An Analysis of the Synergy Degree of Insurance Innovation and Financial Development in China

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Abstract—**The objective of this paper was to figure out the synergetic relationship between two subsystems of the financial system, to measure the synergy degree of them, and to propose suggestions used to develop both insurance innovation and financial development. Synergetic theory was used in this paper to analyze the relationship between insurance innovation and financial development in China. The author built a model to measure the degree of order of the two subsystems. Different indexes were introduced to explain the order performance. And another model, which was based on the former model, was built to measure the synergy degree of the subsystems. The empirical analysis shows that China's financial development is in a steady upward track, but the insurance innovation faces a tough situation. The degree of order of insurance innovation subsystem has been decreasing since 2009. And the low synergy degree of two subsystems indicates that there is a disharmony development relationship between them.**

Keywords-insurance innovation; financial development; synergy degree; degree of order; synergtic development

I. INTRODUCTION

As an important part of modern service industry, the insurance industry has become one of the fastest growing sectors of the national economy. The progress of insurance innovation promotes the financial development, while the promotion of financial development reacts on the level of insurance innovation[1]. Therefore, insurance innovation and financial development are two interrelated subsystems. There is an interactive effect between them. The synergy degree of them is the foundation of national economic development[2].

The relationship between insurance innovation and financial development was first studied in last 90s. There was a positive correlation between development of insurance and financial development[3]. Insurance industry growth had something to do with economic growth, but the causal relationships between them were different from nation to nation in OECD countries[4]. In the demand-following case, the development of finance increased the demand for new insurance service, resulting in boom of insurance innovation; in the supply-leading case, insurance companies were devoted to expand business scales and compete for market share, which contributed to innovation of insurance products and

service[5]. Another studies showed that the relationship between insurance innovation and financial development was restricted by many factors, conditions of promoting or hindering mutually might appear in different situations[6][7]. The study under financial synergy perspective indicated that there was an obvious competitive relationship between the whole insurance (as well as life insurance) industry and banking industry. But there wasn't a dominate party in the competitive and complementary relationship between possession insurance industry and banking industry[8].

The study in IT industry in China built models to measure the degree of order and coordinating level of the entire system consisted of four IT subsystems[9]. Synergy degree model was set in the study of the relationship between technology innovation and energy efficiency, and explained the synergy level of the subsystems of high-tech industry in China[10].

In summary, the mutual close association between insurance innovation and financial development had been widely recognized by academia, but the situation of evolution trends deviating, inconsistent development paces and disordered development paths between them had restricted the development of insurance and finance, even been the barrier of national economic growth.

II. SYNERGY MODEL AND EMPIRICAL ANALYSIS OF INSURANCE INNOVATION AND FINANCIAL DEVELOPMENT

A. Degree of order Model of Subsystem

Let the complex system S consist of insurance innovation subsystem and financial development subsystem S_j, $j \in [1, 2]$. The statue and structure of subsystem Sj (Sj1, Sj2, ······, Sjm) is determined by order parameters. Let the order parameters of insurance innovation and financial development $e_j = (e_{j1}, e_{j2}, \ldots\ldots e_{jm})$, $m \geq 1$, $\beta_{ji} \leq e_{ji} \leq \alpha_{ji}$, $i \in [1, m]$. The degree of order of subsystem is defined as:

$$u_j(e_{ji}) = \begin{cases} \dfrac{(e_{ji}-\beta_{ji})}{(\alpha_{ji}-\beta_{ji})}, & i \in [1, \ l] \\[2mm] \dfrac{(\alpha_{ji}-e_{ji})}{(\alpha_{ji}-\beta_{ji})}, & i \in [l+1, \ m] \end{cases} \quad (1)$$

α ji is the maximum value of i index, j system. βji is the minimum value of i index, j system. The total contribution, which is made from order parameter eji to the degree of order of Sj, can be measured by accumulating ui (eji) . Geometric mean method is used to describe the subsystem's function of degree of order in this paper.

$$u_j(e_j) = \sqrt[m]{\prod_{i=1}^{m} u_j（e_{ji}）} \quad j=1,2 \quad (2)$$

B. Synergy degree Model of Subsystems

Let uj0 (ej) equal the degree of order of subsystem's order parameter at initial time, uj1 (ej) equal the degree of order of subsystem's order parameter at a given time in the developing process of complex system. The synergy degree of subsystems can be defined as:

$$syn = \eta \sum_{j=1}^{m} \delta_j |\mu_j^1(e_j) - \mu_j^0(e_j)| (3)$$

$$\eta = \frac{\min[\mu_j^1(e_j) - \mu_j^0(e_j) \neq 0]}{|\min[\mu_j^1(e_j) - \mu_j^0(e_j) \neq 0]|},$$

$$j = 1,2,...,m, \delta_j \geq 0, \sum_{j=1}^{n} \delta_j = 1$$

C. Empirical analysis of the synergic evolution of insurance innovation and financial development

Choosing the index system of insurance innovation and financial development subsystem according to the rationality and feasibility, comprehensiveness and comparability principle. The evaluation index system of insurance innovation is in Table I and the evaluation index system of financial development is in Table II.

TABLE I. EVALUATION INDEX SYSTEM OF INSURANCE INNOVATION

Category	Index	Meaning
Scale	e11=Premium/GDP	Insurance scale
Risk	e12=Compensation and benefit/Premium	Level of risk control innovation
Structure of insurance asset	e13=Asset of reinsurance company/Asset of insurance industry	Level of insurance innovation
	e14=Asset of foreign insurance company/Asset of insurance industry	Level of insurance market opening
Utilization of insurance asset	e15=securities investment fund of insurance fund / Insurance fund balance	Level of innovative utilization of insurance asset
	e16= corporate-bond of insurance fund /Insurance fund balance	
	e17= bank deposits of insurance fund /Insurance fund balance	Level of traditional utilization of insurance asset
	e18= national debt of insurance fund /Insurance fund balance	

TABLE II. EVALUATION INDEX SYSTEM OF FINANCIAL DEVELOPMENT

Category	Index	Meaning
Financial development	e21=FIR=(M2+L+S)/GDP	Finance structure and development
	e22=M2/GDP	Monetary degree of economy
Technology capital	e23= R&D of finance	Level of technology capital
	e24= number of R&D staff/ number of financial staff	Level of technological human resource
Financial instruments	e25= Stock turnover	performance of stock market
	e26= corporate-bond issuance	Performance of enterprise financing platform
	e27= total volume of futures	Performance of futures market

The values of order parameters of the insurance innovation subsystem and the financial development subsystem are gathered and classified from STATISTICAL YEARBOOK OF CHINA and FINANCIAL STATISTICAL YEARBOOK OF CHINA. The range of the data is from 2005-2012 and listed in Table III and Table IV.

TABLE III. VALUES OF ORDER PARAMETERS OF INSURANCE INNOVATION SUBSYSTEM

Year	e11	e12	e13	e14	e15	e16	e17	e18
2005	0.0269	0.2305	0.019	0.044	0.0786	0.0855	0.3665	0.2548
2006	0.0261	0.2550	0.016	0.044	0.0513	0.1193	0.3367	0.2051
2007	0.0264	0.3219	0.030	0.043	0.0945	0.1051	0.2441	0.1485
2008	0.0310	0.3037	0.030	0.046	0.0539	0.1505	0.2647	0.1377
2009	0.0327	0.2806	0.029	0.051	0.0737	0.1623	0.2811	0.1083
2010	0.0363	0.2203	0.023	0.052	0.0569	0.1723	0.3021	0.1046
2011	0.0306	0.2740	0.026	0.050	0.0527	0.1586	0.3206	0.0859
2012	0.0300	0.3045	0.025	0.047	0.0529	0.1590	0.3421	0.0700

Year	e_{21}	e_{22}	e_{23}	e_{24}	e_{25}	e_{26}	e_{27}
2005	1.5381	1.6154	487	0.0186	6,623.73	2,046.50	32,287.41
2006	3.0863	1.5976	278	0.4112	16,145.23	3,938.32	44,950.82
2007	4.0329	1.5177	404	0.4069	36,403.75	5,058.50	72,846.08
2008	3.0364	1.513	536	0.4106	24,131.39	8,435.40	136,395.97
2009	4.0471	1.7782	709	0.4066	51,106.99	15,864.40	215,751.76
2010	4.0648	1.8075	367.5	0.4039	42,151.98	10,043.38	152,097.09
2011	3.9242	1.8058	332	0.3965	33,956.57	20,143.00	105,413.75
2012	4.319	1.8758	539.6	0.3769	32,881.06	37,366.00	145,052.57

Let the data in Table III and Table IV be standardized and put it into (1), and the outputs are the degrees of order of insurance innovation and financial development subsystems' order parameters, which are listed in Table V and Table VI.

TABLE V. DEGREE OF ORDER OF INSURANCE INNOVATION SUBSYSTEM'S ORDER PARAMETERS

Year	e11	e12	e13	e14	e15	e16	e17	e18
2005	0.0745	0.8993	0.2248	0.0605	0.6308	0.0000	0.0000	0.0000
2006	0.0000	0.6585	0.0000	0.0867	0.0000	0.3892	0.2431	0.2692
2007	0.0304	0.0000	1.0000	0.0000	1.0000	0.2254	1.0000	0.5753
2008	0.4765	0.1794	1.0000	0.2923	0.0599	0.7489	0.8317	0.6335
2009	0.6496	0.4062	0.8997	0.8342	0.5192	0.8853	0.6973	0.7925
2010	1.0000	1.0000	0.4869	1.0000	0.1300	1.0000	0.5263	0.8129
2011	0.4414	0.4712	0.7424	0.8063	0.0329	0.8426	0.3753	0.9139
2012	0.3823	0.1711	0.6493	0.4577	0.0369	0.8471	0.1996	1.0000

TABLE VI. DEGREE OF ORDER OF FINANCIAL DEVELOPMENT SUBSYSTEM'S ORDER PARAMETERS

Year	e21	e22	e23	e24	e25	e26	e27
2005	0.0000	0.2822	0.4849	0.0000	0.0000	0.0000	0.0000
2006	0.5566	0.2333	0.0000	1.0000	0.2140	0.0536	0.0690
2007	0.8969	0.0130	0.2923	0.9890	0.6695	0.0853	0.2211
2008	0.5386	0.0000	0.5986	0.9985	0.3936	0.1809	0.5675
2009	0.9020	0.7311	1.0000	0.9883	1.0000	0.3912	1.0000
2010	0.9084	0.8119	0.2076	0.9813	0.7987	0.2264	0.6530
2011	0.8578	0.8072	0.1252	0.9626	0.6145	0.5124	0.3986
2012	1.0000	1.0000	0.6069	0.9126	0.5903	1.0000	0.6146

Put the data of Table V and Table VI into (2), and the outputs are the degrees of order of insurance innovation subsystem and the degree of order of financial development subsystem. Which are listed in Table VII. Let 2005 be initial time, δ=0.5, and put the data of Table V and Table VI into (3), The output is the synergy degree of insurance innovation and financial development, which is listed and graphed in Table VII and Fig1.

TABLE VII. DEGREE OF ORDER OF SUBSYSTEMS AND

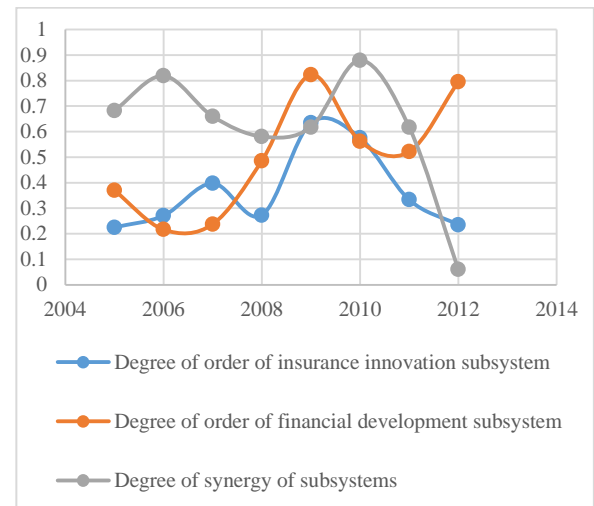| Year	Degree of order of insurance innovation subsystem	Degree of order of financial development subsystem	Synergy degree of subsystems
2005	0.2249	0.3699	-
2006	0.2707	0.2164	0.8185
2007	0.3974	0.2374	0.6600
2008	0.2723	0.4849	0.5811
2009	0.6345	0.8226	0.6178
2010	0.5758	0.5622	0.8796
2011	0.3331	0.5214	0.6176
2012	0.2351	0.7951	0.0599

SYNERGY DEGREE OF SUBSYSTEMS

Figure 1.

Degree of Order of Subsystems and Synergy Degree of Subsystems.

Table VII and Fig 1 indicated that the degree of order of insurance innovation subsystem had been rising slowly, and the degree of order of financial development subsystem had been rising in volatility before the 2008 financial crisis. The synergy degree of subsystems was above a relatively high level at that time. The market showed much less interest to new financial derivatives due to the 2008 financial crisis. It drove the degree of order of insurance innovation subsystem down to the lowest. In 2009, governments all over the world began to conduct a comprehensive strong intervention in the financial system. A lot of government capital injections and political interventions were implemented. As a consequence, the degree of order of insurance innovation subsystem and the degree of order of financial development subsystem increased to more than 0.6 and more than 0.8. The degree of order which is extremely high can't be reached only by the force of market. That is to say the high level of degree of order should thank to the government support largely. But the decrease of the synergy degree of subsystems indicated that although the government intervention

boosted single market, it could not replace the market force to coordinate the relationship between the insurance innovation and financial development. In 2010, with the gradual quit of government interventions, the degree of order of two subsystems declined slightly. The synergistic descend of the degree of order of two subsystems was not satisfactory, they were at a high level of synergy degree though. The financial development subsystem established growth channel orderly resulting from support of other financial fields, but the degree of order of insurance innovation subsystem decreased year by year. Synergy degree of them reduced greatly. It implicated that the insurance innovation subsystem might not be completely free from the effects of the financial crisis or other antis. The fears of market to new financial derivatives and new financial instruments were not disappear with the leaving of financial crisis. At the same time, it also showed that the insurance innovation of China had entered a bottleneck period and been in the deep waters of reform. The innovation and development of insurance had already couldn't adapt to the pace of financial development. Only by insisting on the reform of insurance innovation, can the government let the insurance industry step on the orderly growth path again.

III. CONCLUSIONS

The author used synergy theory to analyze the degree of order of insurance innovation and financial development and the synergistic relationship between them. Conclusion could be made according to the output result that China's financial development was in a steady upward track. The government should maintain the deepening of financial reform trend and increase the support for modern financial service. The insurance innovation slowed continuously after 2009, the degree of order of insurance innovation is now record low, and the synergy degree of insurance innovation and financial development decreased continually. There might be a mutual constraints relationship between them. The

government should adjust the operating mechanism of insurance market, encourage insurance innovation and create a synergistic developing environment as soon as possible.

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