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Evaluation of Default Risk Based on KMV Model for ICBC, CCB and BOC

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Abstract

After the financial crisis, the market capitalization of Industrial and Commercial Bank of China(ICBC), Bank of China(BOC) and China Construction Bank(CCB) rose to the top three global business, fully representative of the China's overall economic growth, while exposure to the banking industry's high financial risks. In order to identify and compare credit risk of three listed banks, using KMV model calculate default distance of the three banks and then compare default rate: First, use stock data to calculate default point, the default distance, compare the risk of three banks, on this basis analyze financial data of three banks; Finally, identify the reasons for differences of default risk. An Empirical Study of three banks through the second half of 2006 to the end of 2008 stock data and annual information, found that: (1) The risk of three banks have tended to increase, including CCB the highest risk of default; (2) key financial indicators of CCB: non-performing loan ratio, loan-to-deposit ratio, the proportion of non-interest income accounted for revenue are worse than ICBC and BOC, which is reason for CCB risk of default is higher than ICBC and BOC. Suggest CCB adjust loans and reduce non-performing loan ratio; improve asset efficiency and profitability; expand intermediary business to reduce risk.

Keywords: Credit risk, KMV model, Default distance, ICBC, BOC, CCB

1. Introduction

There are three main types for KMV model: one is the introduction and analysis of KMV model on the base of theory and modeling framework, focusing on the KMV early studies. Representative is Du, Benfeng (2002)"real option theory in the application of credit risk assessment", Wang, Qiong and Chen, Jinxian (2002) "Credit Risk Pricing Methods and Models" and other articles, these studies highlight the framework of the KMV model, but no study of the applicability of KMV model in China.

Another type of research is the use of domestic data sample directly in accordance with the basic framework of the KMV model and use foreign models and the relation functions to authenticate. Yang,Xing and Zhang,Qiang (2003) take one listed company as sample, Ye,Qingxiang (2005) take 22 ST companies as samples, Chen,Jie (2003)divided a number of listed companies into shares of blue-chip stocks and underperformance, Cheng,Peng and Wu,Chongfeng (2002)divided listed companies into blue-chip stocks, underperformance stocks and high-tech stocks and respectively verify KMV model, Xia,Hongfang and Ma,Junhai (2008) verify the distance of four listed companies' five-year stock price of non-compliance. Such studies verified the basic conclusion is that, risk prediction methods of KMV model can make up for deficiencies in traditional methods, can effectively identify the risks. However, there is difference between Chinese and foreign stock markets, so such studies have not been able to support the applicability of KMV model in China.

There is also a type of study to explore the KMV model in China, the specific applicability of the revisions to the KMV model, based on the full use of the sample data for validation. Such studies include: Lu Wei, Zhao,Hengheng and Liu,Jiyun (2003) pointed out that the KMV model, the critical factor "corporate value" and the "volatility of company value," the relationship varies with the market, and they take advantage of China's stock market data, using

constant-growth model FCF (free cash flow) method to calculate a company's value, Use Bollerslev (1986) generalized conditional heteroskedasticity model (GARCH) to calculate value of volatility of equity, and finally a two-parameter Weibull to describe the value of the company respectively, and the relationship between the volatility of company value function, empirical results showed that compared with KMV model with non-amended relationship between the function of fitting, they can more effectively reflect the real situation in China. Chen,Dongping and Sun,Ming (2007) select the listed companies' non-performing loan rate of commercial banks an alternative default rates, fitting out a function of the non-performing loan ratio and non-compliance distance, indicating that in KMV model using non-performing loan ratio as an alternative measure of listed companies of credit defaults risk is feasible. Sun,Xiaoyan, Shen,Yue and Luo,Luqi (2008) respectively verified ST and non-ST companies with amended KMV model, indicating that KMV model both calculate non-ST companies' value of the assets, but also reflect the ST companies' value of the "shell" resources. Chen, Hongwei and Chen, Fusheng (2008) proved the value of corporate assets by increasing the accuracy of the estimates; KMV model can enhance the recognition of credit risk for listed companies for next two years.

In addition, there is research of the non-tradable shares' conversion price issues caused by the special national conditions of China. Lu, Wei and Zhao, Hengheng et al (2003) proposed weighting methods; Zhang, Yiqiang (2003) proposed to leverage capital surplus as an adjustment factor to adjust the initial sponsor of non-tradable shares. Such research has further strengthened in the study of Chinese listed companies KMV credit risk on the applicability of the results to improve the prediction accuracy and credibility. In recent years, the applicability research of KMV model in China receive higher priority in the application of KMV model, Chinese scholars have done a lot of research in the study of a function to reflect the characteristics of Chinese companies, the study of the corresponding treatment methods in China's special conditions. However, there are still some issues to be addressed: Such as the choice of risk-free rate, default and expected default probability from the mapping relations, etc.

Through the results of the study has also found that, due to the nature of the financial industry itself and the special nature of accounting standards, research of the risks of the financial sector basically by calculating the bank's enterprise customers' credit risk to judge. Less study take the banking industry as a research object, directly use KMV model to identify the bank's own risk of default. Therefore, research of credit risk of China's listed commercial banks has very important significance. This article has been trying to learn from domestic and foreign research results, using KMV model representative of China's three commercial banks: Industrial and Commercial Bank of China, Bank of China and China Construction Bank risk study to compare credit risk of banks of different characteristics, and the reasons with the use of financial data analysis.

2. Calculation Method and Process

KMV model developed by the United States KMV Corporation, named by the three company founder, Kealhofer, MeQuow and Vasieek. KMV model is based on Merton (1974) option pricing theory, through the enterprise's financial reports and the market value of equity and debt data such as the possibility of likely future default. KMV model's basic idea is to use stock to show the options nature, through the stock market and its volatility as well as the value of corporate debt data to value corporate assets and their volatility, and in the coming years in order to estimate the likelihood of corporate defaults (refers only to enterprises due non-payment default risk, non-corporate credit rating changes in credit spread risk), that is, the expected probability of default EDF. KMV model is generally divided into four steps to determine a company's expected default frequency. The first step, estimate the company's asset value and its volatility from the company's stock market, value of the volatility of stock price and liabilities book value. According to assumption of KMV, from the equity capital structure, cash equivalent short-term liabilities are regarded as sustainable long-term pension liabilities and convertible preferred stock component. In this assumption, according to the relationship between the classic Black-Scholes-Merton model put option valuation models and default options, current market value of risk loans is determined by five variables.

Value of an option of loan default risk:

$$\mathrm{E} = f(V, B, r, \sigma_v, \tau) \tag{1}$$

$$f(V, \sigma_V) = E = V \times N(d_1) - B \times e^{-rt} \times N(d_2) \tag{2}$$

$$d_1 = \frac{\ln(\frac{V}{B}) + (r + \frac{1}{2} \times \sigma_V^2)\tau}{\sigma_V \sqrt{\tau}} \tag{3}$$

$$d_2 = d_1 - \sigma_V \sqrt{\tau} \tag{4}$$

V is the market value of assets, B is the price for the loan, r is risk-free rate of interest, σ_s and σ_V Respectively, an enterprise's market value and asset t value, τ is put option expiration date or the time the loan limit ,N(d)-Cumulative distribution probability function.

In order to calculate the value of assets (V) and its volatility σ_V, According to the relationship between the observable fluctuations in the market value of corporate and non-observable fluctuations in the value of assets of the company has established the function:

$$\sigma_S = g(\sigma_V) = \frac{V \times N(d_1) \times \sigma_V}{E} \tag{5}$$

Then uses a continuous iterative method will be able to find V and σ_V .

Second step, determine the default point (Default Point, DPT). Under a large number of empirical analyses, KMV found violations occurred most frequently in a company's value is greater than the critical point is equal to current liabilities plus 50% of the long-term liabilities. Set: CL for short-term liabilities; LL for long-term liabilities, then:

$$DPT=CL+0.5LL \tag{6}$$

Third step, estimate the default DD (Default-distance). Default is the value of the assets from the risk fell within the time limit from the current level of non-compliance point of relative distance, but also can be expressed as the expected future asset values and default points exists between the standard deviation of the future number of asset returns, which is used to measure the default risk indicators can be used for comparisons between different companies. Default Distance:

$$DD = \frac{E(V) - DPT}{E(V) \times \sigma_V} \tag{7}$$

The fourth step, estimate the company's expected default probability (EDF). The expected default frequency (EDF) is determined by the mapping relationship between the distance by default distance (DD) and the expected default frequency. Therefore, establishing mapping relationship is a necessary prerequisite to determine the expected default rates. However, due to China's current credit system is not perfect, so the corporate default or bankruptcy of a serious lack of historical statistical data, it is difficult to change the default distance into the actual default rate, to calculate default probability (EDF) is difficult. Based on the one-to-one mapping relations between the default distances (DD) and the expected default frequency (EDF), the length of the distance to a certain extent reflect the company's credit status, and thus evaluate the level of competitiveness of enterprises.

3. Empirical process and the result

3.1 Data Source

Study involved data from Guo Tai An Data Research Center and RESET databases, daily stock closing price is the comparable prices of the closing price considering of the cash dividend and re-investment, only take available open days prices, without considering the impact of stock stop plate; Value of circulating stocks market (EC) take the mean value of the circulating stocks from 2001 to 2007 of all transactions for each day, Daily Stock Market Mean Prices(PA,PH)is the comparable mean prices of the closing price considering of the cash dividend re-investment of all stocks all trading days per annum. Related financial data and net assets per share (A), the number of circulating stocks (SC), the number of non- circulating stocks(SNC) and the number of H stocks(SH) came from the semi-annual and annual reports of every bank, the number of non- circulating stocks from current semi-annual reports. Risk-free rate (R) obtained from at least six months less than one year certificate bonds interest rate issued by The People's Republic of China Ministry of Finance, as shown in Table 1:

Insert Table 1 Here

3.2 Important parameters on the amendment of China's banking sector

3.2.1 Market Value Calculation

Reference to the principle that negotiated transfer price of the non- circulating stocks are basically floating around the net assets per share of the market pricing, construct a net asset per share as independent variables, the financial markets financial shares transfer price as the dependent variable of a linear regression model-based, suppose the regression equation is:

$$P = m + nA$$

A--Net assets per share

P--The transfer price of financial shares

In order to determine the equation parameters and to validate the reliability of equation. This paper selected Guo Tai An Data Research Center - Data Services - Company Research Series - Chinese Corporate Governance Structure - Basic data - share transfer documents, all 35 times stock equity transfer data of Finance and insurance sector from 2001 to 2008 to regression analysis, regression results were shown in Table 2:

Insert Table 2 Here

Get the regression equation is: P=1.652688+0.906602×A

Market value of the equation as follows: market value = value of A-share circulating stocks + value of A-share non-circulating stocks + value of H-share, namely: P=PA*SC+(1.652688+0.906602×X)*SNC.

Insert Table 3 Here

3.2.2 Default Point Calculation

Based on Debt Risk Valuation Theory and research of KMV, default point (DPT) is a point between long-term debt (LTD) and current liabilities (STD), and the predictive accuracy is sensitive of the model changes in point of the default point. Learn from empirical research on the banking sector, take DPT1 = STD + 0.25LTD, calculated as shown in Table 4:

Insert Table 4 Here

3.2.3 Asset Value and Asset Value Fluctuation Ratio Calculation

Before calculate the semiannual fluctuation ratio σ_S of bank shares, assuming the stock price to meet the lognormal distribution, calculate the daily stock fluctuation ratio S:

$$u_i = In(S_i / S_{i-1}) \tag{8}$$

In formula (8), S_i / S_{i-1} is the daily relative price of the stocks.

Fluctuation ratio in daily stock returns is:

$$S = \sqrt{\frac{1}{n-1}\sum_{i-1}^{n}(u_i - \bar{u})^2} \tag{9}$$

In formula(9): $\bar{u}$ is the mean of u_i .Number of trading days semiannually of the stock is N, relationship between the semiannual fluctuation ratio σ_s and daily fluctuation ratio S is:

$$\sigma_s = S\sqrt{N} \tag{10}$$

2001-2007 three banks semiannual revenue fluctuation ratio is shown in Table 5.

Insert Table 5.Here

According to formula (3) to (7) can estimate the company's asset value *V* and the fluctuation ratio of asset value. Two equations are nonlinear equations, this paper uses mathematical calculation software program MATLAB6.5 to calculate, source code see Appendix A, the calculation results shown in Table 6 and Table 7.

Insert Table 6 and Table 7 Here

3.2.4 Default distance calculation

Finally, use formula to calculate the non-compliance DD of various banks for the next six months (first half of 2009).Using data from 2006 to 2008, three banks' calculation results of non-compliance distance is shown in Table 8 below:

Insert Table 8 and Figure 1 Here

As can be seen from Figure 1, the three banks have a downward trend from the default distance; default risk has the trend to increase. The default distance of Bank of China continued to increase from the second half of 2007 to the second half of 2008, indicating that the default risk was lowered, but in the first half of 2009, default distance is expected to fall to 2.949, default risk rise; default distance of Industrial and Commercial Bank of China in the second half of 2008 after experiencing a modest rise in half year of 2008, will continue to decline in 2009 and is expected to drop to 2.922; default distance of China has the most dramatic change, fell from the first half of 08 5.06to the first half of 2009 0.54, which indicates the default risk of China Construction Bank a sharp rise, become bank of top default risk in the three banks.

3.3 Empirical Analysis

Three banks vary in default risk, depending on their growth performance, operating characteristics, and asset quality.

3.3.1 Comparison of three bank non-performing loan ratio

Insert Figure 2 Here

As can be seen from Figure 2, Industrial and Commercial Bank of China, Bank of China and China Construction Bank's non-performing loan ratio has a downward trend, compared with the end of 2007, by the end of 2008 respectively decreased by 16.4%, 15.1%, 15.0%, of which the lowest rate of non-performing loans is CCB, as well as the smallest decline degree in non-performing loan ratio.

3.3.2 Comparison of three bank loan-deposit ratio

Insert Figure 3 Here

As can be seen from Figure 3, ICBC and BOC loan-to-deposit ratio were gradually increased, while CCB loan-to-deposit ratio dropped from 2007 61.3% to 2008 59.5%. This shows that the CCB efficiency and profitability of assets is lower than ICBC and BOC. In addition, the loan-deposit ratio of the three banks are generally around 60%, compared with Europe and the United States mature banks' about 90%,there is still a wide gap, which is also reflects the domestic banks have a wider profit room for growth.

3.3.3 Comparison of three bank Non-interest income accounted for the proportion of operating income

Insert Figure 4 Here

Commercial bank's core source of profit for one credit business and second, intermediary business, the former form is known as interest income, which is non-interest income. But the credit business interest income earned by the capital adequacy ratio and policy restrictions on long-term growth is difficult at the same time bear the risk of bad debts, while the intermediary business to generate non-interest income do not take up too much capital, but the lower business risks.

According to statistics, non-interest income to total operating income ratio increase every one percentage, the banks pre-tax profits will increase by 1.5 percentage, there is 1:1.5 leverage. As can be seen from Figure 4, the proportion of ICBC non-interest income showed an upward trend year by year, from 2006 8.8% to 2008 15.1%; BOC, the proportion of non-interest income in the three banks in the highest, while in 2007 non-interest income decline, have a rebound in 2008. CCB fell from 2007 12.2% to 2008 10.7%, this shows that compared with CCB, ICBC and BOC created a lower risk, more rapid revenue growth.

In summary, on the basis of the three main financial indicators: non-performing loan ratio, loan-to-deposit ratio, the proportion of non-interest income accounted for revenues of comparison, CCB are worse than ICBC and BOC, this was part of the reason for CCB has a higher risk of default than ICBC and BOC.

3.3.4 Comparison of three bank core capital adequacy ratio

Insert Figure 5 Here

In accordance with China's current "Basel II agreement" standard to require commercial banks core capital adequacy ratio must be greater than equal to 4%, can be seen from Figure 5, the three banks have reach the standard, while CCB is the lowest in the three banks.

The higher the capital adequacy ratio of banks, the stronger risk-resisting ability it has, indicating banks have sufficient own resources to deal with debt pressure, or cover the losses, such as the event of a run on banks or large non-performing loans and beyond recovery to a vicious risk. It can be seen that solvency of CCB in response to non-performing loans beyond recovery to the risk of such a vicious is lower and face greater financial risks.

4. Conclusions and recommendations

4.1 conclusion

Through using KMV model to calculate the default distance of ICBC,BOC and CCB, as well as financial data analysis, concluded that: (1)The three banks' risks have the trend to increase, showed that three banks' ability to resist risks have reduced, but CCB with the highest risk, increasing trend of CCB is clearly higher than ICBC and BOC;(2)Reasons for default risk of is CCB higher than ICBC and BOC are mainly: non-performing loan ratio dropped at a lesser extent, loan-to-deposit ratio reduced, non-interest income declined in the proportion of total operating income and core capital adequacy ratio lower, etc;(3)Compared with ICBC and BOC, ability of CCB to use intermediate business to enhance profitability, reduce business risk is weaker.

4.2 recommendations

Suggest CCB try the following ways to reduce the proposed credit risk, increase ability to resist risks: (1)take more attention to industries and geographic distribution of loans while increase volume of credit, optimize credit structure,

reduce exposure of business in deterioration of operating conditions or which have policy risk, for example, reduce the loan to business of high non-performing loan ratio;(2)expansion of intermediary business and improve non-interest income accounted for the proportion of revenue and reduce earnings risk, increase profit space; (3)improve the core capital adequacy ratio, improving the ability to cope with a vicious financial risks; (4)insist on sound sustainable development model, timely adjust the capital structure and investment strategies to further consolidate the competitive advantages, accelerate the pace of international development in order to promote innovation and diversification.

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Table 1. At least six months less than one year certificate bonds interest rate (%)

	2006.7-2006.12	2007.1-2007.6	2007.7-2007.12	2008.1-2008.6	2008.7-2008.12
R	0.72	0.72	0.81	0.72	0.72

Source: treasury bonds Notice of The People's Republic of China each year

Table 2. Regression results of all 35 times stock equity transfer data of Finance and insurance sector from 2001 to 2007

	m	n	T-test(m)	T-test(n)	F-test	D-W	R2
Result	1.652688	0.906602	2.128303	4.434704	19.6666	1.915527	0.873417

Table 3. Three banks' results of market value (Unit: 100 million)

	ICBC	BOC	CCB
2006.7-2006.12	9716.260479	8104.699936	
2007.1-2007.6	9697.466489	8575.560609	
2007.7-2007.12	11224.40289	8517.472682	7599.72641
2008.1-2008.6	12039.90369	7244.526519	8000.50426
2008.7-2008.12	10489.69012	6201.539755	7699.76438

Table 4.Three banks' results of DPT (Unit: 100 million)

	ICBC	BOC	CCB
2006.7-2006.12	65645.2275	45497.3075	
2007.1-2007.6	65648.0875	50781.1555	
2007.7-2007.12	75127.4055	52623.7605	59401.5435
2008.1-2008.6	82479.4075	57266.7755	59367.2615
2008.7-2008.12	86835.0675	62042.895	66923.3505

Table 5.Three banks' results of semiannual revenue fluctuation ratio σ_S

	ICBC	BOC	CCB
2006.7-2006.12	0.169588226	0.164978611	
2007.1-2007.6	0.282845986	0.305306835	
2007.7-2007.12	0.317486889	0.277766628	0.19188921
2008.1-2008.6	0.306305119	0.263333004	0.30992565
2008.7-2008.12	0.332302893	0.326489257	0.35997641

Table 6.Three banks' results of asset value (Unit: 100 million)

	ICBC	BOC	CCB
2006.7-2006.12	75126	53439	
2007.1-2007.6	75110	59174	
2007.7-2007.12	86048	60929	66761
2008.1-2008.6	94223	64306	67154
2008.7-2008.12	97013	68021	68021

Table 7.Three banks' results of asset value fluctuation ratio (%)

	ICBC	BOC	CCB
2006.7-2006.12	0.0219	0.025	
2007.1-2007.6	0.0365	0.0442	
2007.7-2007.12	0.0414	0.0388	0.0218
2008.1-2008.6	0.0391	0.0297	0.0369
2008.7-2008.12	0.0359	0.0298	0.0298

Table 8.Three banks' results of DD

	ICBC	BOC	CCB
2006.7-2006.12	5.762	5.940	
2007.1-2007.6	3.451	3.209	
2007.7-2007.12	3.066	3.513	5.060
2008.1-2008.6	3.188	3.686	3.140
2008.7-2008.12	2.922	2.949	0.540

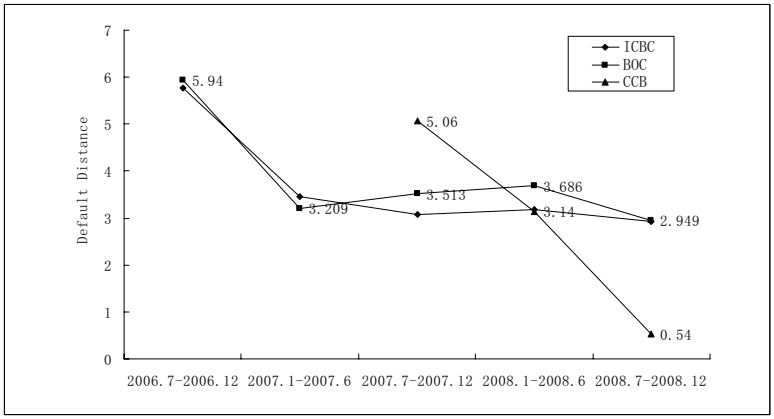

Figure 1.Comparison of three banks from the default distance

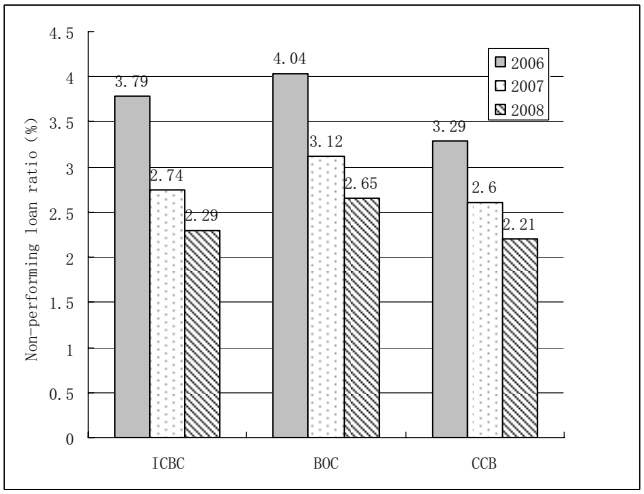

Figure 2.Comparison of three bank non-performing loan ratio

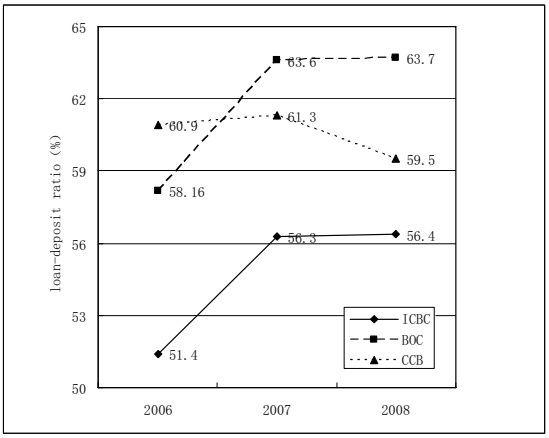

Figure 3.Comparison of three bank loan-deposit ratio

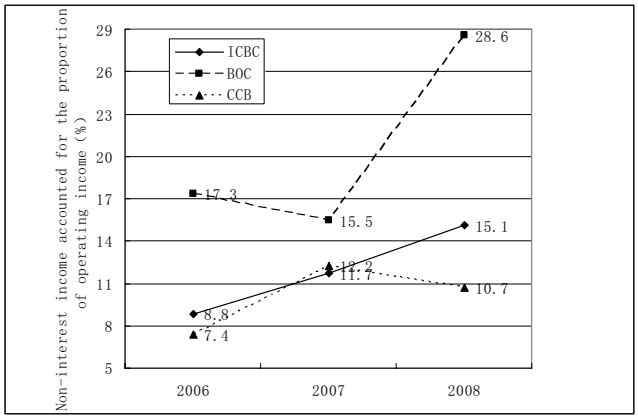

Figure 4.Comparison of three bank Non-interest income accounted for the proportion of operating income

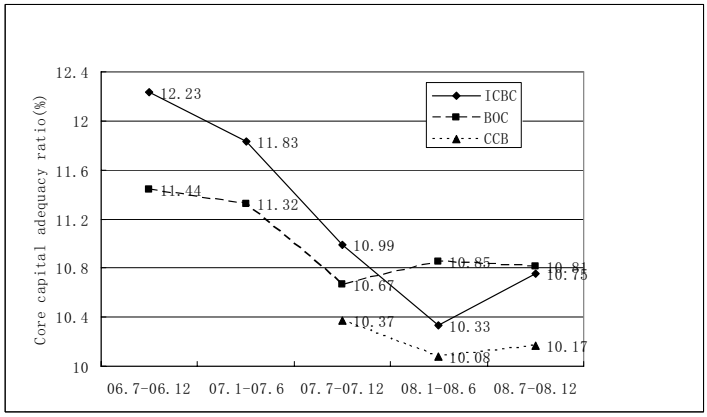

Figure 5.Comparison of three bank core capital adequacy ratio