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# Estimating the Systemic Risk of China's Banking Industries based on Merton Model

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**Abstract:** Banks are linked increasingly, one can adjust the capital surplus and deficiency, but also increases the risks of default between banks. The individual bank's loss will be through a linkage effects to other banks. This effect can significantly increase the risk of banking industry. This paper, from the asset price transmission angle, elaborated the formation mechanism of bank systemic risk and calculated China's banking systemic risk using the data of 2007-2011 of Chinese listed banks. The results show default correlations exist among asset price of inter banks and different types of banks have a crisis of infectious to the other banks but contagion degree is different.

**Keywords:** Asset price, Systemic risk,Default probability, Merton model

## 1 Introduction

Recently, the happening of series of bank crisis over the world reveals a fact that the bank systemic crisis is not far from us. This crisis exposed that bank system is not sound and supervision of bank risk is not perfect. It also sounded the alarm that we should pay close attention to the research on bank systemic risk. So far, China's large state-owned banks have accomplished Joint-stock reform, and have been appeared on the market successfully. With the deepening of China's opening to the outside world, the connection among banks in China and outside is closer. An important behavior of close degree among banks is the rapid development of inter-bank market. The scale expanding of inter-banks' market can adjust capital balance the one hand; but on the other hand, bring risk to the operating of the whole banking. As an industry with high risk, the credit risk in banks can bring large destructive to economy. If a bank suffers default event, it will transfer through the contagion mechanism of banks, so as forms Domino effect. Though there is no larger credit risk in China's banking under strong control, with the marketization and internationalization of Chinas financial system, the possibility of larger risk because of running of bank itself is increasing. Merton1974 [1] proposed the structural model which deemed default events occurred when the company was insolent. The direct factor of default was the change of value of company assets and liabilities, in other words, defaults caused by any reasons will all displayed by company asset value change. So the assumption in this model is that default probability has negative correction with asset value, and has positive correction with liability scale. The default probability will be low when asset value of the company is high, and vice versa. The default probability will be high when company liability scale is large, and vice versa. The research on banking systemic risk has accumulated some achievements in and out of the country. Bundesbank2003 [2,3] studied the change of return on assets when declining of a bank assets price caused by bank running, and its impacts to other banks which have similar assets. Lehar 2003 [4] studied effect of asset correction on bank systemic risk, and he declared that asset correlation can produced large effect on default estimating. Stephen Morris & Hyun Song Shin2009 [5] studied bank systemic risk caused by credit among banks, which can be distinguished by debit and credit and by return correction. Brownlees & Christian & Robert Engle (2010) [6,7] studied the correction among asset price and impacts of asset price volatility to systemic risk. Junlu Ma, Xiaoyun Fan and Yuantao Cao2007 [8] did some empirical analysis on China's bank systemic risk using matrix method and proposed that correction of some bank business relationship such as debit and credit relationship

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caused by lending market, being main way of risk conduction. This way can be divided into infection among domestic banks and infection among domestic and foreign banks. Qin Song2011 [9] gave some analysis on systemic risk of 14 domestic banks, which was mainly based on single bank but without any studying on contagion among banks risk. She concluded that systemic risk of joint-stock banks with smaller scale was obviously higher than large state-owned banks. From the researches in and outside, it can be found that the research about asset price change to systemic risk is uncommon because domestic banks appeared on the market later. The domestic researches mostly use metric method and based on bank systemic risk caused by infection of balance sheet. With more open of China's banking, the number of listed bank is increasing, so there is possible to study bank systemic risk using public data of listed banks. From the perspective of bank asset value change, this paper studies the impact of asset price change of a bank to that of other banks using Merton model. Through contrast between assets and liabilities, this paper also elaborates bank systemic risk by infection of asset price. This research has important theoretical and practical significance to push research of bank systemic risk.

## 2 Estimating method and defining parameters

Researches about banking systemic risk based on contagion of asset price are mainly doing Monte Carlo simulation using banks returns on assets, and then can conclude final market value of banks from yield and initial asset market value, by taking contrast to banks liability. If liability is larger than asset value, banks are default, and vice versa. Combining Black & Scholes and Merton model, using public market data, it can be gotten time series of asset market value . Then yield of asset value may be calculated at any time , and further variance-covariance matrix of yield can be gotten. Assuming a bank suffered crisis, its yield of asset value can be calculated and yield of asset value of other banks can also be simulated according to the yield variance-covariance matrix, also, time series of bank suffering crisis can be obtained using Monte Carlo simulation.

### *2.1 Measuring asset value of single bank based on Merton model*

Assuming any bank's asset is composed of two parts. One is debtor's interest named liability indicated by $B_t$ and the other is shareholders' equity indicate by $E_t$.So total asset of a bank can be represented by $V_t = E_t + B_t$ . The bank's asset value is followed by standard geometric Brownian motion which is described as $dV = \mu V dt + \sigma V dz$ . Here,$\mu$ means drift rate which is the average growth rate of the bank asset value. $\sigma$ means fluctuations which is standard deviation of growth rate of bank asset value. At time $t$ , if $V_t > B_t$ (bank's asset value is larger than liability), shareholder's equity value is $V_t > B_t$ . If $V_t < B_t$ , shareholder will go bankruptcy, shareholder's equity value is 0. This can be concluded by the following formula:

$$E_t = \begin{cases} V_t - B_t \ if V_t > B_t \\ 0 \quad\quad if V_t < B_t \end{cases}$$

Based on option pricing formula of European call option, at time $t$ ,bank equity value $E_t$ is as follows

$$E_t(V,T,\sigma,r,F) = V_t N(d_1) - F e^{-\gamma(T-t)} N(d_2),$$

(1)

Where $V_t$ is a company's asset market value at time $t$ , $r$ is risk-free interest rate, $N(\cdot)$ is cumulative probability function obeyed by standard normal distribution,$d_1$ , $d_2$ mean respectively:

$$d_1 = \frac{\ln \frac{V_t}{F} + \left(r + \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}}.$$

$$d_2 = d_1 - \sigma\sqrt{T-t}$$

Shareholder's equity value $E_t$can be gotten by stock market data, debt value $D_t$ can be got by bank balance sheet, hence, two time series $\{E_t\}$ and$\{D_t\}$ will be obtained at last. Based on Merton model, there is following identity relations between volatility of equity value $(\sigma_E)$ and volatility of bank asset value $(\sigma_V)$;

$$\sigma_E = \frac{VN(d_1)}{E}\sigma_V = g(V,\sigma_V,r,D,T).$$

(2)

Furthermore, the binary equations can be showed as follows:

$$\begin{cases} E(V,\sigma_V,r,D,T) = VN(d_1) - De^{-\gamma T}N(d_2) \\ \sigma_E = \frac{VN(d_1)}{E}\sigma_V = g(V,\sigma_V,r,D,T) \end{cases}$$

(3)

There are two unknown variables such as $V$and $\sigma_E$ in these two equations, which can be solved through MATLAB [10,11].

### *2.2 Defining estimated parameters*

2.2.1 Calculating volatility of bank's equity yields

Volatility of equity yield uses 2007-2011 as its calculating period in this paper. Namely, if trading date in 2011 is $n$, equity daily rate of yield is:

$$u_i = \ln\frac{S_i}{S_{i-1}}, \quad i = 1,2,...,n$$

(4)

$S_i$ is closing price of stock at the date $i$ . And this paper calculates volatility of equity yield using simple Standard deviation method. The calculating formula is as following:

$$\sigma_E = \sqrt{n} \times \sqrt{\frac{1}{n-1}\sum_{i=1}^{n} u_i^2 - \frac{1}{n(n-1)}\left(\sum_{i=1}^{n} u_i\right)^2}$$

(5)

2.2.2 Calculating expected rate of return of bank asset

By method of Leland (2002), this paper first calculates growth rate of stock value of a bank, which is multiplied by equity leverage of listed banks, and then can get expected rate of asset return $\mu$ , the calculating formula is $\mu = \mu_E \times \frac{E}{V}$,$\mu_E$ represents the growth rate of bank stock value, $E$ represents bank stock value, $V$ means bank asset value, $E/V$ then shows bank equity leverage rate. The calculating formula of growth rate of bank stock value is $\mu_{E_i} = \frac{E_i - E_{i-1}}{E_{i-1}}$. This paper first calculates bank stock value $E$ for 4 quarters and then does simple average to it, at last can get approximation value of $\mu_E$.

2.2.3 Calculating risk-free interest rate

Calculating interest rate in this paper is represented by RMB benchmark interest rate of one-year time deposit published by People's bank of China, which means risk-free interest rate.

**Table 1:** RMB benchmark interest rate of one-year time deposit(%)

| Adjusting time | 2010.12.26 | 2011.2.9 | 2011.4.4 | 2011.7.7 |
|---|---|---|---|---|
| One-year deposit rate | 2.75 | 3.00 | 3.25 | 3.50 |

Source: People's bank of China

Because risk-free interest rate in Merton model is assumed fixed, this paper use the simple weighted rate during period of calculating period as approximation of risk-free interest rate. Here taking the data in table 1 as an example of calculating the risk-free interest rate of 2011 as follows:

$$r = 2.75\% \times \frac{1}{12} + 3\% \times \frac{2}{12} + 3.25\% \times \frac{3}{12} + 3.5\% \times \frac{6}{12} = 3.2917\%$$

Similarly it is can be gotten the interest rate in 2007(0.0331),in 2008(0.0394),in 2009(0.0225) and in 2010 (0.0233).

2.2.4 Calculating bank debt maturity

Company maturity debt in this paper use research conclusion of KMV Company, the company default point is generally larger than current liabilities and smaller than total liabilities, which can be described by the following formula:

$$DP = SD + \gamma LD \quad 0 \le \gamma \le 1$$

(6)

DP is default point, SD is current liabilities, LD is long liabilities, $\gamma$ is a known parameters using 0.5 from common practices in and outside. On the other hand, New Basel Capital Accord defined a new standard that bank should estimate one-year default probability of debtor. This paper define the debt deadline as one year, namely, $T = 1$.

2.2.5 Calculating bank stock value

In this paper, all listed bank stock values are represented by simple arithmetic average of every trading day from 2007 to 2011.Using stock closing price at every date multiplied by total stock number, it can be obtained stock value at one trading date and then doing simple arithmetic average of stock value at all trading days, at last getting bank stock value.

2.2.6 Defining variance-covariance matrix of the capital gains

First it needs calculating asset value of every month from 2007 to 2011 by Merton model. That is to calculate a time series of asset value. Return on assets of bank i is defined as$R_i(T) = \ln(V(T)/V_t(0))$ .Time series of return on assets can then be calculated from the above formula. Defining joint income vector is$R(T) = (R_1(T), ..., R_N(T))$ . $R(T)$is a multivariate normal random variable. From time series of return on assets, variance-covariance matrix of the capital gains can be calculated. Mean value is $E[R_i(T)] = T\left(\mu_i - \frac{1}{2}\sigma_t^2\right) = T\alpha_i$, variance value is $Var[R(T) = T\sum]$,that is$R(T) - MVN(\alpha, T\sum), \alpha = (\alpha_1 ..., \alpha_N)$.It can be described as the following simple form:

$$R(T) = \begin{bmatrix} R^1(T) \\ R^2(T) \end{bmatrix} \quad \alpha = \begin{bmatrix} \alpha^1 \\ \alpha^2 \end{bmatrix} \quad \sum = \begin{bmatrix} \sum^{11} \sum^{12} \\ \sum^{21} \sum^{22} \end{bmatrix}$$

(7)

## 3 Calculating process and result analysis

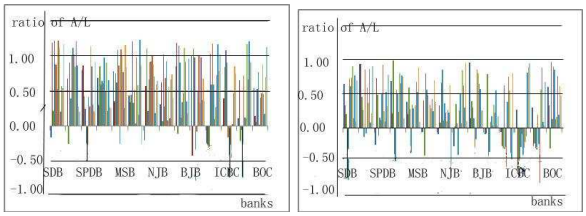
### *3.1 The choice of sample*

This paper chooses all listed banks in China during the sample period. There are 14 listed banks during 2007-2009. They are: Shenzhen Development Bank(SDB), Ningbo Bank(NBB),Shanghai Pudong Development Bank(SPDB),Nanjing Bank(NJB),Huaxia Bank(HXB), Minsheng Bank(MSB),Bank of China(BOC),Merchants Bank(MCB),Industrial Bank(IB),Beijing Bank(BJB),Bank of Communications(BOCOM),Industrial and Commercial Bank of China(ICBC),China Construction Bank(CCB),China CITIC Bank(CNCB).There were 16 samples during 2010-2011.They are Shenzhen Development Bank(SDB),Ningbo Bank(NBB),Shanghai Pudong Development Bank(SPDB), Huaxia Bank(HXB), China Construction Bank(CCB), Minsheng Bank(MSB), Merchants Bank(MCB), Nanjing Bank(NJB), ,Industrial Bank(IB), Beijing Bank(BJB),Agricultural Bank(AOC), Bank of Communications(BOCOM), Industrial and Commericial Bank of China(ICBC), Everbright Bank(CEB), ,Bank of China(BOC), China CITIC Bank(CNCB).The calculating period is from 2007.1.1 to 2011.12.31.The data is mainly from annual report published by listed banks and Finance Yearbook of China. Stock market data is from Royce database. Market benchmark interest rate is from the website of Peoples bank of China. The samples in this paper conclude all large state-owned commercial banks and other listed joint-stock banks. Though number of samples is not large, proportion of assets in these samples taken the whole bank assets is high (higher than 50%).Data of this paper can well reflect the whole Chinas banking situation and has good representative so that research result has credibility.

### *3.2 Calculating ratio of asset to debt*

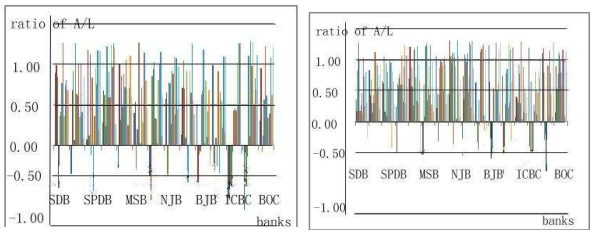
#### 3.2.1 Explaining of calculating process

In the calculating process, there are two parts of data important which can most explain the essence of problem. One is simulated yield of asset value, whose essence is that if one bank suffers crisis which will result in declining of its asset value, and asset value yield of this bank will change certainly and affect asset value yield of other banks due to some connect of asset value yield among banks. The other one is the ratio of asset value and liability of other banks. Crisis in one bank will cause corresponding changes of asset value yield in other banks. In the case of initial asset value is certain, final asset value in this bank will appear corresponding changes. If asset value is lower than liability in one bank, it means this bank has some problem and it will emerge running crisis.




(a) (b)

**Fig. 1:** ratio of asset value and liability in 2007(left) and in 2008(right)




(a) (b)

**Fig. 2:** ratio of asset value and liability in 2009 (left) and in 2010 (right)

#### 3.2.2 Calculating results

Bank asset value in every month can be gotten through monthly data, and then time series of asset value can be obtained, by which can further calculate time series of yield for every bank. At last correlation coefficient of the return on assets among banks are calculated. Combining correlation coefficient of the return on assets, annual asset market value and asset value yield are obtained using Merton model. Assuming one bank arise crisis because of its internal reason called initial shock, it will cause decline of asset yield and then affect asset yield in other banks. By simulating asset yield of other banks, asset yield of all banks can be obtained. To intuitively observe which bank suffers crisis or not, it needs to deal with the data on ratio of asset value and liability(ratio of $A/L$). This paper take data logarithmic, if ratio is larger than 1, the result will be larger than 0, and vice versa. Ordinate is logarithmic of ratio of asset value and liability. After doing this, the result of crisis bank will be lower than 0 under X-axis. The result is as figure 1, 2, 3.

This paper deems that if market value of asset in one bank continued declining, till when being equaled with its total liability, the bank suffers crisis. The frequency of crisis of other banks infected by one bank and frequency of crisis a bank caused by other banks is showed in table 2 and 3.

(1) From table 2 it can be concluded that Everbright Bank(CEB) has only two year data(2011 and 2010).From the data, if CEB meets crisis, the mean of contagion effect

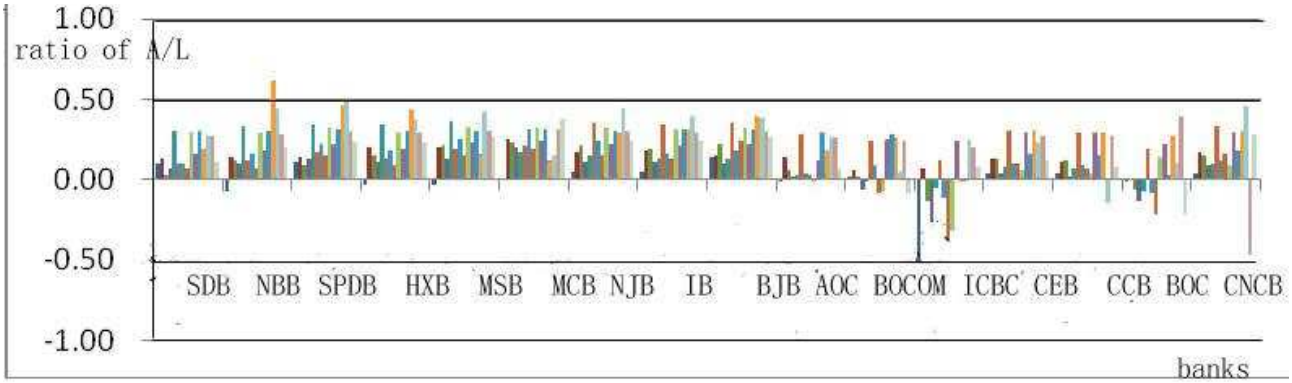



**Fig. 3:** calculating result of ratio of asset value and liability in 2011

**Table 2:** frequency of crisis of other banks infected by a crisis bank

| | 2007 | 2008 | 2009 | 2010 | 2011 | MEAN |
|---|---|---|---|---|---|---|
| SDB | 1 | 2 | 1 | 1 | 0 | 1 |
| NBB | 1 | 2 | 1 | 0 | 1 | 1 |
| SPDB | 2 | 2 | 2 | 1 | 0 | 1.4 |
| HXB | 0 | 2 | 0 | 1 | 1 | 1.8 |
| MSB | 1 | 1 | 1 | 1 | 1 | 1 |
| MCB | 1 | 2 | 1 | 2 | 0 | 1.2 |
| NJB | 1 | 1 | 2 | 1 | 0 | 1 |
| IB | 0 | 3 | 1 | 1 | 0 | 1 |
| BJB | 1 | 1 | 1 | 1 | 1 | 1 |
| AOC | | | | 5 | 2 | 3.5 |
| BOCOM | 3 | 5 | 3 | 2 | 5 | 3.6 |
| ICBC | 4 | 8 | 5 | 3 | 8 | 5.6 |
| CEB | | | | 0 | 0 | 0 |
| CCB | 4 | 9 | 7 | 4 | 1 | 5 |
| BOC | 5 | 7 | 5 | 5 | 6 | 5.6 |
| CNCB | 0 | 1 | 1 | 0 | 1 | 0.6 |

**Table 3:** frequency of crisis a bank caused by other banks

| | 2007 | 2008 | 2009 | 2010 | 2011 | MEAN |
|---|---|---|---|---|---|---|
| SDB | 2 | 6 | 5 | 2 | 6 | 4.2 |
| NBB | 3 | 4 | 5 | 5 | 1 | 3.6 |
| SPDB | 3 | 5 | 7 | 4 | 2 | 4.2 |
| HXB | 2 | 3 | 4 | 4 | 3 | 3.2 |
| MSB | 2 | 7 | 3 | 2 | 3 | 3.4 |
| MCB | 4 | 6 | 2 | 3 | 0 | 3 |
| NJB | 3 | 3 | 3 | 1 | 2 | 2.4 |
| IB | 2 | 2 | 2 | 0 | 3 | 1.8 |
| BJB | 1 | 1 | 0 | 0 | 3 | 1 |
| AOC | | | | 0 | 1 | 0.5 |
| BOCOM | 0 | 1 | 1 | 0 | 0 | 0.4 |
| ICBC | 0 | 0 | 0 | 0 | 0 | 0 |
| CEB | | | | 4 | 2 | 3 |
| CCB | 0 | 1 | 0 | 0 | 0 | 0.2 |
| BOC | 0 | 1 | 0 | 0 | 0 | 0.2 |
| CNCB | 2 | 2 | 1 | 3 | 2 | 2 |
| ANNUAL MEAN | 1.71 | 3 | 2.36 | 1.75 | 1.75 | |

of CEB is 0.Banks whose mean is 1 and under 1 are Shenzhen Development Bank(SDB), Ningbo Bank(NBB), Huaxia Bank(HXB), Minsheng Bank(MSB), Nanjing Bank(NJB), ,Industrial Bank(IB), Beijing Bank(BJB).Five years means of contagion effect of Merchants Bank(MCB) is 1.2. Contagion effect of Agricultural Bank (AOC) is 3.5. Mean contagion effect of Bank of Communications (BOCOM) is 3.6. Mean contagion effect of Industrial and Commercial Bank of China (ICBC) and Bank of China (BOC) are all 5.6, being the largest ones. (2)From table 3 it can be concluded that ICBC has stronger immunity. Crisis number of ICBC is 0, which means ICBC basically wont be infected by other banks. In 2008, BOC and CCB occurred once crisis during the five years. BOCOM appeared twice crisis respectively in 2008 and 2009.AOC only has two year data, reflecting this bank being infected in 2011.Contagious frequencies of other joint-stock banks with smaller scale is larger. Most of them are between 3 and 5.But mean of BJB is 1.Mean of IB is 1.8.Mean of CNCB is 2. (3)From annual mean it can be concluded that mean in 2008 is the largest which is 3.Next is in 2009 which is 2.36.It in 2007 is 1.71.Means in 2010 and in 2011 are the same which are 1.75.

### *3.3 Calculating joint default probability and systemic risk index*

The above research proves that bank risk has infection character, but it doesn't explain how much the probability of bank risk infection is, and it doesn't explain the happening possibility of bank systemic risk. Further, this paper releases joint default probability every two banks from default probability of single bank, from which the probability can be calculated when all banks are in default, which can be used as bank systemic risk index to study all listed bank systemic risk [12,13].

3.3.1 Calculating joint default probability(JDP)

The calculating basis of joint default probability is Merton model. Considering two random variables $D_1(t)$ and $D_2(t)$, which can be used to describe default status of bank1 and 2.$t$ is time period. Status of two banks can be represented by the following formula:

$$D_t(t) = \begin{cases} 1, if\ bank\ i\ suffered\ default\ at\ time\ t \\ 0, or\ else \end{cases}$$

Assuming default event is independent. Joint default probability of two banks is expressed as follows:$P(D_t(t) = 1, and D_2(t) = 1 = P(D_t(t) = 1) \times P(D_2(t) = 1)$ However, when there emerge default event in reality, especially in the same industry, when one entity meets default event, the probability of default event of others will be high. Maybe two are all under pressure at the same time, such as the overall economic situation, industry and area. There may be positive default correlation between two individuals [14,15]. Default correlation coefficient$Corr(D_1(t), D_2(t))$ is defined as the following formula:

$$Corr(D_1(t), D_2(t)) = \frac{E[D_1(t)D_2(t)] - E[D_1(t)] \times E[D_2(t)]}{\sqrt{Var[D_1(t)] \times Var[D_2(t)]}}$$

(8)

Because$D_1(t)$ and $D_2(t)$ are all Bernoulli binomial random variables. there is the following formula:$E[D_i(t)] = P(D_i(t) = 1)$ $Var[D_i(t)] = P(D_i(t) = 1) \times [1 - P(D_i(t) = 1)]$ Default correlation analyzing is very important in deciding joint default probability [16,17]. From above formula, the calculating formula of joint default probability (two banks are all under default) is as follows:

$$P(D_1(t) = 1, and, D_2(t) = 1) = E[D_1(t)D_2(t)] \\ = E[D_1(t)D_2(t) + corr[D_1(t)D_2(t) \\ \times \sqrt{Var[D_t(t)]Var[D_2(t)]}$$

(9)

Based on formula(9), this paper calculates the probability when two banks as will are under default at the same time. It is as followed:

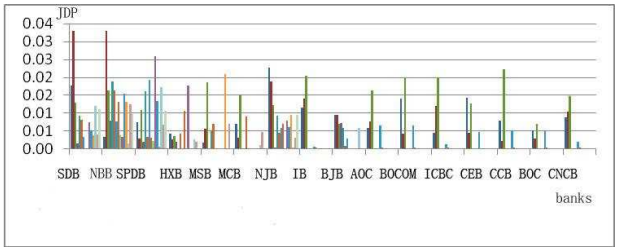
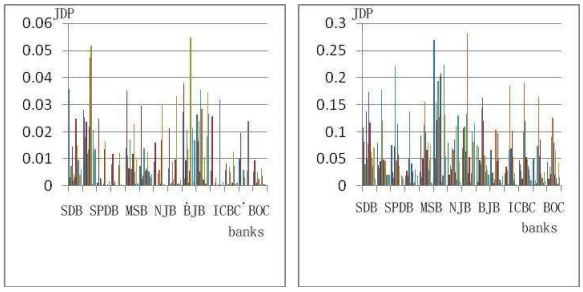
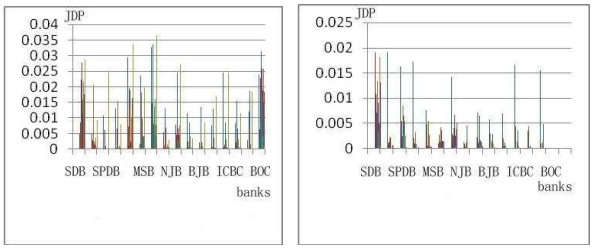



**Fig. 4:** calculating result of joint default probability in 2011




(a) (b)

**Fig. 5:** calculating result of joint default probability in 2007(left) and in 2008(right)




(a) (b)

**Fig. 6:** calculating result of joint default probability in 2009(left) and in 2010(right)

From Figure 4, 5 and 6, it can be concluded that joint default probability is higher, which is fit for the reality. In 2008, subprime mortgage crisis infected into China with large scale, and investment banks in USA impacted China largely. Some banks in China were suffered serious loss, and banking stock declined significantly. To one bank, if the default probability of this bank is higher, joint default probability is higher. Joint default probability of large state-owned commercial banks is lower than that of small-scale joint-stock banks because of firstly banks with smaller scale are easier affected by initial impact. Under the same impact level, smaller-scale banks suffer crisis easily. Secondly, small-scale banks are easier to be get infected by other bank crisis. Through analysis it can be concluded that:(1) Joint default probability of large-scale state-owned commercial banks are lower than that of joint-stock banks and other large state-owned banks, which means their ability to resist risk is high. (2)Joint default probability among joint-stock banks is higher, which is fit for the low ability of their risk resisting. (3)If default probability of one bank is high, the joint default probability with other banks is high.

3.3.2 Calculating risk index of bank systemic(BSRI)

After calculating joint default probability between random two banks, we can get probability of which all banks default at the same time. This paper calculates bank systemic risk index of all banks based on joint default probability of two banks and default probability of single bank. And this paper weighted average to joint default probability of one bank to other banks using default probability of single bank as weights, at last get the probability all banks default at same time, which forms the systemic risk index of banks. This paper calculates systemic risk index of listed banks from 2007 to 2010.Because the banks which were affected by initial impact were different, bank systemic risk were different. So for one year, the number of systemic risk index is based on that of samples. In China there were 14 listed banks from 2007 to 2009, so there were 14 indexes. In 2010 AOC and CEB were listed separately, so there were 16 indexes in these two years.

**Table 4:** calculating result of bank systemic risk index

| | 2007 | 2008 | 2009 | 2010 | 2011 | MEAN |
|---|---|---|---|---|---|---|
| SDB | 0.0104 | 0.0250 | 0.0150 | 0.0064 | 0.0186 | 0.0754 |
| NBB | 0.0205 | 0.0274 | 0.0080 | 0.0110 | 0.0156 | 0.0826 |
| SPDB | 0.0094 | 0.0310 | 0.0098 | 0.0106 | 0.0028 | 0.0638 |
| HXB | 0.0059 | 0.0167 | 0.0089 | 0.0101 | 0.0036 | 0.0452 |
| MSB | 0.0175 | 0.0248 | 0.0201 | 0.0058 | 0.0101 | 0.0783 |
| MCB | 0.0132 | 0.0382 | 0.0133 | 0.0018 | 0.0094 | 0.0758 |
| NJB | 0.0110 | 0.0169 | 0.0230 | 0.0087 | 0.0145 | 0.0741 |
| IB | 0.0130 | 0.0354 | 0.0055 | 0.0015 | 0.0141 | 0.0695 |
| BJB | 0.0241 | 0.0291 | 0.0159 | 0.0035 | 0.0076 | 0.0802 |
| AOC | | | | 0.0057 | 0.0105 | 0.0162 |
| BOCOM | 0.0132 | 0.0187 | 0.0056 | 0.0041 | 0.0126 | 0.0543 |
| ICBC | 0.0171 | 0.0272 | 0.0090 | 0.0043 | 0.0121 | 0.0697 |
| CEB | | | | 0.0137 | 0.0098 | 0.0235 |
| CCB | 0.0080 | 0.0294 | 0.0090 | 0.0102 | 0.0115 | 0.0682 |
| BOC | 0.0150 | 0.0240 | 0.0112 | 0.0027 | 0.0053 | 0.0581 |
| CNCB | 0.0057 | 0.0209 | 0.0147 | 0.0092 | 0.0106 | 0.0611 |
| MEAN | 0.0131 | 0.0260 | 0.0118 | 0.0064 | 0.0105 | |

To explain the problem more directly, the above table can be showed by following figure 7 and Figure 8:

From table 4, Figure 7 and 8 it can be concluded that NBB as initial bank has the highest bank systemic risk index, next is BJB. Bank using AOC as initial bank has the smallest bank systemic risk index, next is CEB. Overall, systemic risk indexes of large state-owned commercial banks are lower than that of small-scale joint-stock banks. From sub-annual, mean of bank systemic risk in 2010 is the smallest, next is in 2011, and then in 2009 and 2007.Bank systemic risk is the highest in 2008 because of subprime mortgage crisis. From contrast with joint default probability, joint default probability in 2008 is higher, but isnt much higher than that in other years. But to bank systemic risk index, it is nearly double to other years, which means relative to joint

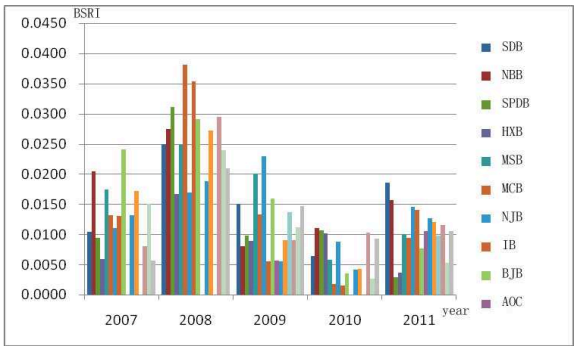
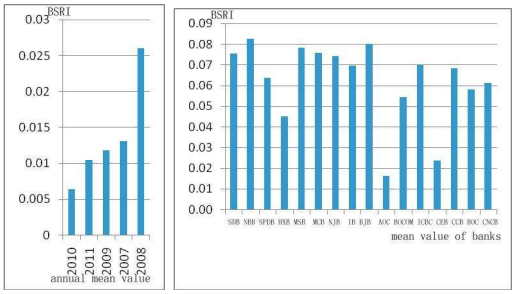



**Fig. 7:** sub-annual chart of bank systemic risk index




(a) (b)

**Fig. 8:** annual mean of bank systemic risk (left)and bank mean(right)

default probability, bank systemic risk index is more obvious in crisis year.

## 4 Conclusions

This paper chooses data of listed banks in 5 years, based on Merton model, from change of bank asset price and view of risk infection, calculating systemic risk of banks in China. The result displays that: (1) the results all show there exits some risk in Chinas banking. From now on, probability of Domino effect of the whole banking affected by crisis of one bank is small.(2)If joint-stock small and medium-sized banks occur crisis, the effect to other banks is very small. Only two joint-stock banks crisis may cause crisis of other banks, and only affect one bank. If state-owned large banks appear crisis, the scope affected is wide. (3)From joint default probability it can be seen that default probability among joint-stock banks and other banks is large. Joint default probability among state-owned commercial banks and other banks is lower, which means risk resisting ability in state-owned large banks is strong. From bank systemic risk index, it is the highest in 2008, which is relative to the worsening

operation of banks in 2008. Overall, from angle of bank asset market value, the research result of Chinas listed bank systemic risk is fit for the reality, which means lower probability of crisis happen in whole China's banking. Nevertheless, it is necessary to prevent risk from improving single bank risk resisting ability, perfecting asset pricing mechanism, blocking risk transmission channels and strengthening banking external supervision.

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