体系建设提供理论与实证支持。

2.文献综述

2.1 对社会资本的研究

近年来，有关社会资本的研究越来越多，根据其研究内容不同可以分为 3 类：

（1）社会资本的定义。社会资本是近年来社会科学中最突出且争议最多的概念，至今依然没有一个统一明确的定义。20 世纪 80 年代后期、90 年代早期，Bourdieu (1985)、Coleman (1988)和 Putnam (1993)的研究是社会资本理论的讨论起点。Bourdieu (1985)首次对社会资本的概念做出了比较系统的界定，他认为社会资本的核心是“个体所拥有的关系网络为其创造了一种有价值的资源,该资源可以使个体进一步摄取经济资本和文化资本”。Coleman（1988）用社会资本的功能为其定义，他给出了社会资本的五种形式：义务与期望、存在于社会关系内部的信息网络、规范与有效惩罚、权威关系、多功能社会组织和有意创建的社会组织等。Putnam et al (1993)提出了经济学界普遍认同的社会资本的定义:“社会资本是一种社会组织的特征，是能够通过推动协调和行动来提高经济效率的网络、信任和规范”。Fukuyama（1999）从经济学角度提出了社会资本的代表性观点，他认为社会资本是群体成员之间共享的非正式的价值观念和规范，这样的规范有助于个体之间相互合作，同时社会资本是以信任为基础的。

（2）社会资本的测度。由于社会资本概念的不统一，学者们对社会资本的度量方法也各异，其中比较有代表性的方法有：韦恩·贝克（1998）提出了四个测量社会网络的指标并把社会资本分成了两种理想的类型，他认为应该通过测量个人的社会网络来评估其社会资本。布伦、奥妮克丝（1995）提出了社会资本的 8 个要素：参与、信任、家庭与朋友的联系、邻居间的联系、工作联系、差异的承受力、社会背景能动性、生活价值,并据此总结出了一套较完善的社会资本测度方法。普特南(1993) 采用投票人参与、非盈利性组织会员数量、报纸读者群等来度量了意大利不同地区社会资本的大小。林南(1999)直接使用了关系主体的财富、权力和地位等特征来测量社会资本,并把社会关系网络的规模、同质性、

异质性、密度、内聚性以及封闭性作为测度社会资本的指标。

（3）社会资本与反贫困。黄英君等（2011）基于社会资本投资的视角研究了我国政府的反贫困政策，发现社会资本投资缺失是未能有效解决贫困问题和实现预防贫困的主要原因。罗连发（2012）指出在发展落后的农村，社会资本的效应较强，非货币形式的社会资本能够显著降低贫困的概率。周晔馨（2014）提出信任对减少绝对贫困有积极作用，社会资本通过平滑消费减轻短期贫困，通过促进融资和创业、促进劳动力流动，有助于消除长期贫困。但总体看来社会资本反贫困的积极作用在逐步减弱。刘彬彬（2015）从农户获取收入和应对风险能力两方面探讨了社会资本在发贫困中的作用，研究发现社会资本在改善农户福利时存在明显的门槛特征，社会资本对资产较低农户的增收作用并不显著，社会资本对农户风险应对能力的影响大于物质资本和人力资本。

2.2 对非正式保险的研究

自 James C. Scott（1976）最早发现东南亚农户间存在非正式保险并出版《农民的道义经济学：东南亚的生存与反叛》后，非正式保险引起了学术界广泛关注。目前对发展中国家非正式保险的研究主要集中在以下几个方面：

（1）非正式保险的概念和特征。非正式保险是相对于国家强制实施的社会保险和商业保险等正式保险制度而言的，蕴含社会网络成员对个体遭受风险冲击所带来的损失进行分担这一功能的制度安排（王凯，2006）。非正式保险的特征主要有三点：第一，非正式保险制度包含着金融市场不完备、私人权利制度发展不规范和参与者难以认同正式保险制度等外部约束（姜广东，2002）。第二，非正式保险制度中提供援助的农户并不期望自己将来能够获得同等数量的回报，他们仅希望那些接受援助的农户能够在自己遭受风险冲击时提供帮助，至于所提供帮助程度的大小，则取决于他们自己的具体情况（Fafchamps,1992）。第三，由于非正式保险制度的运行通常局限于由血缘关系、地域关系和业务关系结成的初级群体，参与成员间信息充分，不存在信息不对称的情况，运行成本低。

（2）非正式保险的限制因素和效率。非正式保险制度主要受参与成员的收入、参与者对未来的重视度、对背叛行为的惩罚程度、信息交流的程度以及脱离社会网络的代价等因素限制（白永秀等，2007）。很多学者对非正式保险的效率进行了研究，绝大多数实证结果都表明非正式保险不能完全分担风险。Morduch（2004）通过对印度的研究发现，虽然转移支付可以降低 40%～90%的收入风险，但在参与者的社会网络内,非正式保险不能实现完全的风险分担。Fafchamps 和 Gubert(2007)通过实证研究发现，非正式保险的参与者不会有意识的与其他收入阶层的人建立联系，因此非正式保险分担风险的效率较低。比较而言，Townsend(1994)的研究则指出，虽然统计上拒绝了完全风险分担，但农户家庭消费变动与村庄整体消费变动密切相关，与农户家庭收入相关性较小，非正式保险的风险分担程度相当高。Mazzocco 和 Saini（2007）认为，以往文献之所以得出非正式保险分担风险效率低下的结论是因为他们假设所有农户的风险偏好相

同。

（3）非正式保险与正式保险的关系。正式保险制度与非正式保险制度之间的相互影响比较复杂，两者既有可能相互排斥产生挤出效应，也有可能相互促进形成共生关系，目前学术界并没有就此达成统一意见。Dubois 等（2008）研究了正式保险和非正式保险的动态互动模型，他们预测正式保险和非正式保险是共生关系,正式保险的存在可以放宽非正式保险的合同约束，提高风险分担效率。与此相反，段誉和刘一鸣等（2011）指出，正式保险机制会挤出非正式保险机制，引入正式保险会提高农户风险分担效率。林莞娟等（2014）实证研究了这种挤出效应和福利变化，结果表明理论预测的过度挤出和风险覆盖率下降并不存在，收入差距过大会导致正式保险对非正式保险的挤出效应过大而风险覆盖率不变。

综上所述，当前学者对社会资本的研究大部分集中于社会资本的内涵和度量等方面，对非正式保险的研究主则要集中于非正式保险的概念形式及其与正式保险的关系，而从社会资本视角研究非正式保险风险分担额度的文章极少。本文利用因子分析法和 Tobit 模型首次考察了社会资本不同维度对非正式保险风险分担额度的影响，余下部分的结构安排如下：第三部分是理论分析与研究假设；第四部分是研究方法及模型；第五部分是实证分析；最后是本文的结论及政策建议。

3.理论分析与研究假设

本文定义社会资本为以资本形态存在于社会关系网络中，并能通过所有者的积累，为自身带来便利和收益的社会资源。社会资本有利于人们达成某种目标，改善自身和周边环境的现状。许多研究表明，正式保险制度缺失时，在发展中国家的大部分地区尤其是农村，可以产生具有风险分担功能的非正式保险制度。而农户能够获得的非正式保险形式和数量与其自身具备的社会资本是相关的。

经济学家从二十世纪 80 年代就开始尝试将非正式保险分担风险的机理形式化，至 90 年代初，Mace(1991)和 Townsend(1994)已经建立了描述非正式保险的数学模型。假定村庄有 n 户人家，且 n=1，2，…，N，c_n 和 z_n 分别为每个农户的消费和消费偏好。农户的效用函数 $u_n(c_n,z_n)$对 c_n 二阶可导，且一阶导数大于零，二阶导数小于零；对 z_n 一阶可导，一介导数大于零。村庄内部分担风险的目的是实现整体效用最大化：

$$MaxU = Max\sum_{n=1}^{N} u_n(c_n, z_n) \tag{1}$$

γ_n是每个农户的家庭收入，村庄整体的收入约束为：

$$\sum_{n=1}^{N} c_n = \sum_{n=1}^{N} \gamma_n \tag{2}$$

在该条件下求解效用最大化问题的条件为：

$$\frac{\partial u_m(c_m,z_m)}{\partial c_m} = \frac{\partial u_n(c_n,z_n)}{\partial c_n}, m, n \in \{1,2,\cdots N\} \tag{3}$$

这表明，如果非正式保险可以完全分担风险，村庄中所有农户的边际效用是

相等的。收入会依据每个农户的支付能力和实际需要在内部进行转移，这是非正式保险制度应对未知风险冲击的必要条件。在非正式保险实现完全风险分担的情况下，农户面临的仅是整个村庄系统风险。

Ligon(2002)提出了动态风险分担模型，本文在其基础上来分析农户社会资本对非正式保险的影响。假设在初始时期 t，农户 n 为了应对未来的风险向另一个农户转移了一部分资产τ_n^t,对向外转移资产的农户而言，$\tau_n^t > 0$；对接受资产转移的农户而言，$\tau_n^t < 0$。农户之间的转移支付以两者的收入为限，在转移之后农户的当期消费仍为非负，农户得到的修正后的效用为：

$$V_t^n = u_n^t(c_n^t - \tau_n^t, z_n) + \sum_{j=t+1}^{\infty} \delta^{j-t} [u_n^t(c_n^t - \tau_n^t, z_n) - u_n^t(c_n^t, z_n)] \quad (4)$$

其中，δ 表示折现因子。如果农户拒绝对外转移，农户的社会网络规模就会缩小，农户间的信任、参与、互惠程度也会降低。这些都是社会资本的维度，它们的降低会直接或间接的减少农户的效用，具体表现为：如果某一农户拒绝为其他农户分担风险，该农户的参与会减少，社会口碑受损，信任水平降低，进而导致该农户在未来发生风险时得不到其他农户的帮助，非正式保险的风险分担额度降低。反之，农户参与风险分担，对外转移资产会在社会资本上增加非正式保险风险分担额度。基于以上分析，本文提出如下假设：

H1：社会资本越丰富的农户，在遭受风险冲击时非正式保险风险分担的额度越大。

H2：社会网络规模越大，参与程度越大，信任水平越强，互惠程度越高，农户的非正式保险风险分担额度越大。

H3：社会资本的信任、社会网络规模、互惠、参与等维度对农户非正式保险风险分担额度的影响程度不同。

4.变量选择及模型

4.1 变量的选取

非正式保险主要形式包括农户间互惠性借贷、实物赠与、货币收入转移和相互提供劳动力等（Habtom GMK and P Ruys,2006; Bloch F, Genicot G, Ray D,2010.）。由于货币收入转移通常发生在家庭内部；实物赠与和相互提供劳动力的数据获取较难;，其价值也难以准确估量。因此，本文以农户间互惠性信贷发生额度和货币收入转移作为基于社会资本的非正式保险风险分担额度。

本文主要以家庭社会网络规模、参与、信任、互惠作为社会资本的测量指标，具体如下：

社会网络规模：社会网络规模通过调查农户平时主要交往且可能给他们带来收益的人数来说明，包括家庭是否有人外出务工，经常往来亲戚个数。在中国农村地区，外出务工网络是社会网络的一种重要表现形式，它可以为农村剩余劳动力提供外出务工的信息和机会，增加非农业性收入，该指标用农户是否有人外出

务工反映社会网络的广延性，以经常往来的亲戚个数度量当地社会网络的密切强度，并假定农户经常往来的亲戚在不存在质的差异。

参与：参与通过融入组织和群体来获取稀缺资源，反映农户参与社会生活的深度。该指标通过调查农户对公共事物的关心程度和参与村干部选举、入党的情况来衡量，分为经常参与、有时参与、很少参与和从不参与 4 个等级，分别被赋予 4—1 分。

信任：信任以人们之间的相互信任为纽带获取利益，反应的是人对外界的信任程度。该指标以家庭对外界包括政策、日常交往对象等的平均信任程度来衡量信任度，具体量级从非常信任到从不信任分别赋予 10—1 分。从某种意义上说，邻里之间的融洽程度也蕴含了农户之间的信任程度。

互惠：指农户与日常交往人群的互相帮助程度，它可以促进成员之间的信任和合作，有效的约束投机，解决集体行为中的"搭便车"问题，该指标通过农户遇到困难时亲戚朋友的作用大小来衡量，选项包括大、较大、一般和无，分别赋予 4—1 分。

4.2 模型

Tobit 模型包含两个部分，一是表示约束条件的选择方程模型，二是满足约束条件下的某连续变量方程模型（又叫潜在因变量模型）。表示如下：

$$y_i^* = \beta_0 + \beta_1 SC + \beta_2 Z + \varepsilon \tag{5}$$

$$y_i = \begin{cases} y_i^*, & if\, y_i^* > 0 \\ 0, & if\, y_i^* \le 0 \end{cases} \tag{6}$$

其中，y_i为因变量，度量农户基于社会资本的非正式保险风险分担额度；y_i^*为潜在因变量。β_0为常数项，β_1、β_2为回归系数矩阵，ε为随机误差项；SC 为解释变量，度量农户的社会资本；Z 为控制变量矩阵。Tobit 模型的一个重要特征是，解释变量是可观测的，而被解释变量只能以受限制的方式被观测到；当$y_i^* > 0$时，观测到的农户互惠性借贷及家庭间馈赠额度$y_i = y_i^*$，称y_i为无限制观测值；当$y_i^* \le 0$时，观测到的农户互惠性借贷及家庭间馈赠额度$y_i = 0$，称y_i为受限观测值。即对潜在因变量y_i^*的值进行了左截取。

5.实证分析

5.1 数据来源和描述性统计

5.1.1数据来源

本文数据来自 2015~2016 年课题组对中国连片特困区农户的 1259 份问卷调查，其中有效问卷共计 1176 份。调查采取随机抽样的方法，由调查员与户主进行面对面的访谈，调查问卷涉及农户基本特征，家庭收入和支出，农户社会资本等项目。

5.1.2农户的社会资本状况

表 1　变量的定义与描述

总体分类	变量名称	变量解释	均值	标准差	最小值	最大值
非正式保险风险分担额度	Y_1	互惠性信贷	10101.20	24273.36	0	300000
	Y_2	家庭间馈赠	8504.57	6374.02	0	50000
社会资本	SC1-1	家庭是否有人外出务工	0.65	0.48	0	1
	SC1-2	经常往来亲戚个数	11.86	9.78	0	50
	SC2	互惠	2.60	0.94	1	4
	SC3	信任	1.94	1.88	0	9.09
	SC4	参与	1.81	0.94	1	4
家庭特征	scale	农户规模	4.44	1.37	1	9
	area	耕地面积	5.82	6.00	0	40
	gender	户主性别（=1 为男性）	0.94	0.24	0	1
	age	户主年龄	48.36	11.34	19	84
	health	户主是否健康(1 为健康）	0.88	0.33	0	1
	edu	户主教育程度	1.95	0.79	0	4
	ifbaoxian	是否购买正规保险	0.32	0.47	0	1
	ifdaikuan	是否得到银行贷款	0.20	0.40	0	1

（1）社会网络规模

从反应集中趋势的均值和反应离散程度的标准差、最大值、最小值来看，被调查农户中有人员外出务工的农户多于无人员外出务工的农户，经常往来的亲戚个数最大值为 50 人，最小值为 0 人，均值为 11.86，标准差为 9.78，这些指标说明被调查农户的社会网络规模差异大，离散程度高。

在家户规模小于 5 的家庭中，有人员外出务工的家庭比例为 61%；家户规模大于 5 的家庭中，有人员外出务工的家庭比例为 74%。当户主年龄指标在 30-40 之间时，有人员外出务工的家庭比例仅有 35%，但家户经常往来的亲戚个数最多；户主年龄指标在 30 岁以下和 60 岁以上的家户有人员外出务工的家庭比例分别为 62%和 70%，经常往来亲戚个数较少。当户主为男性时，经常往来亲戚个数均值为 12.87；当户主为女性时，经常往来亲戚个数均值为 7.82。户主为男性的家庭日常交往人数远大于户主为男性的家庭，这与男性的社会地位和主动性有关，男性户主家庭的社会网络规模大于女性户主家庭。

（2）互惠

通过描述性分析可知，被调查农户的平均互惠水平为 2.60，最大值为 4，最

小值为 1，标准差为 0.94，这些指标说明被调查农户的互惠情况较多，且差异不大。

分析结果显示，户主年龄小于 30 岁和大于 60 岁的农户互惠水平较低，而户主年龄在 30 岁至 60 岁之间的家庭互惠水平较高。这可能是由于户主年龄较小的家庭其所积累的资源有限，户主年龄较大的农户日常交际范围较小，而中年户主农户既拥有相当的资源，也有频繁的交际活动。

（3）信任

通过描述性分析可知，被调查农户的平均信任水平为 1.94，最大值为 9.09，最小值为 0，标准差为 1.88，这些指标说明被调查农户对外界的信任程度较低，且差异不大。

分析结果显示，户主的教育水平不同，对外界的信任程度也不同。户主受教育水平为高中及以下的农户对外界的信任程度高于户主受教育水平为大学及以上的农户，这是因为受教育水平越高，人的主观判断能力越强越谨慎，对外界的信任程度越低。

（4）参与

通过描述性分析可知，被调查农户的平均参与程度为 1.81，最大值为 4，最小值为 1，标准差为 0.94，这些指标说明被调查农户对各种活动和公共事务的参与程度较低，且差异不大。

分析显示，户主年龄小于 30 岁的农户对公共事物的平均参与程度为 1.39，户主年龄在 31-45 之间的农户对公共事务的平均参与程度为 1.66，户主年龄在 46-60 岁之间的农户对公共事务的平均参与程度为 1.91，户主年龄大于 60 岁的农户对公共事务的平均参与程度为 2.33。这说明户主年龄越大的农户威信和社会声望越高，受人们的尊重程度越高，对公共事务的参与程度越大。

5.2 回归结果及分析

社会资本的不同维度之间会相互影响故而产生多重共线性，为解决这一问题，本文根据社会资本各维度不同构造了 5 个 Tobit 模型，将社会资本的不同维度分别带入，其自变量分别为社会资本综合因子、社会网络规模、互惠、信任、参与，计量回归结果如表 2 所示。模型 1 的结果显示，社会资本综合变量回归系数符号为正，在 1%的水平上显著，这表明社会资本越丰富的农户，在遭受风险冲击时非正式保险的风险分担额度越大。

从社会资本的四个维度来看，模型 2 的结果显示，社会网络规模的回归系数为正，在 5%的水平上显著，这表明社会网络规模越大，农户的非正式保险风险分担额度越大；模型 3 的结果显示，互惠的回归系数为正，在 10%的水平上显著，这表明互惠程度越高，农户的非正式保险风险分担额度越大；模型 4 的结果显示，信任的回归系数为正，在 1%的水平上显著，这表明信任水平越高，农户的非正式保险风险分担额度越大；模型 5 的结果显示，参与的回归系数为正，在 10%的水平上显著，这表明参与程度越高，农户的非正式保险风险分担额度越大。这

与研究假说 2 的结论一致。

从显著性水平来看，信任（P=0.0003）、社会网络规模（P=0.0103）、互惠（P=0.0327）、参与（P=0.0821）这四个维度对农户非正式保险风险分担额度的影响在统计学上均显著，且影响程度从高到低依次为信任、互惠、社会网络规模、参与。这验证了社会资本的信任、社会网络规模、互惠、参与等维度对农户非正式保险风险分担额度的影响程度不同的假说。

表 2 计量回归结果

变量	模型 1	模型 2	模型 3	模型 4	模型 5
社会资本综合	1587.63***				
社会网络规模		924.37**			
互惠			2321.66**		
信任				4871.19***	
参与					93.17*
农户规模	-648.21*	-628.62*	-606.37*	-1796.21*	-595.96
耕地面积	283.88**	373.88*	348.06**	822.55*	358.61*
户主性别	5385.259	15123.58	16997.72	9240.41	15108.47
户主年龄	-167.37*	-441.16**	-384.0943*	-337.34*	-421.98*
户主是否健康	-30419.28***	-31324.81***	-30910.96***	-32302.89***	-31496.85***
户主教育程度	2694.86	2453.99	2690.64	2426.08	2679.99
是否购买正式保险	-2201.46*	-2735.92**	-2353.14*	-7611.01	-3126.75*
是否得到银行贷款	24027.52***	31863.41***	31971.09***	23461.71***	30410.16***

注: *、**、***表示 10%、5%、1%的显著性水平。

对于控制变量农户家庭特征，农户规模的回归系数均为负，在 10%的水平显著，说明农户规模越大，非正式保险风险分担额度越小，可能的原因在于农户家

庭规模越大，需要赡养的老人和孩子越多，农户偿债能力越弱，借入的能力有限；耕地面积的回归系数均为正，在 10%的水平显著，表明农户所拥有耕地面积越大，非正式保险风险分担额度越大，可能的原因在于农户拥有的耕地面积越大，农业收入越多，必要时还可以出售或出租，家庭偿债能力越强，可以借入的额度越大；户主性别和户主教育程度没有通过显著性检验；户主年龄的回归系数均为负，在 10%的水平显著，说明户主年龄越大，非正式保险风险分担额度越小，这可能是由于户主年龄越大，劳动能力越低，获取收入越少，农户偿债能力越低，借款的额度越小；户主健康程度的回归系数均为负，在 1%的水平显著，说明户主越健康，非正式保险风险分担额度越小，可能的原因在于户主身体健康则劳动能力较高，获取收入的能力也越高，农户偿债能力越强，借入资金的额度越大；是否购买正规保险的回归系数为负，在 10%的水平显著，表明购买正式保险会降低农户非正式保险的风险分担额度，这可能是由于正式保险会对非正式保险产生挤出效应，参与正式保险的农户在遭受风险冲击时会得到一定的补偿，减轻农户损失，导致农户参与非正式保险的积极性降低；是否得到银行贷款的回归系数均为正，显著性水平为 1%，表明能够获得银行贷款的农户，非正式保险的风险分担额度较高，可能的原因在于能够获得银行贷款的农户一般资信状况良好，偿债能力也较高，可以融入的资金规模也越大。

6.结论及政策建

本文利用中国连片特困区的农户入户调查数据，运用 Tobit 模型从社会网络规模、互惠水平、信任水平、参与程度等四个维度实证分析了社会资本对农户非正式保险风险分担额度的影响。研究结果表明：第一，社会资本对农户非正式保险风险分担额度的影响在统计学上显著，社会资本越丰富的农户，农户非正式保险的风险分担额度越大；第二，信任水平、社会网络规模、互惠水平等社会资本不同维度对农户非正式保险风险分担额度的影响也在统计上显著，信任水平越高，社会网络规模越大，互惠水平越高，农户非正式保险的风险分担额度越大；第三，社会资本的信任、互惠、社会网络规模、参与等维度对农户非正式保险风险分担额度的影响程度依次降低。

总之，在物质资本和人力资本匮乏时，社会资本在很大程度上发挥着"穷人的资本"的作用，通过改善农户社会资本提高农户非正式保险风险分担效率将是一种新的政策选择。结合前人已有的研究成果和本文的结论，在此提出以下针对性的政策建议：第一，突出政府在连片特困区农户社会资本构建中的主体地位，鼓励各种文化娱乐组织的发展，推进社区建设，建立并完善社会信用体系；第二，充分发挥政府在反贫困中的积极作用，注重农户社会资本的培育，扩大连片特困区农户的社会网络规模；第三，在农村地区推行正式保险的同时，应充分认识并发挥基于社会资本的非正式保险在农户风险分担方面的作用，使之与正式保险制度相互配合，推动农村社会保障体系建设。

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社会资本、非正式保险、农户的风险分担

-以中国连片特困区为例

韩锦绵 赵玲

韩锦绵*
副教授
西北大学经济管理学院
西安 710127，中国
电话: (86) 13279291829
Email: jinmianh@nwu.edu.cn

赵玲
硕士生
西北大学经济管理学院
西安 710127，中国
电话: (86) 18292867782
Email: zhaoling10@126.com

关键词： 社会资本；非正式保险；风险分担；Tobit 模型；农户

中文摘要： 农户的贫困问题一直备受学术界和政府的关注。我国划分了 14 个连片特困区作为未来十年扶贫攻坚主战场，这些区域生存条件恶劣、自然灾害频繁，农户直接面临着多样的风险冲击，并以正式保险和非正式保险两种形式分担着风险。现阶段，除新农合、农户社会养老保险外的其他社会保险制度较少进入这些连片特困区，商业保险在连片特困区的发展也非常迟缓，正式保险制度安排十分薄弱。因此，对农户而言，基于社会资本的非正式保险是进行风险分担的主要手段。本文以社会资本为切入点，对非正式保险制度分担风险的机理进行理论分析，并通过对中国连片特困区农户的调研，利用 Tobit 模型和因子分析法进行实证分

析，讨论社会网络规模、参与、信任、互惠等四个不同的社会资本维度对非正式保险制度风险分担额度的影响。最后，论文分析了非正式保险在这些区域的不可或缺性及不足，提出农户风险分担的相关政策建议，研究在当前的制度环境下，如何有效利用非正式保险制度，使之与正式保险制度相互配合进行农户的风险分担。

Research on the Influence of Mandatory Third-party Liability Auto Insurance on the Property Insurance Companies' Efficiency

LU Yanting

Master Degree Candidate
Department of Risk Management and Insurance
Beijing Technology and Bussiness University
No.33,Fucheng Road, Haidian District,Beijing
Phone: (86)15501111271
Email: lyting501@163.com

Keywords: Auto Compulsory Insurance, Efficiency, DEA-Tobit.

Abstract: This paper measured the efficiency of mandatory third-party liability auto insurance from 2013 to 2014 by using the DEA model, based on the auditing reports of 49 property insurance companies, and then analysed the influence of the auto compulsory insurance scale to property insurance companies' efficiency by using the panel Tobit model. The results showed that the more the property insurance company operated auto compulsory insurance, the lower its efficiency. It proves the property insurance companies' lack of motivation to operate auto compulsory insurance. In conclusion, this paper suggests that government should give more policy support to property insurance companies operating auto compulsory insurance in order to improve their motivation.

1. 引言

机动车交通事故责任强制保险（以下简称“交强险”）是我国第一个强制保险制度，于2006年7月1日起正式实施，2012年正式向外资产险公司开放经营，到2014年年底，共有50家中外资产险公司经营交强险业务。中国保监会2015年11月公布的交强险经营数据显示，2014年行业总体承保交强险亏损人民币47亿元，投资收益人民币63亿元，经营利润为16亿元，勉强实现了整体的盈亏平衡。我国开办交强险的意义在于由保险人为机动车交通事故受害人提供基本保障，保护机动车驾驶人以及交通事故受害人的合法权益，更好地履行政府职责，促进道路交通安全，维护社会秩序，这意味着交强险具有一定的社会保险属性。此外，为了保证供给，交强险采取强制保险的实施方式，不仅是强制机动车所有人以及机动车管理人投保，也强制保险公司必须承保，保险公司不得以任何理由拒绝承保，也不能因被保险人未履行缴纳保险费义务而解除保险合同。同时，基础保险费率和保险条款也由保险监管部门统一规定，未按要求从事交强险业务的保险公司将受到监管部门的处罚。政府通过立法强制实施交强险，赋予其公共品属性来解决机动车使用过程中产生的外部性问题。所以说，交强险“是国家为了达到贯彻保险政策、推行社会公众的法律保障目的，而借用了社会保险的强制属性，要求保险公司直接经营与自愿保险相对的商业保险业务。因此，它是除了社会保险以外依照法律规定必须参加的保险。”[1]在上述背景下，产险公司经营交强险的动力几何，交强险业务对产险公司经营效率存在正向还是负向影响，是本文关心并想要解决的问题。

2. 文献综述

许多学者对我国保险公司经营效率进行了研究。黄薇（2006）采用SFA方法对我国保险机构的效率进行了实证研究，但大多数学者采用的是DEA方法进行效率研究。DEA是采用线性规划的方法构建一个非参数逐段线性的包络面（或前沿面），将数据包络起来，根据包络面就可以计算出效率的测度。本文也将采用DEA方法对产险公司的效率进行研究。DEA在保险公司经营效率分析中被广泛运用，恽敏(2003)运用传统DEA模型分析发现1999年我国保险公司经营效率普遍较低，发展潜力巨大。魏华林（2011）运用DEA模型比较分析了2006-2009年我国中资与外（合）资保险公司的经营效率，发现中资保险公司平均技术效率高于外（合）资保险公司。本文也将延续前人的分析思路，采用DEA方法对产险公司经营效率进行研究。

在研究保险公司经营效率的基础上，很多学者又继续对其影响因素进行了分析。黄薇（2011）分析了外资进入对我国保险业效率的影响，发现外资进入能提高保险市场的竞争程度，提升经营效率。朱铭来（2012）分析了入世对外资保险公司经营效率的影响，研究发现全面入世对外资产险公司经营效率影响并不显著。

[1] 张洪涛. 保险经济学[M].2006，中国科学出版社.

赵桂芹（2009）、白彩全（2015）等采用DEA-Tobit两步法分析了我国财产保险公司的经营效率及影响因素，但他们都是基于公司角度，而没有涉及具体保险业务层面。

目前分析交强险业务经营效率的文章较少，朱南军、张昭蓉（2015）采用2008-2012年的分省数据，分别从企业和社会的视角测算了我国保险公司交强险经营效率，并分析了其影响因素，发现城镇化率对交强险的企业效率有显著正影响，对社会效率有显著负影响，而地区面积对企业效率有显著负影响。本文将以经营交强险业务的产险公司作为样本，采用DEA-Tobit两步法研究交强险业务对于产险公司经营效率的影响，进而分析产险公司经营交强险的动力。

3. 产险公司经营效率测定

3.1 评估方法的选择

效率评估的方法分为参数法和非参数法，参数方法需要设定函数形式，同时用样本数据估计最优生产前沿，所以函数形式的设定对评估结果而言最为重要，主要包括厚边界分析法、自由分布法和随机边界法；而非参数方法，又称数学规划方法，相对于参数法而言不需要设定函数形式，这样就可以避免设定误差，实现每个决策单位的最优化，主要包括随机边界分析和数据包括分析。本文选择基于规模报酬可变DEA模型的非参数方法，即由投入、产出指标数据得出产险公司的经营效率值，利用Deap Version 2.1软件实现。

3.2 样本公司的选择

2008年起，中国保监会要求开展交强险业务的产险公司必须按会计年度披露其审计报告和精算报告。2012年外资产险公司被允许在中国经营交强险业务。考虑数据的可获得性[2]，本文选择了2013-2014年除天平汽车保险公司和安盛天平之外的共49家经营交强险的产险公司经营情况进行分析[3]。

3.3 投入产出指标的选择

本文基于前人的研究成果，选择增值法[4]作为投入、产出指标的选取方法。

投入指标：产险公司通常将资本、劳动力作为主要的投入指标（王家庭，2010；魏华林，2011等），同时也有文献将营业费用及固定资产（陈璐2006；韩松，2009）选为投入指标。综上，本文选取了职工人数、金融资本量（实收资本+资本公积）、营业费用（手续费及佣金支出+业务管理费）和固定资产作为投入指标。

[2] 2015 年《中国保险年鉴》尚未出版，故本文只使用 2013 和 2014 年的数据进行分析。

[3] 安盛天平财产保险股份有限公司是 2014 年 1 月由安盛保险与天平汽车保险公司合并组成，剔除后可以保证两年样本数据的可对比性。

[4] 金融机构投入产出指标的选取有三种方法：中介法、成本法以及增值法。中介法将金融机构视为纯金融中介，借入资金并转化为资产后赚取利息差价；成本法参考收益贡献率，若资产收益低于机会成本则视为投入，反之则视为产出；增值法是学术界使用最为普遍的一种方法，这种方法把带来价值增值的要素作为产出，减值要素作为投入。

产出指标：产险公司的产出一般用保费收入、投资收益（侯晋，2004；张春海，2011）来衡量，产险公司通过收取保费实现盈利，所以保费收入是其利润最大化的一个关键因素；另一方面，产险公司从收取保费到履行赔偿责任之间有时间差，这期间产险公司通过资金运用获取收益，所以投资收益也可作为一项产出指标。因此本文选取了保费收入和投资收益作为产出指标。

上述指标数据均是根据《中国保险统计年鉴》（2014-2015）整理得到。

3.4 经营效率的测定结果

本文采用规模报酬可变DEA的multi-stage[5]评估方法对各样本公司分年度进行效率评估，其计算表达式如下：

$$\min_{\theta,\lambda}\ \theta$$

$$\begin{cases} -q_i + Q\lambda \geq 0 \\ \theta x_i - X\lambda \geq 0 \\ I'_{I*1}\lambda = 1 \\ \lambda \geq 0 \end{cases} \quad \text{s.t.} \qquad (1)$$

设有I个企业，每个企业有N个投入，M个产出，列向量 x_i 和 q_i 分别表示第i个企业的投入和产出，θ 表示决策单元离有效前沿面的一种径向优化量或“距离”，λ 使各个有效点连接起来，形成有效前沿面。评估结果如下：

表 1　各公司分年度经营效率值分布情况

公司名称	2013 年	2014 年
安联	1.000	1.000
富邦	0.292	0.425
国泰财产	0.378	0.660
利宝	0.491	0.559
美亚	0.523	0.648
三星	0.788	0.457
史带产险	0.561	0.462
现代	0.699	0.475
民安	0.620	0.671
中航安盟	0.740	0.630
中意	1.000	0.566
安邦	1.000	1.000
安诚	0.358	0.438
安华	0.574	1.000
安信农业	0.891	0.794

[5] multi-stage 是多阶段数据包络分析，因其结果更精确，成为最常用的一种算法。

北部湾	0.102	0.467
渤海	0.471	0.740
长安责任	0.593	0.582
长江	0.156	0.332
诚泰	0.321	0.663
大地	0.623	0.709
鼎和	0.689	0.572
都邦	0.547	0.520
富德	0.113	0.455
国寿	0.725	0.909
国元农业	1.000	1.000
华安	0.563	0.694
华农	0.630	0.711
华泰	0.731	1.000
锦泰	0.530	0.710
平安	0.789	1.000
人保	1.000	1.000
太平	0.612	0.676
太保	1.000	0.896
泰山	0.416	0.402
天安	0.611	0.735
鑫安	1.000	0.855
信达	0.730	0.748
阳光产险	0.751	1.000
阳光农业	1.000	1.000
英大泰和	0.737	1.000
永安	0.794	0.943
永诚	0.630	0.751
浙商	0.580	0.601
中华联合	0.628	0.681
中煤	0.488	0.770
中银保险	0.638	0.638
众诚汽车	0.493	0.543
紫金	0.607	0.513
中资公司平均	0.635	0.738
外资公司平均	0.645	0.596
平均	0.637	0.706

从上表可知，49家经营交强险业务的产险公司的经营效率差距较大，从平均数来看，2013年中外资产险公司经营效率差别不大，而2014年中资产险公司经营效率明显高于外资产险公司。上表中的经营效率值将作为后文的被解释变量。

4．交强险业务对产险公司经营效率的影响

4.1 影响因素的选择

产险公司经营效率的影响因素分为内生因素和外生因素两类。外生因素主要指宏观及行业因素，而内生因素更多的是指公司内部可以自我调控的、与自身经营发展状况相关因素，基于本文的研究目的，仅选取内生因素作为解释变量。本文选择的内生因素主要包括：（1）公司规模。一般认为规模较大的公司具有范围经济以及规模经济优势，相比于规模较小的公司更具有竞争力，经营效率更高，本文选取公司总资产作为公司规模的衡量指标。（2）人力资本。人力资本是公司经营中一种不可或缺的资源，产险公司这种服务型公司对员工专业能力的要求更高，对其经营效率的影响举足轻重，本文选取学士及以上文化程度人数占公司总人数的比例作为人力资本的衡量指标。为了消除数据可能存在的异方差性，本文对资产规模以及人力资本结构数据取对数值进行分析。（3）公司国别性质。由于我国部分保险业务对外资产险公司存在限制，使得外资产险公司在经营时不能很好地发挥规模效益，加之财产保险业务的销售主要看渠道和网络，外资产险公司相比中资公司网点较少，其经营效率与中资产险公司会存在差别，因此本文将公司国别性质也纳入影响因素之中。本文对国别性质采用虚拟变量的形式，中资产险公司设为1，外资产险公司设为0。（4）交强险业务规模。本文基于研究目的，在前人研究的基础上加入了交强险业务规模作为经营效率的影响因素之一，用交强险保费收入占样本公司总保费收入的比例表示。

各影响因素指标假设如下表所示，其中第四项为本文新加入的影响因素，尚无文献内容参考：

表 2　产险公司经营效率影响因素的若干假设

影响因素	假设内容	文献来源	符号预期
1.资产规模对数值	与绩效正相关	黄薇（2006）等	+
2.人力资本结构	与绩效正相关	姚树洁（2005）等	+
3.公司国别性质	尚无一致结论	田新民（2013）等	+
4.交强险业务规模	NA	NA	-

所有指标数据均是根据《中国保险统计年鉴》（2014-2015）整理得到。

4.2 Tobit面板回归模型

前文中DEA模型测算出的效率值（eff）均在（0,1]之间，属于被解释变量受限的情况。由于DEA模型测算出的效率值最大值为1，即使有些公司经营效率值超过1，模型计算出的效率值也为1，因此效率值存在归并现象，即效率值被压缩在1这个点上了，此时效率值的概率分布就变成由一个离散点与一个连续分布所组成的混合分布。线性模型$Y_i = x_i\beta + \varepsilon$中，当$y_i \geq 1$时，所有$y_i$都被归并为1，此时的$y_i$即为“归并数据”。若用OLS来估计，无论用整个样本还是去掉离散点后的子样本，都不能得到一致估计，因此本文选择了基于极大似然估计法的面板数据Tobit模型进行回归分析，通过Stata13.0软件实现。

假设Y为被解释变量矩阵，取值范围为[0,1]，X为解释变量矩阵，μ_i为公司个体效应，ε_{it}为随机干扰项，ε_{it}～N（0，σ_ε^2）。则Tobit模型的一般表达式为：

$$Y_{it}, \begin{cases} 0 < Y_{it} < 1 \\ Y_{it} = \begin{cases} 0, & Y_{it} \leq 0 \\ 1, & Y_{it} \geq 1 \end{cases} \end{cases} \quad (2)$$

$$Y_{it} = A + X^{'}\beta + \mu_i + \varepsilon_{it} \quad (3)$$

$$eff_{it} = \beta_0 + \beta_1\, ln_asset + \beta_2\, ln_edu + \beta_3\, foreign + \beta_4\, pre + \varepsilon_{it} \quad (4)$$

从而本文可以建立出如(4)式的回归模型，其中，ln_asset表示总资产的对数值，ln_edu表示学士及以上文化程度人数占公司总人数的比例的对数值，foreign表示公司国别性质；pre表示交强险保费收入占产险公司总保费收入的比例，即交强险业务规模。

4.3 实证结果

表 3 Tobit 面板回归模型实证结果

影响变量	系数	标准差	t 统计量	P 值
cons	0.2622	0.1286	2.04	0.044
ln_asset	0.0700	0.0150	4.67	0.000
ln_edu	0.0359	0.0511	0.70	0.485
foreign	0.1235	0.0559	2.21	0.030
pre	-0.9568	0.1668	-5.74	0.000

Log likelihood	3.8317
Prob>chi2	0.0000

根据实证结果，产险公司经营效率的影响因素有：（1）公司资产规模（ln_asset)对经营效率为显著的正向影响。(2)产险公司人力资本结构(ln_edu)对经营效率为非显著的正向影响，这与本文此前的预期不一致。（3）虚拟变量国别性质（foreign）对效率值为显著正向影响，说明中资产险公司经营效率高于外资产险公司。（4）交强险业务规模（pre）对产险公司经营效率为显著的负向影响，这说明产险公司缺乏经营交强险业务的动力，因为经营交强险业务对产险公司经营产生的是负向影响。此外，交强险业务规模对产险公司经营效率的影响程度高于资产规模和国别性质对产险公司经营效率的影响程度。

5. 结论与建议

通过上述实证分析可以看出，虽然政府采用强制保险的形式要求产险公司必须承保，但事实上产险公司是缺乏经营交强险的动力的；此外，由图1可以发现，2008年-2013年，交强险综合成本率均高于100%，这就迫使产险公司采取其他方式来弥补交强险业务的损失，如降低保险费率或是捆绑销售商业车险，从而实现整体盈利。

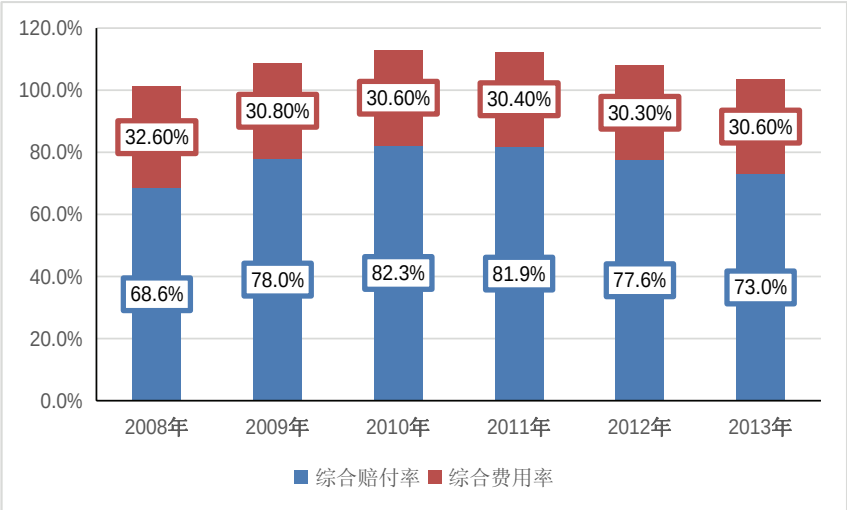


图 1　2008-2013 年交强险综合成本率

交强险可以视为产险公司履行政府职责的一种方式，由政府规定全国统一的基础费率和条款，产险公司基于“不盈不亏”的原则进行经营，但各产险公司又是自负盈亏，我国交强险的“代办模式”给产险公司带来了诸多问题：产险公司的亏损经营已经基本成为共识；强制保险的形式削弱了产险公司风险选择和风险控制的能力；全国统一的基础费率和条款与我国经济、道路交通状况的区域差异

不符，进而导致产险公司的区域经营结果不平衡；“不盈不亏”原则在保证社会效益的同时，也消除了产险公司盈利的可能性。然而，我国并没有给予经营交强险业务的产险公司额外的支持政策，来鼓励其经营。

事实上，很多国家都开办了强制性机动车责任保险，如英国、法国、德国以及美国的马萨诸塞州、纽约州等，但这些保险业发达的国家和地区政府或是给予产险公司单独厘定费率的权利，或是给予产险公司额外的支持政策，以此来鼓励产险公司经营交强险业务。以日本为例，日本的《自动车损害赔偿保障法》（以下简称“自赔法”）规定保险费率应遵循“无损失、无利润”的原则，这一点与我国类似，但在实践中保险监管机关允许产险公司有合理的利润。此外，产险公司可以使用自己的费率，但必须得到金融监督厅长官和运输大臣的批准。为了有效降低保险公司的经营风险，日本的《自赔法》第40-43条规定采用国家再保险制度和保险业者的共保联营制度。除轻型摩托车外，政府应接受强制责任保险的再保险业务。再保险金额按照保险合同金额的60%计算，由运输省负责再保险业务的管理。保险合同金额剩余的40%由保险人组成联营组织，在内部进行分保，由东亚火灾海上保险公司负责联营事宜。日本的强制性汽车责任保险通过国家再保险制度和共保联营制度等支持政策，有效地分散了 “不盈不亏”原则下的经营风险，所以日本的产险公司仍愿意经营。

因此，鉴于我国交强险的经营现状，以及本文“交强险业务对产险公司经营效率产生负向影响”的实证研究结论，本文建议对经营交强险业务的产险公司给予多方面的支持政策，例如税收优惠等，以提升产险公司的经营动力，促进我国交强险业务的稳妥发展。

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交强险业务对产险公司经营效率的影响研究

陆彦婷

硕士生

北京工商大学风险管理与保险学系

北京海淀区阜成路33号, 100048

电话: (86)15501111271

Email: lyting501@163.com

关键词: 交强险；经营效率；DEA-Tobit两步法

摘要: 本文用DEA模型测算了2013及2014年49家经营交强险业务的产险公司的经营效率，并采用面板Tobit模型分析了交强险业务规模对产险公司经营效率的影响。结果表明，交强险业务规模对产险公司经营效率具有显著的负向影响，说明产险公司缺乏经营交强险业务的动力。因此，本文建议给予经营交强险业务的产险公司更多的政策支持，以提高其经营动力。

Seismic Risk in China and a Solution from CAT Bonds

TAO Zhengru, TAO Xiaxin

TAO Zhengru *
Associate Professor
Key Laboratory of Earthquake Engineering and Engineering Vibration
Institute of Engineering Mechanics
China Earthquake Administration
Harbin 150080, China
Phone: (86451) 86652623
Email: taozr@foxmail.com

TAO Xiaxin
Professor
School of Civil Engineering
Harbin Institute of Technology
Harbin 150090, China
Email: taoxiaxin@aliyun.com

Keywords: CAT bonds, Pricing model, Earthquake insurance, Engineering seismic risk assessment.

Abstract. As the accelerated accumulation of properties in China over recent years, the vulnerability from earthquake disasters increases quickly. Since the social structure and the economic system are more and more complicated, earthquake losses, especially indirect losses, cannot be reduced engineering measures separately. Considering the zero-beta characteristic of CAT bonds, it is suggested to mitigate the rocketed seismic risk in China, as a solution. We develop a pricing model for an

earthquake CAT bond, based on engineering seismic risk assessment. A reinsurer is assumed as the issuer of the CAT bond. Yields and proportion of reinvestment, principal protected ratio, issuance fee, circulation and maturity period are designed as factors of the model. The annual coupon rate of the CAT bond is calculated under the equilibrium between the incomes of investors and issuers. Especially, Geometric Brownian Motion and Jump-Diffusion processes are employed to describe the income of the issuer from earthquake reinsurance in normal and abnormal situations, respectively. Four cities in Southeastern of China are adopted as examples to illustrate the feasibility of the pricing model. In this pricing model, occurring probability of a defined earthquake catastrophe, potential claim payments from the issuer are estimated by the improved seismic risk assessment method, thus, the basis risk is reduced if at all possible. Regional economic level and vulnerability of local engineering structures are integrated in this model as well, and moral risk is reduced to some extent.

1. Introduction

China locates between the circum-Pacific seismic belt and the Eurasia seismic belt, squeezed by the Pacific plate, the Philippine plate, the Indian plate and the Eurasia plate. As a result, it is one of the most active seismic regions of the world.

More than 1700 earthquakes with $M_S \geq 5$ happened in China, from January 1, 1970 to June 30, 2013, as shown in Fig.1, data from China Earthquake Network Center (CENC).

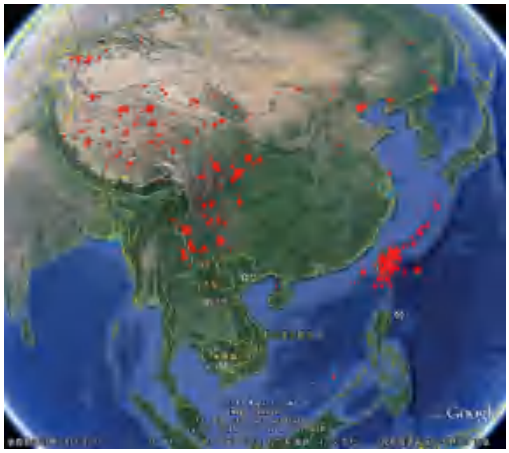


Fig.1 Earthquakes in China ($M_S \geq 5.0$, 1970.1.1 to 2013.6.30)

As the growth of properties and population in China, direct economic loss and casualties are increasing, as shown in Fig.2 and Fig.3, data from National Bureau of Statistics of China, Ministry of Environmental Protection of the People's Republic of China and [1].

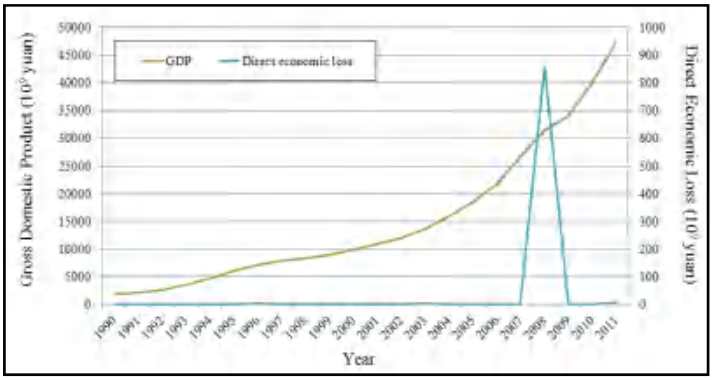


Fig.2 Direct economic loss with GDP

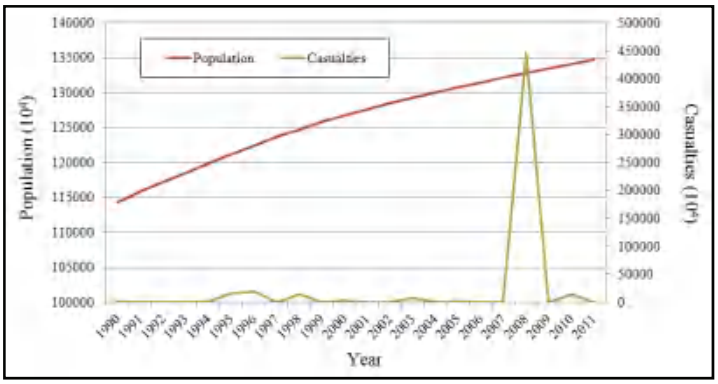


Fig.3 Casualties with population

By comparing the data from 2000-2009 and 1990-1999 with that from 1980-1989, it is clear that the losses dramatically increased more than the number of events, as shown in Table 1.

Table 1. The growth of earthquake losses in three decades of 1980-2009

Periods	Number of destructive earthquakes	Ratio to 1980s	Direct economic loss (10^{10} yuan)	Ratio to 1980s	Casualties	Ratio to 1980s
1980-1989	125	1.000	4.981	1.000	13514	1.000
1990-1999	133	1.064	11.224	2.253	52559	3.889
2000-2009	108	0.864	876.391	175.947	460483	34.075

Dealing with such kind of huge risk, the Chinese government devotes great attention and funds and has achieved significant results through efforts over 40 years. Under the guide of "Law of the People's Republic of China on Protection against and Mitigating Earthquake Disasters" promulgated by the People's Congress of People's Republic of China, a systematic natural disaster prevention system, including monitoring, prediction, prevention, resistance and relief, has been established. Natural disaster reduction and control is one of the primary tasks in science and technology development from the Chinese government's point of view. However, potential economic losses from earthquakes are still huge because of dense population and prosperous business. It is not enough to reduce the losses by engineering measures separately. Catastrophe derivatives is a solution, by which catastrophe risk is transferred to capital markets directly. CAT bonds is the most active one.

After several catastrophes in 1990s, insurance companies began to test CAT bonds or act of God bonds in 1995 and 1996, which is a contract between issuers and investors, but the market met the first success till June 1997 [2,3]. One of the attractive characteristics is there is no or little correlation with capital markets, which is more obvious in this 2008 financial crisis [4,5]. It is significant that the efficient frontiers of traditional portfolios, constructed by stock market indices and bonds market indices, are improved by adding catastrophe risk indices. It means the risk is reduced and the expected return is increased, because of the zero-beta characteristic. A pricing model is developed for earthquake disasters, based on seismic risk assessment, in this paper.

2. Pricing earthquake CAT bonds

In earthquake disasters, direct losses are from the damage of engineering structures mainly, however, the statistic data of historical loss cannot present the engineering characteristics, like the type, age, purpose and seismic design etc. So it is not reasonable to estimate the losses from future earthquakes and price CAT bonds through historical data only. Seismic risk consists of natural hazard, architectural vulnerability, the density of population and the density of properties, most of which can be controlled and improved. If the engineering characteristics are not considered, the uncertainty of the prices will increase.

Additionally, catastrophe insurance and CAT bonds are both instruments against natural disasters. There might be a complementary relationship between the parameters of these two instruments to balance the issuer's catastrophe risk. For simplification, "reinsurer" here is supposed as the issuer of an earthquake CAT bond.

A pricing model of an earthquake CAT bond is developed, based on engineering

seismic risk assessment in this paper. The interest rate is based on the equilibrium between the incomes of investors and the issuer, and calculated by the occurrence probability of the catastrophic earthquake, the yields of reinvestment, the proportion of protected principle and the issuing fee.

As mentioned above, the profits of investors or the issuer depend on the trigger event, so it is important to define "catastrophic earthquake". There are many different definitions, such as PCS's. The one used in our model is related with the explored region, the ratio of losses to GDP in the last year and its population, and an event will be a catastrophe if its losses ratio measures up with each of the indices [6].

From the results of seismic risk assessment, we can obtain the direct losses of buildings of type S, L_S, by:

$$L_S = \sum_j R_S(L|D_j) \cdot P_S(D_j) \cdot A_a \cdot A_1 = A_a \cdot A_1 \cdot \sum_j R_S(L|D_j) \cdot P_S(D_j) = A_a \cdot A_1 \cdot R_S(L) \tag{1}$$

where $R_S(L \mid D_j)$ is the loss ratio in a given damage state j; $P_S(D_j)$ is the probability of buildings of S^{th} type being in j^{th} damage state, which is the product of seismic hazard and architectural vulnerability; $R_S(L)$ is the loss ratio of buildings of S^{th} type; A_a is the aggregate area of buildings of S^{th} type; A_1 is the fee of rebuild or repair unit area for buildings of S^{th} type. Then, the loss ratio of the aggregate losses of model building types to GDP in explored region will be obtained, and a loss ratio exceeding probability curve can be constructed, on which we can get the probability of a catastrophic earthquake occurrence p.

Let the period of validity of the CAT bond be T. The expected income of the issuer at t ($t=1, 2, \ldots, T$) is:

$$E_I(t) = P_2(t) \cdot p + P_1(t) \cdot (1-p) + k[M + P(0)] \cdot e^{rt} + (1-k)[M + P(0)] \cdot e^{r_0 t} \tag{2}$$

where $P_1(t)$ denotes the issuer's income from earthquake reinsurance at t when the defined catastrophe does not occur; $P_2(t)$ is the income when the catastrophe occurs; k denotes the ratio of reinvestment to the circulation M and the earned premium at t=0; $P(0)$ is the reinsurance premium at t=0; r_1 is the yields of reinvestment; r_0 is the risk-free interest rate.

The expected payout of the issuer is: (3)

where C_t denotes the claim payment from earthquake reinsurance when the catastrophe occurs at t; C_T is the claim payment if the catastrophe does not occur; n is the proportion of protected principal; r is the annual coupon rate of the bond; B is issuing fee, which is in a proportion of the circulation of the bond. The claim payment C_t and C_T can be estimated by seismic risk assessment and the distribution of reinsurance policy-holders.

If the catastrophe does not occur at t, earthquake reinsurance premium $P_1(t)$ is described by Geometric Brownian Motion, which are represented by:

$$dP_1(t) = \mu P_1(t)dt + \sigma P_1(t)dW(t) \tag{4}$$

where μ is the mean value of earthquake reinsurance premium; σ is the standard deviation; $W(t)$ is a Weiner process, in which the mean value is 0 and the deviation is 1.

Jump-Diffusion process is adopted to describe $P_2(t)$, the earthquake reinsurance premium if the catastrophe occurs at t, shown as:

$$dP_2(t) = \mu P_2(t)dt + \sigma P_2(t)dW(t) + (J-1)P_2(t)dq(t) \tag{5}$$

where J-1 is the jump size, which follows standard log normal distribution; $q(t)$ is jump times in [0, t], which follows an independent Poisson process with intensity λ.

The CAT bond is a supplement of earthquake reinsurance to keep the issuer safe against earthquake risk, so the expected return should be more than the expected payout, which is also the expected return of investors. According to the equilibrium theory, the market is clear when the expected utility of all investors is maximized. In our model, the expected payout of the issuer is maximized when the market is in equilibrium, that is, the expected payout of the issuer equals to the expected return, $E_I(t)$=$E_O(t)$. Then the annual coupon rates of the bond can be calculated by:

$$r = \frac{1}{t}\ln\left[\frac{E_I - (C_t + nM)\cdot p}{M(1-p)} - \frac{B}{1-p} - \frac{C_T}{M}\right] \tag{6}$$

3. Productions

This model is adopted for four cities in Southwest of China, Nanan, Quanzhou, Zhangzhou and Xiamen. Losses are from vulnerability evaluation and seismic hazard analysis [7-10]. The direct economic losses, corresponding to intensity VI-X, are listed in Table 2.

Table 2. Losses of four cities from vulnerability evaluation (million yuan)

City	VI	VII	VIII	IX	X
Nanan	4.31	46.88	167.51	544.61	1184.23
Quanzhou	18.69	550.00	1571.00	3560.00	7928.00
Zhangzhou	46.97	171.07	571.31	1534.06	3281.37
Xiamen	464.03	1583.17	6976.10	24184.45	56849.91

Since the maturity period of a bond is 3 years generally, the exceeding probabilities in 3 years are evaluated by seismic hazard analysis. The losses in Table 2

are discounted to the values in 2012 by risk-free rate, and the effect of inflation is considered by the approach of Swiss Re. Then, an exceeding probability curve of loss rate, the rate of earthquake losses to GDP in 2011, is constructed and shown in Fig.4.

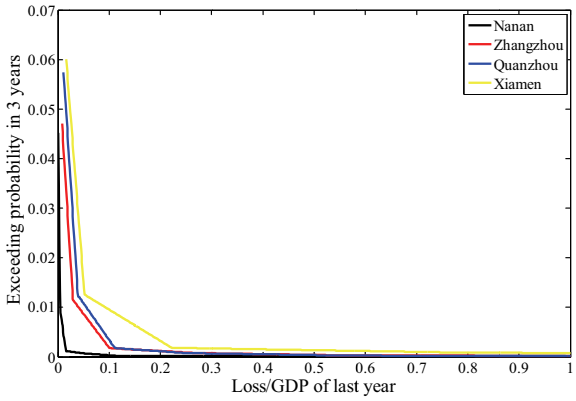


Fig.4 The exceeding probability curve of loss rate

In this figure, the occurring probability *p* of a defined catastrophe in 3 years can be interpolated, which are 0.022%, 0.113%, 0.118% and 0.323% for Nanan, Quanzhou, Zhangzhou and Xiamen, respectively.

The biggest earthquake in this area occurred on Dec.29, 1604, and the isoseismalline was delineated as Fig.5 [11].



Fig.5 Isoseismal map of 1604 Quanzhou offshore earthquake

The probable maximum losses of buildings from this historical maximum earthquake are listed in Table 3, which is discounted from the values in 1998, 1999 and 2001, considering the influence of interest rate and inflation.

Table 3. Direct loss of four cities

City	Intensity	Direct loss (10^{10} yuan)	Direct loss (10^{10} yuan, 2012 values)
Nanan	Ⅶ	0.05	0.27
Xiamen	Ⅶ	1.58	12.46
Quanzhou	Ⅷ	1.57	13.21
Zhangzhou	Ⅵ	0.05	0.37
	Ⅶ	0.17	1.24

According to the results of engineering seismic risk assessment and the definition of catastrophe, the loss from the maximum considered earthquake is not a catastrophe. If a catastrophe occurs, the loss, the claim payment of earthquake insurance and that of reinsurance are listed in Table 4.

Table 4. Loss, claim payments of insurance and reinsurance

City	Loss (10^{10} yuan)	Claim payment of insurance (10^{10} yuan)	Claim payment of reinsurance (10^{10} yuan)
Nanan	13.1798	0.6590	0.1318
Quanzhou	21.3776	1.0689	0.2138
Zhangzhou	19.4312	0.9716	0.1943
Xiamen	56.3034	2.8152	0.5630

Since earthquake insurance has not been large-scale launched in China, relevant data and information is not enough. In some years of 1990s, several insurers covered earthquake risk as extraneous risk of enterprise property insurance, and the premium rate is 10% of the main risk, which is limited strictly. Nowadays, earthquake risk is just provided as extraneous risk of enterprise property insurance as well by property insurers, the premium rate is increased to 20%-30% of the main risk, but the pool is limited. Some huge office buildings and property companies take out this kind of insurance policies on earthquake risk. So in this paper, it is supposed that the premium rate is 20% of enterprise property insurance premium, and 50% policy-holders purchase the additional earthquake insurance. These data is converted for four cities by the ratio of annual national GDP to the cities' GDP. We have to suggest that the insurance is uniform distributed in space. The converted data of earthquake reinsurance premiums is listed in Table 5. And, 20% property earthquake insurance premium belongs to earthquake reinsurance.

Table 5. Earthquake reinsurance premium in four cities (10^7 yuan)

Year	Nanan	Quanzhou	Zhangzhou	Xiamen
1993	0.118522	0.094420	0.045159	0.262274
1994	0.238155	0.188553	0.117055	0.525965
1995	0.185572	0.160003	0.071693	0.474199
1996	0.215074	0.193496	0.085148	0.558326
1997	0.391511	0.423044	0.197331	1.060545
1998	0.415342	0.371193	0.212861	1.115865
1999	0.422555	0.468943	0.226194	1.154756
2000	0.435703	0.488914	0.221503	1.193789
2001	0.351805	0.500043	0.234617	1.232188
2002	0.347761	0.500636	0.236631	1.325463
2003	0.347640	0.513850	0.241565	1.398311
2004	0.367054	0.531781	0.257342	1.480536
2005	0.347328	0.548022	0.252193	1.621959
2006	0.365322	0.592104	0.262636	1.695487
2007	0.422471	0.686695	0.309544	1.952731
2008	0.486055	0.778478	0.344041	2.082375
2009	0.537006	0.913870	0.389437	2.256495
2010	0.652469	1.117319	0.47221	2.787034
2011	0.805525	1.389707	0.600453	3.540297
2012	0.914292	1.482979	0.673978	3.905806

The mean values of the earning of reinsurance premium, in Nanan, Quanzhou, Zhangzhou and Xiamen, μ in Eq.(3) and Eq. (5) are 0.0039, 0.0055, 0.0025 and 0.0146, respectively, the standard deviations σ_P are 0.0016, 0.0033, 0.0014 and 0.0082.

Let the proportion of reinvestment k equal to 10%, the yield r_1=10%, the risk-free interest rate r_0=5.00%, the principal protected ratio n=50% and the issuance fee B=1% of the circulation. The circulation of the CAT bond M equals to half of the reinsurance claim payment if the catastrophe occurs. Then, the earning of reinsurance premium can be obtained.

To reduce the uncertainty from the random processes, we use the mean value of 1000 simulations as the final result. The annual coupon rates of the CAT bond r, for Nanan, Quanzhou, Zhangzhou and Xiamen, are 6.30%, 11.68%, 8.66% and 7.31% from Eq.(6). The principal and coupon will be refunded to investors, for a coupon

bond at maturity, if the defined catastrophe does not occur. The refundments per 100 yuan are 120.80 yuan, 141.96 yuan, 129.67 yuan and 124.52 yuan, corresponding to Nanan, Quanzhou, Zhangzhou and Xiamen, respectively. And the prices of zero coupon bonds, at t=0, are 82.78 yuan, 70.44 yuan, 77.12 yuan and 80.31 yuan, respectively. In other words, the investor purchases the CAT bonds at the prices and will get 100 yuan back at maturity.

4. Conclusion

CAT bonds is an effective instrument to spread catastrophe risk into capital markets, since there is no or little correlation with capital markets. The most important thing is to price it rationally. Our pricing model is based on seismic hazard assessment. The occurring probability of the defined catastrophic earthquake and potential claim payments of reinsurance are from this method. Earthquake reinsurance premiums, in the cases of the defined catastrophe occur or not, are described by two stochastic processes, respectively.

This job is the foundation of further study, which is how to apply the ripe methods or results of Earthquake Engineering in this field to design earthquake insurance derivatives mitigating seismic risk and link with engineering seismology.

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Regional Differences of Agricultural Insurance to Farmers' Income in the Perspective of Supply-side Reform

YANG Fu, SHI Suying

YANG Fu
Associate Professor
Xi'an University of Finance and Economics
Xi'an 710100, China
Phone: 18089238718
Email: claireray@ 163.com

SHI Suying*
Postgraduate
Xi'an University of Finance and Economics
No.2, Wei Chang Lu, Chang An District,
Xi'an City, Shaanxi Province
Phone: 18789414680
Email:506691331@qq.com

Keywords: Supply-side reform, Agricultural insurance, Farmers'income, Regional difference,Cluster analysis.

Abstract: This paper studies how to promote supply-side reform through agricultural insurance, thereby affecting farmers' income and promote the balanced rural construction steadily through perspective of supply side reform. Firstly, this paper starts from the effective supply of agricultural insurance to construct Cobb - Douglas production function (C-D function), selects the indicators of effective supply of agricultural insurance from three aspects of labor, capital and technology to cluster analysis, the 31 provinces and autonomous regions are divided into four regions by way of autonomous clustering. Then, we selected datas of agricultural insurance

premiums and farmers 'income from 2005 to 2013 among 31 provinces in China, in the four regions, the panel model is used to quantitatively analyze the regional differences in the impact of agricultural insurance on farmers' income .The results show that: The total supply of agricultural insurance is adequate in the third largest area (Beijing, Shanghai, Zhejiang and so on), but there is a negative effect of agricultural insurance on the income of farmers, in other regions, there exist some relative shortage of effective supply, but the agricultural insurance has a positive effect on the farmers' income, and there are some differences in the positive effects of each region.

1. 引言

农村建设一直以来都是社会主义建设过程中的薄弱环节和难点之一。当前我国正处于经济新常态发展下的转型期，农业所面临的各项风险日益暴露出来，自然风险、市场风险不断累加，而在当前的形势下，日益推进新农村建设进程更需倚重农村基础设施建设、农业现代化等，较少关注现代农业所面临的各类自然灾害和市场风险，这些风险的存在和发生也严重阻碍我国新农村建设。我国每年因自然灾害生导致农作物受灾面积高达 2000 万公顷。农业保险作为降低农业生产经营风险的社会化手段，在一定程度上能够补偿农民因各种生产经营风险而造成的经济损失，不仅能促进我国农村地区的经济发展，还有完善我国的经济结构调整，提升人民群众安全感、幸福感。2016 年指导"三农"工作的中央一号文件中对农业保险的定位已经不仅仅是防范风险的社会化手段，而是更多地融入到现代化农村建设的各个环节中。在此背景下，农业部和中国保监会联合召开保险服务农业现代化座谈会中提到应加快发展以需求为导向的农业保险，推进农业供给侧结构性改革。

2014 年我国出台的关于加快发展现代保险服务业的若干意见，对"三农"保险工作给出了新的部署，2014 年 8 月"新国十条"给予保险业更高的定位，将保险行业的发展要求提升至国家发展战略中。2015 年国家十三五规划全文中提到完善农业保险制度，加快农业保险服务理念。但我国保险覆盖面不宽，特别是农业保险的覆盖率，与发达国家相距甚远，农作物的承包面积占可保面积的仅 40%左右，农业保险的有效需求严重不足。如何通过供给侧改革，释放农业保险的新活力成为亟待解决的问题。本文基于供给侧视角，注重各个省份的差异性，探索我国不同地区农业保险与农民收入之间的关系，从而有的放矢地增强农业保险供给侧结构的适应性和灵活性，对扶贫减贫、更好地建设新农村，提供理论支持。

2. 文献综述

在农业保险对农民收入的影响方面，国内外的文献主要从农业保险支持扶贫理论、保险支持“三农”发展等方面展开，相关学者们的观点也存在一定的差异。支持农业保险与农民收入正相关相关国外文献主要包括：Ramaswai(1993)和Mosley(1995)[1]认为农业保险可以使农民增强应对风险的能力，有效降低农民贫困的可能性，从而增加农民收入；Zeller 和 Sharma（2000）[2]通过对亚非十国的研究，证实了保险能够提高贫困人口的抗风险能力；Hart 和 Babcock(2000)[3]以美国爱荷华州为例分析农业保险的影响，认为农业保险可以使农户得到诸如保险赔款的直接收益；Yamauchi(1986)[4]利用日本投保稻谷的保险案例来进行论证农业保险对农民收入具有稳定作用；Kraft（1996）、Leatham（1997）及 Goodwin（2001)[4][6]认为政府补贴农业保险可以保障农户收入稳定。Carter and Lybbert(2012)[7]通过对比农民参保前后效用最大化的对比，得出农民参保后能够使得其效用得到提高，并且能够使农民脱离“贫困陷阱”，从而增加收入；张小东、孙蓉（2015）[8]以及周稳海、赵桂玲、尹成远（2014）[9]的实证结果进一步表明农业保险总效应对农民收入具有显著的正向促进作用；屈晓娟，邵展翅，尹海凤（2013）[0] 通过构建非线性耦合模型，得出我国农民收入和农业保险发展之间呈现非单调的关系，农民收入随农业保险发展水平的提高而增加；袁春旺、姚永兴等(2011)[11]，杨春玲、周肖肖(2010)[11]以及梁平、彭勇和董宇翔(2008)[13]建立误差修正模型，论证了农业保险对农民收入具有促进作用；熊军红、蒲成毅(2005)[14]对农民收人与农业保险需求关系进行了实证分析，认为农民货币收入与农业保险需求高度相关。

认为农业保险与农民收入不相关或者负相关的国内外文献主要有：Glauber(2007)[15]认为美国的农业保险对农场主的收入和农产品的产量影响没有确切的结论；祝仲坤，陶建平（2015）[16]利用省级面板数据检验得出农业保险对农户收入有显著地负效应，说明投保农业保险可能会导致农户管理水平的下降；聂荣、闫宇光和王新兰(2013)[17]研究发现政策性农业保险对于对于低收入的30％农户(即穷人)反贫困效果不明显；余新平（2010）[18]通过误差修正模型得出农业保险保费收入与农民增收呈负向关系；高杰(2008)[19]通过实证分析得出，农业保险对农民收入的效应并不显著，甚至两者呈反方向的关系；张跃华等(2006)[20]调查上海农业保险的实践，结论表明农业保险对农业产量和收入没有明显的影响。

综上所述，关于农业保险与农民收入之间的关系国内外学者已经取得了一定

的研究成果，为本文的研究提供了借鉴和启示。但已有文献大多关注在农业保险对农民收入的直接影响效应方面，很少从市场角度出发进行研究。本文供给侧改革为切入点，结合面板数据模型动态的分析农业保险与农民收入之间的长期关系，并在此基础上将全国 31 个省份，依托 C-D 函数从资本、劳动及技术三方面构建影响农业保险发展的各个指标，按照聚类分析的思想将其分为四类区域，进一步进行比较和分析四类区域农业保险的市场发展现状及对农民收入的影响，从而根据地域差异、环境差异提出有针对性的农业保险市场供给侧改革的策略建议。

3. 农业保险对农民收入影响的机理

从效用的角度来进行分析农业保险对农民收入的影响，如果农业灾害发生了，其不仅影响农产品价格，还会导致农民收入的变化。效用函数是价格和收入的函数，那么如何衡量农业灾害的发生影响农民的福利水平？若假设没发生灾害之前农民的效用水平为 U0，农产品价格为 P0，农业生产者收入为 Y0，而发生灾害后农民的效用水平为 U1，农产品价格为 P1，收入为 Y1。那么，当灾害发生时，如何使得农民的效用水平回到灾前的效用水平 U0 上来，在不考虑价格变化，补偿变差为：

$$\begin{aligned} V(P,Y_0) = V(P,Y_1 + CV) = U_0 \\ \Rightarrow Y_0 = Y_1 + CV \\ \Rightarrow CV = Y_0 - Y_1 \end{aligned} \qquad (1)$$

其中，Y0 为农业生产者灾前收入，Y1 是灾后收入，CV 为补偿差价，即支付给消费者的补偿数量，而对农业生产者的补贴 CV 通过政策性农业保险保费形式给予受灾农民，为了更直观的表示补偿差价，利用无差异曲线和预算线的结合，来进行说明（图 3-1）。

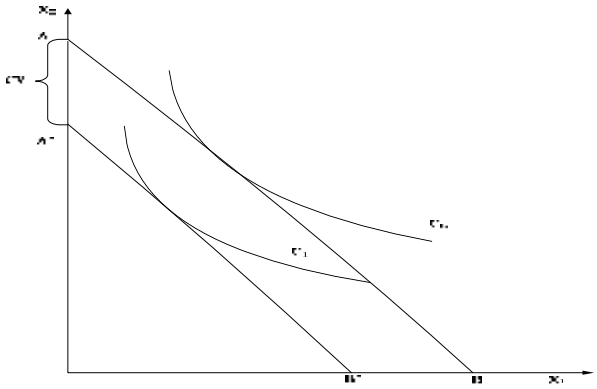


图 3-1 农民收入的补偿差价

从图 3-1 中可以看出，若不考虑价格因素的影响，且只有两种消费商品 X1 和 X2，受灾前，预算线为 AB 线，此时可以购买更多的商品，农业生产者的效用函数为 U0；受灾后，收入减少，导致预算线从 AB 降至 A′B′，从而导致农户的效用降低至 U1。但农户投保，灾害发生后会从获得一笔赔偿款，能使得农业生产者快速恢复至 U0 的效用水平上。

农业保险是现代农业风险管理的有效手段，保险深度和密度是界定保险业在整个国民经济中的地位和发展程度，而我国的保险业特别是农业保险的发展与部分发达国家相比还远远不足，如 2013 年我国农业保险密度为 48.71 元，深度为 0.54%，与发达国家（美国 2013 年保险深度为 7.47%），这表明我国农业保险发展还处于初期，保险密度和深度仍然处于较低的水平。

自 2007 年发布的一号文件，明确提出“各级财政对农户参加农业保险给予保费补贴”，随着政策性农业保险的试点和全面铺开的发展情势促进和提高农业保险的参与率和覆盖率。

根据«2015 年中国保险市场年报»可以看出，在 2014 年，我国农业保险保费收入 325.8 亿元，同比增长 6.3%；参保农户达到 2.5 亿户，同比增长 15.7%；提供的风险保障 1.6 万亿元，同比增长 17.7%；农业保险赔款 214.6 亿元，同比增长 2.9%；受益农户 3244.6 万户次，同比增长 2.1%；农业保险承保主要农作物 11.7 亿亩，占全国主要农作物播种面积的 47.7%。

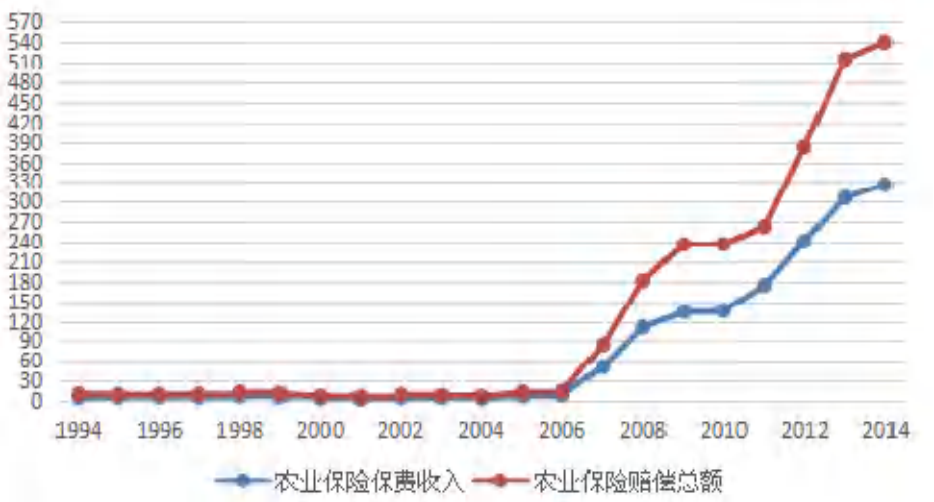


图 3-1 农业保险保费收入和赔偿总额

数据来源于：«中国保险年鉴»（2015）

从图 3-1 中可以看出在 2007 年农业保险保费收入及赔偿都有一个较大的增长幅度，说明我国自全面实施农业保险补贴政策以来，我国农业保险得到了快速的发展，也充分说明了国家对农业保险发展的重视。

4. 农业保险对农民收入影响的区域差异

4.1 计量模型与数据

聚类分析又称群分析，是分类学的一种基本方法，通过将一批数据的个案或者变量的诸多特征，按照关系的远近程度进行分类。本文采用的是分层聚类方法，其主要思想可以归结为“由多到一，层层聚类”即将每一个个体都置入聚类空间，然后将相近程度最高的两类进行合并组成一个新类，再将该新类与相似度最高的类进行合并，不断重复此过程，制止所有的个体都归为一体。度量标准采用欧氏距离（Euclidean distance）,并将所有变量在聚类分析前进行 Z scores 标准化处理，使得不同量纲、不同数量级的数据可以比较。

4.2 数据的选取及来源

聚类分析的数据指标的选取根据构造与农业保险发展有关的柯布-道格拉斯（Cobb-Dauglas）生产函数，即 C-D 函数，由美国数学家柯布和经济学家保罗·道格拉斯于20 世纪30 年代初一起提出来的，被认为是一种很有用的生产函数，主要用来研究用来研究和探讨投入和产出关系的数学模型。该函数的基本的形式为：$Q = AL^{\alpha}K^{\beta}$ 其中，Q 为产量，L 和 K 为劳动和资本投入量为资本投入量，A 代表技术进步系数，α、β 为参数。本文通过“供给侧改革”，从劳动力、资本、技术等三大要素领域选取指标进行聚类分析，数据来源于中国国家统计局网站。

其中，劳动力选取的是农林牧渔从业人员与乡村从业人员1的比值，这个指标更好地排除农民工资性收入及转移性收入等其他因素的干扰；资本选取的是农业保险保费收入及农作物总播种面积(千公顷)，凡是实际种植有农作物的面积，不论种植在耕地上还是种植在非耕地上，均包括在农作物播种面积中；技术：选取农业机械总动力、农用化肥施用折纯量。农业机械总动力（万千瓦)指主要用于农、林、牧、渔业生产经营活动的各种动力机械的动力总和；农用化肥施用折

[1]乡村从业人员指乡村人口中 16 岁以上实际参加生产经营活动并取得实物或货币收入的人员，既包括劳动年龄内经常参加劳动的人员，也包括超过劳动年龄但经常参加劳动的人员；农林牧渔从业人员指专门从业农业生产经营的人员，是在乡村农业人员的口径上统计出来的。

纯量(万吨)指本年内实际用于农业生产的化肥数量，包括氮肥、磷肥、钾肥和复合肥。

4.3 聚类分析结果

本文采用 SPSS20.0 进行聚类分析，分析结果如下图 4-1，根据聚类分析的结果将全国 31 个省市自治区分为四类区域，如表 4-2。

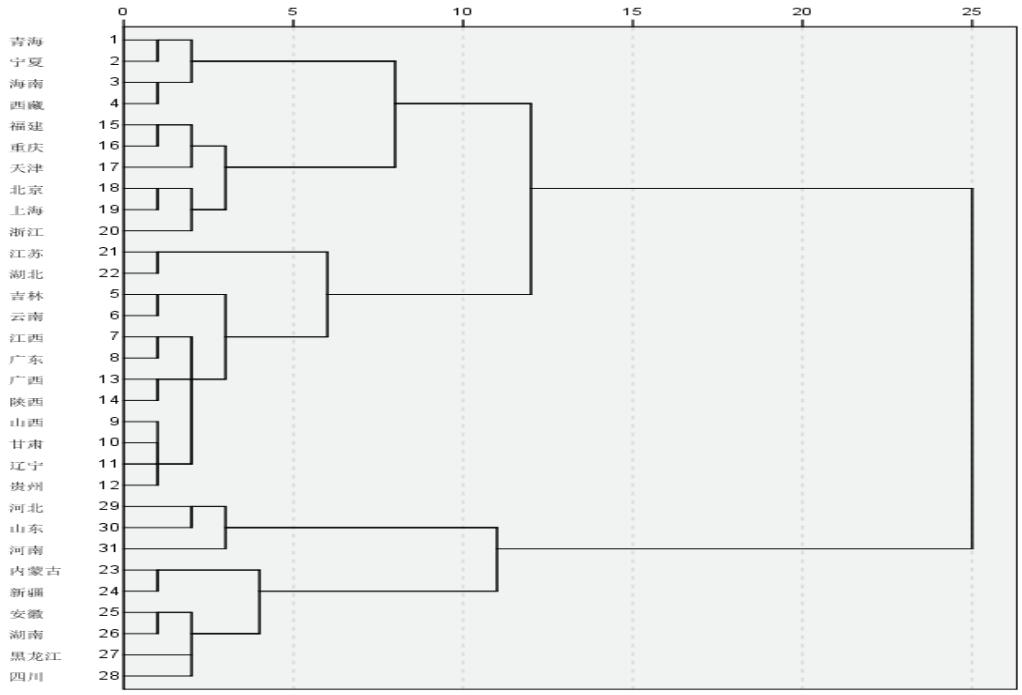


图 4-1 分层聚类分析中的树形图

表 4-2 区域划分

区域划分	省市数量（个）	具体省市名称
第一类区域	4	青海 宁夏 海南 西藏
第二类区域	12	江苏 湖北 吉林 云南 江西 广东 山西 甘肃 辽宁 贵州 广西 陕西
第三类区域	6	福建 重庆 天津 北京 上海 浙江
第四类区域	9	内蒙古 新疆 安徽 湖南 黑龙江 四川 河北 山东 河南

第一类区域中，大部分种植业属于当地特色农业，财政补贴的力度比较大，但大多属于 2010 年新增农业保险保费补贴品种及地区，如天然橡胶生产保险（海南），处于供给不足的状态。第二类区域中，主要为西部地区，受限于地理环境

等因素的影响，可耕种面积较少，农业保险保费收入水平处于中等水平。第三类区域中东部省份居多，经济化水平较高，规模化的农业种植户较多，但创新型的险种开发有限，不能很好地激发农户的潜在需求，这几个省份的农业保险保费收入偏低。第四类区域地处平原，主要为粮食主生产区，且多受到国家政策性农业保险补贴，农业保险保费高于全国水平，且政策性农业保险的覆盖率较广，险种较多，供给能够满足农户需求的产生。

5. 农业保险与农民收入关系的实证分析

5.1 模型的设定、变量的说明

5.1.1 模型的设定

按照面板聚类的思想将全国 31 个省市自治区分为四类区域，然后对这四类区域分别进行面板矩估计，其估计模型主要有 3 种类型，无个体影响的变系数模型（情形 1）、变截距模型（情形 2）及不变系数模型（情形 3）。面板模型形式如下式

$$y_{it} = \alpha_{it} + x_{it}\beta_{it} + \varepsilon_{it} \quad (2)$$

式中，y 代表农民收入，x 代表农业保险保费收入，t 为时间坐标，i 为空间坐标。y_{it} 和 x_{it} 的第 i 个变量分别表示 i 地区的农民收入与农业保险保费收入的时间序列

$$\text{情形 1} \quad \alpha_i \neq \alpha_j,\ \beta_i \neq \beta_j \text{（变系数模型）} \quad (3)$$

$$\text{情形 2} \quad \alpha_i \neq \alpha_j,\ \beta_i = \beta_j \text{（变截距模型）} \quad (4)$$

$$\text{情形 3} \quad \alpha_i = \alpha_j,\ \beta_i = \beta_j \text{（不变系数模型）} \quad (5)$$

实际分析时具体模型的选取需要通过检验来确定，经常使用的检验方法是协方差分析检验，检验假设：$H_1 : \beta_1 = \beta_2 = \cdots \beta_N$；$H_2 : \alpha_1 = \alpha_2 = \cdots \alpha_N, \beta_1 = \beta_2 = \cdots \beta_N$；如果接受假设 H_2，则模型为不变系数模型；如果拒绝假设 H_2，则需要进一步检验假设 H_1，若接受 H_1，则模型为变截距模型，若拒绝 H_1，则模型为变系数模型。

检验需要构造 F 统计量，并分别计算模型变系数模型的残差平方和 S_1、变截

距模型的残差平方和S_2及不变系数模型的残差平方和S_3,在检验是否拒绝假设H_2时，构造统计量F_2，其服从 F 分布：

$$F_2 = \frac{(S_3 - S_1)/[(N-1)(k+1)]}{S_1/(NT - N(k+1))} \sim F[(N-1)(k+1), N(T-k-1)] \quad (6)$$

如果拒绝假设H_2，则继续验证假设H_1，此时构造统计量F_1，其服从 F 分布：

$$F_1 = \frac{(S_2 - S_1)/[(N-1)k]}{S_1/(NT - N(k+1))} \sim F[(N-1)k, N(T-k-1)] \quad (7)$$

其中 N 表示面板数据中含有 N 个个体，T 表示时间序列的最大长度，k 表示解释变量个数

5.1.2 数据处理及来源

文中所涉及的变量数据来源于«中国保险年鉴»与«中国农村年鉴»，数据包括农业保险保费收入（PI）、家庭经营纯收入（NI），为了消除农民其他经营性活动对农民收入的影响，本文选取的收入指标为农村居民家庭经营纯收入。为了消除可能存在的异方差和数据的剧烈波动，对两变量进行对数处理，采用 Eviews7.2 软件进行数据处理。

5.2 实证结果及说明

5.2.1 面板数据的协方差检验及估计结果

对上述的四类区域分别进行协方差检验，检验结果（表 5-1），表明除了一类区域以外其他类区域都是变系数模型。对于变系数模型，组内的估计系数仍然不相等，需要对其再根据聚类分析的思想再进一步细分。区域细分的方法是:以各类之间的欧式距离（Euclidean distance）为基础，逐渐拆分类，每减少一个距离较“远”的成员，做一次面板数据模型设定检验，直至所有的小类均符合变截距模型或不变系数模型为止。根据上述思想将其分为八个区域（如表 5-2），利用面板数据模型对八个区域进行估计各地区变量间的关系，并对变截距模型进行 Hausman 检验选择固定效应模型或随机效应模型，根据其检验结果对固定效应的模型运用 GLS 方法，得出经加权的变截距计量模型，对随机效应运用 LS 方法得出相应的计量模型结果见表 5-3

表 5-1 分为四类区域的面板数据模型协方差检验

区域	检验统计量		检验结果
	F_2	F_1	
一类	5.128（2.440）	0.678（2.711）	变截距模型
二类	10.754（1.6704）	2.272（1.905）	变系数模型
三类	55.579（2.062）	5.847（2.441）	变系数模型
四类	9.541（1.807）	4.513（2.089）	变系数模型

注:括号内数值为在 5%的显著性水平下 F 统计量的临界值

表 5-2 八个区域的面板数据模型检验结果

区域	检验结果	所包含省份
一区	变截距模型	青海 宁夏 海南 西藏
二区	不变系数模型	江苏 湖北
三区	变截距模型	吉林 云南 江西 广东 山西 甘肃 辽宁 贵州 广西 陕西
四区	变截距模型	北京 上海 浙江
五区	变截距模型	福建 重庆 天津
六区	不变系数模型	内蒙古
七区	不变系数模型	新疆
八区	变截距模型	安徽 湖南 黑龙江 四川 河北 山东 河南

注:模型设定结论均为利用协方差分析方法得到，显著性水平是 5%

表 5-3 面板数据的矩估计结果

区域	检验结果	农业保险对农民收入的弹性系数
一区	随机效应模型	0.125221^{***}
二区	不变系数模型	0.082074^{***}
三区	固定效应模型	0.113035^{***}
四区	固定效应模型	-0.048079^{***}
五区	固定效应模型	0.067776^{***}
六区	不变系数模型	0.065350^{***}
七区	不变系数模型	0.305486^{***}
八区	固定效应模型	0.084653^{***}

注：各参数在 1%水平下显著

由于篇幅的限制，本文将以一区的建模过程为例，对变截距模型进行豪斯曼检验，结果如表 5-4。

表 5-4 一区的 Hausman 检验结果

检验内容	卡方统计量	卡方自由度	P 值
相关性随机效应检验	0.060506	1	0.8057

Hausman 检验的结果表明 P 值为 0.8057，不能拒绝原假设，故一区为个体随机效应模型，即随机影响模型中个体影响与解释变量不相关，估计结果见表 5-5。

表 5-5 一区的个体随机效应模型估计结果

变量	系数	标准误差	t-Statistic	Prob
lnpi？	0.125221	0.025952	4.825073	0.0000
C	7.324301	0.175959	41.62494	0.0000
相关性随机检验				
QH – *C*	-0.259314			
NX – *C*	-0.003599			
HN – *C*	0.316551			
XZ – *C*	-0.053638			

据此，得出青海、宁夏、海南及西藏各省份的估计表达式分别为：

$$LNNI-QH=-0.259314+7.324301+0.125221LNPI-QH$$
$$LNNI-NX=-0.003599+7.324301+0.125221LNPI-NX$$
$$LNNI-HN=0.316551+7.324301+0.125221LNPI-HN$$
$$LNNI-XZ=-0.053638+7.324301+0.125221LNPI-XZ$$

检验结果表明，各参数在 99%的置信区间水平下显著，一区的农业保险对农民收入的弹性系数为 0.12522，即农业保险保费平均每增长 1%，农民收入将会增长 0.125%。同理，对其他区域也是同样的分析方法。

5.2.2 实证结果分析

根据上述聚类及面板数据的模型估计，从各个区域弹性系数的不同可以将这八个区域划分为四大类进行说明。

第一类：农业保险对农民收入存在较显著地正相关的第一区及第三区各省份，农业保险对农民收入的弹性系数高达 0.11%，这两大区域的省份大多属于西部地

区的省份，国家政策对这些地区的扶持力度比较大，特别是 2007 年之后家开始对部分农业保险险种进行补贴，2010 年的一号文件提出“加大中央财政对中西部地区保费补贴力度”，且西部地区的农作物的可播种面积及从事农业生产的人数较多，从农业保险市场的供给需求方面来讲，这些省份险种较齐全，能够满足农户的需求，且农户对保险的需求也比较大。

第二类：农业保险对农民收入存在正相关的第二区、第八区及第五区、第六区的各省份，农业保险对农民收入的贡献率处于中等水平，一般在 0.06%以上，但这些省份的农业保险保费收入一直领先于其他区域。这 13 个省份多数属于国家的粮食主产区，农业机械总动力及农用化肥施用量均处在较高水平，说明这些省份的农业现代化水平较高，可能是由于高现代化水平带来的人力的锐减，使得大部分农民工外出务工，这些省份大部分是劳务输出的主要省份，所以从事农业生产的人数相比较而言处于低水平。跨省流动人口一般流向较发达的地区，受发达地区先进文化氛围的影响，提高了这些农户的保险意识，农业保险的有效需求增加，这也就引起农业保险保费收入增加。

第三类：农业保险对农民收入正相关效应最大的第七区（新疆），弹性系数高达 0.31%，2006 年自治区研究制定了农业保险试点实施方案，2007 年新疆被纳入全国首批政策性农业保险的试点省区，且新疆属于自然灾害的多发区，大部分农户的种植面积较大，且从事农业生产者的人数高于其他各区域，这也在一定程度上刺激了农户投保的积极性，从而使得农业保险保费规模及覆盖率均高于全国平均水平。

第四类：农业保险对农民收入存在负相关效应的第四区（北京、上海及浙江），弹性系数为-0.05%。从供给侧的角度看，没有适合专业化或者规模化的农业保险险种的存在，从而单方面导致农户的需求没办法满足，再者，这个区域属于经济比较发达的城市，城镇化水平较高，可适用的耕地面积较少，导致务农的人不多，这些都会导致负相关效应的出现。

6. 结论及建议

为了从供给侧研究农业保险对农民收入的影响，依次进行协方差检验、面板数据矩估计，得出下述结论，在长期内，两者存在长期的稳定关系，并且农业保险对农民收入的影响较为显著，即两者始终处于一种动态的平衡过程中；从各区域的对比中发现，省份较发达的城市，农业保险对农民收入的影响不显著，主要是因为农户的潜在需求没有得到激发，创新型实用型的险种较少，供给虽然很充

分，但很少有针对性的险种推出，而二区和四区的农业保险对农民收入的影响较为明显，险种供给较为充分，能最大化的激发农户的需求，将潜在需求转化为有效需求，且这些区域大多属于粮食主产区，参保率较高。

综合上述的研究结论本文提出建议：在短期内，应加大政府对农业保险的政策补贴，从而增加农户的收入效应，提高农户的购买水平，使得更多的农户有选择的余地；在长期内，农业保险险种创新力度不足，因此，在供给侧改革中应推进农业保险的创新化发展，控制落后单一险种的发展，实行差异化的农业保险政策，针对我国地区农业保险发展不均衡的现象，政府可以对不同地区进行差异化的设定，比如实行不一样的保险补贴制度和农业保险宣传制度，重点加大粮食主产区的农业保险的发展；从农业保险市场的角度出发，以农户需求为导向，按照各地区的特色农业发展的需求，更有效地组织农业保险险种的设计和销售，加快农业保险产品的创新，从而实现其价值，提高农业保险服务品质；进一步优化各区域商业保险的机制，让更多的商业保险公司愿意推行农业保险险种的推出，使得农业保险脱离政策性保险的单一和建立政府扶持下的商业保险经营模式，稳步过渡到商业性保险上来，从而更好地服务农民，发展农业保险。

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“供给侧改革”视角下农业保险对农民收入影响的区域差异研究

杨馥 石素英

杨馥
副教授
西安财经学院经济学院
西安710100，中国
电话: 18089238718
Email: claireray@163.com

石素英*
研究生
西安财经学院经济学院
陕西省西安市长安区韦常路2号
电话:18789414680
Email: 506691331@qq.com

关键词：供给侧改革 农业保险 农民收入 区域差异 聚类分析

摘要：本文以“供给侧改革”为视角来研究如何通过农业保险推动供给侧改革，进而影响农民收入，带动农村建设的均衡稳步推进。首先，本文从农业保险的有效供给出发，构造柯布-道格拉斯生产函数（C-D 函数），从劳动力、资本和技术三方面选取影响农业保险有效供给的指标进行聚类分析，将全国 31 个省市自治区通过聚类的方式分为四个区域，选取 2005 至 2013 年中国 31 个省区的农业保险保费收入与农民收入数据，针对四大区域采用面板数据模型定量分析农业保险对农民收入影响的区域差异。结果表明：第三大区域（北京、上海及浙江等省份）农业保险的总供给较充足，但农业保险对农民收入的影响具有负效应，其余区域各省份均存在有效供给相对不足的问题，但农业保险对农民收入有正向作用，且各个区域的正向效应存在一定差异。

Problems and Countermeasures of China's Liability Insurance against Property Preservation in Litigations

YIN Chengyuan, FENG Yue

YIN Chengyuan*
Professor
School of HeBei University
Baoding 071000, China
Phone: 13930205980
Email: yinchengyuan@139.com

FENG Yue *
MF. Candidate
Department of Finance
University of HeBei
Baoding City, seven one East Road, No. 2666
Phone: 15031292535
Email: 296736515@qq.com

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Abstract. With the increase of civil action cases, how to guarantee litigation property preservation became an important problem that aroused wide concern. However, traditional way of guarantee often caused difficulties when common people apply for property preservation in litigations due to its complex formalities and high requirements for applicants. It is under this background that liability insurance against property preservation in litigations came into being. Liability insurance against property preservation in litigations could provide policy holders with property

guarantee instead of charging the deposit of property preservation in litigations. This kind of insurance satisfied the requirements of common people, broadened the scope of China's insurance services, and promoted the development of the insurance industry. As a new type of insurance, there remained a lot of problems to be solved in practical application and development, such as the lack of legal protection, difficulties in risk assessment, single resource of preservation cases and the lack of effective supervision. In order to promote the development of liability insurance against property preservation in litigations, we shall include it in China's legal system as soon as possible, establish rational risk assessment mechanism and cooperation platform for insurance companies, law offices and courts, strengthen the management and supervision of liability insurance against property preservation in litigations, and bring it into full play.

1. 引言

在我国经济快速发展的同时，民事诉讼案件也在不断增多。在民事诉讼案件中，诉讼财产保全的担保问题又是其中关键的一环。传统的担保方式已经不能满足现在的需要，因此，2012年诉讼财产保全责任保险应运而生。诉讼财产保全责任保险的产生，打破了传统担保方式的桎梏，为诉讼财产保全的担保方式开辟了一条新思路。而在2014年8月，国务院印发的《关于加快发展现代保险服务业的若干意见》中又明确提出要发挥责任保险化解矛盾纠纷的功能作用，用经济杠杆和多样化的责任保险产品化解民事责任纠纷，这更加快了诉讼财产保全责任保险的发展。但因诉讼财产保全责任保险是一种新型险种，在各方面仍不健全，在发展过程中仍存在问题。本文力图分析我国诉讼财产保全责任保险存在的问题，并提出相应的政策建议。

2. 诉讼财产保全责任保险的界定

诉讼财产保全是指为了保证将来生效的民事判决能够得到切实执行，或者为及时、有效避免债权人的合法权益受到难以弥补的损害，根据法律的规定，由债权人提出申请，法院依法采取的限制有关债务人财产处分或者转移的强制性措施。而在申请诉讼财产保全时，人民法院常常责令当事人提供担保。若当事人不提供担保的，人民法院可以驳回申请。因而，担保在诉讼财产保全中具有重要的作用。

传统的担保方式一般有三种，一是以等值的现金作为担保，二是以等值的实物作为担保，三是通过商业银行或者专业的担保公司进行担保。而这三种方式都存在着诸多不足。首先，现金担保和实物担保会造成当事人的经济负担，像农民工这样的群体无法负担较高的担保数额。其次，商业银行通常只针对信用良好的大型企业出具担保函，并且企业要以等量的存款或授信作为条件。个人一般无法通过商业银行进行担保。最后，专业的担保公司常收取高额的担保费，并因自身实力的限制，存在较高的经营风险。

诉讼财产保全责任保险的产生有效地解决了诉讼财产保全中的担保问题，是对我国诉讼财产保全制度的一种创新。具体来说，诉讼财产保全责任保险是以财产保全申请人为被保险人，并向其提供保险产品作为担保物，为其财产保全申请向人民法院提供担保的保险。这种担保方式，是将诉讼财产保全责任保险设计为一种虚拟的担保物，它作为一种与金钱担保、实物担保一样的担保物，在发生保全错误时，财产保全申请人依据保险产品的合约，要求保险公司在保险限额内予以赔偿，保险公司在保险责任触发后保证被保全人所遭受到的损失得以赔偿，继而实现诉讼财产保全担保的目的。保险公司、财产保全申请人和被保全人的关系如图1所示。

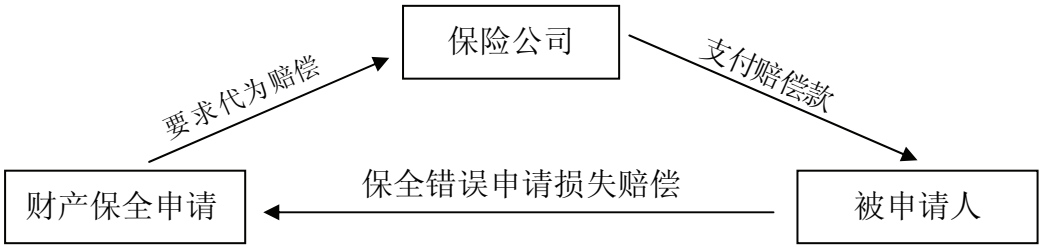


图 1　　诉讼财产保全责任保险

3．诉讼财产保全责任保险的特点

在诉讼担保需求越来越多的背景下，诉讼财产保全责任保险作为一种全新的担保方式，与传统的担保相比，具有很多新特点。

首先，对于申请人来说，诉讼财产保全责任保险不但其担保成本较低，有助于减轻经济负担，还可以保护自身利益不受损害。诉讼财产保全责任保险的保费一般为保全标的额的0.3%-0.8%，也就是说，保全申请人只需支付较少的保费即可由保险公司承担财产保全担保责任。除此之外，运用诉讼财产保全责任保险，既可以避免因无法提供全额资金或实物作为担保，而导致诉讼财产保全申请失败的情况，又可以避免因占用申请人过多的资金，而影响申请人生产或经营。

其次，对于法院来说，引入诉讼财产保全责任保险，可以省去繁琐的审批手续，提高办案效率。在实际中，保全常常是办案的难点，法院既要维护保全申请人的利益，及时对有争议的财产采取临时性强制措施，又要在发生保全错误时，确保被申请人的利益不受损失。而这种责任险可以减少法院所承担的保全风险，加快立案速度，提高结案效率。因此，诉讼财产保全责任保险的运用加快了法院诉讼财产保全案件的审理，保证了案件的顺利开展。

最后，对于被申请人来说，诉讼财产保全责任保险可以保证因财产保全而导致的损失获到足额的赔偿。在诉讼财产保全案件中，被申请人常因财产被采取临时性强制措施而产生损失，而诉讼财产保全责任保险可以确保在发生保全错误时，在一定限额内由保险公司对被申请人进行赔偿。这降低了被申请人的风险，加大了对被申请人权益的保障。

4．我国诉讼财产保全责任保险的现状

2012年，诚泰保险公司率先在云南设立诉讼财产保全责任保险试点。该保险在云南省推出后，就受到了广泛好评，充分地发挥了保险辅助社会管理的作用，获得了较大的反响。随后平安保险、中国人民保险、安信保险、太平保险、阳光保险等多家公司也相继推出诉讼财产保全责任保险，各省市法院也积极引入、推广，并积攒了很多成功经验。截至2016年1月31日，已有湖南、黑龙江、辽宁、天津、山西、浙江、江苏、贵州、广东、广西、海南省高院发文表示接受诉讼财产保全责任保险作为财产保全担保的形式，基于该险种而出的保函已经被全国

1399家人民法院所接受，累计保全金额已达数百亿元。由此可见，我国诉讼财产保全责任保险发展较为迅速，市场前景广阔，发展潜力巨大。

5. 我国诉讼财产保全责任保险存在的问题

诉讼财产保全责任保险作为一种创新型的财产担保形式，其便民性、专业性让其迅速在我国立足发展，但同时也必须清醒的认识到诉讼财产保全责任保险在司法实践中仍面临这许多困难，主要有以下5个方面：

5.1 诉讼财产保全责任保险未收到法律的保护

目前来看，诉讼财产保全责任保险作为一种新型险种，在实际运用中并未受到法律的保护，民事诉讼法中仅规定人民法院采取保全措施，可以责令申请人提供担保，但对担保形式并未具体说明。同时，最高法院也并未对诉讼财产保全责任保险做出明确的司法解释，这极大地限制了该保险的推广和发展。法律的认可是发展诉讼财产保全责任保险的前提和基础，而现在我国法律并未承认和否认诉讼财产保全责任保险，这让其处于十分尴尬的境地，同时对法院来说，这也是一个挑战。有些大胆的法院认为引入诉讼财产保全责任保险可以简化案件审理的手续，有效的保障双方利益，实现三方共赢。而有些法院则认为这是在打擦边球，法律并未明文规定，应不予执行。除此之外，部分法官缺少相关的保险知识，为了自身业绩，避免犯错而对诉讼财产保全责任保险持观望态度，这都使得该险种并未在司法实践中广泛引用。

5.2 诉讼财产保全责任保险的风险不好把控

诉讼财产保全责任保险作为一种新型的担保形式，将保险和我国的法律结合起来，这使保险公司在对风险进行评估时具有一定的难度。在测度该保险风险时，不能像衡量普通保险一样，仅考虑投保主体的风险，同时还要考虑到诉讼案件的性质和其中的诉讼风险，并及时对财产保全标的物的风险进行评估。因此，诉讼财产保全责任保险的风险不好把控，其复杂性对保险公司的风险控制人员要求较高，而保险公司的团队又常常缺乏这种综合型人才，这不利于诉讼财产保全责任保险的推广。此外，作为新推出的险种，诉讼财产保全责任保险也没有可借鉴的风险测量方法，这也在一定程度上阻碍了其发展。

5.3 客户的来源渠道单一，公民的认可度不高

诉讼财产保全责任保险因与诉讼案件相挂钩，所以该保险所针对的客户群体与其他保险不同，来源渠道较为单一，主要客户都集中于我国的人民法院，而人民法院作为国家的审判机关，又无法成为保险公司推销产品的场所，这制约了诉讼财产保全责任保险的进一步发展。同时，保险公司的销售团队因缺少民事诉讼法、财产诉讼保全、担保制度等方面的法律知识，无法精准的定位客户群体，准

确的把握客户的需求，这就使得公民对诉讼财产保全责任保险的认知度不高，认可性不强。

5.4 缺乏对诉讼财产保全责任保险的监督机制

目前，我国保监会尚未对诉讼财产保全责任保险做出明确的相关监督规定，关于诉讼财产保全责任保险的具体运作也未做明确要求，这样一来，因缺少相应的监督管理机制，各大保险公司在规定诉讼财产保全责任保险的费率时便会不尽相同，对该险种的管理也会有不同的标准，不规范化的管理反而又增加了保监会监管的难度。另外，对诉讼财产保全责任保险监管的缺失，也会使保险业协会这类自律性组织难以对保险公司的这种业务进行自律督促，约束保险公司的不正当行为。

5.5 存在申请人与被申请人合谋骗保的漏洞

因诉讼财产保全责任保险推出的时间较短，各方面的机制不健全，这就给了财产诉讼双方可乘之机，当被申请人无力偿还债务或为了谋取额外利益时，申请人与被申请人可串通起来，由申请人故意造成保全错误，而被申请人则夸大因保全所遭受的损失，联手来骗取保险公司的赔偿款。而法院又因在接受保全申请后，需在较短的时间内作出裁定，尤其是诉前财产保全中，必须在四十八小时内作出裁定。较少的时间使法院无法对案件进行详细、实质的审查，从而无法识别出申请人与被申请人的内幕关系，这进一步增加了骗保的风险，不利于诉讼财产保全责任保险的发展。

6．完善我国诉讼财产保全责任保险的建议

我国诉讼财产保全责任保险的发展目前还处于起步的阶段，很多方面仍存在不完善之处，众多问题亟待解决。为了进一步推广诉讼财产保全责任保险，应：

6.1 将诉讼财产保全责任保险纳入民事诉讼法中

我国是依法治国的国家，为了使诉讼财产保全责任保险实现有法可依，不但要将诉讼财产保全责任保险纳入我国民事诉讼法中，而且最高法院还要对其作出明确的司法解释，认可诉讼财产保全责任保险可作为一种财产担保形式，来提供请求保全数额的担保。只有受到我国法律的保护，才能使各大法院敢于引入诉讼财产保全责任保险，法官敢于真正地运用诉讼财产保全责任保险，有效地发挥出保险辅助社会管理的功能，保障涉案各方的合法权益不受侵害，从而更好的为人民服务。

6.2 建立合理的风险评估机制

合理的风险评估机制是诉讼财产保全责任保险持续健康发展的关键因素。只有将诉讼财产保全责任保险中的风险控制在合理的范围内，才能保障保险公司的利益，使该险种长久的发展下去。保险公司所建立的风险评估机制应包括两个方

面，即承保前的风险评估和承保后的风险控制。在承保前的风险评估中，保险公司可聘请专业的律师结构和风险识别机构，在评估时充分考虑到投保人主体的风险、诉讼案件的诉讼风险、财产保全标的物的风险等多方面，确保风险的可控性。在承保后的风险控制中，保险公司应实时跟进诉讼案件的流程，持续关注案件的审判进展及动态，及时识别申请人败诉、发生保全错误等风险，确保保险公司的利益不遭受损失。

6.3 设立三方平台，扩宽渠道，提高认知度

为了促进诉讼财产保全责任保险的发展，保险公司、律师事务所、法院可进行战略合作，设立三方合作平台（如图2所示），由保险公司牵头，引入专业化综合型人才，定期到律师事务所和法院宣讲诉讼财产保全责任保险的特点和作用，普及该险种的相关知识；律师事务所则可以借助这个平台帮助保险公司评估相关案件的法律风险和向有需求的客户介绍诉讼财产保全责任保险；同时，法院也可以通过这个平台明确地表态接纳这种新型担保形式，及时向咨询者推荐这种通过投保来解决担保难的方法，这样便可以扩宽客户的来源渠道，加大对诉讼财产保全责任保险的宣传力度，提高了公众的认识度。此外，保险公司还可以将审计事务所、风险评估公司等机构引进该平台，来辅助合作平台，更好的助推三方平台的发展。

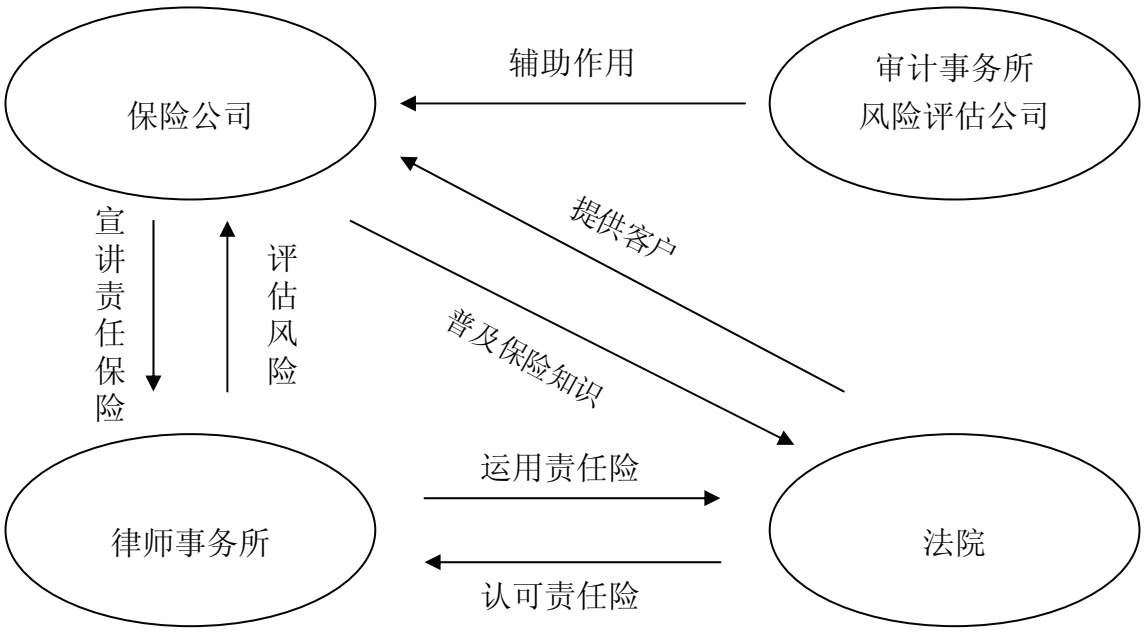


图 2　三方合作平台关

6.4 保监会颁布初步的管理办法，规范诉讼财产保全责任保险的发展

为了加大对诉讼财产保全责任保险的监管，我国保监会应颁布一个初步的管理办法，即《关于诉讼财产保全责任保险的管理与监管办法》。在该办法中，保

监会应对诉讼财产保全责任保险的运作流程、费率设定、赔偿处理、责任免除等方面作出具体的规定，针对该险种的一些市场违规行为也应设置明确的处罚标准，以此来规范诉讼财产保全责任保险的管理与监管，不再让其游离于监管之外。另外，我国的保险业协会也应积极发挥自身的作用，监督诉讼财产保全责任保险的发展过程，督促保险公司合规经营，遵守规则，及时发现其潜在风险，以加快诉讼财产保全责任保险发展的步伐。

6.5 加大审核力度，弥补骗保漏洞

为了防止申请人与被申请人合谋骗保的情况，保险公司和法院应完善诉讼财产保全责任保险的审核机制，降低骗保风险，促进诉讼财产保全责任保险的良好发展。具体来说，在保险公司方面，应严格审查投保人的资信情况，从根上杜绝骗保行为的发生，同时加大向员工普及法律知识的力度，以便及时识别到骗保行为的存在。在意识到骗保行为后，保险公司应及时向法院另行提出第三人之诉，索要赔偿，追究申请人与被申请人的责任。在法院方面，应建立合理的审查机制，增强对证据的分析能力，定期对法官进行培训，普及保险方面的知识，提高法官的综合素质，并注重证据的完整性、有效性和与案件的关联性，尽最大限度避免骗保行为的发生。

7．结束语

诉讼财产保全责任保险突破了传统担保方式的限制，为弱势申请人的群体提供了有效的保障，这是对我国民事诉讼保全制度中担保形式的丰富与拓展。在推广诉讼财产保全责任保险时，保险公司、法院、保监会应积极配合，及时解决在发展中遇到的问题，不断完善关于诉讼财产保全责任保险的机制，使保险功能在民事诉讼案件中发挥出更大的作用。

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我国诉讼财产保全责任保险的问题与对策

尹成远 冯悦

尹成远*
教授
河北大学经济学院
保定071000，中国
电话: 13930205980
Email: yinchengyuan@139.com

冯 悦*
硕士生
河北大学经济学院金融系
保定市七一东路2666号
电话: 15031292535
Email: 296736515@qq.com

关键词: 诉讼财产保全责任保险；合作平台；风险评估

中文摘要. 随着民事诉讼案件的不断增多，诉讼财产保全中的担保问题也成为了各方所关注的重点问题。而传统的担保形式手续复杂、对申请人要求较高，这使得普通百姓在申请诉讼财产保全时常常遇到困难。在这样的背景下，诉讼财产保全责任保险应运而生。诉讼财产保全责任保险可以为投保人提供财产担保，以财产担保的形式来代替需要缴纳的诉讼财产保全押金。这种保险的推出，满足了普通百姓的需要，扩宽了我国保险业务的范围，促进了保险业的发展。但作为一种新型险种，在实际运用与发展中仍存在诸多问题，如：未受到法律的保护、风险评估较为困难、保全案源的来源渠道单一、缺乏有效的监管等。为了更好的推动诉讼财产保全责任保险的发展，应尽快把诉讼财产保全责任保险纳入我国法律体系，建立合理的风险评估机制，设立保险公司、律师事务所、法院三方合作平台，加强对诉讼财产保全责任保险的管理与监管，充分发挥诉讼财产保全责任保险在民事诉讼案件中的作用。

Information Asymmetry, Insurance and Farmer's Access to Credit

ZUO Fei*, LUO Tianyuan

ZUO Fei*
Lecturer
Economics and Management School
Northwest University
Xi'an Shaanxi710127, China
Phone：(8629)153 3907 9756
Mail：165153631@qq.com

LUO Tianyuan
Lecturer
Economics and Management School
Northwest A&F University
Xi'an Shaanxi712100, China
Phone：(8629)180 0926 4790
Mail：40341456@qq.com

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Abstract: In the framework of asymmetric information, this paper constructs a theoretical model and shows that a sufficient level of insurance converge can improve credit rationing towards farmer through sharing of credit risk and better information structure.Utilizing multi-variable Probit Model and based on 491 survey samples fromrural Jiangsu Province, this paper then conducts an empirical analysis on the impact of insuranceon farmers'credit access. The results show that insuranceplays a significant role for improving of farmers'credit availability, but when it comes to productive credit, different types of insurance displays different support, agricultural insurance is found to be relatively better than other insurance types.This study provides a theoretical and further empirical support for the cooperation of insurance

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and bank credit in practice, implying that the interconnection of credit and insurance on product and on related information sharing mechanism should be furthered.

引言

在经典的 Stiglitz 和 Weiss（1981）理论框架中解释，信贷配给是不对称信息信贷市场的一种特殊均衡：信息不对称带来的逆向选择和道德风险使得利率提高到一定程度后，风险增加导致银行的期望利润由升转降，银行不会执行高于能带来最大利润的利率水平，信贷配给便成了必然结果。为克服信息不对称的影响，正规金融机构一般只向借款人提供抵押或担保贷款，抵押和担保起到了信息甄别机制的作用，有助缓解逆向选择和道德风险（Whette，1983；Bester，1985；Schmidt-Mohr，1997 等）。在中国面向一般农户的农村信贷市场中，分散的空间格局与小规模经济组织的特征进一步影响了交易双方的信息结构（刘祚祥等，2010），致使配给成为农村信贷市场的一种常态。但长期以来合格抵押物和担保缺失的事实，使得在国家金融支农力度不断加大的背景下，一般农户依旧难以获得融资支持，成为“三农”发展的重要制约。

保险是农户风险管理的有效工具，也是金融支持农业的方式之一。上世纪 60 年代，拉美一些国家就出现了将保险作为替代性融资支持手段的做法（Hogan，1983）。中国自 2009 年明确提出要“探索建立农村信贷与农业保险相结合的银保互动机制”以来[①]，也出现了很多创新的做法[②]，在一些地区被认为切实提高了获得信贷的农户数量和融资规模，在另一些地区成效却远不及期望（顾银宽，2009；李军，2011；吴本健等，2013；秦涛等，2014 等）。由此引发的思考是：银保互联的做法是否具备理论基础？即保险究竟能否提高农户信贷可得性？通过怎样的机制得以实现？又应如何将二者“互联”才能更好地发挥作用？在严重的信贷约束和农户有效融资支持手段不足的大环境下，这些均是有必要深入探讨的问题。然而总体上，相较实践的发展，学术领域这方面的研究仍显不足，在理论和经验分析中都存在值得拓展或完善之处。因此，本文将针对这一主题展开进一步分析和验证，以期为实践中支持农户信贷以及银保互联的制度设计提供参考。

论文结构安排如下：第二部分是文献综述，第三部分构建理论模型分析保险影响信贷配给的作用机理，第四部分介绍调查数据，讨论计量模型设定和变量选取，第五部分对估计结果进行分析解释并比较不同计量模型的优越性，最后一部分总结全文结论并提出政策建议。

1. 文献综述

国外研究中，最早也是被引用最多的研究Binswanger (1986)提出，农业保险能够发挥抵押品替代的作用，提高贷款人的预期收益，从而将潜在借款人转化

[①]见 2009 年以来各年度的中央 1 号文件。

[②]最常见的做法是将保险作为申请信贷的条件，并约定农户无法履约还款时，保险赔款优先用于还贷。常见的保险有农作物保险或其他相关财产的保险、贷款信用保证保险、主要劳动力的意外伤害保险等。

为实际借款人或提高贷款规模，但同时也强调，这种抵押品替代的作用根据保险本身（承保标的、风险、保障程度等）的不同会有差异，一般的农作物保险和其他涉农财产、人身保险是否可以起到支持融资的作用是一个需要实证的问题[①]（Pischke（1986）持类似观点）。经验分析中，Pomareda（1986）发现农业信用保险提高了贷款人的经营绩效，Mishra（1994）及Raju和Chand（2008）得出农业信用保险的存在增加了获得贷款的小规模农户数量以及户均贷款额，但同样基于保费与贷款总量数据的研究Olubiyo和Hill（2005）并没有发现保险与信贷供给之间明显的关联。总体看，国外对此问题的研究侧重于经验分析（且多针对农业信用保险），而对影响机制并未进行较深入的理论阐释。

国内研究中，理论分析方面，刘祚祥等（2010）提出银保互联的内在动力在于风险分担与信息共享。刘祚祥和黄权国（2012）在修改 Stiglitz 和 Weiss（1981）模型关于银行的信息生产能力及风险-收益关系假定的基础上，引入保险，发现在竞争性信贷市场中，农业信用保险降低了信贷风险，提高了贷款人的收益和放贷意愿。张建军和张兵（2012）构建农户、保险公司和银行参与的多期动态博弈模型，说明保险带来的声誉信号传递能帮助达成贝叶斯纳什分离均衡，降低银行的风险识别成本，提高放贷可能性。以上研究从不同角度阐释了保险作用于信贷配给的机理，为本文研究提供了有益的启示，但若依据信息不对称是信贷配给根本原因这一理论基础，则分析保险对逆向选择和道德风险的作用，应是关于保险影响信贷配给机理的更具一般性，也无法回避的一个讨论。

经验分析方面，刘祚祥和黄权国（2012）、祝国平和刘吉舫（2014）、方首军等（2012）、安东等（2015）采用单方程模型，对贷款与保费总量数据进行回归分析，前两个研究发现农业保险发展能够促进农业信贷规模增加，后两篇文献未发现明显关系。张建军和张兵（2012）基于苏、鄂两省农户调查数据，采用二元 Probit 模型验证发现保险提高了农户获得信贷的可能性。总体看，已有研究还存在如下可拓展之处：（1）研究中的保险均为较笼统的"农业保险"或"涉农保险"，但针对不同标的、风险和损失的保险类别对信贷的支持作用存在显著差异；（2）研究多采用总量数据，但要在信息不对称的框架下考察主体行为倾向及其结果，农户意愿微观数据应是较好的选择；（3）基于微观数据的二元 Probit 模型仅关注了信贷和保险供给决策的结果，未分离需求与供给的内生联系，也未考虑信贷配给的环境中供给对需求显示可能存在的偏差，易导致有偏估计问题。即二元 Probit 模型的内涵还不足以准确刻画信贷配给的环境特征及供需之间和银保两部门互有影响的关系特征。

综上，本文将具体展开两方面的工作：首先，在信息不对称的理论框架下，

[①]中国的《农业保险条例》中规定"农业保险"为以有生命的农作物为保险标的的各类保险，同时规定"涉农保险"是指农业保险以外、为农民在农业生产生活中提供保险保障的保险，包括农房、农机具、渔船等财产保险，涉及农民的生命和身体等方面的短期意外伤害保险。Binswanger (1986)研究中的"农业保险"是一个更加宽泛的概念，口径接近中国的"涉农保险"，但还包括了专门保障信贷的农业信用保险。

厘清保险影响农户信贷活动中的逆向选择和道德风险而作用于信贷配给的一般机理；其次，采用更加匹配的多变量 Probit 模型和最新的农户意愿调查数据，对保险之于信贷供给的作用进行验证，并考察不同类别保险对信贷供给作用的差异。

2. 理论分析

论文在经典的 Stiglitz 和 Weiss（1981）信贷配给模型中引入保险，比较有无保险情形下农户和银行基于各自期望利润最大化目标的行为选择，观察保险对信贷活动中逆向选择和道德风险，进而对信贷供给的影响。

假设有很多个需贷款投资项目的农户，同时有竞争性的银行系统提供无抵押、无担保贷款，贷款农户获得 1 单位资金，利率 r，银行无资金约束。农户和银行均为风险中性。

3.1 农户的逆向选择、道德风险行为与银行信贷配给

已知第 i 个农户项目成功和失败的概率分别为p_i和$1-p_i$，成功和失败情况下的收益分别为R_i和 0。任意单个项目的期望收益同为R^e，即：$p_i \cdot R_i = R^e$。农户清楚自己项目的风险程度（成功概率p_i），而银行只知道成功概率在所有项目中的分布函数$F(p)$和密度函数$f(p)$。则农户 i 贷款投资其项目的期望利润$E(\pi_{fi})$为：

$$E(\pi_{fi}) = p_i[R_i - (1+r)] = R^e - p_i(1+r)$$

上式对p_i求导可得：

$$dE(\pi_{fi})/dp_i = -(1+r) < 0 \tag{1}$$

表明从事高风险投资（成功概率较低）的农户获得更高期望利润。

已知除贷款从事其项目外，农户 i 还有其他投资选择，期望收益为ρ，则由风险中性的假设知，农户 i 选择贷款投资其项目的约束条件应为$[R^e - p_i(1+r)] \geq \rho$，解得农户 i 贷款的保留利率为$(R^e-\rho)/p_i - 1$，即贷款利率超过这一水平便会选择退出市场。亦可解得临界成功概率$\dot{p}$为$(R^e-\rho)/(1+r)$，即成功概率小于临界值$\dot{p}$的农户才会选择贷款。$\dot{p}$对 r 求导得：

$$d\dot{p}/dr = -(R^e-\rho)/(1+r)^2 < 0 \tag{2}$$

说明提高利率会降低临界成功概率$\dot{p}$，致使低风险农户退出市场，即发生逆向选择。

现在假设任意农户 i 贷款成功后有两个项目可选，一个是成功概率较低但期

望收益较高的项目 H，另一为成功概率较高但期望收益较低的项目 L，即有$R_i^H > R_i^L$，$p_i^H < p_i^L$，其他假设不变。风险中性的农户 i 对两项目无差异的充要条件是期望利润相等，即$E(\pi_{fi}^H) = E(\pi_{fi}^L)$，亦即$[R_i^H - (1+r)]p_i^H = [R_i^L - (1+r)]p_i^L$，解得使两项目无差异的贷款利率水平$\dot{r}$为：

$$\dot{r} = [p_i^L R_i^L - p_i^H R_i^H]/[p_i^L - p_i^H] - 1 \tag{3}$$

银行向 H 和 L 两项目放贷的期望利润$E(\pi_{bi}^H)$和$E(\pi_{bi}^L)$分别为$(1+r)p_i^H$及$(1+r)p_i^L$，显然有$E(\pi_{bi}^H) < E(\pi_{bi}^L)$，银行更希望农户选择低风险项目，但因为农户选择高风险项目的期望利润比低风险项目高（（1）式），而由于信息不对称，银行无法有效监督农户的选择，所以银行面临着农户从事高风险项目的道德风险，并且由于$dE(\pi_{bi}^H)/dr = -p_i^H > dE(\pi_{bi}^L)/dr = -p_i^L$，利率越大于$\dot{r}$，农户从事高风险项目的可能性越大，道德风险越显著。

假设农户数量足够多，则农户项目的平均成功概率p^e为$\int_0^{\dot{p}} pf(p)dp \Big/ \int_0^{\dot{p}} f(p)dp$，可证明：

$$dp^e/dr < 0 \text{①} \tag{4}$$

即贷款利率越高，受农户逆向选择和道德风险行为的影响，所有项目的平均风险程度越高。

在竞争性银行系统中，很多个向农户放贷的银行可看作一家银行，因此，假定这“一家”银行单位资金的费用率为 m，所有贷款农户总需求标准化为 1，则银行期望利润$E(\pi_b)$为：

$$E(\pi_b) = \int_0^{\dot{p}} (1+r)pf(p)dp \Big/ \int_0^{\dot{p}} f(p)dp - (1+m) = (1+r)p^e - (1+m)$$

$E(\pi_b)$对 r 求偏导可得：

$$\partial E(\pi_b)/\partial r = p^e + (1+r)\partial p^e/\partial r \tag{5}$$

（5）式等号右边第一项为提高利率的收入效应（为正），第二项为提高利率的风险效应，由（4）式知风险效应为负。随着利率提高，逆向选择和道德风险变得愈加显著，会导致风险效应逐步抵消收入效应，期望利润由升转降，存在一个最优利率水平r^*使得银行的期望利润最高。银行自然不会执行高于r^*的利率水平，

① 证明：
$$dp^e/dr = f(\dot{p})(d\dot{p}/dr)\left[\dot{p}\int_0^{\dot{p}} f(p)dp - \int_0^{\dot{p}} pf(p)dp\right]/\left(\int_0^{\dot{p}} f(p)dp\right)^2$$
$$= f(\dot{p})(d\dot{p}/dr)\left[\dot{p}F(\dot{p}) - \int_0^{\dot{p}} pf(p)dp\right]/F^2(\dot{p}) < 0$$

因此部分借款农户申请更高的利率也无法得到贷款，即发生信贷配给（如图 1，r^* 利率水平上的信贷需求为 OF，信贷供给仅为 OG，FG 即为配给的规模）。

3.2 保险对农户逆向选择和道德风险行为的影响

现在假定农户 i 投保保险，并约定项目失败后由保险公司补偿 c，c 即为保险对 1 单位贷款的保障程度（保障金额/贷款额）。这种情况下银行对农户 i 贷款的期望利润为：

$$E(\pi_{bi}) = (1+r)p_i + c(1-p_i) - (1+m) \tag{6}$$

假设银行对农户 i 贷款的利率可变，则有：

$$dr/dc < 0 ① \tag{7}$$

表明在竞争性市场中提高保险保障程度能降低农户的贷款利率，并且保障程度增加越大，利率降幅越大。本文认为，这是保险的风险分担和信号传递功能使得农户信用水平得以提升的结果：保险是以现在的货币换取依赖于未来特定事件发生应支付的货币（Kenneth J. Arrow，2005）。这种将未来的风险预先支付的经济行为，能够保护风险承担人的财产安全并因此使相关资产资本化，从而使保险合约具有了抵押功能，实现了信用风险的分担；另一方面，保险企业基于保险标的尽量为"同质风险"的要求和审慎经营的原则，会对保户进行风险选择，剔除风险程度较高的个体。因此农户投保的事实提供了一种额外的信号传递机制，改善了银行对贷款农户风险程度的信息不对称。信用提升带来的这种利率降低效应亦可拓展至农户拥有的其他类别保险，一旦发生约定的保险损失，农户可得到来自保险公司的补偿，补偿占农户贷款数量的比重越大，可用于直接还贷的限制越少，理论上越有助于降低农户的利率成本。

根据（2）式，利率下降使更多因利率高过自身保留利率而退出市场的低风险农户选择贷款，临界成功概率$\dot{p}$提高，结果是逆向选择得以缓解；同样，保险带来的信用增强使得贷款利率降低为小于$\dot{r}$时（取决于保险保障程度），有$E(\pi_{fi}^{H}) < E(\pi_{fi}^{L})$，低风险项目对农户而言变得更优，有助降低资金运用的道德风险。缓解逆向选择和道德风险的综合效应是所有贷款项目的平均成功概率p^e提高（（4）式），此时银行的期望利润$E(\pi_b)_1$为：

$$E(\pi_b)_1 = (1+r)p^e + c(1-p^e) - (1+m) \tag{8}$$

① 证明：根据隐函数求导法则，令$G = (1+r)p_i + c(1-p_i) - (1+m) - E(\pi_{bi}) = 0$，$E(\pi_{bi})$在竞争性的市场中为 0，在银行与农户、保险公司的合同中为任意常数，因此有$\partial G/\partial r = p_i > 0$，$\partial G/\partial c = (1-p_i) > 0$，$dr/dc = -(\partial G/\partial c)/(\partial G/\partial r) = (p_i - 1)/p_i < 0$

显然$E(\pi_b)_1 > E(\pi_b)$，并且$E(\pi_b)_1$对 c 求偏导可得：

$$\partial E(\pi_b)_1 / \partial c = 1 - p^e > 0 \tag{9}$$

即银行期望利润随保险保障程度提高而上升。期望利润的提高增加了信贷资金供给，原本因配给无法得到贷款的农户将更可能获得信贷支持，保险对农户和银行带来了双赢的效果。

保险影响信贷配给的机制在 Stiglitz 和 Weiss（1981）框架下做一解释可由下图示：LD 是不变的信贷需求，LS1 和 LS2 分别对应投保前后的信贷供给曲线，并是银行期望利润$E(\pi_b)$的单调增函数。由于农户的逆向选择和道德风险，$E(\pi_b)$和 LS 曲线均呈现先增后减的形态，r^*是能带来最大期望利润的均衡利率水平（区别于瓦尔拉斯均衡）。这种均衡状态下仍存在规模为 FG 的信贷供需缺口（OF-OG）。而在有保险情况下，逆向选择和道德风险得以缓解，农户的平均风险程度降低，银行期望利润上升使得信贷供给曲线也上移到 LS2，供需缺口减小到 HF，配给得到有效缓解。

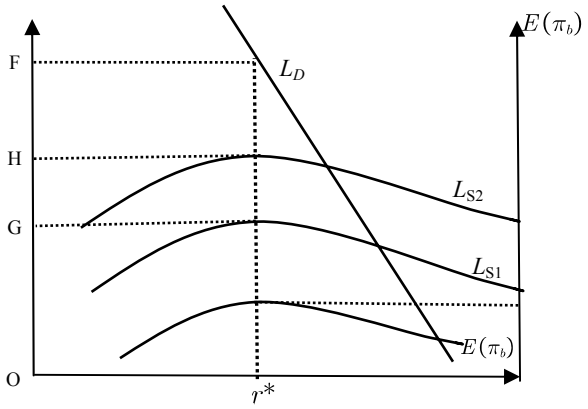


图 1：银保互联对信贷配给的影响：S-W 模型框架下的解释

3. 数据描述、计量模型与变量选择

4.1 数据描述

2015 年 5 月底，笔者指导的调研组在江苏省新沂市和沭阳县开展了为期一周的农户入户调查，访谈收集了 2014 年农户保险和信贷行为的相关信息，涉及样本地区农村种、养、渔三种产业。调查采取随机抽样的原则，在两市（县）分别随机选择 3 个乡（镇），每个乡（镇）随机选取 3 个村，每个村平均获取约 20-30 个农户样本，剔除明显错答、信息不全和个别极端值后，得到有效样本 491 份，其中新沂市 261 份，沭阳县 230 份。苏北地区以小麦和玉米为主要的粮食作物，气候类型属于暖温带半湿润季风气候，以自然风险的类型和程度考量，可作为中国长江以北农业区的一个典型代表；同时，相对中西部地区，江苏省农户的家庭收入和财富水平较高，涉农信贷和保险的发展水平和覆盖程度在国内亦属前茅，

为本文对信贷与保险供给关联的研究提供了较好的样本基础。

样本地区贷款条件以农业生产资料抵押和担保为主，有少量农房抵押的例子，未发现银保互联，将保险作为融资支持手段的做法。全部样本中 2014 年有贷款的农户共 151 户，但其中 50%以上表示贷款小于申请的资金量，39 户农户表示 2014 年提出过信贷申请但未获通过（占比约 7.9%），另有 107 户农户存在贷款意愿，但由于多种原因（包括认为“想贷也贷不到”、“利息太高”、“没有抵押或担保”等）没有提出申请（占比约 21.8%），表明信贷约束的存在。

保险方面，作为 2007 年中央财政支持首批试点的六省(市)之一，截至 2014 年底，江苏省共有财政支持的包括种植业、养殖业、高效设施农业、农机具和渔业五大产业在内的 30 余种涉农保险。样本地区一半以上的种养作物品种有专门保险险种。经统计，全部样本中共计 310 户农户投保了农作物保险，无投保农业信用保险的样本，另有 137 户农户购买了其他商业保险险种，以寿险和意外险占比最多。

4.2 计量模型

农户对于信贷或保险部门的参与行为同时受其自身需求，以及两部门供给决策的影响。理性的信贷供给者在放贷决策中也不仅会考虑农户对信贷的需求，还会考虑农户对保险需求及保险的供给行为。因此，有必要在控制住需求和另一部门影响的情况下，考察信贷和保险供给行为的关联。据此，本文在多元 Probit 模型[24]的一般框架下，构建四元 Probit 模型，联合估计农户信贷需求、信贷供给、保险需求和保险供给四个决策行为及其相互关系，重点关注信贷与保险供给决策行为之间的关系，以此考察保险的存在会否对信贷可得性产生影响①。四元 Probit 模型能考虑到不同主体行为之间的影响，还能通过估计方程误差项相关系数来考察不同行为之间的关联程度，相对于仅考虑信贷和保险供给行为的二元 Probit 模型将更加有效地改进有偏估计问题[25]。

论文所称银行（或信贷部门），指所有在农村地区经营资金借贷业务的正规信贷机构；论文所称保险，指商业性质的保险产品②。选择商业保险作为论文研究中“保险”范畴的原因是：首先，根据上文的理论分析，保障程度越高，更有可能起到支持信贷的作用，而商业保险相对于社会保险险种保障程度明显为高；另外，只有谋取最大利润的商业保险机构对农户的风险选择才可能为信贷机构传递有关农户风险特征的有效信息。

以下分银行和保险两个部门，构建联立方程描述借款农户、信贷机构和保险公司三个利益主体的选择行为。对于银行来说，有：

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①有理由相信这种关联应主要是保险的存在对信贷供给意愿的影响，因为一般认为，保险的供给意愿主要取决于被保险人（作物）的风险状况，与是否有信贷并无直接关联。

②农业保险并不例外，2012 年 2 月我国发布《农业保险条例》，对农业保险定性为“有国家支持的商业保险”，目前农业公司均是由商业保险公司开发经营，财政部门仅对部分品种提供保费补贴。

$$\begin{cases} y_1^* = \beta_1 X_1 + \varepsilon_1 & y_1 \begin{cases} =1 & (y_1^* > 0) \\ =0 & (y_1^* \leqslant 0) \end{cases} \\ y_2^* = \beta_2 X_2 + \varepsilon_2 & y_2 \begin{cases} =1 & (y_1 = 1, y_2^* > 0) \\ =0 & (y_1 = 1, y_2^* \leqslant 0) \end{cases} \end{cases} \tag{10}$$

其中，y_1^*代表农户信贷需求的潜在变量，y_1代表农户信贷需求的决策变量，y_2^*代表银行信贷供给的潜在变量，y_2代表银行信贷供给的决策变量。对保险公司来说，有：

$$\begin{cases} y_3^* = \beta_3 X_3 + \varepsilon_3 & y_3 \begin{cases} =1 & (y_3^* > 0) \\ =0 & (y_3^* \leqslant 0) \end{cases} \\ y_4^* = \beta_4 X_4 + \varepsilon_4 & y_4 \begin{cases} =1 & (y_3 = 1, y_4^* > 0) \\ =0 & (y_3 = 1, y_4^* \leqslant 0) \end{cases} \end{cases} \tag{11}$$

其中，y_3^*代表农户保险需求的潜在变量，y_3代表农户保险需求的决策变量，y_4^*代表保险供给的潜在变量，y_4代表保险供给的决策变量。

（10）和（11）式中的$\varepsilon_1, \varepsilon_2, \varepsilon_3, \varepsilon_4 \sim MVN(0,\ \Sigma)$，MVN 是一个四元正态分布函数。Σ的形式为：

$$\Sigma = \begin{bmatrix} 1 & \rho_{12} & \rho_{13} & \rho_{14} \\ \rho_{12} & 1 & \rho_{23} & \rho_{24} \\ \rho_{13} & \rho_{23} & 1 & \rho_{34} \\ \rho_{14} & \rho_{24} & \rho_{34} & 1 \end{bmatrix}$$

ρ_{12}、ρ_{13}、ρ_{14}、ρ_{23}、ρ_{24}、ρ_{34}表示对应方程误差项间的相关系数。

使用极大似然法估计各自变量的参数β和各个相关系数，似然函数为：

$$L = \prod_{i=1}^{n} L_{i1}^{y_{i1}y_{i2}y_{i3}y_{i4}} \cdot L_{i2}^{y_{i1}y_{i2}y_{i3}(1-y_{i4})} \cdot L_{i3}^{y_{i1}y_{i2}(1-y_{i3})} \cdot L_{i4}^{y_{i1}(1-y_{i2})y_{i3}y_{i4}} \cdot L_{i5}^{y_{i1}(1-y_{i2})y_{i3}y_{i4}}$$
$$\cdot L_{i6}^{y_{i1}(1-y_{i2})(1-y_{i3})} \cdot L_{i7}^{(1-y_{i1})y_{i3}y_{i4}} \cdot L_{i8}^{(1-y_{i1})y_{i3}(1-y_{i4})} \cdot L_{i9}^{(1-y_{i1})(1-y_{i3})}$$

其中，L_{i1}到L_{i9}分别是状态（1，1，1，1），（1，1，1，0），（1，1，0，x），（1，0，1，1），（1，0，1，0），（1，0，0，x），（0，x，1，1），（0，x，1，0），（0，x，0，x）的似然贡献（x 表示观测不到）。由于似然函数的形式相对复杂，一般的计算方法很难估计，本文借助 Stata 软件，使用模拟极大似然法（Simulated Maximum Likelihood）进行估计。①

借鉴 Akoten 等（2006）[26]的研究，本文将重点关注信贷和保险两个供给方程误差项的相关系数ρ_{24}：如果未能拒绝$\rho_{24}=0$的原假设，说明联立方程模型不可

①为了解决似然函数形式较为复杂，或者似然函数的概率密度函数不存在解析式的情况下的极大似然估计而发展出来的一种方法，使用大数量的模拟抽样去得到密度函数的无偏逼近函数，用此逼近函数替代原密度函数进行估计。

取，可转而采用单方程模型进行估计。若ρ_{24}统计上显著不为零，则意味着联立估计是合理的。进一步，如果估计为正，说明保险对信贷可获得性存在正向促进，反之则为负向影响。

4.3 变量选择

4.3.1 因变量

（1）信贷需求。本文界定需求为农户是否对信贷有申请意愿。借鉴刘西川等（2014），定义有申请意愿的农户包括得到信贷机构贷款的农户、申请了贷款但遭拒绝，以及有贷款意愿，但因认为自己贷不到、交易成本或风险高等原因而未申请这几种情况。有申请意愿（即有需求）取值为“1”，反之为“0”。经识别与统计，全部样本中有信贷需求的农户共有 297 户，对农业生产性贷款有需求的农户共 237 户，对消费性贷款有需求的农户共 134 户。

（2）信贷供给。由于供给意愿相对难以识别，论文以农户是否实际获得贷款做以近似衡量，有则取值为“1”，反之取值为“0”。经统计，2014 年有贷款的农户共 151 户，有农业生产性信贷的农户有 93 户，有消费性信贷的农户有 63 户。

（3）保险需求。采取类似上述信贷识别的准则，对农户是否存在保险需求进行识别，存在则取值为“1”，反之为“0”。经过识别，样本中有保险需求的农户共 381 户，对农作物保险有需求的农户共 339 户，对其他类别保险有需求的农户共 200 户。

（4）保险供给。与信贷供给类似，保险供给亦以农户是否实际获得保险做以近似衡量，有则取值为“1”，反之取值为“0”。全部样本中，2014 年实际投保保险的农户有 355 户，投保农作物保险的农户有 310 户，投保其他类别保险的农户有 137 户，其中占比最多的为寿险（88 户）和意外险（32 户）。

4.3.2 自变量

（1）需求影响因素。首先，为了考察农户家庭生命周期对信贷与保险需求的影响，引入年龄、健康、重大事件（黄祖辉等，2007）①、人口负担率变量。其次，为了考察农业生产经营对需求的影响，引入土地面积变量和经济作物产值占比。第三，为了考察家庭收入和消费情况对需求的影响，引入家庭收入和消费支出变量，并引入教育程度变量作为对家庭未来收入能力的一个衡量。第四，为了考察农户家庭经济活动特征对其需求的影响，引入固定资产和非农收入占比变量。

（2）供给影响因素。理论上，保险供给决策的决定性因素是被保险人的风险状况，因而本文引入年龄、健康、家庭收入、非农收入占比、土地面积、经济作物产值占比变量。而信贷供给决策的主要因素是借款人的还款能力与还款意愿，因此本文引入固定资产、家庭收入、非农收入占比、经济作物产值占比、重大事

①指 2014 年发生盖房、买房、婚丧嫁娶、大病治疗、子女上学等支出较大的事件。

件，以及信贷机构可能会考虑的借款人其他特征如年龄、教育程度、劳动力、人口负担率和土地面积。

4.3.3 识别变量

为保证整个方程组可识别，论文在每个方程中加入一个可识别其他方程的排除变量：考虑到农户对信贷和保险产品的了解程度是影响其需求的重要方面，而这两个因素与供给影响因素没有直接关联，因此，在两个需求方程中分别加入信贷知识和保险知识变量进行识别；考虑到农户社会资本对其信贷可得性的现实约束，在信贷供给方程中加入村干部变量进行识别，这个变量与信贷需求和保险供需的影响因素也相对独立；考虑到灾害变量表征的风险程度是决定保险人是否愿意承保的重要因素，对保险供给方程引入灾害变量予以识别①。

表 1　变量定义及描述性统计

变量	定义	观察值	均值	标准差	最小值	最大值
年龄	户主年龄（岁）	491	51.799	10.357	24	83
教育程度	户主受教育年数（年）	491	7.443	2.882	0	15
人口负担率	非劳动力占家庭总人数比例（%）	491	0.409	0.230	0	1
重大事件	2014 年是否发生家庭支出较大事件	491	0.396	0.490	0	1
家庭收入	2014 年家庭人均收入（万元）	491	2.058	2.579	0.05	21.107
非农收入占比	2014 年非农收入占家庭总收入比例（%）	491	0.580	0.348	0	1
家庭消费支出	2014 年家庭人均消费支出（万元）	491	1.005	2.001	0.05	33
土地面积	2014 年底人均生产性土地面积（亩）	491	2.087	2.748	0	23.33
经济作物产值占比	2014 年经济作物产值占农业收入比例（%）	491	0.261	0.396	0	1
固定资产	2014 年底家庭所有的固定资产价值（万元）	491	17.489	20.528	0.5	150
信贷知识	是否了解涉农贷款	491	0.862	0.345	0	1
保险知识	是否了解涉农保险产品	491	0.911	0.286	0	1
村干部	家庭成员是否系村干部	491	0.047	0.211	0	1
健康	户主是否健康	491	0.913	0.283	0	1
灾害	近三年有无较大灾害	491	0.146	0.354	0	1

注：a.二元选择变量取值中，肯定的情况都取 1，反之为 0；b.描述性统计为处理了样本极端值之后的结果。

4. 估计结果及解释

5.1 保险与信贷供给关联的总体估计

①灾害变量也可能是影响保险需求的因素，但因目前没有找到其他更合适的保险供给识别变量，遂予以保留。下文表 2 的估计显示灾害变量在 1%的水平上显著，表明灾害变量作为识别变量有效。

从估计结果看（见表 2），ρ_{12}和ρ_{34}的估计系数在 1%的显著性水平上为正，证实了分离并控制住需求影响的必要性。似然比（LR）和 Wald 检验都在 1%的显著性水平下拒绝了原假设，分别说明 6 个误差项相关系数不同时为 0，以及信贷与保险的供求这四个决策行为相互区别，这两点均支持了采用四元 Probit 模型估计的必要性。在四个识别变量中，信贷知识、村干部和灾害变量的估计都是显著的，表明四个方程可识别。

在论文控制需求和保险部门影响分析框架下，最显著影响信贷供给的因素包括年龄（-）、教育程度（+）、人口负担率（+）和经济作物产值占比（+），表明农村正规信贷机构更加倾向于向较年轻、受教育时间更长、种植经济作物和人口负担更高的农户（户主）提供贷款。其中人口负担率变量估计的影响方向和以往研究结论存在差异，论文认为可能的原因是人口负担较高的农户投资时会更加谨慎，风险程度较低，履约可能性较高，因而更受银行青睐。

从本文关注的焦点ρ_{24}的估计结果看，保险与信贷供给决策之间的关联在 5%的显著性水平上为正，基于论文之前的模型假设，这意味着，其他条件不变时，保险的存在能提高农户的信贷获取能力，信贷与保险互联的内在基础存在。

表 2 农户信贷与保险供求的四元 Probit 模型估计结果

	（1）信贷需求		（2）信贷供给		（2）保险需求		（4）保险供给	
年龄	-0.0015	(-0.25)	-0.0124**	(-1.99)	0.0049	(0.79)	0.0075	(1.29)
教育程度	0.0255	(1.36)	0.0500**	(2.20)	0.0105	(0.86)		
人口负担率	0.2620	(1.09)	0.9530***	(2.93)	-0.1040	(-0.74)		
重大事件	0.2810**	(2.26)	0.1850	(1.51)	0.0221	(0.32)		
家庭收入	0.0811**	(2.30)	0.0144	(0.60)	0.0032	(0.12)	0.0203	(0.78)
非农收入占比	-0.210	(-1.05)	0.2030	(0.94)	0.449**	(2.39)	0.414**	(2.33)
家庭消费支出	.0.0255	(0.85)			0.1440	(0.79)		
土地面积	0.0265	(0.94)	0.0227	(0.91)	-.0161	(.018)	0.0002	(0.01)
经济作物产值占比	0.0701	(0.39)	0.3880**	(2.18)	.0692	(0.16)	-0.21**	(-2.09)
固定资产	0.0034	(0.28)	0.0078***	(2.67)	0.0003	(0.14)		
信贷知识	0.2120**	(2.43)						
保险知识					0.0656	(0.71)		
健康	-0.0703	(-0.34)	0.3810	(1.60)	0.0900	(0.38)	0.2070	(0.93)
村干部			0.0408*	(1.67)				
灾害							0.693***	(3.46)
常数项	-0.3020	(-0.62)	-0.8460*	(-1.72)	0.0077	(0.02)	-0.2880	(-0.71)
误差项相关系数	ρ_{12}		0.9901***	(4.12)	ρ_{13}		0.0571	(0.67)
	ρ_{14}		-0.0034	(-0.04)	ρ_{23}		0.153	(1.32)
	ρ_{24}		0.1380**	(2.08)	ρ_{34}		0.894***	(3.75)
极大似然函数值	-868.66							

Waldχ^2（41）	83.87***			
LR 检验	chi2(6) = 451.94 P> chi2 =0 .0000			
观察值	491	491	491	491

注：*、**和***分别表示在 10%、5%和 1%水平上显著，括号内为估计的 *t* 值，下表同。

5.2 不同类别保险与农业生产性信贷供给间关系的考察

考虑到相对于消费信贷而言，生产性信贷对农业、农村和农民生活的影响更甚，因此，本文在这部分关注保险对农业生产性信贷供给的影响。基于上述 Binswanger (1986)的观点，并根据样本特征，本文将保险区分为农作物保险与其他类别保险，具体考虑以下六种情形：A：是否有农作物保险，B：是否有农作物保险之外的其他类别保险，C：农作物保险和其他类别保险是否都有，D：农作物保险与信贷是否针对同一作物品种，E：是否有寿险以及 F：是否有意外险，分别与农业生产性信贷的供求建立四元 Probit 模型进行估计（自变量与总体考察部分相同，因变量和估计结果见表 3）。①

估计结果证实了每种情形下的四种行为互有关联，并均同时在 1%的显著性水平上证实了四种行为彼此区别以及相关系数不同时为 0②。从关键的ρ_{24}估计结果看，情形 D 针对同一作物品种的保险与生产性信贷供给的关联在 1%的显著性水平上为正（0.749），情形 A 拥有一般的农作物保险与生产性信贷供给的关联在 5%的显著性水平上为正（0.133），同样，情形 C 同时拥有两类保险与生产性信贷供给的关联在 10%的显著性水平上亦为正（0.122），而其他三种情形的估计并不显著。这一结果表明：信贷作物参加专门保险，即拥有专门保障的情形最受信贷机构的青睐，而相对来说，其他一般的农作物保险可以发挥的信贷支持作用较小。可能的解释是一般的农作物保险虽也是对农户生产的保障，但若不与贷款作物的损失挂钩，对信贷风险的分担和信号传递作用相对有限。此外，农作物保险之外的其他类别保险（在本文样本中主要是寿险、意外险）表现出对农户生产性信贷的供给无明显的正向影响（情形 E、F 对情形 B 的估计提供了一定程度的佐证）。可能的原因在于这类保险在被保险标的、损失风险与补偿等方面与农作物保险有较大差别，并且目前在保险金用于偿付债务方面还存有不少法律和制度上的约束和障碍③，因此对农户信用的提升作用比较间接。

①识别变量的情况如下：情形 A 沿用上述总体考察部分的识别变量，B、E、F 三种情形中的其他类别保险供给、寿险供给和意外险供给三个方程使用健康变量进行识别，在相应其他三个方程中剔除健康变量，其他识别变量与上文同；情形 C、D 中两类保险供给和同种作物的信贷与保险供给这两个方程分别同时引入灾害和健康变量进行识别，在相应其他三个方程中剔除此二变量，其他识别变量与总体考察部分相同。

②由于篇幅限制，具体结果略，有兴趣的读者可向作者索取。

③比如根据我国现行《合同法》和《保险法》的相关规定，人寿保险不属于债务的追偿范围，其保险金不能用于偿付被保险人的债务。

表 3　农业生产性信贷与不同类别保险供需的四元 Probit 模型估计结果

	A:是否有农作物保险	B:是否有其他类别保险	C:是否两类保险都有	D:贷款和保险是否针对同一作物品种	E:是否有寿险	F:是否有意外险
方程组因变量	生产性信贷需求 生产性信贷供给 农作物保险需求 农作物保险供给	生产性信贷需求 生产性信贷供给 其他保险需求 其他保险供给	生产性信贷需求 生产性信贷供给 两类保险需求 a 两类保险供给	生产性信贷需求 生产性信贷供给 农作物保险需求 同品种保险供给 b	生产性信贷需求 生产性信贷供给 寿险需求 寿险供给	生产性信贷需求 生产性信贷供给 意外险需求 意外险供给
Wald χ^2（）	Wald chi2(41) = 142.33 ***	Wald chi2(41) = 127.36***	Wald chi2(41) = 145.10***	Wald chi2(41)= 162.63***	Wald chi2(41) =160.10***	Wald chi2(41) =161.27***
LR 检验	chi2(6) = 357.55 P> chi2 =0.0000	chi2(6) = 394.71 P > chi2 =0.0000	chi2(6) =271.35 P > chi2=0 .0000	chi2(6) = 246.68 P > chi2 =0.0000	chi2(6)= 280.739 P > chi2 =0.0000	chi2(6)= 278.219 P > chi2=0 .0000
ρ_{24}	0.1330**（2.21）	0.0462 (0.62)	0.1220* (1.95)	0.7490 ***(3.92)	0.0596 (0.89)	-0.0226 (-0.25)
观察值	490	490	490	490	490	490

注：a：是否同时对两类保险有需求（是为 1，否为 0）；b：保险作物品种与信贷一致则取值为 1，反之为 0。

5. 结论与政策含义

论文在信息不对称的框架下说明，保障程度足够的条件下，保险的存在能够提高信贷机构的期望收益，改善农户的信贷可获得性。在实证分析中，基于 2014 年苏北地区 491 户农户的入户调查数据，论文采用四元 Probit 模型，在考虑但控制住来自需求和保险部门影响的前提下，对保险与信贷供给间的关联进行了验证。实证分析结果证实了使用这一模型的必要性和合理性。分析结论总结如下：

（1）农户信贷与保险供给之间存在显著的正向关联，表明保险的存在，有助于提高农户的信贷可得性，缓解农村信贷市场的配给现象。论文认为，这种效应的实现，可用保险部门的风险选择改善了农户与银行之间的信息结构来解释。

（2）从保险与生产性信贷供给的关联分析结果看，针对同一品种的生产性信贷和农作物保险供给意愿的关联程度为最高，表明信贷机构最青睐贷款品种有专门保障的农户，农作物保险和其他保险都有的情形亦能够显著提高生产性信贷的可得性，但分别而言，农作物保险的支持作用要高于其他类别商业保险。

研究为信贷与保险产品互联提供了进一步的理论和经验支撑。研究结论意味着，着眼于提高农户信贷可得性，缓解农村信贷配给问题，应进一步发挥保险的作用，更加明确用“互联”的眼光来看待农村信贷中的银行和保险两部门。为此，一方面，需要加强宣传，提高基层金融机构和农户对保险功能的了解和认知，并逐步通过专门立法或对现行法律的特别说明，明确信贷与保险关联机制，以及公共部门从财税等方面支持银保合作的职责；另一方面，要考虑不同保险与信贷关联性的差异，拓展信贷与保险产品关联的多样性。作为对此的保障，结合本文分析结论，应进一步支持保险行业扩大农作物保险的品种范围、保障程度和覆盖面，支持保险行业开发针对地方特色信贷作物品种的专门保险产品。同时，农村信贷中的银行和保险两部门可通过共同开发包括农户保险信息在内的农户数据库，实

现信息资源整合与共享，以提高农村金融市场信息的使用效率，为银保合作建立更加坚实的信息基础。

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信息不对称，农业保险与农户信贷可得性
——基于苏北491户农户样本的实证分析

左斐 罗添元

左斐*
讲师
西北大学经济管理学院
陕西西安，中国
电话: (8629)153 3907 9756
Email: 165153631@qq.com

罗添元
讲师
西北农林科技大学经济管理学院
陕西杨凌，中国
电话：(8629)180 0926 4790
Mail：40341456@qq.com

关键词：信息不对称；信贷可得性；农业保险；多变量 Probit 模型

摘 要：有效满足农业生产经营主体的融资需求，历来是“三农”发展的重难点之一。中国自 2009 年明确提出要“探索建立农村信贷与农业保险相结合的银保互动机制”以来，出现了很多创新的做法，在一些地区被认为切实提高了获得信贷的农户数量和融资规模，在另一些地区成效却远不及期望。由此引发的思考是：银保互联的做法是否具备理论基础？即保险究竟能否提高农户信贷可得性？通过怎样的机制得以实现？又应如何将二者“互联”才能更好地发挥作用？在显著的信贷约束和农户有效融资支持手段不足的大环境下，这是有必要深入探讨的问题。

论文在信息不对称的理论框架下说明，保障程度足够的条件下，保险的存在能够提高信贷机构的期望收益，改善农户的信贷可获得性。作为对此的验证，论

文以 2015 年苏北 491 户农户的入户调查数据为样本，采用四元 Probit 模型，考察了保险与信贷供给的关联。结果显示：总体上，保险的存在能够显著提高农户获得信贷的可能性，但不同类别农业保险对农业生产性信贷供给的支持作用并不相同，与信贷损失挂钩的农作物保险相比其他类别保险更能发挥作用。

总体上，论文基于最新的农户意愿调查数据，采用更加匹配的计量模型，对保险改善农户信贷配给的作用提供了进一步的经验证据。论文研究意味着保险可成为提升农户信贷获取能力，平衡农村信贷机构利润诉求与支农目标的现实可行选择，应进一步挖掘保险的作用，支持构建多样化的信贷保险关联机制。为此，建议公共部门应逐步通过专门立法，或对现存相关法律法规的完善，明确对信贷与保险关联机制的肯定。可运用财税等手段支持保险行业扩大农作物保险的品种范围、保障程度和覆盖面，支持保险行业开发针对地方特色信贷作物品种的专门保险产品。

Chapter 4. Life and Health Insurance

Research on the Development of China's Commercial Endowment Insurance Based on the Background of Delayed Retirement

CHEN Wei

School of Insurance
Central University of Finance and Economics
Beijing 102206, China
Phone: 18810137982
Email: chen_wei_130@163.com

Keywords: Delay retirement, Commercial endowment insurance, SWOT model, Actuarial replacement rate.

Abstract. Pension is not only a social problem that has bothered many countries foe a long time, but also an urgent business that has to be dealed with in the process of realizing the great Chinese Dream for China. Recently, as more and more people age, China comes into a dilemma that government shoulder tougher and tougher burden to provide pensions to the elderly. Taking all of these into account, Chinese government put up the Delay Retirement Policy that serves as a measure to help ease the financial pressure. The Delay Retirement Policy seems imperative, but in reality is full of controversy currently around the problems of the Delay Retirement Policy may bring such as the unemployment rate, welfare damage, etc, a heated debate is unfolding across the country. The paper focuses on the prospective influences that Delay Retirement Policy has on the commercial endowment insurance. With the imminent implementation of the Delay Retirement Policy, more and more people see the advantages of the commercial endowment insurance. But due to some historical and practical reasons, the development of the commercial endowment insurance is not good. The paper is based on the purpose of perfecting the multi-level endowment insurance system in China and carries out a comprehensive survey on the commercial endowment insurance: explore the significance of commercial pension insurance, look for the factors affecting the development of commercial endowment insurance, and investigate the characteristics of social residents' demand for commercial pension insurance. On the basis of the results obtained, the paper puts forward practical suggestions for the development of China's commercial pension insurance.

The paper consists of five parts. The first part analyses the current situation of China's population aging and learns Delay Retirement Policy related information, and then fully understands the background of the implementation of the policy. The second part mainly applies the SWOT model, under the background of population aging, compares the social basic endowment insurance with the commercial endowment

insurance, and analyses the recent development of the commercial endowment insurance. The third part first builds the actuarial commercial endowment insurance replacement rate model ,according to the policy of our country, determines the model parameters, and after importing the data confirms the influence Delaying Retirement on the commercial endowment insurance. In the fourth part, by integrating questionnaire survey, we investigate the characteristics of social residents' demand for commercial endowment insurance. In the last part, finishing the above results and combining the basic national conditions of our country, we put forward several practical suggestions from the perspectives of state system, insurance market and society welfare.

1. 引言

2015年3月11日十二届全国人大记者会上中国人力资源和社会保障部部长尹蔚民表示延迟退休政策执行方案肯定会在2020年之前出台。而最新社会基本养老保险新政策已经发布，养老制度发生变革导致了退休年龄的变动，而退休年龄更会影响民众的切身权益。按照国家相关文件，延迟退休政策的施行将采取小步慢走的方式，先从提高女性退休年龄着手，再逐步缓慢地延长男女退休年龄。随着我国老龄化形势逐渐加重，单单凭借基本社会养老保险已经不能满足大多数退休职工的养老问题。就企业员工而言，基本社会养老保险更是无法使其达到在职时的生活水平；而就企业而言，它们也想通过建立健全团体商业养老保险制度，这样它们一方面可以得到税收优惠政策，另一方面也能提高企业税后利润，既拴住员工，招揽人才，有利于企业管理水平的提高，在此背景下商业养老保险受到社会各界的重视。

1.1 课题背景

1.1.1商业养老保险在中国发展的必要性和重要性

由于人口老龄化提前于现代化进程，“未富先老”和“未备先老”已成为我国的基本国情，2013年统计数据显示老年人口数量已经超过2亿，总人数约为2.02亿，人口老龄化程度达到14.8%。老年抚养从2012年的20.66%上升到2013年的21.58%，推动社会总抚养比由2012年的44.62%到2013年45.94%的上升。我国现行社会基本养老保险可视为采取现收现付制度，当期的保费缴费收入用于支付当期的养老金开支，不留或很少留储备基金，随着人口老龄化问题逐渐加剧，社会基本养老保险金主要由基础养老金和个人账户养老金两部分组成，最近有专家估算称中国养老金的“空账”规模达到1.3万亿，社会养老保险收支缺口扩大让很多人担忧自己退休时能否领到退休金。与此同时，商业养老保险的发展，将会有利于完善我国社会保障体系。由于商业养老保险是一种具有市场化、社会化特性的养老风险管理机制，因此其能有效地刺激我国经济增长方式的转变，优化我国金融市场结构。

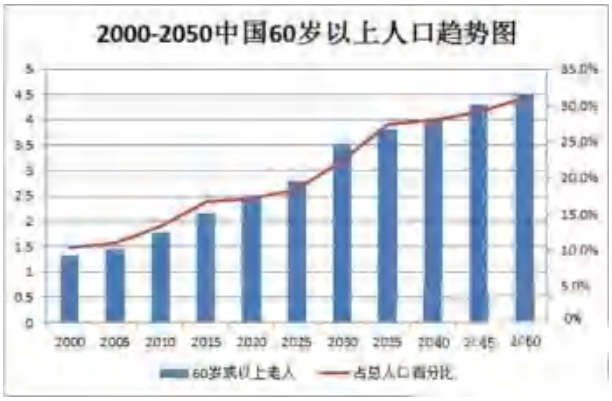


图1中国老年人口趋势图

1.1.2商业养老保险在中国的发展

在国务院印发的《国务院关于企业职工养老保险制度改革的决定》中规定（1991年颁发）：随着社会经济水平的提高，建立社会保障与企业年金保险和职工个人商业养老保险相结合的制度。1994年颁布的《财政部、国家税务总局关于对若干项目免征营业税的通知》中明确指出对开办1年期以上到期返还本息的养老年金保险业务的保险公司的相应保费收入免征营业税，企业年金实行税收递减。1995年颁布的《中华人民共和国保险法》第85条规定经营有人寿业务的保险公司除分立、兼并以外，是不允许倒闭的。这都无疑会使商业养老保险的进一步业务扩展。2015年两会指出2015年内我国将试点个人商业养老保险“延迟缴税”政策，在这一模式下投保人在商业养老保险缴费和收益环节暂时不缴纳个人所得税，而是将纳税义务延迟至实际领取养老金时期，减轻投保人当期纳税负担。这一政策给商业养老保险带来福音，有助于加快商业养老保险发展。

1.1.3延迟退休背景下商业养老保险所面临的机遇与挑战

推迟退休年龄，商业养老保险作为社会基本养老保险的补充，即将迎来重大机遇。随着推迟退休增加在岗时长，居民将会延迟领取基本养老金，因此为了保障退休后生活质量，个人储蓄资金作为养老金尤为重要，商业养老保险对于个人预期养老具有重大意义。业内专家指出，中国当前的改革正在鼓励个人积极参与商业养老保险，保险公司需对自身进行准确定位，以利用这一机遇之窗。

但随之而来的，商业养老保险也面临巨大挑战首先，相关的税收优惠政策不配套，对于个人商业养老保险的税收优惠并未实施。其次，国民养老保险意识仍待提高渣打银行之前发布《中国中产阶级退休养老计划》调查报告中显示中国有大约占总人口的七成人群不了解商业养老保险。中国中产阶级是促进商业养老保险发展的主力军，如果没有他们的参与，商业养老保险将面临毁灭之灾。

1.2 选题目的

1.2.1 全面了解当前延迟退休的政策背景

养老问题不仅是一个持续困扰许多国家的社会性问题，也是中国实现建设富强民主文明和谐社会主义国家伟大中国梦亟需解决的现实问题。我国老龄化程度地不断加剧使得养老问题逐渐严峻，也使得处于转型时期的我国社会保障体系带来了巨大的挑战。延迟退休看似势在必行，实则充满争议。当前围绕着延迟退休带来的失业率问题、利益受损问题和养老保险制度问题，全国上下都展开了激烈的讨论。本文将重点了解延迟退休对于我国整个养老保险制度的冲击，探究我国养保险在新政策下的新道路

1.2.2 探究在即将推行的“延迟退休”新政策背景下，中国商业养老保险发展基本状况

我国保险公司现行的商业养老保险产品种类大致分为传统型养老保险、分红型养老保险、投资连结保险、万能型养老保险。随着延迟退休政策的即将实行，越来越多的居民认识到商业养老保险的优点，但由于一些历史原因、现实原因，

我国商业养老保险发展并不太理想，但是为解决传统社会基本养老保险制度面临的财务危机，本文基于完善多层次养老保险体系的目的，对商业养老保险做一次深入的调查，从中国基本国情出发，借鉴国外经验，探究延迟退休背景，了解我国商业养老保险目前发展状况以及未来发展前景。调查普通群众对于商业养老保险的需求特点，提出有利于商业养老保险发展的切实可行建议。促进商业养老保险发展，缓解政府压力，提高社会保障水平，提高人民幸福水平。

1.2.3 为商业养老保险良好发展提出有效可行的建议

延迟退休背景下，社会基本养老保险的收支盈余压力减轻，有利于社会基本养老保险的发展，根据需求交叉弹性原理可知，作为替代品的商业养老保险的竞争将处于弱势，但是延迟退休政策的实行将让更多的人陷入“银发贫困”困境，因而商业养老保险也将迎来一次巨大的机遇。通过数据整理，调查结果汇总以及国内外商业养老保险现有制度比较，从国家制度，保险公司养老保险险种类、投保费率、宣传等发面提出切实可行促进商业养老保险良好发展的建议。

1.3 文献综述

张运刚（2005）[1]年认为我国一方面应该以低水平覆盖面广泛的社会基本养老保险为主,鼓励在职员工积极参加企业年金并购买具有储蓄或者投资性的个人商业养老保险,完善相应养老保险的法律法规体系,另一方面还要建立全国养老保险应急准备基金,保障养老体系平稳运营。欧伟(2006)[2]研究指出,商业养老保险就是商业人寿保险。他还认为商业养老保险在社会保险保障体系中拥有补充、提高、扩展等作用,采用企业年金保险和个人商业养老保险相结合的办法,是目前最可靠改善养老保障水平的措施。站在制度变迁的视角，王琬(2010)[3]记录我国商业养老保险参与社会保障体系建设的发展历程,对我国商业养老保险提升行业实力和提高服务能力建设方面取得的成就做出肯定评价,但也指出因为社会保障认识的缺乏,我国商业养老保险仍然存在着市场定位不清、缺乏与社会基本养老体系的有效协调等诸多问题。仝春建(2010)[4]指出,要达到促进我国养老产业的发展的目标，必须各种途径和政策鼓励各保险公司的保险资金积极介入养老业务,范围（2011）[5]根据全球有关退休年龄改革的趋势,建议我国采取"分步走"的方式推进延迟退休政策。刘学宁,梁慧静,刘美秀（2014）[6]研究发现社会养老保险虽然是养老保险的基础保障,但商业养老保险能够在一定程度上代替社会基本养老保险。个人所得

① 张运刚.人口老龄化背景下的中国养老保险制度[M].成都:西南财经大学出版社,2005.

② 欧伟.搞好社会保障体系建设为构建和谐社会服务[J].理论界,2006(12).

③ 王琬.中国商业保险的发展与社会保障制度建设[J].人口与经济,2010(6).

④ 仝春建.应鼓励商业保险机构积极参与养老产业[N].中国保险报,2010-03-05.

⑤ 范围.退休年龄比较研究[J].人口与经济,2011(5)

⑥ 刘学宁,梁慧静,刘美秀.商业保险与社会保险的互补与替代:基于养老保险的分析[J].商业文化.2014(17)

⑦ 马宁.税收优惠养老保险模式的最优选择——基于个人所得税税率的效应分析[J].保险研究. 2014(9)

⑧ 曹冬梅，方浪.机关事业单位养老保险改革的转制成本研究[J].统计与决策.2015(10)

税会影响消费者行为，马宁（2014）[7]认为在税率替代率原则下,消费者将会更偏好EET模式的商业养老保险。更多还原更多还原曹冬梅、方浪（2015）认为我国人口快速老龄化导致养老金供需矛盾不断激化，为应对社保养老金缺口应当大力开发和推广企业年金、个人商业养老保险等补充养老金,构建多层次、多方位、三支柱的养老金体系。[8]

1.4 研究方法

1.4.1 文献研究法

通过阅读国内外学者有关中国延迟退休政策及商业养老保险研究，并及时关注相关信息，充分借鉴其他国家养老保险事业的相关文献，获得已有的关于延迟退休政策条件下商业养老保险的研究资料，从而对当前商业养老保险发展的基本状况有一个大致的了解，并充分认知延迟退休政策实施的必要性。

1.4.2 问卷调查法

问卷调查法具有经济性、客观性、标准化、广泛性等一系列的优点。作者将以已有的数据为基准，根据不同的人群和地域，选取具有具有代表性的居民，进行大规模的问卷调查，将调查所得的数据用于后续模型的建立、分析和检验。

1.4.3 SWOT分析法

基于延迟退休背景，运用SWOT分析方法，对我国保险市场上商业养老保险的机遇与威胁进行分析，进而为面临新环境的商业养老保险提供合理化发展建议。

1.4.4 走访研究法

作者充分利用课余时间以及节假日走访国家统计局和相关商业保险公司，获得确切的资料和数据，并采访相关保险从业人群，以便深入了解此次改革对于商业养老保险的影响，从而更加准确地建立各种模型，完成各类研究。

1.4.5 模型分析法

本文作者根据精算均衡等式，即收支现值相等的原则，构建有关商业养老保险替代率的精算模型。通过模型得到的商业养老保险替代率等式找到其影响因素，影响因素主要有:参保时年龄、终极死亡年龄、保险投资收益率、工资年增长率、退休年龄等因素，并得到相应因素对替代率变动的影响。之后着重探究其他条件不变的情况下，退休年龄与商业养老保险替代率的关系。根据经验生命表男女死亡率作为减因率代入得到男性和女性职工随着退休年龄的改变团体商业养老保险替代率的变化趋势。

1.5 研究创新之处

本论文作者从人口学、统计学、保险学、管理学等不同方面多学科交叉对研究进行较全面的构建。

结合我国最新统计资料与新出台政策，分别从宏观和微观角度分析我国商业养老保险的发展，并通过构建SWOT模型比较商业养老保险与社会基本养老保险的优劣。通过构建商业养老保险替代率因子模型，找出影响商业养老保险发展的微观因素。整理问卷调查结果以及对专业人士采访分析，在延迟退休背景下我国的商业养老保险的发展提出针对性意见。

2. 我国商业养老保险发展的SWOT分析

SWOT分析方法即从企业内部分析其优势（Strength）与自身劣势（Weakness），再从企业外部行业市场上分析其机会（Opportunity）与威胁（Threat）。采用SWOT分析方法，企业可以充分认识到自身的优劣势及市场机会与威胁，进而有利于其通过采取合适的资源整合制定战略发展。

2.1 优势分析

2.1.1 技术优势

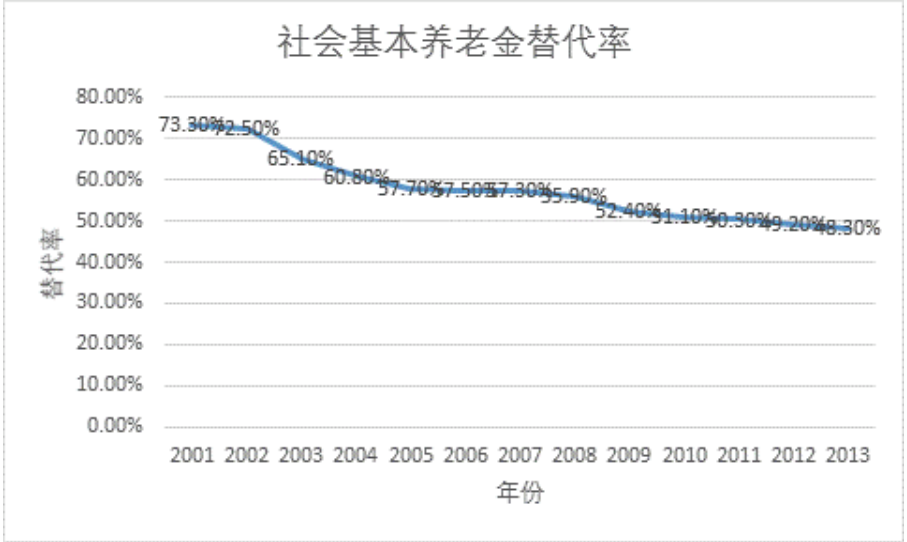
商业养老保险公司因为是进行以盈利为目的的商业活动，因此技术支持对于抢占市场份额以及公司的运营管理等方面都非常重要。所以商业养老保险机构无论是从公司精算部门人才具备的精算技术与产品设计研发技术，还是从信息技术部门提供的软件平台运营技术，亦或是资料收集部门的信息搜集技术等，与社会养老保障机构相比具有明显的优势。

2.1.2 服务优势

商业养老保险公司内部职责与分工明确，如内设产品设计部门，风险管理部门，财务部门，销售部门等等。与政府主管的社会养老保险不同，商业养老保险公司各部门分管售前，售中，售后的各种服务事项，做着咨询、受理、承保、核保、理赔、退保、风险管控、投诉等各项业务。各大商业养老保险公司在养老保险市场竞争越来越激烈的情况下，争相提高自身服务水平，商业养老保险服务水平逐渐提高。与社会养老保险机构相比，商业养老保险具有更好的服务优势。

2.1.3 保障优势

商业养老保险作为社会基本养老保险的一种补充，它的保障水平更高。根据我国人力资源与社会保障部门发布的年度人力资源和社会保障事业发展统计公报可计算得到近些年来我国的基本养老金替代率逐步下降，2013年此替代率仅为48.3%。但根据国际经验，若要保证退休后生活水平较退休前不至于变差，养老金替代率不能低于70%，国际劳工组织的《社会保障最低公约》规定养老金替代率最低标准为55%，可见我国社会养老保险并不能在退休后为投保人提供充分的生活保障。但商业养老保险的保额以及保险类型可以根据投保人自身需要以及承担保费能力进行选择，因此能够较好地满足保障投保人生活水平质量不会大幅下降。



图二 社会基本养老保险金替代率

注：表中数据来源于曾海军老师根据历年《中国劳动统计年鉴》

和历年《劳动与社会保障事业发展统计公报》整理数据

2.2 劣势分析

2.2.1 受政策监管及经济形势的影响

与社会养老保险相比，商业养老保险比较易受保监会等政府机构监管及国内外经济形势方面的影响。保险监督管理委员会可以从企业高层人事安排到保险产品资金投资、种类、销售方式、预期收益率、偿付能力、准备金比例等方面予以监督限制。假如政府的这方面监督恰当合适，则能够有利于促进商业养老保险发展，反之，则可能给商业养老保险运营带来阻碍。此外，目前我国大部分商业养老保险的品种为分红型产品，保险合同双方并未在合同中明确约定确定支付利息，其给付受到国内外经济形势和投资回报率的影响，故可能会出现不能按预期收益率给付分红。而社会养老保险具有福利性质，政府可以通过考虑届时的通货膨胀率等因素，对社会养老金的领取额度做出适当调整。

2.2.2 产品种类局限，购买门槛高

相比社会养老保险覆盖范围广、保障比较基础，商业养老保险作为保险公司谋取利益的手段之一，它的投保设置了一定的条件，如年龄、健康状况、工作年限、年均收入等，其作为一种社会养老保险的补充型保险，投保人群大多为经济条件较好，风险意识较强，对保险比较了解希望在一定年龄后再社保的基础上获得额外的养老保障的人。因此商业养老保险的普及度并不高。

2.3 机会分析

2.3.1 人口老龄化增加养老需求

我国老年人口数量在2013年超过2亿，人口数约为2.02亿，老龄化程度非常严重。但在人口老龄化带来诸如人口红利消失等一系列不利影响的同时也给商业养老保险带来新的发展机遇。因为人口老龄化直接造成养老需求的增加，这种需

求的增加表现在两个方面，一方面是“量”的增加，即需要提供养老保障的老年人口数量增加；另一方面是“需”的增加，老年人口本身对于养老服务需求更加多元化、复杂化。此情形会刺激商业养老保险公司针对不同养老群体开发不同的保险产品进而满足多元化养老需求。

2.3.2 人均可支配收入增加，保险消费水平提高

从图三中可以看出，随着我国近年来的经济飞速发展，我国城乡居民人均可支配收入均呈现出递增趋势。人们在可支配收入水平逐渐提高的同时，其消费水平也会逐步提高，因而作为服务类产品的为未来养老做准备的商业养老保险的市场具有更多的发展机会。



图三 城乡居民人均可支配收入

注： 数据来源：国家统计局，本文绘图整理

2.3.3 民众保险保障意识逐步上升

1992年，美国友邦在上海率先推出人寿保险营销业务，几年后这一营销制度被我国各保险公司所采纳，各保险公司的营销人员也将保险理念与保险知识传入千家万户，而且多次大灾害事故，比如说2016年天津特大爆炸案件，各保险公司积极参与救助和善后处理工作并快速理赔，使得商业保险的职能得到较大程度的体现，增强了民众对保险的认可，更唤醒了民众的保险意识，所以民众保险意识的加强给商业养老保险带来广阔的市场。



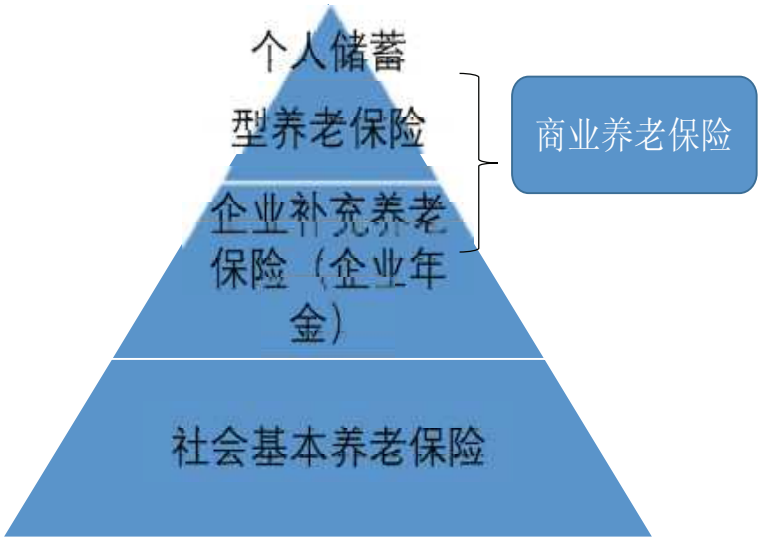
图四 中国保险深度与保险密度统计

注：数据来源：2003年到2014年中国区域金融运营报告

2.4 威胁分析

2.4.1 社会基本养老保险的挤出效应

养老保险体系由三大支柱构成，若作为第一支柱的社会基本养老保险的覆盖越广越深，则对于作为第二、三支柱的商业养老保险而言，产生的挤出效应越大，商业养老保险发展更加困难。



图五 “三支柱”保险体系结构图

2.4.2 投保人或被保险人的道德风险

由于商业养老保险的销售对象并不是全体居民，也不像社会基本养老保险那样具有政府政策强硬执行，即使商业养老保险机构对投保人和被保险人的某些身体或经济条件做出限制，但仍然不可能完全避免投保人或被保险人在投保时或核保过程中虚报信息或隐瞒事实而带来不可估计的道德风险。

3.替代率模型分析

3.1 养老金替代率

养老金替代率（Pension replacement rate），是员工退休后的所获养老金与退休前平均工资收入之间的比率。它反映了劳动者退休后生活水平较退休前的高低，是一个国家衡量其劳动者退休后生活保障水平的基本标准。

3.1.1 影响因素分析

影响商业养老保险替代率的因素有很多，按照其种类可以划分为内生和外生变量。对于商业养老保险替代率精算模型而言，其内生变量主要是劳动者性别、参加工作时年龄、投保时年龄、缴费年限、退休年龄、死亡年龄、保险投资收益率、年均工资增长率、企业缴费比例、缴费年限等等，外生变量主要是由社会失业率、宏观经济变化、国家政策变化等对商业养老保险替代率的影响。

由于实际生活中存在较强的不确定性，个人商业养老保险替代率变化影响较大。本文作者鉴于数据的准确性以及模型的简单性，对企业为员工投保的团体商业养老保险构建精算模型，即确定缴费型团体商业养老保险，遵循在任何时间点上，收到资金的精算现值等于资金给付的精算现值。通过构建个人给付账户模型和个人收入账户模型，实现上述精算平衡，得出确定型缴费团体商业养老保险相应替代率公式，进而分析哪些因素会对企业年金商业养老保险造成影响。

3.1.2 模型假设

（1）选取某个固定企业为研究对象（即企业人口封闭）。假定该企业所有员工均参加确定缴费型团体商业养老保险，期间不考虑新人的加入和老员工的辞职；

（2）假设所有参保员工在投保确定缴费型团体商业养老保险时身体状况合格；

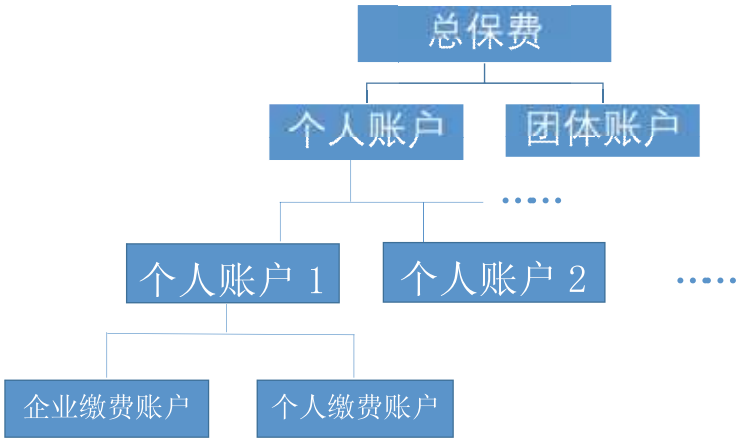
（3）假设企业经营是存续的，不考虑企业破产或被收购等情况；

（4）假设该企业每一位职工投保确定缴费型团体商业养老保险时，被保险员工的年龄为a岁，退休年龄为b岁，死亡年龄为d岁，具体退休年龄以国家相关退休政策规定年龄，本模型不予考虑提前退休情况；

（5）假设参保员工投保时工资水平为$s_{(a)}$,x岁时员工工资为$s_{(x)}$,工资年增长率固定为e；

（6）假设所有职工企业年金账户投资收益率均为i，折现率为v=$\frac{1}{(1+i)}$；

（7）假设该商业养老保险公司为每一位投保职工建立个人账户，在个人账户下游单位缴费账户和个人缴费账户，并为投保企业建立团体账户，将投保企业尚未分配至被保险人即企业员工的保险费计入该账户。个人缴费账户的账户权益归被保险人所有，单位缴费账户和团体账户的账户权益归投保人所有，被保险人在正常情况下不能任意支取。在此确定缴费型团体商业养老保险保障期限内不考虑保险公司的红利分配，账户的投资收益仅来自于账户资金复利收益。



图六 企业年金商业养老保险账户结构示意图

（8）假设该确定缴费型团体商业养老保险缴费是由企业在发放工资前统一扣除，缴费时间为每年年初，以员工当年工资为基数进行缴费，企业缴费比例额为c,即第一年企业为每一员工缴费为$c \times s_{(a)}$,这部分费用划入个人账户下的单位缴费账户，划入系数为m（以为可能会产生管理费用导致不能够全部划入），划入资金数额与被保险人工龄呈正相关，被保险人x岁时工龄为（x-a），此时个人账户内企业缴费账户的数量为$m^{(x-a)}c\times s_{(x)}$。。假设员工缴费比例为g，缴费额度为$g\times s_{(x)}$,个人账户余额为单位缴费账户与个人缴费账户余额之和。

（9）减因率假设

从参保职工购买确定缴费型团体商业养老保险开始，我们就要考虑投保职工未来可能确定缴费型团体商业养老保险的可能性。并将推出企业年金的原因定义为减因，鉴于以上假设，企业员工退保的主要原因是死亡。减因率即为死亡率。

q_x表示x岁的员工在第x岁内死亡的概率

p_x则表示x岁的员工能够活到x+1岁的概率

${}_{x-a}p_a$表示投保时为a岁的员工在第x岁仍然存活的概率

在上述假设的基础上，本探究首先建立缴费确定型企业年金的个人账户的精算模型

$$\begin{aligned} PV_a = (c+g)\cdot s_{(a)} + p_{a+1}\cdot(c+g)\cdot s_{(a)}\cdot(1+e)\cdot v + \cdots + {}_{x-a}p_a \\ \cdot(c+g)\cdot s_{(a)}\cdot[(1+e)\cdot v]^{x-a} + \cdots + {}_{b-1-a}p_a\cdot(c+g)\cdot s_{(a)} \\ \cdot[(1+e)\cdot v]^{b-1-a} \end{aligned} \quad (1)$$

4. 个人账户给付精算模型

该模型假设职工退休后每年领取的养老金为R，给付期限为n，由于确定缴费型团体商业养老保险是定期给付固定金额，并不随时间而发生变化。

参保员工在x岁领取的养老金现值为$R\cdot v^{d-x}$，所领取的概率为 ${}_{x-a}p_a$

与个人账户缴费模型一致，将领取养老金现值换算为第一年投保确定缴费型团体商业养老保险时即员工为a岁时的精算现值，用N_a表示

$$N_a=(R+{}_{b-a}p_a\cdot R\cdot v^{b-a}+\cdots+{}_{d-a}p_a\cdot R\cdot v^{d-a}) \quad (2)$$

要保证个人账户的平稳运营，最基本的原则就是收支平衡

即：$PV_a=N_a$

由(1)，(2)得：

$$R=\frac{(c+g)\cdot s_{(a)}+p_{a+1}\cdot(c+g)\cdot s_{(a)}\cdot(1+e)\cdot v+\cdots+{}_{b-1-a}p_a\cdot(c+g)\cdot s_{(a)}\cdot[(1+e)\cdot v]^{b-1-a}}{1+{}_{b-a}p_a\cdot v^{b-a}+\cdots+{}_{d-a}p_a\cdot v^{d-a}} \quad (3)$$

从(3)中可以看出，在个人账户投资收益率i，即贴现率为v，员工工资年增长率为恒定不变的情况下，养老金年给付额为R与企业所缴费比例分别为c、个人所缴费比率g、职工缴费时间之间存在正相关性。

通过对比参加确定缴费型团体商业养老保险员工退休时所领取养老金与参保期初工资的对比来刻画职工退休后的生活水平，即该确定缴费型团体商业养老保险替代率K:

$$K=\frac{R}{s_{(a)}} \quad (4)$$

将式3结果带入可得：

$$K=\frac{(c+g)+p_{a+1}\cdot(c+g)\cdot(1+e)\cdot v+\cdots+{}_{b-1-a}p_a\cdot(c+g)\cdot[(1+e)\cdot v]^{b-1-a}}{1+{}_{b-a}p_a\cdot v^{b-a}+\cdots+{}_{d-a}p_a\cdot v^{d-a}} \quad (5)$$

由上式可以发现

1、确定缴费型团体商业养老保险替代率的主要影响因素有职工参加工作时的年龄、退休年龄、工资增长率、企业与个人缴费比率、账户投资收益率

2、虽然养老金每年支付金额与初始工资有关，但是确定缴费型团体商业养老保险替代率与工资水平没有关系。

5. 退休年龄对商业养老保险影响模型分析

5.1 模型参数值假设及数据来源

由于女性职工与男性职工在退休年龄和死亡率等方面的不同，我们将按性别分列

（1）工作年龄a,根据《中华人民共和国劳动法》的相关规定，选取a为18。

（2）死亡年龄d，基于我国第六次人口普查数据，我国人口平均预期寿命为74.83，为了计算方便，在这里将死亡年龄设为75岁。

（3）根据《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）的规定，员工个人缴纳8%，企业缴费比例为20%，设定此模型中g

为8%，c为20%，为简化模型，假设企业为员工购买的确定缴费型团体商业养老保险也按此比例缴费。

（4）工资增长率e,根据国家统计局颁布的《中国统计年鉴》中1995-2012年城镇单位就业人员平均工资可得全国实际工资增长率为10.7%，因此设定此模型的工资增长率为10%。

（5）通过数据整理可得中国平安人寿保险下万能保险在2015年的平均结算利率为3.94%，所以设定模型内i为4%。

（6）采用《中国人寿保险业经验生命表（2000—2003）》中的男表和女表，经过整理，可得相应减因率。具体数据在附录中。

表一 模型基本参数假设

性别	a	d	i	g	c	e
男	18	75	4%	8%	20%	10%
女	18	75	4%	8%	20%	10%

5.2 统计影响结果

根据经验生命表中减因率的估计，对不同退休年龄下男女确定缴费型团体商业养老保险保险的替代率测算结果统计为下表：

表二 退休年龄对确定缴费型团体商业养老保险替代率的影响

女		男	
退休年龄	替代率	退休年龄	替代率
55	15.8%	60	25.57%
56	16.84%	61	26.56%
57	17.79%	62	27.06%
58	18.56%	63	27.45%
59	19.10%	64	28.06%
60	20.07%	65	28.57%

从上表可以看出随着退休年龄的逐渐增大，男性和女性确定缴费型团体商业养老保险替代率不断增大，且变化幅度很大。因此退休年龄对于商业养老保险替代率具有重大影响，而商业养老保险替代率又会影响人们购买商业养老保险的积极性，因此我们可以预测得到延迟退休政策的推出，商业养老保险的替代率将会提高因此给商业养老保险的发展带来机遇。

6. 问卷数据统计及分析

基于数学模型所得到的延迟退休对于商业养老保险有影响的结论后，作者采用问卷调查的调研方法，在问卷设计过程中，其将重点放在调查对象对于个人商业养老保险的看法和购买意愿上。并通过分析回收到的128份有效问卷结果对个人商业养老保险的发展提出建议。

根据问卷结果统计回收的有效样本中男性占41.41%，年龄分布大多处于55岁以下，仅有7.03%地调查对象为自由职业，可见问卷调查所得的统计结果具有全面性，不会出现因为性别、年龄、职业等原因造成的问卷结果的片面性。同时问卷调查对象中受过高等教育的对象达近70%，这对于以后的建议地收集和采纳具有代表性。

表三　企业、机关单位是否提供团体商业养老保险情况

所在单位是否提供团体商业养老保险	是	否
所占比例	52.43%	47.66%

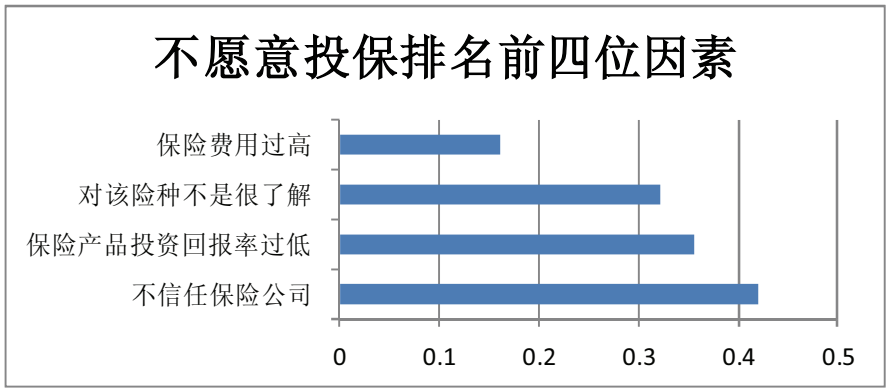
数据来源：调查问卷统计结果

由有效问卷数据可知，在我国团体商业养老保险地覆盖率还需要进一步提高，虽然现有普及率约为50%，但距离在职员工能够退休后达到原来的生活水平仍然需要进一步推广商业养老保险。

表四 意愿投保个人商业养老保险情况

是否有意愿投保个人商业养老保险	所占比例
有意愿且已经投保	32.81%
有意愿但尚未投保	42.97%
不愿意投保	24.22%

由问卷结果可见有将近一半的调查群体虽然并没有投保商业养老保险，却有意愿投保。这对于商业养老保险的发展来说无疑是巨大的机遇，商业养老保险公司应当抓住机遇，不断发展。



图七 不愿意投保商业养老保险主要因素情况

在该问题的答案中我们可以看出一些比较重要的影响人们不投保个人商业养老保险的原因，其中保险公司需要注意的有保险产品投资回报率低，不信任保险公司，险种不了解等。可见如果保险公司想要提高市场份额，就需要从这些方面对保险公司进行改善。

表五 延迟退休对于购买商业养老保险是否有影响情况

延迟退休政策对于购买商业养老保险行为是否存在影响	所占比例
有影响	67.35%
没有影响	12.24%
不清楚有无影响	20.41%

通过该问题回收问卷答案统计我们可以得到只有大概五分之一的人认为延迟退休政策对于他们是否购买个人商业养老保险是没有影响的，所以可见这在实际生活中证明了上述模型推到结果的正确性，退休年龄的推迟对于人们购买个人商业养老保险来说具有一定的影响。

7. 结论

本论文主要从两方面入手，一方面通过构建SWOT模型比较商业养老保险与社会基本养老保险的优劣并构建精算模型推导退休年龄的推迟会对商业养老保险造成影响，并通过经验生命表数据预测延迟退休政策对商业养老保险的影响。

另一方面，通过发放回收问卷、对有效问卷进行数据分析延迟退休政策是否会影响人们购买商业养老保险，为上述精算模型中退休年龄会对商业养老保险造成影响的结论提供事实依据。

本论文旨在根据模型和问卷结果结合对保险从业人士采访内容对我国商业养老保险的发展提出建议，为商业养老保险制度的完善提供实质性的意见，为保障人民退休后生活水平、减缓老龄化人口压力贡献出自己的一份微薄之力。

最后，根据研究结果提出的建议为以下几点：

7.1 政府实行优惠激励政策促进商业养老保险发展

商业养老保险作为社会基本养老保险的补充，它有利于缓解社会基本养老保险压力。商业养老保险替代率的提高将减轻政府的养老压力。鉴于国际上的普遍经验，对于购买个人商业养老保险的投保人提供个人免税或者延迟交税的优惠政策，对于参加企业年金的企业实行税收优惠的政策将会较好地刺激商业养老保险的发展，激励更多的人投保商业养老保险。

7.2保险公司重视新政策的出台并及时做出调整

在作者实地走访和对保险从业人员进行采访的过程中发现大多数保险公司都是在政策完全执行之后进行相关的运营调整。由于政策执行的内部时滞导致保险公司产品及服务并不能较好地满足基本国情需要。因此建议保险公司更加注重社会热点，基本国情，与政策同步推进商业养老保险的发展。同时建议保险公司对延迟退休政策的出台进行相应产品及销售结构调整。

7.3 保险公司增加商业养老保险品种多样性满足不同群体多层次养老需求

随着人民生活水平和人均可支配收入的不断提高，人们对于养老的需求也发生了改变，养老需求具有多样化趋势。因此，保险公司一定要对潜在顾客的消费者需求进行细分，按照不同群体的养老需求进行商业养老保险创新。作者所能想到的有以下几种创新：

7.3.1 保险公司与相关医疗或者护理机构合作，打通上下游产业链

将保险公司充足的养老经验与养老机构合作缓解我国养老困难局面。这种将商业养老保险与养老机构或者社区服务结合的新型产品模式在国内已经有泰康人等保险公司发起。但是这些产品的主要客户群是高端客户，而我国仍有大量中低端老年群体亟需解决养老问题。因此商业养老保险公司可以推出针对中低端老年群体的相关产品。

7.3.2 开发住房反向抵押养老保险产品

由于我国根深蒂固的家的观念，大多数老年人会在生命后期拥有具有高价值但却不能提供养老保障的房产。建议保险公司可以对住房拥有完全产权的人群投保住房反向抵押养老保险，在条款下投保人将自己所拥有的房产抵押给保险公司，在退休后便可以获得保障生活的养老金。

7.4 保险公司提高投资收益率，提高产品预期收益率

在问卷调查的结果分析中可见影响人们不去购买商业养老保险的主要因素有投资回报率低、通货膨胀高、不如其他养老投资方式。根据往年数据分析可知，我国目前保险市场上现有的投资分红型养老保险，它们的投资回报率比银行储蓄相差不大，而购买手续却更加复杂。因此保险公司为了提高市场份额，在保证安全性和流动性的基础上应该提高保险产品收益率。

7.5 保险公司加大宣传力度，提高保险从业人员的专业水平

在研究得到的问卷数据分析中可以看到有近 三分之一的群体对保险公司不信任，近一半的人对保险产品不了解导致他们不选择购买商业养老保险。因此保险公司应当加大正面宣传力度，普及商业养老保险知识，采用新型媒体比如微信公众号、微博等平台对产品及保险公司进行宣传。同时保险公司也应当提高保险从业人员的专业水平和道德素养，改变他们在群众心目中的不美好形象，促进商业养老保险良性发展。

8 研究不足

8.1 缺乏理论支持

有关延迟退休和商业养老保险这二者关系的研究文献很少，本文部分假设和一些模型的设计主要是先进行合理的推理，再通过数据的验证来研究问题，缺乏足够的的理论支持。

8.2 数据选择相对单一

这次调查中，作者在数据的选择上由于种种原因限制，使得问卷调查对象以居住在北京的居民为主，这将可能导致我们在模型的设计上没有考虑地域等因素，最终可能使得我们的结论难以适用全国的其余地区。同时样本数据量不够大，只能够定性分析居民对于商业养老保险的看法，不能够构造相关数学模型定量分析相关因素的影响。

8.3 没有及时跟进国家的政策变化

由于调查研究的时间限制，作者没办法在研究中及时地反映国家相关政策的最新调整，例如国家已确定将在2016年颁布相关渐进式延迟退休的方案，但碍于时间的局限性论文没法将其纳入研究之中，这也使得研究缺少了一定的时效性。

9. 结束语

延迟退休政策会给我国商业养老保险的发展带来机遇，但是就研究结果来看，商业养老保险公司还需要进一步加强自身管理，进一步进行宣传商业养老保险知识，才能迎来商业养老保险业的春天。

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附录

附录1. 中国人寿保险业经验生命表(2000—2003)男表

年龄	男性			
	l_x	d_x	q_x	p_x
18	993951	443	0.000446	0.999554
19	993508	494	0.000497	0.999503
20	993014	536	0.00054	0.99946
21	992478	571	0.000575	0.999425
22	991907	596	0.000601	0.999399
23	991311	618	0.000623	0.999377
24	990694	637	0.000643	0.999357
25	990057	653	0.00066	0.99934
26	989403	669	0.000676	0.999324
27	988734	685	0.000693	0.999307
28	988049	703	0.000712	0.999288
29	987346	725	0.000734	0.999266
30	986621	749	0.000759	0.999241
31	985872	777	0.000788	0.999212
32	985095	808	0.00082	0.99918
33	984287	842	0.000855	0.999145
34	983446	878	0.000893	0.999107
35	982568	920	0.000936	0.999064
36	981648	967	0.000985	0.999015
37	980681	1023	0.001043	0.998957
38	979658	1088	0.001111	0.998889
39	978570	1164	0.001189	0.998811
40	977406	1246	0.001275	0.998725
41	976160	1333	0.001366	0.998634
42	974827	1424	0.001461	0.998539
43	973402	1519	0.00156	0.99844
44	971884	1618	0.001665	0.998335
45	970266	1730	0.001783	0.998217
46	968536	1858	0.001918	0.998082
47	966678	1987	0.002055	0.997945
48	964692	2159	0.002238	0.997762
49	962533	2354	0.002446	0.997554
50	960178	2560	0.002666	0.997334
51	957618	2758	0.00288	0.99712
52	954860	2946	0.003085	0.996915
53	951915	3141	0.0033	0.9967
54	948773	3363	0.003545	0.996455
55	945410	3628	0.003838	0.996162

56	941781	3962	0.004207	0.995793
57	937819	4385	0.004676	0.995324
58	933434	4924	0.005275	0.994725
59	928510	5607	0.006039	0.993961
60	922903	6450	0.006989	0.993011
61	916453	7210	0.007867	0.992133
62	909243	7933	0.008725	0.991275
63	901310	8722	0.009677	0.990323
64	892588	9578	0.010731	0.989269
65	883010	10508	0.0119	0.9881
66	872502	11542	0.013229	0.986771
67	860959	12660	0.014705	0.985295
68	848299	13865	0.016344	0.983656
69	834434	15157	0.018164	0.981836
70	819278	16536	0.020184	0.979816
71	802741	18001	0.022425	0.977575
72	784740	19549	0.024911	0.975089
73	765191	21171	0.027668	0.972332
74	744020	22802	0.030647	0.969353
75	721218	24477	0.033939	0.966061

附录2. 中国人寿保险业经验生命表(2000—2003)女表

年龄	女性			
	l_x	d_x	q_x	p_x
18	995952	212	0.000213	0.999787
19	995739	229	0.00023	0.99977
20	995510	245	0.000246	0.999754
21	995266	260	0.000261	0.999739
22	995006	273	0.000274	0.999726
23	994733	283	0.000285	0.999715
24	994450	291	0.000293	0.999707
25	994158	299	0.000301	0.999699
26	993859	306	0.000308	0.999692
27	993553	314	0.000316	0.999684
28	993239	323	0.000325	0.999675
29	992916	335	0.000337	0.999663
30	992582	348	0.000351	0.999649
31	992233	363	0.000366	0.999634
32	991870	381	0.000384	0.999616
33	991489	399	0.000402	0.999598
34	991091	417	0.000421	0.999579

35	990673	437	0.000441	0.999559
36	990236	459	0.000464	0.999536
37	989777	488	0.000493	0.999507
38	989289	522	0.000528	0.999472
39	988767	563	0.000569	0.999431
40	988204	608	0.000615	0.999385
41	987596	656	0.000664	0.999336
42	986941	705	0.000714	0.999286
43	986236	752	0.000763	0.999237
44	985483	803	0.000815	0.999185
45	984680	860	0.000873	0.999127
46	983821	927	0.000942	0.999058
47	982894	997	0.001014	0.998986
48	981897	1103	0.001123	0.998877
49	980794	1227	0.001251	0.998749
50	979568	1365	0.001393	0.998607
51	978203	1514	0.001548	0.998452
52	976689	1674	0.001714	0.998286
53	975015	1846	0.001893	0.998107
54	973169	2037	0.002093	0.997907
55	971132	2251	0.002318	0.997682
56	968881	2526	0.002607	0.997393
57	966355	2879	0.002979	0.997021
58	963476	3285	0.00341	0.99659
59	960191	3664	0.003816	0.996184
60	956527	4086	0.004272	0.995728
61	952441	4554	0.004781	0.995219
62	947887	5072	0.005351	0.994649
63	942815	5646	0.005988	0.994012
64	937169	6280	0.006701	0.993299
65	930889	6981	0.007499	0.992501
66	923909	7768	0.008408	0.991592
67	916140	8647	0.009438	0.990562
68	907494	9612	0.010592	0.989408
69	897882	10672	0.011886	0.988114
70	887209	11833	0.013337	0.986663
71	875377	13099	0.014964	0.985036
72	862278	14475	0.016787	0.983213
73	847802	15963	0.018829	0.981171
74	831839	17566	0.021117	0.978883
75	814273	19300	0.023702	0.976298

附录3. 个人商业养老保险投保意愿调查问卷

您好，我是中央财经大学在读本科生。我正在做一项关于探究延迟退休政策对于我国商业养老保险发展的课题探究。本调查问卷主要用于该课题论文研究之用，我保证会严格保密，希望您能够如实填写以下问题，在此感谢您的参与！

问题1：您的性别是？（单选题）

〇男 〇女

问题2：您的年龄处于以下哪个阶段？（单选题）

〇18-25〇26-35

〇36-45〇46-55

〇55岁以上

问题3：您的工作单位属于以下哪一组别？（单选题）

〇国有企业 〇机关事业单位

〇外资企业 〇私营个体企业

〇自由职业

问题4：您的家庭状况？（单选题）

〇未婚 〇已婚未生育

〇已婚有孩子

问题5：您的学历是？（单选题）

〇高中及其以下 〇大专

〇本科 〇硕士

〇博士

问题6：您的平均每月收入为？（单选题）

〇2000-4500元 〇4500-8000元

〇8000-15000元 〇15000-30000元

〇30000元以上

问题7：您所在的企业/机关单位是否提供企业补充养老保险（也称企业年金）？（单选题）

〇是 〇否

问题8：您是否有意愿投保个人商业养老保险?(单选题)

〇有意愿且已经投保 〇有意愿但尚未投保

〇不愿意投保

若问题8选项为不愿意投保则回答问题9.

问题9：您不愿意投保的主要因素是？（多选题）

〇保险费用过高 〇保险产品投资回报率过低

〇社会通货膨胀率太高 〇对险种不太了解

〇不信任保险公司 〇认为通过其他途径理财进行养老更好

问题10：您认为延迟退休政策即退休年龄的推迟对您是否购买个人商业养老保险是否有影响?(单选题)

〇有影响 〇没有影响

〇不清楚有无影响

基于延迟退休视角探究我国商业养老保险的发展前景

陈薇

中央财经大学保险学院
北京102206，中国
电话: 18810137982
Email: chen_wei_130@163.com

关键词: 延迟退休; 商业养老保险; SWOT模型; 精算替代率模型

中文摘要.养老问题是一个长期困扰许多国家的社会性难题，也是中国实现建设富强民主文明和谐的社会主义国家伟大中国梦亟需解决的现实问题。我国的老龄化进程使得养老问题变得更加紧迫和严峻，也给处于转型时期的我国社会保障体系带来了巨大的挑战。延迟退休看似势在必行，实则充满争议。当前围绕延迟退休可能带来的失业率、利益受损等问题，全国上下展开了激烈辩论。本文将重点了解延迟退休政策对于我国商业养老保险的影响。随着延迟退休政策的即将推行，越来越多的居民意识到商业养老保险的优点，但由于一些历史原因、现实原因，我国国内商业养老保险发展并不太理想。本文正是基于完善中国多层次养老保险体系的目的，对现阶段商业养老保险展开一次全面的调查:探究商业养老保险的意义，寻找影响商业养老保险发展的重要因素，调查社会居民对于商业养老保险的需求特点，并在此基础上对我国商业养老保险的发展提出切实可行建议。从而促进商业养老保险发展、缓解政府养老压力、提高社会保障水平，增进人民福利。

本文主要分为五大部分：第一部分分析现阶段我国的人口老龄化状况并研习延迟退休政策相关资料，充分了解延迟退休政策实行背景。第二部分主要运用SWOT模型，在当前人口背景下将我国商业养老保险与社会基本养老保险进行比较，分析商业养老保险在国内的发展现状；第三部分首先通过构建精算收支均衡模型来推导商业养老保险替代率的影响因素，之后根据我国政策确定模型参数，再将经验死亡率等数据带入模型，根据替代率模型结果验证退休年龄的推迟对商业养老保险的影响；第四部分分析有效回收问卷，调查社会居民对于商业养老保险的需求特点。第五部分通过整理以上调查结果结合现阶段我国基本国情，从国家制度、保险公司养老产品种类、宣传等方面对商业养老保险的发展提出建议。

Research on the Necessity of Establishing Multi Pillar Pension System
-- Based on the Perspective of Pension Replacement Rate

DONG Xue

School of Insurance
Central University of Finance and Economics
Beijing 102206, China
Phone: 18811301075
Email: snow_cufe@126.com

Key words: multi support; old age security system; replacement rate

Abstract: Pay and payment are unified, pay more is a major principle of social insurance. Have the ability to pay the cost of the workers, in addition to the basic old-age insurance for urban workers, should also participate in the enterprise annuity, commercial insurance, in order to maintain retirement level, improve personal pension replacement rate. Similarly, the ability to pay residents also, can participate in the supplementary pension insurance in the basic old-age insurance. "Workers" + "residents" of the basic old-age insurance as the first pillar, "workers" + "resident" supplementary pension insurance as the second pillar, this kind of commercial insurance individual savings endowment insurance as the third pillar is more appropriate. This paper analyzes the implementation situation of each pillar the calculated by China and the major countries in the world than the social average wage replacement rate and the Engel coefficient in recent 10 years, use data to test benefits for retirees living level of protection, and the reasonable assumptions, estimates in enterprise pension and occupational pension the pension replacement rate found pension levels can improve 30-40%, through empirical analysis to verify multi pillar system to establish the necessity, and put forward reasonable suggestions.

1. 引言

替代率是衡量养老金水平的重要指标，反映退休人员生活水平的高低。目前我国老龄化程度日益加剧，养老金替代率呈逐年走低的趋势，退休人员的生活水平得不到保障，养老情况堪忧。有学者指出退休人员在退出工作岗位后成为了“低收入人群”，这一现象与其为国家的付出不相匹配，不仅使得在职人员对于退休后的生活充满忧虑，而且使得灵活就业人员宁愿参与风险投资，也不愿意参加养老保险。

我国基本养老保险承担着在世界范围内都少有的巨大责任，让国家财政来实现替代率 60%的目标是不现实的，也是社保基金的现状不允许的。基本养老保险提供的是最基本的养老保障，满足老年人基本的需求，而无法注重其发展需求。对于生活要求不高或是年轻时就处于中低收入水平的退休人员而言，“保基本”就是其对于退休生活的要求，但是年轻时有过辉煌岁月的老年人又希望年老时也能够体面生活。可见退休人员的诉求不尽相同。因而响应国际劳工组织的号召，建立多支柱养老保障体系是必要的。

国内外学者对于多支柱养老保障体系的研究很多，但是很少从收入水平的视角出发，分析多支柱养老保障体系建立的必要性。本文将通过比较企业年金与职业年金的替代率，分析补充养老保险对于养老金水平提高的重要性，为完善补充养老保险制度提供依据，呼吁有能力、有需求的民众参与更多的支柱，保障老年生活。

2. 各制度实施概况分析

1991 年国务院颁布《关于企业职工养老保险制度改革的决定》，确定了我国的养老保障体系，由基本养老保险、补充养老保险和个人储蓄性养老保险三个支柱构成。这与世界银行 1994 年提出的“三支柱”相契合。目前，基本养老保险为第一支柱，由国家或政府统一规定、强制实施，以保障广大离退休人员和 60 岁以上的居民的基本生活需要为目的。补充养老保险为第二支柱，主要是企业职工参与的企业年金和公职人员参加的职业年金。用人单位和劳动者在参加基本养老保险的基础上，根据国家政策和企业经济实力进行参与，旨在进一步提高离退休人员的生活水平。个人储蓄性养老保险是第三支柱，是职工自愿参与、自愿选择经办机构的一种补充养老保险形式。在我国，出于成熟、完备性的考虑，政策

大多支持商业保险公司作为经办机构，通过寿险产品实现。在2005年，世界银行顺应发展需求，提出了“五支柱”的概念和建议，增加了零支柱全民共享的普惠制养老金和第四支柱家庭成员的非正式供养。笔者了梳理这三大支柱以及其他两个支柱在我国的实施概况：

2.1 基本养老保险

目前，我国基本养老保险制度按照人群进行划分，可以分为居民养老保险制度和职工养老保险制度。其中前者由农村居民养老保险制度和城镇居民养老保险制度合并而来，后者由城镇企业职工养老保险制度和机关事业单位养老保险制度合并而来。

2.1.1 职工养老保险

2015年1月14日国务院印发《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》，对机关事业单位工作人员养老保险制度进行改革，终结长达8年之久的双轨制——实行社会统筹和个人账户相结合的模式，由单位和个人共同缴费。不过由于时间因素，虽然非公职人员系统与公职人员系统并轨，但是两种制度的实施情况仍存在差异。

我国城镇企业职工养老保险制度在几十年的发展历程中，参保对象由国营企业、公私合营、私营企业职工逐步扩大到城镇各类企业及其职工、企业化管理的事业单位及其职工、无雇工的个体工商户、非全日制从业人员，可谓是“应保尽保”。理论上讲，全国所有省份都实施了城镇企业职工养老保险制度，名义覆盖率应该达到了100%。但事实上，执法不严，违法成本低导致制度在实施中大打折扣。许多中小企业，尤其是私营企业认为社会保险费是企业的重大开销，没有按照国家规定缴纳社会保险费，参加社会保险。因此，城镇企业职工养老保险并未覆盖所有符合条件的劳动者，实际覆盖率只有80-90%。此外，部分企业对社会保障的认识不到位，即便参加职工养老保险，也是秉承能少缴就少缴的原则，虚报职工工资，一律以最低标准[1]作为缴费基数，导致员工退休后，难以领取足够的养老金，生活水平难以保障。

2006年《公职人员法》中明确表示"国家将建立公职人员养老保险制度",其中第八十九条规定"公职人员退休后,享受国家规定的退休金和其他待遇","公职人员养老保险费用列入财政预算予以保障"。公职人员不需要个人缴费，在退休后能根据本人工资和工龄由所属单位记发养老金。这一时期企业职工和公职人员

[1] 地区上年度职工平均工资的60%

是区别对待的。机关事业单位与政府之间是行政隶属关系，员工工资情况相对透明；机关事业单位不以盈利为目标，具有稳定的经济效益，能够负担社会保险支出。基于以上两点原因，公职人员养老保险制度落实更加到位，也导致了公职人员的养老金替代率明显高于企业职工。

2015 年 1 月国务院发布《关于机关事业单位工作人员养老保险制度改革的决定》，公职人员也开始按月缴纳社会保障费，缴费比例、缴费基数的确定、待遇领取的年限、计发标准等均都与企业职工养老保险相同，改革的方法与当年企业职工养老保险改革相同，采取“老人老办法，中人逐渐过渡，新人新办法”的方式。改革初期的成本是高昂的。目前事业单位还没有补缴 2014 年 10 月至 2015 年 1 月的保险费，同时还需要按照老办法给新退休人员发放养老金。公职人员个人缴费的情况发生变化，退休待遇也会发生变化，在职职工对未来充满担忧。大部分年长的公职人员也要求提前退休，但受限于工龄和年龄而难以实现这一诉求。总之，公职人员系统是人心惶惶。这也是正式政策未出台之前，各省对于事业单位保养保险改革都无动于衷的原因。相关部门为了避免公职人员到手的现金大幅减少，在一定程度上增加其工资，补偿心理的落差。然而对于公职人员这一群体而言，社会保险这项福利待遇一直存在，不愿轻易取消，即便是需要自己按月缴费，在行政上司，政府的监督下，在强制的力量下，也不得不维持着这一项“福利”。

2.1.2 居民养老保险

在城镇化和劳动力大规模流动的冲击下，国务院于 2014 年 2 月出台《关于建立统一的城乡居民养老保险制度的意见》，决定在全国范围内建立统一的城乡居民基本养老保险制度，新型农村社会养老保险制度（新农保）和城镇居民养老保险制度（城居保）开始并轨。

城乡居民养老保险的参保对象为年满 16 周岁、非国家机关事业单位工作人员以及不参加职工养老保险制度的居民（不含在校大学生）。相比于职工养老保险，城乡居民养老保险更能够体现公平：缴费来自于政府补贴、集体补助和个人缴费三部分。政府补贴属于匹配性缴费，随个人缴费档次的选择而不同，并随个人缴费一同划入个人账户；对于基础养老金的发放，政府补贴会考虑地区因素，对欠发达的中西部地区的补贴力度较大，对发达的东部地区补贴力度较小。

考虑到居民的收入不同，《意见》规定了 12 个缴费档次，100 元为最低档，2000 元为最高档， 政府补贴和基础养老金都规定了最低值，各省根据实际情况增设缴费档次，自行调整具体数额。2015 年，北京、上海、天津的最低档均超

过 500 元，最低档至少为 3300 元，基础养老金也最低达到 245 元。但是大部分的省份遵循《意见》12 档进行缴费，基础养老金页大多维持在 70 元的水平。西藏的居民参保率达到了 92.8%，但是有 99%的居民都选择 100 元的缴费档次。湖南的居民最高缴费档次以 500 元居多。可见，中西部地区的居民对于居民养老保险还持谨慎态度，即便收入允许，也不愿参加更高档次。最新数据显示[2]，2015 年，城乡居民养老保险平均缴费水平接近 230 元，参保人数比上年度增加 365 万人，相当于每天增加 1 万人。随着政策的完善与推行，越来越多的居民将被纳入到城乡居民养老保险中来。

2.2 补充养老保险

我国的补充养老保险包括面向城镇企业职工的企业年金和面向公职人员的职业年金。二者的差别在于，企业年金自愿参加，而职业年金具有强制性。

2.2.1 企业年金

现行的城镇职工养老保险制度在设立时，目标替代率是 59.2%，其中基础养老金替代率为 35%，个人账户养老金替代率为 24.2%。59.2%基本满足 60%的构想[3]。如果企业还能够建立起企业年金制度，养老金替代率可以达到 70%左右,能够基本满足职工退休后的生活需求。但是，全国仅有不到 10%的企业（通常为国有企业）建立了企业年金制度,覆盖的职工群体非常少，因此大多数退休职工不得不依靠基本养老金维持生活。不仅企业没有意识到养老保障的重要性，相应政策也存在明显缺失。自 2004 年 5 月实施出台《企业年金试行办法》之后，政策止步于此，再也没有对制度本身进行更为详细的规定，也没有完善过税收优惠政策，目前仅对缴费阶段的税收优惠政策有明确规定，“企业缴费在工资总额百分之四以内的部分,可在成本中列支。”[4]未涉及投资运营所得以及养老金发放时的税收政策。

最新的政策是关于基金管理办法的，2011 年出台了《企业年金基金管理办法》,《企业年金基金管理试行办法》不再适用，在“正规”法条的支持下，企业年金维持着较高的收益率，参加企业年金的职工享受到了真实的福利。

2.2.2 职业年金

2015 年 3 月 27 日，国务院办公厅印发《机关事业单位职业年金办法》。职

[2] 来源于金投网
[3] 国务院发展研究中心在研究报告中指出基本保险加个人账户的养老金平均替代率大致在 60%左右是合理的
[4] 国务院发布《关于完善城镇社会保障的试点方案》

业年金与企业年金的缴费方式和累计方式相同，但因为企业与机关事业单位的不同，职业年金与企业年金也存在明显差异，具体体现在与政府的隶属关系、单位性质和现实要求上。

机关事业单位与政府是隶属关系，非营利性和公益性事业单位的职业年金更容易落实到位，甚至对职业年金采取强制实施；单位性质上，机关事业单位不以盈利为目标，经济承受能力和经营效益更加稳定，员工流动率低，职业年金作为一项长期的福利政策容易开展，员工也更容易理解职业年金的优势；现实要求上，虽然机关事业单位基本养老保险制度的改革削减了公职人员的一部分福利，但是职业年金可以有效弥补这部分消失的福利，有望将退休待遇的替代率提高到 70%以上，利于基本养老保险制度的并轨。然而这只是理论上的推论。但目前职业年金单位缴费部分的基数，基金投资管理运营的具体事项还没有确定，仅是单位代扣个人缴费部分，存放起来，实行记账计息。

2.3 个人储蓄性养老保险

个人储蓄性养老保险是职工个人根据个人收入情况，自愿参加，自愿选择经办机构的一种补充养老保险模式。其中，经办机构有社会保险机构和金融机构。

虽然企业年金由于缺乏适合的税收优惠政策以及具体的细则，进展一直很缓慢，但仍然快于对个人储蓄性养老保险的研究探索。由于我国保险市场对个人储蓄性养老保险的需求一直不温不火，发展仍处于起步阶段，相关的理论研究和试点实践都较为缓慢。长期以来，每次养老制度改革几乎都有提及个人储蓄性养老保险，但大都是原则性表述，缺乏相应的配套措施。由于政策的缺失，保险公司和社会保障机构开展相关业务步履维艰，广大民众也缺乏对这一制度的了解使得个人储蓄性养老保险的发展仍然处于滞后状态。

2.4 全民共享的普惠制养老金

2015 年，60 岁及以上的老年人口已经达到 2.12 亿人。全国老龄委的数据显示，中国人口进入急速老龄化阶段，在未来 20 年老年人口将增加至 4.18 亿。为此，不少学者提倡我国应建立普惠制养老金，将国家的养老政策全面覆盖，实现全民共享经济发展的成果。普惠制养老金是不需要个人缴费，养老金完全由财政负担。

但是面对如此庞大的老龄人口，养老金的标准应该如何确定？如果每人每月 50 元，财政每年需要负担 1272 亿元。可见，以我国目前的经济实力，惠及全民

的普惠制养老金还难以建立。不过，我国低保、五保、最低生活保障等社会救助措施，可以在一定程度上缓解贫穷百姓的养老问题。

2.5 家庭成员的非正式供养

养儿防老一直是中国人的传统观念，孝敬父母也是自古以来的传统美德。现在的老年人大多拥有多个子女，可以由子女们共同供养，无论是精神生活还是物质生活，都能够得到较好保障。虽然这一养老方式一直未被“提名”为一大养老支柱，但是在养老事业中一直发挥着重要的作用。

然而在计划生育政策的影响下，“四二一”成为了当代家庭的主要模式，一对夫妇需要赡养四位老人，抚养一个孩子。经济发展越来越快，年轻人的生活压力也越来越大。在这样的情况下，家庭成员的非正式供养发挥的作用越来越弱，老人也大多不愿意给子女添麻烦。并且子女赡养父母是靠道德约束，不是法律强制，导致第四支柱没有在我国建立起来。

3.养老金水平的世界比较

与各国比较养老金水平可以反映出我国养老保障水平在世界范围内的地位。2014 年我国的毛替代率高达 69%，英国这样的老牌福利国家的毛替代率仅有 21.6%,荷兰的毛替代率高达 90.5%。英国、法国这样的福利国家毛替代率都不及我国。不排除欧债危机对欧洲福利国家的社会保障有冲击，但是福利大幅度降低民众是不会同意的。并且我国的毛替代率还处在中上游水平。

单纯用替代率来衡量一个国家的养老金水平是不合适的。因为各国对于养老金替代率的统计口径都略有差异，有的国家以劳动者劳动期间的平均工资为分母，如法国；有的国家以上年度在职职工平均工资为分母，如中国。因为各国养老金计算基数不同，替代率的分母不同，结果差异会很大。其次，各国的制度也不相同。从收入方面来说，许多 OECD 国家的退休金来源还有企业年金、个人储蓄计划的储备，如美国、英国；从支出方面来看，老年人在食品上有需求以外，医疗费用也是一笔重大的开支。OECD 国家普遍拥有较为完善的医疗保障体系，自己负担的费用少，一些国家还有护理保险，但我国的医疗保险的保障程度就弱一些，老年人需要为医疗保健准备一笔钱。

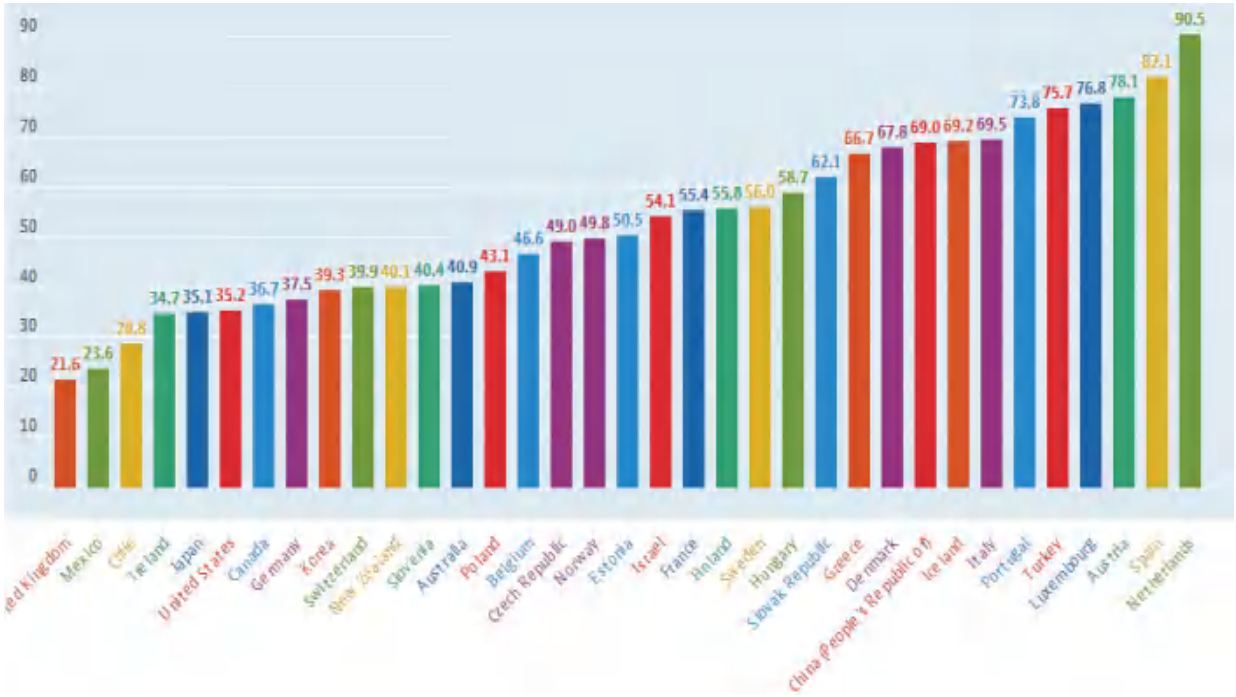


图 1 2014 年世经组织国家和中国的毛替代率[5]

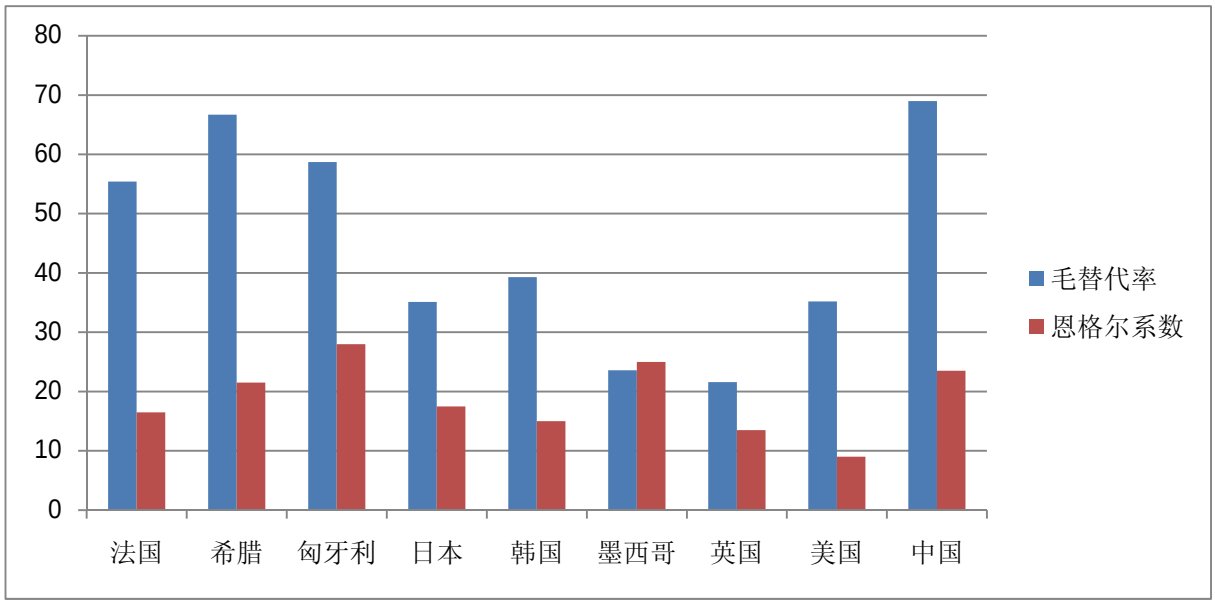


图 2 2014 年法国等九国的毛替代率与恩格尔系数[6]

[5] 数据来源于世经组织
[6] 由于缺乏恩格尔系数的数据，仅得到了 9 个国家的数据，数据来源于美国农业部

表 1 2014 年法国等九国的毛替代率与恩格尔系数的比值

国家	毛替代率/恩格尔系数
法国	3.36
希腊	3.10
匈牙利	2.10
日本	2.01
韩国	2.62
墨西哥	0.94
英国	1.60
美国	3.91
中国	2.94

因而借用李珍（2012）的思想，用替代率与恩格尔系数的关系来反映养老金水平的高低。在 2006 年数据中，中国和墨西哥的比值是接近的，均不足 2[7]。然而表 1 显示，中国的比值已经接近 3 了，可见在 6 年时间当中，我国的养老保障体系不断完善，取得了显著进步。

即便 2014 年的毛替代率达到了 69%，也不能轻易认定我国的养老金水平已经处于世界高位，养老制度已经健全。要从我国的国情出发，我国仍是基本养老保险占据着养老保障的重要地位，企业年金发展缓慢，职业年金还未建立起来，个人储蓄性养老保险覆盖范围也不大，养老金替代率的分子可以说就是基本养老金。基本养老保险“一家独大”，政府负担重，面临老龄化的汹涌浪潮和经济发展的攻坚期，养老保障体系更应该多支柱化来分散风险，对于养老保险体系的完善不能掉以轻心。

4. 替代率的测算

替代率是衡量退休人员的养老金水平的指标，因此以退休人员的养老金替代率来说明养老金水平的高低。企业职工和事业单位职工均有基本养老保险，缴费和计发方法相同，但是补充养老保险的费率不同：企业年金总费率不足 1/6，职业年金总费率为 12%。因而可以比较补充养老保险的作用大小，体现补充养老保险的重要性。

4.1 企业职工部分

企业年金是企业和职工自愿参加的，因而企业年金的养老金替代率可以体现

[7] 详见《基本养老保险目标替代率研究》.李珍.王海东.保险研究.2012 第 1 期

出只参加基本养老保险和参加两种养老保险（基本养老保险和企业年金）的退休职工的养老金收入差距。截止 2015 年，已经有 75454 家企业建立了企业年金，参与的职工达到 2316.22 万人近 4 年来企业年金的待遇领取情况如表 2 所示：

表 2 近 4 年来企业年金的待遇领取情况[8]

年份	分期领取人数（万人）	分期领取金额（亿元）	平均每人每年领取金额	上年度社会平均工资	企业年金替代率	当年加权平均收益率
2012 年	17.71	20.9	11801.242	42452	27.8%	5.68%
2013 年	20.42	27.04	13241.920	47537	27.9%	3.67%
2014 年	27.38	49.67	18140.979	52388	34.6%	9.3%
2015 年	67.23	149.26	22201.398	57361	38.7%	9.88%

从表 2 中可以看出，企业年金的替代率较高，并且在投资收益情况良好时，替代率的增幅更大。从近 4 年的数据来看，企业年金的投资收益较高，资金的运营管理有效。企业年金的替代率也在逐年上升，对城镇企业退休人员的保障功能逐步增强。在企业年金的补充下，养老金替代率增加了 30%-40%，参保人员退休后的生活质量不会较劳动期间下降太多。

4.2 公职人员部分

本文借用曹园和杨再贵（2016）的测算结果。

1.假设 30 岁开始工作，60 岁退休，初始工资水平分别是社会平均工资的 60%、100%、150%，养老金替代率为表 3 所示。

表 3 不同工资水平的养老金替代率的影响

初始工资/社会平均工资	基础养老金替代率	个人账户养老金替代率	过渡性养老金替代率	不含职业年金替代率	职业年金替代率	养老金总替代率
60%	50.2%	21.9%	8.5%	80.6%	50.5%	131.1%
100%	37.0%	21.9%	7.7%	66.8%	50.5%	117.3%
150%	30.4%	21.9%	7.2%	60.5%	50.5%	111.0%

可以看出，工资水平越高，不含职业年金的养老金替代率反而越低，这体现了社会保障收入再分配的作用。初始工资为社会平均工资的 150%时，不含职业

[8] 数据来源于中华人民共和国人力资源和社会保障部官方网站

年金的养老金替代率只有 60.5%。因此，当初始工资水平到达封顶线 300%时，不含职业年金的养老金替代率将会失守 60% 难以维持劳动期间的生活水平。可见，对于中高收入者，职业年金这一补充养老保险意义非凡。

2.假设 30 岁加入工作，退休年龄为 60 岁，初始工资水平为社会平均工资的职工，在职业年金缴费率分别为 4%、6%、8%、10%、12%、14%，六种情况下的养老金替代率水平如表 4 所示。

表 4 不同职业年金缴费率对养老金替代率的影响

职业年金缴费率	不含职业年金替代率	职业年金替代率	养老金总替代率
4%	66.8%	15.9%	82.7%
6%	66.8%	23.9%	90.7%
8%	66.8%	31.9%	98.7%
10%	66.8%	39.8%	106.6%
12%	66.8%	47.8%	114.6%
14%	66.8%	55.8%	122.6%

从表中可以看出，在其他条件一定的情况下，职业年金的缴费率越高，养老金的总替代率越高。当职业年金的缴费率超过 10%时，养老金的总替代率超过 100%，退休后的生活收入反而高于在职时的工资收入。而职业年金目前的缴费率为 12%，其中单位的缴费率为 8%，个人的缴费率为 4%，公职人员退休后的养老金收入比在职的工资收入更高。

4.3 二者的比较

可见，补充养老保险的替代率能达到 30%-40%，较大程度提高养老金水平。表 4 中体现的规律是职业年金的缴费率越高，职业年金养老金替代率越高，养老金总替代率越高。虽然表 2 计算的是参保企业年金的平均养老金替代率，表 3 计算的是 30 岁入职，60 岁退休的个人职业年金养老金替代率，但是二者可以大致进行比较。企业年金的替代率较小，可能是因为《企业年金试行办法》中的缴费率规定得弹性过大，“企业缴费每年不超过本企业上年度职工工资总额的 1/12，企业和职工个人缴费合计一般不超过本企业上年度职工工资总额的 1/6”，导致现实中企业年金的总缴费率下降，从而企业年金的替代率较小。

5.结论与建议

通过对“三支柱”养老保障体系在我国的现状分析，我们发现第一支柱的基本养老保险占据着主导地位，受到民众的过分依赖，第二支柱、第三支柱发展缓慢，惠及到的人群少。然而，经过对企业年金养老金替代率的计算，发现参与企业年金平均可以将替代率提升 30-40%，能够对养老金水平有明显的改善。借助已有论文的测算，发现在现行的缴费率下，职业年金的养老金替代率更高。补充养老保险的作用可见一斑。

因此，我国的三支柱养老保障体系仍然需要完善，尤其是补充养老保险部分，应该在“居民”+“职工”的基本养老保险的基础上，完善“居民”+“职工”的补充养老保险，以及个人储蓄性养老保险。

5.1 加快企业年金和职业年金的制度完善

《机关事业单位职业年金办法》都已经出台，《企业年金办法》也应尽快跟进，毕竟《企业年金试行办法》运行了 12 年之久，已经积累了丰富的经验，足以建立起来一套完整的征缴与发放系统，制定明确的收税优惠政策，促使更多符合要求的企业为职工建立企业年金，切实提高职工的养老待遇。加快出台职业年金投资运营的具体政策和配套措施，指导职业年金步入正轨，加快职工养老保险的并轨运行，同时适当降低职业年金的费率，防止改革后城镇职工与公职人员的养老金待遇进一步拉大，加剧不公平。

5.2 建立城乡居民的补充养老保险

补充养老保险对养老的支持作用明显，有能力参加企业年金、职业年金的职工退休后，替代率能达到 70%，甚至更多。所以应该发挥补充养老保险的补充作用，为其他有能力、有需求的群体建立补充养老保险，如城乡居民，切实改善老年生活水平。有缴费能力的居民在基本养老保险缴费档封顶后，应该参加属于自己的补充养老保险——个人年金计划。采用完全积累制，居民缴费完全记入自己的账户，由指定机构代为运作管理，年老时享受养老金待遇，政府予以一定的税优支持。

5.3 推进个人储蓄性养老保险的试点

政府应该尽快制定税收优惠的细则，鼓励保险公司尽快开发个人储蓄性养老保险产品，定位人群应是企业年金和职业年金未覆盖到的人群，与企业年金和职业年金共同发挥补充作用，为更多有需求的人提供养老保障服务。

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多支柱养老保障体系建立的必要性研究
——基于养老金替代率的视角

董雪

中央财经大学保险学院
北京 102206，中国
电话：18811301075
Email：snow_cufe@126.com

关键字：多支柱;养老保障体系;养老金替代率

中文摘要：待遇与缴费相统一，多缴多得是社会保险的一大原则。有能力缴纳费用的职工，除参加城镇职工基本养老保险以外，还应该参加企业年金、商业保险，以维持退休后的生活水平，提高个人养老金替代率。同样地，有能力缴费的居民，也可以在参加基本养老保险的基础上参加补充养老保险。“职工+居民”的基本养老保险作为第一支柱，“职工+居民”的补充养老保险作为第二支柱，商业保险这类个人储蓄性养老保险作为第三个支柱更为合适。本文分析了各个支柱的实施情况，通过计算近 10 年来我国与世界主要国家社会平均工资替代率与恩格尔系数之比，用数据来检验我国的养老金水平对于退休人员生活的保障程度的高低，并且合理假设，测算参加企业年金和职业年金的养老金替代率，发现养老金的水平可以提高 30-40%，通过实证分析来验证多支柱体系建立的必要性，并提出合理化建议。

The Designing of the Commercial Endowment Insurance System (Tax Deferred) in Hebei Province

FU Zheng, WANG Xianglan

FU Zheng
Teaching assistant
Department of Insurance, Hebei Finance University
No. 3188, Hengxiang Road, Baoding, Hebei
Phone: (86)13832258640
Email: fuzhenggood@126.com

WANG Xianglan*
Professor
Department of Insurance, Hebei Finance University
No. 3188, Hengxiang Road，Baoding，Hebei
Phone: (86)0312-3338185
Email: wxl14130666@126.com

Keywords: Aging; Commercial endowment insurance system (tax deferred); Pension replacement rate; Mechanism design;

Abstract. Designing a tax deferred commercial endowment insurance mechanism has important realistic background. On one hand, the aging of whole people has led to an increasing demand for "quality endowment". However, three pillars (the basic, the annuity and the individual) of the existing endowment insurance system cannot meet the demand of endowment. The basic endowment insurance only provides basic life safeguard after retirement, the enterprise annuity now does not cover all areas, and individual endowment insurance is not enough. On the other hand, Prime Minister Li Keqiang referred in the 2015 government work report to launch “tax deferred commercial endowment insurance system”. Tax deferred commercial endowment insurance has important practical significance. For the individual, it directly reduces the current tax expenditures; For a company, it provides the chance of earning more benefits; For our society, it improves the level of social security and reduces financial burden; For the insurance industry, it expands the scope of business of an insurance company.

This article will use actuarial model to simulate pension replacement rate, learn from the operating experience of European and American countries, combined with the present situation in Hebei province, finally put forward a system. This paper

concentrates on the following questions. First, through the social investigation, we can conclude the demand of commercial endowment for different groups and different ages. Second, we draw lessons from IRAs and Keogh plans in the U.S, the compensatory endowment insurance in Germany and the individual endowment insurance (group) in the U.K. Third, based on a trial basis in Hebei province, we design a tax deferred endowment insurance mechanism including the tax policy, fund account management and investment regulation. Through the simulation of pension replacement rate under the new form, it is concluded that tax deferred endowment insurance is economic and it provides social benefits.

This article uses the research method of questionnaire survey, an actuarial model and case analysis. We adopt the questionnaire survey in the demand research of Hebei province, use the actuarial model in the design of specific mechanism of the endowment insurance (the proposed tax rate, payment methods and efficiency) and use case analysis in learning lessons from advanced countries. The innovation of the article lies in the use of actuarial model when calculating premium and tax rate.

1. 引言

伴随着人口老龄化和养老金空账等社会问题，如何养老得到了越来越多的关注。个人商业养老保险作为养老保障体系三支柱之一，如何发挥它应有的作用，是政府和决策制定者思考的问题，其中的解决方式之一是推行个税递延型养老保险。

2. 个税递延型养老保险的理论界定

个人税收递延型商业养老保险，是指个人在购买商业养老保险时，所缴纳的保费可以有一部分在税前扣除，免缴个人所得税；应缴部分延期缴纳，在投保人退休或领取保险金时按照当时的税收政策缴纳。个税递延型养老保险由于能给普通劳动者带来切实的优惠政策，同时能为缓解养老压力节省成本，因此被认为是未来商业养老保险的主要发展方向之一。

发展个税递延型商业养老保险在河北省具有现实意义。首先，人口老龄化的加剧使得养老越来越成为社会性难题。截止2014年末，全国60岁以上老年人口达2.12亿人，超过总人口的15%。预计到2050年，老年人口将超过总人口的三分之一。和老年人口增加相对应的是人口红利消失、通货膨胀和人们对养老品质的要求提高，特别是河北省一方面是人口大省，另一方面是经济较不发达省份，因此养老问题将在未来一段时间内成为社会的焦点。要解决养老问题，传统的“养儿防老”和目前很多老人已经采用的“养老院养老”都不够，需要社会资本和社会力量投入养老产业当中。

其次，养老保障的“三支柱”体系结构不合理，总量难以满足养老需求。基本养老保险、企业年金和个人商业养老保险构成了养老保障的三支柱。从目前我国现实情况来看，第一支柱的基本养老保险虽然在短时间内实现了从城镇职工到城镇居民再到农民的覆盖，然而存在保障水平偏低的问题，其所提供的退休后待遇和收入将远远低于退休之前，从而可能导致老年生活品质的下降。第二支柱企业年金虽然也提出并落地了税收优惠政策，但是主要的面向对象是有条件的企业，特别是大企业，在中小企业就业或灵活就业的劳动者无法享受到企业年金带来的福利，因此在解决养老问题上杯水车薪，难以真正提高大多数劳动者的退休后待遇。第三支柱是个人商业养老保险，该部分目前在我国养老保障体系中占到的作用基本可以忽略不计，然而在多数社会保障体系较为完善的国家，恰恰是个人养老保险在维持和提高退休后收入和养老金替代率方面占到了最重要的作用。因此有必要发展个人商业养老保险，要提高民众购买个人商业养老保险的积极性，个税递延措施将是最有效最直接的一项措施。

最后，在经济实力上政府和商业保险公司都有能力经营个税递延型养老保险产品。个税递延政策将从一定程度上减少政府当期的税收收入，主要体现为个人

所得税部分。但是整体而言，该部分税收减少对政府财政收入不会造成较大影响，特别是和其带来的利好和未来收益相比，政府只是用少部分支出撬动了大量的养老投入，减轻了未来社会和政府面临的养老成本。对保险公司而言，个税递延型养老保险产品将增加公司的保费收入，增加公司的长期资本，也将是公司承担社会责任和社会使命的重要途径。

3. 河北省发展个税递延型养老保险要解决的现实问题

3.1 区域间经济发展不平衡带来的保障水平不平衡

河北省的不同城市间、城市与乡村间的经济发展水平不平衡，导致劳动者目前收入和劳动者对退休后收入的预期都存在一定差异。这种差异给个税递延型养老保险的运行带来一定困难，中低收入者限于收入水平和养老意识的局限，没有足够的经济实力和主观意愿购买商业型的养老保险产品，从而无法享受税收优惠政策带来的红利。另一方面，不同地区保持相同养老生活所需要的金钱是不同的，这给个税递延型养老保险产品在产品设计，保费缴纳金额和保险金领取方式上带来了一定难度，如何确定缴费金额和领取金额的不同档次，需要进行更多的市场调研。

3.2 社会公平与个人公平的平衡

每项政策的推出都不可能兼顾到所有的利益相关者，个税递延型养老保险产品也是如此。推出个税递延政策，从社会整体的角度看是公平的，政府通过税收递延的方式缓解了养老压力，减少了养老成本，提升了整个社会的福利水平。然而从个人的角度出发却未见得如此，个税递延型养老保险从提出要在上海试点到今天已经有将近八年的时间，但是每当拿出具体的税优方案之后却迟迟得不到批准，在天津滨海新区的试点也因为缴纳金额过高而被叫停。深层次原因就在于，个税递延型政策有可能惠及高收入者，无法惠及中低收入者，从而沦为富人的福利，加大不同劳动者的贫富差距。由于我国目前个税起征点为3500元，因此个税递延政策对应惠及的一定是月收入3500元以上的人群，月收入越高的群体可能享受到的税收优惠幅度越大（超额累进税制下）；与此相对应的，大量中低收入者，灵活就业者和家庭就业者，由于月收入根本没有到达个税征收点，就无法享受到税收优惠政策带来的福利。长此以往，全社会的贫富差距拉大。

3.3 家庭财富构成在不同投资渠道上的均衡

保险“新国十条”中提出，要让保险成为家庭财富管理的重要手段和工具。然而目前，我国家庭财富的主要构成依然是银行存款和不动产，保险在内的金融资产在居民家庭财富构成中占比过低，无法实现通过家庭理财合理安排养老方式的需要。在养老保障三支柱当中，第一支柱占比过大，而企业年金和个人商业养老保险占比微不足道，这不仅增加了社会的养老压力，也增加了财富分配的不均

衡。在美国，超过三分之一的养老资金由个人商业养老保险提供，在英国这一比例也超过了百分之十，因此，有必要以个税递延作为契机，增加居民财富由储蓄和存款转向个人商业养老保险，实现家庭财富在不同的金融资产和不动产投资之间的均衡。

4. 河北省发展个税递延型养老保险的税优设计、产品设计与账户设计

4.1 税优设计

在税优设计方面，比较常采纳的模式有EET（个税递延）和TEE（前端纳税）两种，各个国家在推行税收优惠政策中采用了不同的方式，如美国采用了尽可能满足各人群养老需求的“401k计划”，德国通过“里斯特法案”降低了第一支柱养老金的替代水平，将养老保险由“保障型”转向“投资型”。建议河北省在短时间内采取个税递延的方式，保证有足够多的消费者购买商业养老保险产品，而在试点一段时间之后尝试能够覆盖更多人群和更多中低收入劳动的前端纳税模式，从而把低收入者也纳入税收优惠政策当中，通过建立个人账户的方式，把个人商业养老保险以“准信托”的方式来运行，账户中的资金不受雇佣状态和收入状况影响。在建立的过程中，逐步完善各项对应的税收政策，如对遗产征税，对资本利得征税。

4.2 产品设计

在试点方式上，建议仿照大病保险和政策性农业保险，以招投标的方式吸纳有资质的保险公司经办个税递延型养老保险业务；在试点区域上，建议选择唐山和石家庄作为试点地区，吸取天津在开展个税递延政策方面的教训，借鉴上海提出但未落地的几套方案中的具体开办方式，考虑到河北省的经济发展水平和缴费意愿，确定差别化的缴费方式和保障水平；在产品经营上，以团体投保作为最初的投保方式，鼓励有条件的企业为员工投保团体的养老保险，以长期性作为经营的出发点，把该部分保费以长期的方式来运行，包括准备金的提取，偿付能力的计算和投资方式的选择；在产品形态上，主险为年金保险，60或65岁开始领取，可以附加商业医疗保险；在缴费方式上，以期缴为主，每期缴纳的金额和缴费年限相关，并充分考虑通货膨胀和时间价值的影响；在领取方式上，设计一个有保障的领取期，避免投保人过早死亡带来的不利影响，可以由投保人制定的收益人在投保人死亡后仍然可以领取一段时间。

4.3 账户设计

逐步建立个人商业养老保险的个人账户。允许该账户在全国范围内自由携带，利用网络和公开媒介可以查询账户的资产投资情况和余额。不管劳动者是否一直在一个单位工作，该账户一直跟随劳动者，个体劳动者和灵活就业者可以通过该账户同等地享受到税收优惠带来的利好。账户以信托形式存在，可以用账户

中资金购买不同组合的资本市场产品，包括保险产品、基金产品等，其产生的收益或损失由劳动者自己承担。通过个人账户的形式既可以使税收政策惠及更多劳动者，又可以使普通居民的个人财富不因为温和的通货膨胀而发生较大幅度的贬值。

5. 完善个税递延型养老保险的建议

5.1 不同政府部门间在博弈后实现平衡

养老保险体系的独特之处在于，三个不同支柱有其不同的主管部门。企业年金的主管部门为人力资源和社会保障部门，而个人商业养老保险的主管部门为保监会。因此保监会在整个过程中要起到协调的作用。个税递延型养老保险政策的推出并非易事，需要财政税收部门出台税收递延政策，需要各级人力资源部门放开试点，需要试点地区地方政府厘清障碍。各个政府部门的服务宗旨和目标是有差别的，政策推行的过程也是不同政府部门博弈的过程，要想个税递延型养老保险实现成功，就需要在动态的博弈过程中打成均衡，最终出台有利于各个利益相关方的方案。

5.2 保险资本运作养老资金应注重资金安全性

养老资金要求长期性、安全性和收益性，这和保险投资的要求是吻合的。然而保险资本毕竟是社会资本，如何保证养老资金的安全，将是个税递延型养老保险大规模开展之后要解决的难题。基本养老金的入市，经历了多年的理论探讨和实际试点，而作为商业养老保险的养老金，一旦形成较大规模，将成为监管的重点和难点，也将成为对保险公司投资水平、投资能力和偿付能力的重要考验。因此，在发展个税递延型养老保险的过程中，尤其要重视资金的安全问题，它关系到居民的财富安全，具有系统重要性。

6. 结束语

总体而言，河北省具备开展个税递延型养老保险产品的现实需求和开办条件，虽然在当前开办个税递延型养老保险存在一些现实障碍和问题，但是不应裹足不前，应该积极试点和探索相关的制度和产品，争取在政策允许的前提下开展试点，为解决养老这一社会性难题提供新的解决思路和方法。个税递延型养老保险产品对于个人、家庭、社会和保险公司而言都是有好处的，因此本文为个税递延型养老保险的推出设计了具体的方案，包括产品形态、缴费方式、领取方式、试点区域等，旨在站在保险这一手段的层面为政府解决社会民生问题提供可行的和可供参考的建议。

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发展个税递延型养老保险的机制设计——以河北省为例

付正 王香兰

付正
助教
河北金融学院保险系
河北省保定市恒祥北大街3188号，河北金融学院
电话: （86）13832258640
Email: fuzhenggood@126.com

王香兰*
教授
河北金融学院保险系
河北省保定市恒祥北大街3188号，河北金融学院
电话: （86）0312-3338185
Email: wxl4130666@126.com

关键词: 人口老龄化；个税递延型养老保险；养老金替代率；机制设计

中文摘要

设计个税递延型商业养老保险机制有重要的现实背景。一方面人口老龄化的加剧导致对“品质养老”的需求增加，然而现有的养老保险“三支柱”体系不能满足养老需求。基本养老保险只提供退休后基本生活保障，企业年金参保率低，个人养老保险发展非常缓慢。另一方面国家政策上大力扶持，李克强总理在《2015年政府工作报告》中提到，要推出个人税收递延型商业养老保险。个税递延型商业养老保险的推出有重要的现实意义。对个人，直接减少了当期的税收支出；对企业，为员工提供更多的福利；对社会，提高社会的保障水平，减轻财政负担；对保险业，拓宽了保险公司的业务范围。

本文使用精算模型模拟不同情况下的养老金替代率，借鉴欧美国家个税递延养老保险的运行经验，结合河北省现状，提出可落地的方案。本文研究的主要问题有，第一，通过社会调研，对河北省不同收入地区发放300份左右调查问卷，得出不同年龄、收入、职业的人群对“个税递延型”养老保险的总体需求、参保

意愿、缴费模式和给付方式。第二，“个税递延型”养老保险的经验借鉴，借鉴美国的IRAs和Keogh计划、德国的补充养老保险和英国的个人(团体)养老保险这些第三层次的个人储蓄养老保险的模式，对其运作原理、运行情况进行总结和提炼。第三，“个税递延型”养老保险的机制设计及评价，建立在河北省试行的“个税递延”型养老保险模式的实施方案，包括：“递延个税”的征收方式、缴费待遇模式、配套的税收优惠政策以及基金的账户管理与投资监管。通过对新形式下养老保险替代率的模拟，得出“个税递延型”养老保险是否有经济社会效益的评判。

本文采用的研究方法有问卷调查、精算模型和案例分析。在调研河北省对个税递延型养老保险的需求时主要采用问卷调查法，在设计养老保险采用的具体机制（拟采用的税率、缴费方式及效率）时采用精算模型，在借鉴先进经验时采用案例分析法。

The Mechanism of Social Security to China's Current Account Imbalance: the Mediation Effect on Household Consumption and Labor Cost

LI Qingxia, HAN Yijia

LI Qingxia*
Assistant Professor
School of Economics
Xiamen University
Xiamen 361005, China
Phone: (86)13950006805
Email: liqx@ xmu.edu.cn

HAN Yijia
Industrial Securities
Shanghai 200000,China
Phone: (86)18705925502
Email: hanyijia90@126.com

Keywords: Social Security ; Current Account Imbalance ; Mediation Effect

Abstract. The mechanism of social security to current account depends on two paths: social security-household consumption behavior-current account and social security-labor market-current account. Through the mediation effect analysis, this paper validates the mediation effect of household consumption behavior and labor market, providing empirical support for the theoretical analysis. The empirical results reveal that mediating effect of household consumption accounts for 27.35% and labor cost accounts for 61.75%. At the same time, the threshold effect model test shows that only when social security is above a certain threshold level, current account rebalance impact will become remarkable.

1.导言

解释我国经常账户失衡理论文献汗牛充栋，有“双赤字说”、“储蓄—投资缺口说”、人口结构说、“汇率操纵说”、“新布雷顿森林”国际货币体系、产业转移等理论。但从社会保障的视角思考我国经常账户失衡原因还未有文献涉及。社会保障影响经常账户的两条主要传导路径为：社会保障—居民消费储蓄行为—经常账户和社会保障—劳动力市场—经常账户。第一条传导路径中，社会保障水平影响居民消费与储蓄行为已经得到广泛认知（Feldstein[1], 1976），社会保障影响消费（或储蓄）的作用途径主要体现在三个方面：(1)通过增加居民预期财富提高消费。Feldstein[2] (1974) 用简单生命周期理论框架分析社会保障增加居民预期财富提高消费。(2)改变居民收入分配行为：多消费少储蓄。孙祁祥等[3](2013)利用加入社会保障项目的简单两期模型证明“社会保障通过降低未来不确定性改变当期收入分配行为”。(3)通过缩小收入差距间接促进消费。社会保障可以通过代际之间进行收入横向再分配(Shiller[4], 1999；Wagener[5], 2004)，调节贫富差距，从而提高整个社会平均消费倾向，间接促进消费并提高宏观经济长期绩效。而储蓄—投资缺口是解释经常账户失衡最传统理论，经常账户CA约等于贸易盈余 $CA \approx X - M = (S - I) + (T - G)$，这里 X 表示出口，M 表示进口，S 表示储蓄，I 表示投资，T、G 表示政府收入与支出，此时经常账户余额转化为该国的整体储蓄投资差额。社会保障通过劳动力市场作用于经常账户是第二条路径。 社会保障与劳动力市场相辅相佐，社会保障的存在既可直接影响劳动力成本，也可通过对劳动力供给和需求产生影响间接作用于劳动力市场。Krueger[6] (2002)指出“劳动供给文献主要涉及工作小时调整，而社会保险项目经常影响到是否工作”。劳动力成本导致产品价格刚性(Sbordone[7],2002)，继而影响到经常账户。徐长生等[8](2008)指出“劳动力市场负向扭曲是造成我国宏观经济失衡的主要原因之一”。

社会保障通过预期持久收入、当期收入分配等方面影响居民的消费储蓄行为，社会保障不足是造成我国高储蓄、低消费独特经济结构的重要因素，内需不足情况下，经济发展以出口为导向，造成经常账户盈余的失衡局面。另一方面社会保障通过劳动力市场影响经常账户失衡。社会保障不足抑制了劳动力价格，廉价劳动力是出口的竞争优势，这同样也反映为我国的经常账户盈余。社会保障影响经常账户两条主要路径中，社会保障不足都导致经常账户盈余，同时鉴于我国目前社会保障主要体现在劳动力成本，而非主要体现在消费，因此提出如下假设。

假设1： 社会保障与经常账户盈余之间是负相关关系。

假设2：居民消费水平和劳动力市场在社会保障作用于经常账户盈余中存在中介效应。

假设3： 劳动力市场是社会保障作用于经常账户盈余的主要路径。

2. 中介效应模型与实证

本部分将应用中介效应 (**Mediation Effect**)模型实证研究社会保障对经常账户路径传导影响关系，并检验消费水平和劳动力成本中介效应的存在性以及中介效应强弱。

2.1 模型与方法

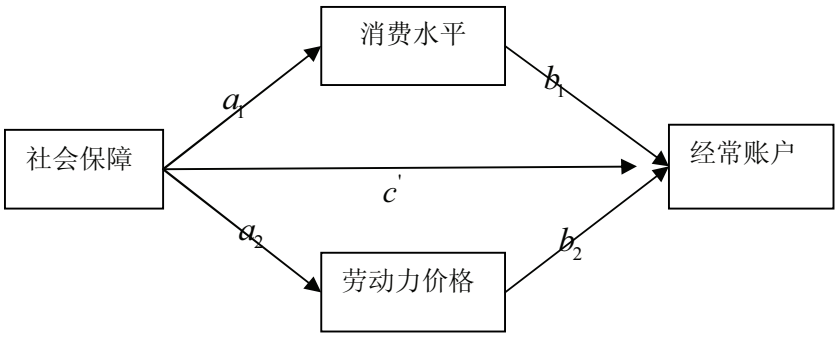


图1 中介效应的路径传导图

根据中介效应模型和路径传导图，可利用下述方程描述变量之间的关系：

模型（1）： $ca = \beta_0 + c \times ss + \chi_1 \times X + \varepsilon$

模型（2）： $M_i = \beta_{1i} + a_i \times ss + \chi_{2i} \times Y_i + u_i$

模型（3）： $ca = \beta_2 + \sum_{i=1}^{2} b_i \times M_i + c' \times ss + \chi_3 \times Z + \xi$

其中，ca 表示经常账户，ss 表示社会保障，$M_i\left(i=1,2\right)$表示中介变量，分别为消费水平 C 和劳动力成本 $wage$， X、Y、Z 是控制变量，ε、u、ξ 是随机扰动项。

模型（1）、（2）、（3）分别表示社会保障对经常账户的影响、社会保障分别对中介变量消费水平和劳动力成本的影响、社会保障和中介变量共同对经常账户的影响。模型（1）中系数 c 是社会保障对经常账户的总效应，模型（2）中系数 a_i 是社会保障对中介变量 M_i 的效应，模型（3）中系数 b_i 是在控制了社会保障影响后中介变量 M_i 对经常账户效应，c' 是在控制了中介变量 M_i 的影响后社会保障对经常账户直接效应。此时，$a_i \times b_i$ 是中介变量 M_i 的中介效应（如果 a_i、b_i 中存在不显著，则须运用Sobel等方法进行检验，检验结果显著则表明中介效应显著），$\frac{a_i \times b_i}{c}$ 反映了中介效应在总效应中的比重，$\frac{c'}{c}$ 反映了直接效应在总效应中的比重。

2.2 变量选择及指标数据说明

2.2.1被解释变量、解释变量和中介变量

被解释变量*ca*是我国经常账户余额*CA*占*GDP*的比重，单位%，数据来源CEIC。解释变量*ss*是人均社会保障支出，单位为元，数据来源国家统计局和财政部。预期符号为负。学者对社会保障支出研究存在口径不一致问题，这里采用当年财政性社会保障支出与当年社会保险支出加总衡量社会保障支出总额。其中，财政性社会保障支出统计口径曾有过一次调整，2006年之前为“抚恤和社会福利救济费用”科目，2007年用“社会保障和就业”科目表示。第一个中介变量*C*是人均消费支出，单位为元，数据来源国家统计局。第二个中介变量*wage*是制造业工人年平均工资，单位为元，数据来源CEIC。数据起止时间为1978-2013年。

2.2.2 控制变量

影响经常账户失衡的可能因素主要包括：政府财政盈余占GDP比重、人口抚养比、净国外资产占GDP比重、实际有效汇率、金融发展水平、贸易开放度、经济发展增速等。参考Chinn和Prasad[9](2003)与谭之博、赵岳[10](2012)实证研究结果，影响经常账户的控制变量*X*选择：(1)净国外资产占GDP比重nfa，单位%，数据来源世界银行。一定时期内，从等式$CA_t = NFA_t - NFA_{t-1}$可以看出，经常项目余额反映的是对其它国家净索取权（净国外资产*NFA*）变化。预期符号为正。(2)金融发展水平finance。采用M2占GDP的比重作为金融发展水平指标代理变量，单位%，数据来源中国人民银行和国家统计局。金融发展水平越高，信贷约束就越宽松，越容易积累大量债务，经常账户赤字增加。预期符号为负，单位%。(3)经济发展增速slngdp。采用取对数后的人均GDP反映经济发展水平，数据来源国家统计局。

影响人均消费支出*C*的控制变量Y_1选择居民人均可支配收入*DI*，单位为元。凯恩斯经典消费理论模型中，可支配收入是影响消费的最重要变量，预期符号为正。按照城镇居民家庭人均可支配收入和农村居民家庭人均纯收入加权平均得到我国居民人均可支配收入，使用的权重系数分别为城镇人口占总人口比重和乡村人口占总人口比重，数据来源国家统计局。

影响制造业工人年平均工资*wage*的控制变量Y_2选择居民消费价格指数*CPI*。这里将CPI环比数据调整为CPI同比数据，设定“1978=100”，数据来源国家统计局，预期符号为正。

控制变量*Z*的选择与控制变量*X*保持一致。

2.3 中介效应模型实证结果

2.3.1 单位根和协整检验

变量人均社会保障、人均消费、制造业工人年平均工资、金融发展水平、人均居民可支配收入、物价指数均取自然对数值，分别表示为lnss、lnC、lnwage、Infinance、lnDI和InCPI。

表 1　数据描述性统计

	ca	lnss	lnC	lnwage	nfa	lnfinance	slngdp	lnDI	lnCPI
均值	2	4.28	7.5	8.47	20.97	4.54	45.43	7.58	5.65
中位数	1.86	4.52	7.84	8.59	12.23	4.64	44.87	7.86	6.03
最大值	10.11	8.05	9.66	10.75	57.38	5.27	66.98	9.83	6.4
最小值	-3.72	0.68	5.21	6.39	-0.61	3.19	27.81	5.14	4.61
标准差	3.11	2.5	1.37	1.37	19.74	0.57	12.03	1.4	0.62
偏度	0.74	-0.09	-0.15	0.04	0.72	-0.62	0.23	-0.1	-0.47
峰度	3.7	1.56	1.74	1.7	2.01	2.27	1.86	1.78	1.61
JB	4.03	3.16	2.51	2.54	4.58	3.11	2.27	2.29	4.24
概率	0.13	0.21	0.29	0.28	0.1	0.21	0.32	0.32	0.12
个数	36	36	36	36	36	36	36	36	36

原始序列水平项上，所有变量Fisher-ADF检验并未拒绝有单位根原假设，说明水平序列有单位根，一阶差分后，所有变量都在5%显著水平下拒绝原假设，是一阶单整平稳序列。

表2　变量间的Johanshen协整关系检验结果

	JJ统计量	0.05临界值	P值	至多存在协整关系个数
模型1	45.94025	33.87687	0.0012	2
模型2.1	48.25076	21.13162	0.0000	1
模型2.2	39.37140	21.13162	0.0001	1
模型3	77.30234	46.23142	0.0000	4

采用Johanshen检验来判断多元变量之间的协整关系。选取最大特征根对应的协整方程，将协整关系标准化，结果见表3。从协整方程中不难看出，社会保障水平确实与经常账户存在负相关关系，体现在数字关系是社会保障支出水平每增加1%，经常账户盈余占GDP比重收窄 4.87%。

表3　模型（1）变量间的Johanshen协整关系

协整方程		对数似然-201.9023		
CA	LNSS	SLNGDP	LNFINANCE	NFA
1.000000	-4.871751 (0.67680)	0.278747 (0.19199)	- 0.233905 (0.03570)	0.263959 (0.04360)

2.3.2 中介效应模型结果

表4　中介效应模型结果

检验程序	步骤一 模型（1）	步骤二		步骤三 模型（3）
		模型（2.1）	模型（2.2）	
自变量	ca	lnC	lnwage	ca

常数项	C	12.138 (t=1.645) (p=0.110)	0.703*** (t=2.911) (p=0.006)	6.887*** (t=8.695) (p=0.000)	8.921 (t=0.342) (p=0.736)
社会保障	lnss	-2.910** (t=-2.572) (p=0.015)	0.095** (t=2.529) (p=0.016)	0.593*** (t=15.619) (p=0.000)	-1.015 (t=-0.719) (p=0.478)
中介变量	lnC				-8.379** (t=-2.257) (p=0.032)
	lnwage				-3.030 (t=-1.674) (p=0.105)
控制变量	lnDI		0.860*** (t=18.608) (p=0.000)		
	lnCPI			-0.164 (t=-0.957) (p=0.346)	
	nfa	0.416*** (t=6.684) (p=0.000)			0.506*** (t=7.376) (p=0.000)
	lnfinance	5.174** (t=2.463) (p=0.020)			1.082 (t=0.427) (p=0.672)
	slngdp	-1.112*** (t=-5.283) (p=0.003)			-1.594*** (t=-3.305) (p=0.002)
R^2		0.762	0.999	0.989	0.807
Adjust-R^2		0.732	0.999	0.988	0.767
F		24.871 (p=0.000)	11894 (p=0.000)	1486.10 (p=0.000)	20.168 (p=0.000)
残差的平稳性检验(c, t, d) (ADF)		(0,0,0) t=-4.678 (p=0.001)	(0,0,0) t=-3.754 (p=0.008)	(0,0,0) t=-5.914 (p=0.000)	(0,0,0) t=-4.571 (p=0.001)

注：***表示在1%置信水平下显著，**表示在5%置信水平下显著，*表示在10%置信水平下显著。

模型（1）回归结果为：

$$ca = 12.138 - 2.91 \times \ln ss + 0.416 \times nfa + 5.174 \times \ln finance - 1.112 \times s \ln gdp$$

回归结果显示，除了金融发展水平指标，其余变量均在1%的显著性水平下显著，R^2达到了0.762，模型解释力度较强。取对数后人均社会保障支出每增加1%,，将导致经常账户盈余比重收窄2.91%。社会保障支出对经常账户余额存在显著负相关关系，也即社会保障支出水平提高会显著收窄过高的经常账户盈余，验证本文提出的假设1，即社会保障与经常账户盈余之间是负相关关系成立。国外净资产符号也符合预期，外国净资产比重对经常账户盈余比重有显著的正向作用，净资产越高，可以享受到的净国外收益越高，收益流入经常账户余额，造成经常账户余额的增加。金融发展水平与经常账户盈余的系数为正，与预期不同，但该系数并不显著，这可能与我国资本市场发展偏倚于银行体系，银行信贷倚重投资，而居民和中小企业银行贷款或融资困难有关，基础货币并未投放到真正具有融资需求的地方。经济发展增速与经常账户盈余的系数为负，并且显著，经济发展增长速度越快，对进口产品的需求越高，从而减少经常账户盈余，反之亦成立。

模型（2-1）回归结果为：

$$\ln C = 0.703 + 0.095 \times \ln ss + 0.860 \times \ln DI$$

回归结果显示两个变量均在5%的显著性水平下显著， R^2达到了0.999。我国社会保障支出对居民消费的影响显著为正，人均社会保障支出每增加1%，人均消费将增加0.095%，这与其它实证研究在系数符号和系数大小方面相吻合。当然，人均可支配收入对消费水平的解释能力更强，人均可支配收入每增加1%，人均消费将增加0.86%。

模型（2-2）回归结果为：

$$\ln wage = 6.887 + 0.593 \times \ln ss - 0.164 \times \ln CPI$$

社会保障对工资水平存在正向影响，人均社会保障每增加1%会引资工人工资上涨0.585%。但是CPI对工资的影响系数仅为-0.164，并且不显著。一般而言，CPI与经济增长高度相关，CPI的系数为负说明工人工资的上涨并没有随着经济的高速发展而得到增长，工人工资水平受到抑制。

模型（3）的回归结果为：

$$ca = 8.921 - 8.379 \times \ln C - 3.030 \times \ln wage - 1.015 \times \ln ss + 0.506 \times nfa + 1.082 \times \ln finance - 1.594 \times s \ln gdp$$

回归结果显示，除了人均社会保障支出、制造业工人年平均工资和金融发展水平指标外，其余变量均在1%的显著性水平下显著， R^2达到了0.807，与模型（1）相比，加入消费水平和工人工资后，模型解释力度加强，侧面说明中介变量确实可以更好地解释经常账户失衡问题。控制变量系数符号与模型（1）保持一致，控制变量系数在数量级上与模型（1）无明显差异，模型稳定性较好。

2.4 中介效应检验

中介效应目前主要存在三种检验方法：(1)因果步骤法 (Judd&Kenny[11], 1981)，该方法来自Baron and Kenny[12](1986) 定义的中介过程；(2)系数乘积法（Sobel[13],1987）；(3)偏差校正的非参数百分位Bootstrapping。根据温忠麟[14]（2014）提出的中介效应检验流程，本质是将因果步骤法与系数乘积法相结合，先进行因果步骤法检验, 不显著才需要做Sobel检验。按照此流程，检验消费水平 C 的中介效应：(1)检验回归系数 c，确认通过显著性检验，社会保障显著作用于经常账户；(2)依次检验 a_1、b_1 均通过显著性检验，社会保障显著作用于消费水平，消费水平显著作用于经常账户；(3)检验系数 c'，未通过显著性检验，社会保障对经常账户的直接效应较弱。消费水平中介效应在总效用中所占比重为27.35%。同理，检验劳动力成本 $wage$ 的中介效应：(1)检验回归系数 c，确认通过显著性检验，社会保障显著作用于经常账户；(2)依次检验 a_2、b_2 有一个未通过显著性检验。社会保障显著作用于工人工资，工人工资并不显著作用于经常账户；(3)进行Sobel检验，构造检验统计量 $z = \dfrac{\widehat{a_2}\widehat{b_2}}{S_{a_2b_2}}$，$S_{a_2b_2}$ 是构造的 $\widehat{a_2}\widehat{b_2}$ 标准误近似公式，

$S_{a_2b_2}=\sqrt{\left(\widehat{a_2}S_{b_2}\right)^2+\left(\widehat{b_2}S_{a_2}\right)^2}$，其中$\widehat{a_2}$、$\widehat{b_2}$分别是$a_2$、$b_2$的估计值，$S_{a_2}$和$S_{b_2}$分别是$a_2$、$b_2$的标准误。根据实证结果求得：$|z|=1.665>1.646$，Sobel统计量在10%的显著性水平下通过检验，故劳动力成本*wage*是显著中介变量，劳动力成本中介效应在总效用中所占比重为61.75%。MacKinnon[15](2002)通过多次模拟比较对临界值表进行改进，以此修正$\widehat{a_2}\widehat{b_2}$服从正态分布的强假设并提高校验功效。该方法适用于样本较小情况。MacKinnon修正后临界值表中，显著性水平0. 05对应的临界值是0. 97而非1.96。此时，$|z|=1.665>0.97$，Sobel统计量在5%的显著性水平下通过检验。

传统Sobel检验是建立在$\widehat{a_2}\widehat{b_2}$服从正态分布假设上，该假设条件较强，在n=36样本条件下，传统Sobel检验具有局限性。Lau and Cheung[16](2010)认为Bootstrapping法是检验多重中介效应较好方法。因此我们采用Bootstrapping法替代Sobel检验劳动力价格*wage*的中介效应。重复1000次，得到a_2b_2置信区间为[-8.636，-1.188]，该置信区间不包括0，拒绝原假设，劳动力价格*wage*的中介效应显著。验证了假设2，即居民消费水平和劳动力市场在社会保障作用于经常账户盈余中存在中介效应成立。

表 5　　中介效应检验结果

中介变量	因果步骤法	系数乘积法	Bootstrapping法
消费水平	显著	显著	显著
劳动力价格	不显著	显著	显著

2.5 稳健性检验

关于模型（1）与模型（3），考虑增加控制变量的方法进行稳健性检验。加入的控制变量分别为：（1）政府财政盈余占GDP比重*deficit*。扩张性财政政策不仅加大政府支出，更有效刺激居民消费，减低储蓄，影响经常账户平衡，预期符号为负。数据来源世界银行。（2）人口抚养比*dependency*。人口抚养比用0-14岁少年和65岁以上老年人口之和与15-64岁劳动人口总和的比值衡量。少年与老年人只消费不储蓄，人口抚养比的上升将导致社会储蓄率下降，造成经常账户赤字，预期符号为负。数据来源世界银行。

关于模型（2-2），因为CPI对工人工资的解释力度不强，我们考虑改用控制变量工业增加值占GDP比重*industrial*。

最终回归结果如表6所示。

表6　　中介效应稳健性检验回归结果

检验程序	步骤一	步骤二		步骤三
	模型1	模型2.1	模型2.2	模型3

自变量		ca	lnC	lnwage	ca
常数项	C	17.935 (t=0.670) (p=0.508)	0.703*** (t=2.911) (p=0.006)	7.213*** (t=13.693) (p=0.000)	43.908 (t=1.099) (p=0.281)
社会保障	lnss	-2.828*** (t=-2.989) (p=0.006)	0.095** (t=2.529) (p=0.016)	0.544*** (t=56.756) (p=0.000)	-1.039* (t=-2.000) (p=0.056)
中介变量	lnC				-5.135* (t=-1.767) (p=0.086)
	lnwage				-3.629 (t=-1.650) (p=0.108)
控制变量	lnDI		0.860*** (t=18.608) (p=0.000)		
	Industrial			-0.027** (t=-2.062) (p=0.047)	
	deficit	-1.141*** (t=-3.660) (p=0.001)			-0.964** (t=-2.549) (p=0.017)
	dependency	0.001 (t=0.007) (p=0.994)			-0.086 (t=-0.426) (p=0.674)
	nfa	0.402*** (t=5.276) (p=0.000)			0.414*** (t=4.954) (p=0.000)
	lnfinance	4.259 (t=1.102) (p=0.279)			0.752 (t=0.158) (p=0.875)
	slngdp	-1.200*** (t=-6.319) (p=0.000)			-1.182** (t=-2.484) (p=0.020)
R^2		0.838	0.999	0.990	0.848
Adjust-R^2		0.804	0.999	0.989	0.803
F		24.957 (p=0.000)	11894.06 (p=0.000)	1633.965 (p=0.000)	18.791 (p=0.000)
残差的平稳性检验(c,t,d) (ADF)		(0,0,0) t=-5.228 (p=0.000)	(0,0,0) t=-3.754 (p=0.008)	(0,0,0) t=-5.914 (p=0.000)	(0,0,0) t=-5.134 (p=0.000)

回归结果显示主要结论并未发生显著变化，社会保障通过居民消费储蓄行为作用于经常账户的中介效应占比17.25%，社会保障通过劳动力市场作用于经常账户的中介效应占比69.80%，验证了假设3，即劳动力市场是社会保障作用于经常账户盈余的主要路径成立。

3. 社会保障对经常账户的门槛效应检验

本部分利用门槛效应模型检验社会保障对经常账户作用的发挥是否存在门槛值需要考量。 采用Hansen[17](2000) 提出的门槛模型。首先检验样本是否存在门槛效应。H_0表示没有门槛值，H_1表示存在一个门槛值。LM统计量：

$LM = n\dfrac{S_0 - S_n\left(\hat{\lambda}\right)}{S_n\left(\hat{\lambda}\right)}$ ，$\hat{\lambda}=\arg\min_{\lambda\in\Gamma_n} S_n\left(\lambda\right)$，其中$S_0$表示在$H_0$下的残差平方和加总，$S_n$表示$H_1$下的残差平方和加总。根据表7结果，LM=7.821，P=0.033<0.05，LM统计量在5%的显著性水平下拒绝原假设，故存在社会保障支出水平的门槛值，门槛值选择$\ln ss = 6.545$。

表7　　门槛效应检验结果

门槛变量	假设检验	Bootstrap LM值	不同显著水平临界值		
			90%	95%	99%
lnss	H_0：没有门槛值 H_1：有一个门槛值	7.821**	5.94	7.35	10.59

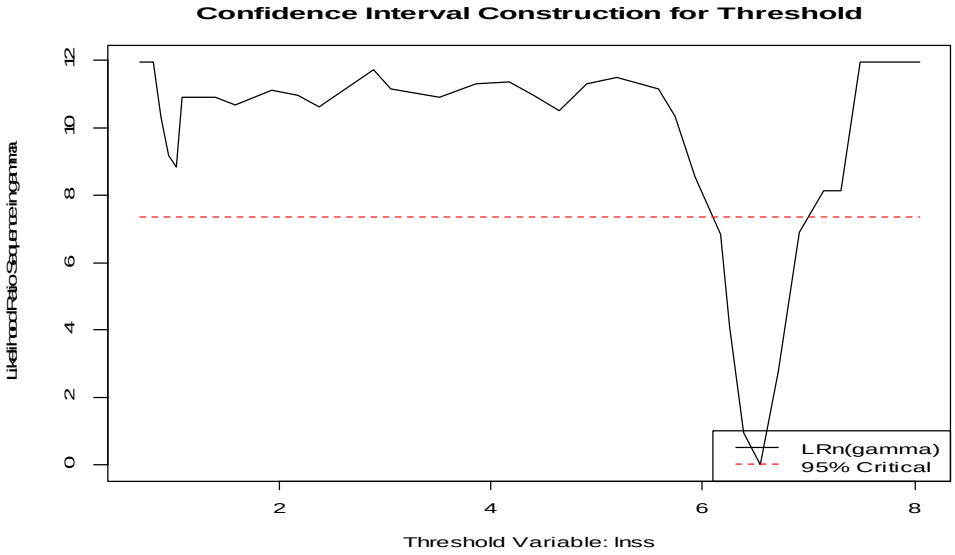


图2　　门槛效应模型残差平方和

门槛效应模型估计方程为：

$$ca = -1.123 + 0.634\ln ss, \qquad \ln ss \le 6.545$$
$$ca = 54.563 - 6.642\ln ss, \qquad \ln ss > 6.545$$

在门槛值$\ln ss = 6.545$的两侧，社会保障水平对经常账户影响的作用相反。当$\ln ss \le 6.545$，即$ss \le 695.76$时，估计系数为0.634，表示社会保障支出水平对经常账户盈余有微弱的促进作用；当$\ln ss > 6.545$，即$ss > 695.76$时，估计系数为-6.642，表示社会保障支出水平的提高可以平衡我国经常账户盈余。

4. 结论

本文的实证检验证实了3个假设：（1）社会保障与经常账户盈余之间是负相关关系；（2）居民消费水平和劳动力市场在社会保障作用于经常账户盈余中存

在中介效应；（3）劳动力市场是社会保障作用于经常账户盈余的主要路径。社会保障对经常账户失衡的影响主要分解为两部分，一部分是通过改善消费水平平衡经常账户失衡，这一部分所占效应为27.35%，第二部分是通过影响劳动力价格平衡经常账户失衡，这一部分所占效应为61.75%，显然社会保障通过劳动力市场再平衡经常账户所起的作用更大。同时门槛效应模型表明社会保障对经常账户作用的发挥存在门槛值需要考量，只有当高于一定水平时，人均社会保障支出才能起到平衡经常账户余额的作用。基于本文实证结果，我们提出两点政策建议：（1）社会保障筹资方面亟需实现新突破，社会保障筹资最根本出路在于协调好劳动力市场和社会保障制度的相互影响关系，在寻求两者发展平衡点的同时不断促进其改革发展。（2）提高社会保障规模，促进居民增加消费，升级劳动力，有助于经济增长模式从“投资驱动型”和“出口导向型”转型为“内需主导型”。

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社会保障与经常账户路径传导：消费和劳动力成本的中介效应

李庆霞 韩亦佳

李庆霞*
助理教授
厦门大学经济学院
厦门361005，中国
电话：(86) 13950006805
Email: liqx@xmu.edu.cn

韩亦佳
兴业证券股份有限公司研究所
上海200000，中国
电话:(86)18705925502
Email: 韩亦佳90@126.com

关键词:社会保障；经常账户；中介效应

中文摘要.社会保障影响经常账户的两条主要传导路径为：社会保障—居民消费储蓄行为—经常账户和社会保障—劳动力市场—经常账户。本文通过中介效应模型研究我国社会保障作用于经常账户路径传导的影响，即检验居民消费水平和劳动力价格中介效应存在性及中介效应强弱。结果显示，社会保障与经常账户盈余是负相关关系；居民消费水平和劳动力价格存在中介效应，社会保障通过居民消费储蓄行为作用于经常账户的中介效用占比27.35%，通过劳动力市场作用于经常账户的中介效用占比61.75%，社会保障通过劳动力市场再平衡经常账户所起作用更大。同时门槛效应模型检验显示，社会保障对经常账户作用的发挥存在门槛值需要考量，只有当社会保障支出高于一定水平时才能起到平衡经常账户余额作用。

The Risk hedging of Variable Annuity under the CPPI strategy

LU Jing, LI Siying

LU Jing*
Ph.D. Candidate
School of Insurance
Central University of Finance and Economics
Beijing 100081, China
Phone: (+86) 15120041469
Email: cufelujing@163.com

LI Siying
Pricing Actuary
Department of Pricing
PICC Life Insurance Company
Beijing 100020, China
Phone: (+86)15120040246
Email: Katerina1990@126.com

Keywords: Constant Proportion Portfolio Insurance(CPPI), Variable Annuity, Ruin Probability, Utility Maximization Theory

Abstract. On May 10, 2011, the China Insurance Regulatory Commission(CIRC) issued "The notice about developing variable annuity insurance" and “Interim management measures of the variable annuity insurance", decided to pilot run the VA in five cities of Beijing, Shanghai, Guangzhou, Shenzhen and Xiamen. The documents firstly officially indicated that China will start to introduce this new type of annuity. The characteristic of its minimum guaranteed benefit makes the risk of capital market declining transfer from the insured to the insurance company. The study links CPPI strategy with multi other aspects like ruin probability and utility maximization theory under the current market environment and regulatory requirements strategy. The results show that: when the ruin probability is no more than a fixed amount, as with the decrease of the risk sensitivity of investors and/or the increase of the investment multiplier’s lower limit, more assets can be invested to risky assets; when the utility is maximum, as with the decrease of guarantee payment, the required investment multiplier decreases gradually. At the same time, the yields of

flexible investment multiplier account and the fixed investment multiplier are higher than the market yield of Shanghai stock exchange, and the yields of flexible account is slightly higher than the fixed account. If transaction cost is not taken into consideration, the regular adjustment of investment positions will receive a higher rate of return than the fixed portfolios, which can be considered as the return to regular adjustment.

1. 引言

近半个世纪以来，变额年金在国外市场十分流行，变额年金在欧美市场是主流的年金产品。变额年金保险在美国市场，每年大约有一千七百亿美元的保费，约占人身保险市场的百分之二十。变额年金的优势在于，其特点较为契合养老产品的购买者的需求，即在保证所需要的一定给付的前提下（通过多种不同类型的最低保单利益保证来提供）仍与资本市场联系紧密，可以不过多落后于市场能提供的投资回报。由于变额年金兼顾养老、投资和抗通胀的特点，可以增加百姓对个人养老保险产品的热情。

2011年5月10日，中国保险监督管理委员会发布《关于开展变额年金保险试点的通知》和《变额年金保险管理暂行办法》，决定在北京、上海、广州、深圳、厦门等五大城市进行变额年金保险试点，正式表明国内将可以开始引入这一全新的年金类型。其试点五周年以来，我国变额年金市场仅有4款产品运行，且上述账户合计规模不到10亿元，但预期未来在商业养老保险市场会有持续的发展。在变额年金的发展中，关于变额年金保证部分风险的对冲将对变额年金的发展与管理具有重要意义。本文针对现有的市场环境以及监管要求，从多角度对变额年金最低利益保证风险的固定比例组合保险策略(CPPI策略，Constant Proportion Portfolio Insurance)进行分析，具有一定的现实意义。

2. 文献综述

相对于国内研究来说，国外的变额年金研究开始较早且更加深入。关于变额年金产品风险对冲的研究可以追溯到 20 世纪 70 年代。研究逐渐由借鉴期权定价公式 Black-Scholes 的思想发展为针对变额年金保障形式特点的风险对冲研究。综合近年来国外对于变额年金的风险对冲的研究，常见的方法主要有静态对冲，半静态对冲以及动态对冲方式。在股票收益率的考虑上也从最初的 Black-Scholes 模型框架进一步发展和引入了 Heston 模型进行考虑。

具体来讲，国外专家学者在此问题上得到以下结论。

Carr, Wu（2002）用一系列短期期权来进行静态对冲并利用蒙特卡洛模拟的方法来衡量对冲误差，模拟结果显示此误差与动态对冲方式效果相当。Ngai, Sherris（2011）利用长期债券以及其衍生品（远期）对长寿风险进行静态对冲。Wang（2009）使用“超级对冲”方法中的分位数对冲方法对变额年金中的最低死亡给付保证（GMDB）风险进行了推导。

Car（2001）推导了对于路径依赖型证券的半静态对冲以及对冲期权的选择。

MacKay（2011）研究利用 Heston 模型对股票指数进行模拟，进一步进行了风险对冲的研究。Liu（2010）在讨论半静态模型的风险对冲方法时，假设组合中各项资产的权重在用于进行对冲的期权的有效期里是一个常数，即仅在用于对

冲的短期期权到期时进行再平衡。Hardy M.（2003）利用动态对冲的方法，针对不同的保证额度以及产品期限计算了对冲的费用，并利用分位数法以及尾部条件期望（CTE）对风险进行了衡量。

变额年金在国内的起步较晚，国内对于变额年金风险对冲的研究尚处于起步阶段。由于《变额年金暂行管理办法和试点通知》中规定中国保监会认可的管理模式有：内部组合对冲模式和固定乘数平衡模式。国内的相关研究均围绕这两种方法来进行。

王旭和邱华龙（2011）介绍了最低保险利益保证的主要风险对冲模式，采用对比与归纳的方法对变额年金风险管理的模式以及原理进行了比较。顾聪，李晓和李胜宏（2012）认为内部组合对冲模式的主要问题是对冲机制可能无法弥补风险资产发生重大下行风险时带来的损失，而固定乘数平衡模式可能发生"账户集中"的风险。赵宇平、龚昊翔（2012）从精算实务的角度出发，采用内部组合对冲的方式对变额年金风险管理进行了实证研究。文章结果表明动态对冲可以显著降低各期损益以及累积损益的波动性。李冰清、廖朴（2012）对变额年金业务的风险采用了尾部期望与破产概率进行考虑，认为保险公司应分产品选择不同的最低保障收益率，并适当投资于股票份额。

本文在 CPPI 策略下，从公司层面考虑破产概率、效用函数的引入对变额年金风险对冲的影响，具体研究在满足一定破产概率条件下，各个因素对风险资产投资成数的影响，及在效用最大化条件限制下，分析保证比例、风险容忍度对投资乘数的影响。

3. 市场模型

BlackJones 与 Perold 给出了简单的投资公式固定比例组合保险策略(CPPI 策略, Constant Proportion Portfolio Insurance)，让投资人可以根据自身的风险承受能力以及对投资收益率的要求来调整投资组合。投资人通常根据自身的风险承受能力以及自身的风险偏好程度来选择参数，固定比例组合保险策略应用相对简单的公式来动态调整风险资产和无风险资产的比例，以达到投资人的要求。

首先定义以下指标：

$V(t_i)$ 表示账户在 t_i 时刻价值；

$R(t_i)$ 表示账户中风险资产在 t_i 时刻价值；

$RF(t_i)$ 表示账户中无风险资产在 t_i 时刻价值；

$G(t_i)$ 表示期初设定 t_i 时刻的保证给付；

ω 表示投资乘数，也叫风险乘数，乘数愈大风险偏好程度愈高，且 $\omega > 1$。若乘数 $\omega = 1$，那么组合保险策略就简化为买入持有策略。若乘数 $0 < \omega < 1$，并且最低保障额度为 0，那么资产组合保险策略就简化为固定组合策略；

$G(t_i)$与ω的设定要根据不同投资者的风险承受能力以及自身的风险偏好程度来设定；

$C(t_i)$表示期初设定t_i时刻的缓冲额度(Cushion)，$G(t_i)=V(t_i)-G(t_i)$；

在一定的投资乘数下和风险底线下，风险资产与无风险资产的比例即可以被决定，来其原理如下：

整个投资组合包括风险资产和无风险资产，即有：

$$V(t_i)=R(t_i)+RF(t_i) \tag{1}$$

在常见的固定比例组合保险策略中，在一段时间内t_i时刻的保证给付$G(t_i)$与投资乘数ω设定后通常不再改变。当经济环境或投资者的风险承受能力以及自身的风险偏好程度发生较大变化时才会改变。

t_i时刻的账户价值$V(t_i)$与t_i时刻的保证给付$G(t_i)$的差额为保护垫(也称缓冲额度)，CPPI 策略将相当于保护垫与投资乘数相乘的资金头寸投资于风险资产，其余投资于无风险资产。随着市场的变动总资产价值，t_i时刻的账户价值$V(t_i)$也随之变化，动态对风险资产和无风险资产的头寸进行调整。在整个保险期内任何时刻$V(t_i)$，要保证在t_i时刻的账户价值$V(t_i)$大于t_i时刻的保证给付$G(t_i)$，从而实现保险的目标。所以

风险资产目标头寸＝投资乘数×（帐户价值－价值底线）。即

$$R(t_i)=\omega\left(V(t_i)-G(t_i)\right) \tag{2}$$

其中ω表示投资乘数，$G(t_i)$表示在t_i时刻的保证给付。

CPPI 模型有如下基本假设：

（1）市场中不存在任何交易成本，不需要支付红利，无卖空限制及借贷限制，没有税收，交易是连续进行。

（2）风险资产的价格$S(t)$服从几何布朗运动，即有$S(t)$满足如下随机微分方程：

$$dS(t)=S(t)\left(\mu dt+\sigma dB(t)\right) \tag{3}$$

其中，μ和σ分别代表风险资产的瞬时收益率的漂移项和扩散项。$B(t)$代表现实概率测度下的布朗运动。

（3）无风险资产的价格$B(t)$服从无扩散项的几何布朗运动，即有$B(t)$满足如下随机微分方程：

$$dB(t)=rB(t)dt \tag{4}$$

其中r代表无风险利率，$B(t)$代表现实概率测度下的布朗运动。

（4）CPPI 是一个自融资的动态投资组合。

$$V(t_{i+1}) = R(t_i)\frac{S(t_{i+1})}{S(t_i)} + RF(t_i)\frac{B(t_{i+1})}{B(t_i)} \quad (5)$$

将(1)式代入（5）式则有：

$$V(t_{i+1}) = R(t_i)\frac{S(t_{i+1})}{S(t_i)} + \left(V(t_i) - R(t_i)\right)\frac{B(t_{i+1})}{B(t_i)} \quad (6)$$

将(2)式代入（6）式则有：

$$V(t_{i+1}) = \omega\left(V(t_i) - G(t_i)\right)\frac{S(t_{i+1})}{S(t_i)} + \left(V(t_i) - \omega\left(V(t_i) - G(t_i)\right)\right)\frac{B(t_{i+1})}{B(t_i)} \quad (7)$$

$V(t_{i+1})$代表账户在t_{i+1}时刻的价值。

4. 风险度量与管理

4.1 关于破产概率的考虑

在 CPPI 策略下，由于变额年金中保证价值的存在，保险公司面临风险。保险公司的风险是：在t_i时刻根据 CPPI 策略构建的资产组合在t_{i+1}时刻的账户价值小于保证价值，我们将这种情况定义为破产，即发生事件：$V(t_{i+1}) < G(t_{i+1})$

本文定义破产概率为：

$$\Pr\left(V(t_{i+1}) < G(t_{i+1}) \middle| V(t_0) = G(t_0)\right) = u \quad (8)$$

将(7)代入（8）则有：

$$\omega\left(V(t_i) - G(t_i)\right)\frac{S(t_{i+1})}{S(t_i)} + \left(V(t_i) - \omega\left(V(t_i) - G(t_i)\right)\right)\frac{B(t_{i+1})}{B(t_i)} < G(t_{i+1})$$

整理得：

$$\frac{S(t_{i+1})}{S(t_i)} < \frac{G(t_{i+1}) - \left(V(t_i) - \omega\left(V(t_i) - G(t_i)\right)\right)\frac{B(t_{i+1})}{B(t_i)}}{\omega\left(V(t_i) - G(t_i)\right)} \quad (9)$$

令$X_i = \frac{S(t_{i+1})}{S(t_i)}$，由于风险资产的价格$S(t)$服从几何布朗运动则有：

$$X_i \sim N\left(\mu - 0.5\sigma^2, \sigma^2\right) \quad (10)$$

再令$y = \frac{G(t_{i+1}) - \left(V(t_i) - \omega\left(V(t_i) - G(t_i)\right)\right)\frac{B(t_{i+1})}{B(t_i)}}{\omega\left(V(t_i) - G(t_i)\right)}$

将X_i，y代入(9)式，则破产概率$\Pr\left(V(t_{i+1}) < G(t_{i+1})\right) = \Phi\left(\frac{\ln y - \left(\mu - 0.5\sigma^2\right)}{\sigma}\right)$

若保监会规定或公司内部风险管理准则要求破产概率不超过 a，则有：

$$\Phi\left(\frac{\ln y-\left(\mu-0.5\sigma^2\right)}{\sigma}\right)\le a \quad \text{即} \quad \frac{\ln y-\left(\mu-0.5\sigma^2\right)}{\sigma}\le \Phi^{-1}(a)$$

整理有：

$$y\le \exp\left(\mu-\Phi^{-1}(a)\sigma-0.5\sigma^2\right) \tag{11}$$

将 y 代入(11)有：

$$G(t_{i+1})-\left(V(t_i)-\omega\left(V(t_i)-G(t_i)\right)\right)\frac{B(t_{i+1})}{B(t_i)}\le \exp\left(\mu-\Phi^{-1}(a)\sigma-0.5\sigma^2\right)\omega\left(V(t_i)-G(t_i)\right) \tag{12}$$

则在保证 $G(t_{i+1})-V(t_i)\ge 0$ 的前提下，整理(12)可得出 ω 的范围为：

$$\omega\ge\frac{G(t_{i+1})-V(t_i)e^r}{\left(V(t_i)-G(t_i)\right)\left(\exp\left(\mu-\Phi^{-1}(a)\sigma-0.5\sigma^2\right)-e^r\right)} \tag{13}$$

4.2 关于效用函数的考虑

效用函数是用来表示经济活动的决策者的效用与其财富之间的函数关系。我们用 $U(M)$ 来表示投资者的效用函数，其中，M 表示经济活动个人的财富数量，并假设 $M\ge 0$。

考虑到投保人购买保险的意图，多数是希望以确定的保费支出将未来不确定的损失转移或是获得一定的保值增值。本文假定投保人都是风险厌恶型 $(U'>0,U''<0)$，并且风险厌恶程度相对较强。所以我们选定以下形式的效用函数：

$$U(M)=aM-bM^2 \qquad (r\le b/2a) \tag{14}$$

则有：

$$E\left[U\left(V(t_{i+1})\right)\right]=E\left[aV(t_{i+1})-bV(t_{i+1})^2\right] \tag{15}$$

最大化效用则有：$MaxE\left[U\left(V(t_{i+1})\right)\right]=MaxE\left[aV(t_{i+1})-bV(t_{i+1})^2\right]$

将(7)式代入上式，在最大化效用函数时可以求得：

$$\omega=\frac{a-2bV(t_i)e^r}{b\left(V(t_i)-G(t_i)\right)e^{\mu-0.5\sigma^2}} \tag{16}$$

5. 结果分析

5.1 参数的敏感性分析

根据前述推导，首先考虑在最大化效用的情况下选取投资乘数时，效用函数的系数对投资乘数的敏感性。其次考虑在最大化效用的情况下选取投资乘数时，保证给付金额变动对投资乘数的影响。

5.1.1 效用函数中的常数b和投资乘数ω的关系

本文赋予使用的参数以下数值作为本部分的基础。根据参考文献[34]，我们假设$r=0.05$，$\mu=0.2156$，$\sigma=0.5$。

根据前述条件，我们假设效用函数中的常数$a=1$，账户价值$V(t_i)=1000$，保证价值$G(t_i)=900$。效用函数中的常数b和投资乘数ω的数值关系如表1所示。

表1 效用函数系数对投资乘数影响

b	0.00045	0.000444	0.000438	0.000432	0.000426	0.00042	0.000414
ω	1.09	1.37	1.65	1.94	2.24	2.54	2.86
b	0.000408	0.000402	0.000396	0.00039	0.000384	0.000378	0.000372
ω	3.18	3.52	3.86	4.22	4.58	4.96	5.35
b	0.000366	0.00036	0.000354	0.000348	0.000342	0.000336	0.00033
ω	5.75	6.17	6.60	7.04	7.50	7.98	8.47
b	0.000324	0.000318	0.000312				
ω	8.99	9.52	10.07				

由表1数据可知，随着常数b的逐渐减小，投资乘数ω逐渐增大，且增大的幅度逐渐减小。即随着投资者风险敏感性的减小，投资乘数ω可以逐渐增大，更多的资产可投资于风险资产部分，这符合常理。

5.1.2 保证给付G和投资乘数ω的关系

本文赋予使用的参数以下数值作为本部分的基础。根据参考文献[34]，我们假设$r=0.05$，$\mu=0.2156$，$\sigma=0.5$。

根据前述条件，我们假设效用函数中的常数$a=1$，常数$b=0.000414$，账户价值$V(t_i)=1000$。保证给付G和投资乘数ω的数值关系如表2所示。

表2 最低保证给付金额对投资乘数影响

G	950	925	900	875	850	825	800
ω	5.72	3.81	2.86	2.29	1.91	1.63	1.43
G	775	750	725	700	675	650	625
ω	1.27	1.14	1.04	0.95	0.88	0.82	0.76

由表2数据可知，随着保证给付G的逐渐减小，投资乘数ω逐渐减小，且减小的幅度逐渐减小。即随着保证给付G的减小，出于最大化效用的考虑，要求的投资乘数ω逐渐减小。可以认为当保证给付比较低的时候，要求保证的投资收益也比较小。由于投资者是风险厌恶的，所以在满足效用最大化的原则下，随着保证给付G的逐渐减小，投资乘数ω逐渐减小。

5.2 结果分析

根据前述推导，考虑在最大化效用的情况下选取投资乘数时，比较ω固定不变时与ω变动时收益率的异同。

本文赋予使用的参数以下数值作为本部分的基础。根据参考文献[34]，我们假设$r=0.05$，$\mu=0.2156$，$\sigma=0.5$。

根据前述条件，我们假设账户价值$V(t_i)=1000$，保证价值$G(t_i)=900$。假设效用函数中的常数$a=1$，常数$b=0.000414$。以上证指数模拟风险资产变动，每周针对市场状况对投资乘数ω进行调整。即每周依据（16）式重新选择投资乘数ω，并保证此时的投资乘数ω能满足不破产。变动ω收益率，大盘收益率和固定ω收益率的对比关系如表 3 及图 1 所示。

表3　投资收益率比较

时期	上证指数	ω	变动ω收益率	大盘收益率	固定ω收益率
1	1236.97	4.55			
2	1254.61	4.15	0.65%	1.43%	0.44%
3	1245.87	4.33	-0.23%	-0.70%	-0.13%
4	1377.04	2.35	4.39%	10.53%	2.91%
5	1341.91	2.62	-0.73%	-2.55%	-0.86%
6	1373.01	2.35	0.82%	2.32%	0.82%
7	1317.58	2.80	-1.19%	-4.04%	-1.37%
8	1333.71	2.63	0.47%	1.22%	0.43%
9	1344.58	2.53	0.32%	0.82%	0.32%
10	1324.87	2.70	-0.41%	-1.47%	-0.42%
11	1349.79	2.47	0.68%	1.88%	0.64%
12	1319.81	2.72	-0.63%	-2.22%	-0.66%
13	1258.83	3.39	-1.45%	-4.62%	-1.33%
14	1270.34	3.23	0.39%	0.91%	0.30%
15	1213.39	4.11	-1.52%	-4.48%	-1.11%
16	1243.74	3.54	1.03%	2.50%	0.63%
17	1224.65	3.85	-0.50%	-1.53%	-0.30%
18	1409.51	1.70	5.74%	15.09%	3.51%
19	1415.33	1.67	0.17%	0.41%	0.20%
20	1423.7	1.62	0.21%	0.59%	0.26%
21	1379.38	1.81	-0.68%	-3.11%	-1.02%
22	1380.28	1.79	0.08%	0.07%	0.08%
23	1368.8	1.84	-0.15%	-0.83%	-0.20%
24	1353.48	1.92	-0.22%	-1.12%	-0.28%
25	1340.22	1.98	-0.19%	-0.98%	-0.22%
26	1347.16	1.93	0.20%	0.52%	0.21%
27	1366.18	1.82	0.43%	1.41%	0.46%
28	1362.15	1.83	-0.01%	-0.29%	-0.03%
29	1323.13	2.04	-0.66%	-2.86%	-0.77%
30	1302.62	2.16	-0.35%	-1.55%	-0.34%
31	1304.92	2.14	0.11%	0.18%	0.11%
32	1243.74	2.59	-1.21%	-4.69%	-1.11%

33	1237.36	2.65	-0.09%	-0.51%	-0.04%
34	1219.43	2.82	-0.38%	-1.45%	-0.23%
35	1246.8	2.53	0.76%	2.24%	0.51%
36	1218.36	2.80	-0.61%	-2.28%	-0.41%
37	1174.82	3.33	-1.04%	-3.57%	-0.62%
38	1133.17	4.03	-1.12%	-3.55%	-0.53%
39	1132.93	4.04	0.05%	-0.02%	0.07%
40	1136.25	3.96	0.16%	0.29%	0.12%
41	1141.52	3.85	0.22%	0.46%	0.14%
42	1159.43	3.52	0.60%	1.57%	0.31%
43	1084.88	5.13	-2.09%	-6.43%	-0.95%
44	1124.33	4.01	1.45%	3.64%	0.53%
45	1194.72	2.80	2.24%	6.26%	0.95%
46	1203.32	2.70	0.28%	0.72%	0.19%
47	1190.46	2.83	-0.25%	-1.07%	-0.11%
48	1204.7	2.66	0.42%	1.20%	0.27%
49	1192.99	2.78	-0.22%	-0.97%	-0.09%
50	1223.41	2.46	0.81%	2.55%	0.49%
51	1178.15	2.89	-0.95%	-3.70%	-0.59%
52	1179.23	2.87	0.09%	0.09%	0.09%
53	1187.64	2.77	0.27%	0.71%	0.18%
54	1215.17	2.47	0.73%	2.32%	0.44%
55	1217.92	2.44	0.12%	0.23%	0.11%
56	1306.51	1.76	2.02%	7.27%	1.32%
57	1274.61	1.92	-0.48%	-2.44%	-0.45%
58	1250.68	2.06	-0.37%	-1.88%	-0.30%
59	1251.31	2.05	0.08%	0.05%	0.08%
60	1275.86	1.88	0.54%	1.96%	0.43%
61	1292.69	1.78	0.37%	1.32%	0.32%
62	1300.49	1.73	0.20%	0.60%	0.19%
63	1249.17	1.99	-0.79%	-3.95%	-0.74%
64	1273.56	1.83	0.52%	1.95%	0.42%
65	1231.94	2.07	-0.66%	-3.27%	-0.54%
66	1214.55	2.18	-0.27%	-1.41%	-0.16%
67	1232.08	2.04	0.42%	1.44%	0.30%
68	1251.09	1.91	0.43%	1.54%	0.33%
69	1232.15	2.02	-0.27%	-1.51%	-0.19%
70	1213.15	2.14	-0.29%	-1.54%	-0.18%
71	1240.07	1.94	0.59%	2.22%	0.42%
72	1222.2	2.04	-0.26%	-1.44%	-0.17%
73	1197.99	2.20	-0.39%	-1.98%	-0.24%
74	1177.3	2.36	-0.35%	-1.73%	-0.18%
75	1199.81	2.16	0.54%	1.91%	0.34%
76	1177.83	2.32	-0.36%	-1.83%	-0.19%
77	1152.36	2.54	-0.46%	-2.16%	-0.22%
78	1141.14	2.64	-0.18%	-0.97%	-0.05%
79	1116.55	2.91	-0.49%	-2.15%	-0.19%
80	1151.78	2.49	0.91%	3.16%	0.43%
81	1120.36	2.81	-0.61%	-2.73%	-0.26%

82	1130.46	2.68	0.30%	0.90%	0.18%
83	1123.48	2.75	-0.09%	-0.62%	0.01%
84	1108.03	2.93	-0.29%	-1.38%	-0.08%
85	1095.94	3.08	-0.22%	-1.09%	-0.04%
86	1147.59	2.43	1.33%	4.71%	0.56%
87	1168.51	2.23	0.50%	1.82%	0.29%
88	1164.43	2.25	-0.01%	-0.35%	0.03%
89	1184.67	2.08	0.46%	1.74%	0.29%
90	1195.44	2.00	0.27%	0.91%	0.19%
91	1199.25	1.96	0.14%	0.32%	0.12%

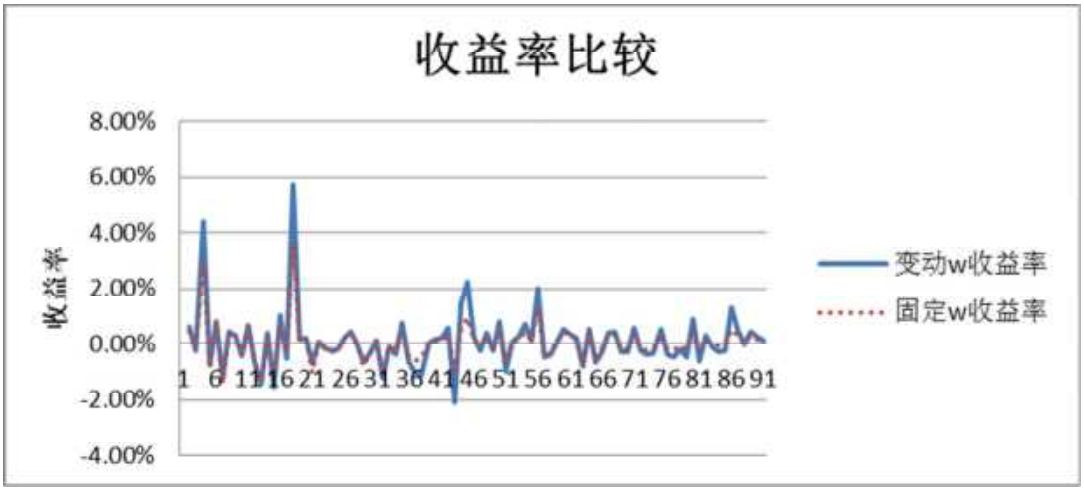


图1　收益率比较

由表 3 及图 1 可知，变动ω的账户收益率和固定ω的账户收益率均好于大盘收益率。同时变动ω的账户收益率较固定ω的账户收益率略好。

6. 结论

本文在 CPPI 策略的模型基础上引入破产概率和效用函数。具体来说，本文在效用最大化限制下考虑投资乘数的选择，并同时考虑在此情况下破产概率。根据本文的分析，可以得到以下结论:

在满足破产概率低于某个固定值的前提下，随着投资者风险敏感性的减小，投资乘数ω的下限逐渐增大，更多的资产可投资于风险资产部分；随着保证给付G的减小，出于最大化效用的考虑，要求的投资乘数ω逐渐减小。可以认为当保证给付比较低的时候，要求保证的投资收益也比较小。那么，保险公司开发、经营变额年金时，需明确其自身的风险偏好类型及风险容忍度大小，以更加准确、合适的进行变额年金产品的风险对冲。

变动ω的账户收益率和固定ω的账户收益率均好于证券交易所大盘收益率。同时变动ω的账户收益率较固定ω的账户收益率略好。在不考虑交易成本的前提

下，定期调整投资头寸将获得比固定投资组合的账户更高的收益率，可以算是对定期调整的回报。

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基于CPPI策略的变额年金风险对冲研究

陆静　李思嬴

陆静*
博士研究生
中央财经大学保险学院
北京100081，中国
电话: (+86) 15120041469
Email: cufelujing@163.com

李思嬴
定价精算师
中国人保寿险公司产品部
北京100020，中国
电话: (+86)15120040246
Email: Katerina1990@126.com

关键词: 固定比例组合保险策略；变额年金；破产概率；效用最大化

中文摘要. 2011年5月10日，中国保险监督管理委员会发布《关于开展变额年金保险试点的通知》和《变额年金保险管理暂行办法》，决定在北京、上海、广州、深圳、厦门等五大城市进行变额年金保险试点，正式表明国内将可以开始引入这一全新的年金类型。变额年金产品具有给付投保人最低保证的特点，使资本市场下行风险从投保人转移到保险公司。本文在固定比例组合保险策略（即CPPI策略）下，引入破产概率和效用函数来研究变额年金产品的风险管理。结果表明在给定破产概率最大值条件下，随着投资者风险敏感度的降低，投资乘数 的下限逐渐增加，更多的资产可投资于风险资产部分；在效用最大化目标下，随着保证给付的降低，要求的投资乘数 也逐渐减小。定期变动投资乘数ω的账户收益率较固定投资乘数 的账户收益率略好。

Discussion on the Improvement of Enterprise Annuity's Tax Policy under EET Tax System----Take Beijing as an Example

SHI Xiaoyu

School of Insurance
Central University of Finance and Economics
Beijing 102206, China
Phone: (86) 18810712627
Email: sxytroy@163.com

Keywords: Enterprise Annuity; Tax-deferred; Tax-preferences; System Perfection.

Abstract. Tax-deferred policy can improve the development of the enterprise annuity. EET system which is the key to stimulate the development has great advantages. Based on the current situation of the enterprise in Beijing and the problems during the implementation process, this article analyses fundamental reasons and doable solutions from the practice and theory research. The possible plan can be divided in to two parts, the principle of the policy and supporting system, which may help to perfect current EET system.

1. 引言

随着我国老龄化人口总体比例的上升，社会养老压力日益严峻。目前，我国的养老体系主要由三支柱构成，分别是社会基本养老保险，企业补充养老保险和个人商业养老保险。而作为第二支柱主体的企业年金，发展速度与覆盖范围仍然较为有限。截至2015年上半年，建立了企业年金的企业个数为7.55 万个，参与

企业年金的职工人数为2316万人，积累基金仅9526 亿元。[1] 与其他国家相比，我国企业年金发展仍处于较低水平。2013年12月6日，财政部、人力资源和社会保障部、国家税务总局联合发布了《关于企业年金、职业年金个人所得税有关问题的通知（财税[2013]103号，以下简称103号文）》，规定自 2014年 1 月 1 日起，符合规定的年金，在年金缴费环节和年金基金投资收益环节暂不征收个人所得税，将纳税义务递延到个人实际领取年金的环节。企业年金通过延迟缴纳个人所得税的方式，激励企业和职工参与企业年金计划。以此达到发挥社会保障体系第二支柱作用，补充社会基本养老保险，提高个人退休时期消费能力的目标。该税收模式也被称为EET模式，其中T为部分纳税或全部纳税，E为减免纳税。

本文的研究重点是，根据北京地区数据，主要针对EET税收模式中税收优惠比例存在的问题进行研究，并针对原因提出相关建议，为EET税收制度的进一步完善提供建议。

2. 文献综述

关于企业年金相关的国外研究主要集中在以下内容：在Fenge R, Werding M(2004)等人的研究中，讨论了内生增长模型中经济增长与国家政策的关系。在隔离变量的基础上，得到适当的政府政策对经济增长有显著影响，经济增长与税收政策之间存在较弱的负相关性的结论。Roseveare D, Leibfritz W, Fore D, et al（1996））则从金融的角度分析认为，企业年金税收优惠政策本质上是国家降低财政税收收入，提高财政支出水平，来降低企业年金参与者的的纳税义务，补贴参加企业年金计划的企业和个人。Davis E. P(2001)指出，产业结构和养老保险制度等诸多因素对企业年金税收优惠政策和企业年金规模有很大的影响，两者的关系很复杂，税收政策优惠幅度大并不一定必然促进企业年金的发展。Ferraresi P M, Fornero E.（2011）等国外学者则从国家利益与企业年金税收优惠关系的角度进行研究。一是以分配公平目标进行研究，通过税收调节收入分配不均的程度，减少收入分配不公平，是最大化福利的必要条件；二是以经济增长目标进行研究，政府实行最佳的税收优惠政策，能够引导和刺激企业和员工增加储蓄和投资。世界银行报告(2004)指出，应建立三支柱养老保险制度模式，其中包括公共养老保险、企业年金计划和个人储蓄计划。同时说明中国正面临着极好机会实现支付养老保险制度积累制的过人中国政府应该增大税收优惠力度，大力发展健全养老保障体制。

随着企业年金制度在中国的迅速发展，相关税收优惠政策的出台，引发了一批学者对纳税递延型企业年金的研究。刘云龙等（2002）指出非税惠政策的社会经济成本远大于实行税收优惠政策造成的财政减少的损失。郑秉文（2010）指出税收优惠政策的不完整和不统一制约了我国企业年金的整体发展。赵倩（2014）

[1]数据来源人力资源社会保障部基金监督司《2015年度全国企业年金基金业务数据摘要》

根据发达国家经验，指出我国现行税收优惠政策优惠比例仍然存在不足。潘慧（2014）基于生命周期理论，在分析小拥挤的基础上得出了模拟的税收递延优惠政策的最优税收优惠幅度。夏茜（2014）在借鉴发达国家经验的基础上，对完善我国企业年金税收制度提出了建议：结合国情、完善法规、加强监管、梯度设置、避免漏洞。汪丽萍（2015）通过精算模型进行模拟，发现：税惠政策能够促进企业年金发展使得覆盖率增加且成本收益比会稳定。

综上所述，国外对于纳税递延型账户的研究主要集中于政策对于家庭财富和宏观经济的影响。我国研究指出目前企业年金税收模式存在问题，社会效用没有达到最优，但是以定性研究为主；所以本文通过量化模型，以中国的经济环境和纳税政策，模拟测算不同情形下EET模式企业年金经济效应具有一定意义，并且可以针对量化结果提出改进方案。

3. 理论模型与赋值模拟

3.1 最优幅度模型——计算个税递延型企业年金最优税收优惠幅度

自2014年1我国落定实行EET模式的企业年金税收优惠政策。所谓EET的税收模式，是指个体在前期购买企业年金时支付的保费可以免除个人所得税，同时在投资阶段获得投资收益同样免除个人所得税，最终在保费列支阶段收取个人所得税的模式。这种模式的实施通过税收的调节，进而影响个人在工作期间和退休期间的消费和一系列资产规划安排。EET模式的影响可以从两方面来看：个人角度，税收的递延增加了工作期和退休期的消费水平，因此具有正面的效用；政府角度，由于只在最后列支养老金的阶段收取个人所得税，因此政府的税收收入会相应减少，产生负面的效应。从这两方面来看，现行规定并不能确保社会整体效用最大化。因此，寻找一个最优的税收幅度，从而使得总体效用最大化是确保新税收制度顺利实施的重要问题。

为了解决这个问题，本文通过建立协调个人效用和税收效用的最优优惠幅度模型，用税收杠杆δ（实施EET之后居民效用的增加值与政府税收的减少值之比）来衡量税收的总体效用，并取使得税收杠杆最大时的比率为最优幅度，在这个幅度下税收杠杆作用发挥最大化，即可以在政府税收成本尽量小的情况下使得居民效用增加最大化。

3.1.1 模型构建

（1）变量假设。

表1. 变量假设表

变量	符号	说明
个体当下平均年龄	n	假设的投保开始年限
当年平均工资收入	w	
平均每年工资上涨幅度	α	假设工资以固定速度上涨

退休年龄	t	投保停止并开始领取保险金时间
寿命中止年龄	d	保险金领取终止年限
贴现率	β	
储蓄率	s	
投资收益	r	
投保阶段个税税率、投资阶段个人投资所得税率、退休阶段个税税率	t_1、t_2、t_3	根据我国个人所得税累进税率计算
保费占储蓄的比值	γ	

（2）递延型税收优惠政策实施后个人效用变化情况。企业年金EET税收模式实施后，个体在退休期间收入由个体购买的企业年金后可以领取的保险金和工作期间的储蓄及收益构成，本模型直接用个体在退休期间的收入贴现到当前年龄的值来表示个人的效用，有如下等式：

$$U_1=\sum_{i=1}^{t-n}\frac{sw\ (1+\alpha)^{i-1}(1-t_1)(1+r)^i(1-\gamma)-sw\ (1+\alpha)^{i-1}(1-t_1)(1-\gamma)\ [\ (1+r)^i-1]t_2}{(1+\beta)^i} \tag{1}$$

$$U_2=\sum_{i=1}^{t-n}\frac{\gamma sw\ (1+\alpha)^{i-1}(1+r)^i}{(1+\beta)^i} \tag{2}$$

$$U_{after}=U_1+U_2 \tag{3}$$

U_{after} 是政策实施后的个人效用，U_1 为工作期间储蓄以及投资收益所产生的效用，U_2 为购买企业年金后在退休期的效用。

在EET的税收模式实施之前，个体并不会选择参与企业年金计划从而购买企业年金，因此个体在退休期间的收入仅包括个体在工作期间的储蓄，如下式：

$$U_{before}=\sum_{i=1}^{t-n}\frac{sw\ (1+\alpha)^{i-1}(1-t_1)(1+r)^i-sw\ (1+\alpha)^{i-1}(1-t_1)\ [\ (1+r)^i-1]t_2}{(1+\beta)^i} \tag{4}$$

由此可得，实施税收递延型企业年金政策后个人退休期间的效用增加值为：

$$U=U_{after}-U_{before} \tag{5}$$

（3）延型税收优惠政策实施后政府税收效用变化情况。EET模式下，政府在年金缴纳和年金投资阶段没有税收收入，而仅在保险金列支阶段进行征税，此时政府税收收入如下：

$$T_1=\sum_{i=1}^{t-n}\frac{(w-\gamma sw)(1+\alpha)^{i-1}t_1+sw(1+\alpha)^{i-1}(1-t_1)(1-\gamma)[(1+r)^i-1]t_2}{(1+\beta)^i}$$

$$T_2=\sum_{i=t-n}^{d-n}\frac{\sum_{i=1}^{t-n}sw(1+\alpha)^{i-1}\gamma(1+r)^i}{\frac{d-t}{(1+\beta)^i}} \quad (6) \quad (7)$$

$$T_{after}=T_1+T_2 \quad (8)$$

T_{after} 是实施EET后政府税收，T_1 是工作阶段工资交税时政府的税收，T_2 是保险金列支过程中政府的税收。

在实施EET模式之前政府的税收如下：

$$T_{before}=\sum_{i=1}^{t-n}\frac{w(1+\alpha)^{n-1}t_1+sw(1+\alpha)^{n-1}(1-t_1)[(1+r)^i-1]t_2}{(1+\beta)^i} \quad (9)$$

由此可得，实施税收递延型企业年金政策后政府的税收效用减少值为：

$$T=T_{after}-T_{before} \quad (10)$$

（4）税收杠杆。税收优惠政策的作用模式是：通过改变征税的时间和税率，吸引个人选择加入企业年金计划并购买企业年金，进而影响个人在退休期间的收入构成从而改变对于个人的效用。然而，这种个人效益的改善同时也减少了政府的税收，给政府造成了税收损失。本模型采用税收杠杆δ来衡量这两种影响的相对大小：

$$\delta=\frac{U}{T}=\frac{U_{after}-U_{before}}{T_{after}-T_{before}} \quad (11)$$

当税收杠杆达到最大时，即个税递延型政策实施之后，在政府财政税收减少一定的情况下使得个人在退休期的效用增加最大化的情况。这种情况下的保险金占工资的比例就是我们要寻找的优惠比率，也是使得社会总体效用最大化的税率。

3.1.2. 数值计算

北京市作为企业年金EET税收制度先行实施的城市之一，具有一定的参考意义。因此，本文选取北京市为例，根据北京市的各个变量的实际值并对部分变量进行合理假设代入模型进行计算，最终得出了养老金列支阶段的最优优惠比率。

（1）变量赋值。

表2. 变量赋值表

变量	实际值	说明
w	77560元	北京市月平均收入6463元[2]
n	40岁	可能加入企业年金计划的个人平均年龄
t	60岁	平均退休时间
d	80岁	根据北京居民平均寿命[3]
s	20%	2014年居民储蓄率为20%左右，为方便计算取整[4]
α	3%	根据实际情况假设
β	3%	将中国人民银行最新公布的一年期存款利率确定为贴现率
r	5%	将中国保险年鉴公布的保险资金年收益率确定为年金投资收益率
t_1、t_2、t_3	5%、20%、4%	根据个人平均月收入和我国七级超额累进税率和个人所得税率税法规定的投资收入税率值得出。为简化计算，根据大数定理规定工资征税税率为5%，养老金领取阶段税率为工资税率的0.8，即4%。

（2）计算结果。为了计算得出最优税率，我们在2%-20%之间以0.5个百分点为间隔构造一系列递延税率，运用北京市的实际数据以及合理假设的数据，对政策实施前后个人在退休阶段的收入和政府的税收收入进行合理贴现后求得变化量，最终求比值得出不同优惠比率下的税收杠杆率，结果如下表：

表3.最优税率表

优惠幅度（保费在工资中的占比 ）	保费在储蓄中的占比	税延后可支配收入增加额现值	税延后政府税收收入减少额现值	税收杠杆
2%	10.0%	7267.37	8474.324	0.85757
2.5%	12.5%	9084.21	8527.537	1.06528
3%	15.0%	10901.1	9032.368	1.20688

[2] 根据北京市统计局、人力社保局发布2014年北京市职工平均工资
[3] 根据2014年《北京市健康白皮书》数据
[4] 根据国家统计局数据

3.5%	17.5%	12717.9	9088.382	1.39935
4%	20.0%	14534.7	9652.418	1.50581
4.5%	22.5%	16351.6	9711.544	1.68372
5%	25.0%	18168.4	10345.42	1.75618
5.5%	27.5%	19985.3	10408.02	1.92018
6%	30.0%	21802.1	11125.04	1.95973
6.5%	32.5%	23619	11191.55	2.11042
7%	35.0%	25435.8	12008.61	2.11813
7.5%	37.5%	27252.6	12079.56	2.25609
8%	40.0%	29069.5	13018.4	2.23295
8.5%	42.5%	30886.3	13094.42	2.35873
9%	45.0%	32703.2	14183.55	2.30571
9.5%	47.5%	34520	14265.42	2.31983
10%	50.0%	36336.9	15542.89	2.33784
10.5%	52.5%	38153.7	15631.58	2.34080
11%	55.0%	39970.5	17149.38	2.33072
11.5%	57.5%	41787.4	17246.14	2.223
12%	60.0%	43604.2	19077.18	2.28567
12.5%	62.5%	45421.1	19183.6	2.34770
13%	65.0%	47237.9	21433.37	2.20394
13.5%	67.5%	49054.8	21551.62	2.27615
14%	70.0%	50871.6	24378.6	2.08673
14.5%	72.5%	52688.4	24511.64	2.14952
15%	75.0%	54505.3	28165.34	1.93519
15.5%	77.5%	56322.1	28317.37	1.98896
16%	80.0%	58139	33214.31	1.75041
16.5%	82.5%	59955.8	33391.69	1.79553
17%	85.0%	61772.7	40282.88	1.53347
17.5%	87.5%	63589.5	40495.73	1.57027
18%	90.0%	65406.3	50885.73	1.28535
18.5%	92.5%	67223.2	51151.8	1.31419
19%	95.0%	69040	68557.16	1.00704
19.5%	97.5%	70856.9	68911.91	1.02822
20%	100.0%	72673.7	103900	0.69945

通过表3可以很直观看出：在当前精确度下并且储蓄率一定即20%时，当优惠幅度为8.5%时即个人拿出工资的8.5%参与企业年金计划，税收杠杆率达到最大值2.359，税收的调节效用最大化，此时优惠税率政策的实施效果最好。

3.2 马太效应模型

3.2.1. 模型构建

将模型1进行变形，即选择现行规定的税收优惠幅度4%固定不变，变化居民平均收入，以此来探究税收递延型企业年金制度对于不同年收入的人群的不同影响，并代入模型1中的（1）、（2）、（3）、（4）式及下式：

$$U = U_{after} - U_{before} \tag{12}$$

计算得出不同收入人群因为EET政策的实施而产生的退休期收入贴现值的增加额并寻找具有的一般性规律。

3.2.2. 数据模拟

以10000元为间隔划分年收入30000-500000元为一系列数据，代入模型后计算结果和折线图如下：

表4. 税延政策对不同收入水平个人效用影响表

[1]	w	[2]	U	[3]	U/w
[4]	30000	[5]	3505.95	[6]	0.1169
[7]	40000	[8]	5182.31	[9]	0.1296
[10]	50000	[11]	7323.98	[12]	0.1465
[13]	60000	[14]	9824.71	[15]	0.1637
[16]	70000	[17]	12670.75	[18]	0.1810
[19]	80000	[20]	15862.11	[21]	0.1983
[22]	90000	[23]	19398.77	[24]	0.2155
[25]	100000	[26]	23280.75	[27]	0.2328
[28]	200000	[29]	81092.61	[30]	0.4055
[31]	300000	[32]	173435.60	[33]	0.5781
[34]	400000	[35]	300309.72	[36]	0.7508
[37]	500000	[38]	461714.95	[39]	0.9234

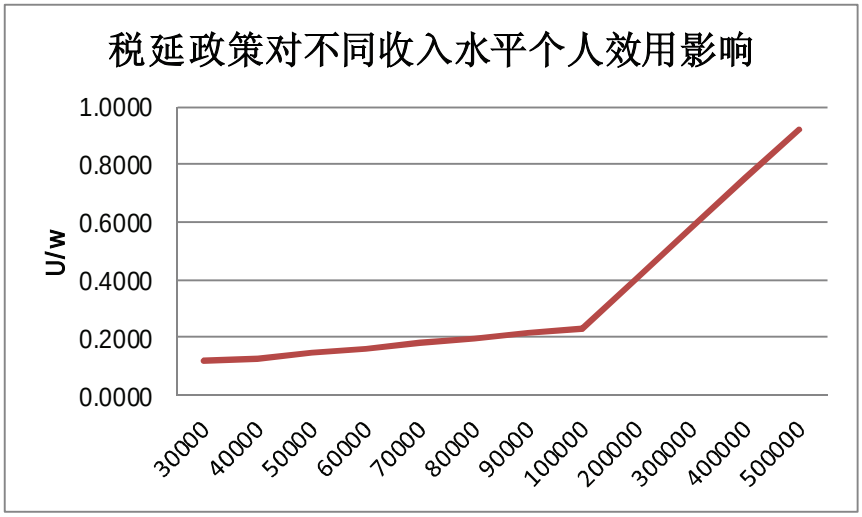


图1. 税延政策对不同收入水平个人效用影响

由图1可得，随着平均收入的上升，U/w的值不断上升，意味着税收递延政策对于年收入越高的人群越有利。在不考虑计算误差的条件下，说明税收递延政策具有马太效应，即“富人越富，穷人越穷”的效应。

为避免EET模式的马太效应对于社会福利公平的负面影响，在制度正式推行之前有《国务院关于机关事业单工作人员企业年金制度改革的决定》（国发[2015]2号）规定“个人工资超过当地上年度在岗职工平均工资300%以上的部分，不计入个人缴费工资基数”，但是由于该《决定》只规定了上限但没有顾及低收入人群以及我国收入差距较大的特殊国情，因此还需要更加合适的制度规定来避免EET的马太效应对社会公平的影响。

4. 研究结果

本文根据中国企业年金现行税收制度，针对《关于企业年金、职业年金个人所得税有关问题的通知（财税[2013]103号）》政策的提出，根据精算模型，测算了企业年金EET模式的税收杠杆效应和由于不同收入造成的“马太效应”，从而深入研究了企业年金税收优惠政策的经济效应，为政策的改善提供依据。研究发现：

1.根据前述“最优幅度模型”计算得出的结果表明，EET模式造成的个人在退休期收入的增加值相对于EET模式导致的政府税收的减少值的比值作为判断效应最优的标准的模型下，将该比值最大化时得出的优惠幅度为8.5%，即免税缴费部分占工资的最优百分比应为8.5%，这个比例大于三部委发布的通知中规定的

4%。该结果在忽略计算误差的基础上说明现行规定的优惠比率并不恰当，需要改进。

2. 根据前述“马太效应模型”计算得出的结果表明，随着平均收入的上升，实际免税额与个人年收入的比值不断上升，即税收递延政策对于年收入越高的人群越有利。在不考虑计算误差的条件下，说明个税递延的税收政策具有马太效应，即“富的愈富，贫的愈贫”效应。我国现阶段已经存在较为明显的养老水平不等，而随着政策实施时间的增加，马太效应会将养老水平差距进一步拉大，最终造成不同收入水平在享受养老福利时更大的差异。

考虑到我国与发达国家居民之间的收入差距，现行的4%优惠比例仍然较低，在制定企业年金相关细则的过程中需要进一步进行详细核算调整税率，加大税收杠杆效应，提高居民养老水平，降低国家养老压力。同时，可以针对不同人群实施差异化的税收优惠机制，在政策中对享受优惠政策的对象进行细分：对于高收入人群，实施税收优惠返还机制，在超过一定金额后，税收优惠逐渐降低，直至完全退出；对于低收入者，实施直接补贴机制，补偿因为养老金增长而多缴付的税费，通过差异化的税收优惠机制可以有效避免“马太效应”，缩小养老水平差距较大的问题。

需要说明的是，在税收杠杆的测算中，本文未考虑由于实行税收优惠政策，政府效应中未列入政府在养老保障方面财政支出的减少，并且在考虑不同阶段税收的比例时用的都是较为普遍的税率，未完全按照分级税率，后续研究可以考虑在这两方面细化。

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EET税制下企业年金税收制度的完善——以北京市为例

施潇宇

中央财经大学保险学院
北京102206，中国
电话：(86) 18810712627
Email: sxytroy@163.com

关键词：企业年金　个税递延　税收优惠　制度完善

中文摘要. 个税递延型的企业年金税收政策能够促进我国企业年金的快速发展，EET模式作为激励企业年金发展的中枢，具有一定的制度优势。本文基于针对北京市企业年金发展的现状以及EET税收模式在实施过程中面临的问题，从实践研究与理论研究的角度，分析EET模式产生问题的原因，从税收优惠制度的原则本身以及配套制度的两方面提出可能的方案，为EET税收制度的进一步完善提出建议。

A Research on Serious Illness Medical Insurance Spending and the Long-Term Equilibrium of Medical Insurance Fund as a Case Study of Beijing

WANG Yan

School of Insurance
Central university of finance and economics
Beijing 102206, China
Phone: 18811386100
Email: wangyan19960890@163.com

Keywords: Serious illness medical insurance; Time series model; A malignant tumor

Abstract.

The urban and rural residents who suffer from a serious illness are easy to bear the high health care costs,which is easy to cause a problem of "poverty due to illness".”A guidance about carrying out the work of a serious illness insurance for urban and rural residents″ was released in 2012 to clearly established the system of a serious illness insurance, however, the complexity of the disease brings difficult problems to the establishment and complement of the serious illness insurance system ,and the possibility of medical insurance fund long-term equilibrium is worth thinking about.

Around because of the level of economic development, health care and technology, medical treatment of a serious illness insurance planning as a whole level is relatively low at present, in this paper,taking Beijing as an example,we will apply the research method of the mathematical model, respectively, to find the Beijing medical expenses and medical insurance fund balance of a serious illness, and then we will analyze the gap between them.

First of all, from the beginning of the health care expenditures of a serious illness, a mathematic model of the costs of serious illness will be established, and then combining the relevant concrete data,we will find the change of Beijing health care expenditures of a serious illness.

Basic of the mathematical model of serious illness costs :

(1) A serious illness expenditure mainly comes from the malignant tumor,we will find the major spending according to the treatment of malignant tumor and malignant tumor incidence.

(2) Serious spending changes over time,influenced by the proportion of total population, ginseng, ageing, inflation rate, the degree of medical technology improvement, the proportion of disease and etc.

(3) Because the undertaking way of serious illness insurance is to adopt like this way ,the government tender select undertaking commercial insurance institutions, determine the way of reimbursement, expenditure of a serious illness insurance company must be considered in the process of the calculation of reasonable profit margins.

Medical insurance fund is based on the break-even equilibrium for a long time.A serious illness care fund is from basic urban residents health insurance funds,and new rural cooperative medical system (NCMS), and urban and rural residents pay no extra fee. In addition, the medical insurance fund will be balanced according to payments situation of region to realize the region as a whole.

To simplify the fund earnings, we will find the fund situation of inference statistics in the future according to the historical data of Beijing medical insurance fund balance situation, through the establishment of time series model, realize regression analysis.

Combining the above two mathematical model, according to the situation and the trend analysis of income and expenses of fund of medical treatment of a serious illness insurance medical insurance fund to analyze the possibility of a long-term equilibrium, and then we will give suggestions for perfecting the medical security system of a serious illness.

To achieve the medical insurance fund long-term equilibrium, there are two major aspects of solving measures, one is to reduce the medical expenses of a serious illness, and the second is to increase the medical insurance fund. Reduce medical expenses of a serious illness is mainly from the Angle of the lower the risk of moral hazard, avoiding the waste of medical resources, and increase the medical insurance fund is mainly from the perspective of tax breaks and increasing funding sources to expand the scale of medical insurance fund.

1.引言

截止 2014 年，三项基本医保合计覆盖超 13 亿人，覆盖率达 96.9%，但“因病致贫”、“因病反困”问题一直是社会热点问题，其原因是最高支付限额的规定使得巨额的医疗支出无法通过基本医疗保险进行分摊。2012 年 8 月，六部委发布《关于开展城乡居民大病保险工作的指导意见》，针对城镇居民医保、新农合参保（合）人大病负担重的情况，引入市场机制，建立大病保险制度，减轻城乡居民的大病负担。大病保险作为商业保险与社会保障的结合，其大病基金的长期均衡值得探索。大病基金收支现状是否可以达到其长期均衡以及如何实现大病基金的长期均衡是本文的研究目的。

2012 年发布的《关于开展城乡居民大病保险工作的指导意见》中，在保障范围方面明确了“大病保险主要在参保（合）人患大病发生高额医疗费用的情况下，对城镇居民医保、新农合补偿后需个人负担的合规医疗费用给予保障。高额医疗费用，可以个人年度累计负担的合规医疗费用超过当地统计部门公布的上一年度城镇居民年人均可支配收入、农村居民年人均纯收入为判定标准,具体金额由地方政府确定”。大病医疗保险实现的是区域管理，全国统筹的管理办法，在模型具体测算中以地方为研究主体更具有现实意义。北京市作为全国一线城市，大病保险相对完善，具有研究大病医疗保险收支长期性平衡的条件。

结合北京市大病保险等具体政策条例，通过采用建立数学模型的研究方法确定北京市大病保险费用支出以及大病基金结余金额，分析两者的缺口，并为北京市大病基金实现长期均衡提供建议。

2.大病医疗保险支出测算模型

测算模型的主要思路为,以恶性肿瘤为主要研究对象，测算出北京市恶性肿瘤费用支出，通过一定的比例测算出北京市大病医疗费用支出后，扣除基本医疗保险、商业保险的补充和个人自付的费用，即为大病医疗保险支出。

2.1 说明

2014 年北京市发布的《关于做好城镇居民大病保险工作的通知》规定，参保人员享受当年城镇居民基本医疗保险待遇后，个人自付医疗费用(已享受民政部门医疗救助金额做相应扣减)超过上一年度本市城镇居民人均可支配收入的部分，纳入大病保险支付范围。“大病”的内涵复杂，包含的疾病种类较多，选取恶性肿瘤为研究对象不仅能够简化模型，也具有一定的代表性。据 36 个城市和 78 个农村县死因统计，2008 年城市居民前十位死因顺位：恶性肿瘤、心脏病、脑血管病、呼吸系病、损伤及中毒、内分泌营养和代谢疾病、消化系病、泌尿生殖系病、神经系病、精神障碍，前十位死因合计占死亡总数的 92.4%。其中，《中国卫生统计年鉴》公布了 30 种疾病平均住院医疗费用，可以发现保障病种主要

集中在急性心肌梗死、冠状动脉搭桥、脑出血和各种恶性肿瘤上。2007 年大病保险支付范围内恶性肿瘤医疗费用占大病医疗费用的 69. 7%，2008 年为 67. 27%， 2009 年为 66. 7%，可见，恶性肿瘤在大病保险费用支付中占比较大，以恶性肿瘤为研究对象具有代表性和研究价值。

2.2 模型内容

$$Ppmt = l \times p \times q \times apmt$$

其中，$Ppmt$ 为隐性支付费用，指北京市所有参保人发生的所有恶性肿瘤医疗费用。l 为参保人数。p 为患病率，指患恶性肿瘤的概率。q：就诊率，指患有恶性肿瘤的人参与检查与治疗的概率。$apmt$：个人检查治疗恶性肿瘤的平均费用。

$$Apmt = Ppmt - bmt - cmt - sf + epmt$$

其中，$Apmt$ 为实际支付费用，指北京市大病基金实际支付的费用。bmt 为基本医疗保险承担的支付费用。cmt 为商业医疗保险承担的支付费用。sf 为个人自担的医疗费用。$epmt$ 为大病基金运行过程中的成本及商业保险公司的必要的利润。大病保险利用市场机制，由政府组织管理，商业保险机构承办。

$$epmt = (pc + pfit) * Apmt$$

其中 pc 为大病基金运行成本率。$pfit$ 为商业保险机构的利润率。

$$PMT = \frac{Apmt}{r}$$

其中 PMT 为北京市大病基金总支出。r 为恶性肿瘤医疗支出在大病保险支出中的比例。

3.大病医疗保险支出测算

3.1 参保人数

根据北京市统计局、国家统计局北京调查总队联合发布的 2010 年人口普查资料显示，北京常住人口为 2170.5 万人，其中外来常住人口为 822.6 万人，占常住人口的 37.9%。北京市卫生局发布的消息显示，北京市基本医疗保险的覆盖率达 96%以上，几乎所有北京市民都享受到了包括城镇居民医疗保险、城镇职工医疗保险等基本医疗保险。下图为国家统计局发布的北京市户籍人口数量的变动。

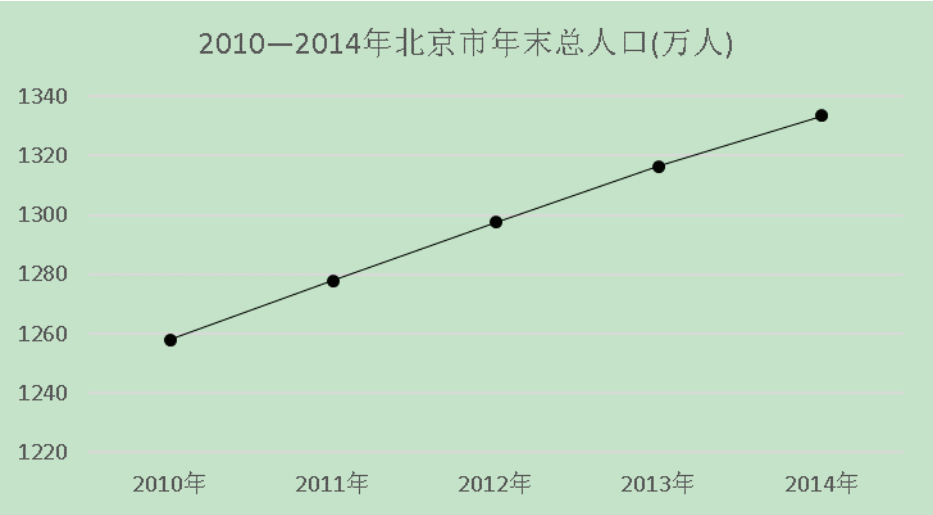


图 1　2010-2014 年北京市年末总人口

由于人口基数较大和人口流动继续，预计未来一段时间内北京市常住人口会继续增加，但增加速度和增加量有限，为简化计算，以某一年为基期计算大病基金收支缺口。

3.2 患病率

根据北京市肿瘤防治研究所 2012 年发布的数据显示，2009 年北京市户籍居民恶性肿瘤粗发病率 297.04/10 万，中国标准人口标化发病率（中标率）为 135.86/10 万，世界标准人口标化发病率（世标率）为 175.17/10 万，粗发病率比 2008 年（280.56/10 万）增长 5.87%，2005-2009 年世标发病率的年平均增长率（APC）为 3.05%。表 1 为北京市 2009 年各区县主要恶性肿瘤发病情况。

表 1. 北京市 2009 年各区县主要恶性肿瘤发病情况（/10 万）

区县	粗发病率	中标率	几种恶性肿瘤发病率				
			肺	乳腺	结直肠	肝	胃
昌平	315.51	165.71	65.50	39.80	31.69	23.77	19.32
朝阳	373.74	158.41	74.45	41.80	44.42	26.11	24.03
崇文	345.91	134.84	75.74	41.15	39.36	21.77	22.07
大兴	270.32	145.71	57.63	29.66	24.24	19.15	19.66
东城	294.11	116.79	60.34	34.69	30.98	20.65	17.75
房山	242.49	123.55	56.25	26.62	24.14	22.32	14.62
丰台	384.00	160.81	77.15	39.68	45.81	26.55	24.25
海淀	256.24	129.54	49.31	33.60	28.34	16.47	17.78
怀柔	242.11	116.42	48.64	21.98	24.14	23.78	14.05
门头沟	303.55	132.41	79.90	23.89	25.54	21.42	17.30
密云	208.27	105.85	39.66	16.93	21.11	23.66	19.25
平谷	211.60	107.18	49.06	18.62	21.89	19.37	12.08
石景山	379.84	152.42	92.94	39.35	43.54	23.44	25.96

顺义	228.63	115.56	52.25	28.82	20.31	18.58	11.63
通州	276.07	137.72	49.82	39.86	24.68	21.15	17.17
西城	299.80	123.96	52.17	36.17	34.78	17.52	18.28
宣武	335.83	128.13	62.15	41.93	38.56	21.53	21.53
延庆	209.30	102.29	53.48	17.47	21.39	18.13	8.20

北京市流动人口较多，为简化运算，结合北京市户籍人口数量变动，北京市2014年恶性肿瘤发病人数约为26400人。

3.3 就诊率

根据《国家第四次卫生服务调查报告》关于被调查地区需住院而未住院与自己要求出院及其具体原因情况的调查方案对北京市相关问题进行研究，可据此得出恶性肿瘤患者由于没有必要、无有效措施或经济困难等原因直接放弃治疗占患病人数的比例，及住院医治的患者由于经济困难和花费太多等原因从特殊需求向普通需求、从较高级别向较低级别的转变比例。其基本形式如表2所示。

表2. 被调查地区需住院而未住院与自己要求出院及其具体原因占比

	具体原因	占比（%）		具体原因	占比（%）
	没有必要	10.7		久病不愈	7.9
	无有效措施	4.1		自认为病愈	27.6
需住院而未住院	经济困难	70.3	自己要求出院	经济困难	35.3
(占总患病人数)	无时间	7.7	(占总出院人数) 36.8%	花费太多	19.2
25.1%	医院服务差	0.1		医院条件差	0.8
	无床位	0.8		其他原因	11.3
	其他原因	6.3			

根据北京市卫生计生委和北京市中医管理局2014年发布的《北京市深化城乡医院对口支援工作实施方案》，方案要求至2015年末，北京将通过城乡医院对口支援，提高医院综合服务能力和服务水平，使区域内就诊率提高到90%.以2014年为研究时点，假设北京市2014年恶性肿瘤就诊率约为85%.则，北京市2014年恶性肿瘤就诊患者约为22400人。

3.3 个人医疗及恶性肿瘤平均费用

根据北京市公共卫生信息中心、北京市医院管理研究所发布的数据，2011-2015年全市部分医疗机构门诊及住院病人人均费用情况如表3所示，

2014-2015 年北京市市二级以上公立医院门诊和住院病人人均医药费用以及我国恶性肿瘤患病医疗费用如表 4、5 所示。

表 3. 2011-2015 年北京市部分医疗机构门诊及住院病人人均费用情况

项目	2011	2012	2013	2014	2015
门诊病人人均医疗费(元)					
#政府办综合医院	365.7	384.4	403.4	418.6	438.9
其中：三级	447.2	456.9	447.6	448.5	467.6
二级	263.0	287.4	305.8	327.5	346.1
一级	168.1	195.8	219.2	169.3	183.6
社区卫生服务中心	138.1	153.9	155.3	174.4	195.9
住院病人人均医疗费用（元）					
#政府办综合医院	16550.6	17494.7	18099.6	18616.2	19789.0
其中：三级	19764.2	20557.3	19510.8	19499.9	20706.0
二级	11011.7	11748.2	13233.7	14339.8	14895.9
一级	5360.8	6797.9	5603.5	3988.4	4120.0
社区卫生服务中心	3940.1	4849.0	5433.9	6106.4	7342.9

注：本表统计范围不包括驻京部队医院和武警医院

表 4. 2014-2015 年北京市市二级以上公立医院门诊和住院病人人均医药费用

项 目	公立医院		民营医院			
			三级医院		二级医院	
	2015	2014	2015	2014	2015	2014
门诊病人次均医药费用(元)	436.9	413.7	462.8	443.7	339.9	319.1
门诊费用上涨(%)	3.8	3.5	2.5	1.4	4.6	5.6
住院病人人均医药费用(元)	20513.4	19241.8	21255.3	20100.5	15974.6	14884.8
住院费用上涨(%)	4.7	2.4	3.9	0.1	5.4	9.6

表 5. 我国恶性肿瘤患病医疗费用 (单位: 元)

诊疗项目	医疗费用	诊疗项目	医疗费用
术前和术后检查费	5 000—10 000	术后化疗	25 000—35 000
手术费	5 000—10 000	普通药物药费	10 000—20 000
住院费	1 500	特效药物药费	21 000—350 000

3.4 非大病保险承担费用

根据北京市人力资源和社会保障局 2014 年 3 月发布的《关于做好城镇居民大病保险工作的通知》，参保人员享受当年城镇居民基本医疗保险待遇后，个人

自付医疗费用(已享受民政部门医疗救助金额做相应扣减)超过上一年度本市城镇居民人均可支配收入(以北京市统计局公开发布的数据为准)的部分，纳入大病保险支付范围。

《北京市城镇居民基本医疗保险办法实施细则》规定，基本医疗保险统筹基金支付的起付标准按上一年本市职工平均工资的 10%左右确定。个人在一个年度内第二次以及以后住院发生的医疗费用，基本医疗保险统筹基金支付的起付标准按上一年本市职工平均工资的 5%左右确定。基本医疗保险统筹基金在一个年度内支付职工和退休人员的医疗费用累计最高支付限额按上一年本市职工平均工资的 4 倍左右确定。退休人员个人支付比例为职工支付比例的 60%。如表 6 为北京市基本医疗保险报销比例。

表 6 北京市基本医疗保险报销比例

	一级医院		二级医院		三级医院	
	在职	退休	在职	退休	在职	退休
起付标准—30000	90%	97%	87%	96.1%	85%	95.5%
30000—40000	95%	98.5%	92%	97.1%	90%	97%
40000—封顶线	97%	99.1%	97%	99.1%	95%	98.5%

个人自付的医疗费用包括，城镇居民基本医疗保险基金起付标准以下的医疗费用；城镇居民基本医疗保险基金起付标准以上至最高支付限额以下按照比例应当由个人负担的医疗费用；检查、治疗项目中使用大型医用设备及单项费用在 200 元(含)以上应当由个人先行负担的医疗费用；基本医疗保险诊疗项目目录、医疗服务设施范围中的乙类应当由个人先行负担的医疗费用；《北京市基本医疗保险、工伤保险和生育保险药品目录》中的乙类药品应当由个人先行负担的医疗费用；城镇居民基本医疗保险基金最高支付限额以上参照城镇居民基本医疗保险基金支付规定可纳入报销范围的医疗费用。此外，根据北京市大病统筹基金支付标准，2000 元以上 5000 元以上的部分支付 90%；5000 元以上 1 万元以下的部分支付 85%；1 万元以上 3 万元以下的部分支付 80%；4. 3 万元以上 5 万元以下的部分支付 85%；5. 5 万元以上的部分支付 90%.个人还需支付另外的部分。

商业医疗保险所占份额较小，在一般在医疗费用很大时发生实际赔付，此处为简化模型计算忽略极端值，也及不考虑商业保险承担的医疗费用。

根据北京市统计局发布的北京市人民生活基本情况（1978-2014 年）数据，选取北京市 2010 至 2014 年城镇居民家庭基本情况与农村家庭基本情况如表 7 所示。

表 7 2010—2014 年北京市人民生活基本情况

城镇居民家庭基本情况	农村居民家庭基本情况

年份	人均家庭总收入（元）	人均可支配收入（元）	人均家庭可支配收入实际增长（%）	城镇居民人均住房建筑面积（平方米）	人均纯收入（元）	人均纯收入实际增长（%）	人均总支出（元）
2010	33360	29073	6.2	28.9	13262	8.1	12805
2011	37124	32903	7.2	29.4	14736	7.6	14503
2012	41103	36469	7.3	29.3	16476	8.2	15196
2013	45274	40321	7.1	31.3	18337	7.7	16994
2014	49730	43910	7.2	31.5	20226	8.6	18011

则，北京市 2015 年基本医疗保险与大病保险所依据上一年度本市城镇居民人均可支配收入为 43910 元。

3.5 大病基金运行过程中的成本及商业保险公司的必要的利润

大病基金运行过程中的成本及商业保险公司的必要的利润通过简化为大病基金的一定比例计算。

结合已知恶性肿瘤医疗支出在大病保险支出中的比例约为 68%，即 r=68%.可以求得最终大病保险支付费用，约为 42 亿。

4. 大病基金资金来源

根据《北京市城乡居民大病保险试行办法》，大病保险实行全市统筹，建立大病保险基金，大病保险基金由城镇居民基本医疗保险基金按照当年筹资标准 5%的额度划拨，纳入社会保障基金财政专户，单独核算，专款专用。大病保险基金结余时，转移至下一年度用于大病保险支出，累积结余达到当年应筹资额度的 50%时，由市人力资源和社会保障局会同市财政局适当降低下一年度大病保险基金划拨比例。

北京市人力资源与社会保障局发布的《2014 年度北京市社会保险事业发展情况报告》显示 2014 年全年城镇职工基本医疗保险基金收入 682.7 亿元，城镇居民基本医疗保险基金收入 20.3 亿元。根据《北京市城乡居民大病保险试行办法》，大病保险基金约为 35.52 亿。

5. 大病基金缺口分析

由上述，大病保险基金年支付费用约为 42 亿，大病保险基金收入约为 36 亿每年，存在一个约为 6 亿的缺口。这其中可能是由于计算的偏差，但不可否认，大病保险基金确实存在一定的风险，由于大病保险资金是从城镇居民医疗保险基金、城镇职工医疗保险基金、新农合基金中划出，不再额外增加群众个人缴费负担，假设在已有医疗保险基金数量适当的情况下，大病保险基金的结余本身就是一个问题。另外大病保险基金的运行建立在已有的基本保险基金之上，其运行程

序适应能力较强，大病保险支出可以快速达成预定的效果，但大病保险基金的均衡应用则还需要经办时间和经验的积累，并且大病保险基金的收入与基本医疗保险的运行密切相关。

6. 大病基金长期均衡及政策建议

6.1 减少医疗资源浪费

医疗资源的浪费现象较为普遍，一方面由于某些医院的机制问题，形成了开高价药的风气。另一方面，随着医疗保险制度的完善，正在逐渐走向“免费医疗”的保险制度，可能造成更加严重的医疗资源的浪费，必须在完善医疗保险制度的同时，改善和发展医疗资源的监督管理机制。

一方面从医疗资源供给方入手，监督管理医疗资源的使用情况，另一方面，对于医疗资源的使用方，可以进行必要的卫生药物教育，强化对于过度医疗的理解，只有双管齐下，才能达到医疗资源的合理利用。

除了医疗资源的利用之外，医保基金的使用也要建立在合理定价的医疗资源上，免费医疗可能造成医疗资源定价的非市场化，医药制作商的定价可能由于潜在的政府购买远大于其内在价值，造成医保基金的浪费。

6.2 扩宽大病基金来源

目前大病基金完全来源于已有的医保基金，不对个人造成另外的负担，不变的收入与变动的支出，必然会造成大病基金缺口的风险。除此之外，通货膨胀、老龄化、二胎政策等不断变化的社会现象和政策都会增加大病基金的风险。必须鼓励个人、企业承担风险，另外适度划拨财政基金，以拓宽大病基金收入渠道。

6.3 建立合理医保机制

除上述以外，可以建立一套合理使用大病基金的医疗保险机制，使得大病基金成为保障医疗水平和家庭经济水平的最后一道屏障，而不是最大的保护伞。使得个人为最大化其效用，必须使用各类医疗保险进行风险分摊。

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以北京市为例研究大病医疗保障支出以及医保基金长期均衡的可能性

王妍

中央财经大学保险学院
北京102206，中国
电话:18811386100
Email:wangyan19960890@163.com

关键词: 大病医疗保险；时间序列模型；恶性肿瘤

中文摘要:

城乡居民由于患大病发生的高额医疗费用很容易使得居民因为疾病问题陷入经济困境，造成“因病致贫、因病返贫"的问题。2012 年发布的《关于开展城乡居民大病保险工作的指导意见》明确建立了大病保险制度，然而疾病的复杂性给大病保险的制度建立与完善带来了棘手的问题，医保基金长期均衡的可能性值得深思。

由于各地经济发展状况、医疗保障水平与技术的差异，目前大病医疗保险统筹层次相对较低，本文以北京市为例，采用建立数学模型的研究方法分别确定北京市大病医疗费用支出以及医保基金结余金额，分析两者的缺口。

首先，从大病医疗保障支出开始，建立大病支出费用的数学模型，并结合北京市相关的具体数据确定北京市变化的大病医疗保障支出。

大病支出费用的数学模型建立基础：

（1）大病支出主要来自于恶性肿瘤，依据恶性肿瘤的治疗费用及恶性肿瘤发病率确定大病支出。

（2）大病支出随时间变化，受到人口总量、参保比例、老龄化、通货膨胀率、医疗技术完善程度、疾病发病比例的影响。

（3）由于大病保险的承办方式采用政府部门招标选定承办的商业保险机构，

确定报销的方式，大病支出的计算过程中必须考虑保险公司的合理利润率。

医保基金长期均衡建立在收支相抵的基础之上，大病医保的资金来源于城镇居民医保基金、新农合基金，城乡居民不再额外交费。此外，医保基金根据收支情况实现地区统筹。

为简化基金收入情况，根据北京市医保基金结余情况的历史数据，通过建立时间序列模型，实现回归分析进而推断统计未来的基金状况。

结合上述两个数学模型，根据基金的收支状况及其趋势分析大病医疗保险下的医保基金长期均衡的可能性，并为大病医疗保障制度的完善提出建议。

要实现医保基金长期均衡，主要有两方面的解决措施，减少大病医疗支出以及增加医保基金筹集。减少大病医疗支出主要从降低道德风险的角度，避免医疗资源的浪费，增加医保基金筹集主要从税收优惠和增加资金来源角度，扩大医保基金规模。

Optimal Retirement Age Estimation and Delay Retirement Policy Recommendationsbased on both the Maximization of Individual Utility and the Balance of Pension

YAO Tangxinxin

Central University of Finance and Economics
Beijing 102206, China
Phone: 18811386277

Email: cufeinsyaotxx@yahoo.com

Keywords: optimal retirement age, actuarial model, pension and social security.

Abstract. With the aging problem becoming more serious and life expectancy increasing, the balance of pension has drawn great attention and therefore postponed retirement is imperative. Nevertheless, policy makers need to take personal willingness into consideration to carry out the policy smoothly. Based on the current situation, this paper focuses on establishing two actuarial models to calculate optimal retirement age, which can provide practical recommendations for implementation of the postponed retirement policy. The paper firstly demonstrates the necessity of delaying retirement from the perspective of both government and individual. Then, the paper establishes the optimal retirement age actuarial model based on the maximization of individual utility and the actuarial model of the optimal retirement age based on the balance of pension payments in the medium and short term to calculate optimal retirement age from two aspects. Based on two models, the paper analyzes the differences between the results of

the actuarial models. Finally, the paper puts forward some reasonable policy recommendations and draws a conclusion.

1. Introduction

The current retirement age standard of China is developed in the 1980s.The retirement age of male workers is 60 and that of female cadres and female workers are 55 and 50. However when making this policy, the average life expectancy of China's population is only about 50 years old. With the economic and social development, people's living standards are increased. In the meantime, medical conditions have been greatly improved. Nowadays, China's average life expectancy has increased to 74.8 years old, reaching the level of moderately developed countries. Based on the historical data,since 2013 the working-age population began to decline. If we still be in accordance with the original formulation of the retirement age to manage the labor retirement population, for a period of time in the future we may face labor shortage problem. In the context of the aging population, the current legal retirement age cannot adapt the need of this development situation. With life expectancy increasing and the implementation of the one-child policy, the amount of labor supply has been decreased, making the number of people who pay the pension decreased. Therefore, pension fund gap appeared and there is an increasing trend in it. Based on these reasons, delay retirement has become a kind of inevitable trend.

As for the whole society, delay retirement is a very necessary measure. However, for many individual labors, delaying the retirement age means the increase of working years and the decrease of pension receiving. If we do not consider changes in other factors, it may be hard for workers to accept, which might hinder the implementation of the policy. In order to smooth the implementation of the delay retirement policy, we need to take both personal willingness and balance of pension payments into consideration, determining a suitable retirement plan. Therefore, the paper establishes the optimal retirement age actuarial model based on the maximization of individual utility and the actuarial model of the optimal retirement age based on the balance of pension payments in the medium and short term to calculate optimal retirement age from two aspects and puts forward some reasonable policy recommendations to make sure the delay retirement policy carrying out smoothly.

2. The Necessity of Raising the Retirement Age

2.1 Governmental perspective

2.1.1 Aging population

According to the census of China and other sample data, we can understand that in recent years China's population structure and age structure. The fact is that the aging problem in China is becoming more and more severe based on social reality. Then the paper will show some data to illustrate this problem.

From table1, we can see that population aged 0 to 14 accounts for the proportion of the total population is declining, felling from 27.7% in 1990 to 16.4% in 2013. In the meantime, population aged 65 and above is rising gradually, from 5.6% in 1990 to 9.7% in 2013.

Table 1. Population composition by age.

Proportion	Year						
	1990	2000	2005	2010	2011	2012	2013
Population aged 0 to 14	27.7%	22.9%	20.3%	16.6%	16.5%	16.5%	16.4%
Population aged 15 to 64	66.7%	70.1%	72.0%	74.5%	74.4%	74.1%	73.9%
Population aged 65 and above	5.6%	7.0%	7.7%	8.9%	9.1%	9.4%	9.7%

Data resource: National Bureau of Statistics of the People's Republic of China

According to the international classification of the types of population standards, if the elderly population coefficient is more than 7%, the community has stepped into the aging. Based on this standard, China has entered an aging country. The fact is that the increase of the elderly population coefficient is more than 0.3% per year. These data indicate that the population of our country is gradually aging and the aging rate is accelerating in recent 20 years. If this situation cannot be effectively controlled and resolved, the aging will lead to a series of problems such as pension problem and etc. Thus the problem of aging population is urgent and needs our key consideration to effectively solve it in order to alleviate the aging problem in China and to maintain social harmony and stability.

2.2.2 Pension balance

According to historical conditions, China's pension fund revenue and expenditure from the total is surplus. However, this is actually dependent on the role of government finance. From the data, we can know that since 2006 the proportion of financial subsidies in expenditure are more than 17% and the average of it is 21.523%. The rate of financial subsidies in the pension is too high, which may increase financial pressure on the government in the future.

From table2, we know that basic endowment insurance fund income in 2013 is 18791 billion Yuan, including pension income 15501 billion Yuan, financial subsidies 2669 billion Yuan. However, the expense is 16460 billion Yuan, which means that if we don't take financial subsidies into consideration, pension insurance fund is deficit.

Endowment insurance fund balance of payments imbalance is a long-term historical debts problem. In the past, the staff and workers of the institution of city and towndid not implement the payment system. Nevertheless, after the reform of pension insurance fund system, the government needs to pay their pension though they did not implement the payment system before. At the same time, China's aging population trend has been intensified. Also, the average life expectancy is increasing year by year, the aging population is increasing, and the pension insurance fund system is not perfect. These issues will make the future pension fund gap further increase. To solve this problem, maintaining the existing payment rate and substitution rate,the government is bound to delay retirement age to alleviate the aging pressure, which is also an effective measure taken by most governments facing such problems. Therefore calculating the optimal delay retirement age reasonably and improving the pension system is the key to solve the problem.

Table 2. The income and expenditure status of basic retirement security of urban workers.

Year	Income	Expenditure	Financial aid
2007	7011	5154	1103
2008	8800	6508	1356
2009	10421	7887	1538
2010	12218	9410	1815
2011	15485	11426	2069
2012	18363	14009	2430
2013	18791	16460	2669

Unit: billion Yuan

2.2 Personal perspective

With the continuous development of economic construction and the constantly improve the level of medical, the average life expectancy has increased year by year. At the same time, with the increase of education investment, the average schooling years are also increasing, which means that as for an individual the proportion of education, work, retirement has constantly changed."Life cycle hypothesis" proposed mainly by Modigliani said that a representative consumer's distribution for the consumption of resources in any age depends only on his life's resources and has nothing to do with the current income. In order to pursue the life cycle lifetime utility maximization, the consumer's consumption behavior will lead to personal income and savings in their lifetime like a hump shaped distribution, which means that within the period of the work, personal income is larger than consumption, forming positive savings within the life cycle and in the retirement stage, individuals use early accumulation of savings to maintain normal life, forming "negative savings within the life cycle. In the current retirement age, the growth of average life expectancy will lead to the increase of individual retirement-life cycle ratio. At the same time, the growth of the years of education means the improvement of initial work age, causing the decrease of individual working-life cycle ratio. A rise and a drop will result in a decline in the working-retirement ratio. Personal savings will be difficult to meet the retirement need of the elderly, resulting in the increasing burden of personal pension. In order to maximize the utility of the individual life cycle, it is necessary to increase the savings in the life cycle, maintaining the level of life in the retirement period. In the real situation, under the condition that wage level is basically stable and the initial working age is raising, in order to increase the positive savings, we must increase the year of savings, which means the delay of retirement age.

An optimal retirement age actuarial model based on the maximization of individual utility

3. Optimal Retirement Age Estimation Models

3.1 Optimal retirement age actuarial model based on the maximization of individual utility

Based on the hypothesis that the individual life only has two states that are the full working statewhich means the utility is entirely from personal consumption and the full retirement state which means the utility is from personal consumption and leisure, the mathematical expression for the expected utility of an individual's life by using consumption function and utility function are as follows.

Symbol description:

$\boldsymbol{C_1}$: Consumption in a full state of work
$\boldsymbol{C_2}$: Consumption in a full state of retirement
$\boldsymbol{b}$:Leisure in a full state of work
$\boldsymbol{u_1}$: Utility in a full state of work
$\boldsymbol{u_2}$: Utility in a full state of retirement
$\boldsymbol{W_i}$:Average wage at the year of i in a full state of work
$\boldsymbol{m}$: Pension in a full state of retirement
$\boldsymbol{W_1}$:The whole wage when D<R
$\boldsymbol{W_2}$:The whole wagewhen D>R
$\boldsymbol{a}$: Marginal propensity to consume
$\boldsymbol{T_0}$: Initial working age
$\boldsymbol{R}$:Retirement age
$\boldsymbol{D}$: Death age
$\boldsymbol{p}$:Probability for individual to die before retirement
$\boldsymbol{r}$:Rate of investment return of pension fund
$\boldsymbol{s}$: Average wage growth rate

Therefore,

$$\boldsymbol{u_1 = ln\,(\alpha W)} \quad (1)$$

$$\boldsymbol{u_2 = ln(\alpha M) + ln\,(b)} \quad (2)$$

If $\boldsymbol{D<R}$, the probability for individual to die before retirementis$\boldsymbol{p}$. If $\boldsymbol{D>R}$, the probability for individual to die after retirement is ($\boldsymbol{1\text{-}p}$),

$$\boldsymbol{E(u) = pu_1 + (1-p)(u_1 + u_2)}$$

$$\boldsymbol{= pln(\alpha W_1) + (1-p)[ln(\alpha W_2) + ln(\alpha M) + ln(b)]}$$

$$\boldsymbol{= (2-p)ln\alpha + (1-p)\,ln\,b + plnW_1 + (1-p)lnW_2 + (1-p)lnM} \quad (3)$$

If$\boldsymbol{D < R}$, the actuarial value of the total wage income at the age of $\boldsymbol{D}$:

$$\boldsymbol{W_1 = w_0(1+r)^{D-T_0} + w_0(1+r)^{D-T_0-1}(1+s) + \cdots w_0(1+s)^{D-T_0} =}$$

$$\boldsymbol{w_0 \frac{(1+r)^{D-T_0}*\left[1-\left(\frac{1+s}{1+r}\right)^{D-T_0-1}\right]}{1-\left(\frac{1+s}{1+r}\right)} = w_0 \frac{(1+r)^{D-T_0+1}-(1+s)^{D-T_0+1}}{r-s}} \quad (4)$$

The actuarial value of the total wage income of individuals when the retirement age is$\boldsymbol{R}$:

$$\boldsymbol{W_2 = W_0(1+r)^{R-T_0} + W_0(1+s)(1+r)^{R-T_0-1} + \cdots + W_0(1+s)^{R-T_0}}$$

$$\boldsymbol{= W_0 \frac{(1+r)^{R-T_0}\left[1-\left(\frac{1+s}{1+r}\right)^{R-T_0+1}\right]}{1-\frac{1+s}{1+r}}}$$

$$\boldsymbol{= W_0 \frac{(1+r)^{R-T_0+1}-(1+s)^{R-T_0+1}}{r-s}} \quad (5)$$

The discounted value ofIndividual retirement pension fund income at the age of $\boldsymbol{R}$:

$$\boldsymbol{M = (D-R)m} \quad (6)$$

$$\boldsymbol{E(u) = (2-p)ln\alpha + (1-p)lnb + pln\left[W_0 \frac{(1+r)^{D-T_0+1}-(1+s)^{D-T_0+1}}{r-s}\right] +}$$

$$\boldsymbol{(1-p)\,ln\left[W_0 \frac{(1+r)^{R-T_0+1}-(1+s)^{R-T_0+1}}{r-s}\right] + (1-p)ln\,[(D-R)m]} \quad (7)$$

Suppose,

$$\boldsymbol{B = (2-p)ln\alpha + (1-p)lnb + plnw_0 + pln[(1+r)^{D-T_0+1} - (1+S)^{D-T_0+1}] - pln(1-s) + (1-p)lnw_0 - (1-p)\,ln(r-s) + (1-p)lnm} \quad (8)$$

Therefore,

$$\boldsymbol{E(u) = B + (1-p)\,ln[(1+r)^{R-T_0+1} - (1+S)^{R-R_0+1}] + (1-P)ln\,(D-R)} \quad (9)$$

MaximizingE(u),

$$\frac{\partial E(u)}{\partial R} = \frac{(1-p)[(1+r)^{R-T_0+1}\,ln(1+r) - (1+s)^{R-T_0+1}\,ln(1+s)]}{(1+r)^{R-T_0+1} - (1+s)^{R-T_0+1}} + \frac{(1-p)*(-1)}{D-R} = \boldsymbol{O} \quad (10)$$

Finally,

$$\frac{(D-R)\,ln(1+s)-1}{(D-R)\,ln(1+r)-1} = \left(\frac{1+s}{1+r}\right)^{T_0-R-1} \quad (11)$$

3.2 Optimal retirement age actuarial model based on the balance of pension payments in the medium and short term

The hypothesis of this model is that the model only considers the basic old-age insurance income and expenditure of urban enterprises, individuals start to pay the pension continuouslyfrom the start of working to the retirement period, and the workers have the same initial work age. The main idea is to select targeted year, making the income and expenditure of the pension reach a basic balance in this period. Therefore, the sum of the accumulative amount in the year before and the annual difference of income and expenditure can represent the pension payments in the target period using this as the precondition of calculating the optimal retirement age.

Symbol description:

$\boldsymbol{n}$: Targeted year

$\boldsymbol{l_{i(t)}}$:At the year of t insured number of urban workers at the age of i

$\boldsymbol{S_{(t)}}$: The average wage of workers at the year of t

$\boldsymbol{C_1}$: Total payment rate,the proportion of pension insurance premiums paid by individuals and enterprisesin wage

$\boldsymbol{C_2}$: Total replacement rate, the proportion of the received pension in former wage

$\boldsymbol{u_1}$: Initial working age

$\boldsymbol{u_2}$: Retirement age

$\boldsymbol{u_3}$: Death age

$\boldsymbol{\alpha}$: Endowment insurance fund adjustment coefficient

$\boldsymbol{g}$:Social average wage growth rate of urban workers

$\boldsymbol{r}$: Pension fund annual rate of return on investment

Therefore,if$\boldsymbol{n = 1}$,

Total contribution of insured workers at the year of $\boldsymbol{T}$:

$$\boldsymbol{I_{(t)} = \sum_{i=u_1}^{u_2-1} l_{i(t)}\, S_{(t)} C_1 =}$$

$$\boldsymbol{C_1 S_{(t)} \sum_{i=u_1}^{u_2-1} l_{i(t)}} \quad (12)$$

The average wage of urban workers aged $\boldsymbol{u_2}$ at the year before they retire: $\boldsymbol{S_{T-1}}$

The average wage of urban workers aged $(\boldsymbol{u_2 + 1})$at the year before they retire: $\boldsymbol{S_{T-2}}$

The average wage of urban workers aged $\boldsymbol{i}$at the year before they retire:$\boldsymbol{S_{[T-(i-u_2+1)]}}$

The total amount of payment by insured people by different age at the year of$\boldsymbol{T}$:

$$\boldsymbol{O_{(t)} = \sum_{i=u_1}^{u_2-1} l_{i(t)}\, S_{[T-(i-u_2+1)]} C_2 (1+\alpha)^{i-u_2+1}} \quad (13)$$

In order to balance endowment insurance fund,

$$\boldsymbol{I_{(t)} - O_{(t)} = C_1 S_{(t)} \sum_{i=u_1}^{u_2-1} l_{i(t)} - \sum_{i=u_1}^{u_2-1} l_{i(t)}\, S_{[T-(i-u_2+1)]} C_2 (1+\alpha)^{i-u_2+1} = 0} \quad (14)$$

Modifying model,

$$\boldsymbol{min \left| I_{(t)} - O_{(t)} \right|} \quad (15)$$

If$\boldsymbol{n \geq 2}$,

The average wage of urban workers aged $\boldsymbol{i}$ at the year of $\boldsymbol{T}$:

$$S_{(T)} = S_{(1)}(1+g)^T \tag{16}$$

$$S_{T-(i-u_2+1)} * (1+g)^{i-u_2+1} = S_T \tag{17}$$

Therefore,

$$S_{T-(i-u_2+1)} = \frac{S_1}{(1+g)^{i-u_2+1-T}} \tag{18}$$

The cumulative amount of the pension fund accumulated to the end of the target year,

$$A = [I_{(1)} - O_{(1)}](1+r)^{n-1} + [I_{(2)} - O_{(2)}](1+r)^{n-2} + \cdots + [I_{(n)} - O_{(n)}] = \sum_{T=1}^{n}[I_{(T)} - O_{(T)}](1+r)^{n-T} \tag{19}$$

Modifying model,min |A|

$$A = max(0, I_{(1)} - O_{(1)})(1+r)^{n-1} + max(0, I_{(2)} - O_{(2)})(1+r)^{n-2} + \cdots max(0, I_{(n)} - O_{(n)}) \tag{20}$$

Finally,

$$A = \sum_{T=1}^{n}[\sum_{i=u_1}^{u_2-1} L_i(T) * S_t * c_1 - \sum_{u_2}^{u_3-1} c_2 L_i(T) \frac{s_1}{(1+g)^{i-u_2+1-T}}(1+\alpha)^{i-u_2+1}](1+r)^{n-T} \tag{21}$$

4. The Analysis of Differences of Two Actuarial Models

From the government's point of view, the government's economic behavior is to pursue social equity and justice, taking into account the long-term stability of the government's financial activities in the meantime.Thus, they need to take into account the benefits and costs. Through a series of administrative means, the government can focus on the social wealth and realize the redistribution of income through the transfer payment in order to pursue the maximization of the social welfare. However, individual in the society as a rational economic person, their behaviors are always based on their own utility maximization. As a consequence of different aim, the optimal retirement age actuarial model based on the maximization of individual utility is from personal perspective and the actuarial model of the optimal retirement age based on the balance of pension payments in the medium and short term is from governmental perspective, which will inevitably lead to the difference of the optimal retirement age.

At the same time, with the rise of personal income, the proportion of leisure and work in their lifetime has significant changes. When the individual wages rise to a certain extent,

the relative people may have more preference for leisure. In addition, with the continuous improvement of the social endowment insurance system, individual pension pressure has been gradually reduced.When the pension is relatively secure, individuals who pursue utility maximization tend to reduce the retirement age. Nonetheless, with the increase of years of schooling and life expectancy, the government is faced with great pressure in endowment insurance fund. Thus, gradually delaying retirement age becomes an effective way for government to alleviate this problem.

5. Policy Recommendations on Delaying Retirement Age

5.1 Raise the retirement age in progressive steps using results of two models as different age ranges

From two actuary models, we can calculate two optimal retirement age. The results of two models will have differences, which has been discussed in the former part in this article. Taking both personal willingness and pension balance into consideration, it may be practical for us to use the optimal retirement age calculated by the model from governmental perspective as legal retirement age and use the other as the floating range of age to raise the retirement age in progressive steps.

The pension policyof our country has been implemented for many years. Since the reform and opening up, average years of education and life expectancy have increased year by year. Therefore, delaying retirement has become an inevitable premise and the implementation of the policy needs to fully consider the acceptability of the broad masses of the people.

Referring to the overseas experience, some European and American countries in the last century has developed a retirement policy, but did not begin until the beginning of this century, and some countries will complete the reform in the middle of this century. Thus, delaying the retirement age will be in a longer period of time and we need tojust the relevant system to the reality of the situation to ensure the smooth implementation of the policy.

5.2 Implement reward and punishment system and strengthen the interest incentive mechanism

In recent years, because the construction of the legal system in our country is inadequate, some individuals just retire before the legal age.According to relevant research, at present, China's urban population average effective retirement age is 56.1 years old.

Therefore, with the further improvement of the legal system in our country, we must gradually avoid such phenomena to ensure that the actual retirement age meet the system requirements. We canestablisha reward and punishment mechanism which means that do appropriate proportion of deduction forthe people who choose to retire ahead of schedule and as for the people who choose to delay retirement age we can properly increase some proportion of their pension. At the same time, we can use the punished money to be the main resources of the reward money in order to make sure balance of the pension.

5.3 Learn from international experience and improve relevant policies

With the development of economic globalization, many countries have to face the problem called the delay retirement.Due to the relatively higher life expectancy, most developed countries have already taken the lead in the development or implementation of the delayed retirement policyand have accumulated some practical experience. We can make full use of international experienceand improve relevant policies and regulations basedon China's actual situation.

5.4 Strength the supervision of the fund and use it properly

At present, China's endowment insurance fund is facing increasingly serious gap between revenue and expenditure. Due to the legacy of institutional transition and other historical issues, the gap has been further expanded. Therefore, we need to strength the supervision of all parties of the future pension fund operation, classifying the different responsibilities of various departments. Secondly, in order to ensure thesecurity of funds and investments, it may be an efficient way to broaden the investment limit and to allow various combinations of investment.Finally, making the endowment insurance fund more professional is a practical way for us referring the successful experience of foreign countries, such as Chile and other countries. Professional fund Management Company can ensure highly transparent management andmake more robust, flexible portfolio to the value of pension funds.

5.5 Obtain social support through extensive publicity

Delay retirement has the necessity of policy implementation, but the individuals also have personal life needs. If we cannot reduce the contradiction properly, the delay in retirement will be very easy to cause people's dissatisfaction, stimulating social conflict. This requiresthe relevant government departments to widely publicize postponed

retirement policy, using community activities, issuing the relevant materials, using media technologythrough television, radio, radio, etc. Through these methods, we can promote the smooth implementation of the delay retirement policy and improve the efficiency of policy implementation.

6. Conclusion

Based on the current situation of our country, aging problem has become more and more serious. At the same time, the increase of year of schooling and life expectancy has also cause great pressure on the pension. There is no doubt for us to carry out the delayed retirement policy to solve such agent problems like many other countries. The key to this problem is to find out a practical way and a proper mode to implement the policy smoothly. The optimal retirement age actuarial model based on the maximization of individual utility and the actuarial model of the optimal retirement age based on the balance of pension payments in the medium and short termconsider this problem in two basic perspectives, which may provide a more feasible way to the government by making combination with two sides. There is a long way to go in the process of implementing the policy of delaying retirement. As a consequence of these, we also need to take other countries' related experience into consideration to make sure the smooth implement of the policy.

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An Empirical Analysis on Adjustment of Contribution and Perfection of Individual Account of China's Enterprise Employee Public Pension --A OLG Model Combined With Public Capital Income and Payroll Tax

GAO Yan, YANG Zaigui

GAO Yan

Ph.D. Candidate

School of Insurance

Central University of Finance and Economics

Beijing 100081, China

Phone: (8610) 6228 8627

Email: gaoyan811116@126.com

YANG Zaigui

Professor

School of Insurance

Central University of Finance and Economics

Beijing 100081, China

Phone: (8610) 6228 8627

Email: yangzaigui@hotmail.com

Keywords: Overlapping-generations model; enterprise employee public pension; the transfer of public capital income; the burden of tax and contribution

Abstract: China's enterprise employee public pension has been facing various problems cannot be avoided since the establishment. Such as: individual account assets are not real, a huge amount of financial subsidies, etc. Another aspect, the contribution and tax burden of enterprises and employees is too heavy. The government proposed a series reform direction of the China's enterprise employee public pension for this

problem: reform the individual account, reduce the contribution and tax burden, achieve the reasonable allocated to the public pension of state capital.

Combined with the problems above, this paper tries to build up a general equilibrium overlapping-generations model to study the China's enterprise employee public pension，and tries to introduce factors of empty account of individual, reasonable allocation to the public pension of state capital into the model. We examines the effects of policy variables and found that the adjustment of exogenous variables such as contribution rate, the tax rate can optimize the pension system and its economic impact. In order to further study the optimal adjustment path of exogenous variables and the optimal adjust target, this paper get the optimal adjustment path of contribution and tax rate from the perspective of social welfare maximization: 1.Reduce the firm contribution rate can raise the optimal individual contribution rate with a elasticity of substitution of 0.99. The sum of the contribution rate will still be lower than the current level. The elasticity of substitution will raise to 1.38 with the decline in the population. 2. Increase the individual contribution rate can decrease the tax rate with a elasticity of substitution of 0.22. The elasticity of substitution will reduce to 0.07 with the decline in the population. 3. The optimal total contribution rate reduced by 1.5 percentage points after the nominal reform of individual account, and the optimal tax rate reduced by 1.3 percentage points after the reform. So the nominal reform of individual account can help to further reduce the tax burden charges.

1. 引言

我国现有的城镇职工养老保险制度是统账结合的部分积累制，即基金积累型的个人账户和现收现付的社会统筹账户相结合的制度模式。部分积累制建立的初衷是既发挥个人账户资金积累、促进经济增长、激发参保人积极性的作用，又体现统筹账户财富再分配和社会保险共济性的特点。但是此制度自1997年建立、2005年进一步完善后，一直面临着无法回避的各种难题：如覆盖率水平低、财务可持续性差以及个人账户资产不实等。同时，受人口老龄化等因素影响养老保险收支压力逐年增大，对政府的财政补贴的需求数额增长过快。据人力资源与社会保障部发布的历年《社会保险公报》和历年的《中国统计年鉴》数据计算，2011年以来，随着我国经济进入新常态，经济增长速度和财政收入的增速都逐渐下降到约8%的水平，但是养老保险财政补贴的增速却一致保持在15%以上。养老保险的财政补贴金额巨大，且增速过快，在没有相对应的社会财富和财政收入做支撑的时候，势必会对财政总支出造成巨大压力。

从另一个方面看，企业和职工则面临着养老保险缴费负担和税收负担过重的现实问题。据财政部经济建设司2013年7月22日发布的《2013年上半年产业经济运行分析及建议》报告，当前中国企业税费负担较重，综合考虑税收、政府性基金、各项收费和社保金等项目后的税负高达40%左右，超过OECD国家的平均水平，居全球高位。根据白重恩（2012）的测算，中国五项社会保险法定缴费之和相当于工资水平的40%，有的地区甚至达到50%。我国的社保缴费率在全球181个国家中排名第一，是东亚邻国的4.6倍。

针对以上城镇职工养老保险制度存在的种种问题，参保企业和职工亟待解决的负担难题，政府提出了一系列今后养老保险改革的方向和目标。2013年党的十八届三中全会提出要“完善个人账户制度”，这意味着对个人账户形式和功能的定位将会有改变，为个人账户的改革提供了空间。2015年党的十八届五中全会提出“划转部分国有资本充实社保基金”，这些配套措施的提出可以为养老保险制度改革提供一定的资金支持。《中共中央关于制定国民经济和社会发展第十三个五年规划的建议》，强调“适时适当降低社会保险费率”，2016年3月5日的政府工作报告进一步明确提出 “制定划转部分国有资本充实社保基金办法”，“适度扩大财政赤字，主要用于减税降费，进一步减轻企业负担”。

综上所述我国城镇职工养老保险制度的新一轮改革需要从降低缴费和税收负担、完善个人账户和实现国有资本向社保合理划拨等方面开展，基于此本文将重点研究个人账户的完善措施，养老保险缴费率和综合税率调整降低的详细路径。

2. 文献综述

国内外运用交叠世代模型（OLG：Overlapping generations model）研究社会养老保险、养老金水平、居民消费和资本积累的文献不胜枚举。Samue1son(1958)在其一篇经典论文中提出了无限期的交叠世代模型，在没有资本市场的假设前提下，模拟了现收现付制社会养老保险体系的运行机制，并证明了养老金的增长主要取决于人口的增长。随后Diamond (1965)，Barro (1974)，Feldstein (1974)， Fuster (2000)等学者基于发达国家的经济背景和公共养老金制度，运用OLG模型对现收现付制和完全积累制养老保险制度进行了详尽的研究。对于养老保险缴费率问题，Samuelson(1975)提出了求解稳态条件下社会保险最优缴费率的方法，Zhang 和Zhang(2007)，用一个特定模型证明了现收现付制社会保障制度存在的合理性，并测算了最优的缴税率水平。国内学者运用不同方法对缴费率的设定问题也进行了研究。孙祁祥（2001）认为中国的养老金社会统筹缴费率本来就较高,再提高缴费率并不可行。彭浩然、申曙光（2007）进一步研究发现提高社会统筹缴费率会阻碍经济增长。杨再贵（2007）（2008）运用OLG模型全面分析指出提高企业缴费率会减少单位劳动资本和个人账户本金，增加社会统筹养老金；提高个人缴费率会增加个人账户本金。杨再贵（2009）运用内生增长的OLG模型重点考察了能控制合理人口规模、促进经济适度增长并鼓励适当家庭养老保障的理想的最优企业缴费率区间。交叠世代模型也可以用来研究国有资产充实社保基金的问题。杨俊，龚六堂等（2006）通过一个存在股权交易的交叠世代模型的分析，认为国有股权型社会保障制度有利于提高经济产出、人均消费和资本积累水平，要优于现收现付制社会保障制度。杨俊，龚六堂（2008）进一步通过交叠世代模型考察了最优的社会保障基金持有国有股的比例，最优的国有资本转移比例。

交叠世代模型是分析养老保险制度的有效工具，但是现有研究模型中基本没有涉及中国部分基金制和个人账户资产不实的模式特点，也没有结合政府财政补贴、国有资产划拨情况综合考虑经济体系的均衡。与以往研究不同，为了

实现国家“适时降低养老保险缴费率”、“减税降费”和“完善个人账户”的政策号召，本文建立了反映我国城镇职工养老保险制度的交叠世代模型，并引入养老保险个人账户资产不实、国有资产收益划拨等现实因素，考察缴费率、税率和就业人口增长率等政策变量对社会储蓄、工资、消费和养老金水平等经济因素的影响，并从社会福利最大化的角度求解缴费率、综合税率的调整路径和最优替代组合方式，证明个人账户的“名义化”改革有利于减轻企业和个人的税收负担，最后从养老金和财政平衡的角度分析最适合的就业人口增长率，为我国城镇职工养老保险制度的改革和完善提供了相应的政策参考。

3. 模型设计与结构

3. 1竞争性模型设计

本文以Diamond（1965）OLG模型为基础，并研读借鉴了杨再贵（2010）的主要模型框架，建立了一个包含养老金收支和国有资产划拨因素的一般均衡体系。具体模型设定如下文所述。

在一个无限存续的封闭经济中，包含了三个基本经济单位：个人、企业和政府。每个人都经历工作期和退休期（通常假设一期为25—30年，本文设定每期28年）。每一期都存在两代人：年轻的工作一代和年老的退休一代。在第t期初有N_t个相同的个人成长为劳动者，劳动者增长率为$n = N_t / N_{t-1} - 1$。各企业在竞争的市场里都生产同质的产品，用规模报酬不变的柯布-道格拉斯生产函数$Y_t = AK_t^{\alpha}N_t^{1-\alpha}\ (0 < \alpha < 1)$来描述生产。政府是社会经济的调控者，其工作目标是使整个社会达到一般均衡和实现社会福利最大化。

3.1.1个人决策

第t期出生的代表性个人都从其工作期消费$c_{1,t}$和退休期消费$c_{2,t+1}$中得到满足，本文用可分离相加的对数函数来反映个人一生的效用水平，$\theta \in (0,1)$是主观效用折现因子个人选择储蓄和两期消费使效用最大，因此，个人的效用最大化问题为：

$$\max_{\{c_{1t},c_{2t+1},s_t\}} U_t = \ln c_{1t} + \theta \ln c_{2t+1} \tag{1}$$

在工作期，每个人向劳动市场无弹性地提供一单位劳动，取得工资收入，缴纳养老保险费和综合税，消费可支配收入的一部分，储蓄其余部分。到了退

休期，每个人将其工作期储蓄的本息、得到的个人账户养老金和社会统筹养老金都用于消费。所以工作期和退休期的预算约束条件分别为：

$$s.t.\, c_{1t} = (1 - \tau_1 - \tau_2) w_t - s_t \tag{2}$$

$$c_{2t+1} = (1 + r_{t+1}) s_t + I_{t+1} + P_{t+1} \tag{3}$$

其中τ_1是基于工资收入的养老保险个人缴费率，τ_2是综合税率，η是基于工资总额的养老保险企业缴费率，w_t是工资，s_t是储蓄，r_{t+1}是利率，I_{t+1}是个人账户养老金，P_{t+1}是社会统筹养老金。在（2）式和（3）式的约束下，效用函数最大化问题的一阶条件为：

$$\theta(1 + r_{t+1}) c_{1t} = c_{2t+1} \tag{4}$$

该式意味着减少一单位工作期的消费造成的效用损失，等于增加$(1 + r_{t+1})$单位退休期消费得到的效用增加。

3.1.2企业生产

企业生产函数为$Y_t = AK_t^{\alpha} N_t^{1-\alpha} (0 < \alpha < 1)$，其中$Y_t$是第*t*期的净产出，Kt是第t期初的国有资本存量，为简化模型，本文假设资本一期全部折旧。资本劳动比为$k_t = K_t / N_t$，产出劳动比为：

$$y_t = \frac{Y_t}{N_t} = Ak_t^{\alpha} \tag{5}$$

在完全竞争市场中，根据*Euler*定理，均衡时资本和劳动分别获得其边际回报：

$$1 + r_t = \alpha A k_t^{\alpha - 1} \tag{6}$$

$$w_t = \frac{(1-\alpha) A k_t^{\alpha}}{1+\eta} \tag{7}$$

3.1.3政府调控

在本模型的设定中，政府是最重要的调控者，要最大化社会福利，实现养老保险和财政的收支平衡。假定政府拥有企业经营的国有资本Kt ,每期可以从企业得到国有资本的净收入：每期国有资本总收入-下一期国有资本预备投资额。

$$\Pi_{t+1} = (1 + r_{t+1})K_t - K_{t+1}$$
$$\pi_{t+1} = \frac{\Pi_{t+1}}{N_{t+1}} = \frac{(1 + r_{t+1})k_t}{(1 + n)} - k_{t+1}$$

Π_{t+1}、π_{t+1}分别表示*t*+1期整个社会的国有资本净收入和人均国有资本净收入，r_{t+1}表示*t*+1期的利率水平，即国有资产的收益率。K_t、K_{t+1}和分别表示*t*期、*t*+1期初的国有资本。

本文假定政府只包含养老保险部门和财政部门，通过向这两个部门分配国有资产的净收入，使得两个部门正常运作并且达到收支均衡。其中以比例ϕ向养老保险部门划拨国有资本净收入$\phi\prod$，以比例$1-\phi$向财政部门划拨国有资本净收入$(1-\phi)\prod$。

（1）养老保险部门分为个人名义账户和社会统筹账户。

个人账户：现行制度下，个人缴费应全部计入个人账户，按照记账利率（一般是银行利率）进行累积，在参保人退休后，按照总积累额结合一定的计发办法给其发放个人账户养老金。但是现实中，现收现付的统筹账户养老金收支压力很大，为保障统筹账户收支平衡，所以个人账户部分资金被透支用于支付当期统筹账户养老金，因此只有个人缴费的一部分，即个人账户做实比例$v\in(0,1)$实际进入了个人账户进行积累。本文假设，为了弥补个人账户资产不实给参保人带来的损失，政府将国有资本净收入向养老保险部门划拨的资金充实个人账户，则个人账户养老金由两个部分组成：一是实际进入个人账户的累积额，二是国有资本净收入的划拨。

$$I_{t+1} = (1 + r_{t+1})v\tau_1 w_t + \frac{\phi\prod_{t+1}}{N_t} \tag{8}$$

统筹账户养老金由企业缴费和从个人账户透支来的金额构成，两部分总额都直接用于当期统筹养老金的发放。

$$P_{t+1} = (1+n)[(1-\nu)\tau_1 + \eta]W_{t+1} \tag{9}$$

（2）财政部门

财政部门的收入来自于两个部分：基于综合税收收入和国有资本净收入划拨部分。财政支出用于提供必要的社会公共服务。其收支平衡可表示为：

$$GY_{t+1} = (1-\phi)\prod_{t+1} + N_{t+1}\tau_2 W_{t+1} \tag{10}$$

其中G为公共支出占社会产出的比重，$(1-\phi)\prod_{t+1}$是划拨到财政部门的国有资本净收入，$\tau_2 W_{t+1}$是政府基于工资的税收收入。将式（10）变换后代入个人账户公式（8）中，将财政收支与养老金收支结合起来。

3.1.4社会资本市场

第t+1期初的人均资本存量由上一期的国有资本、劳动者的储蓄和个人账户本金构成：

$$s_t = (1+n)k_{t+1} - k_t - \nu\tau_1 W_t \tag{11}$$

3.2动态均衡系统

该经济的一个竞争均衡是在已知初始条件k_0、政策参数η、ν、τ_1、τ_2、G和n的情况下，各期变量都满足式(1) - (11)的数列：

$$\{c_{1t}, c_{2t+1}, s_t, w_t, r_t, \prod_{t+1}, I_{t+1}, P_{t+1}, k_{t+1}\}_{t=0}^{\infty}$$

将式（2）、（3）、式（5）-（11）代入式（4），得下列动态均衡系统公式：

$$Ak_{t+1}^{\alpha}(1+n)\left[(1+\theta)\alpha - G + \frac{(\tau_1 - \nu\tau_1 + \tau_2 + \eta)(1-\alpha)}{1+\eta}\right] - \theta\alpha A k_{t+1}^{\alpha-1}\left[k_t + \frac{(1-\tau_1-\tau_2+\nu\tau_1)(1-\alpha)Ak_t^{\alpha}}{1+\eta}\right] - (1+n)k_{t+1} = 0 \tag{12}$$

假设该动态均衡系统存在唯一、稳定又无振荡的定态均衡。这意味着微分 dk_{t+1}/dk_t 在定态k处的值大于0而小于1。为求该系统的稳定条件，将式(12)对 k_{t+1}和 k_t 微分，得：

$$idk_{t+1} + jdk_t = 0$$

其中，系数i、j是偏导数在定态处的值：

$$i = \alpha Ak_{t+1}^{\alpha-1}(1+n)\left[(1+\theta)\alpha - G + \frac{(\tau_1 - v\tau_1 + \tau_2 + \eta)(1-\alpha)}{1+\eta}\right] - (\alpha-1)\theta\alpha Ak_{t+1}^{\alpha-2}\left[k_t + \frac{(1-\tau_1-\tau_2+v\tau_1)(1-\alpha)Ak_t^{\alpha}}{1+\eta}\right] - (1+n)$$

$$j = -\theta\alpha Ak_{t+1}^{\alpha-1}\left[1 + \frac{(1-\tau_1-\tau_2+v\tau_1)(1-\alpha)\alpha Ak_t^{\alpha-1}}{1+\eta}\right] < 0$$

因为 $0 < dk_{t+1}/dk_t = -j/i < 1$，且$j < 0$，所以该动态均衡系统的稳定条件为$i + j > 0$。

动态均衡系统在定态处可表示为：

$$A(1+n)\left[(1+\theta)\alpha - G + \frac{(\tau_1 - v\tau_1 + \tau_2 + \eta)(1-\alpha)}{1+\eta}\right] - \theta\alpha A - \frac{(1-\tau_1-\tau_2+v\tau_1)(1-\alpha)\theta\alpha A^2k^{\alpha-1}}{1+\eta} - (1+n)k^{1-\alpha} = 0 \quad (13)$$

通过式（13）运用Excel软件可求出定态下的资本劳动比，经济进入稳态后，各个经济要素表示为：r^*、w^*、y^*、s^*、π^*、ϕ^*、I^*、P^*、c_1^*、c_2^*、C^*。[1]

$$r^* = \alpha Ak^{*\alpha-1} - 1$$

$$w^* = \frac{(1-\alpha)Ak^{\alpha}}{1+\eta}$$

$$y^* = Ak^{*\alpha}$$

$$s^* = nk^* - \frac{v\tau_1(1-\alpha)Ak^{*\alpha}}{(1+\eta)}$$

[1] 限于篇幅，本文上述所有公式内容均有简化，详细公式推导过程可向作者索取。

$$\pi_{t+1} = \frac{(1 + r_{t+1})k_t}{(1 + n)} - k_{t+1}$$

$$\pi^* = \frac{k^*\left(\alpha A k^{*\alpha-1} - 1 - n\right)}{(1 + n)}$$

$$\phi^* = 1 - \frac{\left[G(1 + \eta) - \tau_2(1 - \alpha)\right]}{\left(\alpha A k^{*\alpha-1} - 1 - n\right)(1 + \eta)}(1 + n)A k^{*\alpha-1}$$

$$I^* = \left(\alpha A k^{*\alpha-1} - 1 - n\right)k^* + \frac{\alpha(1 - \alpha)A^2 k^{*2\alpha-1}\nu\tau_1}{1 + \eta} + (1 + n)A k^{*\alpha}\left[\frac{(1 - \alpha)\tau_2}{1 + \eta} - G\right]$$

$$P^* = (1 + n)\left[(1 - \nu)\tau_1 + \eta\right]\frac{(1 - \alpha)A k^{*\alpha}}{(1 + \eta)}$$

$$c_1^* = \frac{(1 - \tau_1 - \tau_2 + \nu\tau_1)(1 - \alpha)A k^{*\alpha}}{(1 + \eta)} - nk^*$$

$$c_2^* = \left[\frac{(\tau_2 + \tau_1 - \nu\tau_1 + \eta)(1 - \alpha)}{(1 + \eta)} - G + \alpha\right](1 + n)A k^{*\alpha} - (1 + n)k$$

4. 实证模拟

4. 1参数设定

本文对模型涉及的变量进行划分，得到3个外生的参数变量$\{\alpha$、A、$\theta\}$，5个外生的政策变量$\{\tau_1$、τ_2、ν、η、$G\}$和10个内生变量$\{c_1$、c_2、C、I、P、w、k、r、π、$\phi\}$，就业人口增长率n也是一个外生变量。

4.1.1时间跨度与增长率

OLG模型通常假定个人两期，一期25-30年，本文设定28年为一期。《中国统计年鉴》1986年全国城镇就业人员数为13292万人，2014年全国城镇就业人员数39310万人，所以1986-2014年间城镇就业人员的增长率

$n = (39310 / 13292 - 1) * 100\% = 195.74\%$。

4.1.2政策变量

2005年12月颁布的《国务院关于完善企业职工基本养老保险制度的决定》确定我国企业缴费率$\eta = 20\%$，个人缴费率$\tau_1 = 8\%$。

根据历年《中国养老金发展报告》数据计算，近年来我国在做实个人账户政策影响下，做实账户比例缓慢提高，但是比例一直很低，依据2014年数据，本文设定个人账户做实比例ν =12.2%。

表1　2006-2014年城镇企业职工基本养老保险个人账户

	记账额	做实账户规模	空账额	做实账户比例
年份	亿元	亿元	亿元	做实账户规模/记账额 %
2007	11743	786	10957	6.7
2008	13787	1100	12737	8.0
2009	16557	1569	14988	9.5
2010	19596	2039	17557	10.4
2011	24859	2703	22156	10.9
2012	29543	3499	26044	11.8
2013	35109	4154	30955	11.8
2014	40974	5001	35973	12.2

根据历年《中国统计年鉴》数据计算，财政支出占国内生产总值的比重上升速度较快，近年来上升至23.5%左右。所以本文设定$G = 23.5\%$。

表2 国内生产总值与财政收支情况

	2010	2011	2012	2013	2014
GDP(亿元)	408903.00	484123.5	534123.00	588018.8	635910.00
全国财政支出	89874.16	109247.79	125952.97	140212.10	151785.56
财政支出比重	21.98%	22.57%	23.58%	23.84%	23.87%
城镇就业人员工资总额	47269.9	59954.7	70914.2	93064.3	102817.2
个人所得税额	4837.27	6054.11	5820.28	6531.53	7376.61
增值税额	21093.48	24266.63	26415.51	28810.13	30855.36
税率	54.86%	50.57%	45.46%	37.97%	37.18%

由于本文着重考察的是城镇就业人员工资税率的变动与我国养老保险制度的相互影响，所以本文假定个人基于工资缴纳的税额包括个人所得税和我国主要税收收入增值税（假定增值税可以100%转嫁给消费者），则工资税的税负比

例为=（个人所得税额+增值税额）/城镇就业人员工资总额。表2数据显示，工资税率近些年缓慢降低，所以本文设定$\tau_2 = 37\%$

4.1.3其他参数

根据Barro和Sala-I-Martin（2004），Zhang等人（2001）等相关文献，发达国家通常取资本的收入份额为0.3。中国的劳动力相对便宜，因而劳动的收入份额相对较低，资本的收入份额比发达国家的高。Chow and Li(2002)利用中国大陆1952-1998年的数据得到的物质资本产出弹性为0.65。张军、施少华(2003)测算的中国物质资本收入份额为0.609，林忠晶、龚六堂(2007)采用的物质资本收入份额为0.65。本文借鉴以上文献，将资本收入份额α设定为0.6。

根据Pecchenino和Pollard(2002)，将个人效用每年的折现因子设为0.98，那么28年的折现因子为$\theta = 0.98^{28} = 0.568$。

由于本文研究的是人均资本、人均消费和养老金待遇等内生变量随政策变量如何相对变动，所以可将常数A正规化为1。

表3 变量汇总表

n	η	v	τ_1	τ_2	G	α	θ	A
195.7%	20%	12.2%	8%	37%	23.5%	0.6	0.568	1

所有外生参数和变量数值综合于表3。为了更好的展示模型中各个内生变量随外生参数和变量变化的具体形式，本文将表3数据代入模型，通过数值解法求解均衡水平各个变量之间的关系。

4.2实证结论分析

表4 内生变量随η、τ1和v的变化

	η		τ_1		v	
	15%	25%	6%	10%	10%	15%
k	0.000147	0.000112	0.000141	0.000115	**0.000126**	**0.000129**
W	0.001742	0.001364	0.001632	0.001446	**0.001528**	**0.001549**
s	0.000270	0.000206	0.000264	0.000208	0.000235	0.000235
π	0.000870	0.000753	0.000852	0.000765	**0.000803**	**0.000813**
ϕ	0.387775	0.339804	**0.358522**	**0.366657**	**0.363061**	**0.362134**
I	0.001346	0.001061	**0.001152**	**0.001227**	**0.001128**	**0.001272**

P	**0.001134**	**0.001292**	**0.001219**	**0.001230**	0.001229	0.001227
C_1	0.000052	0.000025	0.000038	0.000036	0.000037	0.000037
C_2	0.008012	0.007055	0.007871	0.007152	**0.007473**	**0.007554**

表5 内生变量随τ2、G和n的变化

	τ_2		G		n	
	27%	47%	18.5%	28.5%	150%	250%
k	0.000220	0.000069	**0.000109**	**0.000152**	0.000213	0.000078
W	0.002129	0.001062	**0.001395**	**0.001705**	0.002086	0.001143
s	0.000410	0.000125	**0.000199**	**0.000281**	0.000298	0.000184
π	0.001076	0.000578	**0.000741**	**0.000886**	0.001290	0.000510
ϕ	**0.139363**	**0.567824**	0.651476	0.066682	0.458028	0.249011
I	**0.000806**	**0.001257**	0.001741	0.000511	0.001836	0.000739
P	0.001702	0.000849	**0.001115**	**0.001363**	0.001410	0.001081
C_1	0.000038	0.000028	0.000048	0.000021	0.000070	0.000018
C_2	0.009646	0.005560	**0.007456**	**0.007545**	0.008519	0.006667

表6 内生变量对外生变量的弹性分析

	对η的弹性	对τ1的弹性	对v的弹性	对τ2的弹性	对G的弹性	对n的弹性
k	-0.533301	-0.402264	0.057440	-1.932665	0.779032	-1.853643
W	-0.486244	-0.241882	0.034465	-1.237145	0.470194	-1.168865
s	-0.536299	-0.475664	-0.006528	-1.973213	0.798513	-0.952207
π	-0.287388	-0.216440	0.030830	-1.115633	0.420718	-1.733600
ϕ	-0.263727	0.044872	-0.006390	2.241705	-3.827199	-1.182489
I	-0.473990	0.126061	0.298333	0.809573	-2.566992	-1.705315
P	0.259679	0.018106	-0.002572	-1.237145	0.470194	-0.527909
C_1	-1.411911	-0.123140	0.017512	-0.571778	-1.829029	-2.345504
C_2	-0.254116	-0.191392	0.027255	-0.994106	0.027759	-0.487746

表4显示降低企业缴费率可以带来除统筹养老金外的所有内生变量的提高，而提高个人缴费率可以增加个人账户养老金和统筹养老金。结合表6的弹性分析，企业缴费率变动对各个变量造成的影响要大于个人缴费率同比例变动的影响。所以采取降低企业缴费率的措施，既可以降低企业的经营成本，提高产品竞争力，又可以大幅度的提升资本劳动比、工资、储蓄和消费水平，提高国有资产

净收入的能力，最终提高养老金的总收入。与此同时，为了避免养老金收入减少过多，可以同时采取提高个人缴费率的措施，由于个人缴费率的影响力度小于企业缴费率，所以两个措施同时实施依然可以优化其经济影响。个人账户做实比例对内生变量的影响非常小，基本可以忽略不计。（表格中加下划线数据均与政策变量同向变化）

表5显示综合税率降低会使除划拨比例和个人账户养老金外的内生变量上升。结合表6的弹性分析发现，内生变量对综合税率的弹性要远大于对缴费率的弹性，降低综合税率会带来内生变量更大幅度的上升。公共支出占比的提高使除划拨比例和个人账户养老金外的其他内生变量全部上升。所以降低综合税率既可以弥补个人缴费率提高带来的可支配收入下降的损失，又可以大幅度的优化各个经济变量。就业人口增长率的下降会使内生变量全部上升，并且其影响力都较强，所以从其对经济因素的影响角度分析，就业人口增长率降低是有利的，但是从养老金收支平衡的角度分析，就业人口增长率又不宜过低。

以上分析说明了降低企业缴费率、提高个人缴费率和降低综合税率的调整方法可以优化养老保险制度和其经济影响，但是外生变量的调整是否有合理的范围界定，是否存在一个最优的调整目标，最优外生变量之间怎样相互影响，这些问题可以从社会福利最大化角度出发进行研究并得到合理结论。

5. 社会福利最大化

5. 1社会福利函数

本文假定政府是一个社会计划者，通过社会福利最大化的标准来制定最优的政策变量。首先我们需要推导社会福利最大化时的资本劳动比，即修正黄金律资本劳动比，并且需要使竞争经济下的资本劳动比等于修正率资本劳动比，最后，用此时的资本劳动比推导出最优的政策变量。

将从今往后各世代的代表性个人的效用折现值之和定义为社会福利（Blanchard和Fischer，1989；杨再贵，2010）：

$$W = \theta \ln c_{2,0} + \sum_{i=0}^{\infty} \rho^{i}\left(\ln c_{1,i} + \theta \ln c_{2,i+1}\right) \tag{16}$$

其中$\rho \in (0,1)$是社会折现因子，反映社会计划者对各代人效用的关注和重视的程度。总资源约束为$K_i + Y_i = K_{i+1} + N_i c_{1i} + N_{i-1} c_{2i}$

由于t期劳动人口有N_t，所以劳均资源约束为：

$$k_i + Ak_i^{\alpha} = (1+n)k_{i+1} + c_{1i} + c_{2i}/(1+n)$$

初始条件k_0已知，终极条件为$k_{\infty} = 0$。社会计划者在服从资源约束、初始条件和终极条件的情况下使社会福利最大。构造相应的Lagrange函数：

$$\begin{aligned}
L = & \ldots \\
& + \rho^{t-1}\left(\frac{c_{1t-1}^{1-\sigma}}{1-\sigma} + \theta\frac{c_{2t}^{1-\sigma}}{1-\sigma}\right) + \lambda_{t-1}\left[k_{t-1} + Ak_{t-1}^{\alpha} - (1+n)k_t - c_{1t-1} - \frac{c_{2t-1}}{1+n}\right] \\
& + \rho^{t}\left(\frac{c_{1t}^{1-\sigma}}{1-\sigma} + \theta\frac{c_{2t+1}^{1-\sigma}}{1-\sigma}\right) + \lambda_{t}\left[k_t + Ak_t^{\alpha} - (1+n)k_{t+1} - c_{1t} - \frac{c_{2t}}{1+n}\right] \\
& + \rho^{t+1}\left(\frac{c_{1t+1}^{1-\sigma}}{1-\sigma} + \theta\frac{c_{2t+2}^{1-\sigma}}{1-\sigma}\right) + \lambda_{t+1}\left[k_{t+1} + Ak_{t+1}^{\alpha} - (1+n)k_{t+2} - c_{1t+1} - \frac{c_{2t+1}}{1+n}\right] \\
& + \ldots
\end{aligned}$$

其中，λ_t是第t期资源约束的拉格朗日乘数。令L对c_{1t}，c_{2t}和k_{t+1}的偏导等于零：

$$\frac{\rho^{t}}{c_{1t}} - \frac{(1+n)}{(1+n+T)}\lambda_t = 0,$$

$$\frac{\rho^{t-1}\theta}{c_{2t}} - \frac{\lambda_t}{1+n+T} = 0$$

$$-\lambda_t(1+n) + \lambda_{t+1}\left(1 + \alpha A k_{t+1}^{\alpha-1}\right) = 0$$

在社会最优稳定状态k^*, c_1^*, c_2^*整理，得社会福利最大化问题的一阶条件：

$$(1+n)\theta c_1^{*\sigma} = \rho c_2^{*\sigma} \tag{17}$$

$$1 + \alpha A\left(k^*\right)^{\alpha-1} = \frac{1+n}{\rho} \quad \text{或者} \quad k^* = \left(\frac{1+n-\rho}{\rho\alpha A}\right)^{\frac{1}{\alpha-1}} \tag{18}$$

上标*代表变量的最优定态值。满足式(15)的资本劳动比处于修正黄金律水平。为了让市场经济的稳定状态实现社会福利最大化，就应通过政策变量的调

整、将市场经济稳定状态的资本劳动比调节到修正黄金律水平，即 $k_{t+1} = k_t = k = k^*$。将式(18)代入式(15)，整理得

$$A(1+n)\left[(1+\theta)\alpha - G + \frac{(\tau_1 - v\tau_1 + \tau_2 + \eta)(1-\alpha)}{1+\eta}\right] - \theta\alpha A - \frac{(1-\tau_1-\tau_2+v\tau_1)(1-\alpha)\theta A}{1+\eta}\left(\frac{1+n-\rho}{\rho}\right) - (1+n)\left(\frac{\rho\alpha A}{1+n-\rho}\right) = 0 \tag{19}$$

可见，政策变量的最优组合取决于个人折现因子θ、社会折现因子ρ、资本的收入份额α和人口增长率n。

5.2政策变量的最优组合

社会折现因子是社会计划者给各代人效用的权重，依据相关参数代入式(19)反复试算，得$\rho \approx 0.13049892$ 。

表7 不同人口增长率下、不同做实比例下缴费率的最优组合

	n	η^*	τ^*_1	总和缴费率	替代弹性
v=12.2%	195.7%	15%	**10.66%**	**25.66%**	-0.99
	150%	15%	**11.93%**	**26.93%**	-1.38
v=0	195.7%	15%	**9.36%**	**24.36%**	-0.55
	150%	15%	**10.47%**	**25.47%**	-9.36

如表7所示，其他参数取基准值，就业人口增长率保持在195.7%的前提下，若将企业缴费率由20%降低到15%，对应的最优个人缴费率将从8%上升到10.66%，总和缴费率将下降为25.66%。两种最优缴费率的替代弹性约为-0.99，即企业缴费率降低100%，最优个人缴费率需要提高99%。若就业人口增长率下降到150%的水平上，企业缴费率依然保持15%，对应的个人缴费率会从10.66%上升到11.93%，总和缴费率会上升到26.93%。两种最优缴费率的替代弹性约为-1.38，即企业缴费率降低100%，最优个人缴费率需要提高138%。

由于我国城镇职工养老保险的个人账户做实工作多年来取得进展效果不明显，并且给财政补贴带来了具大的压力，所以本文从养老保险财务可持续性角度出发，假定个人账户向“名义化”完善，即做实比例下调为零，全部个人缴费和企业缴费都用来现收现付的发放当期养老金，即参保人养老金的收益主要取决于了就业人口增长率和工资增长率而不是利率水平。就我国实际数据计算，就业人口增长率和工资增长率之和是大于利率的，所以，将个人账户实有资金

全部用于统筹养老金发放不会带来参保人收益的下降。表7显示，当个人账户做实比例下调为0时，不同人口增长率情况下的最优总和缴费率要低于现行制度约1.5个百分点，即更有利于参保企业和个人降低缴费负担。

表8 不同人口增长率下个人税费的最优组合

	n	η^*	τ^*_1	τ^*_2	替代弹性
v=12.2%	195.7%	20%	8%	**37%**	-
	195.7%	20%	10%	**35.24%**	**-0.22**
v=0	150%	20%	10%	**36.41%**	**-0.07**
	195.7%	20%	10%	**34.02%**	**-0.38**
	150%	20%	10%	**35.19%**	**-0.23**

如表8所示,其他参数取基准值，就业人口增长率保持在195.7%的前提下，当个人缴费率从8%提升到10%时，最优的综合税率下降为35.24%。此时个人缴纳的税和费是替代关系，两者的替代弹性约为-0.22，即个人缴费率提高100%，最优综合税率需要下降22%。当人口增长率下降到150%时，最优综合税率上升至36.41%。税、费的替代弹性约为-0.07，即个人缴费调高100%，最优综合税率可以下调7%。

当个人账户做实比例下调为0时，不同人口增长率情况下的税率较现有制度约低1.3个百分点，说明个人税收负担会进一步降低。

表9 税费调整后的最优就业人口增长率

	η^*	τ^*_1	τ^*_2	n
v=12.2%	20%	8%	37%	195.7%
	15%	10.66%	34.75%	376.2%
v=0	20%	8%	37%	195.7%
	15%	9.36%	34.86%	569.8%

表9动态展示了我国税费的调整反过来对就业人口增长率的影响：当前就业人口增长率条件下，当企业缴费率下降至15%，个人缴费率需要按照0.99的弹性提高到10.66%，同时综合税率需要以0.22的弹性下降到34.75%。当调整全部结束后，最优的就业人口增长率需要上升至376.2%，基本为现有增长率的两倍。当个人账户做实比例下调为0时，最优就业人口增长率需要进一步上升为569.8%，

基本为现有增长率的三倍。所以若要真正降低企业和个人的税费负担，就业人口数量必须要大幅度增加。

6. 结论

6.1国有资产净收入向养老保险划拨可以帮助实现养老保险财务平衡

本文将财政收入、支出和国有资产划拨因素引入OLG模型与养老保险制度结合，目的在于实现“国有资产充实社保基金”的政策目标，同时完善个人账户的作用发挥。本文模型将国有资产净收入向养老保险划拨比例设计为内生变量，根据财政收支变量、养老保险收支水平和就业人口增长率自动确定，直至将国有资产收益合理划分到养老保险部门和财政部门，实现养老保险和财政收支的平衡，为政策的落地实施提供可行方法。

6.2缴费率和税率的调整可以优化养老保险制度及经济影响

为响应国家“适时降低养老保险缴费率”的政策号召，本文通过模型分析给出了缴费率和税率的最优调整路径：在现有就业人口增长率的情况下，企业缴费率和个人缴费率的替代弹性约为-0.99，当企业缴费率下降为15%时，个人缴费率需上升为10.66%，最优总和缴费率下降为25.66%。当就业人口增长率下降到150%时，最优总和缴费率会上升至26.93%。

在现有人口增长率条件下，个人缴费率上升100%，最优的综合税率可以以-0.22的替代弹性下调22%；当就业人口增长率下降到150%时，个人缴费率上升100%，最优税率可以以-0.07的替代弹性下降7%。这一结果为我国养老保险缴费和税率调整提供了科学合理的路径，增强了政策具体实施的可行性。

6.3个人账户的“名义化”改革可进一步降低最优总和缴费率和综合税率

本文模型通过设定个人账户做实比例的政策变量，研究发现当该变量下降时我国养老保险的最优总和缴费率和最优工资税率都将进一步下降约1.3-1.5

个百分点。说明当个人账户的“名义化”改革，可以有效提高资金的利用效率，更大幅度的降低企业和个人的税、费负担。

6. 4就业人口要稳定增长

我国劳动力的生产效率较低，相应的劳动收入份额较小，所以就业人口的快速增长并不能带来经济产出的快速提高，相反会大幅度降低各项人均经济指标。但是就业人口增加短期内可以增加养老保险缴费收入，缓解支付压力；长期内，劳动生产率会随经济生产水平提高而得到提升，就业人口的增加会对各个经济因素产生利好的影响。本文最优化的分析结果表明：要想真正降低企业负担，提高劳动者收入水平需要就业人口的稳步增长。当前我国“单独二孩”“全面二孩”政策已经陆续放开实施，出生人口近期将会增加，但是从出生人口增加到有效劳动人口的增加还需要经历较长的时期。所以从近期来看，人口政策对本研究中的城镇就业人员增长率变化影响不大，但是从长期看来会减缓城镇就业人口增长率下滑的趋势。所以在就业人口增长率真正提高之前，政府需要通过资本、科技、创新等多条途径实现生产力提升，社会财富的增加，为养老保险制度改革和财政收支提供物质基础。

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养老保险缴费率调整路径和完善个人账户的实证研究

—— 基于引入国有资本划拨和工资税的OLG模型

高彦 杨再贵

高彦

博士生

中央财经大学保险学院

北京100081，中国

电话: (8610) 6228 8627

Email: gaoyan811116@126.com

杨再贵

教授 博导

中央财经大学保险学院

北京100081，中国

电话: (8610) 6228 8627

Email: yangzaigui@hotmail.com

关键词：OLG模型； 养老保险； 国有资本划拨； 税费负担

中文摘要：我国现有的城镇职工养老保险制度自建立后，一直面临着无法回避的各种难题，如：个人账户资产不实、财政补贴金额巨大，且增速过快的问题等。另一个方面，企业和参保职工则面临着养老保险缴费和税收负担过重的现实问题。为此政府提出了一系列今后养老保险改革的方向和目标。在党的十八届三中全会、五中全会和《中共中央关于制定国民经济和社会发展第十三个五年规划的建议》

中，强调了我国城镇职工养老保险制度需要从完善个人账户、降低税费负担和实现国有资本向社保合理划拨等方面进行改革。

结合以上问题，本文试图建立一个使我国城镇职工养老保险收支平衡的一般均衡交叠世代模型，创新性的引入养老保险个人账户资产不实、国有资产收益划拨等我国的特有因素，使其能够较为真实的模拟我国基本养老保险制度。

在交叠世代模型设计中，本文将国有资产收益划拨因素取代传统的财政补贴引入养老金账户，并以个人账户资金做实比例为调控工具来区分现行个人账户和"名义化"改革后的个人账户，最终运用模型考察缴费率、税率、财政支出占社会产出比例和就业人口增长率等政策变量对社会储蓄、工资、消费和养老金水平等经济因素的综合影响，研究发现：外生变量如缴费率、税率的调整可以优化养老保险制度和其经济影响。为了进一步研究最优外生变量的调整路径和最优的调整目标，本文从社会福利最大化角度进行了模拟分析，得出了最优缴费率和税率调整降低的具体路径：1、企业缴费率降低会使最优个人缴费率以0.99的替代弹性上升，并且调整后的总和缴费率依然会低于现行水平，可以真正实现缴费率水平的降低。当就业人口增长率降低时，最优替代弹性将会上升为1.38。2、个人缴费率的上升将会使最优税率以0.22的替代弹性下降，可以真正降低个人的税收负担。当就业人口增长率降低时，替代弹性会下降为0.07。3、个人账户"名义化"改革后的最优总和缴费率会比改革前下降约1.5个百分点，最优税率会下降约1.3个百分点。说明了个人账户的"名义化"改革有利于进一步降低税、费负担。

本文运用交叠世代模型，从我国现实国情出发研究模拟了最优缴费率和最优税率的调整降低路径，并从社会福利最大化的角度证明了个人账户的"名义化"改革是完善个人账户的可选途径。

The Study of the Payment Recursive Model and Adverse Selection Risk of Pooled Annuity Fund

Linda Zhang, Qijun Yang

Linda Zhang
Professor
Financial And Statistics Academy
HunanUniversity
Changsha 410006, China
Phone: (86)18684716118
Email: lindazhang0203@126.com

Qijun Yang*
Master
Financial And Statistics Academy
HunanUniversity
Changsha 410006, China
Phone: (86)15200858954
Email: 15200858954@163.com

Keywords: Pooled Annuity Fund; Longevity Risk; Stochastic Dynamical Compertz-Makeham Model; Monte Carlo Simulation; Certainty Equivalent Method.

Abstract. As the lifetime tension of the human all of the world, the financial burden of government, company and insurance company which manage the annuities is becoming heavier and heavier, the result is called longevity risk. Longevity risk belongs to systematic risk, which cannot be solved by law of large numbers, the only way to this is to find the subject that can pay for this. About longevity risk, the results of foreign researchers are mainly focused on the longevity risk securitization, however, China's capital market is still not perfect, and till now, this kind of product still not exist in China. The main innovation of this paper is that we put forward the model of the pooled annuity fund in which the systemic longevity risk is borne by the consumers, and the individual longevity risk is borne by the annuity pool.

The pooled annuity fund can provide the participants with cash flow for pension reserve which is similar to ordinary pension annuity, but the originator should not face for

systemic longevity risk, namely, a group of consumers who have pension reserve requirements pool together by their contributions, and the fund of their contributions is worked by professional insurance company or fund company. Every year the payment is adjusted according to the prescribed manner and mortality rates and interest rates in real time. What's more, when a member die, he will lose the rights and interests of his pension. The searchers in China have not began to this study, and the foreign researchers' result is mainly focused on the payment recursive model. But the results till now about pooled annuity fund still have two defects: the first one is when dedecing the recursive model, the influence of the life extension for annuity actuarial present value's calculation is omitted; the second is when talking about the similarities and differences of ordinary annuity and pooled annuity fund, the results only stay in the qualitative analysis, more accurate and reasonable results have not been reached, so this article measure the value of pooled annuity fund from this two angles: the first one is on the basis of predecessors' research results and the "rule of actuarial fair", we deduce the payment recursive model, and then select stochastic dynamic Compertz-Makeham mortality trend extrapolation model and parts of population data of China to measure the distribution of the amount of the pension of pooled annuity fund each year; Then, contrast the difference between ordinary pensions and pooled annuity fund by the size of the adverse selection risk, namely, in this regard, based on the certainty equivalent method, partial derivative of the money that the consumers want to spend on the ordinary pensions and pooled annuity fund to the Survival rates based on The subjective intention of consumers is secelted to measure the adverse selection risk, and at last, by building appropriate assumption, we contrast the adverse selection risk of ordinary annuities and pooled annuity fund.

1. 引言

随着生活环境和医疗技术水平的不断进步，人类预期寿命不断延长，由此导致的政府、企业及保险公司等经营管理养老保险的机构或企业的财务负担不断加重的风险即为长寿风险。如果管理不当，长寿风险将会给这些机构带来沉重的打击。《华尔街日报》2015年10月27日的报道显示：自1990年到2013年我国人口的平均寿命延长了8年半，由此导致我国居民的养老成本不断增加。人社部的报道显示：由于基本养老保险“资不抵债”，各级政府的财政补贴在逐年增加，2014年补贴达到了3548亿元，2002-2014这13年间基本养老保险的财政总补贴已经超过了2万亿。

长寿风险根据承担主体的差异可以分为个体长寿风险和聚合长寿风险。当消费者实际寿命超过预期从而导致个人资产不足以支付老龄阶段的全部生活费用的风险即为个体长寿风险。当消费者面临个体长寿风险时，最常见的应对措施即为通过购买养老年金来保证未来的资金来源。如果整体预期寿命无明显的变化，保险公司可以通过大数法则来实现无数个个体长寿风险的有效分散，因此个体长寿风险与一般的保险风险并无本质区别；但是如果预期寿命的延长变成整个人类社会的趋势，由此带来整体负债的不断增加的风险即为聚合长寿风险。相比于一般的保险风险，寿命延长是一个整体不可逆转的趋势，因而聚合长寿风险无法通过大数法则来进行分散，只能通过各种渠道来寻找分担主体。关于长寿风险的分担模式，理论方面，国内外学者的研究最多的集中在长寿风险证券化方面，即通过以预期死亡率和实际死亡率为基础的现金流转换将长寿风险转移到资本市场，最主要的形式是长寿互换和长寿债券。实践方面，自2003年Swiss Re发行第一款极端死亡率债券Vita Ⅰ以来，国际市场已经成功发行了很多次类似的长寿债券。而相比于国外较为成熟的资本市场我国的相关机制尚不够完善，目前尚无任何一款长寿风险证券化产品，因此用证券化的方式来转移长寿风险至少在短时间内是无法实现的。除了证券化以外，国内外学者还提出两种长寿风险的转移模式：一是将养老年金和定期寿险组合在一起进行捆绑销售，从而实现产品所保风险的自然对冲；二是在养老年金的给付阶段每年通过计算得到的长寿指数来调整给付金额。但是以上两种方法的效果依然有限：首先，由于逆选择风险的存在，定期寿险和养老年金的消费群体没有明显的交集，因此自然对冲策略很难达到预期效果；其次，长寿指数的计算是基于一个国家非常充足的死亡率统计信息，我国正规的人口统计数据自1994年才开始，数据量明显不足，基于此数据计算得到的长寿指数可信度较低。站在长寿风险分担主体的角度考虑，既然保险行业不愿承担聚合长寿风险，而消费者不愿承担个体长寿风险，不妨将二者的作用互换。因此本文创新性的提出年金池承担个体长寿风险而消费者承担聚合长寿风险的互助养老年金模式，希望能为我国政府、寿险业等涉及养老保险的行业提供解决长寿风险的新思路。

2. 文献综述

互助养老年金(Pooled Annuity Fund)又叫群体自助年金化(Group Self-Annuitisation)，John Piggott，Emiliano A. Valdez和Bettina Detzel(2005)最早提出了较为完整的概念，并推导了精算公平原则下的给付递推公式。但是John Piggott等人并未对互助养老年金的特点进行很好的概括；另外，他们提出的给付递推模型在计算年金精算现值$\ddot{a}_x$的时候仍然采用初始设定的死亡率信息，这样做虽然简化了推导过程，但是由此得到的递推模型并不能完全实现长寿风险的转移。随后，Ralph Goldsticker(2007)给出了互助养老年金的定性分析，详细阐述了其概念及特点。

在John Piggott等人和 Ralph Goldsticker的研究基础上，关于互助养老年金的后续研究内容主要集中在以下几个方面：①Jonathan Barry Forman(2014)从企业人员规模的角度研究了互助养老年金的适用范围；②Moshe A. Milevsky，Thomas S. Salisbury(2015)通过求解欧拉—拉格朗日方程得到基于终生效用最大化的互助养老年金的结构，并检验了该结构关于年金人数和逆选择风险的敏感程度；③Michael Z. Stamos(2008)将互助养老年金和普通养老年金结合在一起，并通过HJB方程分析了不同情况下二者的最优组合；④Catherine Donnelly，Montserrat Guillén和Jens Perch Nielsen(2013)同样基于终生效用最大化理论，将互助养老年金和死亡率连接基金做了对比，最后发现：当投资收益率的方差波动较小时，互助养老年金的期望效用大于死亡率连接基金。本文即在John Piggott等人的研究基础上，通过改进其推导过程得到更为贴近实际情况的互助养老年金给付递推模型，并选用中国部分地区的数据来进行实证分析。

3. 互助养老年金的给付模型推导

互助养老年金本质上属于相互保险的一种，即具有同质保障需求(养老储蓄)的单位或个人，通过订立合同成为会员，并缴纳养老金形成互助基金，该基金由专业的基金公司负责投资运作，在成员退休后每年给付养老金的一种保险模式。2015年初，保监会印发了《相互保险组织监管试行办法》，旨在加强对尚处于萌芽阶段的我国相互保险组织的监督管理和促进我国相互保险业的规范健康发展。

根据相互保险的特点以及John Piggott等人提出的模型可以归纳出互助养老年金和普通的养老年金之间的两个主要区别：

（1）由于具有互助性质，如果互助养老年金中的某个成员死亡，他的资金将会按照一定的方式在年金池内进行再分配，这部分待分配的资金被称为死亡率信用(Mortality Credit)。

（2）每年会根据最新的信息来预测未来死亡率的分布和利率的波动，根据预测得到的结果计算给付额调整因子，用调整因子去修正下一年度的给付额。

John Piggott等人推导了在精算公平的原则下每年调整因子的计算方法，最后得出如下形式的一般情形下的递推模型：

$$ {}^{k}_{x}B_{j,t} = {}^{k-1}_{x}B_{j,t-1} \cdot DEA_t \cdot IEA_t 。$$

其中 ${}^{k}_{x}B_{j,t}$ 表示x岁开始参与互助养老年金计划、到第t年已经加入互助养老年金计划k个年度的第j个成员在第t年领取的养老金金额，DEAt和IEAt分别表示从第t-1年到第t年给付额的死亡率调整因子和收益率调整因子。但是在推导DEAt和IEAt的过程中，对于 $\ddot{a}_x$ 的计算始终基于最初的假设，这显然是不完美的，因此我们在其基础上推导基于精算公平原则的更加贴近实际情况的给付递推模型。

对于互助养老年金的第i个成员，假设其加入互助养老年金初始时刻的年龄为x，在t时刻假设他已经加入了k(k≥1)个时间段，则可以分别用 ${}^{k}_{x}F_{i,t}$ 和 ${}^{k}_{x}B_{i,t}$ 表示该成员此时的尚未收到在t-1到t时刻之间去世的人的资金分配时的资金总额和该时刻领取的养老金数额，则

$$ F_t = \sum_{k\geq 1}\sum_{x}\sum_{A_t} {}^{k}_{x}F_{i,t} + \sum_{k\geq 1}\sum_{x}\sum_{D_{t-1}} {}^{k}_{x}F_{i,t} ，$$

其中Ft表示t时刻互助养老年金的资金总额，At和Dt-1分别表示t时刻尚且存活的成员和t-1时刻到t时刻之间去世的成员。将去世的人的资金分配完成后，第i个尚且存活的成员资金总额记为 ${}^{k}_{x}\hat{F}_{i,t}$ 。根据精算公平的原则，去世的人的资金按照此时尚且存活的成员们各自的资金占他们此时资金总额的比例进行分配，因此有：第j个存活的成员经过分配后的资金总额为

$$ {}^{k}_{x}\hat{F}_{j,t} = \frac{F_t}{\sum_{k\geq 1}\sum_{x}\sum_{A_t} {}^{k}_{x}F_{i,t}} \cdot {}^{k}_{x}F_{j,t} = {}^{k}_{x}B_{i,t} \cdot \ddot{a}_{x+k,t} ，$$

其中 ${}^{k}_{x}F_{j,t} = ({}^{k-1}_{x}\hat{F}_{j,t-1} - {}^{k-1}_{x}B_{i,t-1})(1+R_{t-1})$。

在t时刻刚刚加入的成员由于其资金尚未开始按照约定的规则运作所以不能看成是t时刻基金的一部分，即Ft不包括在t时刻刚刚加入的成员的资金，所以在确定分配额度的时候需要加上k≥1这个条件，即刚刚加入的成员无法获得累积到t时刻的资金的分配。对于刚刚加入的成员，假设其初始资金为 ${}^{0}_{x}F_{j,t}$ ，则其首年领取的养老金金额 ${}^{0}_{x}B_{j,t} = \dfrac{{}^{0}_{x}F_{j,t}}{\ddot{a}_{x,t}}$ 。

对于x岁时加入，已经加入了k(k≥1)年的编号为j的成员，其在t时刻的养老金金额为：

$$ {}^{k}_{x}B_{j,t} = \frac{{}^{k}_{x}\hat{F}_{j,t}}{\ddot{a}_{x+k,t}} = \frac{1}{\ddot{a}_{x+k,t}} \cdot \frac{F_t}{\sum_{k\geq 1}\sum_{x}\sum_{A_t} {}^{k}_{x}F_{i,t}} \cdot {}^{k}_{x}F_{j,t} , $$

由 ${}^{k}_{x}F_{j,t}$ =(${}^{k-1}_{x}\hat{F}_{j,t-1}$ - ${}^{k-1}_{x}B_{j,t-1}$)(1+R_{t-1})， ${}^{k-1}_{x}\hat{F}_{j,t-1} = {}^{k-1}_{x}B_{j,t-1} \cdot \ddot{a}_{x+k-1,t-1}$ ，按照与John Piggott同样的方式，

等式右边乘以一个 $\frac{\ddot{a}_{x+t,t-1}}{\ddot{a}_{x+t,t-1}}$ ，带入并化简得到给付递推公式：

$$ {}^{k}_{x}B_{j,t} = {}^{k-1}_{x}B_{j,t-1} \cdot p_{x+k-1,t-1} \cdot \frac{F_t}{\sum_{k\geq 1}\sum_{x}\sum_{A_t} {}^{k}_{x}F_{i,t}} \cdot \frac{\ddot{a}_{x+t,t-1}}{\ddot{a}_{x+t,t}} \cdot \frac{1+R_{t-1}}{1+R} 。 $$

$DEA_t = p_{x+k-1,t-1} \cdot \frac{F_t}{\sum_{k\geq 1}\sum_{x}\sum_{A_t} {}^{k}_{x}F_{i,t}} \cdot \frac{\ddot{a}_{x+t,t-1}}{\ddot{a}_{x+t,t}}$ ，表示t时刻死亡率调整因子，

$IEA_t = \frac{1+R_{t-1}}{1+R}$ 表示t时刻的利率调整因子。

4. 基于真实死亡率统计数据的养老金金额分布情况分析

在得到给付递推模型的基础上，本部分选取我国真实的人口统计数据及合适的死亡率趋势外推模型来得到未来一段时间内的预期死亡率分布情况，随后采用蒙特卡洛模拟，基于上一部分内容中推导出的给付模型得到每年给付额的分布。

4.1 死亡率预测模型

由于研究对象是聚合长寿风险，所以选取的死亡率预测模型必须能反映死亡率的整体变化趋势。综合多种考虑，在M. Kenan Terziog lu1 和MeralSucu(2015)提出的用于估计土耳其人口分布情况的Compertz—Makeham模型的基础上稍加改进提出随机动态Compertz—Makeham模型(以下简称随机动态CoMa模型)。其形式如下：

$$ \mu_{x,t} = y_{t1} + y_{t2}c^{x}, $$

$$ dy_{t1} = a_1 dt + \sigma_1 dW_{t1}, $$

$$ dy_{t2} = a_2 dt + \sigma_2 dW_{t2}, $$

$$ dW_{t1} dW_{t2} = \rho dt, $$

其中$y_{t1}>0$、$y_{t2}>0$，$c>1$，$\sigma_1>0$，$\sigma_2>0$，$-1\leq\rho\geq 1$，W_{t1}和W_{t2}为标准布朗运动。聚合长寿风险反映在该模型中即为a_1、a_2均为负数。

由布朗运动的特点可知，死亡率 $\mu_{x,t}$ 服从正态分布，其均值和方差分别为

$$ E(\mu_{x,t}) = (a_1 t + y_{01}) + (a_2 t + y_{02})c^{x} $$

$$\mathrm{Var}(\mu_{x,t})=\sigma_1^2 t+\sigma_2^2 t c^{2x}+2\rho\sigma_1\sigma_2 c^x t$$

在知道x岁的人在t时刻的死亡率分布为$\mu_{x,t}=y_{t1}+y_{t2}c^x$的条件下，很容易得知x岁的人在t+s时刻的死亡率的期望值、生存率和年金精算现值分别为：

$$E\left[\mu_{x,t+s}\middle|\mu_{x,t}\right]=(y_{t1}+a_1 s)+(y_{t2}+a_2 s)c^x,$$

$${}_s p_{x,t}=\exp\left[-\int_x^{x+s}\mu_{z,t}dz\right]=\exp\left[-y_{t1}s-\frac{y_{t2}}{\ln c}(c^{x+s}-c^x)\right],$$

$$\ddot{a}_{x,t}=\sum_{s=0}^{\infty}e^{-\delta s}\,{}_s p_{x,t}=\sum_{s=0}^{\infty}\exp(-(y_{t1}+\delta)s-\frac{y_{t2}}{\ln c}(c^{x+s}-c^x))。$$

由于互助养老年金的目标客户群为退休人士或即将退休之人，因此不妨以中国台湾地区为例，数据来源自Human Mortality Database。选取其中年龄段在60-105岁之间，统计年份为1970-2010之间的中国台湾地区不区分性别的综合人口统计数据来拟合上述动态CoMa模型的参数。首先在Human Mortality Database中得到1970-2010年每年不同年龄段的台湾地区不分性别的死亡人数统计数据(Deaths)，记为$\hat{D}_{x,t}$；随后得到1970-2010年每年不同年龄段的台湾地区不分性别的人口总数(Exposure-to-Risk)，记为$\hat{E}_{x,t}$。在$\hat{D}_{x,t}$和$\hat{E}_{x,t}$中，x表示年龄(60-105)，t表示统计时间(1970-2010)。则每年的台湾地区不区分性别的不同年龄的死亡率可由

$\hat{m}_{x,t}=\dfrac{\hat{D}_{x,t}}{\hat{E}_{x,t}}$计算得到。

根据M. Kenan Terziog lu1 和MeralSucu(2015)的假设：死亡率随机过程的均值和方差满足标准泊松过程，即t时刻$E_{x,t}$个x岁的人的死亡率为$\mu_{x,t}$ $E_{x,t}$，那么显然此时条件分布$\dfrac{D_{x,t}}{E_{x,t}}|\mu_{x,t}$的均值为$\mu_{x,t}$，方差为$\dfrac{\mu_{x,t}}{E_{x,t}}$。

为将随机动态CoMa分布中的未知参数与$\hat{m}_{x,t}$建立联系，这里采用条件均值和条件方差公式来推导：

$$E\left[\frac{D_{x,t}}{E_{x,t}}\right]=E\left[E\left[\frac{D_{x,t}}{E_{x,t}}|\mu_{x,t}\right]\right]=E\left[\mu_{x,t}\right]=\mu_{x,t},$$

$$Var\left[\frac{D_{x,t}}{E_{x,t}}\right]=Var\left[E\left[\frac{D_{x,t}}{E_{x,t}}|\mu_{x,t}\right]\right]+E\left[Var\left[\frac{D_{x,t}}{E_{x,t}}|\mu_{x,t}\right]\right]=E\left[\frac{\mu_{x,t}}{E_{x,t}}\right]+\mathrm{Var}\left[\mu_{x,t}\right]$$

$$\approx E\left[\frac{\mu_{x,t}}{\hat{E}_{x,t}}\right]+\mathrm{Var}\left[\mu_{x,t}\right]\approx\frac{\hat{m}_{x,t}}{\hat{E}_{x,t}}+\mathrm{Var}\left[\mu_{x,t}\right]。$$

即x岁的人在第t年的死亡概率服从均值为 $\mu_{x,t}$=(a_1t+y_{01})+(a_2t+y_{02})c^x，方差为 $\frac{\hat{m}_{x,t}}{\hat{E}_{x,t}}+\mathrm{Var}\left[\mu_{x,t}\right]=\frac{\hat{m}_{x,t}}{\hat{E}_{x,t}}+\sigma_1^2 t+\sigma_2^2 tc^{2x}+2\rho\sigma_1\sigma_2 c^x t$的正态分布。根据台湾人口的死亡率数据，不难得到其对数似然函数为：

$$l(m_{x,t})=-\sum_{x=60}^{105}\sum_{t=0}^{40}\ln\left(\left[\sqrt{2\pi\left(\frac{\hat{m}_{x,t}}{\hat{E}_{x,t}}+\sigma_1^2 t+\sigma_2^2 tc^{2x}+2\rho\sigma_1\sigma_2 c^x t\right)}\right]\right)$$

$$-\frac{1}{2}\sum_{x=60}^{105}\sum_{t=0}^{40}\left[\left(\frac{\hat{m}_{x,t}-(a_1t+y_{01})-(a_2t+y_{02})\ c^x}{\sqrt{\frac{\hat{m}_{x,t}}{\hat{E}_{x,t}}+\sigma_1^2 t+\sigma_2^2 tc^{2x}+2\rho\sigma_1\sigma_2 c^x t}}\right)^2\right]。$$

将1886个 $\hat{m}_{x,t}$ 和 $\hat{E}_{x,t}$ 带入，利用matlab输入约束条件：$y_{01}>0$、$y_{02}>0$，$c>1$，$\sigma_1>0$，$\sigma_2>0$可求得当对数似然函数最大时的8个未知参数分别为：

$\tilde{y}_{01}$=0.0003177277，

$\tilde{y}_{02}$=0.0002133334，

$\tilde{c}$=1.0810608025，

$\tilde{a}_1=-2.86299\times10^{-9}$，

$\tilde{a}_2=-2.66076\times10^{-6}$，

σ_1=0.0001693316，

σ_2=0.0000058132，

ρ=0.8786346573。

选择卡方参数 $\chi^2=\sum_{i=1}^{k}\frac{(O_i-E_i)^2}{E_i}$ 来检验得到的参数估计值是否可信。其中 O_i 表示观测到的数据，E_i 表示根据估计的参数值计算得到的分布数据。根据前面估计的参数值计算得到 $\chi^2=\sum_{x=60}^{99}\sum_{t=0}^{80}\frac{\left(\hat{m}_{x,t}-\tilde{m}_{x,t}\right)^2}{\tilde{m}_{x,t}}$=30.45961，而当置信度为95%时，$\chi^2_{k-1-q}$=1978.9，很显然当置信度为95%时，$\chi^2<\chi^2_{k-1-q}$，因此不拒绝原假设。

4.2 随机模拟

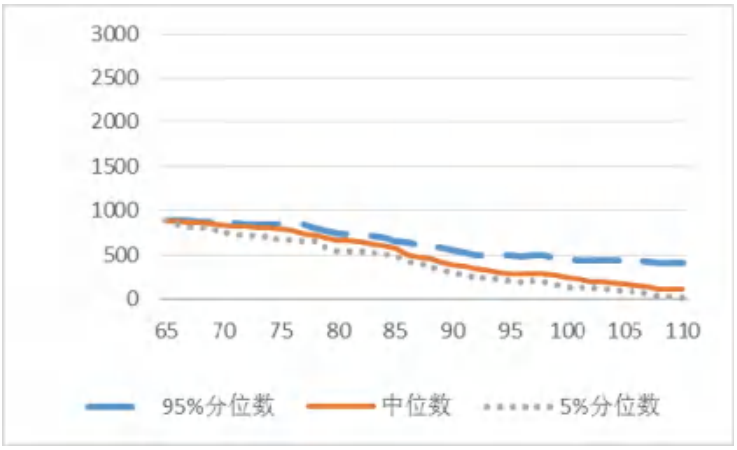
首先提出如下假设：假设2015年为初始时刻有一群年龄65岁的退休人员加入互助养老金计划，初始资金均为10000元。利用matlab做死亡率服从动态CoMa模型，给付额服从第二部分推导得出的递推公式的蒙特卡洛模拟来观察不同情况下

互助养老年金成员退休后的收入情况。选取每年领取的养老金金额的95%分位数、中位数和5%分位数来进行分析。

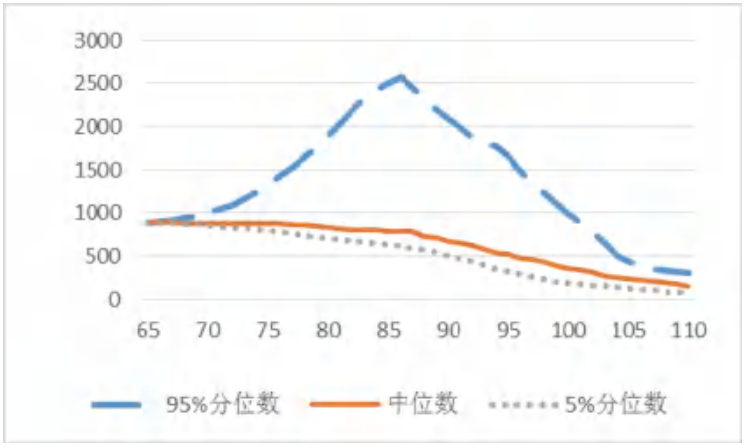
结果分析：

(1) 当互助养老年金封闭(即初始时刻之后不再加入新的成员加入)，且预定利率和实际利率相同均为5%(δ=0.04879)时，首先来观察成员数量N的影响。假设N分别为1，10，1000和10000，得到每年的养老金领取额的95%分位数、中位数和5%分位数分布情况如下图所示：

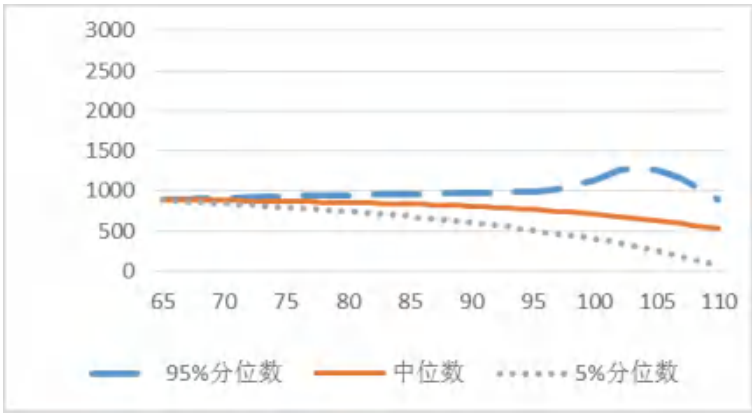
(2)



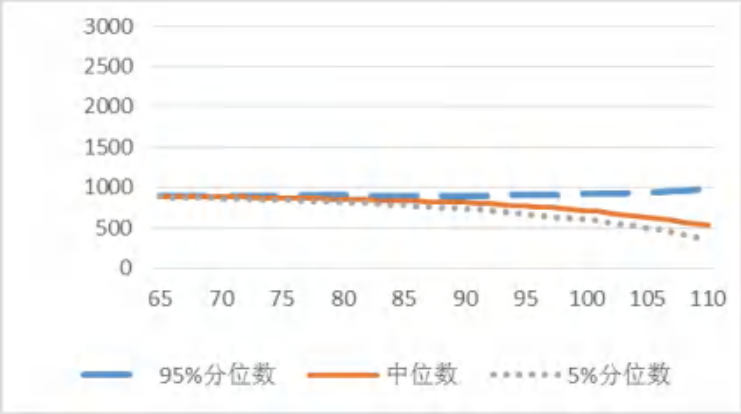
N=1



N=10



N=1000



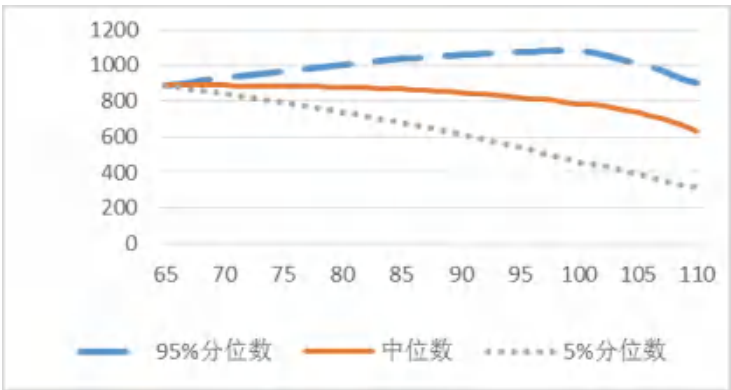
N=10000

图1：不同成员人数的养老金领取金额分布情况

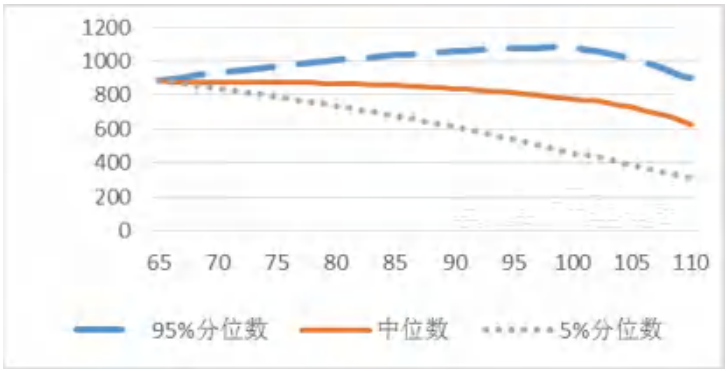
当N=1时，即个人自年金化，按照每年模拟得到的实际死亡率来调整退休后领取的金额，计算得到的结果显示每年的领取金额在逐年下降，即为长寿风险影响下的结果。当N=10时，观察到领取金额95%分位数在中间阶段出现了较大程度的上升，这是因为当成员人数比较少并且又有大比例的人死亡的时候，存活的成员领取的养老金金额将会大幅度上升。但是当N继续变大到1000和10000的时候，可以观察到每年领取的养老金金额的分布情况明显变得较为平滑，且N越大，95%分位数、中位数和5%分位线之间的差距就越小，这说明成员人数越多，互助养老年金的分布情况越稳健。

(3) 现改变条件假设联合养老基金是开放式的，来观察每年有1000个新成员加入和每5年有1000个新成员加入两种不同的情况下养老金金额的变化情况：

(4)



每年均有1000个新成员加入

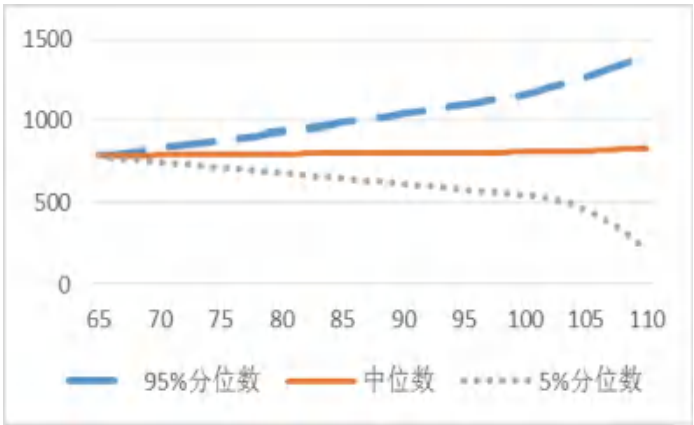


每五年有1000个新成员加入

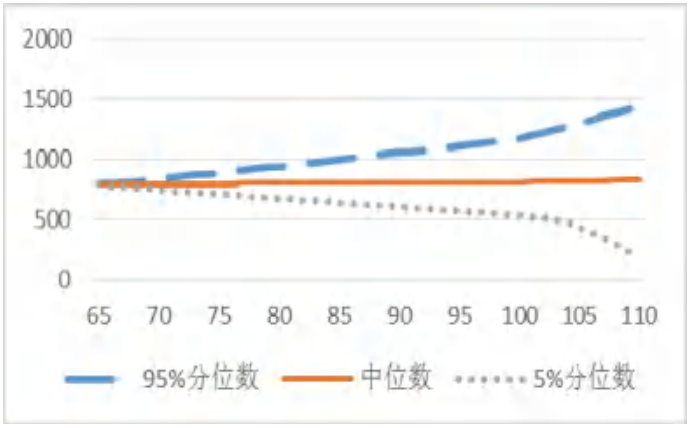
图2：开放式互助养老年金每年领取的养老金金额的分布情况

很明显两种情况下的分布并无显著的差别，唯一的差别是每年均有1000名成员加入的情况下每年领取的养老金金额的波动稍小于每5年有1000名成员加入的情况。这是因为新加入的成员的资金并不会影响其他成员的领取金额，所以两种情况下养老金领取金额的分布情况大致相同，但是新成员加入的频率较快相当于变相增加了互助养老年金的成员规模，所以此时波动就会比较小。

(3)现在考虑收益率的影响。之前都是假设收益率固定为常数5%，现在假设2015年以后实际收益率服从CIR随机利率模型。利用台湾银行公布的1988年7月7日至今的73次均值为0.041739，标准差为0.025481的三年及以上定期存款利率数据来观察分布的变化情况。分别观察收益率固定为0.041739不变和服从均值为0.041739，标准差为0.025481的CIR随机利率模型、通过生成每年的利率随机数作为实际收益率，两种情况下每年领取的养老金金额的分布情况。假设养老金结构为每年有1000名65岁的新成员加入，在两种情况下每年领取金额分别如下图所示：



收益率为0.041739



收益率服从CIR随机利率模型

图3：不同利率下每年领取的养老金金额的分布情况

很明显：当服从CIR随机利率模型时分布的波动稍大但是非常不明显，即收益率的变化对每年领取的养老金金额的影响是非常有限的，成员规模和聚合长寿风险才是影响领取金额变化的主要因素。

5. 互助养老年金的逆选择风险

逆选择表现在养老保险产品上，即为由于对自身健康状况、生活习惯等方面的了解程度较高，被保险人往往会做出对自己更有利的选择。本文通过普通商业养老年金和互助养老年金的逆选择风险的对比来探讨互助养老年金逆选择风险的大小。

假设普通商业养老年金和互助养老年金同时存在，投资者Q的初始资金总额为A，他投资在普通养老年金中的资金为a(a≥0)，投资在互助养老年金中的资金为g(g≥0)。将Q的人生阶段分为退休之前和退休之后两个过程。退休之前通过投资为退休之后的生活进行储备，此阶段财富总额记为W0；退休之后则开始领取养老金，此阶段的财富总额记为W1。假设Ra为普通养老年金初始设定的投资回报率，Rg为互助养老年金初始设定的投资回报率。假设Q关于财富的效用函数为u=u(x)，购买养老年金的消费者均为风险厌恶型，因此对于Q的效用函数显然有u'(x)＞0且u''(x)＜0。那么对于Q来说，其效用函数可表示为：

$$u=u(W_0)+vpu(W_1),$$

其中W0=A-a-g，W1=Raa+RggY。v表示折现因子，p表示根据Q的主观意愿确定的生存概率。通过第二部分的研究发现：互助养老年金的每年都会有一个给付调整因子DEAt·IEAt，在这里为了方便表示简记为随机变量Y。

对Q的效用函数求期望E(u)= u(W0)+vpE(u(W1))。假设Q为理性人，即他会选择使得自己的期望效用最大化的财富分配方式。因此对其期望效用求偏微分：

$$\frac{\partial E(u)}{\partial a} = -u'(W_0)+vpR_aE(u'(W_1))$$

$$\frac{\partial E(u)}{\partial g} = -u'(W_0)+vpR_gE(u'(W_1)Y)$$

期望效用最大化等同于：$\frac{\partial E(u)}{\partial a}=0$且$\frac{\partial E(u)}{\partial g}=0$，因此可得：

$$u'(W_0)=vpR_aE(u'(W_1)) \quad (1)$$

$$u'(W_0)=vpR_gE(u'(W_1)Y) \quad (2)$$

两式相比得：

$$R_aE(u'(W_1))= R_gE(u'(W_1)Y) \quad (3)$$

即当a和g同时满足公式(1)和(2)时Q的期望效用最大。

现在考虑逆选择风险，即基于投资者主观意愿的生存率对财富分配的影响，表现在此处可以用$\frac{\partial a}{\partial p}$和$\frac{\partial g}{\partial p}$表示：当$\frac{\partial a}{\partial p}$和$\frac{\partial g}{\partial p}$大于0的时候即表示存在逆选择风险，且其值越大，逆选择风险越大。

(1)和(2)等式两边均对p求偏导可得：

$$u''(W_0)\left(\frac{\partial W_0}{\partial a}\cdot\frac{\partial a}{\partial p}+\frac{\partial W_0}{\partial g}\cdot\frac{\partial g}{\partial p}\right)$$

$$=vR_aE(u'(W_1))+vpR_aE(u''(W_1)\left(\frac{\partial W_1}{\partial a}\cdot\frac{\partial a}{\partial p}+\frac{\partial W_1}{\partial g}\cdot\frac{\partial g}{\partial p}\right)) \quad (4)$$

$$u''(W_0)\left(\frac{\partial W_0}{\partial a}\cdot\frac{\partial a}{\partial p}+\frac{\partial W_0}{\partial g}\cdot\frac{\partial g}{\partial p}\right)$$

$$= vR_gE(u'(W_1)Y)+ vpR_gE(u''(W_1)Y\left(\frac{\partial W_1}{\partial a}\cdot\frac{\partial a}{\partial p}+\frac{\partial W_1}{\partial g}\cdot\frac{\partial g}{\partial p}\right)) \quad (5)$$

两式相比且根据式(3)可化简得

$$R_aE(u''(W_1)\left(\frac{\partial W_1}{\partial a}\cdot\frac{\partial a}{\partial p}+\frac{\partial W_1}{\partial g}\cdot\frac{\partial g}{\partial p}\right))= R_gE(u''(W_1)Y\left(\frac{\partial W_1}{\partial a}\cdot\frac{\partial a}{\partial p}+\frac{\partial W_1}{\partial g}\cdot\frac{\partial g}{\partial p}\right)) \quad (6)$$

已知$\frac{\partial W_1}{\partial a}=R_a$，$\frac{\partial W_1}{\partial g}=R_gY$，带入整理得：

$$\frac{\partial a}{\partial p} =$$

$$-\frac{v^2pR_aE\left(u'(W_1)\right)\times R_gE\left(u''(W_1)\,Y\left(R_gY-R_a\right)\right)}{vp\left(u''(W_0)\,E\left(u''(W_1)\left(R_a-R_gY\right)^2\right)+vpR_a{}^2R_g{}^2\left(E\left(u''(W_1)\right)E\left(u''(W_1)\,Y^2\right)-\left(E\left(u''(W_1)\,Y\right)\right)^2\right)\right)}$$

$$\frac{\partial g}{\partial p}=$$

$$-\frac{v^2 pR_a E\left(u'(W_1)\right)\times R_a E\left(u''(W_1)\left(R_a-R_gY\right)\right)}{vp\left(u''(W_0)\ E\left(u''(W_1)\left(R_a-R_gY\right)^2\right)+vpR_a{}^2R_g{}^2\left(E\left(u''(W_1)\right)E\left(u''(W_1)\ Y^2\right)-\left(E\left(u''(W_1)\ Y\right)\right)^2\right)\right)}$$

假设$\frac{\partial g}{\partial p}\neq 0$，那么有：

$$\frac{\partial a/\partial p}{\partial g/\partial p}=\frac{R_g^2E(u''(W_1)\ Y^2)-R_aR_gE(u''(W_1)\ Y)}{R_a^2E(u''(W_1)\ )-R_aR_gE(u''(W_1)\ Y)} \tag{7}$$

注意到$\frac{\partial a}{\partial p}$和$\frac{\partial g}{\partial p}$的分母均为：

$$vp\left(u''(W_0)\ E\left(u''(W_1)\left(R_a-R_gY\right)^2\right)+vpR_a{}^2R_g{}^2\left(E\left(u''(W_1)\right)E\left(u''(W_1)\ Y^2\right)-\left(E\left(u''(W_1)\ Y\right)\right)^2\right)$$

$$=\left|H\right|,$$

其中H=$\begin{pmatrix}\frac{\partial^2E(u)}{\partial a^2} & \frac{\partial^2E(u)}{\partial a\partial g}\\ \frac{\partial^2E(u)}{\partial a\partial g} & \frac{\partial^2E(u)}{\partial g^2}\end{pmatrix}$表示期望效用对a和g的二阶偏导数的黑塞矩阵。

记—$v^2pR_aE\left(u'(W_1)\right)$=W，$R_gE\left(u''(W_1)\ Y\left(R_gY-R_a\right)\right)$=A，

$R_aE\left(u''(W_1)\left(R_a-R_gY\right)\right)$=B，那么此时$\frac{\partial a}{\partial p}$和$\frac{\partial g}{\partial p}$可以表示成：$\frac{\partial a}{\partial p}=\frac{W\times A}{\left|H\right|}$，

$\frac{\partial g}{\partial p}=\frac{W\times B}{\left|H\right|}$。

在Q作出投资决策的时候，本部分以确定等值法为基本原则：即包含不同风险类型或不同风险水平的现金流的效用相等，表现在此处即为u(Ra)=E(u(RgY))。根据风险厌恶型消费者效用函数的凹凸性可知：u(Ra)=E(u(RgY))＜u(E(RgY))，又由效用函数的递增性可知：Ra＜RgY。

在此条件下，提出两个假设并予以证明——

假设一：对∀ a≥0，g≥0，均有$\frac{\partial(a+g)}{\partial p}>0$，即无论如何选择养老年金和互助养老年金的组合，均存在逆选择风险。

证明：$\frac{\partial(a+g)}{\partial p}=\frac{\partial a}{\partial p}+\frac{\partial g}{\partial p}=\frac{W\times(A+B)}{\left|H\right|}$

首先很显然W=—$v^2pR_aE\left(u'(W_1)\right)<0$，

其次，

A+B=$R_gE\left(u''(W_1)\ Y\left(R_gY-R_a\right)\right)+R_aE\left(u''(W_1)\left(R_a-R_gY\right)\right)$=E(u''(W$_1$)($R_a+\left(R_gY\right)$)^2)＜0，

最后，根据黑塞矩阵副半正定的性质可知：$\left|H\right|>0$，

所以综上所述可知$\frac{\partial(a+g)}{\partial p}=\frac{W\times(A+B)}{|H|}>0$恒成立，逆选择问题始终存在。

在假设一成立的基础上，提出假设二：假设$E(u''(W_1)Y^2)\leq E(u''(W_1))(EY)^2$成立并且$\frac{\partial g}{\partial p}>0$，那么此时$\frac{\partial a}{\partial p}>\frac{\partial g}{\partial p}$必然成立，即互助养老年金逆选择风险小于普通商业养老年金。

证明：要想证明$\frac{\partial a}{\partial p}>\frac{\partial g}{\partial p}$成立且已知$\frac{\partial a}{\partial p}$、$\frac{\partial g}{\partial p}$均大于0，此时只需要证明$\frac{\partial a/\partial p}{\partial g/\partial p}>1$即可。根据等式（7），即证$\frac{\partial a/\partial p}{\partial g/\partial p}=\frac{R_gE\left(u''(W_1)\ Y\left(R_gY-R_a\right)\right)}{R_aE(u''(W_1)\left(R_a-R_gY\right))}>1$。

根据假设，$\frac{R_g^2E\left(u''(W_1)\ Y^2\right)}{R_a^2E\left(u''(W_1)\right)}=\frac{R_g^2}{R_a^2}\cdot\frac{E\left(u''(W_1)\ Y^2\right)}{E\left(u''(W_1)\right)}\geq\left(\frac{R_g}{R_a}E\left(Y\right)\right)^2>1$

上式等价于$R_gE\left(u''(W_1)\ Y^2\right)<R_aE\left(u''(W_1)\right)$

两边同时减去$R_aR_gE\left(u''(W_1)\ Y\right)$得到：

$R_gE\left(u''(W_1)\ Y\left(R_gY-R_a\right)\right)<R_aE(u''(W_1)\left(R_a-R_gY\right))$

因为$\frac{\partial g}{\partial p}>0$所以上述不等式右边<0，将上述不等式变换形式即得：

$\frac{R_gE\left(u''(W_1)\ Y\left(R_gY-R_a\right)\right)}{R_aE(u''(W_1)\left(R_a-R_gY\right))}>1$，假设成立。

之所以假设$E(u''(W1)Y^2)\leq E(u''(W1))(EY)^2$，是因为长寿风险对死亡率的影响是一个较为缓慢而且渐变的过程，即E(Y)接近1但是小于1，因此不妨通过$E(u''(W1)Y^2)\leq E(u''(W1))(EY)^2$给E(Y)设定一个上限。不难证明如果投资者的效用函数是CRRA效用函数或是指数效用函数，$E(u''(W1)Y^2)\leq E(u''(W1))(EY)^2$均成立。

由此可以总结出互助养老年金相对于普通养老年金而言其优势和劣势：

互助养老年金的优势有：1.相比于普通养老年金而言拥有较高的给付额，原因有两点：首先由于互助养老年金是由参与者承担系统性长寿风险和投资风险因而消费者不需要支付将这部分风险转移给保险公司而产生的风险保费，因而所有的投资收益均在参与者中间进行分配；其次，通过给付递推模型的推导过程可以看出：互助养老年金的死亡率精算假设是基于平均余命，小于普通养老年金所基于的生命表中的极限年龄。2.互助养老年金本质上属于是群体自年金化的一类，因此参与者可以根据自身喜好更加灵活的选择年金基金结构和投资方式。结构方面，可以选择单一群体或多样化群体、封闭式或开放式的互助养老年金；投资方式方面可以选择较为保守但是收益较低的投资方式，也可以选择风险较大但是收

益较高的投资方式。3.透明度较高。互助养老年金和共同基金较为相似，但不同之处在于互助养老年金是基于实时的死亡率信息和利率信息来调整给付额，计算方式也较为简单，参与者们可以随时知道互助养老年金的收益情况和调整方式。4.逆选择风险较低，通过本部分的证明可知，当存在信息不对称时，互助养老年金关于信息不对称程度的敏感性要小于普通养老年金。

互助养老年金的劣势有：1.由于每年都要计算给付调整因子，所以需要对死亡率和利率的未来趋势有较好的判断，否则会严重影响未来领取金额分布的平稳程度。2.通过观察成员人数N对于给付额分布的影响可知：当成员人数较少(N=10)时，给付额分布波动较大，此时可能会诱发成员的道德风险，但是当成员人数上升到一定程度时，给付额分布的波动就变得极小，就不会诱发道德风险。因此互助养老年金要求成员达到一定的数量才可保证正常运行。相信随着人口统计技术的不断提升和我国相互保险业的逐步发展，这两个缺点的影响会变得越来越小。

6. 结论

本文首先在John Piggott等人的基础上给出了基于精算公平原则的更加贴合实际的互助养老年金的给付递推模型，并选取随机动态CoMa模型预测死亡率，通过蒙特卡洛模拟，基于随机动态CoMa模型得到的死亡率分布以及推导得出的给付模式得到养老金金额的分布情况，通过分析得到的结果得出如下结论：利率和新成员加入的速度对领取金额的大小并无实质性的影响。随后，本文以确定等值法为基本原则，通过投保人投资于普通养老年金和互助养老年金的金额关于对自身健康状况的了解程度的一阶偏导数来刻画逆选择风险的大小，并假设投保人均为风险厌恶型，最后通过证明得出结论：在一般情形下，互助养老年金的逆选择风险相对较小。

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互助养老年金的给付模型及逆选择风险研究

张琳 杨起军

张琳
教授
湖南大学金融与统计学院
长沙410006，中国
电话: (86)18684716118
Email:lindazhang0203@126.com

杨起军*
硕士研究生
湖南大学金融与统计学院
长沙410006，中国
电话: (86)15200858954
Email: 15200858954@163.com

关键词: 互助养老年金；长寿风险；随机动态Compertz-Makeham模型；蒙特卡洛模拟；确定等值法

中文摘要. 人类寿命的不断延长导致经营或管理养老年金的政府机构、企业或保险公司财务负担不断加重的风险即为长寿风险。长寿风险为无法通过大数法则进行分散的系统风险，只能通过有效的方式来寻找承担主体。关于长寿风险的研究目前国内外学者主要的研究方向集中在长寿风险证券化方面，但是我国资本市场尚不够完善，目前国内也尚无任何一款长寿风险证券化的产品。因而本文的创新之处为：提出了由消费者承担系统性长寿风险，而年金池来承担个体长寿风险的互助养老年金模式，目的在于为我国政府、企业或保险行业提供解决长寿风险的新思路。

互助养老年金又叫群体自年金化，它可以为其参与者提供类似于普通养老年金的现金流用于养老储备，但是不同于普通养老年金，发起人无需承担系统性长

寿风险，即一群有养老储备需求的消费者通过缴纳资金形成年金池并交由专业的保险公司或基金公司来运作，每年按照约定的方式和实时的死亡率和利率信息来调整给付额，当某个成员去世后，他将丧失其资金权益的一种养老金给付模式。我国学者目前尚无互助养老年金方面的研究，国外学者的研究方向主要集中在给付递推模型上。但是关于互助养老年金的研究内容目前还存在两个缺陷：一是在推导给付递推模型时省略了寿命延长对于年金精算现值计算的影响，二是关于互助养老年金和普通养老年金的异同目前只有定性的分析尚无更为准确合理的对比，因此本文从两个角度来衡量互助养老年金的价值：首先是在前人研究成果的基础上，推导出基于“精算公平原则”的给付递推模型，并选取随机动态Compertz-Makeham死亡率趋势外推模型和中国部分地区的人口统计数据来观测互助养老年金每年领取的养老金金额的分布情况；随后，通过逆选择风险的大小来对比普通养老年金和互助养老年金的区别，即以确定等值法为原则，利用消费者投资于普通养老年金和互助养老年金的资金金额关于消费者基于主观意愿的生存率的偏导数来衡量逆选择风险的影响程度，并通过提出恰当的假设对比了普通养老年金和互助养老年金在一般情形下逆选择风险的大小。

Chapter 5. Pension and Social Security

Mortality Prediction and Longevity Bond Pricing Based on Population Data in China

HAO Jifei, WANG Haiyan, ZHENG Qi, ZHOU Huilin

HAO Jifei
Master Candidate
School of Economics and Management
Tongji University
Rm. 816, Block A Tongji Plaza, No.1500,Siping Rd.
Shanghai 20092, China
Phone:（086）131 6729 7103
Email: 18666845524@163.com

WANG Haiyan*
PhD, Associate Professor
School of Economics and Management
Tongji University
Rm. 816, Block A Tongji Plaza, No.1500,Siping Rd.
Shanghai 20092, China
Phone:（086）139 1728 3932
Email: wanghaiyan@tongji.edu.cn

ZHENG Qi
Master Candidate
School of Economics and Management
Tongji University
Rm. 816, Block A Tongji Plaza, No.1500,Siping Rd.
Shanghai 20092, China
Phone: (086) 188 1820 3503
E-mail: 1223921119@qq.com

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Abstract. Today in the world, with the declining of population mortality, longevity risk gradually highlights. China as a country with huge population but entering the aging society, longevity risk management should be of great urgency.

Study on longevity risk is mainly concentrated on three aspects: mortality prediction, product pricing and securitization design. For the mortality prediction, the trend extrapolation models based on historical data is widely used, in which the dynamic mortality model(first proposed by Lee and Carter) has been favored by

many scholars and it has been continuously improved and gradually form different modified Lee-Carter model, RH model, etc. Moreover, scholars also put forward the general linear model (GLM), HP model and CBD model. At present, the research mostly focuses on the optimization of the existing models; For product pricing, because the market is not perfect, the main research methodology focuses on the concept of risk neutral and probability distortion method proposed by Wang. In the subsequent study, scholars found that Wang transform shows more advantages in bond pricing, however also with its own limitation. Till now, there is still no widely accepted pricing method for longevity risk products; For securitization, the main products include longevity bond, longevity swap, Q forwards, survival option as well as survival futures, Among them, the research concentrates relatively on longevity bond and longevity swap.

Based on the review above and the status quo of longevity risk management in China, this study will predict the mortality rate in China, and then design one longevity bond and price for it. the main part of the paper is structured as follows:

First, for the mortality prediction, we will apply the Lee-Carter model, for which we take the Chinese population data according to gender and age, death risk exposure data and historical mortality rate from the national statistics sources. Then we fit and estimate the model parameters and finally predict and analyze the China future population mortality and related results.

Secondly, we will study the design and pricing of longevity bonds. First, we will study the cash flow and the operating mechanism of triggered longevity bond which widely accepted on the market. Then we will design longevity bonds, construct survival index using the mortality rate predicted above, and then determine the trigger level of the bond. In the end, we will use Wang transfer to change the cash flow distribution, making it conform to incomplete market conditions, and then pricing the longevity bond.

At the end of the paper, we will draw conclusions of our study.

1. 引言

随着我国生产力的持续发展，人口预期寿命得以不断延长，早在2000年，我国65岁以上老年人口已经多达9000万，占比已经达到国际上7%的老龄化标准，自此中国步入老龄化社会，据预测到2030年，这一比例将翻倍至22%。此外，根据联合国公布数据，2010年至2015年我国人口平均预期寿命已达到74岁，到2050年，该数据将达到79.3岁。人口寿命的超预期延长使得养老体系内支出压力不断增长，资金储备后劲不足。由此产生的长寿风险对我国整个养老体系带来了巨大的冲击。

长寿风险的本质是个人或群体由于未来实际平均寿命高于预期寿命而导致养老资源分配不均而产生的风险。根据风险承担主体的不同对长寿风险的类型进行划分。其中个体长寿风险（Individual Longevity Risk）以个人为承担主体，指当个人的实际寿命高于预期寿命时，由于没有参加养老金项目而造成的个人养老积累不足而导致的风险。这类风险可以通过参加政府提供的社会养老保障、企业提供的年金计划以及购买保险公司的商业寿险产品得以规避。与此同时，保险公司和政府等由于聚集了个体人群的长寿风险，形成了聚合长寿风险（Aggregate Longevity Risk），即一个群体的实际寿命超过了预期年限，是无法根据大数法则进行分散的系统性风险。聚合长寿风险的一般管理控制方法有：进行跨地区分散投资、利用年金产品和某些寿险产品进行自然对冲、创新保险产品设计等，但这些方法并不能完全消除长寿风险。因此，为聚合长寿风险寻求有效的创新管理途径至关重要。

现阶段，对于长寿风险的研究主要集中于死亡率预测、长寿风险产品定价以及证券化衍生品开发三方面。

首先，对死亡率预测的研究由来已久。其中包含时间因素的动态死亡率模型应用最为广泛。Lee和Carter（1992）最初将时间效应引入死亡率预测研究并提出了Lee- Carter模型。此后Renshaw和Haberman （2006）将队列效应引入Lee- Carter模型，提出了RH模型。Currie （2006）将原RH模型进行简化以消除其不稳定问题。CMI（2007）和Plat（2009）也对Lee- Carter模型进行了改进。此外， Cairns ，Blake，Down（2006）提出的CBD模型也以其计算相对简单同时拟合结果较为理想而受到国际上众多学者的青睐。近期的研究主要集中于检验已有死亡率模型的有效性方面。Cairns等（2009），Down等（2010），Haberman 和 Renshaw（2011），Wang等（2012）分别比较分析了现有的不同随机死亡率模型的有效性，说明不同模型的预测精度与现实条件以及数据选择的关系，因此应当根据市场状况对模型进行选择。

其次，在长寿风险定价研究方面。由于长寿风险资本市场发展的不完善，领域内主要采用了风险中性定价和概率扭曲定价两种方法。首先采取风险中性定价方法的是Milevsky 和 Promislow （2001）。随后， Dahl 和MØller （2006），

Biffis （2005）， Miltersen 和 Persson （2005），Cairns, Blake 和Dowd （2006a, 2006b）分别应用该方法对长寿风险管理的金融产品进行定价研究。Wang（2000）首先将概率分布扭曲的方法应用于金融和保险风险定价，提出Wang转换并证明其在风险定价方面的优越性。随后Lin和Cox （2005），Denuit等（2007）分别采用该方法对长寿债券进行定价研究；随后，Cox等（2006）将Wang转换方法进行了改进，进而研究了瑞士再保险证券的定价和死亡风险的测定，分析结果证明在不同的定价方法中，Wang转换方法更适用于对长寿债券的研究。

最后，对长寿风险衍生产品开发的研究尚处于起步阶段。Blake 和Burrow（2001）最早考虑到可以利用资本市场来应对死亡率风险。随后Cairns等（2006）和MacMinn（2006）探讨了在生存债券的设计过程中应考虑的诸多因素。Lin和Cox（2005）研究了生存互换，Cairns等（2006）则介绍了生存价差债券和延期生存债券等其他生存债券。

基于以上研究，本文将首先对中国人口死亡率进行预测，并在预测结果的基础上探讨长寿债券的设计和定价。

2．Lee-Carter模型对未来人口死亡率的预测

2.1 Lee-Carter模型

研究表明， Lee-Carter模型对包括中国在内的许多国家的人口死亡率数据都有很好的拟合效果。因此本文拟使用该模型预测中国人口死亡率情况，Lee-Carter模型属于趋势外推模型，主要特征是函数的对数表达式和参数预测过程中的移动平均自回归过程（ARIMA）。

$$ln(m_{x,t}) = \alpha_x + \beta_x k_t + \varepsilon_{x,t} \qquad (1)$$

其中，$m_{x,t}$ 为中心死亡率；α_x 为依赖于年龄因子的参数，是不同年龄人口死亡率自然对数的平均水平，反映针对每个不同年龄类别的死亡率对数变化的基数，即基础死亡率；β_x 表示年龄 x 对死亡率变动的敏感度，反映不同年龄死亡率对数的相对变化趋势，是不同年龄段的死亡率的偏差情况（死亡率的偏差情况越大，则其死亡率的缩减量越大）；k_t 为反映时间因子的参数，反映人口死亡率随时间变化的速度；$\varepsilon_{x,t}$ 是均值为0、方差为 σ_ε^2 的误差项，反映了没有被该模型包括的因素对死亡率的影响。

该模型拟合了一个中心死亡率的矩形排列。用 $(D_{x,t}, L_{x,t})$ 表示该矩阵，其中 $D_{x,t}$ 表示 x 岁的人在年龄段 $[x+t-1, x+t)$ 内的死亡人数，$L_{x,t}$ 为 x 岁的人在年龄段 $[x+t-1, x+t)$ 上的死亡风险暴露数，表示暴露于死亡风险下的人数，即 $l_{x,t}$ 个年龄为 x 的人在 $[x+t-1, x+t)$ 内生存的总人数，则中心死亡率 $m_{x,t} = D_{x,t} / L_{x,t}$ 。考虑某一新生婴儿群体，出生人数为 l_0，生存到 x 岁的人口数为 l_x， x 岁的人口在 $(x+t)$ 岁

内死亡的人数 $D_{x,t}=l_x-l_{x+t}$，同时 $L_{x,t}=\int_0^t l_{x+t}ds$。$x$ 岁的人在 $x+t$ 岁内死亡的概率 $q_{x,t}=D_{x,t}/l_x$。$q_{x,t}$ 和 $m_{x,t}$ 具有以下关系式：

$$m_{x,t}=\frac{q_{x,t}}{t[1-(1-f_{x,t})q_{x,t}]} \tag{2}$$

其中，$f_{x,t}$ 为在年龄段 $[x,x+t)$ 内死亡的人在单位区间上生存的平均年数，定义为 $f_{x,t}=\frac{L_{x,t}-t*l_{x+t}}{t*D_{x,t}}$。为简便计算，根据Cairns，Blake和Down（2006）的研究结果，式（2）可以对中心死亡率的结果进行较为准确的替换:

$$m_{x,t}\approx\frac{q_{x,t}}{1-\frac{1}{2}q_{x,t}}$$

2.2 参数的拟合和预测

由于模型是双线性模型，可以有多个解，因此为了保证模型的参数估计的唯一性，在进行参数求解时，Lee-Carter 模型同时需要一些前提假设条件，如式（3）所示：

$$\sum_t^T k_t=0,\sum_x \beta_x=1 \tag{3}$$

在式（3）所示的两个假设的基础上，用 $ln(m_{x,t})$ 在时间维度上的平均值来表示 α_x 的估计值 $\hat{\alpha}_x$，即：

$$\hat{\alpha}_x=\frac{\sum_t^T ln(m_{x,t})}{T}=ln\left(\prod_t^T m_{x,t}^{\frac{1}{T}}\right) \tag{4}$$

参数求解过程中常用的方法是奇异值分解法和最小二乘法，在参数拟合的过程中，这两种方法对不同年龄人群的死亡率赋予了相同的权重。但是在实际情况中，不同年龄人群面临的初始风险或许不同，相同的权重赋予在死亡率很低的情况下应用效果较差，因此要给不同年龄人群死亡率赋予不同的权重。本节将根据Wilmoth（1996）的研究内容，采用加权最小二乘法来对Lee-Carter模型当中的参数进行估计。

根据式（3）和式（4），本文通过将式（1）两边分别对年龄 x 求和得到 $\hat{k}_t$，进而利用 $\hat{k}_t$ 对 $ln(m_{x,t})-\hat{\alpha}_x$ 进行线性回归，之后基于加权最小二乘法，得到 β_x 的估计值：

$$\hat{\beta}_x=\sum_{t=1}^T \hat{k}_t(ln(m_{x,t})-\hat{\alpha}_x)/\sum_{t=1}^T \hat{k}_t^2$$

根据Wilmoth（1996），$ln(m_{x,t})$ 的方差近似等于死亡人数 $d_{x,t}$ 的倒数，因此将 $d_{x,t}$ 作为残差平方和的权重。最后，采用移动平均自回归过程（ARIMA）对时间因子 k_t 进行拟合，并通过该模型推算出 $\hat{k}_t$ 的预测值，进而得到对未来死亡率数据的预测值。

2.3 Lee-Carter模型用于中国人口死亡率的预测

2.3.1 数据来源

本文选取了1994-2012共19年中国人口分性别年龄为50岁至90+岁的人口数据、死亡风险暴露数和死亡率数据。其中1995年和2000年数据出自《中国统计年鉴》，2010年数据出自《中国2010年人口普查资料》，2007年到2012年数据出自《中国人口和就业统计年鉴》，其余年份数据来自《中国人口统计年鉴》。本文采取每一岁的分组方法。并假设，按百分之一人口抽样与人口普查数据质量相同，且将最高年龄组确定为90岁及以上，对原始数据进行调整。

2.3.2 参数估计与拟合结果

（1）α_x的估计值

在Lee-Carter模型中，α_x反映不同年龄死亡率自然对数的平均水平。图1和图2分别给出了中国50岁以上女性和男性死亡率模型的α_x拟合值。由该图可以看出，随着年龄的增长，各年龄分组的死亡率自然对数平均值以接近线性增长的方式逐渐增加，符合死亡率逐渐上升的自然规律。且女性α_x数值较小也说明女性较男性而言有较低的死亡率，与经验结论相符。

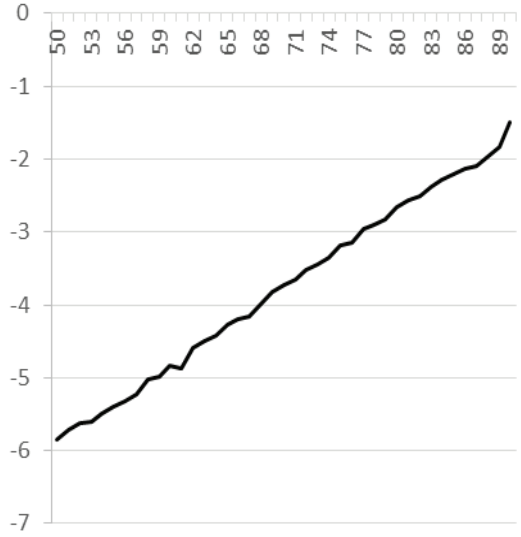


图1　50岁以上女性分年龄死亡率参数α_x估计值折图

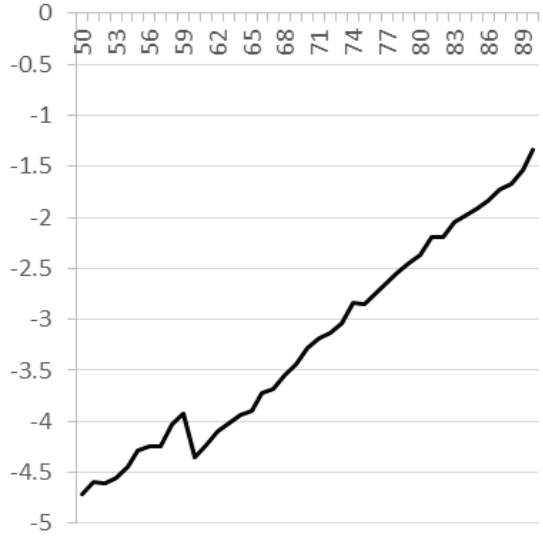


图2　50岁以上男性分年龄死亡率参数α_x估计值折线图

（2）β_x的估计值

β_x为年龄因子，反映不同年龄人群死亡率自然对数的变化速度，数值越大说明死亡率变化率越大。图3和图4给出了我国50岁以上女性和男性死亡率模型参数β_x的估计值。

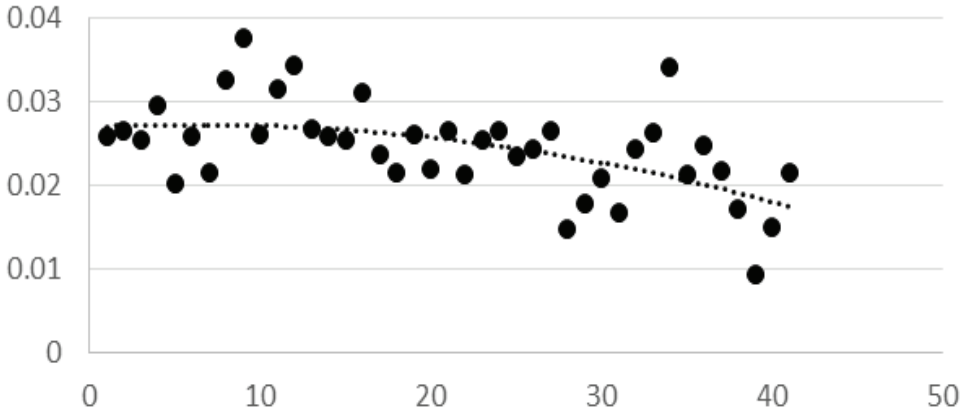


图3　50岁以上女性分年龄死亡率参数 β_x 估计值散点图

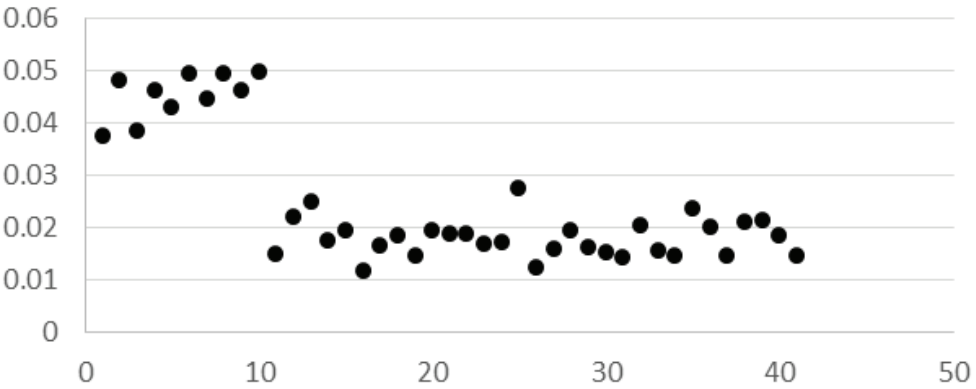


图4　50岁以上男性分年龄死亡率参数 β_x 估计值散点图

由图可以看出，在我国女性50岁及以上的所有年龄组内，β_x 估计值总体呈现出下降趋势，表明随时间推移，各年龄段死亡率均具有下降趋势，与历史死亡率总体趋势一致。并且随着年龄段的增长，死亡率改善趋势越缓慢，其死亡率对死亡率指数 k_t 的变动不十分敏感。

而从50岁以上男性分年龄死亡率参数 β_x 估计值散点图中可以看出十分明显的分段趋势特征，该两阶段的死亡率变化趋势均与一般规律有较大不同。造成这种结果的原因一方面可能是由于死亡率的选择性效果在这一年龄段的体现，另一方面的原因可能是由于统计数据的质量出现问题，不能客观地反映其死亡率变化实际情况。

故本文采用的Lee-Carter模型并不能很好的拟合我国50岁及以上的男性死亡率变化，在模型的选择上还需要进一步的研究。因此在本文之后的研究中，仅使用Lee-Carter模型对女性死亡率数据进行拟合和预测，以尽可能地保证模型的准确性。

（3）序列k_t的建模和预测

死亡率水平指数k_t反映了死亡率整体水平的变化，即人口死亡率随时间变化的速度。图5可以看出，在大部分年份，死亡率指数k_t的整体呈现出下降趋势，说明随着时间的推移，我国女性人口整体死亡率以较为稳定的速度呈现出下降的趋势。指数的显著下降显示了女性人口寿命的显著提升，与我国女性历史死亡率整体呈现下降趋势一致。

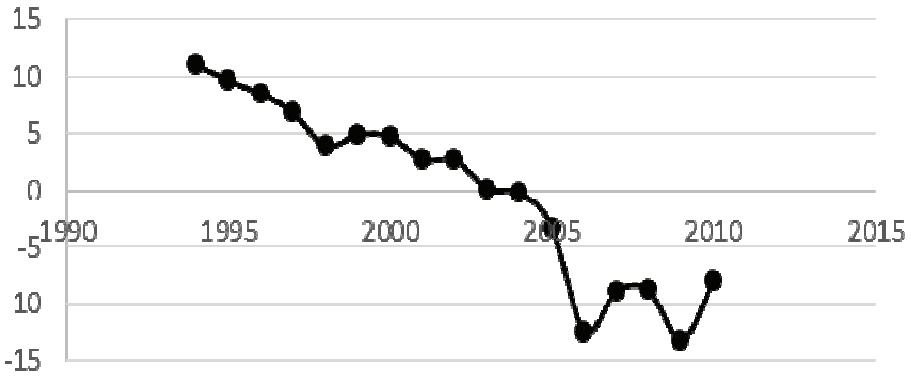


图5　50岁以上女性分年龄死亡率参数k_t估计值折线图

本文运用移动平均自回归过程（ARIMA）对时间序列k_t进行拟合和预测，建立以下模型：

$$\left(1-\sum_{i=1}^{p}{}_{i}L^{i}\right)(1-L)^{d}k_t=\gamma+\left(1+\sum_{i=1}^{q}\theta_i L^{i}\right)\varepsilon_{t-1}$$

其中，L为滞后算子，P为自回归项数，q为移动平均数，d为使k_t成为平稳序列所做的差分次数，γ为常数项，ε为误差项。根据Box-Jenkins方法，利用前文得到的k_t过去19年的估计值对上式进行拟合，得出符合我国1994年-2012年死亡率数据的最优模型选择为ARIMA。利用该模型，本文得出了2013年至2022年未来10年我国50岁及以上女性人口死亡率的k_t预测值，结果如表1所示。

表1　k_t预测值

预测年份	k_t预测值	预测年份	k_t预测值
2013	-10.39319	2018	-15.5004
2014	-21.57735	2019	-30.9629
2015	-14.39411	2020	-29.3588
2016	-18.38606	2021	-21.7007
2017	-27.53925	2022	-44.6972

2.3.3 未来死亡率预测

首先，预测的死亡率时间长度通常取决于估计历史趋势时所采用的样本数据时间年限的长度。因此本文利用我国女性人口19年的死亡率数据，预测2013年以后未来十年的死亡率变化，以期得到相对较为准确的预测结果。

基于中国1994-2012年的人口经验死亡率数据以及前述数据分析，本文给出了2013年至2022年十年的k_t预测值。然后将k_t的预测值代入Lee-Carter模型即可得到2013年至2022年分年龄女性人口死亡率数据预测值。由于本文的年龄分组以一岁为一组，因此从50岁至90及以上总共有41个分组，出于篇幅限制，文中每五个年龄组选取一个进行展示。结果如表2所示。

表2　2013年-2022年女性人口死亡率预测值　　单位：‰

年龄	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
50	2.18	1.63	1.97	1.77	1.40	1.91	1.28	1.34	1.63	0.90
55	3.44	2.57	3.10	2.79	2.20	3.01	2.02	2.10	2.56	1.41
60	5.70	4.01	5.03	4.43	3.32	4.85	2.98	3.14	3.99	1.93
65	10.09	7.14	8.91	7.88	5.93	8.61	5.34	5.61	7.11	3.49
70	18.04	13.43	16.23	14.61	11.47	15.76	10.48	10.93	13.38	7.28
75	31.41	24.02	28.54	25.93	20.81	27.79	19.16	19.91	23.94	13.75
80	57.44	47.87	53.82	50.43	43.43	52.86	41.06	42.15	47.78	32.77
85	81.21	62.10	73.80	67.06	53.77	71.87	49.49	51.46	61.92	35.42
90	165.19	132.11	152.57	140.87	117.10	149.24	109.22	112.85	131.78	82.37

由表2可以看出，中国各年龄组女性死亡率均呈下降趋势，且年龄越低，死亡率改善越明显。但从预测结果来看，高龄人群死亡率数据存在明显失真现象，本文认为，其原因可能由于高龄段人口较少，从统计角度分析，其死亡率波动较大，因此很难准确预测。Coale和Kisker通过大量研究认为，高龄人口死亡率的变化率并不固定，而是呈线性递减状态，从而提出Coale-Kisker模型专门针对高领人群死亡率进行预测。

3．长寿债券的设计与定价

3.1　长寿债券的设计

长寿债券是息票或者本金与指定目标人群死亡率相关的债券，按照给付方式的不同，长寿债券可以分为连续型和触发型两类。其中触发型长寿债券以其触发机制的优越性，相对较短的债券期限等优势受到众多研究者的青睐。目前发行最成功的触发型长寿债券是Kortis长寿债券，它由瑞士再保险公司在2010年12月组

建Kortis资本公司发行，其发行总面值为50000万美元，债券到期日为2017年1月。本文以对Kortis长寿债券的研究为基础，详细解析该类债券的设计与定价方案。

3.1.1 生存指数构建

假设死亡率指数$S(x,t)$表示$t=0$时年龄为x的人存活至t年的概率，$p_{x,t}$为$t=0$时年龄为x岁的人在t期的生存概率，$q_{x,t}$为$t=0$时年龄为x岁的人在t年的死亡概率，因此$p_{x,t}=1-q_{x,t}$。因此生存指数的计算方法为：

$$S(x,t)=p(0,0,t)=p(0,0,t-1)*p(0,t-1,t)=\prod p(0,i-1,i)$$

或者用死亡率表示为：

$$S(x,t)=(1-q(x,1))*(1-q(x,2))*...(1-q(x,t))$$

3.1.2 确定触发器水平

长寿债券中，“触发器”水平的确定能在很大程度上决定投资者和筹资者的风险和利益。在本例中，“触发水平”的定义即为基于标的人群的最高生存概率。当标的人群在某一年的生存概率低于触发水平确定的生存概率，按正常现金流给付。一旦标的人群实际生存人数高于事先确定的最高生存率，在一定范围内，特殊目的组织首先利用投资债券所获收益向寿险公司进行赔付，赔付高于触发水平的年金额度，再将剩余资金向投资者支付息票。因此触发器水平的确定对长寿债券的设计定价十分重要。

本文采用国际上应用比较广泛的Renshaw, Haberman（1996）方法预测死亡率效力，并以此为基础确定触发器水平。该方法预测了30年内65岁-74岁，75岁-84岁以及85岁-94岁三个年龄组死亡率效力改善趋势。如表3：

表3 死亡率效力改善趋势表

年龄组	死亡率效力改善
65-74	-0.0070
75-84	-0.0093
85-94	-0.0103

在考虑到上述效力改善的情况下，各年龄的最高生存人数x_t可以表示为：

$$x_t=\begin{cases}l_x S(x,t)e^{0.0070t} & t=1,2,...10\\ l_x S(x,t)e^{0.07}e^{0.0093(t-10)} & t=11,...20\\ l_x S(x,t)e^{0.163}e^{0.0103(t-20)} & t=21,...30\end{cases}$$

3.1.3 长寿债券设计

以Kortis触发型长寿债券为例，债券在设计构造时主要涉及了三个主体的利益，即寿险公司、特殊目的机构以及投资者或者投资机构。

假设一个寿险公司出售了一笔年金保单，投保人为开始年份$t=0$时人数为l_x的年龄为x的人，令l_{x+t}表示l_x中存活至$(x+t)$岁的人数，保单约定每年年初向l_{x+t}个

投保人每人支付1000元年金，则寿险公司每年需向投保人支付$1000l_{x+t}$元。$t=0$时，保险公司向特殊目的机构以价格P购买再保险。该再保险保单设置触发器水平为x_t，即当标的人口的寿命延长，当年实际生存人数l_{x+t}高于触发器水平时，特殊目的机构需向寿险公司赔付一定数量的超额年金支付，并对该数额设定一个最大值。假设赔付最高额为个人年金支付额度的一定倍数为$1000C$。那么每年$t=1,2,...T$，寿险公司从特殊目的机构处获得的资金收入B_t为：

$$B_t=\begin{cases}1000C & l_{x+t}>X_t+C\\ 1000\left(l_{x+t}-X_t\right) & X_t<l_{x+t}\le X_t+C\\ 0 & l_{x+t}\le X_t\end{cases}$$

寿险公司在t时向投保人支付的现金流$1000l_{x+t}$可以被从特殊目的机构处获得的收入B_t所补偿，因此寿险公司的现金流为：

$$1000l_{x+t}-B_t=\begin{cases}1000\left(l_{x+t}-C\right) & l_{x+t}>X_t+C\\ 1000X_t & X_t<l_{x+t}\le X_t+C\\ 1000l_{x+t} & l_{x+t}\le X_t\end{cases}$$

图6描述了特殊目的机构、投资者和寿险公司之间的现金流关系：

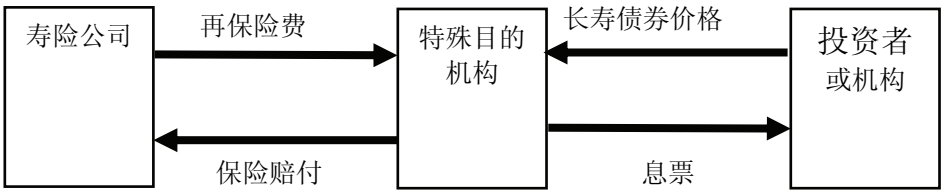


图 6　长寿债券关联方现金流关系图

特殊目的机构向投资者支付的现金流为：

$$D_t=\begin{cases}0 & l_{x+t}>X_t+C\\ 1000\left(C-B_t\right) & X_t<l_{x+t}\le X_t+C\\ 1000C & l_{x+t}\le X_t\end{cases}$$

$$=\begin{cases}0 & l_{x+t}>X_t+C\\ 1000\left(C+X_t-l_{x+t}\right) & X_t<l_{x+t}\le X_t+C\\ 1000C & l_{x+t}\le X_t\end{cases} \quad (5)$$

其中D_t表示特殊目的机构向投资者支付的息票。当无人死亡时，l_{x+t}的最大值是l_x，但是从时间为0点开始，该值是介于0和l_x之间的任意值。令长寿债券的市场价格为V。特殊目的机构在每年$t=1,2,...T$的流出现金流为：

$$B_t+D_t=1000C$$

在$t=T$时，特殊目的机构需支付债券本金额为$1000F$。特殊目的机构应当使现金流入量$P+V$至少与固定利息流出量$1000C$折现值以及债券本金$1000F$现值之和相等，即：

$$P+V \geqslant W=1000Fd(0,T)+\sum_{K=1}^{T}1000Cd(0,k)$$

折现因子$d(0,k)$可以从债券发行时债券市场上拥有相同期限的债券得到。这意味着，若再保险费收入和出售债券所得收益充足，特殊目的机构可以购买收益率等于需要支付给投资者和寿险公司总资金流出量的“对等债券”。每年特殊目的机构从所购买的债券处获得收益为$1000C$，并将其中的D_t支付给投资者，B_t支付给寿险公司。通过上述安排，T年间寿险公司面临的长寿风险可以完全转移至资本市场。

当不发生交易对手风险时，支付给寿险公司的现金流B_t以及支付给投资者或者投资机构的现金流D_t可由T时间内不发生本金交易的互换协议完成。在该种情况下，在$t=0$时寿险公司支付的再保险费用P可以用年支付x表示，即：

$$P=x\sum_{k=1}^{T}d(0,k)$$

每年，寿险公司向特殊目的机构支付x元并获得浮动利息收入B_t。从寿险公司的角度来看，这是用固定支付换取浮动收益。只要不存在交易对手风险，寿险公司能够从特殊目的机构获得足够的再保险赔付。

用相同的方法分析投资者的现金流。投资者可以用每年固定支付y元来代替初始阶段一次性支付债券价值V元，并在每年收到息票收入，即：

$$V=y\sum_{k=1}^{T}d(0,k)+1000Fd(0,T)=\sum_{k=1}^{T}E^{*}[D_t]d(0,k)+1000Fd(0,T)$$

因此有：

$$y\sum_{k=1}^{T}d(0,k)=\sum_{k=1}^{T}E^{*}[D_t]d(0,k)$$

每年，特殊目的机构获得$(x+y)$元用以支付给寿险公司和投资者(B_t+D_t)。与最初的债券设计相比，互换协议没有本金作为抵押，但是当假设不存在固定支付的违约风险时，每年特殊目的机构都会得到足够的现金以支付其浮动支出。

3.2 长寿债券的定价

Wang（1996）提出双重定价规则的转换方程——王氏转换（Wang Transfer），将概率分布扭曲的定价方法应用于不完全市场中的债券定价。本文将使用该方法对不完全市场中的长寿债券进行定价。令$\Phi(x)$为标准正态累积分布函数，即

$$\Phi(x)=\frac{1}{\sqrt{2\pi}}e^{\frac{-x^2}{2}}$$

Wang将转换方程定义为：

$$g\lambda(\mu)=\Phi(\Phi^{-1}(\mu)-\lambda)$$

其中，$0<\mu<1$，λ是参数。给定一个累积分布函数$F(t)$，其扭曲分布为：

$$F^*(t)=g\lambda(F(t))$$

假设寿险公司在$(0,T)$之间的负债为X，则负债的价值为扭曲分布下预期值的贴现值。当忽略折现因素时，负债的理论价格为：

$$H(X,\lambda)=E^*(X)=\int xdF^*(X)$$

其中，$F^*(X)=\Phi(\Phi^{-1}(F(X))-\lambda)$。参数$\lambda$是市场风险价值，衡量系统风险。因此，当给定寿险公司负债X以及债务的累积分布函数F时，王氏转换可以计算出经风险转换的分布函数F^*。在扭曲分布函数条件下的x的均值$E^*(X)$即债务经风险转化在时间点T时的价值，并可以用无风险利率折现到0时刻以获得当前价格。Wang转换的意义在于引入了扭曲的市场风险价值λ，由此实现了不完全市场中的债券定价。

债券市场中，现金流D_t基于相同的生存者分布函数，假设投资者接受相同的定价方式，则长寿债券价格V为：

$$V=Fd(0,T)+\sum_{t=1}^{T}E^*[D_t]d(0,t)$$

其中，D_t由式(5)定义，$d(0,t)$为基于债券发行时利率期限结构下的无风险利率的折现因子。债券本金F不存在偿还风险。

$E^*(D_t)$的计算方式如下，由公式(5)可得特殊目的机构支付给投资者的息票是：

$$\frac{1}{1000}D_t=\begin{cases}0 & l_{x+t}>X_t+C\\ C+X_t-l_{t+x} & X_t<l_{x+t}\le X_t+C\\ C & l_{x+t}\le X_t\end{cases}$$

$$=C-max(l_{x+t}-X_t,0)+max(l_{x+t}-X_t-C,0)$$
$$=C-(l_{x+t}-X_t)_+ +(l_{x+t}-X_t-C)_+$$

因此：

$$\frac{1}{1000}E^*[D_t]=C-E^*[(l_{x+t}-X_t)_+]+E^*[(l_{x+t}-X_t-C)_+]$$

l_{x+t}服从参数为l_x和$S^*(x,t)$的伯努利分布，表示0时年龄为x的人存活到$(x+t)$岁的人数，$S^*(x+t)$为转换后的生存指数。当l_x足够大时，l_{x+t}服从近似正态分布，其均值和方差分别为：

$$E^*[l_{x+t}]=u_t^*=l_xS^*(x,t)$$

$$Var^*[l_{x+t}]=\sigma_t^{*2}=l_xS^*(x,t)(1-S^*(x,t))$$

给定任意随机数 X，有 $E[(X-k)_+]=\int_k^{\infty}[1-F(t)]dt, F(t)=Pr(X\le t)$。均值为0方差为1的正态分布随机数 X，已知密度分布函数为 $\Phi(x)=\frac{1}{\sqrt{2\pi}}e^{\frac{-x^2}{2}}$，累积分布函数 $\Phi(x)=\int_{-\infty}^{x}\Phi(u)du$，因此有 $E[(X-k)_+]=\int_k^{\infty}[1-\Phi(t)]dt$。根据 $\Phi(t)=-t\Phi(t)$，由分部积分可得：

$$\Psi(k)=\int_k^{\infty}[1-\Phi(t)]dt=\Phi(k)-k[1-\Phi(k)] \tag{6}$$

利用（6），可以得到 $E^*[D_t]$ 各部分的值。

$$\begin{aligned}E^*[(l_{x+t}-X_t)_+]&=E^*[(l_{x+t}-u_t^*-(X_t-u_t^*))_+]\\&=\sigma_t^*E^*\left[\left(\frac{l_{x+t}-u_t^*}{\sigma_t^*}-k_t\right)_+\right]\\&=\sigma_t^*\psi(k_t)\end{aligned}$$

其中 $k_t=\frac{x_t-u_t^*}{\sigma_t^*}$。同理：

$$E^*[(l_{x+t}-X_t-C)_+]=\sigma_t^*\psi\left(k_t+\frac{C}{\sigma_t^*}\right)$$

因此，得到 $E^*[D_t]$ 最终计算公式，即

$$E^*[D_t]=1000\left\{C-\sigma_t^*\psi(k_t)+\sigma_t^*\psi\left(k_t+\frac{C}{\sigma_t^*}\right)\right\}$$

4．结论

本文通过对我国人口死亡率的预测以及对长寿债券的定价研究，得出以下结论：

第一，本文使用国际上广泛认可的Lee-Carter模型对我国人口数据进行拟合，结果表明Lee-Carter模型对我国女性人口死亡率拟合效果较好，但无法合理解释我国男性人口死亡率变化情况。因此，本文在女性人口数据基础上预测期在未来十年的死亡率变化情况，并以此为基础进行下一步债券定价研究。

第二，本文利用Wang转换对债券基于死亡率的现金流进行调整，使现金流分布更接近于其在不完全市场中的现实情况。并在此基础上对长寿债券进行结构设计和定价。本文认为，触发型长寿债券在风险分散能力、债券安全性以及交易灵活性方面对投资者更具有吸引力。

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基于中国人口数据的死亡率预测与长寿债券定价

郝纪飞 王海艳 郑琪 周慧琳

郝纪飞
硕士生
同济大学经济与管理学院
上海市杨浦区四平路1500号同济大厦A楼816室
上海 200092，中国
电话:（086）131 6729 7103
Email: 18666845524@163.com

王海艳*
副教授
同济大学经济与管理学院
上海市杨浦区四平路1500号同济大厦A楼816室
上海 200092，中国
电话: （086）139 1728 3932
Email: wanghaiyan@tongji.edu.cn

郑琪
硕士生
同济大学经济与管理学院
上海市杨浦区四平路1500号同济大厦A楼816室
上海 200092，中国
电话: (086) 188 1820 3503
E-mail: 1223921119@qq.com

关键词: 长寿风险，长寿债券，死亡率预测，定价

中文摘要. 当今世界，随着人口死亡率呈现下降趋势，同时伴随而来的是长寿风险的不断积聚，威胁着养老保险及养老金制度的可持续性。中国作为步入老龄化的人口大国，对长寿风险的管理刻不容缓。

现阶段对长寿风险的研究主要集中在死亡率预测、相关产品定价以及证券化衍生品开发三个方面：对于死亡率预测，基于历史数据的趋势外推模型被广泛使用，其中由Lee和Carter首先提出的动态死亡率模型被众多学者青睐并不断完善，逐渐形成了不同改进的Lee-Carter模型、RH模型等，此外学者们又提出了GLM模型、HP模型、CBD模型等，现阶段研究主要集中在针对已有模型的优化方面；对于产品定价，由于市场的不完善，主要使用风险中性以及Wang提出的概率扭

曲定价方法。在随后的研究中，学者们发现Wang转换在债券定价方面更具优越性，但也存在着自身的局限性。因此，目前尚没有形成被广泛接受的定价方法；对于长寿风险证券化产品的开发，目前主要产品包括长寿债券、长寿互换、q远期、生存期权以及生存期货，其中研究热点是长寿债券以及长寿互换。

本文基于对以上三个方面的研究成果的系统梳理，结合中国长寿风险管理现状，对中国人口的死亡率进行预测，并在此基础上设计长寿债券并进行定价。主要思路如下：

首先应用Lee-Carter模型预测我国未来人口死亡率。我们将从国家统计相关数据中选取中国人口分性别年龄的人口数据、死亡风险暴露数据和死亡率数据，拟合并估计模型参数值，最后预测我国未来人口死亡率，并在此基础上分析预测结果。

随后，研究长寿债券的设计与定价方法。首先本文将对国际上广泛接受的触发型长寿债券的运行机制进行解析。而后设计长寿债券，并利用上述死亡率预测数据，构建生存指数，确定债券的“触发器水平”。最后运用Wang转换概率扭曲方程将现金流分布进行一定的扭曲转换，使其符合不完全市场情况，并在此基础上对债券定价。

最后，总结概括本文的研究结论。

Design of the Multi-risk Catastrophe Bond and its Pricing Based on Meteorological Disasters in China

WANG Yeqin, WANG Haiyan, WANG Jiayi

WANG Yeqin
Master. Candidate
School of Economics and Management
Tongji University
Rm. 816, Block A Tongji Plaza, No.1500, Siping Rd.
Shanghai 20092, China
Phone: (086) 150 2192 6137
Email: 965377534@qq.com

WANG Haiyan*
PhD, Associate Professor
School of Economics and Management
Tongji University
Rm. 816, Block A Tongji Plaza, No.1500,Siping Rd.
Shanghai 20092, China
Phone:（086）139 1728 3932
Email: wanghaiyan@tongji.edu.cn

WANG Jiayi
Master Candidate
School of Economics and Management
Tongji University
Rm. 816, Block A Tongji Plaza, No.1500,Siping Rd.
Shanghai 20092, China
Phone: (086) 136 1188 5909
Email: wjygrace_2012@sina.com

Keywords: Catastrophe Risk Management, Multi-Risk, Catastrophe Loss Distribution, Catastrophe Bond Pricing

Abstract. China is one of the countries in the world which faces to most serious natural disasters, with high frequency of occurrence and wide geographic distribution.

Nowadays, it becomes a hot topic in China to establish a multi-level catastrophe risk management system. Focusing on the topic of risk-based securitization in this system, this paper aims at the meteorological disasters in China, empirically tests individually the loss distributions of various meteorological disasters and their joint loss distribution, then constructs and price the catastrophe bond under the multi-risk conditions.

Firstly, based on the economic loss data caused by the disasters such as drought, storms/floods, high wind/hail/lightning, snow/low temperature/freezing weather during 2004~2013, we work out respectively the loss distribution estimations of the above-mentioned four kinds of disasters, and then fit the loss distribution and build finally a joint loss distribution for the multi-risk catastrophic events.

Secondly, according to the different risk preference of the investors, we consider four types of bonds: all principal guarantee, 80% principal guarantee, 50% principal guarantee, and no principal guarantee. We apply CAPM to calculate respectively the rate of return for these four bonds, and finally get the price of these multi-risk catastrophic bonds.

1. 引言

我国是世界上自然灾害最严重的国家之一，灾害种类多，发生频率高，分布地域广，经济损失和人员伤亡惨重。为了更好地保障和改善民生，巨灾风险管理显得尤为重要。但目前我国巨灾保险制度缺位，巨灾保险，巨灾再保险以及各类巨灾保险证券化金融衍生品均很缺乏，从供给和需求两方面来看都应当建立完善的巨灾风险管理体系。

财政支持、巨灾保险和社会救助是健全巨灾风险管理体系缺一不可的三个方面（谢世清，2010）。笔者综合卓志、段胜（2010），黄英君、史智才（2012），许闲（2014）以及王伊琳、范流通、段胜（2014）等学者的观点，认为我国巨灾保险体系应该为：政府为主导、协同商业保险市场化运作、发展再保险市场、建立巨灾基金，并大力发展巨灾保险证券化市场，推出巨灾债券、巨灾期权等衍生品等，从而建立“政府，保险，国际再保险，资本市场，社会力量”融为一体的巨灾保险制度。

巨灾风险债券的概念在国外较早地被提出，Cummins和Weiss（2000）通过对证券市场和保险市场的对比分析，总结了巨灾风险证券化的优势。李延明、吴燕（2005）对巨灾债券的发行过程进行了研究，并着重研究了SPV的运行机理，认为运用巨灾债券转移、分散巨灾风险对我国巨灾风险管理具有重要意义。张宗军（2008）分析了巨灾保险的公共性特征，同时根据美国、英国、土耳其等国家的巨灾保险体系，提出我国需要建立以政府为主导的巨灾保险体系，也引入了巨灾风险债券的概念。陈宇峰（2012）梳理了国外巨灾保险的实践经验，提出我国建立巨灾保险制度应当完善相关法律法规，构建政府为主导、各方共同参与的巨灾保险体系，建立巨灾保险基金，并充分发挥再保险与保险证券化市场的作用。Hagendorff，Keasey等（2014）研究了巨灾债券的有效性，结果发现承销发行巨灾债券的保险公司的投资组合风险较低，降低了巨灾风险敞口和对冲风险。

结合我国金融市场的发展现状以及巨灾风险的发生状况，在众多巨灾保险金融衍生品中，当前发展巨灾债券是最有效的。巨灾债券不仅可以满足债券发起人规避风险的需求，同时可以避免投资者担心的道德风险问题。巨灾债券在发达国家的运作，成功地将保险市场的巨灾风险转嫁给资本市场，使得巨灾保险基金得以有效积累，巨灾保险偿付能力得以扩大，有效弥补了巨灾保险市场资金不足的问题。

目前，国内对于巨灾债券的研究设计均基于单一风险事件，例如地震债券、台风债券等，但是由于我国巨灾事件种类多样，分布较广，因此不能有效避免投资人的道德风险及逆选择，例如四川的债券投资人不会购买地震债券，而福建地区的投资人则不会购买旱灾债券等，因此本文选取干旱灾害、暴风洪涝（滑坡泥

石流）、大风冰雹雷电以及雪灾低温冷冻四种灾难进行多风险巨灾债券的设计。

2. 巨灾债券定价模型

巨灾债券是为了预防如地震、洪水、台风等巨灾事件的爆发造成的损失而进行资金筹集的保险连接型债券，是由保险公司、再保险公司、政府或者大型企业在资本市场发行的、用来分散巨灾风险的巨灾保险证券化产品，其实质是将保险公司和再保险公司承担的巨灾风险运用金融工程的技术，通过特殊目的机构（Special Purpose Vehicle，简称SPV）打包出售，从而将巨灾风险从保险市场转移到资本市场。巨灾债券通常有一个触发机制，根据巨灾风险种类的不同，触发水平的不同以及收益率的不同，在巨灾事件发生后，如果达到触发水平则债券投资人会损失债券收益及部分或全部本金，若未达到触发机制则债券投资人获得债券的正常收益。

巨灾债券作为巨灾保险的证券化产品，除了具有债券本身的市场风险之外，还要承担保险市场巨灾事件发生带来的财产损失的风险。其不仅可以看作是保险产品的证券化，也可以看作是类似违约债券的金融衍生品，因此具有多种定价模型，包括基于资产预期收益与风险关系的CAPM，基于保险精算理论的Wang变换模型、双因素模型、LFC模型以及基于金融衍生品定价方法的模型。

笔者参考了杨晔等学者的研究，发现基于金融衍生品定价方法的模型对数据的要求较高，由于巨灾债券问世的时间不到二十年，受时间短和数据少的限制，加之这类模型对于风险的假定过于简单化，本文的实证研究不采用这类模型；而在用基于保险精算理论的Wang变换模型、双因素模型和LFC模型对多年期限的巨灾债券进行拟合时，并未取得理想的实证效果。考虑到巨灾债券的数据较少，而内部参数变化的不确定性又较高，本文选择基于资产预期收益的CAPM对巨灾债券进行定价。

CAPM的核心思想是研究资产预期收益率与风险之间的关系。风险的度量根据收益率的标准差的形式来量化，CAPM模型如式(2.1)所示：

$$E(R) = R_f + \beta\left|E(R_M) - R_f\right| \tag{1}$$

其中 $E(R)$ 为巨灾债券的预期收益率，R_f 为无风险利率，β 为巨灾债券的风险占系统性风险的比例，$E(R_M - R_f)$ 为风险溢价，也即市场预期收益率与无风险利率的差。

作为保险产品，巨灾债券的收益率由下式表示：

$$E(R) = R*(1-P)+(-S)*P \tag{2}$$

其中 R 为巨灾债券的真实收益率， P 为巨灾损失达到触发点的概率， S 为巨灾损失达到触发点时债券投资人的损失。

结合式(1)和式(2)，对于条件已知的巨灾债券，我们可以确定其真实收益率R。

3. 多风险巨灾灾害损失联合分布

通过查阅整理《中国气象灾害年鉴》，本节选取2004～2013年我国各省干旱、暴雨洪涝、大风冰雹雷电、雪灾和低温冷冻的损失数据，对数据进行分组处理，并排除极值项，计算出损失分布的概率密度函数，得到表1。

表1 巨灾导致的经济损失及其频数和密度分布

损失额度/亿元	频数/干旱	频数密度/干旱	频数/暴雨洪涝	频数密度/暴雨洪涝	频数/大风冰雹雷电	频数密度/大风冰雹雷电	频数/雪灾和低温冷冻	频数密度/雪灾和低温冷冻
0-1	65	0.2166	25	0.0850	36	0.1263	64	0.0011
1-2	23	0.0766	18	0.0612	23	0.0807	42	0.0018
2-3	11	0.0366	12	0.0408	38	0.1333	19	0.0021
3-4	12	0.04	9	0.0306	11	0.0386	15	0.0024
4-5	10	0.0333	17	0.0578	9	0.0316	18	0.0027
5-6	12	0.04	10	0.0340	19	0.0667	5	0.0028
6-7	11	0.0366	3	0.0102	9	0.0316	10	0.0029
7-8	10	0.0333	2	0.0068	14	0.0491	4	0.0030
8-9	3	0.01	10	0.0340	13	0.0456	3	0.0030
9-10	8	0.0266	9	0.0306	14	0.0491	4	0.0031
10-11	6	0.02	2	0.0068	11	0.0386	4	0.0032
11-12	7	0.0233	7	0.0238	3	0.0105	0	0.0032
12-13	4	0.0133	6	0.0204	6	0.0211	2	0.0032
13-14	7	0.0233	5	0.0170	6	0.0211	2	0.0033
14-15	9	0.03	4	0.0136	10	0.0351	4	0.0033
15-16	4	0.0133	3	0.0102	7	0.0246	4	0.0034
16-17	3	0.01	6	0.0204	4	0.0140	4	0.0035
17-18	7	0.0233	4	0.0136	6	0.0211	1	0.0035
18-19	1	0.0033	0	0.0000	2	0.0070	1	0.0035
19-20	1	0.0033	3	0.0102	3	0.0105	1	0.0035

20-25	14	0.0093	9	0.0061	12	0.0084	7	0.0058
25-30	13	0.0086	18	0.0122	6	0.0042	5	0.0041
30-35	6	0.004	11	0.0075	7	0.0049	2	0.0016
35-40	6	0.004	7	0.0048	6	0.0042	2	0.0016
40-45	9	0.006	15	0.0102	3	0.0021	3	0.0025
45-50	5	0.0033	9	0.0061	3	0.0021	3	0.0025
50-60	5	0.0016	13	0.0044	1	0.0004	5	0.0021
60-70	6	0.002	16	0.0054	3	0.0011	1	0.0004
70-80	5	0.0016	5	0.0017			6	0.0002
80-90	3	0.001	3	0.0010			2	0.0001
90-100	3	0.001	6	0.0020				
100-150	5	0.000333	12	0.0008				
150-200	4	0.000266	4	0.0003				
200-300	2	6.67E-05	5	0.0002				
300-400			2	0.0001				
400-500			4	0.0001				

根据国内外学者的研究结果，我们知道巨灾事件的损失通常服从对数正态分布。本节运用数据处理软件Origin8.0，对干旱灾害、暴雨洪涝灾害、大风冰雹雷电灾害、雪灾低温冷冻灾害的直接经济损失和损失分布，分别进行了正态分布拟合。

以干旱损失分布的拟合为例。由于我国干旱灾害发生地点比较分散，有些地区连续十年没有遭受任何干旱损失，因此连续十年干旱灾害损失均为0，十年的时间里有35个取值点的损失金额为0，导致了(0,1)这一段的函数值远高于(1,2)的函数值，出现曲线过于陡峭的情况，使得拟合效果不佳。为了使拟合效果更加平缓，根据经验，将损失金额取其自然对数In*x*进行处理。拟合得到正态分布的函数关系为式(3.1)：

$$y = 0.10701 + \frac{5.53709}{4.9651\sqrt{\pi/2}} e^{-2\frac{(x-5.19526)^2}{4.9651^2}} \tag{3}$$

对暴雨洪涝、大风冰雹、雪灾和低温冷冻的损失分布数据进行同样的处理，分别拟合得到如下正态分布，且拟合效果均很好。

暴雨洪涝损失分布拟合函数为：

$$y=0.04311+\frac{5.73051}{4.78432\sqrt{\pi/2}}e^{-2\frac{(x-5.74587)^2}{4.78432^2}} \tag{4}$$

大风冰雹雷电损失分布拟合函数为：

$$y=0.05155+\frac{4.21848}{3.58615\sqrt{\pi/2}}e^{-2\frac{(x-4.01894)^2}{3.58615^2}} \tag{5}$$

雪灾和低温冷冻损失分布拟合函数为：

$$y=-7.3376+\frac{258.72338}{13.4296\sqrt{\pi/2}}e^{-2\frac{(x-5.30976)^2}{13.4296^2}} \tag{6}$$

通过对干旱损失灾害、暴雨洪涝灾害、大风冰雹雷电灾害以及雪灾低温冷冻灾害的损失分布进行研究，发现前三种灾害的分布均服从对数正态分布，并且参数取值相近，而雪灾及低温冷冻灾害的分布参数取值与其他三种自然灾害出现了明显的差别，为了提高多风险巨灾灾害损失联合分布的准确性及有效性，本文将选取干旱损失灾害、暴雨洪涝灾害、大风冰雹雷电三种灾害进行巨灾债券的设计。

对于多风险巨灾灾害损失联合分布有两种估计方法：一种方法通过直接将原始分段函数进行叠加，得到新的多风险联合损失分段函数，再对新的分段函数进行分布的拟合，本文称为“叠加法”；第二种方法借鉴金融机构进行风险综合管理时的思路，根据不同的损失分布进行算数平均或者几何平均，本文称为“平均法”。由于使用“平均法”计算出的结果会受到一些极大值的影响，例如08年的南方雪灾等，因此本节通过“叠加法”对多风险巨灾灾害损失联合分布进行估计。

表4.1 累计损失的频数密度函数

x	F(*x*)	*x*	F(*x*)	*x*	F(*x*)	*x*	F(*x*)	*x*	F(*x*)	*x*	F(*x*)
3	0.143	21	0.436	39	0.589	57	0.689	135	0.859	300	0.957

6	0.216	24	0.465	42	0.610	60	0.697	150	0.878	450	0.976
9	0.286	27	0.495	45	0.636	75	0.737	180	0.900	600	0.985
12	0.322	30	0.530	48	0.652	90	0.779	210	0.928	900	0.993
15	0.363	33	0.552	51	0.667	105	0.807	240	0.940	1200	0.995
18	0.410	36	0.571	54	0.686	120	0.828	270	0.947	1500	1.000

4. 多风险巨灾债券的收益率和价格的确定

为满足不同风险偏好的投资者的投资需求，本文设计了不同本金保证比例不同的多风险巨灾债券。假设巨灾债券的触发点为L，收益率为R，发行期限为一年，触发比例设置为巨灾损失的30%，对于不同的L的取值对应不同的概率以及收益率。本文选择本金全部保障型、本金80%保障型、本金50%保障型以及本金完全不保障四种。根据上文计算得出的多风险巨灾灾害损失联合分布，本文利用资本资产定价模型（CAPM）对四种不同类型的多风险巨灾债券的收益率及其价格进行了确定。

表5.1 多风险巨灾债券损失分布

多风险巨灾损失/亿元	触发金额/亿元	概率
12	3.6	0.0364
24	7.2	0.0295
36	10.8	0.0193
48	14.4	0.0159
60	18	0.0079
120	36	0.0216
240	72	0.0113
600	180	0.0091
1500	450	0.0045

假设债券为平价发行，票面金额100元，无风险利率为3%，市场组合收益率为10%，多风险巨灾债券的β为0.2，结合式(1)和(2)，分别得到四种不同触发点的多风险巨灾债券真实收益率：

（1）本金完全保障型多风险巨灾债券，触发时收益率为0，触发点为(3.6，0.0364)，将参数代入式(7)，得到多风险巨灾债券的真实收益率R，如式(8)所示：

$$E(R)=R(1-P)+0*P=R_f+\beta(E(R_M-R_f) \tag{7}$$

$$R=\frac{R_f+\beta(E(R_m)-R_f)}{1-P}=\frac{3\%+0.2*(10\%-3\%)}{1-3.64\%}=4.57\% \tag{8}$$

（2）本金80%保障型多风险巨灾债券，触发时，收益率为-20%，触发点为(10.8.0.0193)，将参数代入式(9)，得到多风险巨灾债券的真实收益率R，如式(10)所示：

$$E(R)=R(1-P)+(-0.2)*P=R_f+\beta(E(R_M-R_f) \tag{9}$$

$$R=\frac{R_f+\beta(E(R_m)-R_f+0.2p}{1-p}=\frac{3\%+0.2*(10\%-3\%)+0.2*1.93\%}{1-1.93\%}=4.88\% \tag{10}$$

（3）本金50%保障型多风险巨灾债券，触发时，收益率为-50%，触发点为(14.4，0.0159)，将参数代入式(11)，得到多风险巨灾债券的真实收益率R，如式(12)所示：

$$E(R)=R(1-P)+(-0.5)*P=R_f+\beta(E(R_M-R_f) \tag{11}$$

$$R=\frac{R_f+\beta(E(R_m)-R_f+0.5p}{1-p}=\frac{3\%+0.2*(10\%-3\%)+0.5*1.59\%}{1-1.59\%}=5.28\% \tag{12}$$

（4）本金完全收回型多风险巨灾债券，触发时，收益率为-100%，触发点为(72，0.0113)，将参数代入式(13)，得到多风险巨灾债券的真实收益率R，如式(14)所示：

$$E(R)=R(1-P)+(-1)*P=R_f+\beta(E(R_M-R_f) \tag{13}$$

$$R=\frac{R_f+\beta(E(R_m)-R_f+p}{1-p}=\frac{3\%+0.2*(10\%-3\%)+1.13\%}{1-1.13\%}=5.59\% \tag{14}$$

下文将对多风险巨灾债券的价格进行确定。多风险巨灾债券为一年期巨灾债券，巨灾债券的价格应当为未来现金流的贴现值，因此四种不同触发情况的巨灾债券的定价如下：

（1）本金完全保障型多风险巨灾债券，触发时收益率为0，触发点为(3.6，

0.0364)，真实收益率*R*为4.57%，其价格p如式(15)所示：

$$p=\frac{104.57*(1-3.64\%)+100*3.64\%}{1+3\%}=101.36 \tag{15}$$

（2）本金80%保障型多风险巨灾债券，触发时，收益率为-20%，触发点为(10.8.0.0193)，真实收益率*R*为4.88%，其价格p如式(16)所示：

$$p=\frac{104.88*(1-1.93\%)+100*1.93\%}{1+3\%}=101.73 \tag{16}$$

（3）本金50%保障型多风险巨灾债券，触发时，收益率为-50%，触发点为(14.4，0.0159)，真实收益率*R*为5.28%，其价格p如式(17)所示：

$$p=\frac{105.28*(1-1.59\%)+100*1.59\%}{1+3\%}=102.13 \tag{17}$$

（4）本金完全收回型多风险巨灾债券，触发时，收益率为-100%，触发点为(72，0.0113)，真实收益率*R*为5.59%，其价格p如式(18)所示：

$$p=\frac{105.59*(1-1.13\%)+100*1.13\%}{1+3\%}=102.45 \tag{18}$$

5.结论

本文对基于中国气象灾害的多风险巨灾债券进行了设计与定价，主要结论如下：

1. 巨灾债券可以有效地将保险市场的风险转移给资本市场；

2. 巨灾债券问世时间不长，数据较少，内部参数变化的不确定性又较高，所以CAPM适合作为巨灾债券定价的模型；

3. 计算多风险巨灾灾害损失联合分布时，应选取损失均服从同一个分布且参数值相近的灾害事件，以提高多风险巨灾债券的有效性；

4. 通过巨灾债券的定价结果发现，本金保障率越高的巨灾债券，其触发点越低，价格也越低，反之则越高。

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基于中国气象灾害的多风险巨灾债券设计与定价

王晔琴，王海艳，王嘉懿

王晔琴
硕士生
同济大学经济与管理学院
上海市杨浦区四平路1500号同济大厦A楼816室
上海201800，中国
电话：150 2192 6137
Email: 965377534@qq.com

王海艳*
副教授
同济大学经济与管理学院
上海市杨浦区四平路1500号同济大厦A楼816室
上海 200092，中国
电话: （086）139 1728 3932
Email: wanghaiyan@tongji.edu.cn

王嘉懿
硕士生
同济大学经济与管理学院
上海市杨浦区四平路1500号同济大厦A楼816室
上海 200092，中国
电话: （086）136 1188 5909
Email: wjygrace_2012@sina.com

关键词：巨灾风险管理；多风险；巨灾事件损失分布；巨灾债券定价

中文摘要. 我国是世界上自然灾害最严重的国家之一，灾害种类多，发生频率高，分布地域广，经济损失和人员伤亡惨重。建立多层次的巨灾风险管理体系成为当前的热点话题。本文选取巨灾风险管理体系中巨灾风险证券化这一点，以

The Parameter Estimation of Lee-Carter Model with Missing Data

WU Xiaokun

Ph.D.
Department of Mathematics and Physics
North China Electric Power University
Baoding 071003, Hebei, China;
Phone: (86312) 7525 078
Email: wuxk@ruc.edu.cn

Keywords: Lee-Carter model, missing data, weighted maximum likelihood estimation.

Abstract. About Chinese age specific population survey data, data of different years have different rates of sampling and different age limits and some data of young ages exist no death observation records. In general, the age specific death data of our country has irregular upper age limit and missing value in some young ages. When we construct mortality models using these data, such as Lee-Carter model, irregular and missing value data bring about some troubles on parameters estimation of the model. Many researchers adopt the method processing the data first and then applying it again. In this paper we propose to construct our country population mortality Lee-Carter model by weighted Poisson maximum likelihood estimation directly using original irregular data containing missing values. The estimated parameters, predicted mortality and life expectancy gained by this method are compared with other methods.

1．引言

我国分年龄的人口调查数据分为普查数据、1%抽样调查数据和接近1‰的人口变动情况抽样调查数据，这首先是抽样比例的不同。另外在数据形式上，近几次的普查数据和1%抽样调查数据的年龄上限为100岁，数据中不存在缺失值；而人口变动情况抽样调查数据的年龄上限大多为90岁（1996年为85岁），并且在很多年份的低年龄数据中存在无死亡人口的观测记录，即人口变动情况抽样调查数据相对于普查和1%抽查数据存在缺失数据。总的来讲，我国人口死亡数据存在年龄上限不规则与某些年龄无死亡观测的情况，在统计上都可称为缺失数据问题。数据中的缺失值不利于死亡率预测模型的建立，比如Lee-Carter模型[1]。

对于死亡率数据在年龄上限的不规则，很多研究者，比如卢仿先和尹莎(2005)[2]，祝伟和陈秉正(2009)[3]，韩猛和王晓军(2010)[4]，李志生和刘恒甲(2010)[5]，王晓军和任文东(2012)[6]等，采取了对90岁以上数据进行合并，对年龄上限为85岁的数据进行扩展至90岁，对于某些数据在低龄人口的缺失，这些研究者对数据进行了5岁一个年龄组的合并，这样形成5岁一组，年龄上限为90岁的整齐数据，以方便于建立死亡率预测模型。运用这样处理了的数据建立的模型损失掉了很多信息，如果要得到每一个年龄的死亡率还要对得到的5岁一组的预测结果进行拆分。也有研究者，王晓军和任文东(2012)[6]，舍弃一些年份数据仅保留普查和1%抽样数据。无论何种处理数据的方法，都会不同程度的带来数据信息的损失或改变。本文尝试一种直接利用原始数据建模的方法——加权泊松极大似然估计法，在存在缺失数据的情况下对我国人口死亡率Lee-Carter模型中的参数进行估计。这种方法建立的模型与完整数据建立的模型是一样的，在后续的应用上不必进行变换便可以预测任意年份任意年龄的死亡率。

Lee-Carter模型参数估计的常用方法，泊松极大似然估计法，是可以直接利用缺失数据建模的。然而如果不对参数估计的方法（程序）进行任何的改动，在含有缺失数据的情况下一般难以实现多个参数的快速估计，在需要快速模拟运算的应用中就会变得不实用。本文尝试在求解Lee-Carter模型参数的似然函数上附加适当的权重，对缺失数据进行形式上合理可行的补全，但实质上不参与参数估计运算，形成加权泊松极大似然估计法，以此实现参数的快速估计。

2．中国人口分年龄分性别的死亡数据

根据《中国人口统计年鉴》和《中国人口和就业统计年鉴》，可以得到1994年到2014年的中国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1995年和2005年为1%抽查数据，2000年和2010年为人口普查数据，年龄范围为0~100岁，剩余数据为接近1‰的人口变动情况抽样调查数据，其中1996年数据的年龄上限为85岁，其余为90岁。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，可能是由于样本总量偏少而死亡率本身又很低造成的，但是如果认为该年龄人口的死亡率为0显然不合适。

如果不加任何处理的运用这些数据建立死亡率模型，比如Lee-Carter模型，将这些数据放到一起无法形成规则的矩阵形数据，因此Lee和Carter (1992)[1]中的奇异值分解方法无法应用。而对于利用牛顿-拉夫逊算法实现的最小二乘或者极大似然法，如果认为死亡人数(率)是0是可以应用的，但是在超过85岁或者90岁的观测中认为死亡人数(率)是0肯定是不合适的，因为对于这些高龄人口的死亡数据是存在的，只是没有单独记录，而是仅仅将85岁或90岁以上人口的死亡情况进行了一个笼统的记录。由于观测样本偏少产生的无死亡记录和多年龄合并产生的笼统记录，从单一年龄数据的角度来说都是缺失数据。

3．Lee-Carter模型的加权极大似然估计

3.1 加权极大似然估计

Lee 和 Carter (1992) [1]构造的形式简洁、适用广泛的死亡率模型，现在一般简称为 Lee-Carter 模型，其形式为

$$\ln \mu_x(t) = \alpha_x + \beta_x \kappa_t \tag{1}$$

这里 x 表示年龄，t 表示时间，$\mu_x(t)$ 为时间 t 年龄 x 岁的死亡力，建模时常常直接使用中心死亡率 $m_x(t)$，$m_x(t) = d_{xt} / er_{xt}$，其中 d_{xt} 为死亡人数，er_{xt} 为平均年中人口数；α_x 为年龄 x 的总体死亡率因子；β_x 为年龄为 x 岁的死亡率变化因子，度量 x 岁人的死亡率的变化强度（通常为改善强度）；κ_t 为时间因子，度量 t 时期所有年龄死亡率的改善水平。

在死亡人数服从泊松分布的假定下，参数估计的加权对数似然函数为(详细内容可参考 Pitacco 等(2009)[7])

$$l(\alpha_x, \beta_x, \kappa_t) = \sum_{x,t} w_{xt} (d_{xt} \log(\lambda_{xt}) - \lambda_{xt} - \log(d_{xt}!)) \tag{2}$$

其中，$\lambda_{xt} = er_{xt} \exp(\alpha_x + \beta_x \kappa_t)$。依据极大似然原理与牛顿-拉夫逊算法，参数的极大似然估计迭代算法为

$$\theta^{(i+1)} = \theta^{(i)} - \frac{l'(\theta^{(i)})}{l''(\theta^{(i)})} \tag{3}$$

其中，$\theta^{(i)}$ 代表参数 θ 的第i步的迭代值，$\theta^{(i)}$ 可以是似然函数中的任意参数或参数向量，代入具体的参数和数据便可以进行具体参数的极大似然估计值的运算。

3.2 缺失数据的加权极大似然估计

公式(2)中 $\sum_{x,t}$ 的含义是对所有年龄x和所有时间t求和，如果数据中存在缺失值我们将它舍弃就行了，也就是公式(2)是可以直接用于还有缺失值的数据。但是，运用计算机求解参数的极大似然估计时规则数据容易进行快速运算，不规则数据如果不加任何处理会给快速计算带来一定的麻烦。一个简单的处理办法是为

缺失数据设置任意合理的数值，但是在其对应的权重处施加0权重，这样缺失数据本质上不会参与到参数估计的求解，而在形式上数据已经变成了计算机容易处理的规则数据。

4．缺失数据下中国人口Lee-Carter死亡率模型的建立与应用

4.1 参数估计结果与比较

以男性为例，利用第2节所述的数据和第3节所述的方法，我们构建中国男性人口Lee-Carter死亡率模型，可以很容易的得到模型的参数估计。

如果将低龄数据中的缺失值都按照零来处理也是可行的，这样处理后三个参数估计中与直接利用缺失数据所得估计值基本一致，它们的最大绝对偏差分别为，α_x的最大偏差为0.00266；β_x的最大偏差为4.402363e-05；κ_t的最大偏差为0.2949001。

为了进行估计结果的比较研究，我们将年龄上限为85岁的数据延拓至90岁，将年龄上限为100岁数据在90岁截断，得到年龄上限为90岁的规则数据。原始不规则缺失数据和处理后规则数据下所估计的模型参数如图1-3所示。

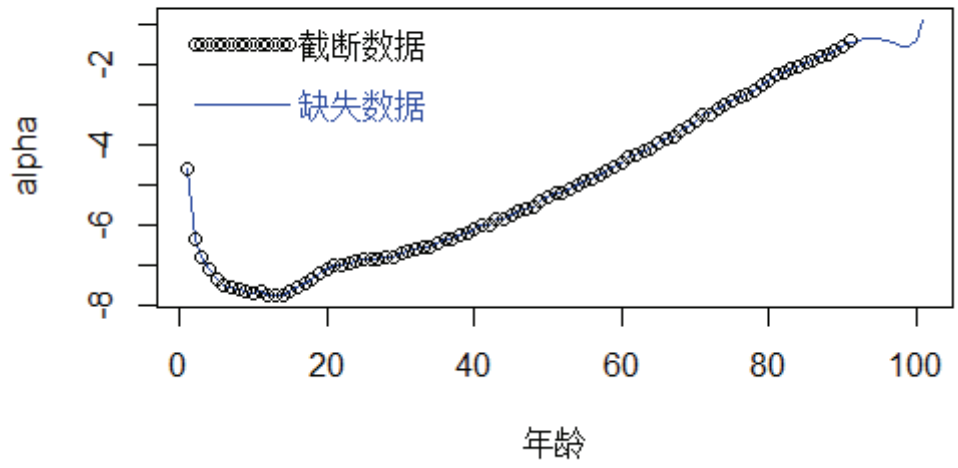


图1 α_x的估计比较

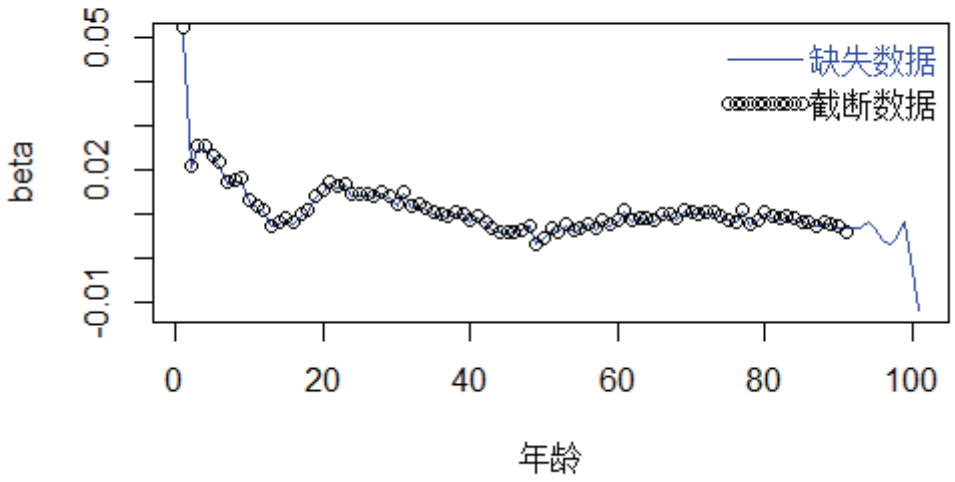


图2 β_x 的估计比较

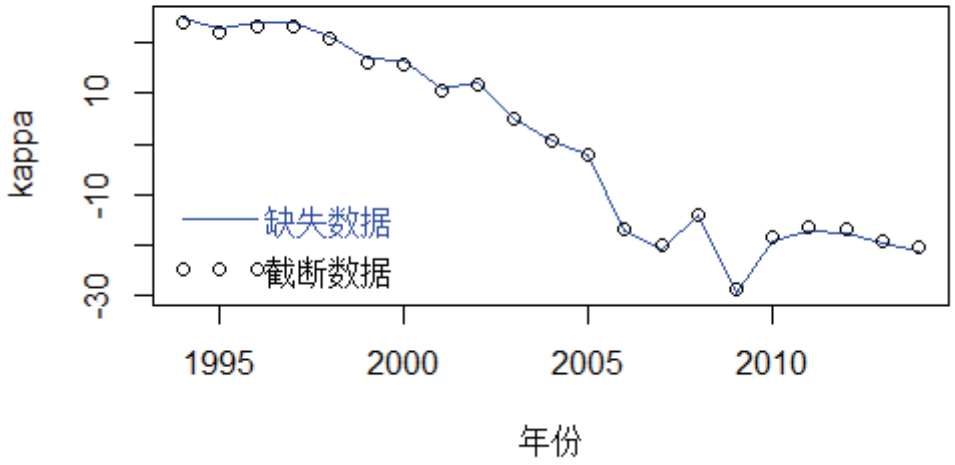


图3 κ_t 的估计比较

在原始数据和截断数据下估计的结果，除了 α_x 和 β_x 在年龄上限的不同外，剩余参数的估计值基本一致。在相同年龄一致的情况下，本文所利用的估计方法能够得到更多年龄的估计参数，使得模型死亡率的年龄上限由90延长到100岁，提高了模型的使用价值。另外，相同年龄估计结果的一致性也说明了估计方法具有很好的稳健性。这种稳健的估计结果，从一定角度可以从侧面印证超过90岁以上模型参数估计结果的可靠性。

4.2 死亡率预测

本文对死亡率进行了10年和20年的预测，结果见图4，截断数据和原始不规则的缺失数据下小于90岁的死亡率估计与预测结果基本一致，差异不大，然而经过处理的截断数据无法得到90以上各年龄的死亡率。根据原始的不规则数据预测所得90岁以上各年龄的死亡率，表现出一定的曲线变化，与90岁以前的规律有明显的不同。可见对90岁以上数据的截断丢失了有价值的信息，因此，使用全部的原始数据而不是进行截断，更有利于真实死亡率的预测。

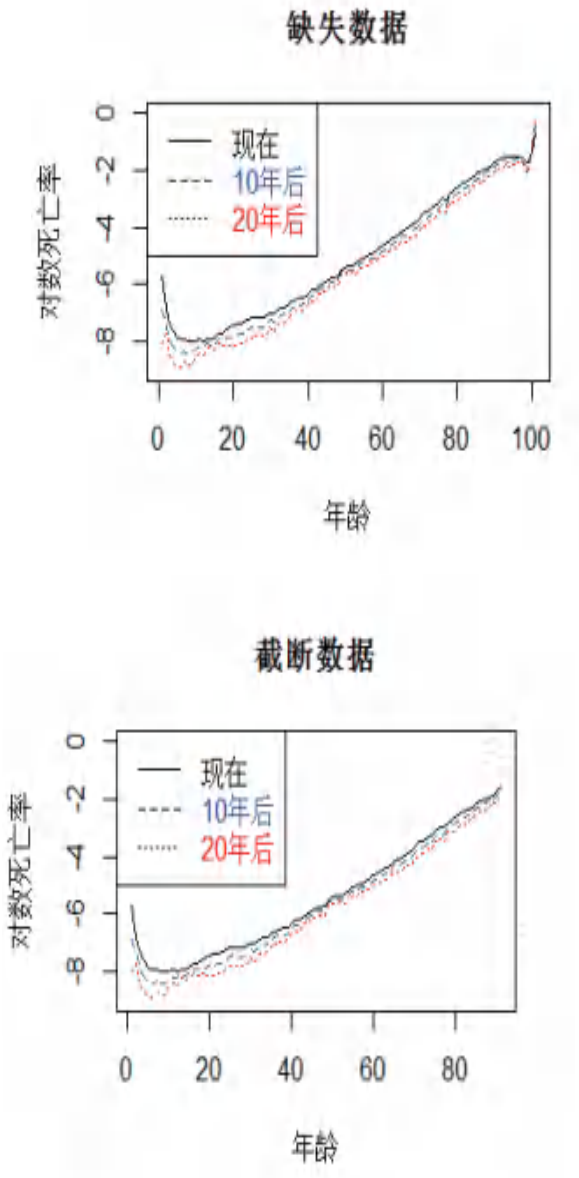


图4 死亡率的预测

4.3 预期寿命预测

通过预测的不同年份（2025年、2035年）的各年龄预期寿命的比较，见图5-6，我们会发现截断数据下的预期寿命均低于不规则原始数据下的预测结果，并且随着预测年份的延长和预测年龄增加，它们之间的差异越来越明显。运用截断数据

建立模型，如果不进行死亡率在年龄上的延伸，以男性为了，2025年60岁预期寿命将比原始数据预测下的预测结果偏低0.75岁以上，80预期寿命偏低1.2岁左右。用高龄截断的方法处理数据，虽然扫除了后续的建模过程的障碍，但是如果运用这样的模型进行死亡率预测和应用，会造成的我们对长寿风险的严重低估。

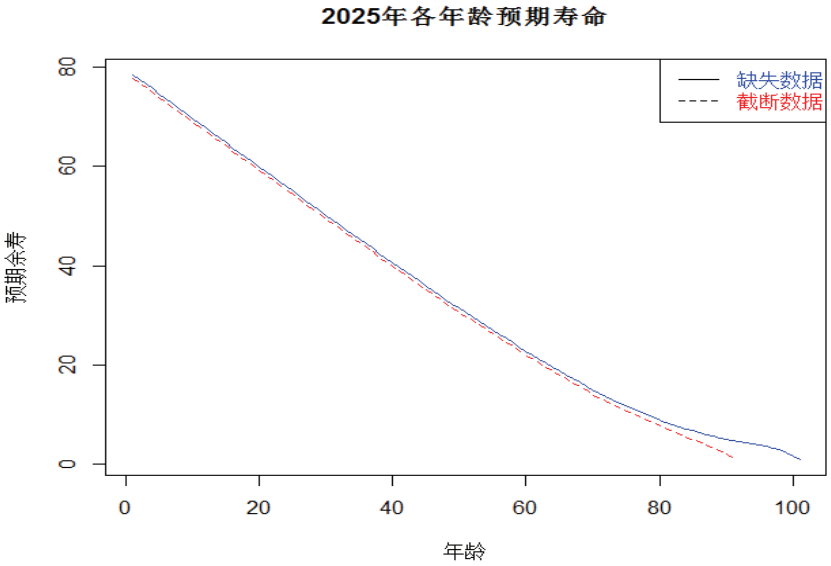


图5 预期寿命

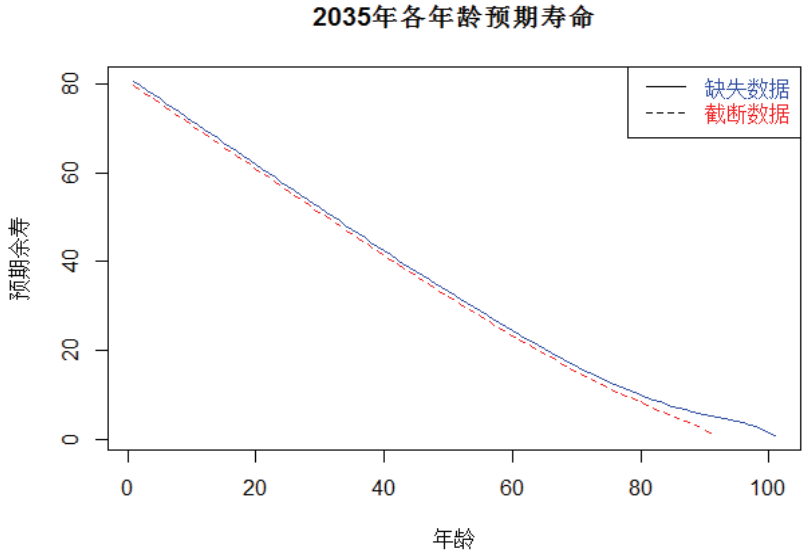


图6 预期寿命

5．结束语

本文利用加权极大似然估计的方法实现了不规则并含有缺失值的人口数据下Lee-Carter死亡率模型的构建与死亡率和预期寿命的预测，并与截断处理数据下构建的模型与预测结果进行比较，新方法可以实现分年龄，年龄上限为100岁

的死亡率的预测，较分组并截断处理数据然后建模具有明显的优势，尤其在长寿风险的研究中会有广泛的应用空间，期待其能在进一步的应用中发挥作用。

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缺失数据下**Lee-**Carter模型的参数估计

吴晓坤

博士
华北电力大学（保定）数理系
保定071003，河北，中国
电话: (86312) 7525 078
Email: wuxk@ruc.edu.cn

关键词: Lee-Carter模型; 缺失数据; 加权极大似然估计

摘要. 我国分年龄的人口调查数据在不同年份的抽样比例和年龄上限并不一致，并且在有些年份的低龄存在未观测到死亡样本的情况，总的来说，我国人口死亡数据年龄上限不规则并在低龄存在缺失数据。这给建立死亡率预测模型带来了麻烦，很多研究者采取首先对数据进行加工处理然后再应用的方法。本文尝试直接利用原始不规则并含有缺失值的数据的方法——加权极大似然估计法，建立我国人口死亡率Lee-Carter模型，并与其它方法进行比较研究，包括参数估计、死亡率预测、预期寿命预测的比较研究。

Transformation of High-Tech SMEs Loan Guarantee Premium Rate Setting

ZHANG Daijun, CHANG Na

ZHANG Daijun
Professor
School of Finance
Zhejiang University of Finance and Economics
Hangzhou 310018,China
Phone:13750815909
Email:zdj0303@126.com

CHANG Na
Master
School of Finance
Zhejiang University of Finance and Economics
No.18, Xueyuan street,
Xiasha Higher Education District ,Hangzhou Zhejiang Province.
Phone:18917456475
Email:1587527499@qq.com

Key words: Small and mid-sized enterprises of Science and technology Science and technology achievements transformation Loan guarantee insurance Rate making

Abstract: Science and technology achievements transformation of small and medium-sized enterprises to small and medium-sized enterprises, which will face the market for domestic and foreign, growing enhance their own competitiveness, ensure that China's economy is moderate growth, ease the employment pressure, promote technological innovation, improve national economic development and maintain social stability plays an important role. Therefore, it is the key factors to promote the social productivity for Small and medium-sized enterprises of science and technology achievements transformation, which will has been a steady growth. However, the scientific and technological achievements conversion rate is low in our country, the contribution rate of technological progress on economic growth is small, the current scientific research achievements conversion rate of 60% for the main developed countries, the contribution rate of technological progress on economic growth of 60% to 80%; In our country, however, industrial scientific and technological achievements conversion rate of 37%, agriculture is 40%, the contribution rate of technological progress on economic growth, our country exists the gap with the developed country, rooted in the financing bottleneck of transformation of scientific and technological achievements in our country. To solve the problem of the financing for the transformation of scientific and technological achievements is the key to promoting the development of small and medium-sized enterprises and social progress.

The loan guarantee insurance in the development of science and technology achievements transformation of small and medium-sized enterprises financing is the main line of this paper. Then analysis the place in the enterprise is based on life cycle theory for the transformation of Scientific and technological achievements, by introducing mechanism of loan guarantee insurance plans to solve the problem of science and technology achievements transformation of small and medium-sized enterprises financing difficulties, and rates set by the principle of expectations. At the first, this article analyzed the financing necessity of the loan guarantee insurance in science and technology achievements transformation of small and medium-sized enterprises ;Then expounds the operation mechanism of loan guarantee insurance, by listing the running mode of foreign loan guarantee insurance, combining the domestic existing social background, draw lessons from foreign loan guarantee insurance operation mode, finally sums up the suitable for China's national conditions of the running mode of loan guarantee insurance; The third chapter, studies the pricing of China's small and medium-sized enterprise loan guarantee insurance, through the expected loss model, based on the questionnaire data of science and technology achievements transformation of small and medium-sized enterprises loan guarantee insurance rates has carried on the empirical research, get a loan guarantee insurance rate; The fourth chapter, this paper puts forward relevant policy Suggestions.

This study has important significance, through the study of this article is helpful to promote transformation of scientific and technological achievements of our country enterprises solve the problem of financing difficulties, accelerate upgrading of industrial structure, is conducive to the rapid development of science and technology of small and medium-sized enterprises in our country, promote economic growth, promote small and mid-sized enterprise technology innovation, enhance enterprise competitiveness.

1.引言

21世纪是一个以科技创新为主题的知识经济时代，各国之间以科技创新为基础的综合国力的较量变得日趋激烈。世界经济模式已完成了由传统的工业经济模式向知识经济模式的过渡，在知识经济时代中，世界各国竞争的重心转变为了知识、科技的竞争，进而表现为科技成果转化的竞争。促进科技型中小企业成果转化成为新时代科技型企业稳步成长、促进社会生产力提高的关键因素。但是，我国现今的科技成果转化率低，技术进步对经济增长的贡献率小，我国与发达国家存在较大差距，根源在于我国科技成果转化的融资瓶颈。

为解决科技型中小企业融资难问题，国内外学者对保证保险支持企业融资的相关问题进行了大量的研究，并发现贷款保证保险对缓解科技型中小企业融资难问题意义重大。国外学者 George M.von Furstenberg(2005)指出贷款保证保险有利于平滑不同州之间和同一州在不同时点之间的消费。而 Malawi(2007)对影响信用保险需求大小的原因进行了研究，他指出当借款人在投保信用保险时，那些收入水平越高并且受教育程度也越高的借款人对信用保险的依赖程度越高，但是若借款人不选择投保信用保险，以上两个因素与借款人之间则不存在明显的相关关系。彭南刚(2003)、姜涛(2005)、陈淑华(2009)和高力(2010)认为中小微企业由于自身信贷条件的缺乏，导致其信用水平较差,难以达到银行的资信审查条件,引入保险机制后,可以有效地提高中小微企业的信用等级和资信能力,增强银行对中小微企业贷款的信心。鲍静海、周稳海、李浩然(2007)从保险公司、金融机构以及政策扶持等多个角度对构建中小企业信贷保证保险制度的必要性和可行性进行了分析，同时提出了构建这一制度的总体思路。欧阳平、周汝辉(2013)指出建立企业信贷保证保险制度一方面能够提高企业的信用等级和融资能力，另一方面有助于保障银行信贷资产的安全，从而增强银行对企业贷款的信心。

国内外学者在研究如何利用保证保险缓解中小企业融资难问题上已经取得了不错的成绩，但仍有许多问题需要加以解决并不断完善。当前大多数学者是针对中小企业信用保证保险和中小企业小额贷款保证保险的研究，而将科技型中小企业成果转化融资与贷款保证保险结合起来进行系统探讨的文献比较少见，进行科技成果转化融资保证保险定价还没有相关文献涉及。本文通过调查问卷的形式取得科技成果转化企业的违约次数和违约金额，运用期望损失模型进行费率厘定，以期望能最大程度的接近真实费率。

2.科技小企业科技成果转化和贷款保证保险的相关理论

2.1科技型中小企业的概念和界定

2.1.1中小企业

（1）定性界定（更新到最新发表的论文对中小企业的定性界定）

中小企业已经成为我国国民经济和社会发展的重要推动力，我国对中小企业的界定是：在中国境内依法设立的有利于满足社会需要，增加就业，符合国家产业政策，生产各种所有制形式的经营规模的中型和小型规模的企业。通俗的讲，中小企业就是与大型企业相比，资产规模较小，职工人数和营业额有限的企业。

（2）中小企业的定量界定

我国在2011年，出台了《中小企业划型标准规定》，从员工人数，销售额，和资产总额三个方面对各行各业，划分了明确的标准：

表2.1 中国中小企业划型标准

所属行业	员工人数	销售额（人民币）	资产总额（人民币）
工业	＜1000	＜40000万	
建筑业		＜80000万	＜80000万
农林牧渔		＜20000万	
批发业	＜200	＜40000万	
零售业	＜300	＜20000万	
交通运输业	＜1000	＜30000万	
仓储业	＜200	＜30000万	
邮政业	＜1000	＜30000万	
批发业	＜200	＜40000万	
住宿业	＜300	＜10000万	
餐饮业	＜300	＜10000万	
信息传输业	＜2000	＜100000万	
软件&信息技术服务业	＜300	＜10000万	
房地产		＜200000万	＜10000万
物业管理	＜1000	＜5000万	
租赁&商务服务业	＜300	＜12000万	

资料来源：《中华人民共和国中小企业促进法》和《国务院关于进一步促进中小企业发展的若干意见》，2011—06—18

2.1.2科技型中小企业

（1）科技型中小企业的定性界定

本文在定性上认为科技型中小企业是指以科技人员为主体，主要从事符合国家产业政策要求的科学研究和高新技术产品的研制、生产以及销售，以科技成果商品化为最终目的，以市场为导向，自筹资金、自主经营、自负盈亏和自我发展的技术密集型经济实体。

（2）科技型中小企业的定量界定

依据《中华人民共和国科学技术进步法》和《中华人民共和国中小企业促进法》，参照《科学技术部、财政部关于科技型中小企业技术创新基金的暂行规定》，本文将科技型中小企业界定为：

（1）在中华人民共和国境内工商行政管理机关依法登记注册，具备法人资格的企业，具有健全的财务管理制度；

（2）主要从事高新技术产品的研制、开发、生产或者服务业务；

（3）职工人数原则上不超过500人；

（4）全年销售收入在3亿元以下或资产总额在3亿元以下；

（5）具有大学以上学历的科技人员占职工总数的比例不低于30%，或直接从事研究开发的科技人员占职工总数的比例不低于10%；

（6）近三年每年用于高新技术产品研究开发的经费不低于当年销售额的3%。

表2.2各省市对科技型中小企业界定标准

	从业人员人数	营业收入（万元）	科技人员所占比重	高新技术产品销售收入占总收入比重	研发费用占销售收入比重
浙江省	＜500		＞20%	＞50%	＞5%
四川省	＜300	＜10000	＞20%	＞20%	＞1%
北京市	＜500		＞50%		＞5%
上海市			＞30%	＞50%	＞5%
山东省	＜500		＞30%		＞5%
河北省	＜300	＜10000	＞20%		＞2%

资料来源：周畅 科技型中小企业贷款保证保险的发展研究，2015.

2.2科技成果及科技成果转化的概念

2.2.1科技成果的定义

科技成果可以理解为通过科技活动所产生的成果。由于科技活动涉及研究开发(包括基础研究、应用研究、试验发展)、研究开发成果转化和应用、科技服务3个部分，因此从广义上讲科技成果应包含这三类科技活动所对应产生的成果。然而，根据我国有关法律、法规对科技成果的定义，其多是从狭义的方面，即从研究开发这一方面来对科技成果进行界定或分类。例如，根据我国1986 年出版的《现代科技管理词典》对科技成果的定义，科技成果是指科研人员在他所从事的某一科学技术研究项目或课题研究范围内，通过实验观察、调查研究、综合分析等一系列脑力、体力劳动所取得的，并经过评审或鉴定，确认具有学术意义和实用价值的创造性结果。

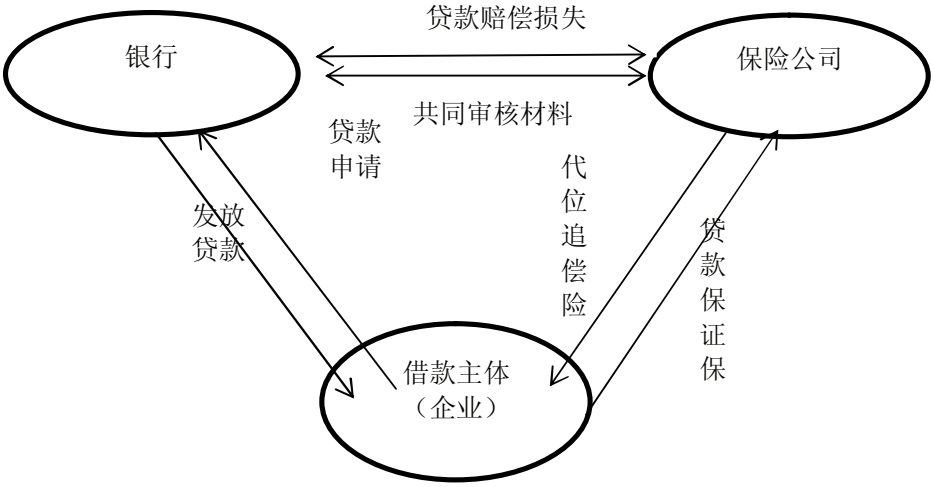
2.2.2科技成果转化的定义

由于科技成果的概念存在广义和狭义之分，因此科技成果转化的概念也可以从广义和狭义两个方面进行理解。从广义的角度看，科技成果转化包含从知识的生产到最终生产力的形成这一创新链条中各个环节的转化，如基础研究所产生的新知识、新理论的传播、共享与普及可以视作为转化，应用研究及实验发展环节所产生的新技术、新装置的应用、形成新产品并产生经济社会效益可以视作为转化，软科学的研究成果被政府部门采用也可以视作为转化; 而从狭义的角度看，科技成果转化主要侧重于创新链的末端，即应用技术成果向能实现经济效益的现实生产力的转化。我国目前关于科技成果转化的概念的官方界定多是从狭义的角度进行界定的。

2.3贷款保证保险的概念

贷款保证保险是指借款人或借款企业作为投保人，应银行等金融机构的要求，以自身的信用为保险标的向保险公司进行投保，保险公司承保偿还银行贷款义务的一种保证保险。在贷款保证保险业务中，被保险人为银行等可开办贷款业务的金融机构，保险人为保险公司。若在保险期间内，投保人不能按照与被保险人签订的贷款合同的约定及时偿还贷款，并且所拖欠的欠款已经超出保险单规定的“赔款等待期”时，保险公司应就投保人所欠的贷款本金和利息之和按照保证保险合同的约定向被保险人即银行予以赔付。银行、保险公司和借款企业是企业贷款保证保险涉及到的三个参与主体；而借贷合同和贷款保证保险合同是该保险涉及到的两个合同（如下图）。除此之外，再保险公司在满足一定条件的基础上也会参与到企业贷款保证保险的实施过程中。

债务人投保贷款保证保险能够提高自身的信用水平，并且为银行提供还款保障。近年来，由于科技成果转化企业自身的高风险以及与银行之间的信息不对称等问题的存在，导致科技型成果转化企业很难获得银行的资金支持，进而面临资金供不应求的局面。在这种情况下，交易双方都需要有一个资金稳定、信誉较高以及立场较客观的第三方进行协调，进而降低由于信息不对称产生的风险。而企业贷款保证保险就是这样的一种新兴的融资增信机制。



贷款保证保险运行模式

3.贷款保证保险介入科技型企业成果转化中的融资必要性分析

3.1我国科技成果转化融资模式和现状分析

3.1.1科技成果转化的融资模式分析

（一）科技成果转化融资需求特征

（1）融资需求及风险具有阶段性。

科技成果转化是一个过程，具有显著的阶段性特点，学术界对其阶段的划分

有不同理解，目前较为公认的“四阶段论”将其分为科学成果阶段、技术成果阶段、技术产品阶段、技术商品阶段。在科学成果阶段，科学技术因素占主导地位，所需资金量不大，但所有投入承担技术风险大；在技术成果阶段，从实验室取得的科研成果要经过小试中试环节，对实验室中的技术与产品是否合格，以及成为具有市场需求且能够企业化生产的产品进行论证，该过程需要一定的资金投入，及时的资金支持是科技成果转化能否成功的关键所在，但可能没有与之配比的收入产生，风险很大；在技术产品阶段，通过产学研合作对技术、工艺、管理等再次创新进入批量生产，融资需求增长快，风险较大；技术商品阶段，科技成果转变为能在市场上销售的成熟产品，并促进其产业化，财务业绩迅速增长，融资需求大幅增加，风险相对较小。

（2）融资渠道具有多元性、层次性。

由于科技成果转化的阶段性特点，需要多渠道的资金支持，其融资具有层次性的特征。在科技成果阶段，技术风险最大，主要是自有资金和政府的专项资金支持；技术成果阶段需要的资金投入增加，在这一阶段产品不成熟，风险很大，财务业绩很少甚至为负，不符合金融机构贷款的基本要求，融资来源有企业资金、天使资金、创业投资等；技术产品阶段资金需求快速增长，产品进入批量生产，有一定的财务业绩，但设备、原材料采购需要大量资金，而为了获得订单扩大新产品的销售，大量采取赊销方式，使流动资金不足，主要依靠金融机构提供有针对性的融资服务快速融通资金；技术商品阶段，企业进入稳定发展期，风险较小，资金需求规模大，可以在资本市场上通过股权转让、上市、并购等方式融资。

（二）科技成果转化多层次融资模式选择。

科技成果转化的整个过程需要投入大量资金，在转化的不同阶段风险与收益特征不同，各投资主体的风险承受力及收益要求存在差异，科技成果转化对融资服务的需求也存在显著差异，需要多种金融手段优化组合、协同合作。表3.1列示了科技成果转化不同阶段的风险特征、财务绩效、资金需要量及相应的融资模式。科技成果转化需要多层次的融资服务，既要求要有政府的专项资金、企业的自有资金，还需要各种金融资本的参与，共同实现金融服务体系的协同发展。需要政府的引导、科技金融机构的不断创新以及市场化运作的中介机构等提高科技成果转化融资服务的连续性、衔接性和匹配度，满足科技成果转化的多样化、动态性的资本需求。

表3.1 科技成果转化融资模式

阶段	科学成果阶段	技术成果阶段	技术产品阶段	技术商品阶段
风险	技术风险	资金风险	市场风险	收益风险
财务绩效	无	无或少量	不稳定	稳定
资金需要量	少	较大	大	大
主要融资方式	自有资金、政府专项资金	风险投资、政府贷款、民间借贷	风险投资、银行贷款、民间借贷、融资租赁、发行债券	发行股票、银行贷款、民间借贷、发行债券

3.1.2科技成果转化融资现状分析

我国科技成果转化的现状是：转化率低，技术进步对经济增长的贡献率小，当前主要发到国家的科研成果转化率为60%，技术进步对经济增长的贡献率到60%-80%；然而在我国，工业的科技成果转化率为37%，农业为40%，技术进步对经济增长的贡献率仅占28.7%，我国与发达国家之所以存在差距，根源于我国科技成果转化中的融资瓶颈。

科技成果转化要经过R＆D研究、中间试验和工业性生产的发展阶段，每一阶段都需要相应资金的投入，其比例在国外一般为1：10：100，而目前我国的比例约为1：1：10。显然，我国在中试和批量生产阶段的资产投入不足，导致某些科技成果滞留在研究开发阶段而无法转化为现实的生产力。

3.2我国科技成果转化融资难原因分析

资金是企业进行生产经营的重要生产要素，也是进行科技成果转化的基础。目前主要的融资渠道有：国家财政资金、银行信贷资金、其它企业资金和居民个人资金等。主要的融资方式有：吸引直接投资、发行股票、银行贷款、发行债券和财政资金补助等，但这些传统融资方式难适应科技成果转化对资金的需求。融资渠道不畅通，是造成科技成果转化融资难的重要原因。

3.2.1创业者资金投入

创业者进行科技成果转化，首先要投入生产经营所需要的资金。由于创业者个人资金有限，向外部机构融资又比较困难，经常要向亲戚、朋友借贷，但民间借贷资金成本较高。对于进行科技成果转化的初创期企业来说，无法支付高昂的民间借贷利息，一般也只能进行短期的借贷，用于临时性的资金周转。同时，高利贷存在很大的风险，也不受法律保护。

3.2.2吸收创业投资

创业投资也称为风险投资，属于吸收直接投资的融资方式。1999年国务院办公厅转发七部委《关于建立风险投资机制的若干意见》后，我国曾掀起设立创业投资企业的热潮。到2000年8月以后，创业投资企业的数量就开始下降。主要原因有：一是创业投资的短期经营行为。创业投资主要投资成熟期的企业，特别是1-2年内就能够上市或者是市场占有率在前3名的企业，而不愿意投资种子期

或起步期的企业。二是创业投资自身运作不规范。不少创业投资涉足证券和房地产，甚至将其当作了主业，增加了经营管理风险。三是创业投资退出通道不畅通，尚不能为创业资本提供自由灵活的退出通道。我国创业投资发展十分缓慢，科技成果转化项目吸收创业投资的资金也很少。

3.2.3发行股票

20世纪90年代初我国开始有股票市场，长期以来，股票市场主要是为国有企业改革服务，虽然目前情况有很大改变，但是一直有两个主板市场，从2014年2月证监会最新发布的《首次公开发行股票并在创业板上市管理办法》来看，主板的上市条件较高，在公司规模方面，发行前股本总额不少于人民币3000万元；申请股票上市，股本总额不少于人民币5000万元。在公司盈利方面，发行人最近3个会计年度净利润均为正数且累计超过人民币3000万元，经营活动产生的现金流量净额超过人民币5000万元或者最近3个会计年度营业收入累计超过人民币3亿元。创业板于2009年10月建立，尚处于起步阶段，上市融资规模有限，现行的创业板证券审核制仍强调企业过去的财务业绩和未来盈利能力等定量指标，绝大多数科技型中小企业达不到标准。对企业的研发能力、科技含量及成长潜力等指标不作要求，不适用于处于创业期的高科技企业。

3.2.4银行贷款

我国《商业银行法》规定，商业银行贷款，借款人应当提供担保。商业银行应当对保证人的偿还能力，抵押物、质物的权属和价值以及实现抵押权、质权的可行性进行严格审查。科技型中小企业初创期一般租赁在科技产业园区办公，没有自己的经营场所，机器设备等固定资产也较少，没有银行要求可以做抵押的固定资产，又没有担保单位为其贷款提供担保；同时，科技型中小企业创办时间较短、信用等级不足，所以科技型中小企业很难获得商业银行的贷款。另一方面从商业银行自身经营方面来说，商业银行办理中小企业的信贷业务，与大型企业的项目相比，要花费更多的经营成本；办理中小企业信贷业务综合回报率较低，商业银行也不愿意办理科技型中小企业贷款业务。

3.2.5发行债券

根据《证券法》规定，企业发行债券要有规模的要求，股份有限公司净资产不低于3000万元，有限责任公司净资产不低于6000万元；并具有一定的偿债能力，最近三年平均可分配利润足以支付公司债券1年的利息。根据证监会《公司债券试点办法》规定，发行公司债券，要经资信评级机构评级，债券信用级别良好。科技型中小企业因经营规模较小、信用等级也不足，初创期的科技企业还没有开始盈利，并不具有偿债能力，也无法通过发行债券取得资金。

3.2.6财政资金补助

目前，政府设立了成果转化引导基金，通过政府资金引导社会资本共同出资对企业进行阶段参股的模式，解决成果转化融资难的问题，发挥财政资金的杠杆效应。截止2014年底，国内共成立209支政府引导基金，目标设立规模达1233.93

亿元，平均单支基金规模为6.19亿元。但政策性风险投资机构仍占主导地位，政府对民间资本进入风险投资领域的引导和吸纳作用不够，风险投资存在准入限制，从事创业投资的机构少且资本规模较小，风险投资运作的效率低，因多层次资本市场体系未完善，缺乏完备的风险投资退出机制，难以满足科技成果转化的资金需求。

3.3贷款保证保险介入科技成果转化融资的意义

3.3.1能够增强科技型中小企业的融资能力

科技型中小企业由于规模小,没有专业的风险管理部门,风险识别能力和控制能力较差,在经营中存在很多风险漏洞。科技型中小企业向保险公司申请贷款保证保险后,保险公司对科技型中小企业经营的风险状况进行调查,从企业内部管理和外部环境科技型对中小企业面临的风险进行全面的分析,对科技型中小企业在经营中的风险控制方面提出专业的意见。另外,保险公司与科技型中小企业签订贷款保证保险合同后,会对科技型中小企业进行持续的跟踪管理,对科技型中小企业的风险情况进行调查,针对其风险情况提出改进的意见。由于保险公司是专门经营风险的机构,能从专业的角度给科技型中小企业提出风险控制的意见,加强对风险薄弱环节的管理,促进企业的利润的增长和经营的稳、定性,从而增加企业资金的积累,提高企业的内部融资能力。

3.3.2能够增加银行贷款资金的安全性

贷款保证保险介入科技中小企业成果转化融资，可以从多个方面来增加银行贷款给中小企业的可能性，同时增加银行贷款资金的安全性，从更大程度上保证银行收回借款。首先，保险公司作为第三方介入到中小企业贷款可以向双方提供更多的真实可靠的信息，减轻了企业和银行之间信息不对称的问题；其次，保险公司在收到借贷双方的保险费之后，就要按照权利义务对等的原则承担还本付息的责任，保险公司参与贷款项目的评估和贷款使用的监督，以确保高效利用贷款及贷款安全，避免代表中小企业进行债务清偿。这增加了中小企业贷款的道德风险和操作风险的监督和控制，保险公司成为银行的风险共担者，使得银行的贷款风险和管理成本相对降低，使银行信贷资金安全得到保证；再次，那些参与信用保险的贷款信用评级增加，银行可以提高其他投资决策的准确性与竞争性，提高银行盈利能力和竞争力。

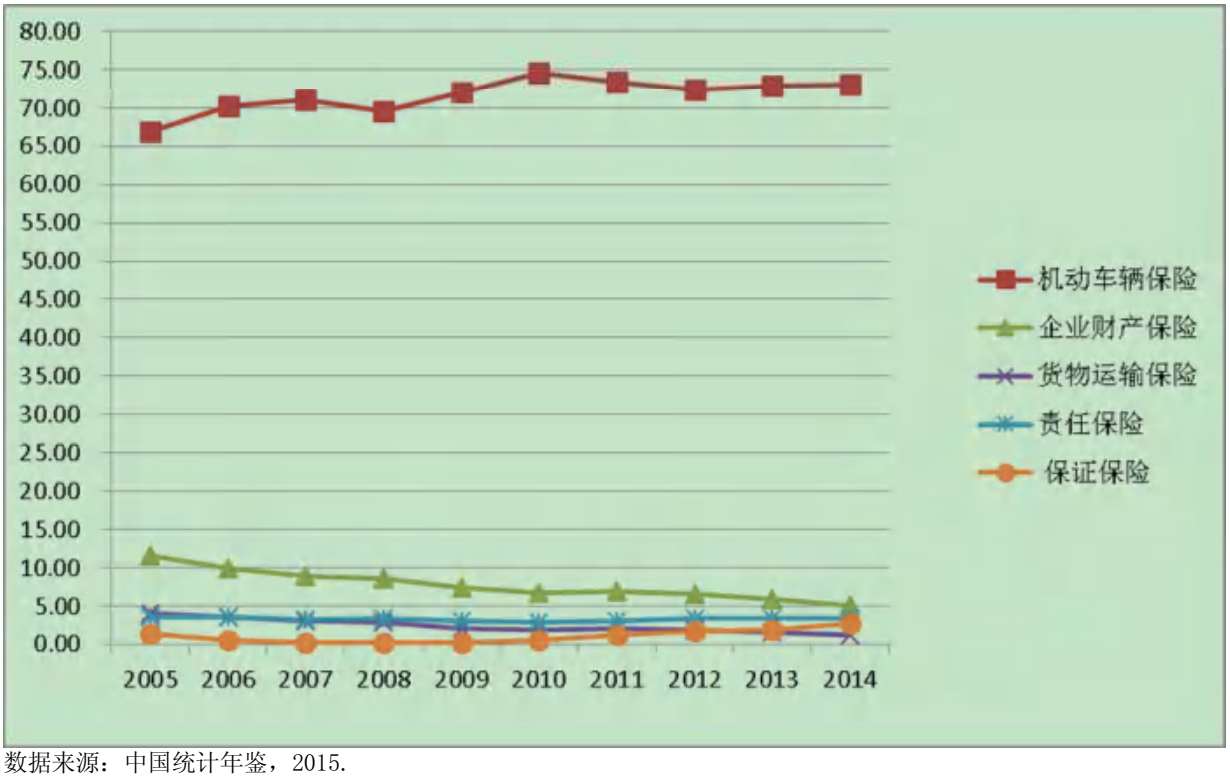
3.2.3拓展新的保险业务领域

目前,我国财产保险的主要业务仍在机动车辆保险、企业财产保险和货物运输保险三大传统业务上,这三大险种的保费收入所占比例仍在78%以上。在国外财产保险业中占很大一部分比例的责任保险和保证保险在我国仅占不到7%的比例。下面是2005年以来我国财产保险公司不同险种的保费收入占比情况。

表3.2 2005-2014年财产保险公司不同险种保费收入占比情况 单位（%）

年份	机动车辆保险	企业财产保险	货物运输保险	责任保险	保证保险
2005	66.87	11.61	3.98	3.51	1.40
2006	70.17	9.94	3.55	3.55	0.51
2007	71.14	8.95	3.02	3.19	0.20
2008	69.59	8.57	2.90	3.34	0.26
2009	72.02	7.40	2.05	3.08	0.27
2010	74.60	6.74	1.95	2.88	0.57
2011	73.33	6.90	2.05	3.10	1.18
2012	72.43	6.52	1.84	3.32	1.69
2013	72.84	5.84	1.59	3.34	1.86
2014	73.11	5.13	1.26	3.36	2.65

图3.1 2005-2014年财产保险各险种收入占比情况折线图 单位（%）



数据来源：中国统计年鉴，2015.

上述表格反映了2005年到2014年财产保险公司不同险种的保费收入占比情况，从历年的数据看，保费收入最高的仍为机动车辆保险、企业财产保险和货物运输保险三大传统险种。其中，机动车辆保险的保费收入最高，占总保费收入的70%左右，远远高于其他险种的保费收入，机动车辆保险在财产保险中一家独大，具有不可替代性。其次是企业财产保险，企业财产保险的保费收入约占总收入的10%，但该项保费收入近几年有下降的趋势。第三个是货物运输保险，该项险种的下滑现象比较严重，2014年，其保费收入所占比例下降到1.26%。最后是责任保险和保

证保险,这两个险种的发展比较缓慢,二者的保费之和占总保费的比例不到7%,但从图表分析，最近几年,这两类保险的发展有上升的趋势。

通过对我国财险业的分析,发现我国财险的险种结构存在严重不平衡的现象,各大保险公司的目光仍停留在三大传统险种上,而责任保险、保证保险等，所占比例极小且发展缓慢。目前,三大传统险种的发展也存在很大的问题,机动车辆保险的保费近几年停步不前，企业财产保险的存在明显下降趋势,货物运输保险下滑趋势严重，传统的财产保险业务已经不能满足社会的需求，保险公司想要在社会经济新形势下需求新发展，就只有不断开发新的险种,使得各险种平衡、协调的发展,才能使得财险业稳定、健康地发展下去。我国科技型中小企业数量多,对贷款的需求量非常大,而贷款难几乎是每个企业面临的难题。所以如果保险公司针对科技型中小企业开展贷款保证保险,则会面临非常大的市场需求。保险公司将业务延伸到贷款保证保险领域,即开发了新的保险险种,适应社会需求，也提升了自身竞争力，促进了保险的多样化发展。

4.我国科技型中小企业成果转化贷款保证保险定价机制的研究

4.1定价模型

4.1.1定价模型的选取

(1)期权定价模型。这一模型的表达公式为: $p = f(S,E,r,T,a)$ ，其中P表示保费,S表示贷款企业的资产价格,E是贷款的本金,r是无风险利率,T是贷款的期限,是贷款企业资产市场价值波动的标准差。这一模型在实际运用中的一个难点是如何衡量贷款企业资产市场价值及波动情况。对于这一问题,有的学者提出可以用账面价值代替市场价值,一直以来,企业的账面价值或者财务指标都不能得到银行的认可,对于财务制度不健全,信用风险较大的中小企业而言,更是不能得到银行的认可。对于企业资产净值的波动情况,KMV公司提出可以根据企业的股权价值的波动情况来衡量。但是这种方法就排除了未上市的中小企业,而我国未上市的中小企业数量非常多,显然这种方法不适合我国中小企业的实际情况。这一模型的条件太过理想化,在我国当前的条件下,并不能满足。

(2)贷款死亡率模型。这一模型是根据寿险的生命表提出的,对于寿险来说存在死亡率,Altaian根据这种思想,设计了贷款的死亡率表。将贷款分为违约和不违约两种,根据贷款企业违约的历史数据得出贷款的违约率(死亡率)。这样就能用寿险的定价方法来对企业贷款进行定价。这种方法比较新颖,用寿险的思想来研究企业贷款的保证保险。这种方法的优点是根据企业过去的贷款数据来得出违约率,这些数据可以从银行得到,只要银行确定贷款“死亡”,就能向保险公司索赔。但是关键的问题是如何界定贷款“死亡”,没有确切的衡量指标,简单地依靠企业资不抵债来衡量是不准确的,会严重影响保费的制定。

(3)期望损失模型。在期望值原理下，安全附加是期望赔付额的一定比例。令S 表示个体保单的年索赔额，它是1年内N次事故所对应的索赔额 $X_i(i=1,2,...,N)$ 之和，即 $S=X_1+X_2+...+X_N$ 。假N 与 $X_i(i=1,2,...,N)$ 相互独立，$X_i(i=1,2,...,N)$ 独立同分布。用H表示保费计算原理，则按期望值计算的纯保费与安全附加之和（以下简称为风险保费）为 $H(S)=(1+r)E(S)=(1+r)E(N)E(X)$ 其中 $E(S)=E(N)E(X)$ 为纯保费，$rE(S)=rE(N)E(X)$ 为安全附加保费。

期望损失模型是传统的精算模型，计算过程简单，需要数据易采集而且模型成立条件没有那么严苛，对于科技型中小企业来说，数据的搜集比较困难，因此简捷易操作的特点能够满足数据采集需要，因此本文运用期望损失模型基础上结合内部收益率模型来得出贷款保证保险的保费。

4.1.2模型设计思路

本文运用的是期望损失模型，运用期望损失模型计算保险费率的决定因素有期望索赔率和期望索赔强度。对于科技型中小企业成果转化贷款保证保险而言，其所保对象为行等可开办贷款业务的金融机构，当企业因非故意原因无力偿还或不能及时偿还贷款时，由保险公司代替企业偿还的一种保险，其风险为企业在到期还款日不能偿还利息和本金时，由保险公司代为偿还贷款。针对这一风险，其期望索赔率，即单一企业在贷款期间逾期不还款的次数；而期望索赔强度，即单次逾期还款的贷款额度。估计期望索赔频率和期望索赔强度应当分别以科技型中小企业在规定被调查时间内的贷款逾期次数和每一次逾期的贷款额度决定。然而，能有搜集到的企业违约信息有限，无法达到大数定律统计分析的要求，故须找到其他替代信息，以扩大基础数据量。从而，需要对投保企业的特征进行进一步地分析，其中，经营状况、科研能力、公司规模对于科技成果转化企业来说是对其起决定性作用的个体特征。所以保险公司可以在承保前收集一定数量科技成果转化企业的相关信息，并在承保过程中不断补充和完善数据库，从而无限接近大数定律的统计分析要求。

4.1.3模型建立

假设离散随机变量N代表特点时间内调研企业违约的次数，这些企业具有相似特征；连续随机变量X企业每次违约的贷款额度。然后对N和X进行分组的数据统计，进而分别绘制直方图。通过观察直方图，根据直方图所呈现的数据特征选择分布。然后通过矩估计进行参数估计，并对分布的拟合进行K-S检验，最终确定违约次数的分布函数 $F_N(n)$ 和密度函数 $f_N(n)$，以及违约金额的分布函数 $F_X(x)$ 和密度函数 $f_X(x)$ 。

由于保险公司在保险理赔过程会产生成本，所以有必要设置免赔额（d），即低于免赔额的损失不予理赔；与此同时，保险公司赔偿损失也需要存在限额（u），即高于保额的部分不予赔偿。由于免赔额对于损失频率分布的影响主要

表现在对分布模型的调整，并不影响分布模型种类；赔偿限额则不对损失次数分布产生影响，因此可以直接利用调整后的参数求出期望理赔频率$E(N)$。

首先，排除赔偿限额的影响，只考虑免赔额的影响，计算免赔额影响下的赔偿金额，故而选择非零赔款均值公式:

$$E_1\left(Y_1^P\right)=\frac{(1+r)\left[E(X)-E\left(X\wedge\frac{d}{1+r}\right)\right]}{1-F_x\left[\frac{d}{1+r}\right]} \tag{1}$$

将有限期望函数定义公式:

$$E(X\wedge d)=\int_0^d xf(x)dx+d\left[1-F_x(d)\right] \tag{2}$$

将其代入（1）式可得：

$$E_1\left(Y_1^P\right)=\frac{(1+r)\left\{E(X)-\int_0^{\frac{d}{1+r}} xf(x)dx-\frac{d}{1+r}\left[1-F_x\left(\frac{d}{1+r}\right)\right]\right\}}{1-F_x\left(\frac{d}{1+r}\right)} \tag{3}$$

然后，排除免赔额的影响，只考虑赔偿限额的影响，计算赔偿限额影响下的赔偿金额，故而选择赔偿限额赔款公式:

$$E_2(Y_2)=(1+r)E\left(X\wedge\frac{u}{1+r}\right) \tag{4}$$

将有限期望函数定义公式:

$$E(X\wedge u)=\int_0^u xf(x)dx+u\left[1-F_x(u)\right] \tag{5}$$

将其代入（4）式可得:

$$E_2(Y_2)=(1+r)\int_0^{\frac{u}{1+r}} xf(x)dx+\frac{u}{1+r}\left[1-F_x\left(\frac{u}{1+r}\right)\right] \tag{6}$$

同时考虑免赔额和赔偿限额的影响，计算出期望索赔强度为:

$$P_P=E(X)*E(N)=\left[E(X\wedge u)-E(X\wedge d)\right]*E(N) \tag{7}$$

进而计算出保费为:

$$E(X)=E(X\wedge u)-E(X\wedge d) \tag{8}$$

将（2）式和（5）式代入（8）式可得保费具体公式为：

$$P_P=\left\{\int_0^u xf(x)dx+u[1-F_x(u)]-\int_0^d xf(x)dx+d[1-F_x(d)]\right\}E(N) \tag{9}$$

上述结果到公式（9）为止仅为纯保费的计算。但保险公司在运营过程之中也会产生成本，因此，在保费计算中还需考虑附加保费，其中费用附加是附加保费的重要组成部分。对于固定险种而言，费用附加为定值，所以假设费用附加为l，而在保险期内保险公司支付的总成本：

$$L=P_P+l \tag{10}$$

与此同时，为了保障保险公司的正常运作和基本利润，可以利用内部收益率模型对保费进行定价。假设市场上的无风险利率为r_f，保险公司为新险种投资的资本金为S，资本成本为L，税率为T_c，负债的期望收益率为r_L，则可得最终厘定的保费为:

$$P=\frac{L}{1+r_L}+\frac{S*r_f*T_c}{(1+r_f)(1-T_c)}+\frac{(L/S)(r_f-r_L)}{(1+r_L)(1+r_f)} \tag{11}$$

4.2实证分析

4.2.1数据的选取

本文的数据是通过走访杭州滨江和下沙的高新科技园区，由于高新园区的企业大都为国家支持的科创型企业，都会涉及到科技成果转化问题，因此可以认为调查数据能够代表科技型中小企业成果转化贷款情况，发放问卷得到的数据，本次数据的采集一共发放了150份问卷，回收了109份问卷，回收率为72.67%。

（1）问卷信度分析

在对问卷数据进行分析之前，先对手机回来的数据进行信度分析：

表4.1　　信度分析

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.678	.956	2

我们运用SPSS软件对问卷的可信度分析，可能存在问卷的Cronbach's α 系数在0.5和0.7之间，为0.678，属于很可信。由于本次问卷渠道受限，调查对象主要为有项目的高新企业，对象较为特殊，问卷中可能忽略了主因素以外的其他因素的影响，但由于仍在可信范围内，可以有一定的参考价值。

（2）绘制直方图

依照科技成果转化贷款保证保险费率厘定设计，绘制违约频率和违约强度直方图，如图4.1和4.2所示：

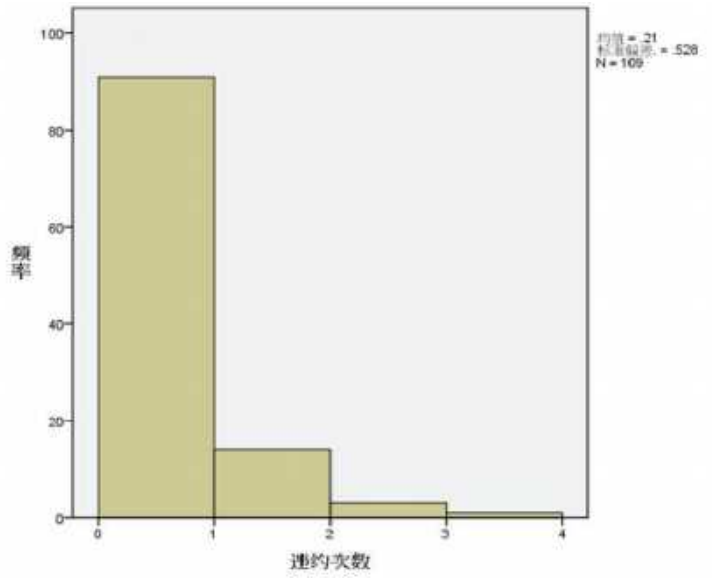


图4.1　违约次数直方图

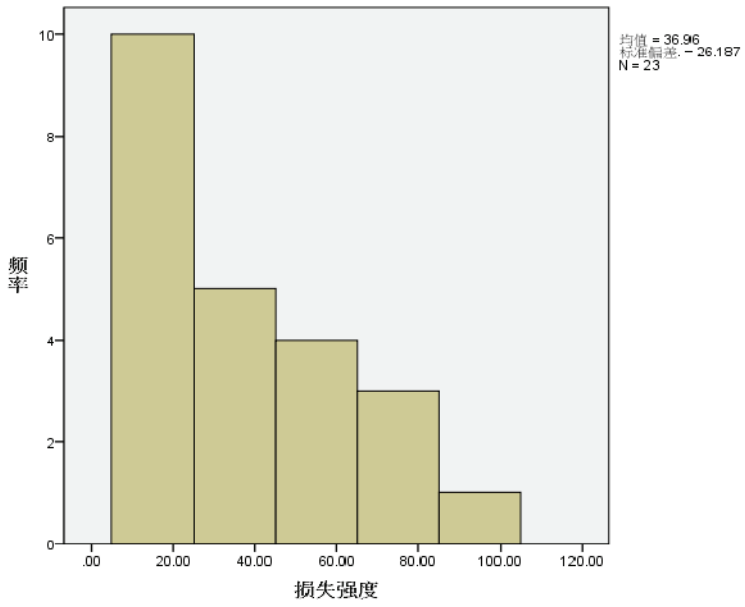


图4.2　违约强度直方图

通过直方图可以初步推测损失频率可能服从泊松分布，损失强度可能服从指数分布。分别用SPSS软件对其进行单样本的Kolmogorov－Smirnov检验(K－S检验），得到如下表所示结果。

表 4.2　损失频率泊松分布K － S 检验结果

单样本 Kolmogorov-Smirnov 检验

		违约次数
N		109
Poisson 参数[a,b]	均值	.21
最极端差别	绝对值	.025
	正	.025
	负	-.017
Kolmogorov-Smirnov Z		.262
渐近显著性(双侧)		1.000

a. 检验分布为 Poisson 分布。

b. 根据数据计算得到。

表4.2显示损失次数分布与泊松分布拟合后Sig值为0.607，远大于0.05，所以接受非零假设，即损失频率分布服从泊松分布；均值为0.21，即表明该损失频率分布服从$\lambda = 0.21$的泊松分布，其概率分布为：

$$F_N(n) = \frac{0.21^n}{n!} e^{-0.21} \quad (n = 0,1,2\ldots) \qquad (12)$$

根据指数分布密度函数和分布函数的关系可以算出其分布函数为：
单位:万元

表 4.3　损失强度正态分布K － S 检验结果

单样本 Kolmogorov-Smirnov 检验

		损失强度
N		23
指数参数。[a,b]	均值	36.9565
最极端差别	绝对值	.237
	正	.071
	负	-.237
Kolmogorov-Smirnov Z		1.137
渐近显著性(双侧)		.151

a. 检验分布为指数分布。

b. 根据数据计算得到。

表4.3显示损失强度分布与指数分布拟合后 Sig 值为0.151，远大于0.05，所以接受非零假设，即该损失强度分布服从指数分布；又由于 Mean值为369565元，因由此可知$\lambda = 2.71\times10^{-6}$，则该指数分布的密度函数为：

$$f(x) = 2.71\times10^{-6}e^{-2.71\times10^{-6}x} \tag{13}$$

（3）纯费率的计算

基于问卷调查数据可知，再回收回的109份问卷中，其违约金额最小的为10万元，且仅仅出现两次，我国对科技企业贷款的最高限制额度是500万，因此设置免赔额（d）为2万元，保险金额（u）为100万元，把值带入公式(2)(5)可得$E(X\wedge u)$=369564.51元，$E(X\wedge d)$=87612.61元，由公式（8）可得P_p=59209.90元。

（4）附加费率和总费率

通过期望损失模型我们得出了科技型中小企业科技成果转化贷款保证保险的纯费率,要得到总的保费还要计算出附加保费,附加保费包括保险公司的费用和利润。附加保费常用的计算方法是比例法,即按纯保费或保险金额的一定比例作为附加保费。目前,在科技型中小企业贷款保证保险的研究中,关于这一比例的确定没有统一的标准。由于数据有限,本文对附加保费的研究仅限于费用,不考虑保险公司的利润,用费用支出占赔付支出的平均比例来近似测算附加费率。下表是我国保险公司2015年4月到2016年3月的赔付支出,费用支出以及费用支出占赔付支出的比例情况。

表4.4　2015年4月到2016年3月保险费用支出占赔付支出的比例情况

年份	赔付支出（亿元）	费用支出（亿元）	费用支出占赔付支出的比例
2016.03	992.57	295.91	0.298125069
2016.02	886.13	259.35	0.292677147
2016.01	1012.63	283.06	0.279529542
2015.12	951.36	455.88	0.479187689
2015.11	793.19	308.38	0.388784528
2015.1	669.04	268.88	0.401889274
2015.09	703.26	295.21	0.419773626
2015.08	670.11	261.43	0.390129979
2015.07	683.06	254.48	0.37255878
2015.06	627.64	303.83	0.484083232
2015.05	610.09	247.75	0.406087626
2015.04	655.22	241.98	0.369311071

数据来源：中国经济信息网

从上表可以得出保险公司的费用支出占赔付支出的平均比例约为38%。纯费率乘以这一比例即为附加费率,纯费率和附加费率之和即为总的费率，也就是相当于保险公司的总成本。因此由公式（10）可得，L=81709.66元。

（5）保险费率厘定

目前银行利率为1.5%，故取无风险利率$r_f=1.5\%$，假设保险公司投入的资本金为10万元，即S=10000000元。2009年至2012年，为积极响应国家支持中小企业发展的政策，中国人保财险先后与宁波市、天津市、浙江省以及湖南省科技主管部门联合开展支持科技型中小企业贷款保证保险的项目，且是全国首家开展科技型中小企业贷款保证保险的保险公司，所以我们以中国人民财产保险股份有限公司为例，根据其2015年年报中所反映的应交税费和收益总额的数据计算所得为22.47%，关于对高新技术企业实行15%的优惠税率规定《中华人民共和国企业所得税法》(以下简称“新税法”)对高新技术企业实行15%的优惠税率,不再作地域限制,在全国范围都适用，因此可得T_c=19.01%。

负债的期望收益率是保险公司根据自身的投资情况计算出的预计收益率，反映投资项目预计可以获得的收益率，体现着保险公司的资产负债管理情况。以中国人民财产保险股份有限公司为例，在其2014年年报中显示，其投资收益率为5.65%。并且中国保监会在2015年12月11日下发了《关于加强保险公司资产配置审慎性监管有关事项的通知》，要求这些保险公司进行压力测试，保监会将加强审慎性评估,引导其建立资产配置风险排查和预警机制,促进保险公司稳健经营，加强资产负债协同管理，实现资产与负债的良性互动和动态匹配，防范错配风险和流动性风险。在此的基础上，保监会将研究出台相关压力测试信息披露、资产配置能力标准、资金账户监管等的制度规定,以推动保险公司加强资产负债管理。所以假设负债的期望收益率为6%，则可根据公式（11）得最终保费为:

$$P=\frac{L}{1+r_L}+\frac{S*r_f*T_c}{\left(1+r_f\right)\left(1-T_c\right)}+\frac{\left(L/S\right)\left(r_f-r_L\right)}{\left(1+r_L\right)\left(1+r_f\right)}=99837.59\text{元}$$

保险费率为保险费与保险金额的比率，保险金额即保险公司承担赔偿的最高限额，本文设置为500万。由上述已知的假定条件可得保险费率为0.02。从现在已经有的贷款保证保险试点城市厘定的保险费率来看，宁波市小额贷款保证保险费率为0.03，蚌埠市小额贷款保证保险费率为0.02，因此本文通过期望损失模型厘定得出的保险费率还是比较合理的。

5. 推行科技型中小企业成果转化贷款保证保险的对策建议

5.1依靠政府扶持，坚持“政银保”的经营模式

科技型中小企业成果转化贷款保证保险区别于现在初步发展的科技型中小企业贷款保证保险，其针对的对象更加具体，针对的是科技成果转化过程中的融资难问题。这一贷款保证保险对于有成果转化企业来说，能够减少保险成本，因为这类企业主要的融资支出是在R&D，因此，投保科技型中小企业成果转化贷款保证保险是有利的；对于保险公司来说，成果转化贷款保证保险使其承保范围缩

小，保险事故更加明确，有利于保险管理和保险事故发生后核保工作的进行；对于政府来说，科技创新研发一直都是国家经济发展的源泉，加强对有成果转化的科技型中小企业的扶植，对于经济又好又快发展起到了决定性的作用。为了推行科技型中小企业成果转化贷款保证保险发展，首先，需要依靠政府大力扶持，开展由政府、银行和保险公司多方参与、风险共担的合作经营模式，使更多的成果转化的科技型中小企业在缺乏合格抵质押品的情况下增加获得银行等金融机构贷款资金的可能性。其次，要实行科技型中小企业成果转化贷款保证保险以“政银保”的经营模式继续发展，需要对国家的产业政策、金融政策以及财政政策进行有效的整合。为此，一方面政府应加大对科技型中小企业成果转化贷款保证保险的宣传，发掘有能力推行科技型中小企业成果转化贷款保证保险的保险公司进行业务引导，并承诺给予大力的政策和税收优惠支持，协助保险公司开展相应的业务工作，成为企业、保险公司和银行沟通的桥梁；另一方面，政府应建立由其主导的专业化信用保证保险机构，充分发挥其在资源、信用等多面的优势，大力推动科技型中小企业科技成果贷款保证保险的发展。

5.2 完善科技型中小企业成果转化贷款保证保险的定价模型

完善科技型中小企业成果转化贷款保证保险的定价模型，首先，要提高定价的实用性。由于获取数据存在较大的困难，当前科技型中小企业成果转化贷款保证保险的定价研究，还仅仅是理论阶段，涉及到具体的定价的文献较少，本文对于科技型中小企业成果转化贷款保证保险的费率厘定，却没有将信用风险、市场风险、风险附加、追偿等复杂因素考虑进去。因此，本文的费率厘定还存在一定的缺陷，我们应通过不断积累经验数据和完善定价模型来提高科技型中小企业成果转化贷款保证保险定价的准确度和可信度。与此同时，还应根据政府、银行以及保险公司之间确定的风险分担比例以及科技型中小企业的信用等级等采用差异化的保险费率。其次，构建完善的信用评分体系。保险公司在对科技型中小企业成果转化贷款保证保险进行定价时，由于信息不对称造成对科技型中小企业资信评估极为困难，易产生定价效率低下的问题。因此，保险公司可以通过构建一个简洁高效的信用评分模型来提高对科技型中小企业成果转化贷款保证保险定价的效率。在此过程中，保险公司首先应通过构建信用评分指标并加以合理配值以确定信用评价模型；其次，根据对科技型中小企业的资信状况的调查将相关指标量化，并代入信用评分模型，由于是针对科技型企业成果转化阶段的保险，因此应该讲转化项目的未来市场价值也一并考虑到信用评分模型中去，经过一体化的考察最终确定科技型中小企业成果转化贷款保证保险的定价结果，这个过程不仅节省了人力物力，提高了贷款保证保险定价的效率，而且通过量化指标保证了定价结果的客观性和准确性。

5.3建立专业化贷款保证保险人才队伍

当前我国贷款保证保险的发展还处于发展阶段，专业化人才缺乏，并且贷款保证保险业务的风险发生常常具有频率高、关联度小以及不确定性大的特点，因而需要大力培养精通贷款保证保险业务的专业化人才以推行科技型中小企业成果转化贷款保证保险业务的发展。在对专业人才的培养上，首先，既要做到“精”，也要做到“通”，即专业化与复合型人才共同培养；其次，应放宽视野，广开思路，树立科学的，可持续的人才观，着重培养人才的学习和实践能力，努力提高专业化贷款保证保险人才的开拓创新能力；再次，积极探索合理的要素分配制度，致力于建立一个将个人贡献、绩效、风险以及责任等考核指标一体化的分配制度，加大对经营管理人才和各类保险专业人才的激励，充分激发其工作热情和积极性。与此同时，应加强对社会各行各业人才的吸收，消除行业壁垒，可以从证券、基金及银行等相关行业和部门，引进金融、财会类专业人才，可以极大缓解保险行业的人才缺口，也对与跨行业间的交流和沟通起到促进作用。有助于其他行业的先进经验和技术的引进，达到共同发展、共同繁荣的美好局面。

附注：此文为 2015年度浙江省软科学研究计划重点项目“民间资金参与科技成果转化融资的保险制度优化设计”（项目编号：2015C25044）的研究成果和浙江财经大学校级课题“科技成果转化信贷保证保险制度优化设计”的研究成果。

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科技型中小企业成果转化贷款保证保险费率厘定

张代军　　常娜

张代军
教授
浙江财经大学金融学院
杭州 310018，中国
电话：13750815909
Email：zdj0303@126.com

常娜
硕士生
浙江财经大学金融学院
浙江省杭州市下沙高教园区学源街18号
电话：18917456475
Email:1587527499@qq.com

关键词：科技型中小企业　科技成果转化　贷款保证保险　费率厘定

中文摘要：科技型中小企业成果转化对于中小企业面向国内外市场，不断增强自身竞争力，保证中国经济适度增长、缓解就业压力、推动技术创新、促进国民经济发展和保持社会稳定都有着重要的作用。因此，促进科技型中小企业成果转化成为新时代科技型企业稳步成长、促进社会生产力提高的关键因素。但是，我国现今的科技成果转化率低，技术进步对经济增长的贡献率小，当前主要发达国家的科研成果转化率为60%，技术进步对经济增长的贡献率为60%-80%；然而在我国，工业的科技成果转化率为37%，农业为40%，技术进步对经济增长的贡献率仅占28.7%，我国与发达国家之所以存在差距，根源于我国科技成果转化中的融资瓶颈。解决科技成果转化的融资问题成为促进中小企业发展，社会进步的关键。

本文以贷款保证保险在科技型中小企业成果转化融资中的发展运用为主线展开研究。基于生命周期理论对科技成果转化在企业中的地位进行阐述和分析，本文通过引入贷款保证保险机制，拟解决科技型中小企业成果转化融资难问题，并运用期望值原理进行费率厘定。本文先是对贷款保证保险介入科技型中小企业成果转化融资的必要性进行分析；接着阐述了贷款保证保险的运行机制，通过列举国外贷款保证保险的运行模式，再结合国内现有的社会背景，借鉴国外贷款保证保险运行模式，最终总结出适合我国国情的贷款保证保险的运行模式；第三章，

研究了我国中小企业贷款保证保险的定价方式，通过期望损失模型，基于问卷数据对科技型中小企业成果转化贷款保证保险的费率进行了实证研究，得到贷款保证保险的费率；第四章，提出相关的政策建议。

本次研究有着很重要的意义，通过本文的研究有利于促进我国的科技成果转化企业解决融资难问题，加速产业结构升级，有利于我国科技型中小企业的快速发展，促进经济增长，有利于促进科技型中小企业技术创新，增强企业竞争力。

The Research on the Pricing of the Loss of Financing Projects of the Key High Tech Enterprises in China

ZHANG Daijun, XU Chenfei

ZHANG Daijun
Professor
School of finance, Zhejiang University of Finance and Economics
Hangzhou 310018, China
Phone: (0571)87557108
Email: zdj0303@126.com.

XU Chenfei *
Undergraduate
School of finance, Zhejiang University of Finance and Economics
Room 3, building 521, Zhejiang University of Finance and Economics
Phone: (0575)82128089
Email: 1004267011@qq.com

Keywords: Key high tech enterprises; scientific and technological achievements transformation; financing project loss insurance; insurance pricing

Abstract. The transformation of scientific and technological achievements is an important step in scientific and technological innovation, and the key high-tech enterprises as a result of the transformation of scientific and technological achievements An important subject in research and technological achievements were applied until formed in the process of industrialization, often by means of financing to meet capital requirements, due to some uncertain factors, project financing may can not achieve the expected gains and losses. The concept of financing project loss insurance is proposed. In this paper, according to key high-tech enterprise financing project investment insurance concept, carries on the investigation to selected "Torch Plan" listing Corporation for the insured object, through the company's official website and China financial portal website inquiries, collected 159 companies in 2014 annual report, the annual report of the reading, finally meet the statistical requirements of 100 home, a total of 165 loss items, and collect the financing project of key high-tech enterprise investment loss frequency and loss amount of specific data as the sample data, combined with the difference of losses and the government for different types of residual focus of high-tech enterprises to implement incentive policies and other stakeholder responsibilities, according to the relevant literature and actuarial knowledge the data analysis and Research on science and technology enterprises premium. According to the premium process and result, gave the government, insurance companies, key high-tech enterprises, banks and other financing bodies and other stakeholders in dealing with the corresponding risk and profit or loss of policy recommendations.

1. 引言

科学技术是第一生产力，集中体现着社会先进生产力的发展状况。当今世界，科学技术的发展水平是反应一个国家综合国力和核心竞争力的重要因素。而科技创新是提高社会生产力和综合国力的战略支撑，衡量科技创新的重要标准是科技成果转化为现实生产力的水平。由此看来，科技成果的转化尤为重要，它将直接关系到我国的经济发展方式转变和产业结构优化升级能否顺利实现。

由于在科技创新的过程中会面临很多难以预测的风险，于是“科技保险”就由此产生。所谓科技保险，是指运用保险作为分散风险的手段，对科技型企业在进行研发、生产、销售过程中发生的损失给予保险赔偿或给付保险金，进而减小科技型企业的损失，起到帮助和支持其发展的重要作用。在2007年，我国的科技保险试点工作才正式展开，发展的时间还比较短，所产生的经验也并不成熟，科技保险市场上可供科技型企业自由选择的产品种类也很少。

本文提出的重点高新技术企业融资项目损失保险就是对科技保险的一种细化和完善。

在科技成果研发应用直至形成产业化过程中，企业一般会通过银行贷款、发行债券、吸收风险投资、私募融资等方式来筹集资金以满足其资金需求。但是随着市场需求变化、行业竞争急剧扩大等不可控因素的影响，一些融资项目的进展可能和预期有比较大的差距，甚至出现项目中断的情况。无论是项目无法实现预期收益还是项目可行性发生改变，都将给企业带来很大的损失，会阻碍高新技术企业的发展。有了这种融资项目损失保险，在科技成果转换前期，企业支付保险公司一定金额的保费，如果之后由于客观因素导致科技成果转换不能进行而导致企业发生损失，保险公司将给予企业一定补偿，使企业的损失尽量达到最小，最大程度地保证重点高新技术企业的发展。

涉及到某一项具体的保险产品，保费显得格外重要，保费是指被保险人参加保险时，根据其投保时所订的保险费率，向保险人交付的费用。保费由保险金额、保险费率和保险期限构成。简单地来说，保费高低不仅会影响保险公司的收益也会影响保险购买者的需求情况。本文将考虑各方面因素，通过全方位衡量，并结合相关文献资料，建立起一组数学模型，计算出适当的保费。

2. 理论机理与定价方法

2.1. 基本理论阐述

2.1.1. 重点高新技术企业的定义

重点高新技术企业是指入选国家“火炬计划”的高新技术企业。火炬计划旨在发展中国高新技术产业，是一项指导性计划，早在1988年8月就由我国政府批准，并在科学技术部的组织引导下实施。火炬计划的主要内容包括：为高新

技术产业创造合适其发展的外部环境、建立和发展高新技术产业开发区、建立社会公益性质的高新技术创业服务中心等，从而支持和帮助高新技术企业的发展，促进高新技术企业的成果商品化、商品产业化和国际化。

重点高新技术企业主要特点如下表所示：

表 1　重点高新技术企业特点

特点	已被认定为省级高新技术企业满一年
	在同行企业中在技术、销售、社会效益方面比较突出，对该行业有促进和带动作用
	年销售收入过亿且其中高新技术产品的销售收入占比60%及以上
	整体研究开发和技术创新能力较强，每年对研究开发项目的投入不低于总销售额的30%
	管理科学、规范
	重视人才的培养，包括科技开发、市场营销、企业管理等方面人才
	认真制定发展规划

认定为重点高新技术企业之后，国家和地方共同在市场、信息、资金、管理、服务等方面给予支持，促进地方区域经济的发展。

融资项目和科技成果转化的关系

首先来解释文中对于项目的定义，某一生产经营活动被定义为项目，它一定有以下特征：有明确的目标性，并且受到时间和预算的制约，其开展过程往往比较复杂。对于重点高新技术企业而言，其项目是在一定预算和时间范围内将某一科技研究成果转化为现实社会生产力，并投入生产出某一产品以获得收益。而重点高新技术企业往往是知识、技术密集型企业，它通过研究开发或者科技成果转化形成企业自主核心知识产权，并在此基础上进行经营活动。所以重点高新技术企业的项目又区别于其他企业的项目，他往往与科技成果转化息息相关。

科技成果转化有广义和狭义的界定。其中，劳动者素质的提高、技能的加强、各类成果的应用等被定义为广义的科技成果转化。而狭义的科技成果转化则实际仅仅指技术成果的转化，即将具有创新性的技术成果从科研单位转移到生产部门，使新产品增加，工艺改进，效益提高，最终实现经济进步。本文中所指的科技成果转化是指狭义的科技成果转化，仅指技术成果的转化，其过程是将科学技术转化为现实生产力的过程，不仅仅对于高新技术企业有着重大意义，对于整个社会也有着重大意义，科技成果的成功转化可以形成产业化，进而推动社会生产力的发展。

但是科技成果转化的过程需要大量资金的投入，对于企业本身而言，它所拥有的流动资金不足以支持一个乃至多个项目的运行，所以企业一般会通过吸收风险投资、私募融资等方式来筹集资金以满足其资金需求。

所以，融资项目和科技成果的转化过程密不可分，对于高新技术企业而言融资项目也是其生产经营活动中的重要形式。

2.1.2. 融资项目损失保险的定义

融资项目损失保险属于科技保险的范畴。它是运用保险作为分散风险的手段，对重点高新技术企业在融资项目进行开发、研究、成果转换等过程中，因各类现实面临的风险而导致企业的财产损失、利润损失或科研经费损失等，由保险公司给予保险赔偿或给付保险金的保险保障方式。

2.1.3. 融资项目损失保险重要性

科技保险是化解和转移科技风险的重要手段，科技保险能为高新技术企业的发展提供坚实的后盾。我国科技保险试点工作在2007 年才正式展开，尚处于起步阶段，有限的经验还很不成熟。根据国内外科技保险的理论研究和保险实践，以及企业从事技术创新活动中科技风险的特点、国内科技保险的需求和供给情况，反映出我国现行科技保险还存在着概念界定不清晰和对科技风险可保性的研究过于笼统等问题。

从科技保险的需求状况分析来看，企业普遍认为科技企业目前最需要的三种科技保险产品是研发责任保险、项目投资损失保险和高管人员和关键研发人员团体健康保险和意外保险。为了充分发挥科技保险在风险防范过程中作用，也为了迎合科技型企业对于科技保险的需求，研究和开发能有效应对企业科技研发风险的科技保险险种应成为下一步推动科技保险发展实施的工作重心。

在国外高科技企业中，专利、知识产权被视为生命，并没有名称严格为“科技保险”的保险产品。所以，国外对于科技保险、技术保险的政策也主要是针对“专利、知识产权保护”这一问题，有的只是与科技、创新相关的险种，一种表现方式是分散在项目保险、投资保险和合同保险等一揽子保险产品之中；另外一种表现方式则是专为各行业的科技企业提供的行业保险。

参考上述国内外科技保险的现状，重点高新技术企业融资项目损失保险是对科技保险的细化，以方便企业根据自身的风险需求合理安排风险转移，一方面可以促进高新技术企业的发展，另一方面也是对科技保险的完善。

2.1.4. 融资项目损失保险的公共治理模式

科技保险的发展需要科技企业、保险公司、政府部门、第三方机构共同治理。所以，重点高新技术企业融资项目的损失，也由政府、企业、银行、保险公司共同承担。

就保险公司而言，需要从自身建设出发，不断创新，以满足科技型企业的各种保险需求。并且要设计有针对性的科技保险险种，最大限度地满足高新技术产业的风险保障诉求。

就政府而言，科技保险的发展应以政府支持为基础，实施政策性科技保险，政府可以设立一个国家层面的科技保险引导基金从而进一步激励地方增加对科技保险的财政补贴。政府还可以实施科技保险保费补贴政策，给予高新技术企业税收方面优惠减免，以帮助高新技术企业发展。除此之外，政府还可以采取激励政策和措施，排除企业认知障碍、属性障碍、资金障碍、信任障碍和险种障碍。

就银行而言，它作为第三方机构，若能恰当运用金融创新工具和有效的风险管理技术，使信贷资金介入高新技术企业，以满足高新技术企业的发展要求。

对就高新技术企业自身而言，企业科技风险自我管理在科技风险保障体系中占基础性地位，自我管理能够培养和提升企业的风险应对能力，对科技保险发展具有促进作用。企业可以通过建立和完善企业科技风险管理框架结构、完善科技风险识别和评估的技术手段、多样化企业主导的科技风险管理手段、探索和建立科技风险预警机制等方式来加强科技风险的自我管理。

2.2. 定价方法选择

2.2.1. 保险定价精算理论

在传统的保险精算理论中，要求保费与潜在损失的期望值相等，也即是纯保费（p）。假设被保险人的总损失为Y，其中Y为随机变量，它的平均值和标准差我们计为a和b。所以根据保费要与潜在损失相等，纯保费p必须覆盖损失的期望值，也就是随机变量Y的平均值a。但是因为保费是保险公司事先所确定的，所以在定价过程中，保险公司也必须事先确定a和b的值。而潜在损失为随机变量，保费是固定不变的，所以可能产生p小于a的情况。

所以，保险公司需要通过建立附加安全系数c来控制其发生损失的概率s，所以可以计算出保费为$(1+c)\times a$。假设投保人（N）足够多，且他们的损失风险呈独立分布的状态，根据中心极限理论可以得出$c=(Z_{1-s}b)/a\sqrt{N}$，其中Z_{1-s}是标准正态分布的$1\text{-}s$分位点。

由此可见，随着N的增多，被保险人的平均损失也会与实际真实损失分部的均值更加接近，c约等于0。所以保险公司可以通过提高附加安全系数或者增加保单数量的方式来减少自己发生损失的概率。

除此之外，保险公司在运营过程之中也会产生成本，这些成本也需要由保费收入来负担，因此，保险公司还需设定附加成本系数d，于是计算出保费为$(1+c+d)\times a$。

一般情况下，保险公司的产品定价都基于以上方法，但是我们也无法排除普遍性中的特殊性，由于各个保险项目的周期和潜在损失都存在差异，所以对于不同业务的保险定价需具体问题具体分析，采取不同的处理方法。

2.2.2. 科技保险定价方法选择

科技保险是一种不同于一般保险产品的险种，它是为了规避在研发创新、成果产品化、科技推广过程中可能出现的的不确定性，导致创新活动失败，达不到预期目标的风险而创新的金融保险产品。针对科技保险因缺乏数据而产生的定价困难问题，基于传统的精算定价方法，可以从数据收集、模型可靠性改进、保险公司风险管理和控制等方面改进保险定价的法方法和策略，从而为科技保险产品定价提供有益的参考和帮助。针对保险定价在实际应用中的基础理论问题，可以以随机过程为基础，先选择单一变量，列出函数公式，然后再整合变量，同时考虑多个变量的影响，进而推导出一般情况下的保险定价公式。

3. 融资项目损失保险费率厘定及模拟分析

3.1. 设计思路

保险费率的决定因素有期望索赔率和期望索赔强度。对于重点高新技术企业融资项目投资损失保险而言，其所保对象为因企业经营状况、市场需求状况等因素的改变导致项目运行没有达到预期收益甚至项目中断发生的风险损失。针对这一风险，其期望索赔率，即单一企业在投保期间融资项目发生损失的频率，由投保企业的特征因素决定；而期望索赔强度，即单次损失的强度，由企业项目的投资额度和项目发生损失后对企业影响的严重程度决定，其中对企业影响的严重程度也由投保个体特征因素决定，比如两家企业项目损失的数额是相同的，那么对于在初创期和在稳定期的企业的影响程度势必是不同的；对于经营状况良好、资金实力雄厚和经营状况较差、对外负债累累的企业的影响程度也是不同的。因此，估计期望索赔频率和期望索赔强度应当分别以投保企业的投资项目发生中断的次数以及各次所造成的损失额度决定。然而，单个企业所有的投资项目十分有限，无法达到大数定律统计分析的要求，故须找到其他相似企业，以扩大基础数据量。从而，需要对投保企业的特征进行进一步地分析，其中，经营状况、发展历史、公司规模对于重点高新技术企业来说是对其起决定性作用的个体特征。所以保险公司可以在承保前收集一定数量重点高新技术企业的相关信息，并在承保过程中不断补充和完善数据库，从而无限接近大数定律的统计分析要求。

3.2. 模型建立

假设离散随机变量N代表投保的重点高新技术企业的融资项目发生中断的次数，这些重点高新技术企业具有相似特征；连续随机变量X为因项目中断造成的损失强度。然后对N和X进行分组频率统计，进而分别绘制直方图。通过观察直方图，根据直方图所呈现的数据特征选择分布。然后通过极大似然估计或矩估计进行参数估计，并对分布的拟合进行x^2检验，最终确定损失次数的分布函数$F_N(n)$和密度函数$f_N(n)$，以及损失金额的分布函数$F_X(x)$和密度函数$f_X(x)$。

由于保险公司在保险理赔过程会产生成本，所以有必要设置免赔额（d），即低于免赔额的损失不予理赔；与此同时，保险公司赔偿损失也需要存在限额（u），即高于保额的部分不予赔偿。由于免赔额对于损失频率分布的影响主要表现在对分布模型的调整，并不影响分布模型种类；赔偿限额则不对损失次数分布产生影响，因此可以直接利用调整后的参数求出期望理赔频率$E(N)$。

首先，排除赔偿限额的影响，只考虑免赔额的影响，计算免赔额影响下的赔偿金额，故而选择非零赔款均值公式:

$$E_1\left(Y_1^P\right)=\frac{(1+r)\left[E(X)-E\left(X\wedge\frac{d}{1+r}\right)\right]}{1-F_x\left[\frac{d}{1+r}\right]} \tag{1}$$

将有限期望函数定义公式:

$$E(X\wedge d)=\int_0^d xf(x)dx+d\left[1-F_x(d)\right] \tag{2}$$

将其代入（1）式可得：

$$E_1\left(Y_1^P\right)=\frac{(1+r)\left\{E(X)-\int_0^{\frac{d}{1+r}}xf(x)dx-\frac{d}{1+r}\left[1-F_x\left(\frac{d}{1+r}\right)\right]\right\}}{1-F_x\left(\frac{d}{1+r}\right)}\ [1] \tag{3}$$

然后，排除免赔额的影响，只考虑赔偿限额的影响，计算赔偿限额影响下的赔偿金额，故而选择赔偿限额赔款公式:

$$E_2(Y_2)=(1+r)E\left(X\wedge\frac{u}{1+r}\right) \tag{4}$$

将有限期望函数定义公式:

$$E(X\wedge u)=\int_0^u xf(x)dx+u\left[1-F_x(u)\right] \tag{5}$$

将其代入（4）式可得:

$$E_2(Y_2)=(1+r)\int_0^{\frac{u}{1+r}}xf(x)dx+\frac{u}{1+r}\left[1-F_x\left(\frac{u}{1+r}\right)\right]\ [2] \tag{6}$$

[1] 其中Y_1^P表示保险公司实际非零赔款的随机变量，$E_1\left(Y_1^P\right)$表示非零赔款的均值。

[2] 其中Y_2表示应用赔偿限额u后所生成的随机变量，$E_2(Y_2)$表示应用赔偿限额后的赔偿均值。

同时考虑免赔额和赔偿限额的影响，计算出期望索赔强度为:

$$P_P = E(X) * E(N) = [E(X \wedge u) - E(X \wedge d)] * E(N) \tag{7}$$

进而计算出保费为:

$$E(X) = E(X \wedge u) - E(X \wedge d) \tag{8}$$

将（2）式和（5）式代入（8）式可得保费具体公式为：

$$P_P = \left\{ \int_0^u x f(x) dx + u[1 - F_x(u)] - \int_0^d x f(x) dx + d[1 - F_x(d)] \right\} E(N) \tag{9}$$

上述结果到公式（9）为止仅为纯保费的计算。但保险公司在运营过程之中也会产生成本，因此，在保费计算中还需考虑附加保费，其中费用附加是附加保费的重要组成部分。对于固定险种而言，费用附加为定值，所以假设费用附加为l，而在保险期内保险公司支付的总成本：

$$L = P_P + l \tag{10}$$

与此同时，为了保障保险公司的正常运作和基本利润，可以利用内部收益率模型对保费进行定价。假设市场上的无风险利率为r_f，保险公司为新险种投资的资本金为S，资本成本为r_e，税率为T_c，负债的期望收益率为r_L，则可得最终厘定的保费为:

$$P = \frac{L}{1 + r_L} + \frac{S * r_f * T_c}{(1 + r_f)(1 - T_c)} + \frac{(L/S)(r_f - r_L)}{(1 + r_L)(1 + r_f)} \tag{11}$$

3.3. 模拟分析

依照重点高新技术企业融资项目投资损失保险的构想，以入选“火炬计划”的上市公司为投保对象进行调查，这些企业有以下共同特点：都是经省级科技行政管理部门认定的高新技术企业，且自认定后的运营期在一年以上；上年度产品销售收入均超过1亿元；技术性收入与高新技术产品销售收入的总和均占本企业当年总收入的60%以上；每年用于高新技术及其产品研究开发(R&D)的经费均占本企业当年总销售额的5%以上。通过这些公司的官网和中国财经门户网站的查询，搜集到159家企业的2014年年报，通过对年报的阅读，最后符合统计要求的有100家，共165个损失项目。

依照高新技术企业项目投资损失保险的费率厘定设计，首先绘制损失频率直方图，图3.2所示：

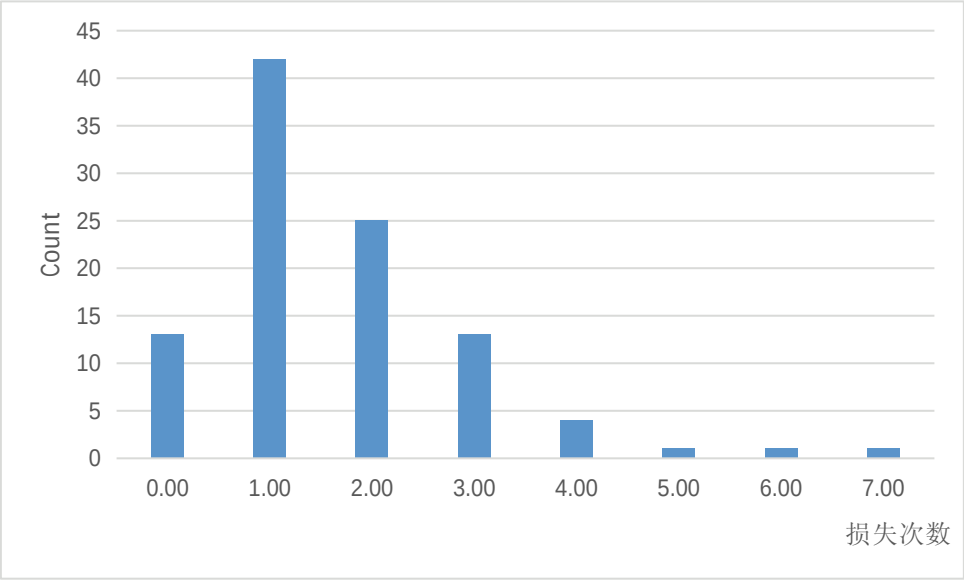


图 1　损失频率

通过直方图可以初步推测损失频率可能服从泊松分布，用SPSS软件对其进行单样本的Kolmogorov－Smirnov检验(K－S检验），得到如下表所示结果。

表 2　重点高新技术企业损失频率泊松分布 K － S 检验结果

单样本 Kolmogorov-Smirnov 检验 3		
N		100
Poisson 参数[a,,b]	均值	1.6500
最极端差别	绝对值	.062
	正	.041
	负	-.026
Kolmogorov-Smirnov Z		.062
渐近显著性(双侧)		.836
a. 检验分布为 Poisson 分布。		
b. 根据数据计算得到。		

表3.3.1显示损失频率分布与泊松分布拟合后Sig值为0.836，远大于0.05，所以接受非零假设，即损失频率分布服从泊松分布；均值为1.65，即表明该损失频率分布服从 $\lambda = 1.65$ 的泊松分布，其概率分布为：

$$F_N(n) = \frac{1.65^n}{n!} e^{-1.65} \quad (n = 0,1,2\ldots) \tag{12}$$

在损失强度的数据分析过程中，考虑到沉淀成本的存在，即在融资项目投入运行的之前已发生的投入，不能由现在或将来的任何决策而改变，这部分的支出不能被当做被保险对象的损失计算。与此同时，企业可以将进行到一半的项目、还未完全转化的科技成果转让给其他企业，因此获得的收益可抵消企业的一部分损失。因此，可以计入保险范围的损失因在样本数据的基础上乘以一定百分比。根据上述重点高新技术企业的实际情况，我们假设此比重为70%。与此同时，融资项目发生损失时，融资企业也会按照合同约定的股份比例承担相应损失。由于各个合同均有所不同，在此，我们假设股份比例为10%，即融资企业承担10%的损失。所以，最终计入保险损失范围的损失为样本数据乘以63%。

此外，由于重点高新技术企业融资项目各有不同，损失的大小也有很大差异。考虑到计算结果的准确性，根据损失强度的大小分为三类：A：损失强度在0-1000；B：损失强度在1000-15000；C：损失强度在15000以上。

分别绘出A、B、C三类的损失强度直方图：

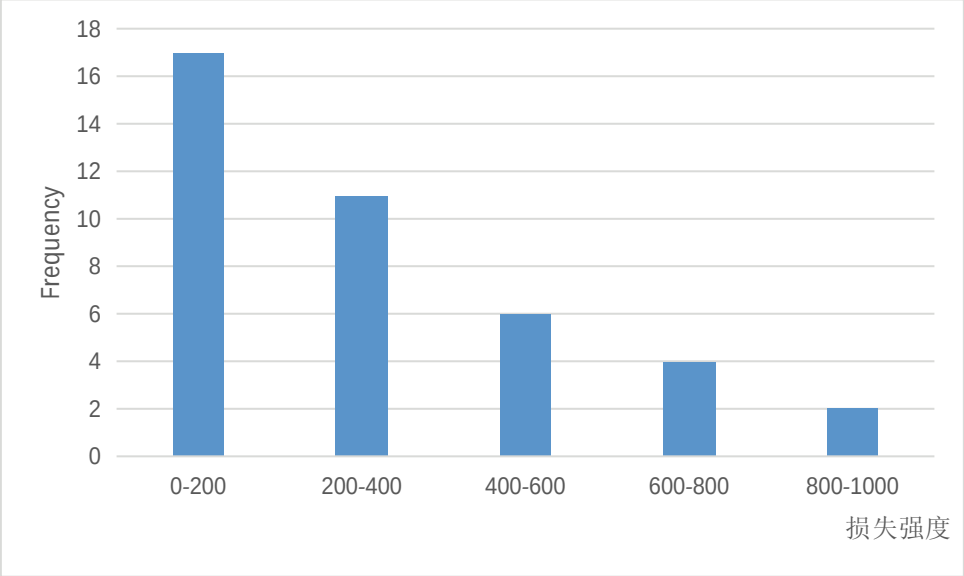


图2　损失强度（A类）

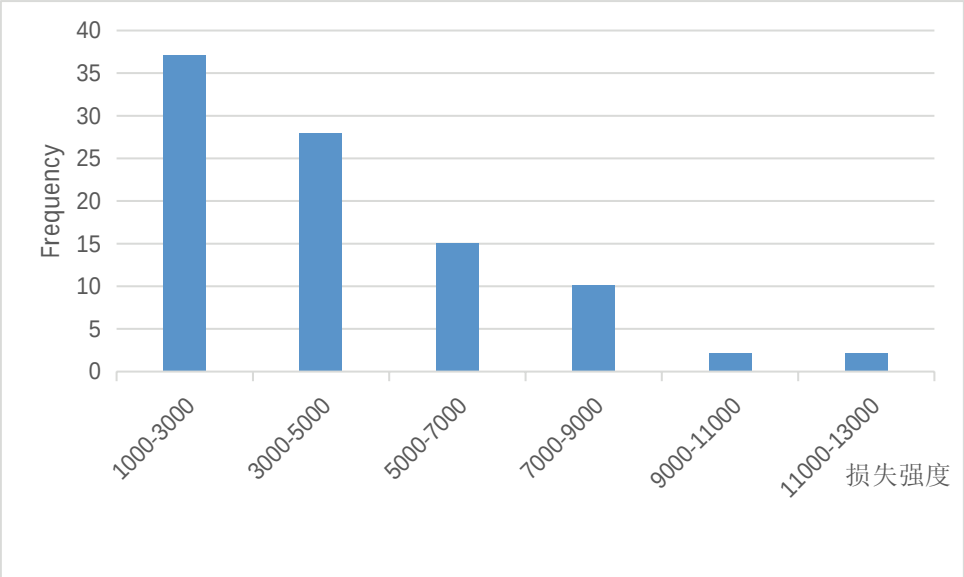


图 3 损失强度（B类）

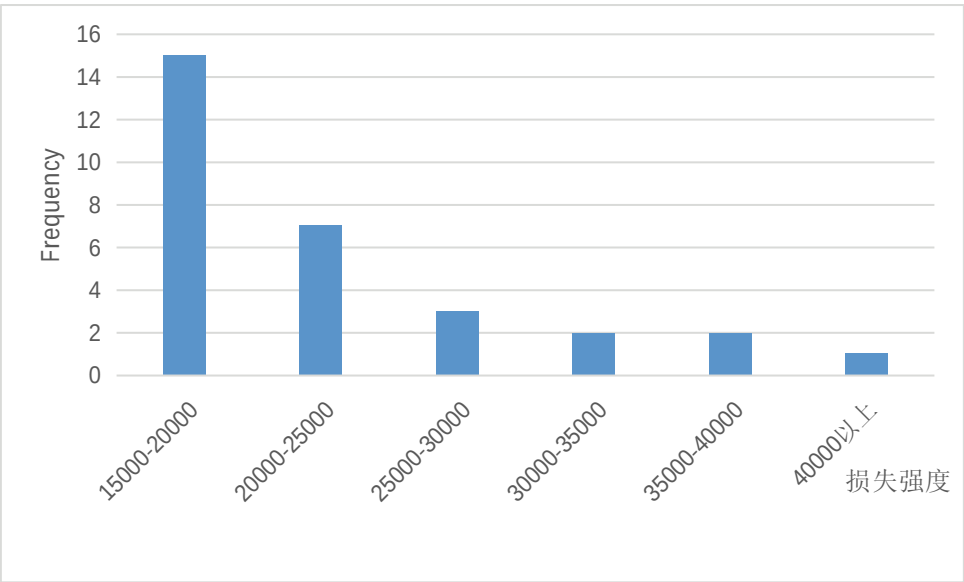


图4 损失强度（C类）

通过直方图可以初步推测损失强度可能服从指数分布，用SPSS软件对其进行单样本的Kolmogorov－Smirnov检验(K－S检验），得到如下表所示结果。

表3　重点高新技术企业损失强度泊松分布K — S 检验结果（A类）

单样本 Kolmogorov-Smirnov 检验 4		
N		40
指数参数。[a,,b]	均值	462.5553
最极端差别	绝对值	.178
	正	.145
	负	-.178
Kolmogorov-Smirnov Z		1.020
渐近显著性(双侧)		.249
a. 检验分布为指数分布。		
b. 根据数据计算得到。		

表4　重点高新技术企业损失强度泊松分布K — S 检验结果（B类）

单样本 Kolmogorov-Smirnov 检验		
N		95
指数参数。[a,,b]	均值	5107.2147
最极端差别	绝对值	.177
	正	.077
	负	-.177
Kolmogorov-Smirnov Z		1.290
渐近显著性(双侧)		.103
a. 检验分布为指数分布。		
b. 根据数据计算得到。		

表5　重点高新技术企业损失强度泊松分布K — S 检验结果（C类）

单样本 Kolmogorov-Smirnov 检验		
N		30
指数参数。[a,,b]	均值	22726.7630
最极端差别	绝对值	.449
	正	.173

	负	-.449
Kolmogorov-Smirnov Z		1.339
渐近显著性(双侧)		.185
a. 检验分布为指数分布。		
b. 根据数据计算得到。		

表3显示损失强度分布与指数分布拟合后Sig 值为0.249，远大于0.05，所以接受非零假设，即该损失强度分布服从指数分布；均值为462.56，因此损失强度分布服从$\lambda = 2.16\times10^{-3}$的指数分布。其密度函数为:

$$f_X(x) = 2.16\times10^{-3}e^{-2.16\times10^{-3}\times x} \tag{13}$$

由此，根据指数分布的密度函数和分布函数的关系，可以算出其相应的分布函数为：

$$F_X(x) = 1-e^{-2.16\times10^{-3}\times x} \tag{14}$$

表4显示损失强度分布与指数分布拟合后Sig 值为0.103，远大于0.05，所以接受非零假设，即该损失强度分布服从指数分布；均值为5107.21，因此损失强度分布服从$\lambda = 1.95\times10^{-4}$的指数分布。其密度函数为:

$$f_X(x) = 1.95\times10^{-4}e^{-1.95\times10^{-4}\times x} \tag{15}$$

由此，根据指数分布的密度函数和分布函数的关系，可以算出其相应的分布函数为：

$$F_X(x) = 1-e^{-1.95\times10^{-4}\times x} \tag{16}$$

表5显示损失强度分布与指数分布拟合后Sig 值为0.185，大于0. 05，所以接受非零假设，即该损失强度分布服从指数分布；均值为22726.76，因此损失强度分布服从$\lambda = 4.4\times10^{-5}$的指数分布。其密度函数为:

$$f_X(x) = 4.4\times10^{-5}e^{-4.4\times10^{-5}\times x} \tag{17}$$

由此，根据指数分布的密度函数和分布函数的关系，可以算出其相应的分布函数为：

$$F_X(x) = 1-e^{-4.4\times10^{-5}\times x} \tag{18}$$

设置免赔额时，考虑到重点高新技术企业是指被选入“火炬计划”的高新技术企业，国家对于其创新型产业集群项目原则上会给予不超过1000万元的国拨经费，给予其子项目不超过300万元的国拨经费。对于其科技服务体系项目原则上会给予不超过1000万元的国拨经费，给予其子项目不超过200万元的国拨经

费。可见，国家对于入选“火炬计划”的高新技术企业的项目会给予200-1000万元的国拨经费，所以在设置免赔额时需要将此考虑在内。

由于无法依次考量每个项目具体所享受的国拨经费，所以在此我们假设A类中平均可享受到的国拨经费为250万元，B类中平均可享受到的国拨经费为625万元，C类中平均可享受到的国拨经费为1000万元。

通过察观A损失强度数据，首先排除单次损失在250万元以下的项目，可以得出单次损失最大值为962.44万元，而800万元以上损失仅出现2次；单次损失低于350万元的损失仅出现4次，因此，为了在降低保费的同时获取最大的损失补偿，可以设定免赔额为350万元，赔偿限额为800万元。

通过察观B损失强度数据，可以得出单次损失最大值为13858.05万元，而11000万元以上损失仅出现6次,仅占比重6%；单次损失低于1500万元的损失仅出现10次，仅占比重10%，同时，考虑到平均可享受到的国拨经费625万元，因此，可以设定免赔额为2125万元，赔偿限额为11000万元。

通过察观C损失强度数据，可以得出单次损失最大值为42118.69万元，而40000万元以上损失仅出现1次；单次损失低于16000万元的损失仅出现4次，同时，考虑到平均可享受到的国拨经费1000万元，因此，可以设定免赔额为17000万元，赔偿限额为40000万元。

假设现在不考虑通货膨胀率的影响，将已知数据代入公式（2）（5） 可以得出:

$$\begin{aligned} &A: E(X \wedge d) = 245.58 \qquad E(X \wedge u) = 380.72 \\ &B: E(X \wedge d) = 1739.72 \qquad E(X \wedge u) = 4527.85 \\ &C: E(X \wedge d) = 11970.17 \qquad E(X \wedge u) = 18817.16 \end{aligned} \tag{19}$$

将已知数据代入公式（8）求得纯保费为:

$$\begin{aligned} &A: P_P = (380.72 - 245.58) \times 1.65 = 222.98 \text{ 万元} \\ &B: P_P = (4527.85 - 1739.72) \times 1.65 = 4600.41 \text{ 万元} \\ &C: P_P = (18817.16 - 11970.17) \times 1.65 = 11297.52 \text{ 万元} \end{aligned} \tag{20}$$

早在2010年3月份，保监会、科技部就联合下发了《关于进一步做好科技保险有关工作的通知》，科技保险开始在全国范围推广。同年12月份，科技部又联合中国人民银行、保监会、证监会、银监会发布了《促进科技和金融相结合试点实施方案》，号召创业投资机构、银行、券商、保险公司、各类科技金融中介共同搭建支持科技创新的金融平台。对于重点高新技术企业项目融资保险而言，其作为科技保险的一种，政府会对其有一定程度的补贴。与此同时，我国保险业发展迅速，2014年保险业实现保费收入1258亿元,比上年增长13.4%。截至 2015 年 5 月，行业整体实现原保险保费收入 11666.41 亿元，同比增长19.46%。

因此，高新技术企业项目融资保险费用附加不会太高。可以设置为纯保费的2.5%，代入（10）式可得：

$$\begin{aligned} &A：L = P_P + l = 228.55 \text{ 万元} \\ &B：L = P_P + l = 4715.42 \text{ 万元} \\ &C：L = P_P + l = 11579.96 \text{ 万元} \end{aligned} \tag{21}$$

目前银行利率为1.5%，故取无风险利率 $r_f = 1.5\%$ ，根据我国保险业的发展情况以及中央政府对科技保险的支持力度，假设保险公司投入的资本金为10亿元。根据保险公司在“营改增”实行后，按金融保险业6%的税率交增值税，再以增值税为税基交城建税7%，教育费附加3%,地方教育附加2%，除此之外，保险公司还需缴纳房产税、城镇土地使用税、车船使用税、印花税、企业所得税。

融资项目损失保险属于财产保险的范畴，所以我们以中国人民财产保险股份有限公司为例，根据其2014年年报中所反映的应交税费和收益总额的数据计算所得为17%，由于现在保险公司“营改增”已经得以开展实施，由于增值税可以抵扣，保险公司可以加大管理成本的力度，比如通过各种进项抵扣的方式来抵扣增值税。“营改增”会确保所有行业的税负只减不增。所以我们假设保险公司在营改增全面实施之后其税率将下降1个百分点，即税率为16%。

负债的期望收益率是保险公司根据自身的投资情况计算出的预计收益率，反映投资项目预计可以获得的收益率，体现着保险公司的资产负债管理情况。以中国人民财产保险股份有限公司为例，在其2014年年报中显示，其投资收益率为5.65%。并且中国保监会在2015年12月11日下发了《关于加强保险公司资产配置审慎性监管有关事项的通知》，要求这些保险公司进行压力测试，保监会将加强审慎性评估，引导其建立资产配置风险排查和预警机制，促进保险公司稳健经营，加强资产负债协同管理，实现资产与负债的良性互动和动态匹配，防范错配风险和流动性风险。在此的基础上，保监会将研究出台相关压力测试信息披露、资产配置能力标准、资金账户监管等的制度规定，以推动保险公司加强资产负债管理。所以假设负债的期望收益率为6%，则可根据公式（11）得最终保费为:

$$\begin{aligned} A: P &= \frac{L}{1+r_L} + \frac{S \times r_f \times T_c}{(1+r_f)(1-T_c)} + \frac{(L/S)(r_f - r_L)}{(1+r_L)(1+r_f)} = 497.11 \text{ 万元} \\ B: P &= \frac{L}{1+r_L} + \frac{S \times r_f \times T_c}{(1+r_f)(1-T_c)} + \frac{(L/S)(r_f - r_L)}{(1+r_L)(1+r_f)} = 4730 \text{ 万元} \\ C: P &= \frac{L}{1+r_L} + \frac{S \times r_f \times T_c}{(1+r_f)(1-T_c)} + \frac{(L/S)(r_f - r_L)}{(1+r_L)(1+r_f)} = 11205.98 \text{ 万元} \end{aligned} \tag{22}$$

根据科技保险试点城市财政补贴情况进行实际考虑：

表6　部分试点城市财政补贴情况

城市	补贴比例上限
北京	70%
重庆	70%
无锡	50%
天津	50%
武汉	100%
苏州	50%

上述数据来源于各试点城市政府出台的关于科技保险保费补贴资金的管理使用办法。计算得出补贴比例上限的平均数为65%，所以企业实际承担的保险费用为原保险费用的35%，计算可得：

$$\begin{aligned} &A: 523.04\times 35\% = 173.98 \text{ 万元} \\ &B: 5210.35\times 35\% = 1655.5 \text{ 万元} \\ &C: 12567.02\times 35\% = 3922.09 \text{ 万元} \end{aligned} \tag{23}$$

由于在当今现实情况之下，银行因为受到银监会监管的要求，无法直接进行股权投资，目前金融创新中的小额股权投资也需要第三方搭建通道。今年两会提出和酝酿的债转股也未必可以在银行系统之中得到试点和推广。银行作为纯粹的债权投资者，只是承担债权人角色，哪怕企业破产、资不抵债也只能对剩余资产根据债权比例进行分配。所以在高新技术企业融资项目损失发生的情况下，银行并不会因此承担风险和责任。

总结上述结果，企业可以根据自己融资项目的实际情况，选择合适的融资项目损失保险，A类适合融资项目金额在1000万元以下的企业，企业所承担的保险费用为173.98万元；B类适合融资项目金额在1000-15000万元的企业，企业所承担的保险费用为1655.5万元；C类适合融资项目金额在15000万元以上的企业，企业所承担的保险费用为3922.09万元。

3.4. 费率比较

保险费率为保险费与保险金额的比率，保险金额即保险公司承担赔偿的最高限额。根据以上数据，可以计算出A，B，C三类的保险费率为

$$\begin{aligned} &A: 183.06 \div 800 = 0.22 \\ &B: 1823.62 \div 11000 = 0.15 \\ &C: 4398.46 \div 40000 = 0.10 \end{aligned} \tag{24}$$

由于缺乏相关资料直接显示科技保险的保险费率的具体限额。但是根据我国各地科技保险的发展情况，结合相关文献中的数据，推算出科技保险的大致费率为0.25。上述三类融资项目损失保险的费率在0.10-0.22之间，略低于0.25，在合理的费率范围之内，具有一定的参考价值和意义。

4. 对政府的启示与建议

通过以上的测算、比较和分析，重点高新技术企业融资项目损失保险作为科技保险的一种，他的发展需要在政府的指导下结合各方的力量，高新技术企业的发展任重道远。

4.1. 增加补贴支持力度

政府的政策激励与财政优惠补贴政策是企业融资项目投资损失保险发展的重要动力。首先，政府可以通过建立多样化的补贴方式，实现对科技保险更大力度的支持。当前，政府主要四种补贴科技保险的方式 ：保险费补贴、经营主体管理费补贴、再保险补贴及税收优惠。其次，是选择合理的补贴标准。补贴标准要因地制宜，因时制宜，在政策允许范围内确定不同的财政补贴比例和补贴递增率。此外，是细化补贴实施细则。以法律形式明确各级政府对科技保险的管理责任以及财政补贴的科技保险险种、补贴标准及计算方法等，同时建立一个专门的科技保险经营管理机构，代表政府监督科技保险经营和财政补贴发放等情况。

4.2. 加大宣传力度

一是利用好报纸、电视、网络等大众传播媒体，扩大该保险知识宣传受众面，如在主流刊物和网站中开辟宣传模块，在财经频道播放专业节目、定期刊登该保险相关知识和典型案例等。二是加强高新企业、高校、金融机构和政府之间的学术交流。开展交流会，强化相关机构、部门的保险认知、交流和互助，增强企业信任和对科技保险正确认识。

4.3. 支持保险公司改进险种并合理厘定费率

经济发展变化迅速，企业对于险种的需求也是不断变化的，优化升级传统险种，分析现有险种的不足，使其符合高新企业的实际需求，并根据政府政策进行规范化和可操作化的调整。可根据市场分类进行基本型、研发型和上市型的推出，对现有险种也可以进行综合创新。

费率问题一直是投保人十分关注的问题，根据文献资料显示有高达54.2%的企业期望科技保险有合理费率。在诸多纷繁复杂的科技风险规律没有完全被认知、缺乏过去相关参考数据测算保险标的的算是分布等条件下，对科技保险的精算原理及其产品价格进行探讨，无论是理论还是实务操作都是十分困难且必要的。需要各个保险公司之间通力合作并建立关联数据，不断完善定价模型。

4.4. 引导银行积极参与

银行作为重要的第三方机构，理应积极参与高新技术企业的融资活动，使信贷资金进入高新技术企业科技成果转化的过程之中，进而支持我国高新技术企业的发展。针对高新技术企业高收益高风险的基本特性，商业银行可以建立一套更为稳健、完整的风险识别。首先，银行可以建立起贷款风险识别制度，

对企业生产经营中已经或即将面临的问题进行定期诊断，并对其进行成因分析和趋势预测，从而进一步研究解决问题的对策。其次，银行可通过增加资本保障的方式来提高企业自身抗风险能力，从而降低贷款风险与防范机制。再次，银行可在贷款合同中设立一些约束条款，限制未经银行同意的股权转移、资产转移；限制对外长短期投资。

5. 结语

重点高新技术企业是科技创新的重要主体，解决其融资项目损失分摊问题是一个重要的研究课题。本文对重点高新技术企业融资项目损失保险定价进行了一定的测算、比较和分析，不仅仅对于重点高新技术企业适用，也同样适用于其他没有被列入“火炬计划”的高新技术企业。结合我国科技保险的发展现状，建议开展高新技术企融资项目损失保险，并通过更深入的研究，不断完善精算模型，进而为科技成果转化过程筑造坚实后盾，为高新技术企业的发展助上一臂之力。

附注：

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中国重点高新技术企业融资项目损失保险定价研究

张代军　　徐晨菲

张代军
教授
浙江财经大学金融学院
杭州30018，中国
电话: 13750815909
Email: zdj0303@126.com.

徐晨菲*
本科生
浙江财经大学金融学院
浙江财经大学3号楼521室
电话: (0575)82128089
Email: 1004267011@qq.com

关键词: 重点高新企业;科技成果转化;融资项目损失保险;保险定价

中文摘要. 科技成果转换是科技创新的重要步骤，重点高新技术企业作为科技成果转换的重要主体，在科技成果研发应用直至形成产业化过程中，往往会通过融资的方式来满足资金需求，由于一些不确定因素，融资项目可能不能达到预想的收益进而发生损失。融资项目损失保险的概念由此提出。本文根据依照重点高新技术企业融资项目投资损失保险的构想，以入选“火炬计划”的上市公司为投保对象进行调查，通过这些公司的官网和中国财经门户网站的查询，搜集到159家企业的2014年年报，通过对年报的阅读，最后符合统计要求的有100家，共165个损失项目，并收集重点高新技术企业融资项目投资损失次数和损失额度的具体数据作为样本数据，同时结合项目损失残值和政府针对不同类型重点高新企业实施的差异化鼓励政策以及其他利益相关者的权责，依据文献和精算的相关知识对科技型企业保费厘定进行数据分析和探究。根据保费厘定过程与结果，给出政府、保险公司、重点高新企业、银行等融资主体以及其他相关利益主体在处理相应风险与收益或损失关系方面的政策建议。

Design of Cross-regional Typhoon Catastrophe Insurance Fund

ZHOU Yan, TU Haiping

ZHOU Yan*
Professor
Faculty of Economics and Management
East China Normal University
Shanghai 200241, China
Phone: 136 6157 9199
Email: sdzhouyan@163.com

TU Haiping
Postgraduate Student
Faculty of Economics and Management
East China Normal University
Shanghai 200241, China
Phone: 159 2191 1093
Email: 627799407@qq.com

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Abstract. As an important means to spread the catastrophe, the catastrophe insurance fund has aroused wide public concern of the government and in all sectors. Although the catastrophe insurance system of Shenzhen and Ningbo have established in 2014, limited to the dependence of government finance, this new system is difficult to promote in other regions. Therefore, comparing the different models and defects existing, the essay proposes to establish a cross-regional typhoon catastrophe insurance fund which fits our national conditions. Then the essay uses empirical methods to divide 11 coastal regions into different premiums levels, and set up the proportion of the initial allocation funds according to the level of regional economic development. The paper finally gives the conclusions and policy recommendations.

1. 引言

我国是自然灾害频发的国家，台风作为最常见的巨灾之一，近10年来平均每年给我国造成的经济损失高达344.3亿元，尤其是我国11个沿海省、市、自治区深受台风巨灾的侵害，台风巨灾风险亟待分散。但是，和世界平均保险赔付占巨灾损失比重的38%不同，我国巨灾仍处于依赖政府救援资金的阶段，保险赔付占比不足10%[1]。

2014年8月出台的《国务院关于加快发展现代保险服务业的若干意见》明确提出要建立巨灾保险基金、巨灾再保险等制度，逐步形成财政支持下的多层次巨灾风险分散机制，国家"十三五"规划中也提及了要加快建立巨灾保险制度。截至2015年底，深圳、宁波等地纷纷出台地方性巨灾保险制度，但其涵盖多种巨灾风险，对台风风险的针对性不足，并且过度依赖地方财政资金，难以在全国范围内进行推广。因此，探寻适合我国国情的台风风险分散模式势在必行。

本文在分析现有深圳、宁波巨灾保险制度存在问题的基础上，结合台风灾害的风险特征及我国国情，从组织机构和运行机制等角度入手，提出跨区域合作型台风巨灾保险基金的具体设计方案。进而以极值理论和灰色系统理论为出发点，运用POT模型和复合泊松过程测算台风巨灾保险基金的初始规模，并计算出不同置信度下的CVaR值，设计损失补偿机制。在兼顾公平与效率的原则下，从脆弱性评估的角度出发，使用灰色关联度法，进行11个沿海地区的风险区划，并结合各个地区的经济发展水平制定具体的分配方案，以期为台风巨灾保险的开展提供有价值的实证研究支持。

2. 文献综述

国外有关巨灾风险管理的研究起步较早，在构建巨灾保险基金方面经验丰富，目前已有十多个成功实施的巨灾风险管理项目[2]。相比之下，国内该领域的研究起步滞后，虽然近年来理论成果初现，但实践经验上仍然十分缺乏。

2.1 关于巨灾保险基金的研究综述

关于巨灾保险基金的研究国内外主要将着眼点集中于基金规模的测算、资金来源及其运作模式。

巨灾保险基金究竟应该达到多大规模才能发挥应有的作用？Scott and Greg（2003）运用局部均衡模型，通过整合美国巨灾损失的风险分布数据，测算巨灾保险基金的规模。也有学者根据近百年美国火灾、暴雪、飓风的灾害数据，运用最大似然估计的方法来确定各巨灾的参数，用威尔伯分布拟合火灾受损面积，用

[1] 数据来源于《2014全球灾害风险与巨灾保险发展》：http://www.sinoins.com
[2] 主要包括英国洪水巨灾保险基金、美国洪水基金、日本地震巨灾保险基金、新西兰地震保险基金、佛罗里达飓风灾害基金、土耳其地震保险基金、加勒比地区巨灾保险基金等。

泊松分布拟合暴雪和飓风灾害情况，模拟了2013年美国所面临的巨灾损失。庹国柱等（2010）根据应赔付的实际损失金额与启动赔付金额之差确定巨灾风险准备金规模。田玲（2013）发现负二项分布比泊松分布拟合效果更佳，用最佳自留额法测算最优自留额度，并采用随机模拟技术对地震风险损失进行了模拟，进而用VaR方法测算基金规模，并且还考虑了风险度量和保险市场承保能力度量对确定基金规模的影响。

常规的基金资金来源主要包括政府财政拨款、保费收入、会员会费、税费减免以及社会各界捐赠等几个途径[3]。Boulatov and Dieckmann（2013）认为资金来源应当包括捐助资金、政府财政资金、保险公司每年的保费收入以及资本市场融资等部分。农业巨灾保险基金的来源主要由储备金对外贷款获得的本息收益、资本市场融资和保费收入组成（Marietta and Krzysztof，2014），政府应当组织进行灾前融资，以有效应对巨灾（Kunreuther and Pauly，2006）。

关于巨灾保险基金的运作模式，政府应当扮演巨灾保险基金的发起者和管理者的角色参与运作，推动基金的健康有效发展（Lalor，1996），国内外学者对此已基本达成共识，政府若能以更低的利率筹措资金并进行跨期分配，将会比私人提供的巨灾保险更有效率（Lewis and Murdock，1996）。政府应当建立递延税费的巨灾保险基金或其他政府项目（Greg，2002）。

综上，国内外学者对保险市场、政府、社会资源等领域的资金来源方式基本达成一致，从学术成果上看，国内学者已经有所突破，在巨灾保险基金规模的测算思路上与国外学者趋于一致，但由于巨灾保险基金实践经验的缺乏，更多地停留在理论层面，在可行性和实践性方面存在较大完善空间。

2.2 台风巨灾风险的研究现状

关于台风巨灾风险的研究路径，大致可分为三个阶段。第一阶段主要是针对台风巨灾风险特征及损失的探索和研究。Kerry(2005)提出以总功耗为基础、综合气旋生命周期的指数来反映飓风强度。针对中国东南部沿海地区的巨灾，应建立一个更为具体、完善、细致的台风数据库(Yap et al.,2015)，以便分析台风致灾因子和台风灾害损失间的关系（牛海燕、刘敏等，2011）。薛建军、李佳英等（2012）在我国台风气候特征和灾害特点的基础上，提出可依靠基于风险区划的防灾能力建设降低风险。

第二阶段是台风巨灾风险分散途径选择的研究，具体包括再保险、巨灾产品证券化、巨灾保险基金等。Joanne et al.(2015)研究了金融渠道分散巨灾风险的效果，他们认为融资等传统灾后金融手段能有效分散风险，同时提出灾前金融工具的运用更具效果。Kunreuther et al.(2013)基于飓风预测、保险市场条件、再保险

[3] 保费收入主要指巨灾基金在履行再保险职责时向原保险人收取的分保费用，会员会费指会员制的巨灾保险基金中，各会员以会员费的形式加入，并以会员费的多少确定其权利大小。

可用性、减灾措施等因素，评估了佛罗里达地区商业保险公司的飓风风险保费及损失覆盖能力。

Dodo et al.(2005)运用线性规划对洛杉矶地区地震减灾资源最优分配进行研究，在最小化成本投入的前提下制定建筑改造方案。该模型被Legg et al.（2013）运用到木结构建筑在飓风灾害中的易损性评估之中。在此基础上，Peng et al.(2014)从博弈论出发，采用随机规划优化模型来提高美国自然灾害管理水平。郑慧（2012）通过理论和实证模型对风暴潮灾害保险费率厘定以及基于再保险模式的风暴潮灾害风险分散策略进行设计。李永、范蓓、刘鹃（2012）基于中国台风巨灾财产损失和受灾面积，设计了多事件触发的巨灾债券产品定价模型。李永、刘鹃(2010)对我国1990年来损失在1亿元以上的台风损失以及次数分布进行拟合，并结合无套利BDT利率期限结构模型以及转移概率参数，建立了我国台风灾害债券短期利率离散形式的动态变化模型。

第三阶段是构建台风巨灾保险基金。Grace et al.(2005)研究了2004-2005年飓风季后保险市场中各方对待飓风风险的变化趋势，建议建立联邦巨灾再保险项目。和佛罗里达情况类似，我国东南沿海的广东、浙江、福建容易遭受台风的袭击，可以考虑设立台风巨灾保险基金（谢世清，2011）。可以从运行机制、核心机构、资金来源和运营支出四个方面对台风巨灾基金的运行进行初步设计，探讨台风巨灾基金筹资比例和缴费分级问题（沈蕾，2012）。冯锐（2009）提出构建政府主导型海洋巨灾风险基金，从筹资途径、投资运营和损失分担三个方面简单规划该基金运作流程，并采用因子分析、模糊评价等实证方法量化分析政府参与海洋巨灾基金的具体方式。

从现有的文献来看，目前国内外学术界对巨灾保险的研究已经较为深入，而对于台风巨灾的研究也逐渐升温，这为本研究奠定了坚实的基础。虽然国内对台风巨灾保险基金的研究较为宽泛，但极其缺乏定量研究。因此，本文力图通过收集和整理较全面的台风灾害统计数据，选择合适的实证研究方法，对台风巨灾风险做定量研究，并给出更具体的跨区域型台风巨灾保险基金设计框架，以期为相关领域的研究提供参考。

3. 现有巨灾风险分散模式存在的问题与跨区域型台风巨灾保险基金的优势

3.1 深圳、宁波“三位一体”巨灾保险模式存在的问题

作为我国首批巨灾保险试点地区，2013和2014年深圳和宁波分别建立了巨灾保险制度。深圳市巨灾保险制度由政府巨灾救助保险、巨灾基金和个人巨灾保险三部分组成，而公共巨灾保险、巨灾基金和商业巨灾保险则构成了宁波市巨灾保险制度，二者都采用了“三位一体”的巨灾保险体系。也就是说，首先通过财政购买的方式向商业保险公司定制“低保障、全覆盖”的基本巨灾保险，其次让商业巨灾保险来满足个性化巨灾保险需求，最后建立巨灾保险基金以满足再保险的需

求。深圳、宁波两地的巨灾保险方案是我国建立巨灾保险制度的大胆尝试，可以在一定程度上保障居民的生产生活水平，但仍存在许多缺陷。

（1）保障效果差。两地巨灾保险制度的第一部分都是力求对市民进行风险全覆盖[4]，但损失赔付金额较低。如宁波的公共巨灾保险中每户的财产损失赔付上限仅为2000元，显然不能满足居民对巨灾保险的需求。

（2）个性化巨灾保险需求难以满足。目前商业巨灾保险仍处于摸索阶段，保险公司缺乏承保经验和动力，符合居民个性化巨灾保险产品的设计难以实现。

（3）价格无竞争性。该模式以政府财政资金为主要巨灾风险保障，政府向商业公司购买公共巨灾保险的价格并非市场竞争价格，商业保险公司只需提供基础的公共巨灾保险即有利可图，并没有开设个性化巨灾保险的动力。

（4）风险独立性条件难以实现。两地方案都涵盖了多重灾害种类，风险范围广泛，但保险区域却相对狭小，很可能将导致风险之间的独立性条件不能满足，从而导致可保性原理失效。多重灾害的承保将会导致赔付的频繁发生，政府将疲于应对各种灾害的赔付而很难有足够的保险资金积累。

综上所述，两地“三位一体”的巨灾保险制度具有灾种多、覆盖广、保障低的特点，难以满足发达地区对巨灾风险保障的需求，而其主要依赖地方财政支持的特点也很难在经济欠发达地区进行复制和推广，因此两地的巨灾保险制度方案值得商榷。

3.2 跨区域型台风巨灾保险基金的优势

“跨区域”一词是相对于区域型或地方性保险基金而言的，即风险能覆盖我国所有受台风影响的地区。具体包括11个省、市、自治区，分别是辽宁、河北、天津、山东、江苏、上海、浙江、福建、广州、广西和海南。跨区域型巨灾保险基金相比于区域性巨灾保险基金主要有以下优势：

（1）能够更大程度地在空间上分散风险，确保台风巨灾风险的独立性原则成立。我国11个沿海省、市、自治区虽然都受到台风巨灾的侵袭，但单个台风灾害很难同时对所有区域造成损失，并且不同区域间风险单位的相关性微乎其微，从而使台风风险具有可保性。

（2）有助于带动经济欠发达地区开展巨灾保险业务。巨灾保险基金的建立初期及后续运营都需要大量的财政资金投入，这会给经济欠发达地区造成较大负担。通过跨区域的方式，可以使所有受灾地区的投入资金汇集到同一个资金池中，富庶的地区也能更有针对性地帮扶经济欠发达地区开展相关保险业务，从而兼顾公平和效率。

[4]从灾害种类涵盖上来看，两地巨灾保险都包括台风、强热带风暴、龙卷风、暴雨、洪水、雷击，地震、台风、海啸、泥石流等自然灾害，深圳方案还包括由自然灾害引发的核事故风险，基本上涵盖了一般性巨灾及特殊风险。

（3）单灾种巨灾保险基金风险管理更具针对性。我国常见的巨灾种类繁多，其出现方式、发生频率、致灾因子、后续灾害、损失评估等各方面都存在差异，难以设计同时覆盖如此多种灾害的巨灾基金。单灾种巨灾保险基金则能针对单个灾种进行深入研究，根据其风险特征设计出更具应用价值的保险产品。

4. 跨区域型台风巨灾保险基金方案设计

4.1 跨区域型台风巨灾保险基金设计目标

跨区域型台风巨灾保险基金是由全国11个受灾地区共同出资建立的，以政府为主导，以商业保险公司为支撑，以提供再保险为主要形式的，不以盈利为目的的台风单项巨灾保险基金。其设立目标就是通过政府部门和商业保险公司的合作，提高对台风巨灾风险的承保能力，改变当前我国台风巨灾风险覆盖率低的现状，对我国境内受台风灾害地区进行全面覆盖，将台风巨灾风险进行充分分散和有效转移，以保障居民的生产生活，维护社会稳定。

4.2 跨区域型台风巨灾保险基金的组织机构

国际上现有的巨灾保险基金模式可以分为政府主导型、纯商业型和合作型三类，组织机构因基金模式的不同而不同。三种模式下的组织机构各有利弊，但政府和商业合作的模式能最大程度地扬长避短，充分发挥政府和市场的优势，而且考虑到我国的实际国情，在台风巨灾保险基金起步阶段政府的财力支持必不可少。因此，政府与市场合作模式下的组织机构最为适宜。

该模式的核心管理机构由合作各方共同参与构成。本文将跨区域型台风巨灾保险基金的核心管理机构定为台风巨灾保险基金管理委员会，由11个受灾省、市、自治区联合各地商业保险公司共同参与组成[5]，下设董事会和监督审计委员会。董事会由基金管理委员会推选，具体包括来自11个受灾省、市、自治区的代表、国家财政部代表、巨灾领域专家学者、商业保险机构代表等。审计委员会独立于董事会，执行内部监管、审计职责。当然，台风巨灾保险基金还会聘请第三方审计机构，对保险基金的日常运作及资金流动进行实时监督和审查。

具体的跨区域型台风巨灾保险基金组织机构设计如图1所示。

[5] 11个省、市、自治区可以建立相对独立的二级台风巨灾保险基金，在充分贯彻台风巨灾保险基金总部精神的基础上，依据本地的现实情况在合理范围内对政策执行做出适当的微调。

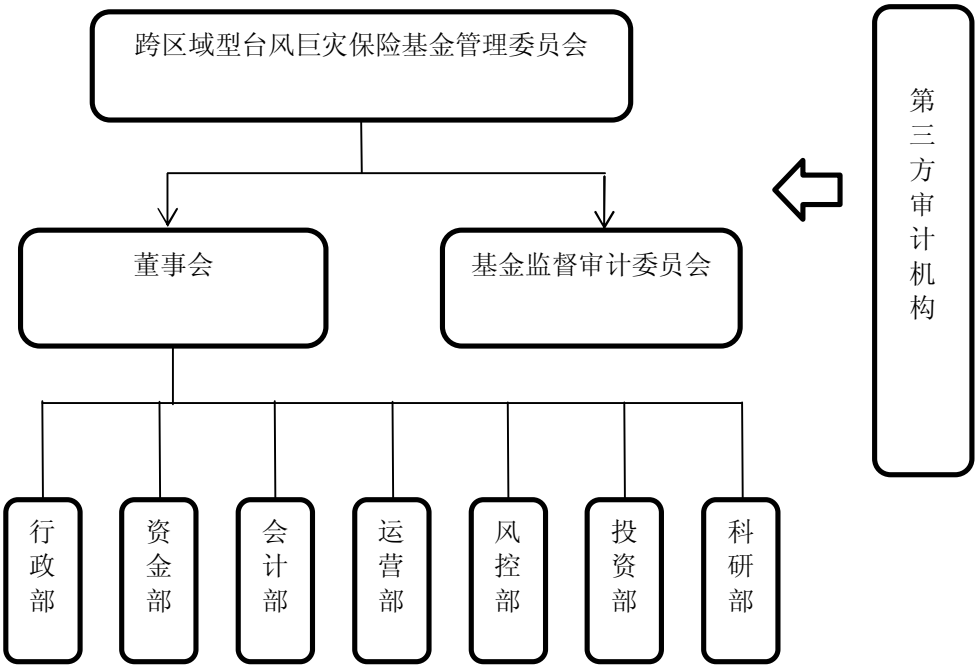


图1 跨区域型台风巨灾保险基金组织机构图

4.3 跨区域型台风巨灾保险基金的运行机制

跨区域台风巨灾保险基金的主要目标是提供充分的再保险以提高社会承保能力，基金主要以再保险人的角色参与整个台风巨灾保险过程。具体的运行机制见图2。

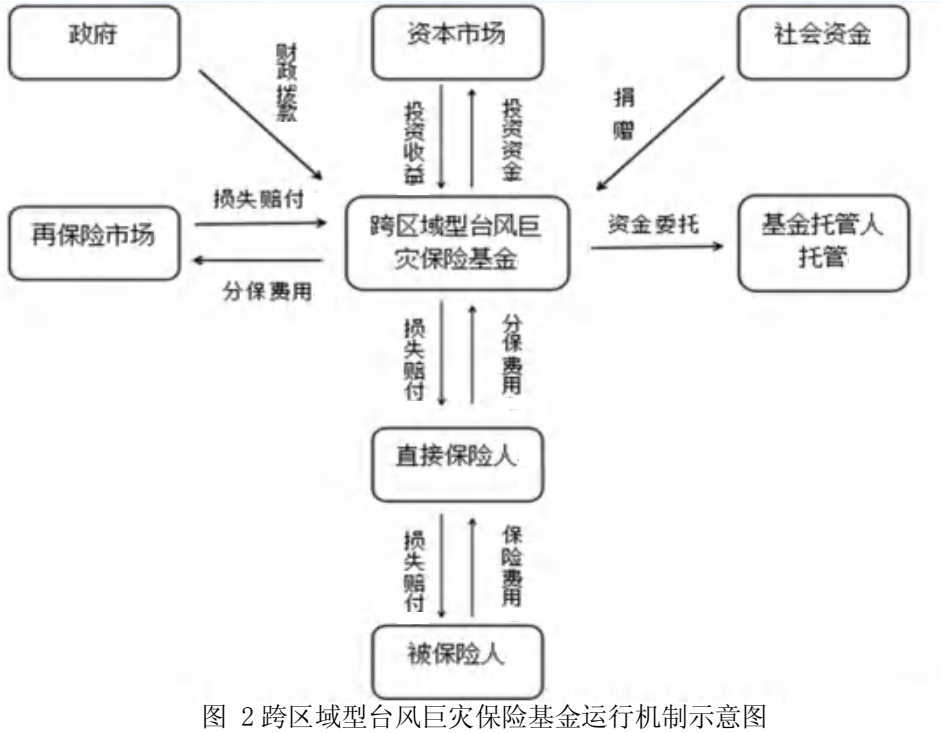


图 2 跨区域型台风巨灾保险基金运行机制示意图

其中直接保险人由我国商业保险机构组成，再保险人包括国内商业保险公司和国外再保险机构。为保证台风巨灾风险基金运作的公开透明，选择一家信誉良好、资金雄厚的商业银行作为基金的托管人，并由银监会对其进行监管。

跨区域型台风巨灾保险基金的初始资金来源包括各级政府财政拨款、直接保险公司保费收入、基金的投资运作收益，还包括灾后的社会捐赠、巨灾时政府临时性救灾款项、国际再保险市场损失摊赔等。

5. 跨区域型台风巨灾保险基金的实证研究

5.1 台风巨灾损失强度及基金初始规模估算

5.1.1 数据来源与数据处理

根据台风巨灾的极值特点，本文通过收集和整理《中国海洋灾害公报》、各地统计年鉴，得到1989年到2014年台风及台风引起的风暴潮灾害损失，共计126起灾害数据。运用R软件，选用广义帕累托分布的POT模型对台风损失数据进行拟合并估计参数，得到台风巨灾损失强度分布函数，并运用复合泊松过程估算台风巨灾基金的初始规模。

考虑到数据时间跨度较大，物价水平已经发生了巨大的变化，因此根据历年城镇居民消费指数，以2014为基期，对台风巨灾损失数据进行了调整。

5.1.2 台风巨灾损失强度分布的参数估计

5.1.2.1 正态分布检验

表1为数据处理后的描述性统计，可见台风巨灾的平均损失额度在35.56亿元，但是其峰度为15.24，偏度为3.59，具有明显的尖峰厚尾特征，不符合正态分布[6]。考虑到样本数据量为126，属于较小的样本，谨慎起见，再使用R软件中lillie.test和ad.test函数对灾害数据做正态分布检验。结果显示，无论是K-S检验还是A-D检验，p值都小于0.05，都拒绝服从正态分布的原假设，因此可以考虑使用广义帕累托分布下的POT模型进行拟合。

表 1 样本描述性统计表

样本数	均值	方差	偏度	峰度
126	35.56	3545.9173	3.5934	15.2416

5.1.2.2 阈值u的选取

广义帕累托分布实质上是对超过阈值u以上的r个次序统计量的考察，合理的阈值u的选取是POT模型的关键。关于阈值选取的方法，目前主要有图解法和计算法两大类。由于图解法具有直观、简便的特点，本文使用R软件下ismev包中的gpd.fitrange函数进行绘图，结果显示在95%置信度下，u在3.65附近时形状参数和尺度参数展现出较好的稳定性，因此选择u=3.65作为POT模型的阈值。

5.1.2.3 广义帕累托分布参数估计

[6]通过绘制QQ图、直方图也可以判断出其不符合正态分布，此处QQ图、直方图略。

运用R软件中gpd.fit函数，得广义帕累托分布参数估计结果如表2，进而运用R软件中gpd.diag函数对广义帕累托分布拟合优度进行诊断，得图3。

表 2 广义帕累托分布参数估计结果

参数	β	ξ
估计值	0.6929717	-0.0692791
标准差	0.1883022	0.2166752

由图3中的P-P图[7]和Q-Q图[8]可以看出，超过阈值的台风巨灾损失样本点基本分布在直线附近，不能排除样本数据符合广义帕累托分布的假设。概率密度曲线估计图中各个点都落在置信区间内，直方图的分布同样支持拟合结果。此外，K-S检验的P值大于0.05，因此可以认为拟合的模型是正确的，检验结果支持台风损失数据服从广义帕累托分布模型的假设。

综上所述，通过对历史损失数据的拟合，发现台风巨灾损失强度在超越门限值3.65后，服从形状参数为-0.06928、尺度参数为0.693的广义帕累托分布。

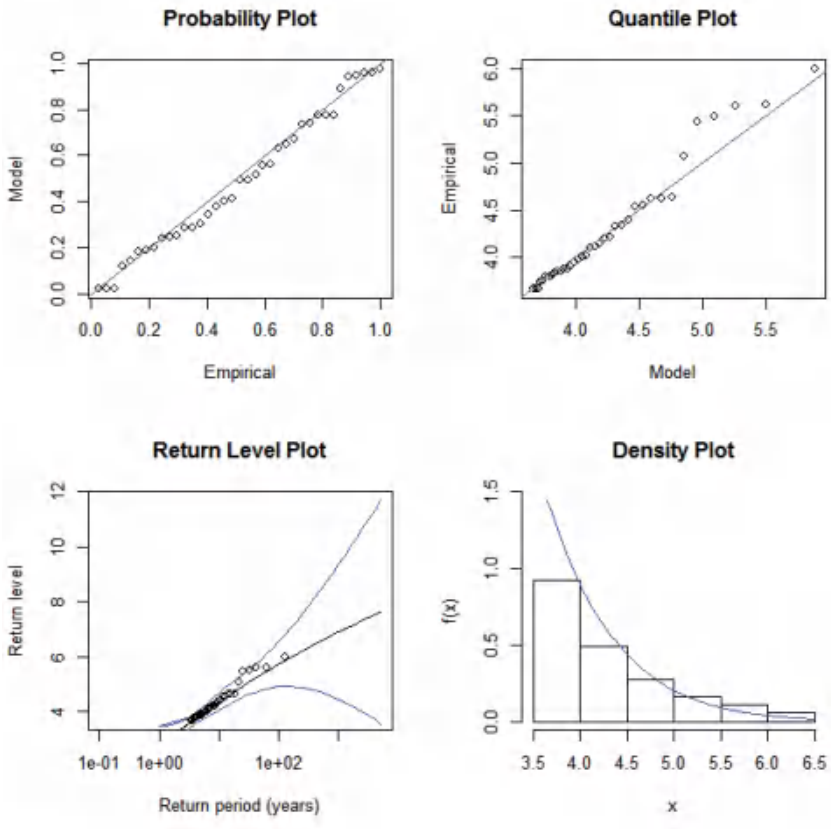


图 3 广义帕累托分布拟合优度诊断图

[7] P-P图是根据变量的累积比例与指定分布的累积比例之间的关系所绘制的图形。当数据符合指定分布时，P-P图中各点近似呈一条直线。

[8] Q-Q图可用于鉴别样本数据是否近似于正态分布。当近似服从时，图上的点在一条直线附近，且该直线的斜率为标准差，截距为均值。

5.1.3 台风巨灾保险基金初始规模测算

首先，对1989年至2014年间超过POT模型中阈值的台风巨灾损失数据，选取泊松分布进行台风巨灾损失发生频次的拟合，检验结果支持超过阈值的台风巨灾损失发生频数服从泊松分布的假设。进一步，根据极大似然估计，泊松分布的参数 λ 的估计值为1.48[9]。因此，台风巨灾损失发生频数服从参数为1.48的泊松分布，这也进一步验证了POT模型拟合台风巨灾损失强度分布的有效性。

其次，根据前文的模拟和检验，台风巨灾损失强度满足广义帕累托分布，台风巨灾损失频数满足泊松过程，在此基础上，本文采用复合泊松过程对台风巨灾总损失测算。

再次，广义帕累托分布的期望值能较好地反映极值情况下巨灾损失强度的平均水平。台风巨灾发生的频数服从泊松分布，能有效估计超过阈值的年度台风巨灾发生次数。两者相乘得到的台风平均年度损失可以作为台风巨灾保险基金规模的有效参考指标。

具体而言，以 $\overline{w}_{\xi,u,\beta}$ 表示服从形状参数为 ξ、尺度参数为 β、阈值为 u 的广义帕累托分布的均值，则台风巨灾的平均年度损失 $E(S)$ 可以表示为：

$$E(S)=\lambda E(X)=\lambda\overline{w}_{\xi,u,\beta}=\lambda(u+\beta(u)/1-\xi) \quad (1)$$

将各参数代入，再换算成以2014年年度物价水平为基准的金额，得到台风巨灾的平均年度损失期望值为108.87亿元。由于跨区域型台风巨灾保险基金主要提供再保险服务，较低层次的损失补偿由投保人和原保险公司承担，因此实际基金规模应该小于平均年度损失期望值。但是考虑到台风巨灾保险基金初始筹建阶段商业巨灾保险的滞后性，大部分资金将由巨灾保险基金承担。因此，台风巨灾保险基金的初始规模应该在100亿元至110亿元之间，足以应对多数台风巨灾风险，并且有足够的资金进行增值保值。

5.2 基于台风巨灾损失强度分布的VaR值与CVaR值估计

5.2.1 VaR 值的估计与检验

POT模型下的VaR计算方法属于极值理论法中的一种。在POT模型下的VaR计算方法如下:

由POT模型可得，对于一个充分大的阈值 u，$F(x)$ 的超出量条件分布函数 $F_u(y)$ 可以用 $G(y;\beta(u),\xi)$ 近似，即：

$$F(x)=(1-F(u))G(y;\beta(u),\xi)+F(u) \quad (2)$$

[9] 也有学者采用负二项分布对巨灾损失频数进行拟合，如田玲（2013）在研究地震巨灾频数时采用了负二项分布拟合，但本文中频数数据较少，统计特征不明显，且台风巨灾与地震巨灾间存在显著差异，负二项分布并不能很好的刻画台风巨灾发生频数。而泊松分布顺利通过拟合优度检验，因此笔者选取泊松分布。

令n为样本数，n_u为大于阈值u的样本x的数量，根据历史模拟法，$(n-n_u)/n$可以近似表示$F(u)$，式（2）变形为

$$F(x)=(1-\frac{n-n_u}{n})G_{\beta(u),\xi}(x-u)+\frac{n-n_u}{n}=1+\frac{n_u}{n}(G_{\beta(u),\xi}(x-u)-1) \quad (3)$$

用GPD的分布形式替代其中的$G_{\beta(u),\xi}(x-u)$，并对其进行统计估计，尾部估计可以表示为

$$\hat{F}(x)=1-\frac{n_u}{n}(1+\hat{\xi}\frac{x-u}{\hat{\beta}(u)})^{-1/\hat{\xi}},x>u,\xi\neq 0 \quad (4)$$

由于VaR本身是损益分部的一个高分位数，对于给定的置信水平q，有$VaR_q=F^{-1}(q)$，进行变换后可以估计出给定的置信水平q下的分位数：

$$VaR_q=u+\frac{\hat{\beta}(u)}{\hat{\xi}}((\frac{n}{n_u}(1-q))^{-\hat{\xi}}-1) \quad (5)$$

根据式（5）计算出VaR值如表3。

表 3　VaR估计值

置信度	VaR估计值
99.00%	310.8
97.50%	184.93
95.00%	122.11
90.00%	79
85.00%	60.64

为了检验模型的有效性，需检验得到的VaR值对实际损失的覆盖程度[10]，检验结果见表4。结果显示，使用VaR值测度的模型低估了台风巨灾风险，这可能是由VaR模型本身存在的缺陷造成的。

表 4　VaR估计值检验结果

计算方法		广义帕累托分布		
显著水平	理论溢出数	实际溢出数	实际溢出率	VaR值
5%	6	6	4.76%	122.11
2.50%	3	5	3.97%	184.93
1%	1	1	0.79%	310.8

5.2.2　CVaR 值的估计与检验

针对VaR模型存在的缺陷，本文采用CVaR模型对其进行修正，并用相同方法来检验风险覆盖情况。CVaR值的公式表达为

$$CVaR=E(X\mid X>VaR) \quad (6)$$

进一步可得

[10] 根据样本计算出损失超过VaR值的次数n，进一步计算出溢出率E，$E=n/N$，其中N为样本数。再将E值与显著性水平$1-p$进行比较，来判断模型的有效性。在置信水平为p时，如果$E>1-p$，则说明模型低估了风险，反之，表明预测的模型结果覆盖了实际损失，但是如果E太小，则说明模型的估计过于保守。

$$CVaR = VaR_p + E(X - VaR_p \mid X > VaR) \quad (7)$$

其中$E(X - VaR_p \mid X > VaR)$表示超过阈值$VaR_p$以上的平均超出量分布$F_{VaR_p}(y)$，根据广义帕累托分布的性质，平均超出量分布具有形状参数ξ和尺度参数$\beta(u) + \xi(VaR_p - u)$。

对于任意的$u > u_0$，平均超出量函数可以定义为

$$e(u) = E[X - u \mid X > u] = \frac{\beta(u_0) + \xi(u - u_0)}{1 - \xi} \quad (8)$$

则有

$$E(X - VaR_p \mid X > VaR) = \frac{\beta(u) + \xi(VaR_p - u)}{1 - \xi} \quad (9)$$

若$\xi < 1$时，可得

$$\hat{CVaR}_p = E\hat{S}_p = \frac{\hat{VaR}_p}{1 - \hat{\xi}} + \frac{\hat{\beta}(u) - \hat{\xi}u}{1 - \hat{\xi}} \quad (10)$$

根据公式（10）可得CVaR值如表5。

表 5 CVaR估计值

置信度	CVaR估计值
99.00%	519.34
97.50%	319.56
95.00%	216.72
90.00%	144.21
85.00%	112.6

再使用相同的方法对测度结果进行检验得表6。

表 6　CVaR估计值拟合检验结果

计算方法		广义帕累托分布		
显著水平	理论溢出数	实际溢出数	实际溢出率	CVaR值
5%	6	5	3.97%	216.72
2.50%	3	1	0.79%	319.56
1%	1	0	0%	519.34

结果显示得到的CVaR值在接近显著水平的同时覆盖全部风险，因此可以认为使用CVaR值相比于VaR方法要更有效。因此，在台风巨灾发生时，我们有85%的把握认为造成的最大损失为112.6亿元，有90%的把握认为最大损失在144.21亿元，95%的把握认为最大损失在216.72亿元。随着置信度的提高，所造成的最大损失可能也显著增加，从95%到97.5%，增加2.5个百分点的把握需要增加100亿元的资金，而从97.5%到99%，增加1.5个百分点的把握需要增加200亿元的资金。然而，为了提高少许把握而需要增加巨额补偿资金是否合适，值得探讨。

5.3 台风巨灾风险区划与初始资金分配比例

5.3.1 指标选取

我国沿海11个省区的致灾因子、风险承受能力、经济发展水平各有差异，因此在台风巨灾保险基金初始份额的募集和后续费用缴纳时，应该综合考量不同区域的台风巨灾风险脆弱性水平。台风风暴潮灾害的脆弱性主要包括风险暴露和区域经济发展水平两部分。考虑到数据的可得性和各地的承灾能力，本文给出了脆弱性水平评价体系的所有指标，见表7。

表 7 台风巨灾脆弱性水平评价指标

分类	编号	指标		释义
风险暴露	X1	受灾人口（万人）		受自然因素控制的台风风暴潮灾害损失敏感性指标
	X2	受灾面积	农田（千公顷）	
	X3		水产养殖（千公顷）	
	X4	设施损毁	海岸工程（千米）	
	X5		房屋（间）	
	X6		船只（艘）	
	X7	直接经济损失（亿元）		
区域经济发展水平	X8	人均GDP（元）		个体抗风险能力
	X9	城镇居民家庭人均可支配收入（元）		
	X10	地方财政收入（万元）		社会总体抗风险能力
	X11	救灾支出占比		财政救灾负担指标
	X12	每万人口卫生床位数		医疗条件指标
	X13	高校毕业生人数占比		风险意识指标
	X14	保险密度		社会保障指标
	X15	保险深度		

风险暴露指标的数据来源于《中国海洋灾害统计报告》，区域经济发展水平的各项指标数据来源于各省、自治区历年统计年鉴。

5.3.2实证方法与原始数据处理

由于风暴潮灾害损失的数据具有样本小、数据少、多变量、数据不完整等特征，本文运用灰色关联度分析法对11个省区的风险脆弱性进行分析。具体过程包括将评价指标原始观测数进行无量纲化处理、计算关联系数、关联度以及根据关联度的大小对评价指标进行排序。

5.3.3 实证结果

根据上述步骤计算，得到排名结果如表8[11]。

表 8 脆弱性水平灰色关联度排名

省市	分辨系数=0.2		分辨系数=0.1	
	灰色关联度	灰色关联度排名	灰色关联度	灰色关联度排名
广东	0.9722	1	0.9478	1
海南	0.9675	2	0.9398	2

[11] 本文灰色关联度的计算使用南京航空航天大学灰色系统研究所开发的灰色建模软件。

浙江	0.9645	3	0.9329	3
福建	0.9624	4	0.9286	4
辽宁	0.9350	5	0.8808	5
上海	0.9284	6	0.8700	6
山东	0.9148	7	0.8481	7
广西	0.8927	8	0.8147	8
天津	0.7627	9	0.6584	9
河北	0.5042	10	0.3970	10
江苏	0.4735	11	0.3782	11

从表8可以看出，在分辨系数为0.2时，天津市、河北省和江苏省的综合关联度小于0.8，分辨系数为0.1时更是降到了0.7以下，说明这三个省市相对的台风巨灾风险脆弱性程度较低，所受损失较为有限。分辨系数为0.1和0.2时，广东、海南、浙江和福建四省份的关联度均超过了0.9，意味着其受台风巨灾损失影响较大，脆弱性程度较高。辽宁、上海、山东、广西四省市则处于中等水平。

因此，综合台风巨灾风险暴露水平和区域经济发展水平，可以将广东、海南、浙江、福建四省划定为缴费等级最高的A类地区，辽宁、上海、山东、广西四省市次之，划定为B类地区，而天津、河北、江苏三地的灰色关联度较小，划归为缴费等级最低的C类地区。

5.3.4台风巨灾保险基金的初始资金分配比例

兼顾公平和效率，对经济欠发达地区需要给予适当的优惠，在确定台风巨灾保险基金的初始资金分配比例时，取消对区域经济发展水平的逆化、倒数化处理，以体现“损失严重地区多承担、经济发达地区多承担”的原则。计算步骤和上述过程一致，最终得到的结果如表9。

表 9　初始资金分配灰色关联度排名

省市	分辨系数=0.2		分辨系数=0.1	
	灰色关联度	灰色关联度排名	灰色关联度	灰色关联度排名
广东	0.9794	1	0.9616	1
浙江	0.9775	2	0.9577	2
福建	0.9763	3	0.9556	3
海南	0.9737	4	0.9505	4
上海	0.9709	5	0.9457	5
辽宁	0.9658	6	0.9349	6
山东	0.9546	7	0.9176	7
广西	0.9123	8	0.8472	8
天津	0.7770	9	0.6869	9
河北	0.7103	10	0.5855	10
江苏	0.5520	11	0.4505	11

对比风险区划中的灰色关联度计算结果，发现海南省由原来的第二位下降到第四位，上海市由第六位提升到第五位。海南省的区域经济发展水平明显弱于排名靠前的其他省份，人均GDP和家庭可支配收入都接近各地区中的最小值，财政收入及个人抗风险能力有限，缺乏雄厚的财政资金支持，对跨区域型台风巨灾保险基金的建立需求更为迫切。

上海市排名上升是因为其强大的社会保障能力和雄厚的资金实力。上海人均GDP、家庭可支配收入都位列第一且与第二位差距明显，除此之外，充足的卫生医疗设施，强烈的风险保障意识等也是促使其排名上升的主要原因。

6. 结论和建议

6.1 研究结论

6.1.1 限于我国有限的保险市场供给能力和不完善的资本市场，本文认为应该建立以巨灾保险基金为核心的台风风险分散模式。鉴于国内现有模式存在保障水平低、个性化需求难以满足、政府负担重、承保灾种过多等问题，本文提出建立跨区域型台风巨灾保险基金。该基金具有充分分散台风风险、推动欠发达地区巨灾保险发展、更具针对性和专业性、在不同区域的子灾害中分散风险等优势。

6.1.2 跨区域型台风巨灾保险基金是以政府为主导，以市场为支撑，提供再保险为主要形式的非营利性台风单项巨灾保险基金。其根本目的是提高我国对台风巨灾风险的承保能力，全面覆盖台风风险，以保障居民财产安全，维护社会稳定。

6.1.3 对跨区域型台风巨灾保险基金的组织结构和运作方式进行了设计。其核心机构为基金管理委员会，下设董事会、监督审计委员会、各职能部门及外部监督机构，总部与各级子基金构成二元式多级组织形式。

6.1.4 对跨区域型台风巨灾保险基金的初始基金规模、资金分配方案、台风巨灾保险形式进行了探讨。通过实证模型的估算，得到初始基金规模在100亿元至110亿元之间，初始资金主要由广东、福建、海南、浙江、上海等地区分担，从而体现了效率兼顾公平的原则。

6.1.5 根据实证研究的结果，将沿海11个省区划分为A、B、C三个缴费等级。通过对历史台风损失数据的研究，得到台风损失强度满足形状参数为-0.06928，尺度参数为0.693，阈值为3.65的广义帕累托分布，超过阈值的损失数据服从参数为1.48的泊松分布，台风平均年度损失期望值为108.83亿元。本文从风险暴露和区域发展水平两个角度，采用灰色关联度法对11个受灾地区进行风险区划，将广东、海南、浙江、福建定位缴费等级最高的A类地区，上海、辽宁、山东、广西次之为B类地区，天津、河北、江苏为缴费等级最低的C类地区。

6.2 政策建议

6.2.1 尽快建立、完善巨灾保险相关法律法规。我国《保险法》中对巨灾保险业务的开展并未做出明确规定，法律真空状态对巨灾保险的发展极为不利，应尽快制定明确、详细的法律条文，以引导商业保险公司提供符合市场需求的巨灾保险产品，为巨灾保险业务的开展提供有利的制度环境。

6.2.2 政府必须积极参与基金运作的各个环节，各级政府为台风巨灾基金的设立募集初始资金的同时，必须为基金提供强大的政府信用，以保证能在资本市场乃至国际市场上进一步分散风险，并且应给予跨区域型台风巨灾保险基金相应的优惠政策。

6.2.3 建立完善的台风巨灾损失数据库。必须加大针对台风灾害的科研力度，确保台风发生频率和强度的有效预测，为台风巨灾保险的开展提供理论支撑，为保险公司开发创新台风保险产品提供技术支持。

6.2.4 加快推动资本和保险市场发展。鼓励资本和保险市场发展与竞争，为非传统性风险转移工具的创新提供发育土壤，让更多的投资者以不同的形式参与到台风巨灾风险的分散和转移中来，开拓更丰富、多样的台风巨灾风险融资方式，开发出满足市场需求的台风巨灾保险产品。

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跨区域型台风巨灾保险基金设计

周延　屠海平

周延*
教授
华东师范大学 经济与管理学部
上海 200241，中国
电话: 136 6157 9199
Email: sdzhouyan@163.com

屠海平
硕士研究生
华东师范大学 经济与管理学部
上海 200241，中国
电话: 159 2191 1093
Email: 627799407@qq.com

关键词：跨区域型; 台风巨灾; 巨灾保险基金; 损失规模测度

中文摘要.巨灾保险基金作为分散巨灾风险的重要手段，已经引起政府和社会各界的广泛关注，并且深圳和宁波已于2014年陆续建立了巨灾风险分散制度，但限于该制度对政府资金的过度依赖性，很难在全国范围内推广。因此，本文通过对比分析现有巨灾风险分散模式及存在的问题，提出了建立跨区域型台风巨灾保险基金的具体设计方案，并运用实证研究的方法，对11个沿海地区的台风风险进行区划，进而根据各地区的经济发展水平制定初始资金的分配比例，最后给出结论和政策建议。

Chapter 6. Actuarial Science

Empirical Analysis of the Basic Medical Insurance System's Influence on Residents' Happiness in China

LIU Chao, LING Wei

LIU Chao*
Associate Professor
School of Mathematics and Systems Science
Beihang University
Beijing 100191, China
Phone: 13141202037
Email: statchao@buaa.edu.cn

LING Wei
M.S. Candidate
School of Mathematics and Systems Science
Beihang University
Phone: 15010792118
Email: lingwei@buaa.edu.cn

Keywords: Basic medical insurance system, Life satisfaction, Social justice sense, Income Inequality, Hierarchical Linear Model.

Abstract. This paper investigates the influencing mechanism of whether having the basic medical insurance on residents' life satisfaction and social justice sense with CGSS2013 micro research data and hierarchical Linear Model. The results include: (1) Basic medical insurance improves residents' life satisfaction and social justice sense significantly. (2) The improvement of residents' life satisfaction from basic medical insurance isn't influenced by the regional income inequality. In the regions with different income inequality degree, having the basic medical insurance all shows the positive influence on residents' life satisfaction. (3) The improvement of residents' social justice sen-se from basic medical insurance significantly influenced by the regional income inequality. In the social structure with low income inequality degree, having the basic medical insurance still improves residents' social justice sense. However, having the basic medical insurance inhibits residents' social justice sense in the social structure where income inequality degree is high and the "inhibition gradient" of the basic medical insurance on residents' social justice sense will be steeper with higher regional economic inequality. The above results remains valid after introducing omitting variables which might affect individual's emotion into the model.

1．引言

随着社会主义市场经济体制的确立和国有企业改革的不断深化，我国原有的保险制度已难以解决市场经济条件下的居民基本医疗保障问题，国务院于1998年12月下发了《国务院关于建立城镇职工基本医疗保险制度的决定》，部署了全国范围内全面推进职工医疗保险制度改革工作。尤其是近年来，随着我国各地区的基本医疗保险体系的不断完善，居民的身体健康得到了更多的保障，家庭负担也得到了减轻，居民的幸福感也在不断提升，2015年发布的盖洛普《全球幸福国家排行榜单》显示，我国居民的综合生活满意度排名较高，在145个国家和地区中排名31位，而2010年还仅位列第125位。然而，随着改革深入，社会不平等、贫富分化、城乡差距拉大等社会问题渐趋严重。人们对生活状况的主观评价不再仅仅局限于物质保障生活上的满意程度，也越来越关注所处的社会环境公平与否。只关注医疗保险等社会保障制度的发展而忽视公民对社会公平的真实感受，必然会导致发展的片面化。如果公民对社会公平度评价较低,就会导致其经济压力加剧和伴随而来的心理压力加剧,社会风险就会从这一群体中发生,在合适的外在条件下可能演化为激烈的矛盾冲突,这种社会冲突会进一步阻碍社会经济的有效增长。近年来的全国性调查也显示，社会公平和收入差距问题已被公众广泛认为应该得到政府和社会的更多重视。建立良好的社会交往关系以及适应社会发展的要求来促进经济的发展，是今天中国经济社会发展的一个重要的课题。因为人们彼此之间的良好互动、积极乐观的社会心态是社会稳定的根本。在积极乐观的心态占主导时，能够产生“正能量”，促进社会进步；而在消极负面的心态下，容易不断放大并阻碍社会发展，则不利于社会稳定发展，从而导致社会福利下降。

我国经济正逐渐进入新常态的发展阶段，伴随着医疗保障体系的不断完善，人们是否也会在对生活满意的同时感知到了更多的社会公平呢？进一步来看，不断扩大的贫富差距是否会影响医疗保障制度和它们之间的关系？本文采用中国综合社会调查（China General Social Survey，简称CGSS）2013年的调查数据，基于地区收入不平等的视角，考察了基本医疗保险制度对我国民众生活满意度和社会公平感的影响机制。

2．数据、变量与模型

2.1 模型设定

考虑到不同地区的经济发展水平和收入不平等程度参差不齐，因此，本文采用分层线性模型（Hierarchical Linear Model）对我国居民的生活满意度和社会公平感进行分析。首先，我们只使用是否参与了基本医疗保险对居民的生活满意度

和社会公平感建立无第二层预测变量的随机效应分层线性模型，从整体上考察基本医疗保险制度对它们的影响,具体的模型形式为：

$$y_{ij} = (\beta_{0j} + \beta_{1j} insurance + controls) + \varepsilon_{ij} \tag{1}$$

$$\beta_{0j} = \gamma_{00} + \mu_{0j}, \beta_{1j} = \gamma_{10} + \mu_{1j} \tag{2}$$

其中，β_{0j} 为第一层模型的截距项，β_{1j} 第一层模型中基本医疗保险的回归系数，代表参与了基本医疗保险对于居民生活满意度和社会公平感的影响趋势，*controls* 为可能会影响个体情感的遗漏变量的影响。与传统OLS回归不同的是，第一层模型中的截距 β_{0j} 和基本医疗保险的回归系数 β_{1j} 都不是固定而是随机的，两者的随机性体现在第二层模型中。γ_{00} 和 γ_{10} 分别为 β_{0j} 的固定截距和 β_{1j} 的固定斜率部分，代表 β_{0j} 和 β_{1j} 没有随地区经济发展水平差异而变化的部分，μ_{0j} 和 μ_{1j} 则分别是由于不同地区间经济发展水平存在差异而在第一层模型截距项 β_{0j} 和基本医疗保险的回归系数 β_{1j} 上产生的随机扰动项。

其次，我们希望进一步考察在收入不平等程度不同的地区中基本医疗保险制度对居民生活满意度和社会公平感的影响是否存在差异。为此，我们计算了各省及直辖市地区的居民收入基尼系数，2013年的CGSS调查数据包括了28个省及直辖市的样本。我们首先根据每个地区的受访者样本求得百分比收入的人数比例函数 $p(x)$，其中 x 为个人收入除以最高收入，$p(x)$ 即百分比收入为 x 的样本数占总样本数的比例，基尼系数则可以通过下式计算得到：

$$Gini = \frac{1}{2}(\int_0^1 p(x)dx - \frac{1}{2}) \tag{3}$$

接着，我们将各地区的基尼系数加入到第二层模型中，此时第二层模型的形式为：

$$\beta_{0j} = \gamma_{00} + \gamma_{01} Gini + \mu_{0j}, \beta_{1j} = \gamma_{10} + \gamma_{11} Gini + \mu_{1j} \tag{4}$$

进一步将(4)式代入到第一层模型(1)式中可以整理得到(5)式：

$$y_{ij} = \gamma_{00} + \gamma_{10} insurance + \gamma_{01} Gini + \gamma_{11} insurance \times Gini + (\mu_{0j} + \mu_{1j}) \tag{5}$$

其中 γ_{11} 代表了是否参与了基本医疗保险与地区收入不平等间的交互效应对居民生活满意度和社会公平感的影响。如果 $\gamma_{11} = 0$ 则说明收入对居民的生活满意度或社会公平感的影响不因地区收入不平等程度的不同而发现变化；如果 $\gamma_{11} \neq 0$ 则说明在收入不平等程度不同的地区，基本医疗保险制度对居民生活满意度或社会公平感的影响存在显著差异。

2.2 数据和变量

本文的数据源自于中国人民大学的中国综合社会调查数据。该调查2013年在全国一共抽取100个县（区），调查480个村/居委会，每个村/居委会调查25个家庭，每个家庭随机调查1人，加上北京、上海、广州、深圳和天津5个大城市，作为初级抽样单元，总样本量约12000人。2013年的CGSS问卷设计了相应问题来调查居民的生活满意度和社会公平感。关于生活满意度的相关问题是“总的来说，您觉得您的生活是否幸福?”，选项范围从1-5，其中1=非常不幸福；2=比较不幸福；3=说不上幸福不幸福；4=比较幸福；5=非常幸福。关于社会公平感的相关问题是“总的来说，您认为当今的社会公不公平?”，选项范围从1-5，其中完全不公平=1；比较不公平=2；说不上公平但也不能说不公平=3；比较公平=4；完全公平=5。在解释变量上，除了本文关注的受访者是否参与了基本医疗保险外，我们还使用了受访者提供的收入水平、教育程度、性别、政治面貌、户口、民族、社交活动、基本健康保险、有无子女、是否肥胖[1]等在分析中需要控制的要素，以及地区收入不平等性因素[2]。由于原始数据中的一些样本数据存在不同程度的变量缺失情况，因此我们将缺失值数量大于全部变量数15%的受访者样本进行删除，其余数据用随机森林插补方法（Random Forest Interpolation Method）进行了插补。对原始数据进行删除和插补后得到有效样本10189条，数据清洗前后生活满意度和社会公平感的分布情况如表1所示，可以看到这样的处理方法使得它们的分布情况在清洗前后几乎没有差异。表2给出了数据清洗后全部变量的描述统计情况。

表1　　数据清洗前后生活满意度和社会公平感的分布情况

变量	变量取值	清洗前分布（%）	清洗后分布（%）
生活满意度	比较幸福或非常幸福	0.723	0.720
	说不上幸福不幸福	0.187	0.189
	比较不幸福或非常不幸福	0.090	0.090
社会公平度	比较公平或完全公平	0.404	0.405
	说不上公平但也不能说不公平	0.235	0.234
	比较不公平或完全不公平	0.361	0.361

表2　　变量的定义和描述统计

变量	变量的描述和定义	最小值	最大值	均值	标准差
生活满意度	连续变量，数字1-5分别表示“非常不幸福、比较不幸福、说不上幸福不幸福、比较幸福、非常幸福”	1	5	3.75	0.84
社会公平感	连续变量，数字1-5分别表示“完全不公平、比较不公平、说不上公平但也不能说不公平、比较公平、完全公平”	1	5	3.00	1.04

[1] CGSS2013中提供了被访者的身高和体重数据，可通过计算体重(kg)/身高(m)^2得到被访者的BMI指数，如果BMI指数大于28，可认为被访者属于肥胖体型。

[2] 地区的收入不平等程度通过各省及直辖市的收入基尼系数来衡量，每个地区的收入基尼系数基于地区居民样本的年收入和（3）式计算得到。

基本医疗保险	分类变量，是否参与了社会基本医疗保险(1=是，0=否)	0	1	0.90	0.30
收入不平等	连续变量，用基尼系数定义	0.24	0.60	0.50	0.08
收入水平	连续变量，用年收入的对数定义	0.44	13.82	9.39	1.45
教育程度	分类变量，是否上过大学 (1=大学及以上学历，0=没有上过大学)	0	1	0.08	0.28
性别	分类变量(1=女性，0=男性)	0	1	0.47	0.50
政治面貌	分类变量，是否为党员(1=党员，0=非党员)	0	1	0.11	0.31
民族	分类变量，是否为汉族(1=汉族，0=少数民族)	0	1	0.91	0.28
户口	分类变量，是否为城镇户口(1=城镇，0=农村)	0	1	0.46	0.50
社交活动	分类变量，是否经常参加社交活动(1=经常参加，0=很少参加)	0	1	0.27	0.44
肥胖	分类变量，是否肥胖(1=肥胖，0=不肥胖)	0	1	0.06	0.23
子女	分类变量，是否有子女(1=有子女，0=无子女)	0	1	0.87	0.33

3．实证结果

表3给出了我国居民生活满意度和社会公平感的分层线性模型估计结果。其中，模型1是只使用参与了基本医疗保险对两者分别建立的随机效应模型，模型2在模型1的第二层中引入了代表地区不平等程度的基尼系数指标，同时我们将各地区的基尼系数按照全部基尼系数的均值进行了中心化处理（grand mean centered）。模型3中进一步引入了可能会影响个体情感的遗漏变量，以尽量消除变量遗漏带来的估计偏差，从而验证模型2结论的可靠性。

我们可以观察到：

表3　　2013年我国居民生活满意度和社会公平感的分层线性模型估计结果

被解释变量	生活满意度			社会公平感		
自变量	模型1	模型2	模型3	模型1	模型2	模型3
参与了基本医疗保险	0.154***	0.152***	0.125***	0.135***	0.018**	0.012**
基尼系数		-0.399	-0.129		0.803	0.29
参与了基本医疗保险*基尼系数		-0.162	-0.182		-1.212***	-1.509***
受过大学教育			0.043*			-0.068*
女性			0.073***			0.018*
共产党员			0.135***			0.133***
城镇户口			0.018			-0.153***
汉族			-0.149***			-0.120***
经常参与社交活动			0.160***			0.079***
年收入对数			0.050***			-0.020**
有子女			0.003			0.091***
肥胖			0.018			-0.01
截距项	3.762***	3.762***	3.761***	2.997***	2.996***	2.993***
基本医疗保险系数的随机项	0.079***	0.085***	0.085***	0.048***	0.037***	0.035***
随机截距项	0.167***	0.168***	0.167***	0.183***	0.177***	0.160***

（1）在模型1中，参与了基本医疗保险对居民的生活满意度和社会公平感都为正向影响。这说明基本医疗保险制度的完善总体上提高了居民的生活幸福感和并且加强了人们对社会公平的认可程度。

（2）第二层模型中的随机截距项及参与了基本医疗保险系数的随机项的估计结果均为显著，这说明经济发展水平不同的地区，居民的生活满意度和社会公平感存在显著差异，同时基本医疗保险的建立和完善对居民生活满意度和社会公平感的影响也因地区的不同而产生了变异。

（3）在生活满意度的模型2和模型3中。参与了基本医疗保险和地区基尼系数的交叉项系数均不显著，这说明无论是在贫富差距较大还是较小的地区，参与基本医疗保险都会显著提升居民的生活满意度。而在社会公平感的模型2和模型3中参与了基本医疗保险和地区基尼系数的交叉项系数均显著为负，这说明在贫富差距较为悬殊的地区，参与了基本医疗保险的居民反而会感知到更多的的社会不公，意味着社会保障体系对居民社会公平感的影响会受到宏观经济中的收入不平等现象地极大左右。该结论可以通过下面的图1和图2得到更加直观的展现。

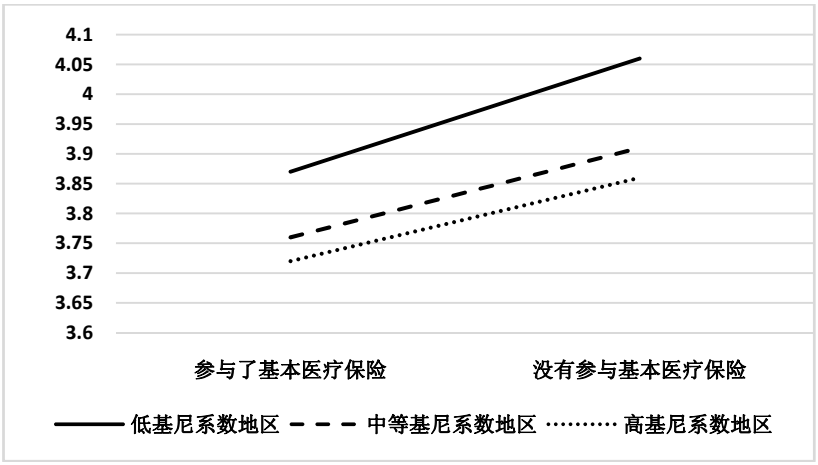


图1 不同地区居民是否参与了基本医疗保险与生活满意度的关系图

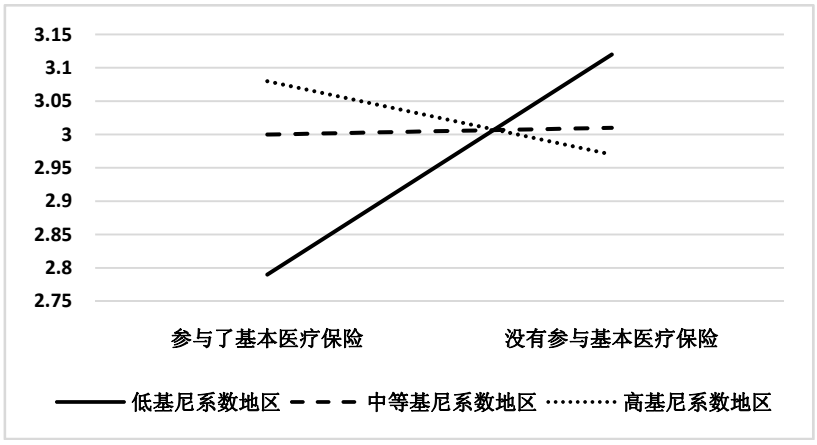


图2 不同地区居民是否参与了基本医疗保险与社会公平感的关系图

注:图1和图2中的不同直线分别是将各地区基尼系数的最小值、均值和最大值均值中心化后（grand mean centered）带入表3中生活满意度和社会公平感的模型2中得到的投影直线，
其中横坐标表示居民是否参与了基本医疗保险，纵坐标表示生活满意度和社会公平感的取值由低至高。

（4）控制变量上也提供了一些信息。具体来说：收入水平和教育程度的提升会提高居民的生活满意度但也降低了居民的社会公平感，这可能是因为收入水平和教育程度较高的居民虽然物质生活较为富足但是往往也会感知到更多的社会不公现象；相对男性而言，女性通常面对相对较小的生活压力和较低的社会责任，因此容易感受到生活满意以及社会公平；相对农村居民，城镇居民能够拥有更多渠道了解社会不公现象，因此会降低其社会公平感；相对汉族居民，少数民族居民的生活满意度和社会公平感都更高一些，这可能是民族保护政策给少数民族居民带来了更强的社会认同感；经常参加社交活动以及党员身份都会增强居民的生活满意度和社会公平感。

4．结论与启示

基于CGSS2013的调查数据对我国居民生活满意度和社会公平感的分析，我们发现尽管随着我国社会基本医疗保险体系的不断完善，居民的生活满意度得到了大幅度的提升，但是对居民社会公平感的影响却在收入不平等程度不同的地区存在显著差异。为什么地区收入不平等会导致基本医疗保险制度对于居民社会公平感的影响出现差异呢？通常人们把不平等当成是社会分化，即收入不平等反映了社会的等级程度。在收入差距较大的地方，社会等级也较为明显，即收入不平等反映了社会的等级程度。这种社会等级现象导致了地区社会保障水平对于居民社会公平感“负向影响梯度”的出现。当一个地区的社会不平等程度越高，这个地区的社会保障水平对于居民社会公平感的“负向影响梯度”也就越陡峭。由于人们对于地区社会公平的感知通常来源于居民对社会福利和社会保障分配结构的评价，因此我们常常简单地将完善社会保障体系作为改善人们生活水平、调节居民社会心态的核心手段。如果只单纯强调基本医疗保险等社会保障制度的推广，而忽视不断扩大的贫富差距带来的分配不公平等问题，这就会导致社会保障措施对于居民社会公平感的“调节梯度”会因为地区贫富差距的扩大而受到极大的抑制，当地区的收入结构处于高度不平衡状态时，社会保障水平与居民对社会公平的感知就会呈现显著的负向关系，这也许是收入高度不平等地区的社会矛盾相比经济发展较为平衡地区更为突出的重要原因之一。

综合以上分析，我们认为，收入的高度不平等是导致参与基本医疗保险反而会抑制居民社会公平感的关键结构性因素。在贫富差距较小的地区，社会的等级分化相对不明显，社会保障和福利的分配较为公开和透明。从而使基本医疗保险等制度的推广不仅可以提升居民在物质生活上的幸福感同时也加强了人们对社会公平的感知，这符合社会发展的客观规律，只有当完善的社会保障措施能够带

动提升居民的生活满意度和社会公平感，才会调动人们的工作积极性，推动社会经济的快速发展，同时反过来进一步加强人们的社会认可，形成一个良性的社会结构体系。而在贫富差距较大的地区，社会等级分化也较严重，社会福利和保障的分配结构存在大量的不公平现象，而这些不公平现象往往更容易被社会保障体系中的参与者所感知，这就可能降低人们工作的积极性，主动性，创造性，使本来生机盎然的经济很大程度上失去了活力。我国当前正处于社会转型的关键时期，贫富差距的存在是合理而且是必需的。因为在市场经济条件下，竞争是必然存在的，不可能搞平均主义。有差距的存在才会产生竞争，促进社会的发展。但是过大的贫富差距会使得基本医疗保险等社会保障制度的推广反而降低了地区居民对社会公平的感知。因此除了进一步完善地区基本医疗保险等社会保障制度，当务之急是大力推广那些减少社会收入不平等的收入再分配政策，例如阶梯式的税收制度、贫困社会保障制度等。这对维持地区的公平正义和持续稳定的发展有着非常积极的作用。

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基本医疗保险制度对居民幸福感影响的实证分析

刘超 凌巍

刘超*
副教授
北京航空航天大学数学与系统科学学院
北京100191，中国
电话：13141202037
Email：statchao@buaa.edu.cn

凌巍
硕士研究生
北京航空航天大学数学与系统科学学院
电话：15010792118
Email：lingwei@buaa.edu.cn

关键词：基本医疗保险制度；生活满意度；社会公平感；收入不平等；分层线性模型

中文摘要. 本文使用2013年CGSS微观调查数据，采用分层线性模型从地区经济发展结构性差异的角度考察了基本医疗保险制度对我国居民的生活满意度与社会公平感的影响机制。研究显示：（1）从全国地区来看，参与基本医疗保险对我国居民的生活满意度和社会公平感都有显著的提升作用。（2）参与基本医疗保险对我国居民生活满意度的提升作用没有受到地区收入不平等的影响，在贫富差距不同的地区，参与基本医疗保险都提升了居民的生活满意度。（3）参与基本医疗保险对我国居民社会公平感的影响在收入不平等程度不同的地区存在显著差异。在贫富差距较小的社会结构中，参与基本医疗保险能够提升居民的社会公平感，但是在贫富差距较大的社会结构中，参与基本医疗保险反而会抑制居民的社会公平感，而且随着地区收入不平等程度的增高，参与基本医疗保险对居民社会公平感的“抑制梯度”也越陡峭。上述结果在模型中引入了可能会影响个体情感的遗漏变量之后依然成立。

An Examination of Herding Behavior in Insurer Underwriting

REN Yayuan
Associate Professor
College of Business
Illinois State University
Normal, IL, 61791, USA
Phone: (01) 309 438 7779
Email: yren2@ilstu.edu

Keywords: Herding, Underwriting
Abstract. In this paper I investigate the underwriting activities of property-casualty insurers in United State from 2001 through 2015 to determine whether insurers herd in underwriting. I particularly examine whether insurance underwriting movements are due to adjustments for fundamental changes or over-adjustments resulted from herding. I find that fundamental changes cannot fully explain the movements of insurer underwriting and that insurers tend to follow their peers to increase or decrease underwriting. Insurers are also fund to be more responsive to the herd of supply cutting than the herd of supply expanding. Further more, herding imposed greater impact on large firms and small firms (compared to medium-size firms), mutual firms and young firms. Firms of larger size and older age are more likely to be part of the herd.

1. Introduction

Policymakers often express concerns that herding by financial market participants destabilizes markets and increases the fragility of the financial system. Many market failures such as excess market volatility, bubbles and the emerging market meltdowns are considered attributed to the phenomenon of herding. The property-casualty insurance market is known to alternate between soft markets and hard markets. Insurers are known to expand insurance supply and compete for market share in soft markets and limit underwriting in hard markets. Do insurers herd to increase or decrease underwriting in soft and hard markets? Are the insurance underwriting movements due to adjustments for fundamental changes, or over-adjustments resulted from herding? Such questions are essential to understanding insurer underwriting and the underwriting cycle, which motivates this study.

Do Insurers Herd in Underwriting?

The term "herding" broadly refers to a tendency of many agents to take similar actions at the same time (Sia, 2004; Jegadeesh, 2010). Bikhchandani and Sharma (2000) emphasize that herding is an obvious intent by agents to imitate the behavior of other

agents. That is, for an individual to imitate others, she must be aware of and be influenced by other actions. This should be distinguished from "spurious herding" where groups facing similar information sets take similar decisions. Their information may be similar either because they all independently acquired information that happened to be correlated, or they may have rationally learned information from their peers' actions. This spurious herding would not have the destabilizing effect especially when they all react to the same fundamental changes in a timely manner. On the other hand, if herding is driven by a desire to imitate the actions of others, then herding forces may move price away from fundamentals and lead to excess volatility in price. For example, if the collective underwriting cut by many insurers in hard markets is solely resulted from a loss shock or capital deficiency, this would be an efficient outcome. On the other hand, intentional herding by insurers in underwriting cut would lead to over-adjustment and inefficiency. In this paper, we raise the question whether the insurance price movements along the underwriting cycle are due to adjustments for fundamental changes, or, to some extent, due to over-adjustments resulted from herding, which to my knowledge has not been directly addressed in prior research.

Do insurers herd in underwriting? Although by far it is an unanswered question without empirical investigations, prior studies in insurance indicate different predictions to the question. Among many studies on the causes of the underwriting cycle,[1] a notable work by Lai et al. (2000) suggests that the market-wide insurance price movements are mainly resulted from the changes of expectations on fundamental factors. This theory posits that the changes of expectation on interest rate, future losses and expenses to much extent affect the underwriting. It is suggested that the collective underwriting movement by insurance companies is largely a rational reaction to the changes of fundamentals.

In contrast, Harrington and Danzon (1994) and Harrington (2004), in their explanation of the fluctuations of insurance price, propose a hypothesis that the herding behavior among insurers results in mispricing and aggravates the underwriting cycle. They suggest that some insurers may have priced below cost because of moral hazard that is resulted from limited liability and risk-insensitive guaranty programs or low loss forecasts relative to optimal forecasts, giving rise to winners' curse effects. Other insurers could cut prices in response to such aberrant firms to preserve market share and avoid loss of quasi-rents from renewal business related to investments in tangible and intangible capital. As a result, aberrant behavior by some firms could aggravate price competition during soft markets, which contributes to the supply cut in the subsequent hard market.

While Lai et al. (2000) implies that underwriting movements are adjustment for fundamental changes, Harrington and Danzon (1994) suggests that irrational herding

[1] For example, the capacity constraint theory (Gron, 1994; Winter, 1988, 1991, 1994; Cummins and Danzon, 1997) suggests that the cyclical premium adjustments reflect changes in insurer surplus that affect the industry's capacity for bearing risk. The institutional intervention theory proposed by Cummins and Outreville (1987) posits that the informational lags in data collection, regulation, and policy renewals lead to the cyclical performance. The interest rate theory (e.g. Doherty and Kang, 1988; Doherty and Garven, 1995) relates the underwriting cycles to the fluctuations in interest rates. The under-pricing theory (e.g. Harrington and Danzon, 1994; Harrington, 2004) suggests that the competition-induced excessive price cutting in soft market contributes to the overpricing in the subsequent hard market. Moreover, Lai et al. (2000) develop a multi-factor model to explain the underwriting cycle and emphasizes the role of expectation changes in generating a cycle.

among insurers contribute to mispricing and the volatility of insurance price. Neither of them, however, empirically examines the role of herding in underwriting.

The Causes of Herding Behaviors

Why do individuals herd? There has been substantial theoretical and empirical literature that explores the issue and offers several potential reasons. The most important of these are imperfect information, concern for reputation, and compensation structures of agents. Information-driven cascade models (Bikhchandani et al. 1992; Welch, 1992) show that with the assumption that agents can observe each other's actions but not the private information or signals that each player receives, later agents, inferring information from the actions of prior agents, optimally decide to ignore their own information and act alike. Once a cascade starts, public information stops accumulating. The information externality leads to an inefficient outcome.

The reputation theory of herding (Scharfstein and Stein, 1990; Rajan, 1994; Zwiebel, 1995) shows that a manager, in order to preserve or gain reputation, may prefer to follow the market consensus. This benefits the manager, and if other investment professionals are in a similar situation then herding occurs.

Maug and Naik (1996) and Bernnan (1993) provide another theory of herding. They show that if an agent's compensation depends on how her performance compares to other agent's performance, then the risk-averse agent has an incentive to imitate the benchmark action, and may end up with an inefficient portfolio. For more discussion on the literature regarding herding, refer to Devenow and Welch (1996), Bikhchandani and Sharma (2001), and Hirshleifer and Teoh (2003).

Why may insurers herd in underwriting? The incentives discussed above may all apply to insurers. The two key assumptions in the informational cascade model are the uncertainty about the payoff of investment and the imperfect information about market participants. The uncertainty nature of insurance risk and insufficient information in risk pricing gives ground to insurers following their peers to increase or cut underwriting. The managers of insurance company may have incentives to follow the herd of underwriting changes in order to preserve their reputation or to maximize their own compensations. Furthermore, as indicated by Harrington (2004) the competition pressure also provides incentive for insurers to herd to cut price in order to preserve and expand their market shares. For these reasons, I suspect that insurers may, at least to some extent, herd in underwriting.

Drawing from the literature, I test two hypotheses in this paper: (1) The insurance underwriting movements are adjustments for fundamental changes, and (2) The insurance underwriting movements are over-adjustments resulted from herding. We call the former "Adjustment Hypothesis" and the latter "Herding Hypotheses." The two hypotheses are not necessarily competing with each other. The significant price movements may be caused by multiple factors. Therefore, it is an empirical issue to examine to what extent each of such factors, fundamental changes and herding, contributes to the underwriting movements.

To test above hypotheses, we first develop a measure to capture herding in insurance underwriting. The measure, inspired by Lakonishok et al. (1992) and Wermers (1999), is based on the portion of the insurers that increase (decrease) insurance price. Although empirically it is difficult to identify and distinguish among the causes of herding, it should be possible to separate out spurious herding from intentional herding by explicitly allowing for changes in fundamentals. If after factoring out the effect of

fundamentals, I still find herding in the data, then intentional herding is likely to exist. To differentiate "spurious" herding from intentional herding, the measure is then regressed on fundamental variables, and the resulted residual values of the regression are used to capture the true herding.

With the measures of herding, we are able to examine whether herding plays a role in insurance underwriting. The empirical results support the Herding hypothesis—fundamental changes cannot fully explain insurance price changes, and insurers tend to follow the herd to lower or raise insurance price. Furthermore, we also find that insurers have higher propensity to follow the herd of decreasing underwriting than the herd of increasing underwriting. Moreover, large and small firms (compared to medium-size firms), mutual firms and young firms are found more subject to the impact of herding. Lastly, I find that firms size, age and leverage are shown to have impact on insurers' decisions to herd.

The rest of the paper is organized as follows. Section 2 describes the sample and data. The mythology of empirical tests and model results are presented and discussed in Section 3. Section 4 concludes.

2. Sample and Data

I investigate the role of herding in underwriting for property-casualty insurers in United States. The primary data source is the database of statuary financial statements of insurance companies provided by SNL Financial. Quarterly data are available from 2001 to 2015. The final sample covers the period 2001 to 2015 and consists of 15214 observations for 2124 insurance companies. The firms in the sample are affiliated and unaffiliated individual companies. About seventy percent of the insurers in the sample are stock companies. The industry-level data, such as combined ratio, investment return and market concentration, are obtained from SNL database of aggregated statistics for insurance markets. The interest rate and GDP data are published by U.S. Department of Treasury and U.S. Bureau of Economic Analysis.

3. Methodology and Empirical Results

3.1 Measures of Herding

To test the two hypotheses, I first develop a measure of herding. Prior studies have proposed many herding measures mostly for the stock market and investors.[2] Our measure is inspired by that used in Lakonishok et al. (1992) and Wermers (1999).

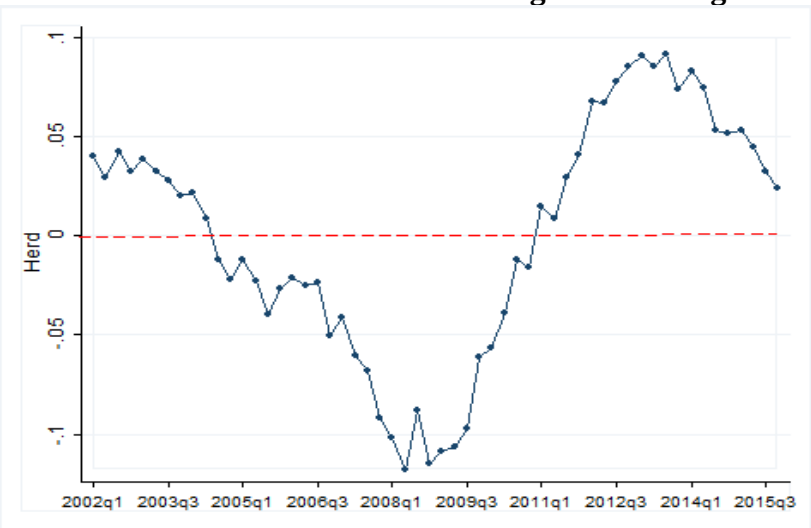
It takes two steps to construct our measures of herd. In the first step, measures are constructed to capture the propensity of herd based on the portion of firms change underwriting toward to the prevailing. HM_t is defined as the preliminary measure of herding as shown in Equation 1. To differentiate the direction of herding, we define IHM_t as the preliminary measure of herding to increase underwriting, and DHM_t as the preliminary measure of herding to decrease underwriting, which are expressed as

[2] For example, Lakonishok, Shleifer, and Vishny (1992) and Wermers (1999) develop a measure of herding in stock market based on changes in the number of buyers and sellers. Nofsinger and Sias (1999) use the proportion of institutional ownership to measure herding. Chang, Cheng and Khorana (2000) and Christie and Huang (1995) employ cross-sectional standard deviation of stock returns to detect herd behavior in a market setting. Hwang and Salmon (2004) develop a measure of herding in a market based on the cross-sectional variance of beta.

$$HM_t = I_t - E[I] \quad (1)$$
$$IHM_t = I_t - E[I] \mid I_t > E[I] \quad (2)$$
$$DHM_t = D_t - E[D] \mid ID_t > E[D] \quad (3)$$

where I_t is the proportion of all insurers that increase insurance underwriting, and D_t is the proportion of all insurers that decreases insurance underwriting in year t. Figure 1 displays the time series of I_t, which visualizes the volatility of underwriting movement over the sample period. $E[I]$

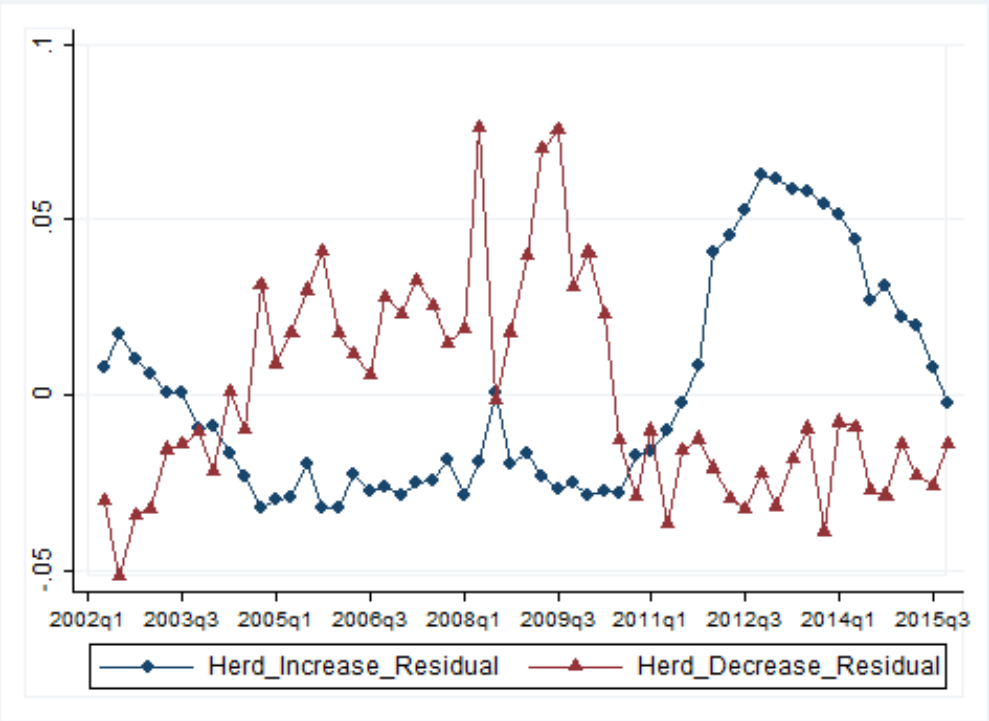
Figure 1 The Portion of Insurers Increasing Undewriting over Time



and $E[D]$ are the average proportion of insurers increasing and decreasing underwriting over the sample period. Insurance underwriting by firm *i* in year *t*, is measured as net premiums written.

To test the two hypotheses, it is critical to empirically differentiate between co-movements reacting to changes in fundamentals and correlated behavior due to intentional herding. In the second step, therefore, we regress the herding measure developed in step one on the changes of macro-fundamental factors including the changes of industry combined ratio, investment return rate, concentration ratio, one-year yield of Treasury bill and GDP, and then use the residuals from the regression to capture the degree of insurer intentional herding. In this way, we remove the effect of fundamental adjustments from HM_t, IHM_t and DHM_t. The resulted measures of herding are denoted as $HERD_t$ $HERD_INCREASE_t$ and $HERD_DECREASE_t$. The time-series trends of $HERD_INCREASE_t$ and $HERD_DECREASE_t$ are displayed in Figure 2. As shown in Figure 2, $HERD_INCREASE$ peaks during the period 2012-2014, which is known to be a soft market period, while $HERD_DECREASE$ is highest during the hard market of 2008-2010.

Figure 2 Herding Measures Over Time



3.2 Do Insurers Herd in Underwriting?

With the measures of herding, we are able to test the research hypotheses by incorporating the measures of herding into the insurance underwriting model. The insurance underwriting model used in the paper is very similar to the one in Lai et al. (2000) in terms of the selection of determinant factors in insurance underwriting.

$$\text{Dependent Variable}_{it} = \text{Herding Measures} + f(\text{COMBINED_CHANGE}, \text{LOSS_CHANGE}, \text{EXP_CHANGE}, \text{INV_CHANGE}, \text{LIQUIDITY}, \text{LEVERAGE}, \text{SIZE}, \text{AGE}, \text{STOCK}, \text{AFFILLIATE})_{it} \quad (4)$$

where Dependent Variables is the ratio of net premium written change relative to the same quarter of year t-1. The herding measure of $HERD_t$, $HERD_INCREASE_t$ and $HERD_DECREASE_t$ are defined in the earlier section. The other variables are defined as follows

PREM_GROWTH	=	Net premium written growth over the same quarter of year t-1.
COMBINED_CHANGE	=	Percentage change of combined ratio from quarter t to quarter t-1 ;
LOSS_CHANGE	=	Percentage change of loss ratio from quarter t to quarter t-1 ;
EXP_CHANGE	=	Percentage change of expense ratio from quarter t to quarter t-1 ;
INV_CHANGE	=	Percentage change of net yield on the invested assets from quarter t to quarter t-1 ;
LIQUIDITY	=	Net admitted cash and short-term assets as percentage

of total liabilities;
LEVERAGE = Total liability divided by surplus;
SIZE = Logarithm of total assets;
STOCK = 1 if stock company, otherwise 0;
AGE = Current year minus year of found;
AFFILATE = 1 if affiliated, otherwise 0

If insurers adjust underwriting only because of changes in fundamentals, then the coefficients of HERD, HERD_INCREASE (HERD_DECREASE) should be insignificant in model (4). On the other hand, a significant HERD, HERD_INCREASE (HERD_DECREASE) would suggest evidence supporting the herding hypothesis. We estimate the coefficients using panel data fixed-effect models. While both fixed-effect and random-effect models generate very similar results, we report the results of fixed-effect models because Hausman's test suggests that fixed-effect models are superior to random-effect models. The constant firm specific variables STOCK and AFFFILIATE, however, are not estimable in fixed-effect models. Therefore, the coefficients of these variables are estimated using random-effect models. Moreover, to account for serial correlation in underwriting change, we assume the covariance structure in the fixed-effects models follows a first order autoregressive process AR (1).

Table 1 reports the summary statistics of the variables. The estimation results for model (4) are presented in Table 2. Panel A presents the results where the herding measure is HERD. Panel B and Panel C presents the results for HERD_INCREASE and HERD_DECREASE.

Consistent to Herding hypothesis, the coefficients of HERD, HERD_INCREASE and HERD_DECREASE are significant. When the herding measure HERD_INCREASE (HERD_DECREASE) is higher, insurers tend to increase (decrease) underwriting. The results suggest that fundamental changes in insurance product cannot fully explain the underwriting movements, and insurers tend to follow their peers to increase or decrease underwriting ignoring their own analysis. Further more, comparing Panel B and Panel C, we find the asymmetry of results between the two directions of herding. The magnitude of coefficient for HERD_DECREASE is greater than that of HERD_INCREASE, indicating that the herding of decreasing underwriting imposes a greater impact on insurer underwriting than the herding of increasing underwriting.

3.3 Impact of Herding on Different Firms

After finding the evidence of impact of herding on insurer underwriting, I further examine the impact of herding on different type of firm. In particular, I examine the impact of herding on firms of different size, different organizational form and different age. To achieve this purpose, I divided the sample into subgroups based on firm characteristics (big firms vs. small firms, stock firms vs. mutual firms, and young firms vs. old firms). Then I estimate Model 4 for each subgroup and compare the values of coefficient for the three herding measures.

Table 1 Descriptive Statistics of Variables[†]

Variable	Mean	Median	Standard	Minimum	Maximum

			Deviation		
PREM_GROWTH	0.139	0.037	0.787	-5.141	9.949
COMBINED_CHANGE	-0.116	0.010	6.765	-14.710	20.090
LOSS_CHANGE	0.049	-0.005	2.818	-90.731	99.935
EXP_CHANGE	0.182	-0.002	3.600	-93.852	99.644
INV_CHANGE	0.029	-0.012	2.379	-99.662	97.634
LIQUIDITY	172.530	140.377	115.398	-10.049	998.483
LEVERAGE	182.204	151.569	183.309	7.461	3927.350
SIZE	11.664	11.573	1.930	6.173	18.960
STOCK	0.718	1.000	0.450	0.000	1.000
AGE	45.964	30.000	41.723	0.000	263.000
AFFILIATE	0.767	1.000	0.423	0.000	1.000

Table 3 compares the coefficients of the herding measures for subgroups of firms of different size. The upper panel compares the coefficients of herding measures for the four quartiles of firm size, where firm size is measured by total assets. The lower panel compares the coefficient for three subgroups ranked by firm size: the top 10 percentile, middle 50 percentile and bottom 10 percentile. It shows that compared to the middle-size firms, large firms and small firms, are more subject to the impact of herding.

Table 4 compares the coefficients of the herding measures between stock firms and mutual firms. Mutual firms are found more influenced by the herding than stock firms.

Table 5 compares the coefficients of the herding measures between young firms and old firms. Young firms are the group of firms with firm history shorter than 10 years, which fall in the bottom quartile of firm age. Old firms are the group falling in the top quartile with firm history longer than 50 years. It can be seen that herding has much greater impact on young firms than on old firms.

In sum, the results show that large and small firms, mutual firms and young firms are more influenced by herding.

3.4 What Kind of Insurers Tend to Be Part of Herd?

After establish the fact that insurers intentionally herd to raise or lower insurance price, a natural question follows: what kind of insurers is more likely to be part of herd? What are the relationships between firm characteristics and decisions to herd? To answer these questions, we first need to capture a firm's propensity to herd.

Let HERD_INCREASE_DUM be denoted for a dummy variable equal to 1 if a firm increases underwriting more than the industry average when the market appears to herd to increase underwriting, i.e. $PREM_GROWTH_{it} > \overline{PREM_GROWTH}$. $\overline{PREM_GROWTH}$ is the average of premium growth among the firms who increase underwriting. Similarly, HERD_DECREASE_DUM represents a dummy equal to 1 if a firm decreases underwriting more than the industry average when the market herds to decrease underwriting, i.e. $PREM_DECREASE_{it} > \overline{PREM_DECREASE}$. $\overline{PREM_DECREASE}$ is the average of premium decrease ratio among the firms who decrease underwriting.

$$HERD_INCREASE_DECISION_{it} \begin{cases} 1, & \text{if } PREM_GROWTH_{it} > \overline{PREM_GROWTH} > 0 \\ 0, & otherwise \end{cases}$$

$$HERD_DECREASE_DECISION_{it} \begin{cases} 1, & \text{if } PREM_DECREASE_{it} > \overline{PREM_DECREASE} > 0 \\ 0, & otherwise \end{cases}$$

Table 2 Impact of Herd on Insurer Underwriting

	Model A	Model B	Model C
INTERCEPT	0.424***	0.419***	0.418***
	(0.032)	(0.032)	(0.032)
HERD t-1	0.436***	-	-
	(0.069)		
HERD_INCREASE t-1	-	0.523***	-
		(0.120)	
HERD_DECREASE t-1	-	-	-0.828***
			(0.121)
COMBINED_CHANGE	-0.001**	-0.001***	-0.001**
	(0.000)	(0.000)	(<0.001)
LOSS_CHANGE	0.002*	0.002*	0.002*
	(0.001)	(0.001)	(0.001)
EXP_CHANGE	-0.005***	-0.005***	-0.005***
	(0.002)	(0.002)	(0.002)
INV_CHANGE	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
LIQUIDITY	-0.03E3	-0.03E3	-0.02E3
	(0.06E3)	(0.06E3)	(0.06E3)
LEVERAGE	0.02E3	0.02E3	0.02E3
	(0.03E3)	(0.03E3)	(0.03E3)
SIZE	-0.022***	-0.022***	-0.022***
	(0.002)	(0.002)	(0.002)
AGE	-0.001***	-0.001***	-0.001***
	(<0.001)	(<0.001)	(<0.001)
STOCK	-0.005	-0.006	-0.006
	(0.013)	(0.013)	(0.013)
AFFILIATE	0.043***	0.044***	0.044 ***
	(0.013)	(0.013)	(0.013)
Wald $\chi 2$	6122.95	6119.67	6066.37

Notes:
* indicate significance at 10% level
** indicate significance at 5% level
*** indicate significance at 1% level
† Standard errors are heteroscedasticity and autocorrelation consistent. Robust standard errors are reported in the parentheses below coefficient estimates. Company specific intercepts are included in the fixed effects models, but are not reported here.

Table 3 Firm Size and The Impact of Insurer Herding

	HERD t-1	HERD_INCREASE t-1	HERD_DECREASE t-1
Top quartile	0.493***	0.609***	-0.908***
	(0.102)	(0.171)	(0.174)
Second quartile	0.344***	0.452*	-0.632***
	(0.132)	(0.232)	(0.229)
Third quartile	0.197	0.052	-0.537**
	(0.136)	(0.236)	(0.239)
Bottom quartile	0.699***	0.952***	-1.264***
	(0.167)	(0.299)	(0.293)
Top 10th percentile	0.472***	0.637***	-0.796***
	(0.145)	(0.243)	(0.248)
Middle 50 percentile	0.273***	0.276*	-0.571***
	(0.096)	(0.167)	(0.167)
Bottom 10th percentile	0.604**	0.746	-1.119**
	(0.271)	(0.487)	(0.474)

Table 4 Organizational Forms and The Impact of Insurer Herding

	$HERD_{t-1}$	$HERD_INCREASE_{t-1}$	$HERD_DECREASE_{t-1}$
Stock firms	0.409***	0.478***	-0.760***
	(0.089)	(0.152)	(0.152)
Mutual firms and others	0.463***	0.600***	-0.951***
	(0.010)	(0.181)	(0.175)

Table 5 Firm Age and The Impact of Insurer Herding

	$HERD_{t-1}$	$HERD_INCREASE_{t-1}$	$HERD_DECREASE_{t-1}$
Young firms	0.888***	1.228***	-1.577***
	(0.179)	(0.331)	(0.293)
Old firms	0.248**	0.321**	-0.472**
	(0.097)	(0.154)	(0.187)

Note:
* indicate significance at 10% level
** indicate significance at 5% level
*** indicate significance at 1% level

Table 6 Firm Characteristics and Decision to Herd

	Soft Market (2007-2009)	Hard Market (2012-2014)
INTERCEPT	-0.467*	1.343***
	(0.269)	(0.237)
COMBINED	0.002	-0.005**
	(0.003)	(0.002)
LOSS	<0.001	-0.001***
	(<0.001)	(<0.001)
EXENSE	<0.001**	-0.0029***
	(<0.001)	(<0.001)
INV_CHANGE	0.057***	-0.002
	(0.007)	(0.005)
LIQUIDITY	<0.001*	-0.0003***
	(<0.001)	(0.0001)
LEVERAGE	<-0.001**	-0.0002***
	(<0.001)	(0.0001)
SIZE	0.079***	0.021***
	(0.007)	(0.007)
AGE	0.005***	0.005***
	(<0.001)	(<0.001)
STOCK	0.028	0.070*
	(0.038)	(0.039)
AFFILIATE	0.119***	-0.016
	(0.039)	(0.040)
Log Likelihood	-7505.725	-7957.666

Notes:
* indicate significance at 10% level
** indicate significance at 5% level
*** indicate significance at 1% level
† Standard errors are heteroscedasticity and autocorrelation consistent. Robust standard errors are reported in the parentheses below coefficient estimates. Company specific intercepts are included in the fixed effects models, but are not reported here.

We then regress the above dummy variables on a series of firm characteristics variables, including LOSS_RATIO, EXPENSE_RATIO, LEVERAGE, LIQUIDITY, INVEST, SIZE, STOCK, AFFILIATE and AGE.

To differentiate the two directions of herding, I examine the herding to increase underwriting for the period of 2012 to 2014 and the herding to decrease underwriting for the period of 2007 to 2009. As discussed earlier, the period of 2007 to 2009 is a hard market with peak values of the measure of herding to decrease underwriting, while the period of 2012 to 2014 is a soft market with peak values of the herding to increase underwriting measure.

Table 6 reports the results of the probit model. The coefficient of SIZE is significantly positive in both models, suggesting that firm of larger size are more likely to be part of herd. AGE is also significant positive in both models, indicating that older

firms are more likely to be part of the herd of increasing price. Affiliated firms are more likely to be part of the herd to increase underwriting than unaffiliated firms, but the relation is not found for the herd to decrease underwriting. Further more, firms with better performance (lower combined ratio, lower loss and expense ratio, more liquid assets) are more likely to herd to decrease underwriting. This finding suggests that better-performing insurers are more conservative as they are more likely to cut supply when the market turns hard. While we expect that mutual insurers may behave differently from stock insurers, the coefficient of STOCK is insignificant.

4. Conclusions

Herding is believed to be a crucial element of behavior in financial markets and contribute to a number of economic phenomena such as bubbles, momentum and business cycles. In the insurance market, herding may lead to excess volatility in insurance supply and systematic erroneous pricing. To our knowledge, this paper is the first study to explore the role of herding in underwriting.

Using a sample of property-casualty insurers in United States, I investigate the role of herding in underwriting. I first establish the fact that fundamental changes cannot fully explain underwriting movements, and insurers tend to herd to increase or decrease underwriting. I also find that insurers are more responsive to the herd of decreasing underwriting than to the herd of increase underwriting. Further more, large and small firms (compared to medium-size firms), mutual firms and young firms are influenced by herding to a larger extent. I then investigate the characteristics of insurers that are more likely to be part of herds than others. I identify that larger and older firms are more likely to be part of the herd. This result is consistent to the prediction of Harrington (2004) that some inexperienced small insurers may have priced below cost because of moral hazard that is resulted from limited liability or low loss forecasts, giving rise to winners' curse effects. Larger insurers may follow such aberrant firms to cut price in order to preserve market share and avoid loss of quasi-rents from renewal business. I also find that mutual insurers have the similar herding pattern as stock insurers.

The results of this paper enrich the understanding of insurer underwriting behavior and the underwriting cycle. Herding may not only aggravates market fluctuation and prolongs the but also contributes to the systemic mispricing. The issue of herding in underwriting has important implications for insurance regulation and deserves future research.

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Scale Estimation and Money Raising for Catastrophe Fund in China

ZHU Zhangting, WANG Haiyan, CUI Shuo

ZHU Zhangting
Master Candidate
School of Economics and Management
Tongji University
Rm. 816, Block A Tongji Plaza, No.1500,Siping Rd.
Shanghai 200092, China
Mobile: (86)18621961819
Email: joycezzt@163.com

WANG Haiyan*
Ph.D., Associate Professor
School of Economics and Management
Tongji University
Rm. 816, Block A Tongji Plaza, No.1500,Siping Rd.
Shanghai 200092, China
Mobile: (86) 13917283932
Email: wanghaiyan@tongji.edu.cn

CUI Shuo
Master Candidate
School of Economics and Management
Tongji University
Rm. 816, Block A Tongji Plaza, No.1500,Siping Rd.
Shanghai 200092, China
Mobile: (86) 15216718066
Email: 090230@tongji.edu.cn

Keywords: Catastrophe fund, Extreme value theory, fund scale, principal component analysis

Abstract. China is a vast country vulnerable to catastrophe, but the status quo of China's catastrophe insurance is extremely backward. Currently, the compensation of catastrophe losses is mostly dependent on fiscal income. It is very urgent to build up

catastrophe fund (Hereinafter referred to Cat-fund) to make the loss compensation more efficiently. This paper will focus on the research of scale estimation and money raising standards for Cat-fund in China. Catastrophe loss has typical thick tail shape, so the tail needs to be described by extreme value theory and piecewise fitting function. After the net premium and maximum possible loss of catastrophe insurance are determined, the scale of the Cat-fund can also be estimated and calculated under various compensation ratios. A multi-level Cat-fund is recommended to be built in order to ensure the fairness and efficiency of the fund. Different provinces should have different standards of fund raising. According to the principle component analysis (PCA) method, we extract 3 factors, namely economic development, farmland losses and human losses, from original 8 indicators, and then set the weights for the 3 factors according to their variance contribution. Finally, with the historical loss data and fiscal income data, we apply the double-factor model to calculate individually the percentage of the Cat-fund that local government of each province needs to assume.

1. 问题的提出

巨灾在中国的发生频率极高，而我国的巨灾补偿主要依赖财政收入。近年来 ，随着我国巨灾的接连发生和灾害损失的不断增长，灾后救助给国家财政带来的负担越来越大，同时却仍然不能满足损失补偿的需要。据统计， 2008 年汶川地震给我国带来的直接经济损失共计 8451 亿元，而保险公司的赔付约为 20 亿元，仅占 0.24%。相比之下，国际上已有 12 个国家建立了以巨灾保险基金为核心的补偿机制，且运行比较成功。比如，美国 2005 年卡特里娜飓风的保险赔付就达到了直接经济损失的 50%。可见，巨灾保险基金的加入能够使巨灾风险补偿更为有效。

然而巨灾基金在我国的实施仍面临诸多困难，比如缺乏巨灾风险补偿的相关法规，政府职责不明确；巨灾基金规模测算难度较大；各省经济发展和受灾影响差异大，巨灾基金的缴纳标准制定也是一项挑战。国内外学者围绕巨灾保险基金已作了大量研究，以下就巨灾基金的运作、规模测算、资金筹集方式等方面作总结。

王安（2008）将巨灾保险基金的运作分为四种主要模式：政府作为巨灾保险提供者的美国国家洪水保险基金模式；商业化运作和商业化管理的挪威模式；多方合作的土耳其巨灾保险基金模式；政府提供巨灾风险再保险的佛罗里达飓风巨灾基金。谢世清(2009)认为建立我国巨灾保险基金的总体思路应当是，通过再保险的方式建立全国统一的巨灾保险基金，对巨灾保费实行单独立账核算，由专业再保险公司代为管理，统一安排国际再保险、运用风险证券化等方式分散风险，实现成本收益的最优化。

在巨灾基金资金规模测算方面，胡浪多和官华平（2013）认为巨灾准备金的金额是应赔付的实际损失金额与保险公司封顶赔付金额之间的差额。首先算出2001-2010年十年间巨灾基金的值，再将十年的平均值加总算出巨灾准备金水平。但该方法主要是分析了历史数据，对巨灾基金的灾前筹集和日常运营问题参考性较小。刘甲子（2011）运用破产论模型来考察巨灾基金的各种概率性质和保险公司的风险特征，计算了出我国地震在保险基金的初始规模、期望收益现值等重要数量指标,并用随机模拟验证了结果的有效性。田玲等（2013）选取地震和洪水这两种巨灾风险进行实证研究，通过使用条件最大可能损失作为巨灾风险度量的指标，计算出对于我国财产保险业而言，在巨灾保险基金成立初期，巨灾承保比例为 40%时对应的巨灾保险基金总规模为 289.22 亿元。

对于巨灾基金筹集方式的研究，张雪芳（2006）认为彩票与传统的保险存在一定的相似之处，提出了以发行彩票方式筹资的巨灾风险基金模式。赵昕、冯锐（2009)提出通过构建商业手段融资，但采取政府公共管理模式的巨灾风险基金，从中央和地方两个层面为巨灾风险提供分层保障。潘席龙、陈东（2009）在分析

目前财政救助性巨灾补偿体系弊端的基础上，提出在建立我国巨灾补偿基金的时候，至少应遵循补偿主体和补偿资金来源多样化、补偿方式货币化、按受灾情况确定补偿额、成本与补偿对等、有利于风险预防和控制等几个方面的原则。

我国沿海各省市面临台风巨灾风险的程度不同，在确定各省市台风巨灾基金筹资比例和缴费等级时，应该要体现这种差异性。沈蕾（2012）应用灰关联分析理论对于该问题进行分析，得出广东、福建和浙江这三个省份可以划入为 A 类等级，也就是缴费的最高等级；海南和广西可以划入为 B 类等级，缴费费率低于 A 类等级；江苏、上海、山东则划入为 C 类等级，也就是缴费的最低等级。

关于基金的巨灾损失支付的文献主要围绕着巨灾基金的起赔点和巨灾风险补偿机制中各参与人的偿付责任展开。王安（2008）认为，为了尽快建立一个有赔付能力的巨灾基金，巨灾保险基金建立初期应该实行不足额赔付。纪朝彬和冯锐（2009）主要从政府灾后参与巨灾超额损失赔付的角度，使用巨灾损失划分的模糊灾度判别法，对于风暴潮灾损度进行定级，并结合“损失事件+损失程度”设置政府灾后参与超额损失赔付的触发点。

本文主要研究我国巨灾基金规模的测算和资金缴纳标准的制定问题，希望能为我国巨灾基金的构建提供一些建议。

2. 巨灾保险基金规模测算

本部分将对 2015 年巨灾保险基金的规模进行测算。基金的形式是全国范围的联合巨灾基金，包括地震、洪水、滑坡、野火、雪灾等所有已在我国发生的巨灾风险。

2.1 数据来源及分析

本文使用的巨灾数据来自 EM-DAT 数据库，该数据库收录了 1980 年-2014 年间发生在我国的自然灾害损失数据共 412 条。EM- DAT 灾难数据库的“灾害”损失录入门槛至少要满足以下三个条件之一：灾害发生后有 10 人或以上死亡；有 100 人或以上人口受到灾害影响；政府针对灾害事件宣布过国家处于紧急状态或请求过国际援助。本文对巨灾的界定标准同 EM-DATA 数据库保持一致。

412 条损失均值为 72.93 亿元，最大损失值高达 5073.66 亿元，损失来源是 2008 年的汶川地震。分布的偏度为 12.07，称为右偏态，直观表现为右边的尾部相对于与左边的尾部要长。本分布峰度为 179.70，说明分布的极端值非常多，巨灾损失分布具有明显的尖峰厚尾形态。

图 1 是对原始数据进行对数变换得到的对数频数直方图，可以更直观地表示正偏分布的形态。图 2 的正态 Q-Q 图呈现为向上弯曲，验证了巨灾损失分布的厚尾性质。

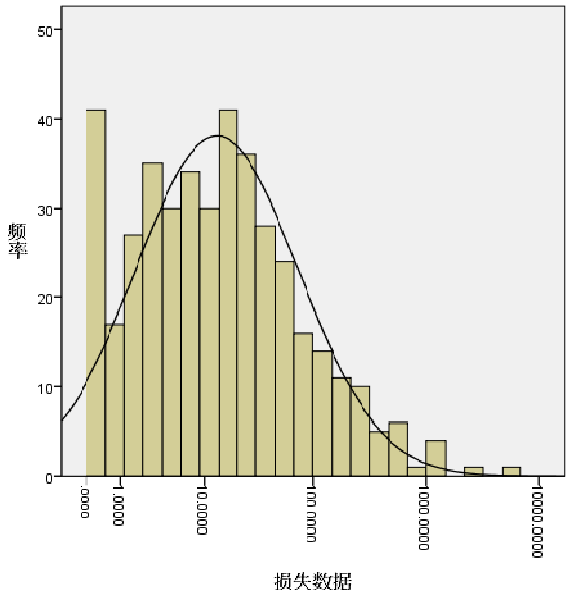


图 1　损失对数频数直方图

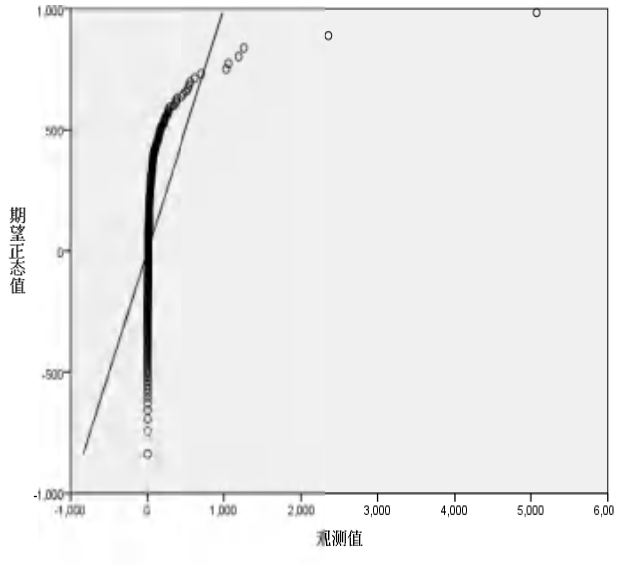


图 2　损失正态 Q-Q 图

保险人样本选取了在我国进行经营活动的财产保险公司和再保险公司的所有者权益值，共 65 家。样本时间为 2014 年末。65 家保险人 2014 年末所有者权益的总和为 2309.69 亿元，即 $\sum_{i=1}^{65} Q_i = 2309.69$.同时，2014 年末一年期存款基准利率水平为 3.00%。即 $r = 0.03$。

2.2 阈值的确定

极值理论中的超越阈值方法（POT）比较适合对巨灾损失的厚尾分布进行拟合，其中 GPD（广义帕累托分布的简称）分布运用最为广泛。GPD 有三个主要参数：位置 μ，也就是阈值；规模 β；形状 ξ。巨灾损失的分布函数可以表示为：

$$F(x) = \begin{cases} F_1(x) & x \prec \mu \\ F_2(x) & x \geq \mu \end{cases} \qquad (1)$$

分布 $F_1(x)$ 可以采用比较常用的损失分布函数，分布 $F_2(x)$ 采用广义帕累托分布进行拟合。阈值 μ 的选取是关键，可以使用超额均值函数（MEF）或是 Hill 图两种方法。

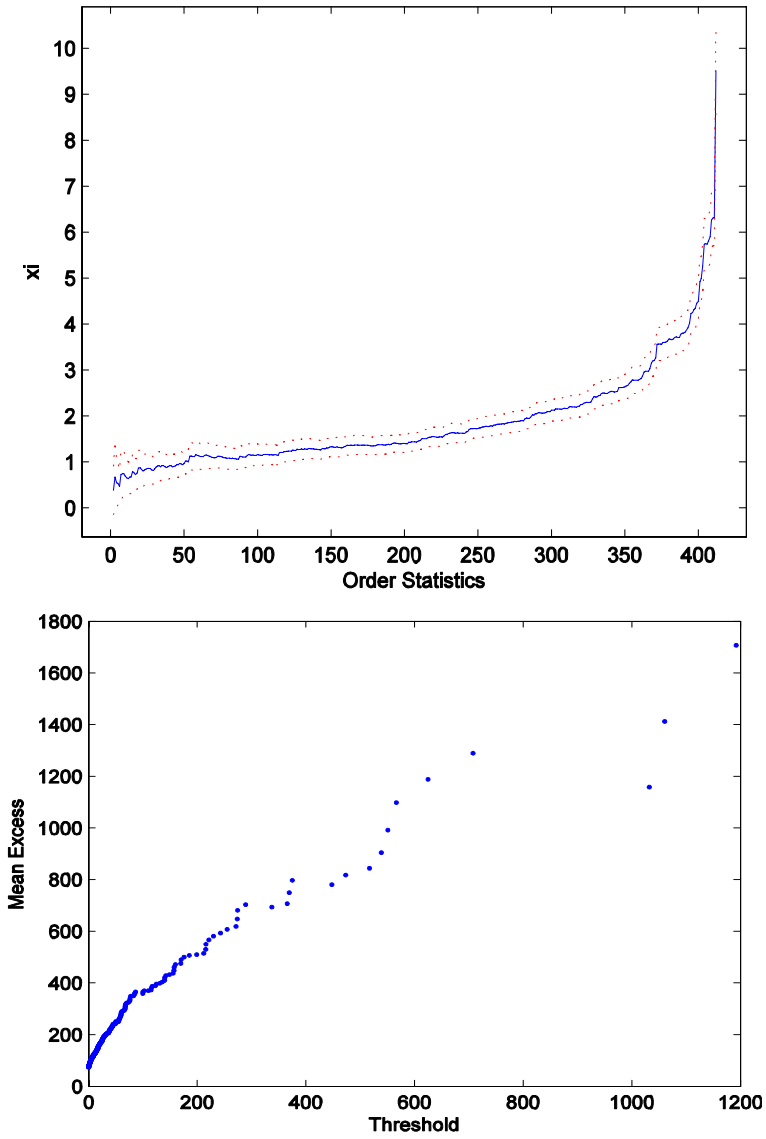


图 4　MEF 图

由图 *4* 可见，尾部指数稳定区域的起始点所对应的横坐标为 *375*。*MEF* 图也能印证这一点，图中 $x \geq \mu$ 时是向上倾斜的，说明数据来源于参数 ξ 为正的 *GPD* 分布。因此本文的阈值选取为 *375* 亿元。阈值以下的观测值有 *379* 个，阈值以上的观测值有 *15* 个。本文采用 *1980* 到 *2014* 年 *34* 年间的观测样本，因此阈值 μ 以下的损失频率服从参数 $\lambda_1 = 11.147$ 的泊松分布，阈值 μ 以上的损失频率服从参数 $\lambda_2 = 0.441$ 的泊松分布。

2.3 分段拟合

将 379 个值取对数绘制成 P-P 图，如图 5 所示，预测的点同实际正态分布的

直线基本重合，可以初步断定$F_1(x)$满足对数正态分布。将对数化的样本值进行K-S 正态性检验，结果显示 K-S 值为 1.210，对应的 p 值为 0.107，大于 0.05，不能拒绝正态性假设。因此阈值左边的样本满足正态对数分布。

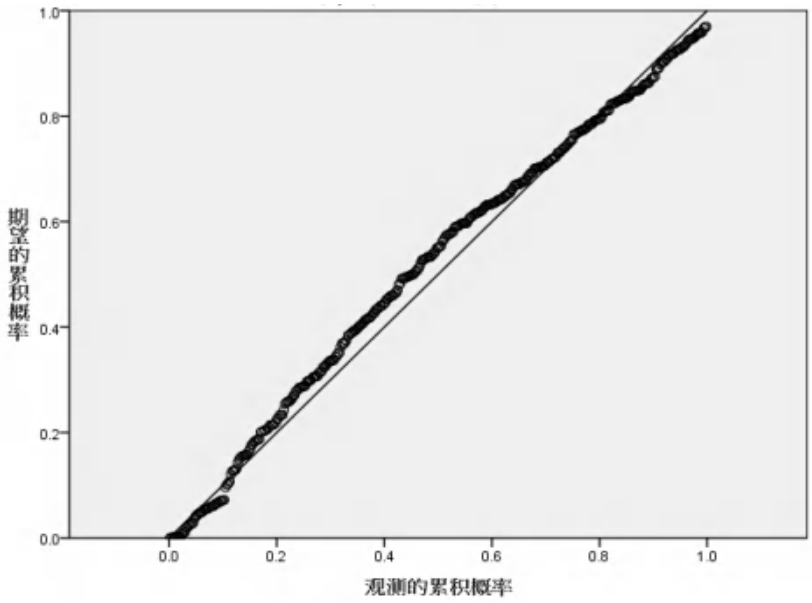


图 5　对数的正态 P-P 图

所以小于阈值的样本点满足的分布形式可以表示成：

$$Ln(x) \sim N(0.8739, 0.9305^2) \tag{2}$$

进一步可以推导出F_1的解析式为：

$$F_1 = \int_0^x \frac{1}{\sqrt{2\pi} * 0.8739x} e^{-\frac{(\ln x - 0.9305)^2}{2*0.8739^2}} \quad (x \prec 375) \tag{3}$$

由于阈值以上数据仅有 15 个，数据较少，因此使用蒙特卡洛模拟扩充样本容量后，再对参数β和ξ进行估计。下图为β和ξ的核密度估计图。

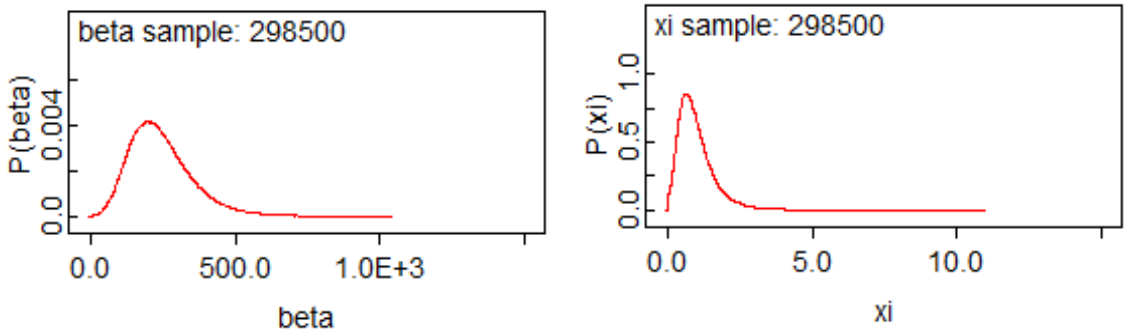


图 6　核密度估计图

通过估计得到F_2的解析式为：

$$F_2(x) = 1 - \left(1 + \frac{0.964x}{241.400}\right)^{-\frac{1}{0.964}} \quad (x \geq 375) \tag{4}$$

在 GPD 分布形式确定后可以求出 PML 值。

$$PML_\alpha = \mu + \left\{\left(-\frac{\lambda_2}{\ln(1-\alpha)}\right)^{\xi} - 1\right\}\frac{\beta}{\xi} \tag{5}$$

$\alpha = 0.01$时，$PML_{0.01} = 9714.107$，即百年一遇的灾害年中，最大可能损失值为 *9714.107* 亿元。$\alpha = 0.001$时，$PML_{0.001} = 88776.805$，那么千年一遇的灾害年中，最大可能损失值为88776.805亿元。

2.4 纯保费计算

当数据充分时，直接使用极值理论对大额索赔的保费进行估计是比较常用的方法。理论上，纯保费应该等于期望年索赔额。可以推导出纯保费等于年索赔次数的期望和年索赔额期望的乘积。在保险精算领域，索赔次数N服从时齐的泊松分布已经被业界普遍接受，因此这里假设N服从参数为λ的时齐泊松过程，并同时将分段的损失分布函数考虑进来。那么纯保费可以表示成：

$$\begin{aligned} E(S_N) &= \lambda_1 E\left(X|_{\{X<\mu\}}\right) + \lambda_2 E\left(X|_{\{X\geq\mu\}}\right) \\ &= \lambda_1 \int_{-\infty}^{\mu} x dF_1(x) + \lambda_2 \int_{\mu}^{+\infty} x dF_2(x) \end{aligned} \tag{6}$$

其中λ_1为阈值μ以下的损失量所满足的泊松分布参数，其中λ_2为阈值μ以上的损失量所满足的泊松分布参数。

阈值两边的样本损失分布函数都已经确定，将两段函数合并在一起就构成了整体巨灾损失的分布：

$$F(x) = \begin{cases} \int_0^x \dfrac{1}{\sqrt{2\pi} * 0.8739x} e^{-\frac{(\ln x - 0.9305)^2}{2*0.8739^2}} & (x < 375) \\ 1 - \left(1 + \dfrac{0.964x}{241.400}\right)^{-\frac{1}{0.964}} & (x \geq 375) \end{cases} \tag{7}$$

在求出了整体损失分布的前提下，我们可求出巨灾保险的纯保费：

$$E(S_N) = \lambda_1 E\left(L|_{\{L<\mu\}}\right) + \lambda_2 E\left(L|_{\{L\geq\mu\}}\right) \tag{8}$$

$$E(S_N) = 11.147 * E(L|_{\{L<375\}}) + 0.441E(L|_{\{L\geq 375\}}) = 300.556 \text{（亿元）}$$

即在现有损失数据计算基础上，2015 年我国综合巨灾保险的纯保费应该为300.556 亿元。

2.5 巨灾保险基金总规模测算

在自然灾害损失风险的度量中，较多采用的方法是可能的最大损失（Probable Maximum Loss，以下简称 PML）。PML 的求解方程为：

$$P[L \leq \text{PML}(\alpha)] = 1 - \alpha \quad (9)$$

其中 L 是随机变量，α为任意小的数，指可以容忍的巨灾风险发生的概率。如果α=0.01，代表可以容忍百年一遇的风险。上式的含义是 PML 表示风险容忍度为α的最大可能损失，PML 是 L 的分位数：

$$PML(\alpha) = F_L^{-1}(1-\alpha) \quad (10)$$

Cebrian（2003）在前人研究的基础上进一步证实，在 GPD 中，超出阈值ц的超出损失次数也可以用泊松分布来模拟，并推演出 PML 的估计式为：

$$PML_\alpha = \text{ц} + \left\{(-\frac{\lambda_2}{ln\,(1-\alpha)})^{\xi} - 1\right\}\frac{\beta}{\xi} \quad (11)$$

其中λ_2为阈值 ц 以上的损失量所满足的泊松分布参数：

$$\lambda_2 = E\left[N_{X>\text{ц}}\right] \quad (12)$$

在一个单时期中，保险人i在年终的权益终值T_i应该等于：

$$T_i = \max\{(P_i + Q_i)(1+r) - L_i.; 0\} \quad (13)$$

式中P_i是去掉费用后的巨灾保险产品的净保费，Q_i是保险人 i 的所有者权益。为了方便计算我国财险市场最大承保能力，假设巨灾保险是非盈利性质的，因此净保费等同于纯保费。保费一般在年初收取，r为贴现率。

$$P_{ij} = \text{E}(S_N)$$
$$T_i = \max\{(\text{E}(S_N) + Q_i)(1+r) - L_i.; 0\} \quad (14)$$

某一年份里，财险市场上所有保险人承保能力之和加上巨灾保险基金的资金应该能够覆盖当年所有的巨灾损失。在极限情况下，年终的权益终值T_i等于零，我国巨灾保险的规模（Scale of fund）应为：

$$\text{SCF} = \max\{\text{PML} - (\text{E}(S_N) + \textstyle\sum_{i=1}^{n} Q_i)（1+r）; 0\} \quad (15)$$

即构建的巨灾保险基金的规模应该由最大可能损失,保险人所有者权益和巨灾保险纯保费的年末终值三项共同决定。

$$\text{SCF}_{0.01} = \max\left\{\text{PML}_{0.01} - (\text{E}(S_N) + \sum_{i=1}^{n} Q_i)（1+r）; 0\right\}$$

$$= 7103.861\text{（亿元）}$$

$$\mathrm{SCF}_{0.001}=\max\left\{\mathrm{PML}_{0.001}-(\mathrm{E}(S_N)+\sum_{i=1}^{n}Q_i)（1+r）;0\right\}=86166.559（亿元）$$

我国 2015 年国民生产总值为 67.67 万亿元。在巨灾保险承保比例为 100%的时候，风险忍受度为 0.01 的时候，巨灾保险基金的测算规模为 7103.861 亿元，占 GDP 比重 1%; 风险忍受度为 0.001 的时候，巨灾保险基金的规模为86166.559亿元。

由表 1 可知，随着承保比例的上升和风险忍受度的下降，基金的最低规模和筹集难度变大，筹集时间也会拉长。

在 0.001 风险忍受度情况下，即时承保比例 50%，2015 年巨灾保险基金规模也要达到 41778.16 亿元，占 2014 年全国财政收入 140370.03 亿元的 29.76%，比例太高不可承担。因此现阶段国情下，风险忍受度应该定在 0.01 水平上。

表 1　承保比例与巨灾基金规模（单位：亿元）

承保比例	$\mathrm{SCF}_{0.01}$	$\mathrm{SCF}_{0.001}$
10%	0	6267.435
25%	0	19583.96
50%	2246.808	41778.16
75%	4675.334	63972.36
90%	6132.45	77288.88
100%	7103.861	86166.56

同时本文建议在巨灾保险初创阶段进行不完全承保，这样可以降低规模要求，减少赔付额，加快基金的积累速度。

3. 巨灾基金地方政府缴纳标准的制定

3.1 数据来源、假设和研究方法

本文使用的气象灾害直接经济损失等数据来源于 2004 年到 2013 年的《中国气象灾害年鉴》。地震数据和崖崩数据的来源是 EM-DAT 数据库（地陷损失和崖崩损失数据未能找到，所以本文不再将其纳入统计范围）。其他数据来源于国泰安数据库。所有经济损失数据都已剔除了通货膨胀因素，通胀数据来源是 CountryData 的《各国宏观经济指标宝典》，CPI 计算采用的基准年是 2005 年。本文采用 2004 年到 2013 年各地方数据的算术平均值作为分析数据。

为了简化分析，本文将巨灾损失的承担方主要分为私人市场和政府两大部分，社会捐助等资金来源不作讨论。在巨灾保险基金的建设初期，私人市场发挥的作用有限，因此本文假设私人市场承担 20%，政府承担 80%的巨灾损失。

另外，根据《2014 年中国统计年鉴》披露的数据，中央政府财政总支出为 22570.07 亿元，占全国财政总支出的 14.87%；地方政府的财政支出总额为 129215.49 亿元，占地方政府总支出的 85.13%。由于我国没有针对政府用于抗灾救灾和灾后重建的资金的独立统计，本文将根据财政支出的比例情况来确定中央

政府和地方政府的承担比例。本文假定中央政府巨灾承担比例为 20%，略高于14.87%；地方政府承担比例为 80%。具体的巨灾损失承受比例安排见表 2。

表 2　巨灾损失承受比例安排（单位：亿元）

		占比	承保比例 50%	承保比例 75%
私人市场	国际再保市场	20%	433.70	919.41
	金融市场			
政府	中央政府	16%	346.96	735.52
	地方政府	64%	1387.84	2942.10
合计		100%	2168.50	4597.03

中央政府 2014 年的财政收入为 64493.45 亿元，即使是 75%承保比例下的735.52 亿元资金也仅占中央财政收入的 1.14%，中央政府完全有能力承担。

地方政府拨款是巨灾保险资金来源的一个重要组成部分，我国有 34 个省市自治区直辖市。在面对巨灾风险的时候，不同地区之间存在着自然条件、经济发展和承载能力上的差异。我们需要将这些差异纳入考虑范围，科学地制定地方政府巨灾基金缴纳标准。

本文采用主成分分析法对来分析可能对巨灾经济损失产生影响的因素。本文中模拟的巨灾基金所覆盖的巨灾风险是参照现已运行中的深圳市巨灾救助保险中包括的灾种[1]。本文选取了八个指标，其中第一个指标是区位因素。地质学上，根据自然灾害的空间分布规律，可将我国划分为六个灾害带，分别使用数字 1~6 为区位因素指标赋值，具体见表 3。一共选取的八个指标为：国有及非国有规模以上工业企业工业总产值（X_1）、农林牧渔业总产值（X_2）、固定资产投资总额（X_3）、区位因素（X_4）、农作物受灾面积（X_5）、农作物绝收面积（X_6）、受灾人数（X_7）、死亡人数（X_8）。

采用 Kaiser（1962）提出的 KMO 检验和 Bartlett 检验来分析数据是否适合使用主成分分析法。检验结果显示数据的 KMO 值为 0.613，Bartlett 的球形度检验 P 值小于 0.05，可以使用主成分分析。

表 3　区位因素划分

	灾害带	**分布地区**	**包括省份**	**主要灾害**	**对工农业生产的影响**
1	海洋灾害带	东部和南部海域	辽宁、山东	以台风、风暴潮、赤潮等自然灾害为主	对海洋渔业和石油平台、船舶、港口造成灾情
2	东南沿海灾害带	主要指连云港以南的东南沿海地区	上海、江苏、浙江、福建、广东、广西、海南	以台风、风暴潮、暴雨、洪涝、海水入侵等自然灾害为主	对城市、港口、海水养殖场等造成严重灾情

[1] 该巨灾保险的保障灾种主要包括暴风（扩展到狂风、烈风、大风）、暴雨、崖崩、雷击、洪水、龙卷风、飑线、台风、海啸、泥石流、滑坡、地陷、冰雹、内涝、主震震级 4.5 级及以上的地震及地震次生灾害，以及由上述 15 种灾害引发的核事故风险。其中暴风、暴雨、雷击、洪水、龙卷风、飑线、台风、海啸、泥石流、滑坡、冰雹和内涝等 12 中灾难属于气象灾
害及气象灾害的次生灾难。

3	东部灾害带	主要指第三级阶梯	北京、天津、河北、吉林、黑龙江、河南、安徽、江西、湖南、湖北	洪涝、旱灾、病虫害是主要的自然灾害。此外，东北的霜冻、华北的地震也很显著	对农业和城市危害严重
4	中部灾害带	主要指青藏高原以东的第二级阶梯	四川、重庆、贵州、云南、山西、陕西、宁夏、内蒙古	以暴雨、洪水、地震、滑坡、泥石流等自然灾害为主，而且水土流失、风蚀沙化等土地退化问题严重	对农业、交通设施与建筑物造成严重危害。其中，内蒙古的雪灾、黄土高原的暴雨洪水和干旱、西南地区的地震、滑坡和泥石流灾害尤为突出
5	西北灾害带	主要指西北内陆的新疆、甘肃、宁夏、内蒙古西部地区	新疆、甘肃	以地震、沙尘暴、霜冻、干旱、病虫害等自然灾害为主	对绿洲农业、城市建筑和畜牧业造成灾害
6	青藏高原灾害带	主要指西藏、青海和四川西北部	西藏、青海	以暴风雪、地震、寒潮、雪崩等自然灾害为主	对畜牧业造成严重灾害

3.2 构建因子模型

3.2.1 因子提取

由于不同因变量的量纲不同，首先需要对数据进行标准化的处理，将每组数据都转化为均值为 0，方差为 1 的数组，近似服从标准正态分布。基本的因子模型可以表示为：

$$Z_p = \sum_{i=1}^{11} l_{pi} F_p + \varepsilon_p$$

其中 i 的范围是 1~8，指本文选取的 8 个指标。P 的范围是 1~31，指本次参与统计的我国省直辖区个数（由于数据获得难度较大，本次分析不包括台湾，香港和澳门地区）。F_i为公共因子；ε_p表示特殊因子，其中包含了随机误差；l_{pi}称为第 i 个变量在第 p 个因子F_p上的载荷，又称因子载荷。因子荷载越大，变量在公共因子中所占地权重越大。

根据方差贡献率的大小提取出公共因子，可以发现选取的前三个指标的累计贡献率为 83.459%，对总体方差给出比较有效的解释。

本文选择使用主成分法作为因子载荷的估计方法。下表为使用主成分分析法提取的因子载荷矩阵。该矩阵显示了三个主成分与 8 个指标间之间的线性关系，三个主成分由指标进行线性组合而成，因子载荷（指标系数）反映了提取出的主成分与指标的相关性。

表 4　旋转后的因子载荷矩阵

因子解释	指标	成份		
		F_1	F_2	F_3
经济发展因子	国有及非国有规模以上工业企业工业总产值（X_1）	**0.926**	-0.052	-0.006
	农林牧渔业总产值（X_2）	**0.803**	0.397	0.289
	固定资产投资总额（X_3）	**0.954**	0.162	0.126
	区位因素（X_4）	**0.615**	-0.239	-0.214
耕地受灾因子	农作物受灾面积（X_5）	0.130	**0.959**	0.173
	农作物绝收面积（X_6）	-.064	**0.954**	0.001
人口受灾因子	受灾人数（X_7）	0.003	-0.052	**0.896**
	死亡人数（X_8）	0.051	0.220	**0.818**

我们把各因子中载荷大于 0.5 的指标归在同一个因子下。从矩阵结果可以看出，因子F_1在国有及非国有规模以上工业企业工业总产值（X_1）、农林牧渔业总产值（X_2）、固定资产投资总额（X_3）和区位因素（X_4）四个指标上载荷值很大。其中除区位因素外，其他三个指标分别从不同维度反映了当地经济的在险价值。国有及非国有规模以上工业企业工业总产值（X_1）反映的是当地工业的发展水平；农林牧渔业总产值（X_2）反映的是第一产业的体量；固定资产投资总额（X_3）包括基建和房地产投资，反映了城市在面对巨灾风险时的可能损失情况。区位因素会同经济指标们归类到一个因子下，笔者认为是因我国经济带和灾害带的划分有很大的重合区域。地方经济越发达，该地区的在险价值就会越高，巨灾带来的可能损失就越高。

因子F_2反映了 10 年来历史平均耕地受灾情况，主要包括了农作物受灾面积（X_5）、农作物绝收面积（X_6）两个指标。耕地是巨灾损失的主要载体，以在中部灾害带和西北灾害带的巨灾对农业的打击最为严重。

因子F_3反映了人口损失的情况，包括死亡人数（X_7）、受灾人数（X_8）量个指标。人员伤亡对地方巨灾基金缴纳额之间应该存在明显的正相关性。

3.2.2　因子有效性检验

多元回归的调整R^2为 0.82，说明该模型的拟合优度良好。同时模型的 F 值为 41.32，可以通过失拟性检验，说明从八个指标中提取出的三个主因子能有效反映各地巨灾直接经济损失。

表 5　回归系数

模型	非标准化系数		t	Sig.
	β	标准误差		
(常量)	91.561	9.770	9.371	0.000
经济发展因子	22.139	9.932	2.229	0.034
耕地受灾因子	23.532	9.932	2.369	0.025
人口受灾因子	109.020	9.932	10.977	0.000

通过上表可知提取出的三个公共因子的系数 P 值都小于 0.05，说明变量显著。

同时回归系数都为正，说明三个因子与直接经济损失呈正相关，也应与地方政府巨灾基金缴纳额呈正相关。

3.3 基于主成分分析结果的综合赋权

本文使用的主成分分析法的赋权方式是以公共因子的总方差贡献率的比重作为权重。

表 6　因子方差贡献率

	F_1	F_2	F_3
公共因子	经济发展因子	耕地受灾因子	人口受灾因子
方差贡献率	36.795	26.013	20.651
总方差贡献率	36.795	62.808	83.459

得到地方政府巨灾经济损失的因子模型为：

$$F=（36.795F_1+26.013F_2 \ +20.651F_3）/83.459$$

$$F=0.441\ F_1+0.312\ F_2+0.247\ F_3$$

根据上述模型，对各省的巨灾经济损失情况进行打分，并将最终打分结果转化为 10 分制（见表 7）。得分比较高的前五个省份中，山东、江苏和广东省是 F_1 经济发展因子得分较高；辽宁省是 F_2 耕地受灾因素得分较高；而河南省三项因素得分都高于平均水平。得分比较靠后的五个省份中，宁夏、青海和西藏三个省份 F_1 得分比较低，说明这三个省份由于经济发展程度比较落后，在险的经济价值比较低；上海和北京两个地区三项因素得分都比较低，笔者认为主要原因是两地的耕地面积和人口规模都比较小。

本文提出利用双因素标准来得到地方政府巨灾保险基金的缴纳标准。双因素标准使用每个省份地区的巨灾损失的预期值和财政收入作为决定因素，高财政收入的省份地区多承担一些缴纳义务，在保证巨灾保险基金缴纳公平的基础上，兼顾巨灾保险基金资金收集的效率性。

表 7　损失情况得分表

	F1	F2	F3	损失情况得分
山东	8.4079	0.3725	0.3503	8.0599
河南	3.6597	3.4698	3.3356	7.7349
辽宁	3.5543	5.2539	-0.4105	7.3866
江苏	5.9906	-0.3259	-0.1563	6.8841
广东	4.4424	0.8012	0.2166	6.6846
河北	2.3606	2.1856	1.8327	6.6125
湖南	1.2555	1.7379	1.8647	6.0960
四川	1.5359	0.6364	1.8125	5.9019
云南	-1.1701	1.2299	5.3346	5.7880
湖北	1.5240	0.6134	0.5918	5.6394

内蒙古	-0.4602	3.1629	-0.0121	5.4478
广西	0.1473	0.2280	0.5059	5.0149
安徽	0.7491	-0.7709	0.5339	4.9823
浙江	1.8327	-1.8941	-0.9274	4.7870
新疆	-1.9186	2.5389	-0.2138	4.7073
陕西	-0.6356	-0.0092	0.5886	4.6822
黑龙江	-0.7080	0.3760	-0.8388	4.4610
福建	0.7080	-1.9821	-1.3907	4.2546
吉林	-1.1323	-0.1744	-0.7450	4.1811
江西	-0.7401	-1.0186	-0.3942	4.1782
贵州	-2.1848	-0.3658	1.3277	4.1720
山西	-1.7357	0.4897	-0.7187	4.1372
甘肃	-2.5377	0.7642	0.2735	4.1184
重庆	-1.8645	-1.4753	-0.1272	3.7008
海南	-2.6753	-1.3491	-1.0440	3.2460
天津	-2.0074	-2.6210	-2.0380	2.9556
上海	-1.8985	-2.9707	-2.3019	2.8502
宁夏	-3.6150	-1.6190	-1.5720	2.7210
北京	-2.7480	-2.5290	-2.0267	2.7094
青海	-3.8873	-2.1767	-1.7177	2.4456
西藏	-4.2486	-2.5787	-1.9334	2.1636

3.4 巨灾基金地方政府缴纳标准制定

本文假定损失因子和公共预算收入因子权重各为 50%，在此标准上进行测算，结果见表 8。

表 8　双因素标准下各省缴纳金额（2014 年，单位：亿元）

	承保比例 50%		承保比例 75%	
	单因素法各省缴纳金额	缴纳金额占公共预算收入比	单因素法各省缴纳金额	缴纳金额占公共预算收入比
西藏	22.4198	18.04%	47.5279	38.25%
青海	24.4356	9.71%	51.8014	20.58%
宁夏	26.2911	7.74%	55.7349	16.40%
海南	29.9758	5.40%	63.5461	11.44%
甘肃	35.3505	5.26%	74.9399	11.14%
新疆	40.6285	3.17%	86.1289	6.72%
广西	37.3616	3.10%	79.2033	6.58%
吉林	39.2735	3.02%	83.2562	6.40%
黑龙江	42.8304	3.01%	90.7966	6.38%
云南	48.1273	2.83%	102.0257	6.01%
贵州	37.8177	2.77%	80.1702	5.87%
内蒙古	46.6274	2.53%	98.8459	5.36%

河南	62.5462	2.28%	132.5924	4.84%
河北	51.6533	2.28%	109.5005	4.84%
湖南	55.1908	2.26%	116.9996	4.78%
陕西	42.3766	2.24%	89.8346	4.75%
辽宁	39.0303	2.14%	82.7407	4.54%
山西	39.4561	2.10%	83.6434	4.44%
安徽	45.1202	2.03%	95.6509	4.31%
江西	49.9778	1.95%	105.9485	4.13%
湖北	61.9574	1.94%	131.3442	4.11%
四川	36.8400	1.92%	78.0974	4.06%
重庆	41.3894	1.75%	87.7418	3.71%
福建	53.0224	1.73%	112.4028	3.67%
山东	34.0183	1.42%	72.1157	3.02%
天津	71.5296	1.42%	151.6364	3.02%
浙江	49.9219	1.21%	105.8300	2.57%
江苏	71.6433	0.99%	151.8774	2.10%
广东	37.6972	0.94%	79.9148	1.98%
北京	73.0865	0.91%	154.9368	1.92%
上海	40.2434	0.88%	85.3123	1.86%

双因素方法下的缴纳金额测算结果显示，在 50%承保比例下仍是西藏的缴纳金额—公共预算收入比大于 10%，在 75%承保比例下，还是西藏、宁夏、青海、海南和甘肃五省比例大于 10%。因此我们还将这些省份缴纳金额中超出公共预算收入的 10%的部分让其他省份来共同承担。测算结果如下表 9。

表 9 平均后的双因素标准下各省缴纳金额（2014 年，单位：亿元）

	承保比例 50%		承保比例 75%	
	双因素法各省缴纳金额	缴纳金额占公共预算收入比	双因素法各省缴纳金额	缴纳金额占公共预算收入比
西藏	12.4270	10.00%	12.4270	10.00%
青海	24.6545	9.80%	25.1680	10.00%
宁夏	26.5266	7.81%	33.9860	10.00%
海南	30.2442	5.45%	55.5310	10.00%
甘肃	35.6670	5.30%	67.2670	10.00%
新疆	40.9923	3.20%	86.4927	6.74%
广西	37.6962	3.13%	79.5378	6.61%
吉林	39.6251	3.05%	83.6079	6.42%
黑龙江	43.2139	3.04%	91.1801	6.41%
云南	48.5583	2.86%	102.4566	6.03%
贵州	38.1563	2.79%	80.5088	5.89%
内蒙古	47.0449	2.55%	99.2634	5.38%
河南	63.1063	2.30%	133.1525	4.86%
河北	52.1159	2.30%	109.9630	4.86%

湖南	55.6850	2.28%	117.4938	4.80%
陕西	42.7560	2.26%	90.2140	4.77%
辽宁	39.3797	2.16%	83.0902	4.56%
山西	39.8094	2.12%	83.9967	4.46%
安徽	45.5243	2.05%	96.0549	4.33%
江西	50.4253	1.96%	106.3961	4.14%
湖北	62.5122	1.96%	131.8990	4.13%
四川	37.1698	1.93%	78.4273	4.08%
重庆	41.7600	1.77%	88.1124	3.73%
福建	53.4972	1.75%	112.8776	3.69%
山东	34.3229	1.44%	72.4203	3.03%
天津	72.1701	1.44%	152.2769	3.03%
浙江	50.3689	1.22%	106.2770	2.58%
江苏	72.2848	1.00%	85.1946	2.12%
广东	38.0348	0.94%	152.5189	2.11%
北京	73.7409	0.91%	155.5912	1.93%
上海	40.6037	0.89%	85.6727	1.87%

平均后的双因素标准下各省缴纳金额都比较合理，每省都可以将缴纳金额—财政收入比可以控制在 10%或 10%以下。

4. 结论

本文主要研究了巨灾保险基金的规模测算与资金的筹集问题，主要得到了以下结论：

1. 巨灾损失低于阈值的部分服从对数正态分布，高于阈值的部分服从广义帕累托分布。
2. 巨灾保险基金的规模由最大可能损失、保险人所有者权益和巨灾保险纯保费的年末终值三项共同决定。
3. 在保险市场承保能力最大化的前提条件下，风险忍受度为 0.01 时，我国巨灾保险基金的规模为 7103.861 亿元。
4. 影响巨灾损失的三个主要因子分别是经济发展因子、耕地受灾因子和人口受灾因子。
5. 在 50%及 75%的承保比例下，各省地方政府巨灾基金的缴纳金额都可以控制在 10%及以下比较合理的范围内。

在本文的基础上可以进一步研究的方向有：巨灾起赔额的设定；私人市场和政府承担比例、中央政府和地方政府承担比例等问题。

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中国巨灾基金的规模测算及资金筹集研究

朱张婷 王海艳 崔朔

朱张婷
硕士研究生
同济大学经济与管理学院
四平路 1500 号同济大厦 A 楼 816
上海 200092，中国
电话: (86)18621961819
Email: joycezzt@163.com

王海艳*
博士，副教授
同济大学经济与管理学院
四平路 1500 号同济大厦 A 楼 816
上海 200092，中国
电话: (86) 13917283932
Email: wanghaiyan@tongji.edu.cn

崔朔
硕士研究生
同济大学经济与管理学院
四平路 1500 号同济大厦 A 楼 816
上海 200092，中国
电话: (86) 15216718066
Email: 090230@tongji.edu.cn

关键词：巨灾基金；极值理论；基金规模；主成分分析法

中文摘要. 我国是巨灾大国，但是目前我国的巨灾补偿体系还比较落后。现阶段我国补偿巨灾风险主要依赖于财政收入，但是随着巨灾的不断发生和灾害损失的增加，灾后救助给国家财政带来了沉重负担，建立巨灾保险基金刻不容缓。本文主要研究巨灾基金的规模测算与地方政府的资金缴纳标准制定问题。由于巨灾损失的厚尾分布特征，本

文使用极值理论中的超越阈值方法对巨灾损失的分布进行分段拟合，确定了小于阈值的部分服从对数正态分布，大于阈值的部分服从广义帕累托分布。在得出巨灾可能最大损失的基础上，对 2015 年的巨灾基金总规模进行测算。本文利用主成分分析法提取出的三个影响巨灾损失的主要因子，以及 2004 至 2013 年间灾害直接经济损失数据的均值和 2014 年财政收入的数值，对各省地方政府资金缴纳额度的制定作了探讨，在双因素标准下得出的各地方政府的缴纳比例都较为合理。

Economics Analysis and Insurance Law Regulation on Moral Hazard of the Insured

WANG Pengpeng

Ph.D. Candidate
Xia Men University
Xia men city 361005, Fujian province, China
Number 422 of Siming south road of Xia men city
Tel: +86-18750236198
Email: chinadayly@126.com

Keywords: Moral Hazard; Economics Analysis; Regulation of Insurance Law; Rational-economic Man

Abstract: Because of the information asymmetry between the insurer and the insured, moral hazard occurs. However, it has long time been blamed on the party concerned' s moral problem, neglecting how it forms and the inter-discipline analysis of its prevention mechanism basing on combining economics and law. The person concerned in the insurance contract is deemed economically rational. After taking a fully consideration of the cost and benefit, the person makes decision. The moral hazard is possibly triggered when the person thinks he can get more benefit than cost. . One game between insurer and applicant will result in Nash Equilibrium, which couldn't stipulate moral hazard effectively. Only suffering constant repeated games, is that possible to amend the applicant's moral hazard achieving Pareto Optimality. Throuth establishing the economic model, I find the duty of disclosure, the duty to mitigation the damage, insurance fraud and other clauses in the law of insurance can't achieve stipulating moral hazard. Only plenty of external punishment mechanism intervene, improving the insurance's behavior costs that are higher than the earnings, can it achieve the purpose of correcting applicant's moral hazard. Therefore,only if a sufficient external punishment mechanism is introduced, the cost of the misbehavior of the parties concerned in the contract is raised, which is more than their benefits, can the moral hazard of both the insured and insurer be corrected. The moral hazard has betrayed the basic principle of insurance law, the principle of utmost good faith. So the regulation of the moral hazard from the insurance law will defend the root of the principle.

1. 问题的提出

在保险合同签订的过程中，投保方[1]和保险人之间存在着严重的信息不对称现象，道德风险普遍存在。道德风险的形成是由于双方的信息不对称，不可能完全掌握对方的行为，作为理性经济人的决定偏离帕累托最优的水平。[2]相较于保险人，投保方在保险合同的订立过程中对于保险标的信息掌握的更加全面。作为理性经济人，投保方在没有其他条件的约束情况下存在巨大的道德风险。

对于道德风险的研究，有些学者认为道德风险形成是由于市场的不成熟，人们容易钻法律或者合同的漏洞。[3]也有学者认为道德风险是由于人们的道德水平低下，并把消除道德风险的可能寄托于提高人们的道德水平。[4]还有学者认为道德风险的形成是由于我国征信体系还不健全，人们存在侥幸心理。[5]但是很少有学者从经济学的层面分析投保方的道德风险的生成模型并且在模型中运用法律的手段进行规制分析。

本文采用法经济学分析的方法对投保方道德风险生成的经济动因进行模型构建，并运用博弈理论分析投保方与保险人的动态均衡。在此基础上，对《保险法》中关于投保方的道德风险经济分析，检验其规制效果。希望本文对于道德风险研究有所裨益。

2.道德风险的经济学模型构建

投保方的道德风险的主要表现形式是故意隐藏重要的信息以参加投保，或者在签订保险合同后为骗取保险金，故意或者疏忽的行为影响保险事故发生的概率的风险。以保险合同签订为节点，道德风险可以分为事前和事后的道德风险。6事前的道德风险主要是投保人在签订保险合同时，未尽如实告知义务，甚至故意隐瞒保险标的的重要信息完成投保行为或者以较低的价格获得保险；而事后的道德风险主要是为获得保险赔偿金，投保人一方故意或者重大疏忽促成保险事故的的风险。

2.1 投保方道德风险的形成机制

投保方的道德风险是对保险标的信息的掌握情况以及在投保后的行为对保险发生的概率所产生的影响。投保方所实施的道德风险行为使保险的发生概率提

[1] 相较于保险人，投保人、保单持有人、被保险人和受益人的利益趋于一致。本文研究的主体是投保方的道德风险，为行文方便，将投保人、保单持有人、被保险人和受益人定义为投保方，特此说明。
[2] 殷林森：《双方道德风险、股权七月安排与相机谈判契约》，载《管理评论》2010 年第 8 期。
[3] 该观点的文献有：李勇杰：《论农业保险中的道德风险防范机制的构筑》，载《保险研究》2008 年第 7 期；尹杞月：《国外银行存款保险制度的道德风险问题研究》，载《保险研究》2012 年第 2 期等。
[4] 持有该观点的学者主要是社会学学者，如郝文清：《道德风险的防范与化解》，载《社会科学家》第 5 期；梅世云：《中国金融道德风险的伦理分析》，载《伦理学研究》2009 年第 2 期等。
[5] 该观点的文献有：李玫、杨东勤：《中国存款保险条例中道德风险法律问题析评和完善》，载《河北法学》2016 年第 5 期；陈海燕、刘怀旭：《围观博弈视角下网贷平台道德风险的随机监督策略研究》，载《甘肃金融》2016 年第 3 期等。
[6] Skippe,Harold.jr:*International Risk an Insurance：An Environmental Management Approach*,McGraw-Hill,1998.

高，致使保险人的运行成本增加。投保方的道德风险将经由一定的路径形成。

投保方道德风险形成主要有两个路径：一是投保方在订立保险合同前，故意隐瞒或者因重大过失的行为，与保险人订立保险合同；二是投保方在订立保险合同后，放任保险标的风险提高，致使保险事故发生的概率增加。投保方道德风险的形成的两个路径归结起来就是由于投保方的行为影响保险人的成本和保险事故发生的概率。道德风险形成机制的一个基本假设投保方是理性经济人。理性经济人的外在表现就是趋利避害。在订立保险合同或索赔中，投保方选择性的描述对自己有利的信息，而自动过滤或者忽视对不利于自己信息的描述。

投保方道德风险形成是基于当事人的主观意愿。道德风险生成路径都是受投保方主观意愿驱使产生。由于客观因素影响的保险事故发生概率或者保险人运行成本的高低均无法形成道德风险。客观因素所引起的事故发生概率的变化虽并不直接形成道德风险，但若投保方对于知悉影响保险事故发生概率变化而不积极采取保护措施进行防护，也将转化为投保方的道德风险。此类型的道德风险形成还是经由投保方主观意愿转化后而形成的。所以，单纯的客观因素的变化是无法形成道德风险的。

投保方道德风险形成的动因是行为所带来的超额收益。保险合同作为射幸合同，投保方为订立保险合同所付出的保费将为其在保险事故发生时获得经济赔偿。投保方所付出的保费与保险人给付的赔偿金比例悬殊较大，并不形成对价。保险作为专门经营风险的经济行为，是基于同一团体所面临的共同风险，运用大数法则，核算出保费数额。投保方的道德风险行为影响了保险事故发生的概率，且增加了保险的运行成本。保险人所支付了本不应该支出的赔偿金就是其保险运行成本的直接体现。理性经济人的行为驱动被解释为行为主体的一致性与追求自身利益最大化的统一。[7]对于个体而言，投保方获得了本不应该得到的保险赔偿金，并且其所付出的成本将远远低于保险赔偿金。正是理性经济人趋利的本质，促使投保方实施道德风险行为。

2.2 投保方道德风险的“成本—收益”模型构建

理性经济人的自愿行为都是自利的。[8]投保方的道德风险行为将为其带来经济利益，运用“成本—收益”模型可以分析投保方行为的动因，进而从第三方介入的方式矫正道德风险行为。投保方向保险公司支付费用 L 元购买一张保单价值为 B 元的保险，其中保险标的价值为 V（其中 V≥B）[9]，实施道德风险的行为成本为 A（A≥0），保险事故对保险标的所产生的损失比例为∂（$0<\partial\leq 1$）。

基于以上假设，当投保方不存在道德风险时，其 “成本—收益”分析如下：

[7] 参见何大安：《行为经济人有限理性的实现程度》，载《中国社会科学》2004 年第 4 期。
[8] 参见王文宇：《民商法理论与经济分析》，中国政法大学 2002 年版，第 8 页。
[9] 当保险标的的价值小于投保金额时，为超额保险。在财产保险中，超额保险并不能获得超额赔偿，为研究方便将此种保险方式排除在外。

成本 C=L

损失 $D=\frac{V}{B}\times B\times \partial=\partial V$

当不存在道德风险时，投保方发生保险时候后的损失∂V，保险公司将按照保险合同的约定向投保方赔偿金∂V。所以收益 $R_1=\partial V-\partial V-L=-L$。即投保方需要付出保费 L 才能获得保险保障。

当保险方存在风险时，其“成本—收益”分析如下：

成本 C=L+A

损失 $D=\frac{V}{B}\times B\times \partial=\partial V$

但是由于存在道德风险，投保方上保险公司所主张的赔偿金 D2＞D(D2≤ B)。若投保人的道德行为得逞，保险公司将按照投保方所主张的赔偿金 D2 进行赔偿。此时投保方所产生的收益 R2= D2-∂V-(L+A)。

上述两种情形，投保方在存在道德风险和不存在道德风险时所产生的净收益为 R=R2-R1= D1-∂V-(L+A)-（−L）= D2-∂V-A。当且仅当净收益 R＞0 时，理性的投保方才愿意实施道德风险，取得保险赔偿金。通过经济学手段，在矫正投保方的道德风险，需要引入惩戒措施，提高成本，使净收益 R≤ 0。

2.3 投保方道德风险的市场影响

投保方的道德风险对市场的直接影响是无法确定保险发生的概率，进而影响保险费用。在不存在道德风险的情况下，保险人所承保的风险发生概率降低，其所收取的保费也就较低，取值为 F（min）；但投保人一方的故意行为导致道德风险，其承保风险发生的概率就高，所收取的保费也就相应的增多，取值为 F（max）。由于保险人无法确定在此团体中可能出现的道德风险的高低，所以其收取的保险费用应该是介于 F（min）和 F（max）之间,即

F（min）＜F（fact）＜F（max）

如果保险人能够一直有效的控制投保方的行为，则保险人则不会被道德风险所困扰。[10]作为理性经济人，不存在道德风险投保方，其实际支出的费用 F（fact）大于其本应该支出的费用 F（min），选择不购买保险；而存在道德风险的投保方，其所支出的实际费用 F（fact）小于其本应该支出的费用 F（max），将选择购买保险。当投保方的主体趋于无限时，其将产生“劣币驱逐良币”的市场挤出效应，即存在道德风险的投保方疯狂购买保险，而不存在道德风险的投保方逐渐退出保险市场。长此以往下去，保险公司也将被市场的“劣币”击垮，从而造成正常保险市场失灵，导致风险分散交易在保险市场上无法实现。

3.投保方与保险人的道德风险的博弈

[10] [美]肯尼斯 S.亚伯拉罕：《美国保险法原理与实务》，韩长印等译，中国政法大学出版社 2012 年版，第 7 页。

在保险市场，投保方和保险人均作为理性经济人，出于对自身利益最大化的追求，都会做出道德风险的行为。保险人为有效控制投保方的道德风险，需要提高监督投保方的成本。道德危险所带来的保险成本增加，将影响保险人的保险水平。在有限的市场资源内，投保方与保险人进行反复的博弈，达到利益均衡。保险合同中投保方和保险方通过不断重复博弈，进而可以建构当事人的守信基础。

3.1 投保方与保险人的单次博弈

投保方与保险人的单次博弈，各自的利益是可预期的，采取的策略也是有限的。投保方的策略就是（信任，不信任），保险人的策略就是（守信，不守信）。投保方与保险人的策略通过两两相互组合后，将得到以下四种不同的策略组合：

	保险人	保险人
投保方	（信任、守信）	（信任、不守信）
投保方	（不信任、守信）	（不信任、不守信）

在单次博弈中，彼此的利益不一致，属于非合作博弈。[11]投保方可以信任保险人签订保险合同也可以不信任拒绝签订保险合同。保险人也可以选择守信按照保险合同的约定赔偿保险事故，也可以不守信拒绝进行赔偿。将上述不同的博弈策略组合中，投保方信任保险人，保险人守信履行保险合同是保险市场运行的理想状态。但在单次博弈中，理性经济人双方利益是可以预期的，双方的道德风险是难以避免的。投保人只有信任保险人，保险人才可能产生收益；而投保人不信任保险人则无法达成合同，将难以产生收益。在单次博弈中，保险人不守信带来的收益将远远大于守信。作为理性投保方，其也预测保险人的不守信，所以最好的选择就是不信任保险人，不签订保险合同。在这单次博弈中，投保方不信任保险人，保险人不守信，将出现纳什均衡。

纳什均衡是现代非合作博弈理论的核心内容，是指参与者在一种策略组合下，任何参与则单独改变其策略都不会得到好处。[12]在静态的单次博弈中，纳什均衡是博弈一方在某种概率分布随机的选择不同行动是所作出的对策。[13]在投保方和保险人的单次博弈中，彼此难以形成信任的基础，出于追求自身利益的考量难以达成协议。若市场上长期存在单次博弈，并不利于保险市场的稳定发展。

3.2 投保方与保险人的重复博弈

单次博弈将产生纳什平衡，但在重复博弈中，双方的预期将发生转变。投保人会信任保险人，保险人也会守信的履行合同。双方如果没有受到欺骗，投保人就会一直信任保险人，博弈就重复下去，一旦保险人有欺骗行为，投保人将不再相信保险人。

[11] 参见朱晔：《金融中介的博弈均衡分析》，载《经济问题》2013 年第 5 期。
[12] 李沛瑜：《关于纳什均衡问题的若干研究》，大连理工大学 2013 年博士论文。
[13] 陈通、张国兴、谢国辉：《委托代理框架中道德风险的临界行为》，载《天津大学学报》2002 年第 2 期。

在重复博弈中，保险人也可以有两种选择：一是不守信，得到的利益是一次性的；二是守信，投保人所得到的利益将是长久的。保险合同双方都有机会去“惩罚”实施道德风险行为的人。这时，欺骗的动机会被受到惩罚的威胁所克服，这时会趋向于帕累托最优。

帕累托最优是经济上的一种均衡状态，是指没有一个人能够在不损害其他人利益的前提下，使自身的利益得到改进，也就是达到互利互惠的效率状态。[14]从纳什均衡到帕累托最优的转变，是投保方与保险人之间的重复博弈的结果。此种最优状态也是投保方与保险人在相对确定的市场状态以及现有资源的约束下所大能达到均衡。帕累托最优的状态也会随着相关条件的变化而发生变化，并且随着重复博弈的重复进行从而达到新的均衡。可以说，现有的保险体制下，投保方与保险人的博弈是可重复的，投保方与保险人订立合同时都将认为其到达帕累托最优的状态。

3.3 道德风险博弈的规制

保险人和投保方若长期存在道德风险行为的主要危害在于：保险人在于在保险案件中以不正当的理由拒赔拒付，投保方的利益将受到损害；同时，投保人如果能够通过道德风险行为轻松获得收益，保险公司将加大对监督成本的投入，进而提高经营成本。若长期放任道德风险的存在，将严重影响到保险制度存在的基础。

道德风险的实质是对诚实信用原则的违背，对道德风险规制是对保险制度的维护。根据上述分析，归纳出保险业道德风险规制的基本条件在于：一是投保方和保险人的博弈重复长期存在；二是投保方和保险人不守信的道德风险行为被及时发现；三是投保方和保险人由于道德风险行为所获得的收益行为将被惩罚，甚至受到损失。上述三个条件，第一个条件是基于保险业长期存在的基本假设，第二个条件是对投保方和保险人自身能力的个体假设，第三个条件是对投保方和保险人行为结果的假设。

笔者认为，对于投保方和保险人的道德风险分析均是建立在理性经济人的基础上，理性人做出道德风险行为的内在动因在于其认为道德风险所付出的经济成本要低于经济收益，也就是说道德风险行为为行为人到来了超额的经济利益。从经济学的角度，要矫正道德风险路径就在于增加行为人实施道德风险的成本，减少超额收益。从法学的角度，矫正道德风险的行为可以通过规定不利的法律后果，从而达到规制目的。

4. 保险法对投保方道德风险的规制

从保险法的角度，道德风险行为是对其所确立的“最大诚实信用原则”的违

[14] 李绍荣：《帕累托最优与一般均衡最优之差异》，载《经济科学》2002 年第 2 期。

背，是投保方在合同订立和履行的过程中，采用故意隐瞒或者欺骗的方式，以获取超额的经济利益。从本质上看，道德风险将对保险合同的射幸性个别给付的不对等性、当事人信息的不充分和不对称，以及保险合同作为特别买卖合同在风险等方面的诸多不确定性产生挑战。[15]《保险法》中对于道德风险规制主要体现在如实告知义务、防损减损义务以及保险欺诈等条款。

4.1 如实告知义务的道德风险规制

投保方的如实告知义务是基于最大诚信原则，该项义务对于保险合同的成立及履行都会产生重要影响，是法律道德风险规制的重点。[16]投保方在订立保险合同前应该对保险标的以及被保险人情况进行如实告知，但是当事人为订立保险合同，往往故意隐瞒或者重大过失为履行上述义务，从而影响保险人是否同意承保或者保险费率的行为，该行为属于投保人在订立保险合同阶段的道德风险行为的具体体现。

《保险法》第 16 条对此种道德风险行为进行了规制，赋予保险人解除权，若投保方实施上述风险行为，保险人有权解除合同。按照合同法基本原理，合同解除后，合同的法律关系自始或者仅向将来消灭的行为。[17]但是保险人对于投保方未尽如实告知义务的发现也是基于索赔时所进行的调查，需要付出额外的监督成本。[18]从《保险法》第 16 条分析，投保人由于未尽如实告知义务，保险合同已经成立生效。该条文根据投保人的主观意愿对于保险合同的解除效力进行区别对待。对于故意不履行告知义务的，保险人可以解除合同并且不退还保费，并且对于合同解除前的保险事故不承担保险责任；而对于投保人重大过失不履行如实告知义务的，对于保险期间所发生的保险事故不赔偿，但是应该退还保险费用。对于故意与重大过失的区别规定，主要是由于故意的存在是非常明显的主观恶意，无需审视其中危险结果；而重大过失虽有客观行为，但是恶意并不明显，所以其惩罚力度较小。[19]

按照投保方产生的“收益—成本”模型 $R= D2-\partial V-A$ 分析，对于上述两种情形，其产生的损失也是真实存在的为∂V，未履行如实告知义务可能的成本为 A。但是由于在投保方未尽如实告知义务，保险人不赔偿其保险损失，即 $D2=0$。按照《保险法》第 16 条的规定的两种情形，对于投保人故意不履行如实告知义务的，其可能产生的收益为 $R= -\partial V-A$，上述模型计算所产生的收益 $R\leq 0$。

投保方在由于未尽如实告知义务，在外部惩戒机制的介入下，其产生的收益均为负数。作为理性经济人，投保方对于保险人就保险标的有关情况所提出的询问，应该进行如实告知。但是在保险实务中，投保方不履行如实告知义务的道德

[15] 韩长印、韩永强：《保险法新论》，中国政法大学出版社 2010 年版，第 52 页。
[16] 参见王静：《如实告知义务法律适用问题研究》，载《法律适用》2014 年第 4 期。
[17] 崔建远：《合同法》，法律出版社 2007 年版，第 231 页。
[18] See Thomas F. Segalla & Carrie P. Parks, “Misrepresentations In Insurance Applications: Dangers In Those Lies” , 73 Def. Couns. J. 118, 128 (2006).
[19] 参见叶名怡：《重大过失理论的建构》，载《法学研究》2009 年第 6 期。

风险为何还依然存在？固然有投保方侥幸心理的存在，认为其未尽如实告知义务不会被保险人发现，从而顺利获得保险金赔偿。但是笔者认为《保险法》第 16 条第 3 款所规定的不可抗辩期间有直接的关系，该条文认为保险合同的解除权自保险合同成立之日起超过两年就将丧失。之所以做如此的规定，法学学者认为不可抗辩条款的设定是最大诚实信用原则对投保人适用的一个例外。[20]

笔者认为，这种规定无疑是增加了保险人对于投保方实施道德风险行为的监督成本，助长了投保方实施道德风险行为的可能。关于保险合同效力的问题，按照《保险法》第 16 条的规定，保险合同签订后合同已经成立生效，并没有因为投保方为履行如实告知义务，而使保险合同效力处于不确定状态。相反，投保方在故意或者重大过失未履行如实告知足以影响保险人决定是否同意承保或者提高保险费率的行为，是对保险所确立的“最大诚实信用”原则的背离，并不会因为两年的时间而发生性质改变。从经济角度分析，保险人为了防止投保方未履行如实告知义务，将投入大量成本进行监督。保险人所付出的监督成本将远远高于投保方如实告知的成本，是对社会经济资源的浪费，是极其不经济的表现。

不可抗辩期间的设定增加了保险人的监督成本，是不经济的行为。长期的司法实践也表明，不可抗辩期间的设定往往也是和被保险人欺诈、保险合同效力等问题纠缠在一起，从而给投保方的道德风险行为合理的牟利可能。[21]就经济学分析，在“成本—收益”模型中，投保方经过不可抗辩期间之后，其行为的经济模型将发生变化，由原来的 $R= -\partial V-A$ 转变为 $R= D2-\partial V-A$，收益也将从负数变为正数。此种转变将放任投保方的道德风险行为，动摇保险法所确立的“最大诚实信用”原则。所以，笔者认为从规制道德风险的角度，不可抗辩期间应该进行调整，甚至废除，提高保险的运营效率。

4.2 防损减损义务的道德风险规制

当保险事故发生时，保险标的处在保险方所控制的范围内，保险方可以采取必要的措施减少损失的发生。由于投保方已经就保险标的向保险公司购买相关保险，投保方所可能引发的道德风险为放任该保险损毁，待保险公司进行赔偿。我国《保险法》第 57 条对此种情形进行了相应的规定。

《保险法》第 57 条规定，保险事故发生时，投保方应该采取必要的措施，防止或者减少损失。但是该条文并没有对投保方不采取必要措施防止或者减少损失行为的后果进行不利结果的规制。从经济动因的角度，《保险法》第 57 条很难鼓励投保方进行采取必要的措施防损或者减损。

按照 $R= D2-\partial V- A$ 的模型分析，投保方可能的经济风险为∂V。在此种情况发生后，投保方按照保险合同的约定，在保险限额内可以获得 D2 的赔偿金。若 $\partial V \leq D2$，投保方都将获得足额赔偿。反而是在投保方采取必要的措施，此时还

[20] 参见罗秀兰：《论保险法上的不可抗辩条款及其修订》，载《法学杂志》2009 年第 12 期。
[21] 梁鹏：《保险人抗辩限制研究》，中国人民公安大学出版社 2008 年版，第 307 页。

需要在付出额外的成本。若保险条款没有约定不采取必要措施造成损失可能获得的不利结果或者采取必要措施后可能获得额外的收益，作为理性经济人的投保方将很难有动力去采取必要的措施防止保险损失的扩大。

此外，《保险法》第 57 条第 2 款对投保方采取措施防止或者减少损失所产生的费用进行了严格的限定，只有“必要且合理”的费用才可以在保险赔偿金额内进行赔偿。虽然该费用可以在保险赔偿金额度之外进行计算，但是其金额还是不可以超过保险金的数额。投保方因减损或者防损的行为所付出的“必要且合理”的费用是真实的损失，保险人可以在保险金额的数额内进行承担，投保方并没有因为该必要行为而获得额外的收益，很难刺激投保方的抢救行为。相反，若投保人的施救行为所付出的“必要且合理”的费用超出保险金额额度，投保方只能自行承担。作为理性的经济人，其不采取必要的措施防止或者减少损失的发生，其也可以在保险额度内获得相应的赔偿，不会产生其他的损失。相反，由于投保方的采取施救措施所付出的费用，可能会造成不确定性因素的损失。

《保险法》第 57 条的规定对投保方可能的道德风险行为很难进行有效规制。只有规定不实施必要的措施防止或者减少损失的发生，将受到不利的结果；或者规定实施了必要措施有效的防止或者减少损失，将受到额外的收益。作为理性经济人的投保方，将因为不利结果或者额外收益而减少道德风险的发生。

4.3 保险欺诈的道德风险规制

保险事故未发生，投保方为获取保险赔偿金，谎称发生保险事故，从而向保险人索赔。此类道德风险的动因是投保方通过自己的道德风险行为，获得超出其实际损失的经济利益，且该行为是认为风险的范畴，手段具有相关的隐蔽性。[22]《保险法》第 27 条对其进行的规制。

《保险法》第 27 条是对保险欺诈行为进行规制，分别规定了谎称保险事故发生、故意制造保险事故以及编造虚假保险事故原因或者夸大损失程度三种情形的法律后果与法律责任。对于谎称保险事故发生的行为，保险法的规制措施是保险人解除保险合同，并不退还保险保险费；对于故意制造保险事故的，其规制手段是不承担赔偿责任，除例外情况外，保险人不退还保险费；对于编造虚假保险事故原因或者夸大损失程度的，对于虚报或者夸大部分不承担赔偿责任。

按照 R= D2-∂V-A 的模型分析，对于第一种情形，由于没有产生实际的损失，所以∂V=0,投保方的欺诈行为也被保险人所识破，所以 D2=0，投保方实施道德风险所产生的收益 R= -A＜0。从经济收益模型看，达到规制道德风险的目的。对于第二种情形，投保方产生经济损失∂V，投保方的欺诈行为也被保险人所识破，保险公司赔偿额度 D2=0，投保方所产生的实际收益 R= -∂V- A＜0，达到规制道德风险的目的。

[22] 参见朱孟烨：《保险欺诈防范研究与思考》，载《保险研究》2009 年第 5 期。

对于第三种情况，在保险合同约定的保险事故损失范围内，保险人将按照约定赔偿损失。但是对于虚报或者夸大损失程度部分，在 R= D2-∂V-A 的模型中，对于虚报或者夸大损失程度的部分并没有影响且在这一部分中的并未造成实质损失，所以∂V=0。在这一情形中，投保方可能产生的收益 R= D2-A。在这一模型中，投保方实施虚报或者夸大损失程度道德风险行为的成本 A 极低，基本可以忽略不计，所以其产生的的收益可能是 R= D2。按照《保险法》27 条规定，投保方道德风险行为被识破的不利后果也就是"不承担赔偿或者给付保险金的责任"，即 D2=0。在这一模型中，投保方由于道德风险行为可能产生的收益 R≥0，达不到规制投保方道德风险的目的。

5. 结语

本文采用经济学分析的方法研究道德风险，并且对《保险法》相关的法条进行的验证，是传统法学定性分析向定量分析的一次尝试。对待道德风险这一问题，从法学和经济学的不同角度分析和研究，这对于道德风险的立法、司法等实务都有一定的意义，借助经济模型以及博弈利益，分析投保方由于道德风险行为，改变了决策的随意性。从立法上看，通过"成本—收益"分析，引入外部惩罚机制，使行为者不能因为道德风险行为而受益；从司法上看，借助经济模型分析，使裁判更加有利于实现司法的公平正义的价值，避免法官裁判的随意性。

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投保方道德风险的经济学分析及保险法规制

王鹏鹏

博士生
厦门大学法学院
福建厦门, 361005

关键词：道德风险　法经济学分析 保险法规制 理性经济人

摘要：道德风险的产生是由于保险人与投保人之间存在信息不对称。作为理性经济人，投保方是在充分考量“成本—收益”后认为收益远远大于成本时，才有可能引发道德风险。在与保险人一次博弈中，将产生纳什均衡，无法有效规制道德风险。只有不断重复的博弈，才有可能对投保方道德风险行为进行修正，以达到帕累托最优。通过建构经济学模型，对《保险法》中如实告知义务、防损减损义务以及保险欺诈等条款的分析，认为并没有达到规制道德风险的目的。只有足够的外部惩罚机制介入，提高保险当事人行为成本，并且大于其收益时，才能有效矫正投保方道德风险的目的。回归保险所确立的基本原则，道德风险的产生是“最大诚信原则”的背离，保险法对行为人道德风险的规制，是对“最大诚信原则”的根基的捍卫。

Corporate Property Insurance and Corporate Value:

Evidence from Chinese Listed Companies in Manufactory Industry

ZHOU Haizhen, ZHANG Ji

ZHOU Haizhen
Associate Professor
Zhejiang University of Finance and Economics
Hangzhou 310018, China
Phone: 15957120135
Email: zhouhaizhen@zufe.edu.cn

ZHANGl Ji*
Graduate student
Master of Insurance
Zhejiang University of finance and economics
Phone: 15869144998
Tao Li Yuan, Zhejiang University
Email:18758259080@163.com

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Abstract: In recent years, with deeper operating of China's Reform and Open polocy, Chinese economy is undergoing huge devolopment. At the same time, the scale of insurance industry also becomes flourishing. However, the speed of development of corporate insurance is slower than other types of insurances, which leads to the falling of ratio of corporate property insurance to the property insurances. In order to explain this weird phenomenon in China, this paper uses the panal data of manufacturing indastry to analyse the relationship between behaviour of buying corporate property insurance and corporate value. The result reveals that corporates' behaviours positively correlate with their ROA, which means that corporate property insurance can significantly improve the value of corporates.

1. 引言

近二十年，受益于改革开放政策，我国经济飞速发展，国民生产总值与全社会固定资产投资额快速增长（见图 1）。与此同时，我国保险业也开始恢复，保费收入快速增加。

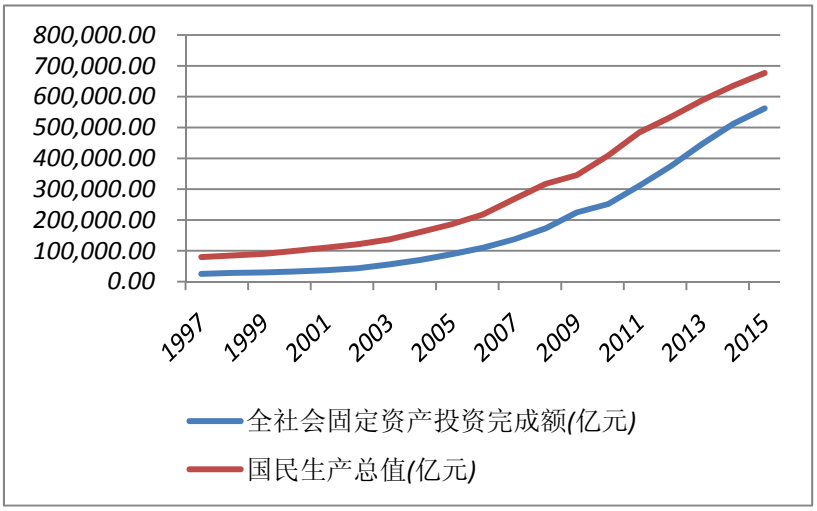


图 1 我国国民生产总值与全社会固定资产投资额增长情况

然而我国企业财产保险（以下简称企财险）的发展近来却不尽如人意。我国企财险保费收入占财产保险（以下简称财险）总保费收入的比例除了 1997 年骤升，其余年份都是处于下降的状态（朱铭来、吕岩等，2010）。事实上，从 2006 年至今，企财险增长率基本上处于保险业平均增长率之下（图 2），而企财险保费收入占财险保费收入的比例还在持续下降（见图 3）。

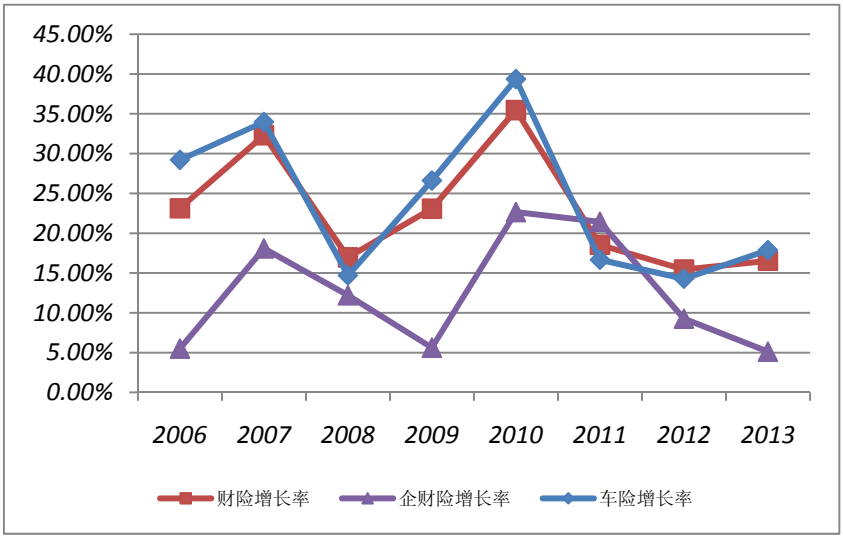


图 2 我国财险、企财险和车险增长情况

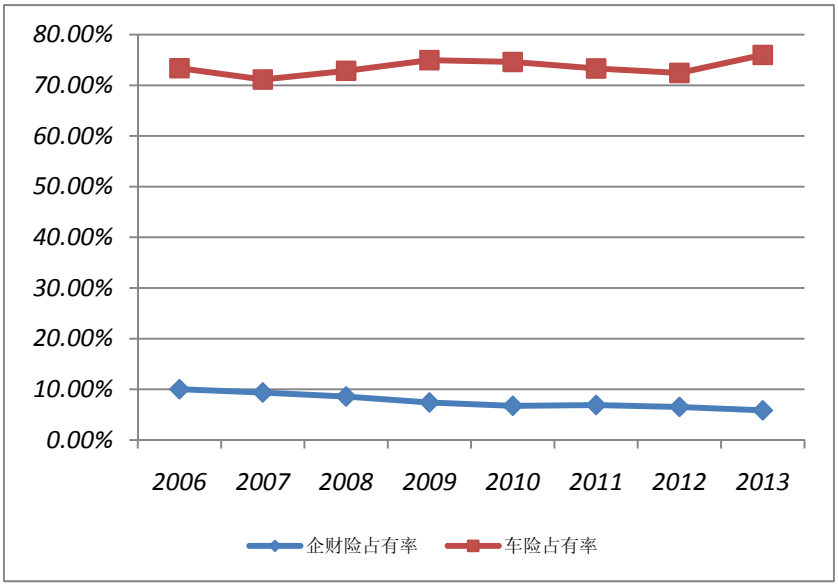


图 3 我国企财险与车险占财产保险比例

那么是什么原因造成了这种异常现象？现有文献大多只关注对保险需求的影响因素问题，而较少研究我国企财险发展遭遇困境的原因。而对这种现象产生的原因，却鲜有文献涉及。

国外对于企业财产保险需求的研究主要是探索影响保险需求的因素。Brian G. M. Main 在 1983 年和 2000 年分别对美英两国经理人进行了购买企财险动机的问卷调查，得出公司购买企财险主要是为了维持公司流动性和盈利的稳定性，而人力资本、债务要求与税务效应的影响在现实中并不明显。Hoyt & Khang 利用美国上市公司数据进行的实证考察显示：企业对企财险的需求与其负债比例、经理人持股情况、企业规模、风险成本等多种因素相关。Yamori（1990）、Regan&Hur 也分别对日本、韩国的上市公司进行了相似的研究，得出了类似的结论。Michel-Kerjan 等人（2014）将恐怖主义对企业保险需求的影响也考虑在内，并且认为对恐怖主义风险的保险比对财产风险保险更具有价格弹性。以上国外学者的研究一般集中在公司层面，关注微观因素对企财险需求的影响。但国外保险需求相关研究起步早，保险市场相对我国发展程度高，这与我国的实际情况略有差异。

而国内对保险需求的研究大多仍然是建立在影响保险需求因素的角度上。林宝清等（2004）发现我国财产险的需求弹性系数与 GDP 不存在相关关系。黄枫等（2014）应用 2001 至 2007 年制造业企业数据，发现企业保险行为与财产保险平均费率显著相关。赵红梅等（2013）利用调整地区和时间权重的面板数据，得出固定资产投资、交通事故损失、火灾事故损失以及受教育程度是影响财产保险的需求因素。但由于国内企财险发展的特异性，我国学者还提出我国企财险需求存在的一些问题。如朱铭来等（2010）利用 31 个省、市、自治区的面板数据发现固定资产投资、企业所得税、企业规模等因素与保险需求显著正相关，并论证了我国存在着“投保不足”的现象。以上研究虽然根据我国保险的实际情况提出

了"投保不足"的概念，但主要的研究内容却主要以宏观数据为支撑，在公司层面的研究相对较少。

另一方面，我国目前对于保险需求的研究，一般不针对保险产品，从而可能忽略了我国保险市场历史相对较短、保险市场发展滞后对保险产品带来的影响。例如我国保险产品存在一定同质化，保费厘定的市场化程度不够充分等问题。购买企财险是否能真正意义上提高公司价值、保证公司盈利能力还未得到验证。

因此，本文借鉴国外学者立足微观的研究方法，结合国内实际情况，将研究对象聚焦到我国上市公司。在国内企财险对公司价值影响的领域，本文首次采用机械制造行业上市公司的面板数据的计量方法。相对于宏观层面较多关注于个体与时间差异的角度而言，以公司为研究对象能更直接地说明企财险对公司价值的影响。采用微观层面的公司面板数据为研究，可以在考察企财险的购买情况对公司价值的影响外，同时将不同公司的财务风险与经营风险对其价值的影响排除，从而得到更加准确的结论。

对国内公司价值影响因素的领域也有较多的研究成果可以参考。殷红等（2012）以 2006-2010 年的战略性新兴产业上市公司的数据为样本，实证分析得出战略性新兴产业上市公司的股权结构、负债与公司价值存在两两内生性；股权结构与公司价值之间存在双向互动关系，负债不利于公司价值的提高。而在竞争激烈的传统行业如家电行业，股权结构却与公司价值没有显著相关性（朱武祥等，2001）。王爱群等（2015）通过研究 2000-2013 年沪深两市 A 股上市公司发现，内控质量能够引起公司价值的变化，且内控质量越高，其公司价值越大。因此，对公司价值的影响方面，主要集中在两个方向，一是公司股权对公司价值的影响，二是公司内控质量，即财务管理方面的因素对公司价值的影响。但已有文献对公司价值影响因素的研究多集中在财务风险与管理风险，对于纯粹风险对公司价值影响的研究甚是少见。企财险是公司用于管理纯粹风险的主要手段，因此本文认为，公司是否购买企财险也会影响公司价值。

2. 企财险与公司价值关系的理论分析

在企业保险行为对于公司价值影响的领域，人们已经对其进行了多方面的研究。一般的保险与风险控制理论普遍认为，采用保险的方式进行风险管理，基本上都是为了减少公司的非系统性风险。而对公司特定风险的管理是不会影响资本的机会成本的，因此根据公司价值的计算方法，通过购买保险的方式来减少公司风险的行为，将增加股东及公众对于公司的期望现金流，从而使得公司价值增加。

传统的论证保险行为增加公司期望现金流的理论，一般是从四个方面来说明购买保险是如何增加公司的期望现金流的：

2.1 通过捆绑的方式降低公司风险控制的成本

保险公司在提供赔付承诺的服务时，一般还能提供许多其他方面的服务，例如损失控制和理赔方面的服务，这些服务与赔付承诺均存在一定的联系。通过捆绑服务的方式，保险公司既能具有更高的积极性提供高质量的损失控制和理赔服务，还能更容易地对欺诈性索赔进行识别，从而保险公司的管理成本得到一定的控制，这将会反映到保险公司对投保公司所提供的捆绑服务的费用中。所以，保险公司提供与赔偿承诺捆绑的保险服务将降低公司风险控制的成本。

2.2 减少公司在出现损失时不得不以高成本融资的可能性

公司在遭受了财产损失后，通常面临如何弥补损失以保持公司正常运转的问题，由于遭受损失后公司必然要使用相当部分的流动资金来弥补损失，因此这会对公司的发展带来巨大发展，主要是从两个方面来分析其影响。

一方面，如果公司遭受损失后缺少具有充分流动性的自有资金或资产，那么公司就必须以股权或债权的方式进行外部融资来弥补损失，这种外部融资行为会带来极高的成本，并且由于股权或债权的持续性，这种极高的成本带来的影响会对公司的长期发展带来不利影响，最终导致公司价值的下降。

另一方面，如果公司即使在遭受损失后仍然持有流动性充足的资金，虽然其自有资金足以用于弥补保险事故带来的损失，但是由于自有资金被用于支付损失，公司将付出这一部分资金的机会成本，即本应投资于净现值更高的部分项目的资金被用于损失补偿。这种情况会导致公司放弃部分高净现值的新项目，或者以高于自有资金机会成本的价格为新项目进行新的融资，公司价值将会因此下降。

2.3 减少财务困境的可能性，降低期望破产成本

如果公司在遭受了损失之后公司无法进行损失补偿，则可能会导致公司无法支付债权人的资金，那么公司则会面临财务困境。一旦公司陷入财务困境，公司就必须进行重组以调整债务结构或进行清算以支付债务。

进入重组或清算的公司首先将面临巨额的直接成本，如聘请清算律师的费用、法院诉讼费用和财务会计费用等，这些费用使得公司价值急剧降低。其次，公司还将面临一些财务困境带来的间接成本，例如，由于公司风险的增大，新的债权人将会要求比公司正常运营时更高的利率以获得足够的风险补偿。最后，公司还将面临委托代理制度带来的一系列“代理成本”的上升，主要包括“投资不足”和“资产置换”，即在财务困境下，代理人可能高估新项目的风险而放弃投资决策，并且在股东授意下，代理人有动机做出利于股东却损害债权人的行为。

因此，采取减少破产可能性的措施将有利于公司价值的提升。

2.4 减少期望税赋

在现行会计制度下，企财险的保费是计入管理费用中的，在计算息税前利润时即予以扣除。因此，购买企财险对企业来说有一定的避税效应，在累进税制

下，对所缴税费越多的公司，当期所缴纳的保费越多，在下一期计算应缴税费时，避税效应就越显著。从而购买企财险变相地减少了企业所缴税费，增加了公司价值。

当然，由于购买企财险需要向保险公司支付保费与附加保费，购买企财险也对公司期望现金流有负面影响，会导致公司价值的减少。那么，购买企财险对企业价值是否有正向的影响？这个问题也是推动本文研究企财险与公司价值相关关系的原因。

在上文分析的基础上，本文选取机械制造行业上市公司来研究企财险与公司价值的相关关系。原因有以下几点：一是机械制造业业公司拥有较多的固定资产，这类公司是企财险的主要购买对象；二是机械制造业在生产过程中较易发生火灾、爆炸等事故，一旦发生事故，会造成大量的资产减值；三是在考察期内，相关政策针对机械制造业进行了更改，因此机械制造业相较其他高危行业如化工、工程建造等，前者对政策变化更有敏感性。

3. 模型设定与变量说明

3.1 模型构建

本文所选取的数据是平衡面板数据，则根据计量经济学原理，应采用面板数据分析模型。由于每家公司每年购买保险的情况都有可能发生变化，因此作为保险行为的变量是一个随个体时间不同变化的量。而总结过去文献研究的情况，又主要把影响企业价值的因素分类为企业外部和企业内部的因素，因此，本文设定的基本模型如下：

$$Y_{it} = \alpha_{it} + \beta_1 \times Insurance_{it} + \beta_2 \times INNER_{it} + \beta_3 \times EXT_{it} + \varepsilon_{it} \quad (1)$$

其中 Y_{it} 是被解释变量，是 i 企业 t 年（后文 i，t 表示的含义均与此一致）的公司价值；$Insurance_{it}$ 是表示企业是否购买企财险的解释变量，$INNER_{it}$ 表示企业内部可控制变量，EXT_{it} 表示企业外部不可控制变量，ε_{it} 为随机扰动扰，服从独立同分布。

3.2 变量选取

3.2.1被解释变量：

本文选取资产收益率（ROA）为模型的因变量。研究公司价值度量有多种指标可以选择，资产收益率（ROA）相对于 TobinQ、资产收益率（ROE）、EPS 及市净率等指标在研究企财险对公司价值的影响上更具有优势。原因有二：一是公司购买企财险主要是为了补偿意外发生的灾害（如火灾、台风、地震等）对公

司实物财产带来的损失，这类损失一般是资产减值及资产可利用价值的减少；二是目前大多文献采用的度量指标均与公司股价相关，而选择 ROA 作为指标可以减小股价波动带来的公司价值波动，使计量结果更具说服力。因此本文采用 ROA 作为因变量，通过对公司资产盈利能力的描绘来衡量公司价值。

3.2.2解释变量：

根据各样本企业财务报表披露的信息，本文设定虚拟变量 $Insurance_{it}$ 来表示公司是否购买企财险。$Insurance_{it}$ 为 1 表示公司购买了企财险，为 0 则表示公司没有购买企财险。

3.2.3控制变量的选取：

本文选取两类变量 $INNER_{it}$ 与 EXT_{it} 作为控制变量，根据研究的具体情况，选择具有代表性的统计量来衡量这两类指标。

1) 内部控制变量 $INNER_{it}$：

a) 衡量公司运营状况的变量

总资产周转率 $Turnover_{it}$ 可用于衡量公司营运状况。其定义如下：

$$\text{总资产周转率} = \frac{\text{营业收入}}{\text{资产总额期末余额}}$$

对于公司而言，资产总额在短期内，除非发生重大的变故，资产总额不会发生巨大的变化。因此，根据总资产周转率的定义，总资产周转率越大，意味着公司的营业收入越高，从而公司的运营状况越好。反之若总资产周转率水平较低，则说明公司运营较差。

b) 衡量公司债务水平的变量：

在债务水平的度量指标上，大部分文献采用资产负债率（B/S）作为衡量公司债务水平的指标。本文由于被解释变量是资产收益率（ROA_{it}），若采用资产负债率作为控制变量，可能会对被解释变量产生干扰。而相关研究表明，债务期限结构通过对代理成本的影响，也可影响公司价值（李琪等，2011）。因此，为了准确衡量公司的债务水平且不对被解释变量 ROA_{it} 产生干扰，本文选取长期债务占比（LTD_{it}）作为描述样本企业债务状况的变量。

2) 外部控制变量 EXT_{it}

外部控制变量是指企业无法通过自身经营或管理改变的变量，如相关政策的制定与实施、宏观环境发生变化等。根据《财企〔2012〕16 号企业安全生产费用提取和使用管理办法》（以下简称为《办法》），为了建立企业安全生产投入长效机制，加强安全生产费用管理，保障企业安全生产资金投入，维护企业、职

工以及社会公共利益，2012 年起机械制造类企业必须以上年度实际营业收入为计提依据，采取超额累退方式按照以企业规模划分的标准平均逐月提取安全生产费。由于计提安全生产费对企业的运营会产生较大的影响，从而影响公司价值，因此，本文设定虚拟变量 d_t 来表示该政策实施情况，设定 2012 年以前 d_t 为 0，表示未施行《办法》；2012 年以后为 d_t 设定为 1，表示 2012 年后企业需按《办法》计提安全生产费用。

基于以上分析，本文最终计量模型为：

$$ROA_{it} = \alpha_{it} + \beta_1 \times Insurance_{it} + \beta_2 \times Turnover_{it} + \beta_3 \times LTD_{it} + \beta_4 \times TAX_{it} + \beta_5 \times d_t + \varepsilon_{it} \quad (2)$$

4. 计量结果和分析

本文选取 2010 年到 2015 年 174 家机械制造业上市公司的财务数据作为样本数据，数据主要来源于 Wind 数据库。剔除了一部分在实证年份之间进行了重组并导致其财务数据产生了较大变化的公司和变量数据缺漏的公司，最终有效样本企业为 134 家 A 股机械制造业上市公司。此外，本研究所使用的数据处理以及统计分析软件为 Stata12.0。

4.1 计量结果

4.1.1 变量的相关系数分析

通过求取变量的相关系数（见表 1），可以得知，各变量间的自然相关性不是很大，模型不会存在严重的多重共线性问题，因此本文所选取的变量与样本数据可以用于回归分析。

表 1 各变量相关系数矩阵

(obs=804)	insurance	Turnover	d	LTD
insurance	1			
Turnover	0.0598	1		
d	-0.0318	-0.189	1	
LTD	0.0233	-0.262	-0.0337	1

注：*表示相关系数在双端 0.05 水平上显著

4.1.2 模型回归结果

使用固定效应模型对样本数据进行回归的结果（见表 2）表明：混合效应 F 检验结果显示，固定效应模型和随机效应模型优于混合效应模型；Hausman 检验结果显示固定效应模型又更优于随机效应模型。

回归结果显示，企业是否购买企财险与资产收益率有显著的正相关关系。总资产周转率也对资产收益率有显著正向影响。长期债务占比与财务政策均对资

产收益率有显著负向影响。

表 2 固定效应面板数据回归结果

变量	系数	标准误差	t 统计量	p 值
insurance	0.0153	0.00588	2.600	0.00900
Turnover	0.0635	0.00856	7.410	0
LTD	-0.0119	0.00277	-4.300	0
d	-0.0413	0.0143	-2.890	0.00400
混合效应 F 检验：	F(133,666)=7.170		p=0.0000	
Hausman 检验：	chi(6)=29.38		p=0.0000	

4.2 对实证结果的分析

根据固定效应模型回归结果，企业购买企财险的行为与公司价值有显著的正相关关系。总资产周转率与公司价值也有显著正向影响。长期债务占比和财务政策均与公司价值有显著负向影响。

4.2.1 对解释变量回归结果的分析

公司是否购买企财险（$Insurance_{it}$）：回归结果显示，公司购买企财险对公司价值有显著的正的相关性，公司购买企财险会提高资产收益率，从而提高公司价值。根据回归结果，购买企财险的行为，平均能给公司资产收益率带来 1.5%的提升，这说明公司购买企财险的行为对提升公司价值起到了一定的作用。

根据计量结果，结合上文对企财险与公司价值的理论分析，我们可以推测，公司购买企财险后，虽然公司支付保险费会导致其现金流出，但购买企财险对公司价值的提升也有一定正面的效果。当投保公司没有发生保险事故时，保险公司可以通过提供完善的服务帮助投保公司进行风险管理以降低投保公司发生风险事故的机率；当投保公司发生了保险事故，由于事前购买了企财险，保险公司能及时帮助投保公司弥补保险事故带来的损失，帮助投保公司快速恢复生产、保证投保公司正常进行的项目不受影响，从而投保公司的期望价值上升。

就本文的实证结果来看，目前购买企财险所获取的对公司价值的提升还是比较有限，这一方面可能是由于我国企财险市场发展时间较短，保险产品的本身的功能还有待提高，另一方面可能是在企财险定价方面，由于我国保险市场化程度有限，相关保险的定价还比较保守。

4.2.2 对控制变量回归结果的分析

总资产周转率：总资产周转率与公司价值显著正相关，意味着总资产周转率越高，资产周转速度越快，公司价值越高。这与已有的研究成果与实际情况一致。公司总资产周转率越高，显示其营运状况越好，业务规模业大，这些好处都有利于公司价值的提升。

长期负债比率：长期负债比率与公司价值有显著的负向关系。在相关财务

理论关于债务期限的描述中可知，长期负债由于存在期限风险与较大的利率风险，其成本高于短期负债。因此，长期负债的比例过高会造成债务成本升高，从而增加企业运营成本，降低公司价值。本文LTD_{it}的系数为负，说明长期负债比率越高，公司价值越低，与实际情况与已有理论一致。

会计政策的实施：根据本文模型回归结果来看，《办法》的实施导致公司价值下降。这是因为根据《办法》规定，机械制造企业以上年度实际营业收入为计提依据，采取超额累退方式按照以企业规模划分的标准平均逐月提取安全生产费会造成企业现金流的减少，企业在计提安全生产费后会减少企业的流动资金，从而企业在运营时更为谨慎，而放弃原本采纳的激进的增长方式，因此会造成一定的企业价值的下降。

由上文分析可以得知，对控制变量的分析显示，本文所选取的控制变量与已有理论是高度吻合的，而从实际情况来看，本文选取的控制变量的回归结果也是可信的，可以作为解释变量的补充对被解释变量进行说明。

5. 结论与建议

对企财险的购买行为与公司价值的相关性研究为解释我国企财险近年来发展遇到的困境提供参考。本文认为，只有实证购买企财险的切实提高了公司价值，我们才可以进一步对企财险的需求端进行更深入的理论和实证分析。鉴于此，本文利用 2010 年至 2015 年机械制造行业上市公司财务数据，实证检查了上市公司购买企财险行为与公司价值的关系。结果发现：目前，虽然购买企财险对公司价值有显著为正的影响，但提升程度仍比较有限。

那么，根据本文得到的结论，我们提出以下建议：

加大对企财险产品开发的，给予财产保险公司的企财险业务予以适当的资金支持、技术支持和政策支持，推动财产保险公司降低企财险产品的开发成本和运营成本；

进一步提高企财险市场市场化程度，通过开放市场，促进财产保险公司之间的竞争，促使财产保险公司加大对企财险业务竞争力的重视，最后实现通过市场竞争提升企财险产品的效果。

激励保险公司开发新的企财险产品，对新开发的企财产险品予以专利保护或政策补贴，以扩大可保风险的范围，从而提高企财险产品的保障范围，提升企财险产品的效用。

此外，我们在重视提升企财险产品功效的同时，还应该着力于释放对于企财险的需求，如提供更加优惠的税收政策、对不同条件的公司予以分类补贴以刺激保险需求、对投保不足的企业较多的地区进行风险控制观念的普及等。

然而本文仍存在一些不足，如使用虚拟变量作为企业购买保险行为的测度较难体现企业对于财险保险的程度、选取机械制造行业可能无法完全体现企财险

对于所有公司的价值的影响。鉴于此，在本文基础上进行的下一步可以从扩展行业出发研究企财险相关影响，也可以考虑测度公司的保险深度对公司价值的影响情况。此外，基于本文得出的结论，还可研究导致“投保不足”的具体原因，以帮助我国企财险发展走出困境提供更多的理论和实证研究的支持。

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企业财产保险对公司价值的影响研究

——基于机械制造行业上市公司的实证分析

周海珍 张吉

周海珍
副教授
浙江财经大学金融学院
杭州310018，中国
电话: 15957120135
Email: zhouhaizhen@zufe.edu.cn

张吉*
保险硕士
浙江财经大学金融学院
杭州市江干区下沙经济技术开发区
学源街
电话:15869144998
Email: zhangji11991@163.com

关键词：企业财产保险；公司价值；机械制造行业；面板数据

摘要：近年来，随着改革开放的进程，我国经济高速发展，保险业的规模也在迅速壮大。然而，企业财产保险的发展速度却远低于其他险种，这导致企业财产保险在财产保险份额的占比不断下降。为了尝试对这种异常现象进行解释，本文以机械制造业上市公司为样本，采用面板数据固定效应模型分析机械制造行业上市公司购买企业财产保险的行为与公司价值的关系。结果显示，企业购买企业财产保险的行为与其资产收益率显著正相关，意味着企业财产保险能显著提高公司价值。



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