

Research on Risk Transmission Path of Stock Market

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ABSTRACT

This paper identifies the risk points of the stock market and finds the best transmission path of risks. First, we select the weekly data of listed companies in the stock market from 2013 to 2019 as research samples. The CoVaR method is used to screen out 15 risk-point companies in all industries and study their market risk contribution. Then, we construct the correlation network between risk points and use the minimum spanning tree (MST) to construct the best risk transmission path, and clarify the direction of risk transmission. The research results reveal that the financial industry and real estate industry are the key nodes in the transmission path, and they are significant in risk control. Finally, based on the above analysis, the countermeasures and suggestions for systemic risk control in the stock market are proposed.

Keywords: *Stock market fragility, risk point, best risk transmission path*

1. INTRODUCTION

From the Wall Street financial tsunami in 2008 to the Greek sovereign debt crisis, with the frequent occurrence of financial crises, stock prices fluctuated particularly abnormally, with cliff-like declines. Since 2015 alone, stock prices have experienced five sharp drops. Stock market volatility not only causes the loss of wealth, but also exacerbates the risks of the financial system, and has a huge impact on social stability. The stock market is a barometer of the national economy. Studying the risk transmission path of the stock market provides a reliable window for understanding the spread of systemic risks in Chinese financial market and the entire Chinese economic system. It is of practical significance for effectively preventing crises and maintaining financial stability.

At present, research on stock market risks mainly focuses on the following aspects. The first is the measurement of stock market risk. Many foreign scholars used the CoVaR model to define the contribution of a single financial institution to the overall systemic risk (Jorion[1]; Pagano and Sedunov[2]; Trabelsi and Naifar[3]). Since then, domestic scholars begun to study the systemic risk of commercial banks, the CoVaR model was widely used in the analysis to judge the importance of each bank (Du and Li[4]; Shen and Xing[5]). Follow-up scholars deepened the research method and expanded the research scope, they used static and dynamic CoVaR methods and E-CoVaR models to study systemic risks in the banking, insurance, and securities markets (Tong et al.[6]; Deng[7]; Liu and Lu[8]). The second is the research on risk transmission mechanism. Allen, Gale[9] and Freixas et al.[10] first applied correlation networks to analyze the risk spillovers and propagation paths. Regarding the construction method of correlation networks, Mantegna[11] proposed a minimum spanning tree method (MST), Tumminello et al.[12] proposed Planar Maximally Filtered Graph

(PMFG). Many domestic scholars adopted the minimum spanning tree (MST) method to construct and analyze the correlation network and identify important key nodes (Ouyang and Liu[13]; Zeng et al.[14]; Hu and Zhou[15]; He and Xing[16]).

Obviously, it can be found that there are more studies on risks in the banking and financial industries, and relatively few studies on risks in other industries. In addition, the stock market risk transmission research does not cover listed companies in different industries and cannot scientifically reflect the stock market risk transmission mechanism. However, predecessors' research methods for risk measurement and transmission provide guidance for the empirical analysis of this paper.

The relationship between the stock market and listed companies is interdependent. Research on the risk transmission path of the stock market is inseparable from listed companies. Therefore, this paper takes the stock market as the research object, and uses the static CoVaR method to identify 15 representative listed companies that cause stock market risks according to the Wind industry classification. Then, we use the stock market network analysis method to construct the correlation network with the logarithmic return rate of the stock price of the risk point, and find the best transmission path of the stock market risk on the basis of the correlation network. Furthermore, we analyze the correlation between the risk points to explore the path of the stock market crisis. Thus, when the stock market crisis comes, we can effectively block the spread of the crisis and reduce the losses caused by the stock market crisis.

2. RESEARCH DESIGN

2.1. Sampling and Data Sources

This paper uses the 11 industries (real estate, utilities, telecommunications services, information technology, finance, healthcare, daily consumption, energy, materials, industry and optional consumption) listed in the Wind industry classification as the research objects. In view of the large number of listed companies and the large amount of data, this paper uses the top 10 listed companies in various industries as a sample and selects the weekly data from January 4, 2013 to December 27, 2019.

2.2. Variable Definitions

Definition 1. (Weekly closing price) January 4, 2013 was taken as the closing price of the first week, and December 27, 2019 was taken as the closing price of the last week. A total of 363 weekly observations were obtained. If there is a company suspension in the sample interval, the price of the previous trading day is selected as the closing price.

Definition 2. (Rate of return) Based on the weekly closing price data, the geometric rate of return of listed companies selected by each industry is measured, and the calculation formula is as follows.

$$R_t = \ln \frac{P_t}{P_{t-1}} \quad (1)$$

Definition 3. (Macroeconomic state variables) In view of the fact that the stock market is deeply affected by the macroeconomic situation, this paper selects appropriate macro state variables and introduces the risk spillover models based on the risk characteristics of the stock market.

Table 1 Macroeconomic state variables

| Index | Variable |
|-------|-----------------------|
| M1 | Interest rate changes |
| M2 | Liquidity spread |
| M3 | Term spread |
| M4 | Credit spread |

2.3. Empirical Models

This paper determines the risk points of all industries based on the static CoVaR method, and refers to Liu and Lu^[8] using the dynamic CoVaR method to reflect the marginal contribution of each risk point company to the stock market risk.

$$CoVaR_q^{j|i} = VaR_q^j | VaR_q^i = \hat{\alpha} + \hat{\beta} VaR_q^i \quad (2)$$

$$\Delta CoVaR_{q,t}^i = CoVaR_{q,t}^i - CoVaR_{0.05,t}^i = \hat{\beta}_q^{system|i} (VaR_{q,t}^i - VaR_{0.05,t}^i) \quad (3)$$

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In the static CoVaR calculation, the VaR is solved by historical simulation method. Then, adding the lagging macroeconomic variable Mt-1, formula (4) uses the quantile regression method to calculate the company's dynamic $\Delta CoVaR$. Compared with the CoVaR indicator, $\Delta CoVaR$ subtracts the company's unconditional risk value, which can accurately reflect the marginal risk contribution of listed companies to the stock market.

Drawing lessons from the ideas of Ouyang and Liu[13], using the stock market network analysis method to construct the related network of 15 listed companies. First, we calculate the correlation coefficient matrix between the 15 listed companies in the stock market; second, transform the correlation coefficient matrix into a distance matrix. Finally, we build an association network based on the distance matrix and use the MST algorithm to find the shortest path of risk transmission.

$$\frac{E(Y_i Y_j) - E(Y_i)E(Y_j)}{\sqrt{[E(Y_i^2) - (E(Y_i))^2][E(Y_j^2) - (E(Y_j))^2]}} \quad (5)$$

$$d_{ij} = \sqrt{2(1 - \rho_{ij})} \quad (6)$$

Among them, formula (5) calculates the correlation coefficient between two nodes, and formula (6) converts the correlation coefficient matrix into a distance matrix.

3. RESEARCH RESULTS AND ANALYSIS

3.1. Identification of Risk Points

Based on the selection of the static CoVaR value, a total of 15 risk points that may trigger a stock market crisis are selected from various industries. They are: (1) Poly Real Estate, (2) Yangtze Power, (3) Dr. Peng, (4) Longji, (5) Haitong Securities, (6) Agricultural Bank, (7) Xinhua Insurance, (8) China Pacific Insurance, (9) Construction Bank, (10) Fosun Pharmaceutical, (11) Luzhou Laojiao, (12) Gree Electric, (13) Rongsheng Petrochemical, (14) Sany Heavy Industry, (15) Yanzhou Coal industry.

Table 2 Dynamic $\Delta CoVaR$ of each risk point (weekly average)

| S/N | VaR (5%) | VaR (50%) | $\beta_{system i}$ | $\Delta CoVaR$ |
|-----|----------|-----------|--------------------|----------------|
| 1 | -8.857 | 0.107 | 0.397 | -3.425 |
| 2 | -3.207 | 0.259 | 0.755 | -2.619 |

| | | | | |
|----|---------|--------|-------|--------|
| 3 | -12.417 | 0.054 | 0.218 | -2.723 |
| 4 | -10.038 | 0.252 | 0.211 | -2.167 |
| 5 | -7.759 | -0.186 | 0.469 | -3.555 |
| 6 | -5.236 | 0.097 | 0.732 | -3.908 |
| 7 | -8.806 | 0.217 | 0.414 | -3.741 |
| 8 | -7.877 | 0.055 | 0.485 | -3.854 |
| 9 | -5.781 | 0.058 | 0.524 | -3.062 |
| 10 | -8.005 | 0.299 | 0.392 | -3.260 |
| 11 | -7.957 | 0.204 | 0.362 | -2.961 |
| 12 | -6.763 | 0.287 | 0.371 | -2.618 |
| 13 | -10.953 | 0.365 | 0.269 | -3.050 |
| 14 | -8.213 | 0.246 | 0.492 | -4.162 |
| 15 | -10.186 | -0.084 | 0.304 | -3.071 |

In order to facilitate the composition of the picture and the table, the 15 companies and the serial numbers 1-15 are mapped one by one in order, the following is the same.

Table 2 examines the dynamic risk overflow strength of 15 risk points, Among them, the greater the ΔCoVaR value, the greater the impact of the risk point on the stock market. To facilitate the overall comparison, calculate the weekly average VaR (5%), VaR (50%) and ΔCoVaR . We can observe that each risk point company has a different degree of influence on the stock market systemic risk. In terms of ranking, with 3.4 as the boundary, 4 of the top 6 risk companies in ΔCoVaR are in the financial industry, indicating that the financial industry is more risky than other industries, and large-scale heavy industry companies have the second highest risk; in addition, Poly Real estate also occupies the top position, indicating that the real estate industry should not be ignored in risk analysis.

3.2. Stock Market Network Construction

In order to understand the relationship between risk points in various industries in the stock market better, this paper builds a correlation network based on the correlation coefficients between risk points, and on this basis, finds the best risk transmission path based on the (MST) function in MATLAB. The result after running with the help of Matlab software is shown in Figure 1.

The weight of the connecting edge in Figure 1 is the correlation between 15 risk points, and the weight value and the correlation coefficient change in the opposite direction. It can be seen from Figure 1 that the distances between nodes are different, the MST path is unique, and the MST distance is the shortest, so the minimum spanning tree path is the best transmission path of stock market risk. The path formed by the points and edges highlighted in Figure is the path through which risks are most easily transmitted when the stock market is in a crisis state. Market risks will spread and pass through the entire stock market along the MST.

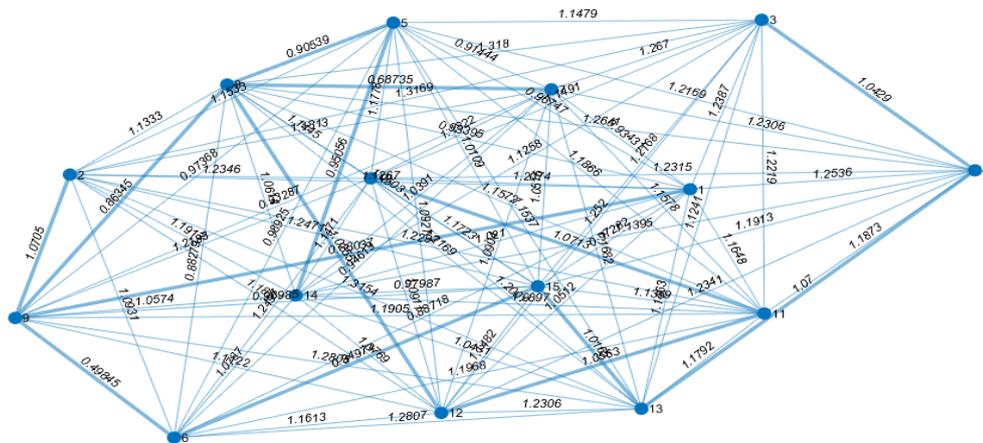


Figure 1 Minimum spanning tree network among 15 risk points

3.3. Analysis of Risk Transmission Path of Stock Market

We extract the minimum spanning tree path above separately. It can be clearly seen that the best risk transmission path among the 15 risk points is shown in Figure 2.

There are some important spreading nodes in the propagation path. These nodes are connected with multiple parties and are essential for the spread of market risk. There are five key nodes: China Construction Bank, Agricultural Bank, China Pacific Insurance, Poly Real Estate, and Yangtze Power. Among them, China Construction Bank is at the top of risk transmission and is associated with four risk point companies. It occupies an important position in the spread of stock market risks and has a greater impact on stock market risks. Agricultural Bank of China and China Pacific Insurance are at the second level of risk transmission, which is the key node of risk transmission. China Pacific Insurance's associated risks are the largest except for the top risk points. It has a greater impact on the overall market risk and the impact is mainly on financial institutions. The industry plays an important role in the process of risk communication. Poly Real Estate and Yangtze Power are other key nodes. Among them, Yangtze Power, as a public utility company, is relatively weakly affected by the economic cycle. The small weekly average of ΔCoVaR in the previous paper also indicates that its marginal contribution to the stock market risk is low. Poly real estate is a potentially important factor that constitutes risk accumulation and transmission. As an important tool for asset allocation, the real estate industry has a large scale of credit funds and numerous related industries, which can cause stock market risks easily.

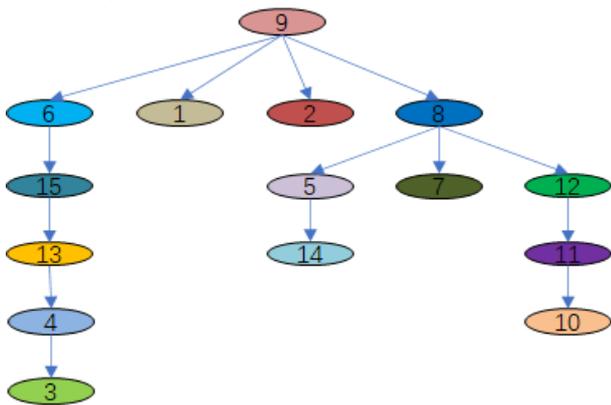


Figure 2 The best transmission path of risk among 15 risk points

4. CONCLUSIONS AND RECOMMENDATIONS

This paper starts with the listed companies in the stock market to study the risk transmission mechanism of the domestic stock market. We use the CoVaR method to identify 15 risk points from the listed companies in all industries, and build a network of correlations between the stock market risk points, and explore the best transmission path of stock market risk on this basis. In the analysis of the transmission path, it is found that the risk transmission effects of different industries are related. The financial industry is the industry with the most connected risk points, and it is easy to generate the risk spillovers that affect the stability of the entire stock market. At the same time, the real estate industry also occupies an important position in the risk contagion process. In recent years, the continuous overheating of the real estate industry and the securitization of real estate mortgages have promoted the close connection between the real estate industry and the financial industry, indirectly intensifying the spread and spread of risks in the real estate industry to other industries. In order to reduce the speed of risk spread in the stock market and control the path of risk spread, it is necessary to give full play to the government's role in mitigating stock market risks. Government agencies should first improve financial regulations, strengthen financial supervision and industry credit risk early warning, monitor and control heavyweight risk points in the financial industry, and cut off risk points around the source of potential crises. Secondly, because the real estate industry is also the hardest hit by the stock market crisis, the government should improve the excessively high risk of the real estate industry caused by the economy's excessive dependence on real estate, and while promoting the optimization of the real estate industry, it will transfer more capital resources from real estate to other industries. Finally, the regulatory authorities should use scientific and technological achievements to introduce advanced technologies such as big data and artificial intelligence into the stock market risk monitoring, increase stock market monitoring and capture possible abnormal signals in daily transactions.

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