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China Risk Oriented Solvency System Catastrophe Risk Module

China Property & Casualty Reinsurance Company Ltd.

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CHINA PROPERTY & CASUALTY REINSURANCE COMPANY LTD.

Content

Theoretical Defects of EU SII Catastrophe Module

Innovation of China C-ROSS Model

Data, Model and Results

Main Problem of EU SII Risk Framework

- **Main problem of EU Solvency II Risk Framework exists in the correlation matrix**

Inconsistency of Combinations

Unboundedness of Coefficients

Inconsistency of Combinations in EU SII Risk Framework

- **Solvency II of EU Insurance Industry mainly refers to Basel II of EU Bank Industry.**
- **The greatest difference between these two industries is that, the risk distribution of bank industry is comparably asymmetric, while the distribution of insurance industry is generally right-skew, especially catastrophe risk, which is severely right-skew and has fat-tail.**
- **Theoretically, the probability features of risk in insurance industry lead to no solution under the framework of correlation matrix.**
- **We have discussed with experts in Europe about this issue.**

Scenario under Bivariate

- Under bivariate, correlation matrix framework works well.
- Here is an example:

Suppose China only has two areas: Beijing and Tianjin, and here, we calibrate the earthquake risk capital.

The result of constructing cat. model for only considering Beijing area is • 99.5% PML=0.15%.
The result of constructing cat. model for only considering Tianjin area is • 99.5% PML=0.12%.
The result of constructing cat. model for considering two areas together is • 99.5% PML=0.22%.

Scenario under Bivariate

- According to the formula given by EU SII about correlation matrix, we can compute that the correlation matrix coefficient of Beijing and Tianjin is 0.3194.

$$c = \sigma_{12}^2 - \sigma_1^2 - \sigma_2^2 / 2\sigma_1\sigma_2$$

$$c=\sigma\downarrow 12\uparrow 2-\sigma\downarrow 1\uparrow 2-\sigma\downarrow 2\uparrow 2/2\sigma\downarrow 1$$

- Here is the correlation matrix:

	Beijing	Tianjin
Beijing	1	0.3194
Tianjin	0.3194	1

Scenario under Multivariate

- **Under multivariate, correlation matrix framework causes inconsistency.**
- **Here is an example:**

Suppose China only has three areas: Beijing, Tianjin and Hebei, and here, we calibrate the earthquake risk capital.

The result of constructing cat. model for only considering Beijing area is: 99.5% PML=0.15%.
The result of constructing cat. model for only considering Tianjin area is: 99.5% PML=0.12%.
The result of constructing cat. model for considering Beijing and Tianjin together is: 99.5% PML=0.22%.

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Scenario under Multivariate

- **Continue the example:**

The result of constructing cat. model for only considering Hebei area is: 99.5% PML=0.10%.
The result of constructing cat. model for considering Beijing and Hebei together is: 99.5% PML=0.20%.
The result of constructing cat. model for considering Tianjin and Hebei together is: 99.5% PML=0.18%.
The result of constructing cat. model for considering Beijing, Tianjin and Hebei as a whole is: 99.5% PML=0.34%.

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Scenario under Multivariate

- **Correlation matrix of the three areas is:**

	Beijing	Tianjin	Hebei
Beijing	1	0.3194	0.25
Tianjin	0.3194	1	0.3333
Hebei	0.25	0.3333	1

- **If we use this correlation matrix to compute the total risk capital for these three areas, the result is 0.272%, which is not equal to 0.34%, result of cat. model. Therefore, these two methods are not consistent.**
- **Theoretically, inconsistency here leads to no solution.**

The Current Solution for Inconsistency

- **Currently, our solution to Inconsistency is: instead of relying on the presumed distribution, to minimize weighted-MSE.**
- **In this formula, w is based on whether the area is Key Zone in cat. model or not.**
- **In this way, we ensure to fit VaR in high-risk area more reasonable, and moderately compromise the fitting of VaR in low-risk area.**
- **Difference still exist between the result of this method and the realistic result of cat. model.**

Unboundedness of Coefficients of EU SII Risk framework

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- **EU Solvency II treats VaR as the value to measure risk. Because VaR is unqualified of subadditivity, correlation matrix coefficients would be greater than 1.**
- **Here is an example:**

Suppose China only has two areas: Shaanxi and Gansu, and here, we calibrate the earthquake risk capital

The result of constructing cat. model for only considering Shaanxi area is: 99.5% PML=0.35%
The result of constructing cat. model for only considering Gansu area is: 99.5% PML=0.90%
The result of constructing cat. model for considering Shaanxi and Gansu together is: 99.5% PML=1.30%

Unboundedness of Coefficients of EU SII Risk framework

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- **According to the formula given by EU SII about correlation matrix, we can compute that the correlation matrix coefficient of Beijing and Tianjin is 1.2024.**

$$c=\sigma\downarrow 12\uparrow 2-\sigma\downarrow 1\uparrow 2-\sigma\downarrow 2\uparrow 2/2\sigma\downarrow 1\sigma\downarrow 2$$

- **Here is the correlation matrix:**

	Shaanxi	Gansu
Shaanxi	1	1.2024
Gansu	1.2024	1

Unboundedness of Coefficients of EU SII Risk framework

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- **Problem: Why could correlation coefficients be greater than 1?**
- **Interpretation: Here is an example to illustrate this problem.**

Earthquake Code	Shaanxi	Gansu	Two Areas
1	100	200	300
2	200	150	350
3	300	650	950
4	400	500	900
VaR 75%	300	500	900

- **Here, the correlation matrix coefficient of Shaanxi and Gansu is 1.5666.**
- **This example illustrate the fact that, use VaR to measure risk do not satisfy sub-additivity.**

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- **Correlation matrix of EU SII is only meaningful in statistics. But the real force to connect risks in different areas is catastrophe events. Therefore, we no longer adopted the statistical correlation matrix, instead, we adopt catastrophe events with specific physical significance.**
- **We call this method to address correlation Event-linked Dependency Methodology.**

Techniques of China C-ROSS catastrophe risk

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- **Here is an example:**

Suppose China only has three areas: Beijing, Tianjin and Hebei, and here, we calibrate the earthquake risk capital

From the catastrophe model, we can derive the table as above, including every catastrophe event.

Year	Earthquake Code	Beijing	Tianjin	Hebei	Three Areas
1	0001	20	100	80	200
2	0002	300	30	400	730
3	0001	20	100	80	200
3	0002	300	30	400	730
4	-	0	0	0	0

Techniques of China C-ROSS catastrophe risk

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According to previous table, we can convert it into annual loss table, and then directly compute the corresponding VaR.

Year	Earthquake Code	Beijing	Tianjin	Hebei	Three Areas
1	0001	20	100	80	200
2	0002	300	30	400	730
3	0001, 0002	320	130	480	900
4	-	0	0	0	0
VaR 75%		300	100	400	730

Techniques of China C-ROSS catastrophe risk

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- **Event-linked Dependency framework is better than Correlation Matrix framework**
- **Continue the previous example, if we keep using EU SII correlation framework, we need to compute VaR of every two areas first:**

Year	Earthquake Code	Beijing + Tianjin	Beijing + Hebei	Tianjin + Hebei
1	0001	120	100	180
2	0002	330	700	430
3	0001,0002	450	800	610
4	-	0	0	0
VaR 75%		330	700	430

- **Compute the correlation matrix:**
- **Based on the correlation matrix, domestic Var 75% is 723.74, less than the right ~~value of 730~~.**

	Beijing	Tianjin	Hebei
Beijing	1	0.1483	1
Tianjin	0.1483	1	0.1863
Hebei	1	0.1863	1

Techniques of China C-ROSS catastrophe risk

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- **Event-linked Dependency framework succeeds in addressing the problem under correlation matrix framework**

No more inconsistency of combinations

No more usage of correlation matrix coefficients

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