Systemic Risk of the Global Important Insurers

Based on Granger Causality Network

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Abstract: In this paper, we study the systematic correlation between the global important insurers, which is based on the Granger causality network model. We analyze the stock returns of a sample of the 34 world's most important insurers which are selected according to the IAIS criteria for G-SIIs. First, we apply CAPM and GARCH to the daily stock returns in order to filter out the systematic risk in the capital market and build a causal network model based on the Granger causality relationships of the insurers' risks. Second, we apply the model to the sample in general case and typical bull and bear cases to conduct the empirical analysis. The results show that the global insurance sector has more significantly Granger causalities in the bear market than in the bull market. The important insurers in North America and Europe have stronger Granger influence. However, the insurers in Asia and Oceania are more vulnerable and the ones in Asia have the weakest influence.
Keywords: Systemic risk, Granger causality network, systemic importance

1. Introduction

At the peak of the financial crisis of 2007–2009, the occurrence the American International Group (AIG) federal bailout emphasized the importance of systemic risk in the insurance sector. It was a shock because most people considered systemic risk was only confined to the banking sector. Previously, economists believed that traditional insurance activities were not a major source of systemic risk. However, insurers indeed could trigger systemic risk problems and increase the interconnectedness between each other.

The risk of global systemically important insurers has stronger spillover effect, which can even severely influence the stability of financial system and the development of social economy. In 2012, the International Association of Insurers Supervisors (IAIS) asked for advice on the evaluation and regulation for global systemically important insurers. In 2013, the Financial Stability Board released the first list of the Global Systemically Important Insurers (G-SIIs). These insurers play a key role in the global insurance and finance system. Once major risk events occur or they are faced with financial crisis, the stability of global financial system would be threatened. The global insurers are mainly connected by reinsurance and one's crisis could directly influence others' reinsurance payments. As a result, systemic risk might spread across border. Besides, the utilization of insurance funds bonds insurance companies and other financial institutions closer. The influence of insurance funds on capital markets is growing because of the potential large amount, which could also increase the approaches that systemic risks spread.

Ping An Insurance Group is the only insurer that was included in the list from developing countries and emerging insurance markets. It is playing a more important role in the global market. As a consequence, it will also meet tighter regulation in order to guarantee the stability of global financial system. China's insurance industry is still at a primary stage of development with a late start, a weak basis but a rapid growth, which may encourage the potential for systemic risks. In 2016, the China Insurance Regulatory Commission (CIRC) published the list of Domestic Systemically Important Insurers (D-SIIs), trying to construct the macro-prudential regulation system to enhance risk management.

In order to promote the healthy development of global insurance markets, we need to make clear approaches that risk spread, evaluate and regulate potential systemic risk properly. Insurance sector functions as the stabilizer of economic development. We study the risk correlation of global important insurers, construct the model to analyze the approach that risks spread and make suggestions to better prevent the systemic risk from emerging. The decrease of risk spread from insurance sectors is going to have a positive effect on financial system and the real economy, which is of great significance.

2. Literature review

In the past, little research has been conducted about systemic interconnectedness in the insurance sector. In this paper, we summarize the related literature from three main aspects, systemic importance, systemic risk and causality network model.

The concept of systemic risk in finance field started from banking sector, and later it was applied to insurance institutions. Basel Committee on Banking Supervision (BCBS) (2010) first put forward the concept of Global Systemically Important Banks (G-SIBs) and pointed out that we can evaluate from five aspects, size, interconnections, substitutability, complexity and global activity. IAIS (2012) brought up G-SIIs and established the evaluation criteria on size, global activity, interconnections, non-traditional insurance and non-insurance activities and substitutability. Finally, they published the first nine G-SIIs list in 2013. Liu Xingya (2013) analyzed and summarized the valuation approach and regulation policy. Paola Bongini (2016) applied the G-SIIs' valuation method by IAIS to pick out 44 samples of global systemically important insurers and found that it is still difficult to reduce systemic risk within the new regulation framework.

As for systemic risk, there is no such specific definition. But definitions from different institutions and scholars have something in common. First, systemic risk is more related to some important parts of the financial system. Second, systemic risk has negative externality and spillover effect. Third, the risk of individual institutions might influence other institutions and even the real economy. FSB (2009) believed that systemic risk was the risk of financial service that might have severe negative externality on the real economy and it could not be reduced by risk management. But proper regulation could aid to discourage it from intensification. Hart and Zingales (2009) made the definition from the standpoint of the spread of risk. They pointed out that systemic risk was a kind of risk that was generated from the bottom of the financial system, such as the bankruptcy of individual institutions, spread to other institutions and sectors and even influenced the real economy. Helwege (2010) defined from the perspective of new risks. He thought that systemic risk was brought out by the interconnections of the financial institutions and had to be coped with them together.

The research on systemic risk was carried out mainly for financial system, while little for insurance system. The main methods were network modeling, CoVaR, MES, etc. The network modeling was first applied to evaluate the interconnections of the banking sector. Eisenberg and Noe (2001) measured systemic risk by calculating the vectors of connected financial institutions. Márquez-Diez-Canedo (2007) constructed the network model to track the spread of credit risk, with banks represented by the vertexes and risk spread represented by the lines. CoVaR measures systemic risk by calculating the value at risk of one financial institution provided another institution's risk is of the value at risk. Quantile regression is often used to implement in this model. Adrian and Brunnermeier (2008) first put forward CoVaR method and measured one's contribution to systemic risk. Later, there were many people trying to improve this method. Gao Guohua and Pan Yingli (2011) applied GARCH Model to calculate the dynamic CoVaR. They measured the Chinese banks' contribution to systemic risk of the banking system with data of 14 listed banks from 2002 to 2010 in Shanghai and Shenzhen stock markets. MES is the derivative of systemic expected shortfall with respect to the number of institutions, which is used to measure financial institutions' marginal risk contribution. Acharya, Pedersen and Philippon (2010)

defined systemic expected shortfall and marginal expected shortfall and evaluated the risk contribution of financial institutions using the stock data of 102 listed institutions in 2008. Weiβ (2014) estimated the systemic risk during the crisis from 2007 to 2008 in America based on △CoVaR.

During the development of network model, some people began to analyze the systemic interconnectedness of financial institutions or markets using stock yields. Namaki (2011) thought if the correlation degree between two companies' stock yields exceeded the threshold, risk transmission would occur within the two companies. However, it was difficult to identify the order of risks. Therefore, Granger causality test could be applied to analyze the spread of risk. Billio (2012) used Granger causality test to study the correlations of American financial companies' stock yields from 1994 to 2008 and constructed the Granger network model to depict the spread of risk in financial system. Gao Bo and Ren Ruoen (2013) used CAPM to pre-process the stock yields in order to filter out the systematic risk and constructed the Granger network model of China's financial system.

In this paper, we draw on the method of Paola Bongini (2016) to pick out the sample of global systemically important insurers from 2007 to 2016. And we improve the method of Billio (2012), Gao Bo and Ren Ruoen (2013) to construct the Granger causality network model of the global insurance system. We study the systemic interconnectedness within the global important insurers and make the following improvements. First, we draw on the evaluation method of IAIS for global systemically important insurers and pick out the sample of 34 companies in accordance with weighted assessment of size, global activity, interconnections, non-traditional insurance and non-insurance activities and substitutability. Second, we construct the Granger network model in general case and typical bull and bear cases and make comparison of the characteristics of risk spread in bull and bear markets. Third, we study from the intercontinental perspective to analyze the features of risk spread and make suggestions to discourage systemic risks of insurance sector from intensifying.

3. Data and methodology

3.1 Data source

In 2012, IAIS published the assessment methodology to identify the G-SIIs, which evaluated the insurance institutions from five aspects, size, global activity, interconnections, non-traditional insurance and non-insurance activities and substitutability, in order to distinguish those whose difficulties might disturb global finance and real economy. Later, IAIS published the list of first 9 G-SIIs, pointed out that they were picked out from 50 systemically important insurance groups in 14 countries and disclosed the methodology.

To start with, IAIS picked out insurers that met the following requirements. Data were collected from the information disclosed by the regulators from 14 countries. (1) The total assets were at least above USD 60 billion and the premium ratio from jurisdictions outside the home jurisdiction to total premium was at least 5%. (2) The total assets were at least above USD 200 billion and the premium ratio from

jurisdictions outside the home jurisdiction to total premium was between 0% and 5%. Besides, some financial guaranty insurers were added to the sample according to supervisory judgement.

We developed the methodology of IAIS, evaluating the insurance institutions from 5 categories and 19 individual indicators. The detailed indicators and weightings are shown on Table 1. The most important categories are interconnections, non-traditional insurance and non-insurance activities, which take a proportion of 40% and 45% respectively. Interconnectedness means the inner relations among the insurance institutions and systemic risks could spread from certain insurers to the entire financial system. There are 7 individual indicators under interconnectedness which evaluate the insurers' degree of interconnectedness in capital markets according to the investment, credit, derivatives and reinsurance business. Non-traditional insurance and non-insurance activities represent the investment and speculation activities, such as CDS, collateral, etc. This kind of capital market operation may have potential systemic risk and in the case of the outbreak of financial crisis, it is likely to influence the stability of financial system.

Table 1: Weighted categories and indicators of G-SIIs by the IAIS

Category	Weighting	Indicator	Indicator weighting
Size	5%	Total assets	2.50%
		Total revenues	2.50%
Global activity	5%	Revenues from abroad	2.50%
		Number of countries	2.50%
Interconnectedness	40%	Intra-financial assets	5.70%
		Intra-financial liabilities	5.70%
		Reinsurance	5.70%
		Derivatives	5.70%
		Large exposure	5.70%
		Turnover	5.70%
		Level-three assets	5.70%
Non-traditional insurance and non-insurance activities	45%	Non-policy holder liabilities and non-insurance revenues	6.40%
		Derivatives trading	6.40%
		Short term funding	6.40%
		Financial guarantees	6.40%
		Minimal guarantees on variable annuities	6.40%
		Intra-group guarantees	6.40%
		Liability liquidity	6.40%
Substitutability	5%	Premiums for specific business	5.50%

Source: International Association of Insurance Supervisors, 2013.

Furthermore, we selected insurers satisfying the following requirements. (1) Insurers that were the group's parent company. (2) Insurers that were listed before 2010. Finally, we picked out a sample of 34 global systemically important insurers. In our sample, there are 19 European insurers, 10 North American insurers, 4 Asian insurers and 1 Oceanian insurer. The detailed information is shown on Table 2. We believe that although there are little Asian and Oceanian insurers as a result of the development level, this sample generally represents the structure of global insurance system objectively, which is of great practical significance.

The majorities of our sample are insurers with a large scale of assets, diverse range of business and branches all over the world. They have close relationships and enjoy irreplaceable positions in the global financial system. These insurers not only take a leading performance in insurance industry, but also expand their business to other non-traditional and non-insurance business, such as derivatives, collateral, and provide comprehensive financial services. These global insurance groups play an important role in keeping the stability in global finance and even the real economy.

Table 2: Sample of global systemically important insurers

	Country	Insurers
North American	the United States	Aflac Inc, American International Group, Berkshire Hathaway Inc-Cl A, Hartford Financial Svcs Grp, Lincoln National Corp, Prudential Financial Inc, Unum group
	Canada	Manulife Financial Corp, Great-West Lifeco Inc, Sun Life Financial Inc
Europe	England	Aviva Plc, Legal & General Group Plc, Old Mutual Plc, Prudential Plc, Standard Life Plc
	Germany	Ageas, Hannover Rueck Se, Muenchener Rueckver Ag-Reg
	Switzerland	Baloise Holding Ag – Reg, Swiss Life Holding Ag-Reg, Zurich Insurance Group Ag
	Holland	Aegon Nv, Ing Groep Nv-Cva
	France	Cnp Assurances, Axa Sa
	Italy	Assicurazioni Generali
	Spain	Mapfre Sa
	Belgium	Ageas
	Norway	Storebrand Asa
Asia	Japan	Ms&Ad Insurance Group Holding, Dai-Ichi Life Insurance
	China	Ping An Insurance Group Co-H, Aia Group Ltd
Oceania	Australia	Amp Ltd

The sample period is from the first trading day of 2007 to the last trading day of 2016. Figure 1 shows the closing price of global stock markets by some representative indexes of North America, Europe and Asia. In order to make a comparison between the global insurance systems in typical bull and bear cases, we select two sample bull and bear periods. The first typical bull period is from March 2, 2009 to October 27, 2009, during which the indexes shown rose more than 40%. Similarly, during the second typical bull market, from June 28, 2012 to May 6, 2013, all the indexes rose

steadily. The first bear market is from May 6, 2008 to November 12, 2008 and the important indexes dropped by about 40%. In the same way, these indexes fell dramatically during the second bear market, from October 15, 2015 to February 29, 2016.

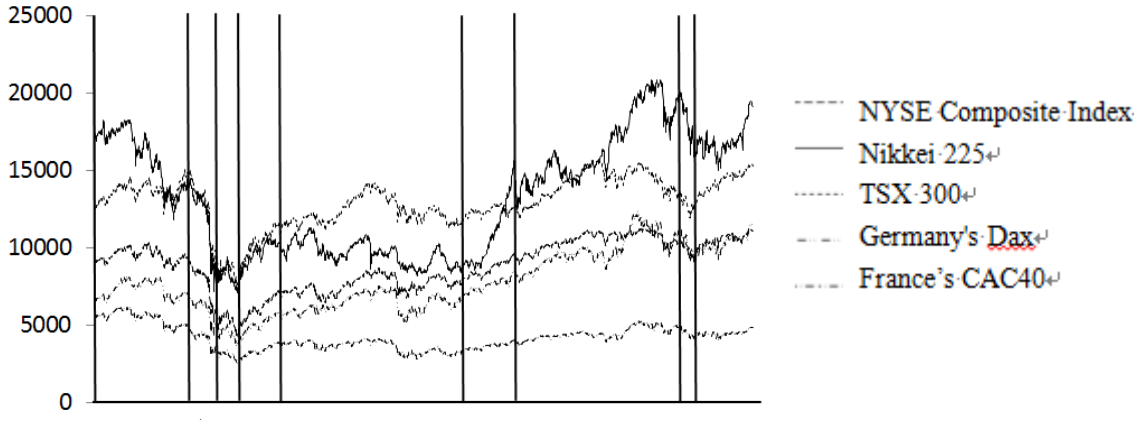

Figure 1: 2007-2016 global stock markets

In this paper, we use the data of 34 insurers and the indexes' daily closing price during the sample period, interbank borrowing rates, etc. The data are collected from WIND. The descriptive statistics of the sample daily returns are shown in Table 3. The statistical software used is Stata14.

Table 3: Summary statistics of sample daily returns

	Mean	Maximum	Minimum	Standard deviation	Skewness	Kurtosis
North America	1.64E-05	0.7049	-0.7249	0.0326	-0.9392	67.6782
Europe	-6.63E-05	0.8362	-0.4060	0.0259	0.3883	44.9842
Asia	1.53E-04	0.1467	-0.2091	0.0241	-0.2047	7.1731
Oceania	-3.24E-04	0.1038	-0.1376	0.0189	-0.4979	8.7154

3.2 Data preprocessing

Before introducing the Granger causal network model, we apply CAPM and GARCH(1, 1) to the daily stock returns as technical treatments in order to control the effect of common factors in the capital market. This improvement helps to measure the systemic risk more accurately.

Suppose there are n insurers in an insurance system, the stock return of insurer i is R_i, $R_i = \ln(p_t / p_{t-1})$,where p_t is the daily closing price of the insurance institution. R_f is the risk free rate of return, which is represented by the one-year deposit rate. R_m is the market rate of return. According to CAPM,

$$R_i = R_f + \beta_i(R_m - R_f) + \varepsilon_i, i = 1, 2, \ldots, n, \quad (1)$$

where βi denotes the beta coefficient, ε_i denotes the residual error. Then we can get β_i, let

$$\overline{R}_i = (R_i - R_f) - \beta_i (R_m - R_f). \quad (2)$$

As the raw data shows volatility clustering characteristic, we use GARCH(1,1) model to eliminate the heteroscedasticity and autocorrelation.

$$\overline{R}_t^i = \mu_i + \sigma_{it}\varepsilon_t^i, \quad \varepsilon_t^i \sim WN(0,1), \quad (3)$$

$$\sigma_{it}^2 = \overline{\omega}_i + \alpha_i (\overline{R}_{t-1}^i - \mu_i)^2 + \beta_i \sigma_{it-1}^2, \quad (4)$$

where μ_i denotes the conditional mean, σ_{it} denotes the conditional standard error, ε_t^i is a strong white noise process, $\overline{\omega}_i$、α_i、β_i are parameters. Let

$$\overline{Z}_t^i = \overline{R}_t^i / \sigma_{it}. \quad (5)$$

In order to construct the Granger causality network model, we need to make Granger causality test between every two insurers of our sample. Take Zurich Insurance Group and Ping An Insurance Group for example. First, we got the beta from regression analysis using (1), which was significant under the confidence level of 1%. Second, we obtained the residual error $\overline{R}_i$ by (2). Then, using GARCH(1, 1), ie (3) and (4), we could get the conditional standard deviation. Finally, sequences of heterogeneous risk for both of them, $\overline{Z}_t^i$ and $\overline{Z}_t^j$ were got. The results of parameter estimation are shown on Table 4.

Table 4：Estimation of parameters for GARCH(1，1)

	μ_i	ω_i	α_i	β_i
Ping An Insurance Group	-0.0050	-6.39E-05	0.2060	0.8738
Zurich Insurance Group	-0.0013	-8.94E-06	0.3102	0.7098

Stationary time series are necessary in order to avoid spurious regression. Therefore, we applied ADF test to $\overline{Z}_t^i$ series. The test results showed that the time series of all financial institutions during the sample periods meet the stationary requirement. We continue the case of Ping An Insurance Group and Zurich Insurance Group, the results of ADF test are shown on Table 5.

Table 5：Sample ADF test results

	Ping An Insurance Group	Zurich Insurance Group
With intercept	-52.857	-38.634
Without intercept	-50.696	-38.525

Notes: The critical values under the 1%，5%，10% confidence level are -3.430，-2.860，-2.570 respectively with intercept; and -2.580，-1.950，-1.620 without intercept.

3.3 Granger causal network model

The Granger causal relationship can be defined as follows:

If the prediction of $\overline{Z}_t^j$ is more precise when the historical information of $\overline{Z}_t^i$ is used in addition to the historical values of $\overline{Z}_t^j$, ie the historical change of $\overline{Z}_t^i$ helps to explain the future change of $\overline{Z}_t^j$, $\overline{Z}_t^i$ is said to be the Granger cause for $\overline{Z}_t^j$.

$$\overline{Z}_{t+1}^j = a^j \overline{Z}_t^j + b^{ji} \overline{Z}_t^i + e_{t+1}^j, \tag{6}$$

$$\overline{Z}_{t+1}^i = a^i \overline{Z}_t^i + b^{ij} \overline{Z}_t^j + e_{t+1}^i. \tag{7}$$

where a^j、a^i、b^{ji} and b^{ij} are parameters, e_{t+1}^j and e_{t+1}^i are uncorrelated white noise processes.

If $b^{ji} \neq 0$ is significantly true, we reject the null hypothesis and conclude that $\overline{Z}_t^i$ is the Granger cause for $\overline{Z}_t^j$. In the same way, if $b^{ij} \neq 0$ is significantly true, we reject the null hypothesis and conclude that $\overline{Z}_t^j$ is the Granger cause for $\overline{Z}_t^i$. If $b^{ji} \neq 0$ and $b^{ij} \neq 0$ are significantly true simultaneously, $\overline{Z}_t^i$ and $\overline{Z}_t^j$ are pairwise Granger causes for each other.

Define $(i \to j)$: if $\overline{Z}_t^i$ is the Granger cause for $\overline{Z}_t^j$, $(i \to j) = 1$ and we draw the directed edge from insurer i to insurer j; if $\overline{Z}_t^i$ is not the Granger cause for $\overline{Z}_t^j$, $(i \to j) = 0$ and no directed edge is added. Therefore, take the n insurers as vertices and their Granger causality as directed edges and the Granger causal network can be constructed.

4. Empirical results

4.1 General case

First, we did pairwise Granger causality test for sample insurers in order to construst the Granger network model for global insurance system in general case. For example, the test results for Ping An Insurance Group and Zurich Insurance Group are shown on Table 6, by formula (6) and (7). Under the confidence level of 10%, the heterogeneous risk of Zurich Insurance Group is the Granger cause for that of Ping An Insurance Group. Therefore, we draw the directed edge from Zurich Insurance Group to Ping An Insurance Group, while we did not draw the directed edge from Ping An Insurance Group to Zurich Insurance Group.

Table 6: Results of sample Granger causality test

Null hypothesis	Statistic	P-value
The heterogeneous risk of Ping An Insurance Group is not the Granger cause for that of Zurich Insurance Group	2.724	0.256
The heterogeneous risk of Zurich Insurance Group is not the Granger cause for that of Ping An Insurance Group	20.310	0.000

Similarly, we did Granger causality test for other sample insurers pairwise and draw the directed edge between every two insurers that have Granger causality. The

final Granger network of global systemically important insurers is shown as Figure 2. In this paper, we represent Europe, North America, Asia and Oceania by ●、■、▲、⬣ respectively and we use directed edges ⟶、⟶、⟶、⟶ to stand for the Granger causality of insurers from Europe, North America, Asia and Oceania to other insurers.

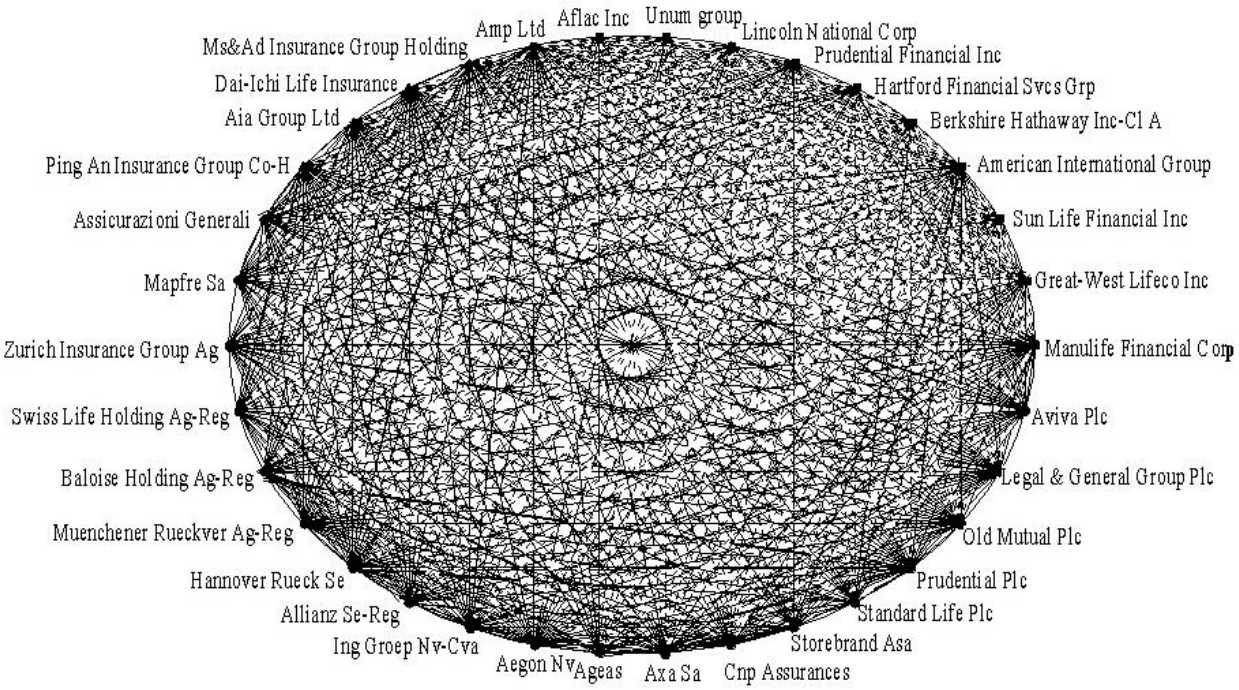

Figure 2: Granger network for global systemically important insurers in general case

Then, in order to measure the pairwise degree of interconnectedness and describe the results more clearly, we define the correlation index from continent α to γ,

$$(\alpha \to \gamma) = \sum_{i \in \alpha} (i \to \gamma) = \sum_{i \in \alpha} \sum_{j \in \gamma} (i \to j)$$

.

Further, because the number of insurers from different continents differs in our sample, we calculate the correlation index as a percentage of all the potential Granger causalities. In this way, we reflect the degree of Granger causality between different insurance sectors comparably. The results are shown on Table 7.

Table 7：Summary of correlation indexes between sample insurers in general case

	Correlation index					Percentage				
	North America	Europe	Asia	Oceania	Total	North America	Europe	Asia	Oceania	Total
	2007-2016 (Total sample period)									
North America	43	168	38	10	259	48%	88%	95%	100%	78%
Europe	68	170	75	19	332	36%	50%	99%	100%	53%
Asia	1	15	2	1	19	3%	20%	17%	25%	14%
Oceania	2	8	2	0	12	20%	42%	50%	-	36%
Total	114	361	117	30	622	35%	58%	89%	91%	55%

Notes: The figures in the left of the table represent the number of Granger causality from the sample row insurer to column insurer, the same as following tables.

According to Figure 2 and Table 7, we find that in general case, systemically important insurers in North America have a bigger Granger influence on insurers elsewhere, which reflect that insurers from the United States and Canada play the most important role in the global insurance system. The American insurance market is the largest in the world, which is quite mature and plays the major role in the global financial and insurance systems. It is used for reference by insurers from other parts of the world as for insurance plans, utilization of insurance funds and the development of supervisory system. Besides, European insurers also have a strong Granger influence, especially on Asian and Oceanian insurers. European insurance market has a long history and covers a wide range of business with developed actuarial techniques and management of insurance fund. There are a number of large insurance companies that are closely connected and they hold a significant role in the global insurance system.

In contrast, Asian and Oceanian insurers are more likely to be affected by others, and Asian insurers have the weakest Granger influence. The insurance industry in Asia starts late, and there are little global systemically important insurers with weak power. With the globalization of the insurance, foreign-funded insurance groups quickened the pace to enter Asian insurance market and Asian insurance groups also tried to expand overseas markets. Under these circumstances, it is unlikely to avoid insurance risk from spreading cross border. Although insurance industry in Asia is developing rapidly these years, there is still a relatively large gap with the advanced ones, especially as for global competitiveness and influence. The late start and lack of experience contribute to the shortage of core competitive advantage, a low level of multinational management, the relative backwardness of management and techniques and the weaker influence.

Further, we draw Granger causality network for insurers from Asian and other continents to clarify our result, as shown in Figure 3.

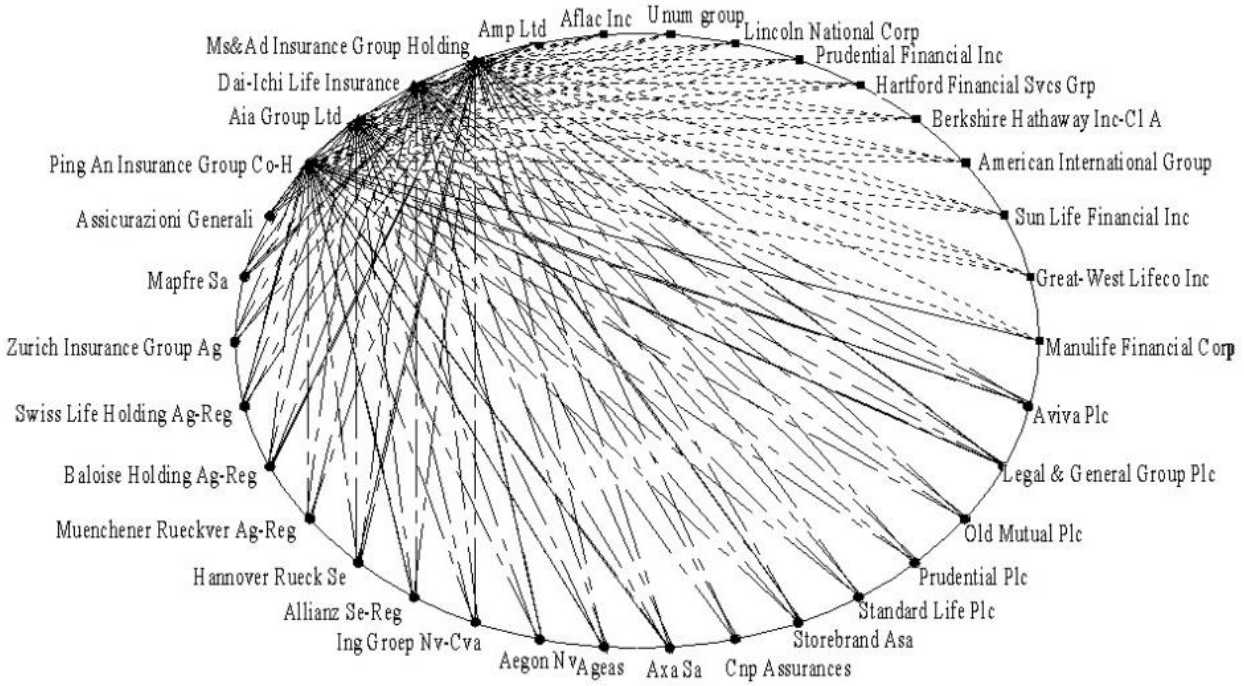

Figure 3: Granger causality network for global systemically important insurers from Asia in general case

4.2 Typical bull and bear cases

In this part, we compare the Granger causality network for global insurers in typical bull and bear cases and draw the network diagram, shown in Figure 4 and Figure 5. We find that global insurance system has more Granger causal links in bear markets. To show our results more clearly, we construct Table 8 to for summary of correlation indexes between sample insurers in sample bull and bear markets.

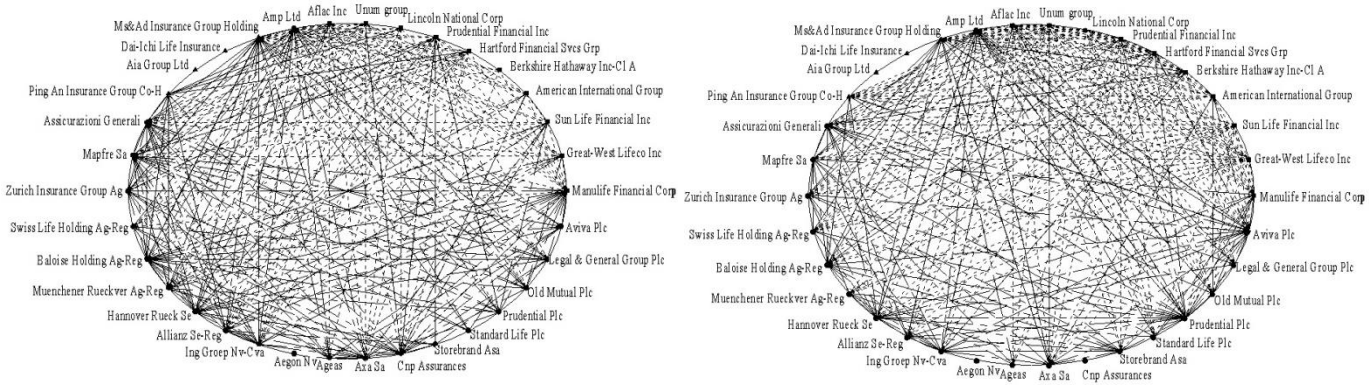

Figure 4：Granger network for bull（left）and bear（right）markets in the 1st sample period

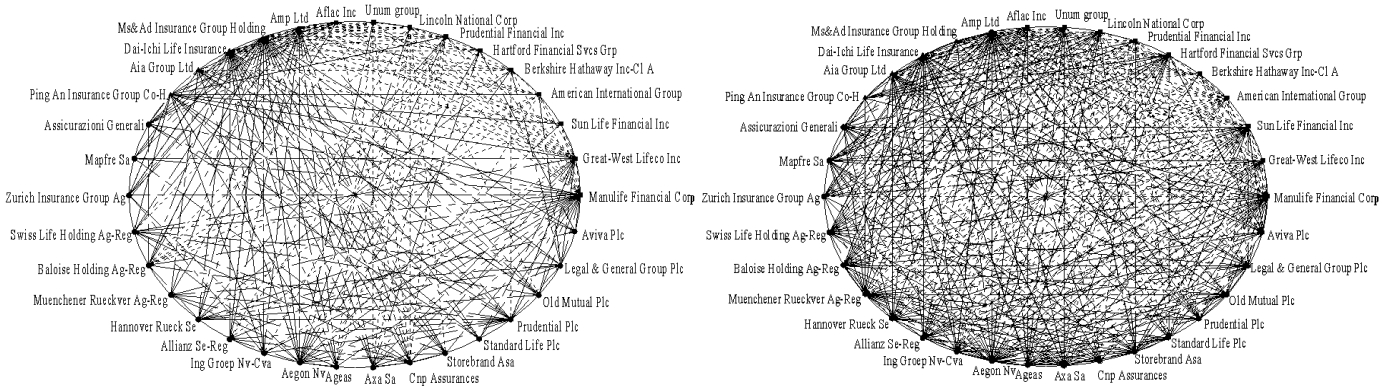

Figure 5：Granger network for bull（left）and bear（right）markets in the 2nd sample period

Table 8: Summary of correlation indexes between sample insurers in bull and bear matkets

	Correlation index					Percentage				
	North America	Europe	Asia	Oceania	Total	North America	Europe	Asia	Oceania	Total
	2008/05/06-2008/11/12 (1st sample period of bear market)									
North America	37	99	18	7	161	41%	55%	90%	70%	54%
Europe	23	73	9	11	116	13%	24%	25%	61%	21%
Asia	1	8	0	0	9	5%	22%	0%	0%	15%
Oceania	0	10	0	0	10	0%	56%	0%	-	33%
Total	61	190	27	18	296	20%	35%	45%	60%	32%
	2009/03/02-2009/10/27 (1st sample period of bull market)									
North America	17	76	9	9	111	19%	42%	45%	90%	37%
Europe	37	77	15	16	145	21%	25%	42%	89%	27%
Asia	4	9	0	1	14	20%	25%	0%	50%	23%
Oceania	0	0	0	0	0	0%	0%	0%	-	0%
Total	58	162	24	26	270	19%	30%	40%	87%	29%
	2012/06/28-2013/05/06 (2nd sample period of bear market)									
North America	21	28	21	9	79	23%	15%	53%	90%	24%
Europe	43	35	40	11	129	23%	10%	53%	58%	21%
Asia	8	15	1	0	24	20%	20%	8%	0%	18%
Oceania	0	1	1	0	2	0%	5%	25%	-	6%
Total	72	79	63	20	234	22%	13%	48%	61%	21%
	2015/10/15-2016/02/29 (2nd sample period of bear market)									
北美洲	23	116	26	9	174	26%	61%	65%	90%	53%
欧洲	79	92	27	18	216	42%	27%	36%	95%	34%
亚洲	6	18	5	3	32	15%	24%	42%	75%	24%
大洋洲	1	8	1	0	10	10%	42%	25%	-	30%
总计	109	234	59	30	432	33%	37%	45%	91%	39%

In general, global systemically important insurers have closer Granger causalities in bear markets than in bull markets. In bear periods, North American and Oceanian insurers have stronger Granger influence, especially to Asian insurers. While there is little difference in the Granger influence in bull and bear markets for European and Asian insurers. Besides, North American, European and Asian insurers show a closer inner connection in bear markets than in bull ones.

The results indicate that the risks of developed insurance markets are more likely to spread to Asia during financial crisis. This is probably a result of the closer relationship of reinsurance and investment business of global insurance groups during bear markets. Once the insurance groups in developed countries face difficulties, there is a great possibility of the systemic risk in global insurance markets occurring intensively, which would threaten the stability of the global finance system. The relationship between Asian and global insurance markets is getting closer and closer, which makes it difficult to avoid the negative impact of global financial crisis, especially when the insurers do have problems with insurance funds or solvency, the risks abroad are more likely to trigger the crash of the entire system. Thus, insurers in Asia are expected to make efforts to guarantee the stability of the economy and capital market, take measures to strengthen risk management against external shocks, and enhance the ability of resisting risks from global insurance markets.

5. Conclusions

This paper follows the evaluation method of IAIS for global systemically important insurers and pick out the sample of 34 companies in accordance with weighted assessment of size, global activity, interconnections, non-traditional insurance and non-insurance activities and substitutability. The sample time interval is from the first dealing day of 2007 to the last dealing day of 2016. Then, we apply CAPM and GARCH to the daily stock returns in order to filter out the systematic risk in the capital market and build a causality network model based on the Granger causality relationships of the insurers' risks in both general case and typically bull and bear markets to make comparisons. The results show that the global insurance markets are much more closely connected by Granger causality in typical bear markets than in bull markets. North American and European global systemically important insurers have stronger Granger impact on other insurers. However, Asian and Oceanian insurers are more likely to be influenced by the Granger causality from other insurance companies. Asian insurers have the weakest Granger influence. The detailed conclusions and suggestions are as follows.

(1) The global insurance markets have closer Granger causalities in bear markets than in bull markets. This might be due to the closer business connections between those insurance companies, such as the insurance plans, investment strategies and reinsurance. In this way, the systemic risks of global insurance are more likely to occur during bear markets. Once there are insurers with solvency problems coming out, spillover effect is easier to arise, which may lead the entire insurance system to face difficulties. Therefore, global insurance groups and regulators are required to construct a robust risk management framework, with an extremely high alert against the systemic risk during bear markets. Meanwhile, the results shed some light on

counter-cyclical supervision for insurance regulators. The insurance sector is able to soften the impact of cyclical changes and financial crisis to the financial system to some degree, and assist in avoiding the concentrated outbreak of systemic risks. Insurers are required for proper capital cushions to deflate bubbles when an economy overheats and lessen negative shocks when the crisis occurs, thus strengthen the stability of insurance and financial system.

(2) The systemically important insurers in North America have the strongest Granger influence on other insurers, and it is even more significant in bear markets. While European insurers, with strong Granger influence, performs little difference in bull and bear markets. European and North American insurers play an important role in the global insurance system, which is the role model for other insurers to study and use for reference. Their systemic risks are more easily to spread in the global insurance system once their major insurance companies face difficulties. In order to avoid such unfavorable situations, insurers from North America and European are expected to pay high attention to their risks and take close supervisions. At the same time, Asian insurers are also supposed to be highly concerned about insurers from North America and Europe, notice their potential systemic risk and take precautions against the concentrated outbreak of crisis.

(3) Asian systemically important insurers have the weakest Granger influence, and insurers in Asia and Oceania are most likely to be influenced by other insurers. Global systemically important insurers in Asia are few and easily influenced by insurers in developed countries, with a short period and low level of development. It is impossible to stay away from the global markets and avoid the impact of developed countries. It is of great importance to strike a balance between innovation and risk management. Therefore, the Asian insurance companies are expected to continue to expand, develop international plans and supervise with a more prospective and active perspective. Besides, training people with high risk management capability and constructing normative regulation systems are also needed to promote the development of insurance. Personnel talents could add competence of the companies, especially when involved in global markets.

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