ISSN 2616-5902 Vol. 5, Issue 21: 103-111, DOI: 10.25236/AJBM.2023.052115

Research on the risk contagion effect between commercial banks in China under tail risk events

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Abstract: *With the outbreak of the conflict between Russia and Ukraine, the study of financial risks under the tail event has become the mainstream. This paper selected eleven commercial banks in China as research objects, and used the TVP-VAR risk spillover index model to study the risk contagion effect among commercial banks in China. The results show that compared with other commercial banks, the risk spillover and spillover strength between state-owned commercial banks is larger. Compared with the Ukraine crisis, Sino-US trade friction has a greater impact on the market risk spillover effect of commercial banks, and the overall spillover index shows a significant jump upward trend. The smaller the comprehensive volume and scale of commercial banks, the more vulnerable they are to risk spillover from other commercial banks in the whole market risk spillover network of commercial banks, and they become the commercial banks with the greatest risk spillover intensity.*

Keywords: *Tail risk events; Risk contagion effect; TVP-VAR model*

1. Introduction

With the gradual improvement of the opening degree of our capital market, the possibility of our financial system being influenced by other countries is more and more, and the loss is more and more serious. Banking is an important component of China's financial system, and the stability of banking is related to China's economic life. Although China's banking industry has not had a major crisis, but the potential risks can not be ignored. China's banking industry is not only affected by the impact of other countries, but also by the impact of domestic economic fluctuations. Because of the credit relationship between the real economy and the banking industry, the depression of the real economy will affect the security of the banking industry in China.

The research purpose of this paper is to reveal the size and direction of inter-market risks of Chinese commercial banks. On the basis of existing research, the risk spillover model is used to measure the risk spillover, and then social network analysis is used to construct the inter-market risk contagion network of Chinese commercial banks and visualize its risk-contagion effect. It makes some contributions to the study of risk contagion effect between commercial banks in China.

2. Literature review

Since the 1980s, a series of systemic risks have broken out in some developing and developed countries. The problem of systemic risk contagion has become the focus of scholars' research, and many scholars have empirically confirmed the existence of risk contagion. Furfine used matrix method to study the problem of risk contagion in the American interbank market, taking large banks as inducers to investigate the risk contagion effect caused by their bankruptcies, and found that risk contagion did exist in the American interbank market.[1]

On the problem of the channel of systemic risk infection, scholars have done sufficient research. Ma Junlu et al. believe that there are three main channels of systemic risk transmission: passive channel, transmission through inter-bank business and information induced bank systemic risk. The latter two channels both emphasize the spillover effect when banks fail. Among them, the risk contagion based on the actual business contact between banks generally has two channels, the interbank market transaction and the payment system channel.[2]

Each infection channel corresponds to a different systematic risk measurement method. The matrix approach uses relatively easy data availability and minimal data requirements, and links the spread of systemic risk to actual transactions between banks. Therefore, it is a good way to use matrix method to study systemic risk in our country. The application of matrix method to the study of risk contagion in the inter-bank market started relatively early in foreign countries. Upper and Worms introduced the cross-entropy method to optimize the matrix model, and used the matrix method to study the risk contagion effect of the German interbank market, and found that the possibility of risk contagion in the German interbank market was relatively high.[3]There are some limitations in the existing research. For example, it can measure the size of the risk contagion effect among commercial banks, but it cannot visualize the direction of the risk contagion effect. Therefore, on the basis of the above, this paper applies the latest TVP-VAR-DY risk spillover model and social network analysis, and strives to accurately measure the size and direction of the risk contagion effect among commercial banks, and visualize it. The possible contribution of this paper is to focus the research perspective on the commercial bank market, and improve the defects of past studies that can not visualize the risk contagion effect between commercial banks.

3. Theoretical basis

Since the 1990s, the European monetary system crisis (1992), the Mexican financial crisis (1994), the Asian financial crisis (1997), the United States financial crisis (2008), and the European debt crisis (2010) have brought great impacts on the stability of regional (global) financial markets.[4]This makes the financial regulatory authorities of some countries realize that the regional financial market is a network formed by the connection of capital flows between the financial markets of different countries. In the network structure, the financial markets of different countries, as nodes in the network, form connections in the network structure by the correlation of mutual fund transactions and capital flows, while the financial markets of a single country with high connectivity become the core of the financial network structure, and the robustness of its operation determines the stability of the entire regional financial market.[5][6][7]

Financial risk contagion network refers to the complex network structure among various financial institutions, market participants and assets in the financial market, which are interconnected through financial and credit relationships. This network can spread financial risk, allowing problems in one financial institution or market to quickly spread to other institutions and markets, triggering a broader financial crisis. On the one hand, the financial crisis outbreak country can trigger the outbreak of the currency crisis of the trade associated country through "competitive currency devaluation", and at the same time cause the trade deficit of the trade partner country and the deterioration of the economic fundamentals;[8]On the other hand, the asset allocation of transnational investors in different markets and the capital lending between transnational banks have formed a certain correlation between the financial markets of different countries, and the outbreak of financial risks in some markets may be transmitted to other markets through the capital chain.[9]

4. Research methods and data processing

4.1. Construction of TVP-VAR model

Compared with the VAR model, the coefficients and shock covariance matrix of the TVP-VAR model used in this paper are time-varying, which can capture the time-varying characteristics and possible nonlinear characteristics of the model's delayed structure. First, a structural VAR model is established and the changes of parameters are introduced:

$$Ay_t = F_1 y_{t-1} + \ldots + F_s y_{t-s} + \mu_t, t = s+1, \ldots, n, \tag{1}$$

Where y_t is the $k \times 1$ dimensional observation vector, A is the $k \times k$ dimensional simultaneous parameter matrix, $F_1 \ldots\ldots F_s$ is a sparse matrix of $k \times k$ dimensions, and the disturbance term μ_t is a structural shock of $k \times 1$ dimensions, assuming $\mu_t \sim N(0, \Sigma\Sigma)$, where:

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$$\Sigma = \begin{bmatrix} \sigma_1 & 0 & \cdots & 0 \\ 0 & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \cdots & 0 & \sigma_k \end{bmatrix}$$

In particular, we assume that the simultaneous relationship of structural shocks is subject to recursive identification, that is, A is the lower triangular matrix:

$$A = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ a_{21} & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ a_{k1} & \cdots & a_{k,k-1} & 1 \end{bmatrix}$$

Therefore, equation 1 can be simplified as follows:

$$y_t = B_1 y_{t-1} + \ldots + B_s y_{t-s} + A^{-1} \sum \varepsilon_t, \varepsilon_t \sim N(0, I_k) \tag{2}$$

Where $B_i = A^{-1} F_i$, for $i = 1,\ldots s$,Straighten the row element in B, ctrip $k^2 s \times 1$, and define $X_t = I_s \otimes (y_{t-1},\ldots, y_{t-s})$, where $\otimes$ represents the Kronecker product, so equation 2 can be simplified to:

$$y_t = X_t \beta + A^{-1} \sum \varepsilon_t \tag{3}$$

Then make all coefficients and parameters time varying, and further transform equation 3 into:

$$y_t = X_t \beta_t + A^{-1} \sum{}_t \varepsilon_t, t = s+1,\ldots,n \tag{4}$$

Among them, the coefficient β_t, the simultaneous parameter A_t and the random fluctuation covariance matrix $\sum_t$ are all time-varying. In this paper, we follow the treatment methods of Primiceri (2005) and Jouchi Nakajima (2011).Straighten the lower triangular matrix A_t and the non-zero and one elements into a column of vectors :

$$a_t = (a_{21}, a_{31}, a_{32}, a_{41},\ldots, a_{k,k-1})$$

4.2. Diebold-Yilmaz Risk Risk overflow building

The generalized impulse response function (GIRF) and generalized prediction error variance decomposition (GFEVD) need to be calculated according to the risk spillover measurement principle of Diebold and Yilmaz. Therefore, according to the ergodic principle of Wold, the above formula TVP-VAR model is first converted into the time-varying parameter vector moving average form (TVP-VMA), and the impulse response function can be expressed as:

$$GIRF_t(H, \delta_{j,t}, F_{t-1}) = E(y_{t+H} \mid \varepsilon_{j,t}, F_{t-1}) - E(y_{t+H} \mid F_{t-1}) \tag{5}$$

$$\varphi^g_{j,t}(H) = \frac{A_{H,t} S_t \varepsilon_{j,t}}{\sqrt{S_{jj,t}}} \frac{\delta_{j,t}}{\sqrt{S_{jj,t}}}, \delta_{j,t} = \sqrt{S_{jj,t}} \tag{6}$$

$$\varphi^g_{j,t}(H) = S^{-\frac{1}{2}}_{jj,t} A_H S_t \varepsilon_{j,t} \tag{7}$$

Where, $\phi^g_{j,t}(H)$ represents the generalized impulse response function of listed company j , H represents the prediction step, $\delta_{j,t}$ is the selection vector, if it is the H th element, it is equal to one, otherwise it is equal to zero.

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In addition, the ratio of forecast error variance of listed company i caused by listed company j can be obtained by the decomposition of forecast variance error, that is, the risk spillover effect. After a series of standardized processing, the final form is as follows:

$$\tilde{\theta}_{ij,t}^{g}(H)=\frac{\sum_{t=1}^{H-1}\varphi_{ij,t}^{2,g}}{\sum_{j=1}^{N}\sum_{t=1}^{H-1}\varphi_{ij,t}^{2,g}} \tag{8}$$

Where,. $\sum_{j=1}^{H}\tilde{\theta}_{ij,t}^{g}(H)=1$, $\sum_{i,j=1}^{N}\tilde{\theta}_{ij,t}^{N}(H)=N$.

Therefore, the total spillover effect of listed company i on all other listed companies is:

$$C_{i\to t,t}^{g}(H)=\frac{100\sum_{j=1,i\neq j}^{N}\tilde{\theta}_{ij,t}^{g}(H)}{\sum_{j=1}^{N}\tilde{\theta}_{ij,t}^{g}(H)} \tag{9}$$

The total risk spillover effect of listed company i by all other parent companies is:

$$C_{i\leftarrow t,t}^{g}(H)=\frac{100\sum_{j=1,i\neq j}^{N}\tilde{\theta}_{ij,t}^{g}(H)}{\sum_{j=1}^{N}\tilde{\theta}_{ij,t}^{g}(H)} \tag{10}$$

Subtract equation 10 from equation 9 to represent the net risk spillover effect of listed company i:

$$C_{i,t}^{g}(H)=C_{i\to t,t}^{g}(H)-C_{i\leftarrow t,t}^{g}(H) \tag{11}$$

$C_{i,t}^{g}(H)$ indicates that the risk spillover effect of listed company i to other listed companies is greater than the risk spillover effect of other listed companies, and it is a net risk passer.And vice versa.In addition, by decomposing the net risk spillover, the net risk spillover effect between the two listed companies can also be calculated:

$$NPDC_{ij}(H)=\frac{\tilde{\theta}_{ji,t}^{g}(H)-\tilde{\theta}_{ij,t}^{g}(H)}{T}\times 100 \tag{12}$$

Where, if $NPDC_{ij}(H)>0$, it indicates that listed company i has a positive risk spillover effect on listed company j. In other words, listed company i drives listed company j in the risk-contagion relationship. Conversely, if $NPDC_{ij}(H)<0$, it indicates that listed company i has a negative risk spillover effect on listed company j. In other words, listed company i is driven by listed company j in the risk contagion relationship.

5. Empirical analysis

5.1. Data specification

In this paper, eleven banks listed in China's A-share market are selected as research objects: Industrial and Commercial Bank of China (DICBC), Construction Bank (DCCB), Agricultural Bank of China (DABC), Bank of China (DBC), China Merchants Bank (DCMB), Bank of Communications (DBCM), China Citic Bank (DCITIC), Ping An Bank (DPAB), Shanghai Pudong Development Bank (DSPDB), Everbright Bank (DCEB), Bank of Ningbo (DN)BCB), using daily closing prices as data, the sample period is from January 5, 2011 to December 30, 2022, and the data frequency is daily. Based on the studies of Jin Yuying et al. (2020) and Fang Yi et al. (2019), the time window of each major event is set as follows: August 14, 2017 - July 6, 2018 (the period of Sino-US trade friction);January 20, 2020 - July 20, 2020 (COVID-19);The remaining periods are regarded as normal periods, and the sample data are all from Wind.

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5.2. Descriptive statistics

In order to solve the characteristics of data instability, first-order log-difference processing was carried out on the above data (the economic significance of the processed data: similar to the daily rate of return). The ADF test and PP test results of the processed data both showed that the daily rate of return of each bank belonged to a stationary series, so the TVP-VAR model could be established for empirical research. The descriptive statistics of the samples are shown in Table 1.

Table 1: Sample descriptive statistics.

variable	mean value	skewness	kurtosis	Jarque-Bera statistics	ADF value	P value
DABC	0.0002	0.171	13.272	21415.603	-25.71603	0.0000
DBC	0.0002	0.433	14.966	27305.719	-40.32325	0.0000
DBCM	0.0001	0.096	14.174	24414.720	-24.22659	0.0000
DCCB	0.0002	0.124	9.420	10788.816	-24.08840	0.0000
DCEB	0.0000	0.532	7.907	7734.141	-52.98574	0.0001
DCITIC	0.0001	0.471	7.423	6802.014	-52.30661	0.0001
DCMB	0.0005	0.366	3.661	1693.823	-54.81077	0.0001
DICBC	0.0002	0.133	11.099	14977.251	-25.50108	0.0000
DNBCB	0.0005	0.199	3.318	1356.681	-55.31580	0.0001
DPAB	0.0003	0.262	3.701	1697.532	-53.50291	0.0001
DSPDB	0.0001	0.278	7.076	6121.463	-54.22031	0.0001

According to Table 1, it can be determined from the ADF test and its P-value that the data is stable after first-order logarithmic difference; Secondly, the skewness of each time series in the table is not 0, and the kurtosis is greater than 3, that is, the sample data does not belong to the normal distribution, and the data distribution is relatively steep and skewed to the right, with a significant "peak and thick tail" feature.

5.3. Static risk spillover analysis

The optimal lag order p=1 of the TVP-VAR model was determined according to AIC information criterion. In view of the fact that the Diebold-Yilmaz method used by scholars from various countries to measure the spillover index specifically has different prediction variance decomposition stages, ranging from 3 to 12, the expected error variance decomposition stage H=6 was set in this paper. According to the information set by the above parameters, the calculation results of various spillover indexes are shown in Table 2.Where, TO represents the spillover index, that is, the spillover effect of commercial bank i on other commercial banks; FROM represents the overflow index, that is, commercial bank i receives spillover effects from other commercial banks; NET is the difference between the spillover index and the spillover index, that is, the net spillover effect of commercial bank i on other commercial banks; TCI is the total spillover index, that is, the average of the spillover index or spillover index of commercial banks.

Table 2: Static overflow index results.

	DABC	DBC	DBCM	DCCB	DCEB	DCITIC	DCMB	DICBC	DNBCB	DPAB	DSPDB	FROM
DABC	13.31	10.76	9.58	10.41	8.58	7.30	6.97	10.78	5.73	6.49	7.09	83.69
DBC	10.53	15.97	9.85	10.00	9.01	8.04	6.88	10.04	6.07	6.47	7.12	84.03
DBCM	9.11	9.57	15.39	9.07	9.92	8.73	7.54	8.56	6.48	7.16	8.48	84.61
DCCB	9.98	9.78	9.19	15.68	8.74	7.44	7.56	10.78	6.38	7.26	7.23	84.32
DCEB	8.20	8.74	9.92	8.67	15.52	9.25	7.94	7.73	7.50	8.06	8.46	84.48
DCITIC	7.71	8.62	9.62	8.18	10.16	17.46	7.40	7.37	7.53	7.82	8.13	82.54
DCMB	7.32	7.29	8.33	8.25	8.76	7.32	17.39	7.55	8.93	9.65	9.22	82.61
DICBC	10.91	10.41	9.10	11.42	8.22	7.08	7.23	16.70	5.68	6.35	6.89	83.30
DNBCB	6.51	7.09	7.72	7.63	8.88	8.07	9.89	6.40	19.10	10.45	8.27	80.90
DPAB	6.83	6.93	7.90	7.99	8.95	7.86	9.93	6.56	9.86	18.20	8.99	81.80
DSPDB	7.36	7.46	9.36	7.81	9.21	8.09	9.21	6.99	7.52	8.75	18.23	81.77
TO	84.45	86.65	90.58	89.43	90.44	79.17	80.55	82.78	71.68	78.47	79.87	914.06
NET	0.77	2.62	5.96	5.11	5.96	-3.37	-2.06	-0.52	-9.22	-3.34	-1.90	91.41/83.10

According to the results in Table 2, we can see that there are significant risk spillovers between the markets of commercial banks in China. Specifically, (1) In addition to the spillover effect of China Construction Bank, Agricultural Bank of China and Bank of China (9.98% and 9.78%), the spillover intensity among the other four major banks exceeds 10%, and the spillover intensity between other commercial banks or with the four major banks is weaker than the spillover intensity between the four major banks. Agricultural Bank has the largest spillover intensity to ICBC (10.91%), while receiving the largest spillover intensity from ICBC (10.78%).(2) From the value sequence of To and from, BOCOM has an "active" performance in the whole risk spillover system of commercial banks. While the total risk spillover value (90.58%) is the largest, the total risk spillover value (84.61%) is also the largest. Among them, on average, BOCOM has the largest spillover intensity to other commercial banks and the largest

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spillover intensity to receive from these commercial banks.(3) From the perspective of Net risk spillover, the Net values of Agricultural Bank of China, Bank of Communications, Construction Bank and Everbright Bank are greater than 0, indicating that the above commercial banks play a net spillover role in the entire risk spillover system of commercial banks. Among them, Bank of Communications and Everbright Bank have the highest Net value, so they are the main net risk spillover commercial banks in the whole risk spillover system.(4) From the perspective of Net risk spillover Net, the net values of China Citic Bank, China Merchants Bank, Industrial and Commercial Bank of China, Bank of Ningbo, Shanghai Pudong Development Bank and Ping An Bank are less than 0, indicating that the above commercial banks play a net role in the entire risk spillover system of commercial banks. Among them, Bank of Ningbo has the smallest Net value, so in the whole risk spillover system of commercial banks, it is the main net risk spillover into commercial banks, which has "vulnerability" and is easy to suffer the risk impact of other commercial banks.

5.4. Dynamic risk spillover analysis

This paper makes a dynamic description of the overall spillover index of commercial banks' inter-market risks, and further explores the changes of the inter-market risk spillover effect of commercial banks at different time points. Figure 1 shows the time-varying chart of the overall spillover index of commercial banks' market risks from January 5, 2011 to December 30, 2022.

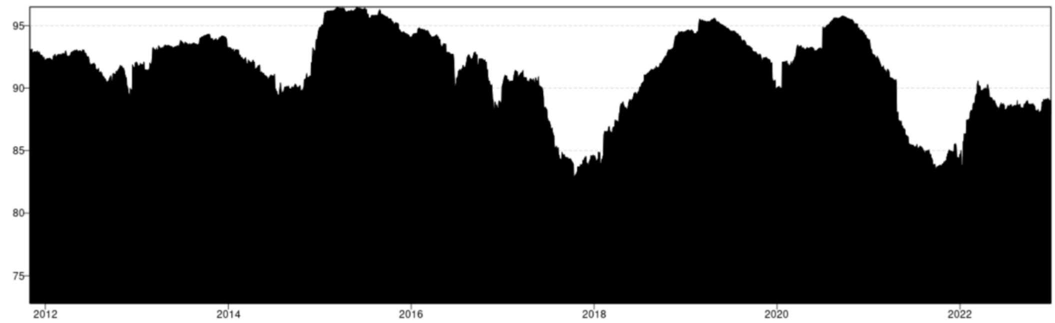

Figure 1: Time-varying chart of the overall risk spillover index.

It can be seen from Figure 1 that the overall spillover index of the commercial bank market has significant time-varying characteristics and can be roughly divided into five stages. The first stage: January 2011 - December 2014.At this stage, except for a significant decline in the risk spillover index curve in late 2013, the spillover index curve of the commercial bank market in the rest of the period was generally stable. The second stage: January 2015 - November 2017.At this stage, we can clearly find that during the period from January 2015 to January 2016, the risk spillover index curve increased significantly and reached its peak in June 2015, which was caused by the stock market crash in China from June 12, 2015 to January 31, 2016.Subsequently, with the end of the stock market disaster, the entire commercial market gradually recovered, so the risk spillover index curve showed a downward trend after January 2016, reaching the lowest value of 83% in October 2017.Phase 3: November 2017 - December 2019.At this stage, the risk spillover index curve showed a rapid upward trend, the reason for which was that in March 2018, former US President Donald Trump signed a presidential memorandum announcing a 25% tariff on goods imported from China, officially provoking Sino-US trade friction. Under the impact of Sino-US trade frictions, the total spillover index curve of risks has risen sharply in a short period of time, and systemic risks have accumulated rapidly. In September 2018, the United States imposed the second round of additional tariffs on China, announcing a 10% tariff on 200 billion goods, and the total market spillover index of commercial banks showed a jump growth trend again, rising rapidly from about 65% to more than 70%, and then maintained a small fluctuation. Phase 4: January 2020 - November 2021.At this stage, affected by the novel coronavirus pneumonia, the overall economy declined, the overall social consumption declined, and the loan business of commercial banks was hit. Therefore, in the early stage of the epidemic, the risk spillover index curve showed an upward trend. After reaching the peak, with the active management of the Chinese government, China's entire economic market improved, so the risk spillover index curve continued to decline from August 2020.Phase 5: December 2021 - December 2022.At this stage, when the Ukraine crisis broke out, the risk spillover index showed an upward trend in the early stage of the outbreak, but when it reached a predetermined level, the risk spillover index showed a stable trend.

This paper finds that the growth and reduction of the total market risk spillover index of commercial

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banks have significant asymmetric characteristics. Specifically, in the beginning of 2018 and the second half of 2018, the total market risk spillover index of commercial banks increased rapidly under the impact of Sino-US trade frictions. After reaching the peak, the total risk spillover index did not rapidly decline to the original level, but showed a slow decline or small fluctuation. At the beginning of 2020, under the continuous impact of Sino-US trade frictions and the impact of Brexit, the total market risk spillover index of commercial banks rose rapidly, reached a higher peak, and slowly declined to the level before the rapid rise after two years. This shows that Sino-US trade frictions and Brexit have a persistent impact on the market risk spillover of commercial banks, that is, systemic risks in the stock market accumulate rapidly under the impact of extreme events, and this risk spillover needs a long time to be completely reduced. In addition, the total risk spillover index of the stock market has different sensitivity to the impact of different extreme events. By comparing the change trend of the total spillover index curve between Sino-US trade friction and Ukraine crisis, it can be found that there is a relatively significant linear growth trend in Sino-US trade friction period, while there is no significant growth or decline trend in Ukraine crisis period. This shows that compared with the Ukraine crisis, Sino-US trade friction has a greater impact on the risk spillover effect between commercial banks.

5.5. Construction of market risk spillover network of commercial banks

Based on the whole time period and the practice of Demrieretal, based on the complex network theory, this paper adopts the threshold method to construct the risk spillover network of three periods, and represents the risk spillover effect between commercial banks' markets from the spatial dimension. In this paper, the intermediate value of the market risk spillover value (TO value) of commercial banks in each stage is selected as the threshold value, which not only ensures that all network nodes are connected, but also can not form a local independent network, and can maximize the screening of risk spillover information, so as to achieve effective network construction. Figure 2 shows the results of the risk spillover network of the commercial bank market in the whole period. The arrow points to indicate the direction of risk spillover, and the thickness of the edge reflects the intensity of risk spillover. That is, the thicker the joint edge, the greater the risk spillover strength; The thinner the edge, the smaller the risk spillover strength.

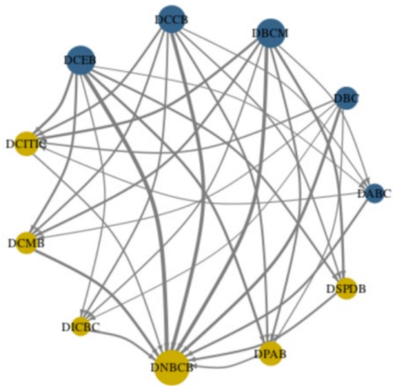

Figure 2: Risk overflow network diagram of the whole period.

According to Figure 2, we can draw the following conclusions: (1) In the entire market risk spillover network of commercial banks, Everbright Bank, China Construction Bank, Bank of Communications, Bank of China and Agricultural Bank of China are the main net risk spillovers. In addition, the above banks have the largest risk spillover intensity to Bank of Ningbo from the thick line on the side;(2) In the whole market risk spillover network of commercial banks, China Citic Bank, China Merchants Bank, Industrial and Commercial Bank of China, Bank of Ningbo, Ping An Bank and Shanghai Pudong Development Bank are the main net risk spillovers, in other words, they are the main recipients of risk spillovers of other commercial banks. In addition, as the strongest of the four major banks, ICBC is the main recipient of risk spillover, but the risk spillover intensity received is small, and it is mainly from Everbright Bank, Construction Bank, Bank of Communications and Bank of China. Due to its small size in the whole sample, Bank of Ningbo is the commercial bank that receives the greatest risk spillover strength from other commercial banks, and has high "vulnerability", the possibility and destructiveness of risk impact.

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6. Conclusion and revelation

6.1. Conclusion

Firstly, this paper adopts the spillover index method based on TVP-VAR model to construct the spillover index matrix of inter-market risks of multi-dimensional commercial banks, and identifies the role and status of commercial banks in the whole market risk spillover system of commercial banks from a static perspective. Then, the risk spillover index of commercial bank market is dynamically described to grasp the time-varying characteristics of risk spillover effect between commercial bank markets. Finally, a whole-time risk spillover network is constructed to more clearly visualize the risk spillover and contagion path between the entire commercial bank market. The conclusions are as follows: (1) Compared with other commercial banks, the risk spillover and spillover strength between state-owned commercial banks is larger;(2) Compared with the Ukraine crisis, Sino-US trade friction has a greater impact on the market risk spillover effect of commercial banks, and the overall spillover index shows a significant jump upward trend;(3) The smaller the comprehensive volume and scale of commercial banks, the more susceptible they are to risk spillovers from other commercial banks in the whole market risk spillover network of commercial banks, and they become the commercial banks with the greatest risk spillover intensity.

6.2. Revelation

Based on the above conclusions, this paper puts forward the following revelations:

First, the business transactions between state-owned commercial banks need to develop more stringent compliance and risk control systems. Due to its own characteristics, state-owned commercial banks: Due to its large volume, wide business scope and wide influence, major omissions in business will cause huge damage to other commercial banks and even the entire banking market, financial market and national economy. Therefore, it is necessary to establish more stringent compliance and risk control systems to avoid such incidents and reduce the intensity of damage caused by such incidents.

Second, crises in financial markets and international trade require greater regulatory attention than geopolitical crises. The current global economic environment is volatile, extreme events are frequent, and the resulting panic and economic policy uncertainty remain a major threat to the capital market. On the one hand, countries need to contain the development and spread of domestic extreme events and minimize the negative impact of risk factors on financial capital markets. On the other hand, countries should unite to uphold the vision of a community of shared future, work together to maintain international economic stability, reduce the probability of extreme events, and create a sound environment for the healthy development of the global financial market.

Third, commercial banks with small overall volume and scale need to take the most stringent risk control measures when tail risk events occur. When tail risk events occur, commercial banks with large comprehensive volume and scale can rely on their own cash flow and other means to withstand greater risk shocks in a short time. However, small commercial banks do not have such conditions. If they do not do a good job of risk control measures, it is likely to bring a big blow to the basic business of the bank when facing a big risk impact. Therefore, when such commercial banks are faced with tail risk events, they need to take the most stringent risk control measures to reduce the loss when they suffer from risk shocks.

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