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Application of KMV Model in Credit Risk Management in Banking Industry

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Abstract: ***As an important part of the national financial system, the banking industry bears important responsibilities for the national economy. In addition, the banking industry is considered an area full of high risks. The risk management of banks not only involves the national finance, economy and national security, but also directly affects the national financial system and the stability of the global financial order. Credit risk has always been one of the risks that domestic and foreign banking banks pay special attention to. Effectively identifying and preventing credit risk is the key to ensure the smooth operation of banks. In order to better identify and manage the credit risk of the listed banks in China, this study uses the KMV model to measure the default distance of the sample banks. Will default distance as assessment of China listed commercial Banks credit risk agent variables, using before 2019 in China's a-share market listed commercial Banks build panel data, empirical analysis, and discuss the analysis results, put forward relevant policy Suggestions, model support for the healthy and steady development of the banking industry. This paper analyzes the current situation of the application of modern credit risk measurement model in the risk management of the banking industry. Meanwhile, combining with the data of some listed banks in China, discusses the credit risks and challenges faced by banks through in-depth analysis, and provides development suggestions with the data analysis of financial model.***

Keywords: Financial Engineering; Banking; Risk Management; KMV Mode.

1. FOREWORD

1.1 Research background

As a risk enterprise, there is no doubt that its risk management ability is the crucial core competitiveness in terms of operation and management. After a five-year transition period, China's banking industry was fully opened to the outside world on December 11,2006, followed by a series of changes. With the acceleration of banks of China to the international market, more and more foreign banks are rushing to enter China's financial field, so China's banks need to constantly strengthen the level of risk control to make it stronger. The quality of risk management is the embodiment of the core competitiveness of commercial banks, which plays a vital role in the development prospects of banks. At the same time, good risk management ability not only affects the operating conditions of banks, but also makes an important contribution to the stable operation and development of the financial market. It is the key pillar of the development of the financial industry. In China, credit risk is still the biggest risk faced by banks in China.

Commercial banks need to establish a sound risk management mechanism to control the risk level. This mechanism needs to keep pace with The Times, adapt to the social situation and the speed of social development, and constantly improve and improve it. Through long-term development and practice, many internationally renowned commercial banks have accumulated and summarized many ideas and methods, which has laid a solid foundation for the construction and progress of the comprehensive risk management system. However, during the subprime crisis in 2008, the risk management of commercial banks was severely hit. The international leading financial institutions has been a model of commercial Banks, but these institutions also suffered huge losses in the financial crisis and bankruptcy, this is a wake-up call to the global banking, also emphasized for the future in the risk management technology, regulatory concept and practice attaches great importance to, especially for the risk of China's banking control put forward the grim warning. Therefore, in the current financial background, how to effectively prevent risk, especially the credit risk, has become one of the important problems facing China's banking industry, and the credit risk assessment is the commercial bank to prevent and manage credit risk in the most basic and the most important link, the accuracy of the evaluation results directly affect the follow-up work smoothly.

In addition, on April 6,2023, the China Banking and Insurance Regulatory Commission issued the Annual Report of the China Banking and Insurance Regulatory Commission on the Construction of a Law-based Government in 2022 (hereinafter referred to as the Report). According to the report, the CBRC focuses on strengthening the basic

institutional system of banking and insurance supervision and actively promoting banking supervision and management. The report disclosed that the CBRC will follow the principles of marketization and rule of law in terms of regulatory punishment and strict supervision of market behavior, and take corresponding measures in the supervision of commercial banks. In addition, the CBRC also pointed out that there are some deficiencies in the construction of a law-based government in the banking industry in the past year, mainly reflected in risk management, data security and foreign-related rule of law. It is expected that the supervision of credit risks of commercial banks will be further strengthened in the next three years. With the improvement of internal credit risk level and the strengthening of external supervision, major commercial banks need to improve their credit risk management ability, and the credit risk management and prevention of listed commercial banks are still an important issue of concern in China's financial industry.

1.2 Research purpose and significance

In the case of the financial crisis and financial globalization, the security of banks plays a vital role in maintaining the stability of social order and promoting the development of national economy. As a result, the regulatory requirements have become more stringent. In this context, it is particularly urgent to study the challenges of Chinese bank risk management and the development direction of improvement. At the same time, the KMV model based on the financial engineering model theory is still relatively novel in the bank credit risk management theory, and there are still many fields that need to be further explored.

China's commercial banks are regarded as an important national financial infrastructure and the main platform for the comprehensive operation of the financial industry, and play a leading role in China's financial field. According to data released by the China Banking and Insurance Regulatory Commission, by the end of 2023, China has six state-owned commercial banks, 12 joint-stock commercial banks and 134 city commercial banks, which rank among the world in terms of asset size, operating income and total profits. In the past few years, with the global outbreak of COVID-19, China's macro economy has faced greater downward pressure, leading to the decline in the overall asset quality of banks, and the industry has also assumed certain credit risks. Still, the banking sector needs to play a "countercyclical" role to support the growth of the real economy in the current economic downturn. Since 2020, in order to mitigate the impact of COVID-19 on the domestic economy, regulators have asked banks to increase credit support in areas related to epidemic prevention and control, including extending or renewing loans to severely affected enterprises, and appropriately lowering lending rates. Therefore, studying the credit risk of China's listed commercial banks is of great significance to the credit risk management of China's banking industry.

At the same time, in recent years, not only domestic scholars, but also foreign scholars have conducted extensive research on the credit risk of commercial banks, and have contributed rich achievements. It is worth mentioning that western countries started early in the field of the study of the credit risk of commercial banks, and established a variety of solid theoretical foundations and practical models to evaluate the credit risk of banks. However, due to the relatively late development of the domestic financial market, the credit risk management system is not perfect, and so far no unified standard has been formulated to manage the bank credit risk. In this paper, while using the KMV model for credit measurement, correcting the characteristics of the Bank of China, and further studying the influencing factors of default distance, the classification of Chinese listed banks includes state-owned banks, joint-stock banks and city banks. From the macro economy, management level and equity structure, comprehensive consideration of various factors on the influence of different listed commercial Banks default distance, aims to expand the related theory of bank of China credit risk research, provide specific Suggestions for bank credit risk management, help to enhance the bank's credit risk management level, improve the credit management system.

2. THE MAIN CREDIT RISK PROBLEMS THAT EXIST IN CHINA'S BANKING INDUSTRY

So far, although the development direction of China's banks is gradually clear, but still facing many challenges. At present, the credit risk situation is worrying, the management experience is not rich enough, and the corresponding management methods need to be improved. Compared with developed countries, there is an obvious gap between commercial banks in credit risk management, and they need to solve a number of problems. In order to effectively cope with the current challenges of credit risk management faced by banks, it is necessary to deeply understand the current situation of credit risk management of China's commercial banks, find out the root causes of the problems, and put forward feasible improvement measures, so as to enhance the overall strength of China's

commercial banks and promote the further improvement of risk management level. In this context, this paper mainly enumerates the specific performance of Chinese commercial banks in credit risk management in detail through data collection, so as to deeply understand the current situation of credit risk management of China's commercial banks, and then analyze the specific problems existing in credit risk management.

2.1 Non-performing loan ratio

Credit risk is mainly assessed according to the quality of loans, among which the non-performing loan rate is a particularly important factor. The non-performing loan ratio is one of the important indicators to assess the financial situation of banks, which reflects the proportion of non-performing loans in the total loan. The non-performing loan ratio directly affects the operating stability of banks, and should usually be kept below 5%. The challenges faced by China in the field of non-performing loans not only pose potential risks to a single bank or the whole banking industry, but also may bring potential threats to the financial market and macro economy. Given the changing market environment, it is difficult for commercial banks to avoid the challenges brought by credit risks. At present, with the continuous exploration and development efforts of China's major commercial banks, the non-performing loan ratio has been significantly improved, dropping from 2.42% in 2008 to 1.59% at present. The specific changes in the non-performing loan ratio of major banks in recent years are shown in the figure below.

Table 1: Changes in the non-performing loan ratio of major commercial banks

Time	ABC	BOC	CCB	ICBC	CGB	BOCOM	CMB
2018	1.59	1.42	1.46	1.52	1.45	1.49	1.36
2019	1.4	1.37	1.42	1.43	1.55	1.47	1.16
2020	1.57	1.46	1.56	1.58	1.55	1.67	1.07
2021	1.43	1.33	1.42	1.42	1.41	1.48	0.91
2022	1.37	1.32	1.38	1.38	1.64	1.35	0.96

(Data source: China Taian, wind financial terminal)

According to the data in the above table, during the five-year period from 2018 to 2022, both the non-performing loan balance and the non-performing loan ratio of China's commercial banks showed a significant downward trend. The data clearly reflect the operating results of commercial banks in reducing non-performing loans, indicating that their operating robustness is significantly enhanced, and they face relatively low risks. However, there are many potential risks hidden behind this good development trend. With the adjustment of monetary policy, money and credit have maintained steady growth, but the new loans are not come from substantial growth, and a considerable part of them come from the adjustment of measurement methods of commercial banks, that is, off-balance sheet business is re-included in the balance sheet. This "move" did not have a significant impact on the actual bank profits, but it led to a significant decline in the non-performing loan ratio. By 2023, the RMB loans of China's commercial banks have increased by as high as 3.2 trillion yuan. In this case, the decline of financial indicators does not mean that the risk has been reduced.

2.2 Capital adequacy ratio and income ratio

The capital adequacy ratio is calculated as follows: (core capital + affiliated capital) / 100% (> 8% is the standard). The following information presents the capital adequacy ratio of China's major commercial banks in 2023. Through data analysis, it can be concluded that the capital adequacy ratio of China's commercial banks has basically complied with the provisions of Basel Accord, which shows significant progress in credit risk management.

Table 2: Changes in the capital adequacy ratio of the major commercial banks

Bank	Net core Tier 1 capital	Capital adequacy ratio	Core capital adequacy ratio
BOC	1.99134E+12	17.52	11.84
CCB	2.70646E+12	18.42	13.69
ICBC	3.12108E+12	19.26	14.04
ABC	2.2154E+12	17.2	11.15
CGB	2.58161E+11	12.96	8.81
BOCOM	8.40164E+11	14.97	10.06
CMB	7.99352E+11	17.77	13.68

(Data source: China Taian, wind financial terminal)

China's commercial banks mainly use the spread between deposits and loans to achieve profits. According to statistics, about half of banks' interest income exceeds 75% of their total income. Such a high proportion of interest income means that the income obtained through credit business accounts for a high proportion of the bank income, and the resulting credit risk is also high. Moreover, the interest rate fluctuation will also directly affect the operation of the bank and increase the interest rate risk. Although the model of earning profits by interest rate spreads has brought considerable income to banks, with the increasingly strict capital supervision, commercial banks need to adjust their profit methods and gradually increase the proportion of non-interest income.

Table 3: Ratio of interest income of major commercial banks

Ranking	Name	Net interest income (RMB 100 million)	Year-on-year growth rate of (%)	Proportion (%)	Non-interest income (RMB 100 million)	Proportion (%)
1	ICBC	5275.98	3.22	74.16	1837.94	25.84
2	CCB	4827.07	7.71	76.55	1478.32	23.45
3	ABC	4480.5	4.27	79.35	1165.7	20.65
4	BOC	3429.93	8.54	73.32	1248.25	26.68
5	PSBC	2054.41	2.27	79.96	514.9	20.04
6	BOCOM	1280.27	7.37	60.94	820.49	39.06

(Data source: China Taian, wind financial terminal)

3. RISK ASSESSMENT BASED ON KMV

3.1 Data capture

In view of the late listing of some commercial banks, the sample size is small, which may have a certain impact on the accuracy of the regression model. Therefore, we have selected the commercial banks listed in China's Shanghai and Shenzhen A-share markets before 2019 as the research objects, including 8 joint-stock commercial banks, 5 state-owned commercial banks and 14 city commercial banks. Considering that the annual financial reports of commercial banks are usually released at the end of April of the following year, the period 2008 to 2022 will be set as a measurement range for a consecutive year, and the benchmark date is December 31 of the year. The data sources of this study include the China Statistical Yearbook, the public data of China's A-share market, and the annual financial reports of the major commercial banks. The following table lists the names of 8 joint-stock commercial banks, 5 state-owned commercial banks and 14 city commercial banks that have been listed on the A-share market.

Table 4: Classification of commercial Banks

Joint-stock commercial bank	State-owned commercial banks	City Commercial Bank	
CMB	ICBC	Bank of Zhengzhou	BANK OF CHENGDU
CMBC	CCB	Bank of Beijing	Bank of Changsha
CNCB	ABC	Bank of Shanghai	Bank of Wuxi
CEB	BOC	Bank of Jiangsu	Bank of Jiangyin
SPD BANK	BOCOM	Bank of Nanjing	Bank of Changshu
PAIC		Bank of Ningbo	Bank of Zhangjiagang
HXB		Bank of Hangzhou	
CIB		Bank of Guiyang	

(Source: China Statistical Yearbook)

3.2 Analysis of the default distance of different sample banks

There is an inverse relationship between credit risk and default distance, that is, the shorter the default distance of a bank in a certain year, the higher the credit risk in that year. According to the classification of commercial banks by China Banking and Insurance Regulatory Commission, the study will be rated as state-owned commercial banks, joint-stock commercial banks and city commercial banks, and then use the calculation results of KV model to carry out in-depth analysis of the asset value and default distance of each sample bank.

3.2.1 Asset value

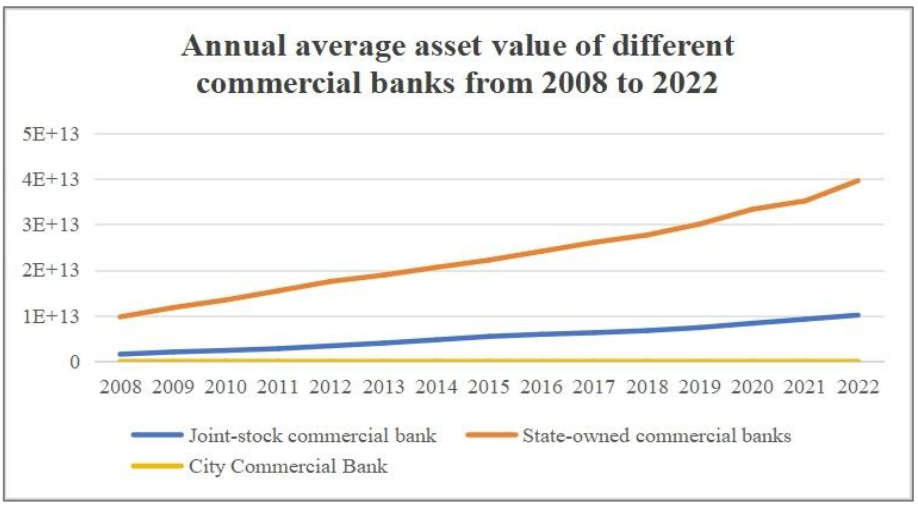

Figure 1: Average annual asset value of different commercial banks
(Source: China Statistical Yearbook, China Tai'an)

In the past 14 years, the asset scale of commercial banks has shown a steady upward trend. With the continuous growth of China's macro-economy, the banking industry, as the core industry of the national economy, has maintained a steady growth. Under such a general background, the scale of assets continues to expand, and the value of assets continues to climb. When comparing the value of assets of various commercial banks, a general rule is found: the asset value of state-owned commercial banks is higher than that of joint-stock commercial banks and city commercial banks. The state-owned commercial banks are large banks directly controlled by the state, with a good market reputation and playing an important role in the financial system. As a result, they are usually large, and have a high asset value. By contrast, joint-stock commercial banks have a more complex shareholder composition, with the largest shareholders usually not state institutions and the banks being smaller than state-owned banks. Therefore, the asset scale of city commercial banks is not as good as that of state-owned commercial banks. The history of City Commercial Bank can be traced back to the establishment of City Credit Union in the 1980s. Its main responsibility is to provide economic support for local small and medium-sized enterprises and promote the growth of the local economy. Because its business scope is mainly concentrated in a city or region, the geographical restrictions lead to the relatively small assets of city commercial banks. Compared with state-owned commercial banks and joint-stock commercial banks, city commercial banks focus more on the development of local economy. Usually, the urban commercial banks with better performance will be concentrated in economically developed areas. Therefore, it can be seen that the asset value of city commercial banks is generally lower than that of state-owned commercial banks and joint-stock commercial banks.

3.2.2 Volatility in asset value

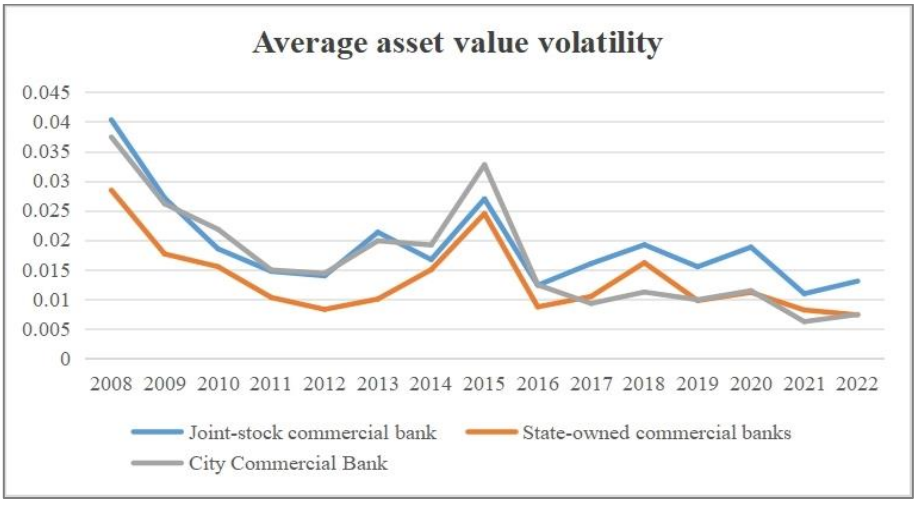

Figure 2: Volatility of the annual average asset value of different commercial banks
(Source: China Statistical Yearbook, China Tai'an)

Asset value volatility is a way to measure the uncertainty of asset value. Horizontally, from 2008 to 2014, the volatility of asset value of commercial banks showed a downward trend. During this period, the country's various economic indicators have performed well, and China's banking industry has taken a series of effective measures to promote the development of commercial banks. Therefore, the asset quality of commercial banks has steadily improved, and their asset volatility is also declining. In 2015, the overall market value of China's A-share market fluctuated sharply, rising from 3.695 billion yuan at the end of 2014 to 6.29 trillion yuan at the end of May 2015, and then reaching 4.172 billion yuan and 5.296 trillion yuan at the end of September and December respectively. The drastic fluctuations in the A-share market have seriously affected the investment confidence of the society, and also caused A certain impact on the real economy. Therefore, the asset volatility of commercial banks has risen to a certain extent. From 2016 to 2022, China's national economy entered a stage of steady development, and commercial banks constantly improved their business strategies. During this stage, the asset value volatility of commercial banks did not change significantly. Longely speaking, there is little difference in the asset value volatility of the three types of commercial banks.

3.3.3 Default distance

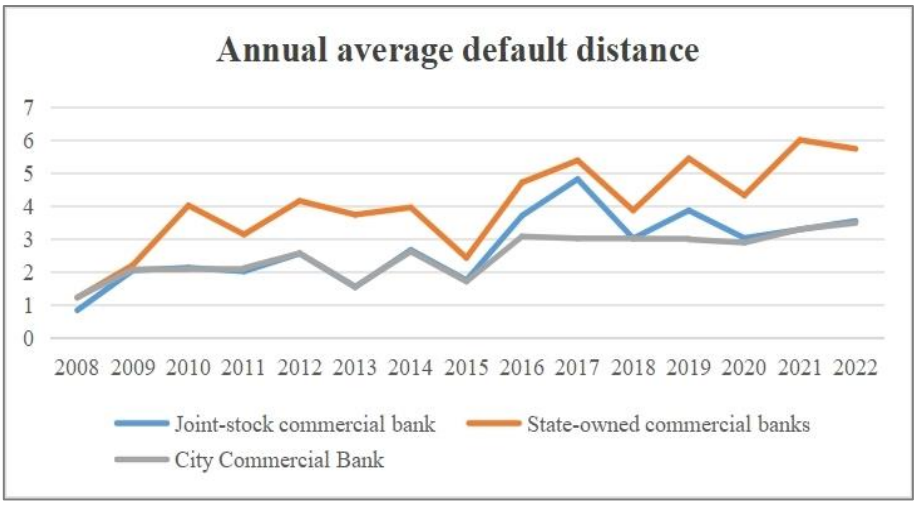

Figure 3: Average annual default distance of different commercial banks
(Source: China Statistical Yearbook, China Tai'an)

From 2008 to 2021, the default distance fluctuation of commercial banks increased, mainly due to the shareholding reform of China's banking sector in the 21st century. In this process, various commercial banks have pursued to straighten out the property rights relationship, promote the separation of government and enterprise, strengthen management reform, and gradually achieve public listing. The promotion of the shareholding system reform has not only greatly enhanced the overall strength of China's banking industry, but also significantly improved the capital strength, asset quality and operating efficiency. According to data disclosed by the China Banking and Insurance Regulatory Commission, the total assets of China's banking financial institutions reached 419.64 trillion yuan by the end of 2022, up more than 15 times from 27.64 trillion yuan in 2001. At the same time, commercial banks have significantly enhanced their risk management ability through equity reform. According to data released by the CBRC, the non-performing loan ratio of banking financial institutions fell from 23.6 percent at the end of 2001 to 1.71 percent at the end of 2022.

2008 was the year when the default distance of China's joint-stock commercial banks reached the lowest point. This phenomenon is mainly due to the outbreak of the global financial crisis, which brought severe challenges to the global financial industry and led to capital losses for commercial banks. The financial crisis has brought operational difficulties to commercial banks, but also increased the difficulty of repaying borrowers, and further increased the credit risk of banks. In the following years, the default distance of various types of joint-stock commercial banks gradually increased, although there were slight fluctuations between 2013 and 2015. This is mainly due to the gradual completion of the shareholding reform of major Chinese commercial banks from 2009 to 2017, the overall strength has been strengthened, the default distance has also increased, and the credit risk has been reduced. However, during the period from 2013 to 2015, the overall trend of The Chinese stock market was

relatively weak, which is also one of the important factors leading to the volatility of listed commercial banks. With the gradual recovery of China's stock market after 2015, the default distance of commercial banks has also gradually expanded. From 2018 to 2022, the default distance of commercial banks showed a fluctuating upward trend, although the growth rate was relatively slow. Due to the outbreak of COVID-19 in 2020, there is a certain obstacle to economic growth. The financial situation of enterprises and residents has been affected to varying degrees, which leads to the rise of the non-performing loan ratio of commercial banks, and increases the challenge of banks facing greater credit risks.

In the longitudinal comparison, from 2008 to 2022, China's state-owned commercial banks always showed a higher default distance than joint-stock commercial banks and local commercial banks, indicating that the credit risk of state-owned banks is relatively low. The reason for this phenomenon is that the capital scale of state-owned banks is stable, their business growth is relatively stable, and they are vulnerable to less major threats. In addition, state-owned commercial banks have a wider deposit market and do not need to absorb deposits by making frequent business adjustments, which suppresses the emergence of non-performing loans to some extent, thus reducing credit risk. Joint-stock banks and local commercial banks have similar situations. However, generally speaking, the default distance of local commercial banks is lower than that of joint-stock commercial banks, indicating that their credit risk is relatively high. This phenomenon is mainly due to the fact that local commercial banks are geographically restricted, their main business is concentrated in a certain city, their development is limited, and their ability to resist credit risks is weak. In contrast, the business layout of joint-stock commercial banks covers the whole country, and increasing deposits through flexible business activities can resist credit risks to a certain extent.

3.3 Analysis of the influencing factors of the default distance

In order to ensure the accuracy of the model regression, considering many factors such as the equity value, equity value volatility, risk-free yield and total liabilities, they are closely related to the default distance of the sample bank. Based on the values of these factors, the default distance DD can be calculated. Therefore, explanatory variables from macroeconomic, self-operation and ownership structure are selected to analyze their influencing factors on listed commercial banks. The specific contents are shown in the following table:

Table 5: Factors affecting the default distance

Variable	Symbol	Variable declaration
Default distance	DD	Calculated according to the KMV model
The GDP growth rate	GDP	(GDP of this year-GDP of last year) / GDP of last year
M2	M2	The money supply is naturally a log of money
The benchmark one-year lending rate	OLR	Benchmark interest rate issued by the central bank
Pay attention to the loan rate	SLR	Concerned loans / Total loans
Return on equity	ROE	Net income / net assets
asset-liability ratio	DAR	Total liabilities / total assets
proportion of state-owned shares	PSS	Number of state-owned shares / total number of shares
The largest shareholder shareholding ratio	FSP	Number of shares held of the largest shareholder / total number of shares
Equity checks and balances	EBR	Number of shares held by the second to the fifth largest shareholder / number by the first largest shareholder

(Data source: China Taian, wind financial terminal)

In this paper, the panel model is used to measure the relationship between the various influencing factors and the default distance of commercial banks:

$$DD_{it} = \alpha_0 + \alpha_1 GDP + \alpha_2 M2 + \alpha_3 OLR + \alpha_4 SLR + \alpha_5 ROE + \alpha_6 DAR + \alpha_7 FSP + \alpha_8 PSS + \alpha_9 EBR + \varepsilon$$

α Is a constant term, and Ɛ is a random perturbation term. The model aims to study the influencing factors of credit risk from three aspects: macroeconomic environment, self-management level and equity structure.

3.3.1 Descriptive statistics and correlation analysis of the variables

Table 6: Descriptive statistics of the related variables

The type of bank	Metric	SLR	ROE	DAR	FSP	EBR	PSS
State-owned banks	Crest value	0.46	0.22	0.95	0.68	0.7	0.85
	Least value	0.15	0.09	0.91	0.24	0.33	0.33
	Average value	0.27	0.15	0.93	0.44	0.48	0.62
	Standard deviation	0.07	0.04	0.11	0.14	0.13	0.22
Joint-stock bank	Crest value	0.71	0.30	0.98	0.67	0.8	0.65
	Least value	0.12	0.04	0.90	0.06	0.23	0.00
	Average value	0.33	0.14	0.94	0.26	0.47	0.10
	Standard deviation	0.12	0.05	0.19	0.17	0.17	0.18
city bank	Crest value	0.59	0.19	0.95	0.30	0.55	0.40
	Least value	0.10	0.01	0.88	0.04	0.21	0.00
	Average value	0.29	0.11	0.93	0.14	0.35	0.07
	Standard deviation	0.11	0.04	0.21	0.05	0.08	0.11

(Data source: China Taian, wind financial terminal)

State-owned commercial banks are large banks directly controlled by the state and usually develop relatively stable. Compared with other types of banks, the average value and standard deviation of the concern loan ratio (SLR) of state-owned commercial banks are significantly lower, indicating that their asset quality is better than that of other types of banks. At the same time, the largest shareholder shareholding ratio (FSP) and the state-owned share ratio (PSS) of state-owned commercial banks are higher than those of other bank types, indicating the relative concentration of equity. Compared with city commercial banks, state-owned commercial banks and joint-stock commercial banks have a higher equity balance (EBR), which means tighter constraints between shareholders.

In the panel data regression analysis, in order to test whether the model has a multicollinearity problem, the correlation analysis of each indicator needs to be performed first. The study showed that the correlation coefficient between each index is not significant, and the correlation coefficient between each variable does not reach 0.8, so it can be concluded that there is no obvious strong correlation.

Table 7-1: Panel data

	OLR	GDP	M2
OLR	1		
GDP	0.682	1	
M2	-0.734	-0.712	1

Table 7-2: Panel data

	SLR	ROE	DAR
SLR	1		
ROE	0.346	1	
DAR	0.329	0.467	1

Table 7-3: Panel data

Variable	VIF	1/VIF
M2	5.61	0.17816
FSP	4.64	0.215369
OLR	4.31	0.232229
EBR	3.48	0.287006
DAR	3.30	0.302685
GDP	2.41	0.414482
ROE	2.4	0.416806
PSS	1.83	0.547612
SLR	1.42	0.703965
Mean VIF	3.27	

(Data source: China Taian, wind financial terminal)

3.3.2 Results analysis of the regression equations

Different types of banks have a certain degree of heterogeneity due to their unique enterprise structure and business characteristics. Therefore, in this section, we will perform a sub-sample regression on the panel data to study the effect of each factor on the different samples. We will use fixed-effects (FE) and random-effects (RE) for measurement analysis and process data using SPSS software.

Table 8: Results of the regression analysis of the sample data

Sample Banks	Regression models	Variable	Coef	P
Full sample of banks	FE	GDP	6.52***	0.000
			(6.43)	
		M2	-10.97***	0.000
			(-6.44)	
		OLR	-1.16***	0.000
			(-6.92)	
		SLR	-4.35***	0.000
			(-2.96)	
		ROE	1.28***	0.004
			(2.95)	
		DAR	-1.11***	0.001
			(-3.46)	
		FSP	-1.59***	0.009
			(-3.42)	
		EBR	1.81*	0.061
			(1.88)	
		PSS	0.15	0.471
			(0.72)	
State-owned banks	RE	GDP	2.92**	0.041
			(5.13)	
		M2	-6.57***	0.005
			(-6.12)	
		OLR	-1.08***	0.000
			(-7.91)	
		SLR	-7.19***	0.000
			(-7.27)	
Joint-stock banks	FE	GDP	8.40***	0.008
			(2.70)	
		OLR	-1.03***	0.000
			(-5.23)	
		DAR	-1.97***	0.000
			(-5.29)	
		SLR	-3.25***	0.000
			(-2.20)	
		FSP	-1.79***	0.002
			(-3.11)	
		EBR	2.39**	0.040
			(2.07)	
City Commercial Bank	FE	GDP	6.16**	0.013
			(2.55)	
		OLR	-2.05***	0.000
			(-6.81)	
		SLR	-5.13***	0.000
			(-6.49)	
		DAR	-2.13***	0.000
			(-5.54)	

		ROE	2.21*** (2.13)	0.033

Note: *, * *, * * * are significant at 10%, 5%, and 1%, respectively
(Data source: China Taian, wind financial terminal)

According to the results of the overall regression analysis, the model shows a good regression effect, which can show the impact of each variable on the credit risk of commercial banks to some extent. However, the regression coefficient of PSS proportion is not significant, which means that the influence of PPSS proportion on the credit risk of listed commercial banks in China is not statistically significant.

In the other three regression results, for different types of listed commercial banks, the impact shows their own characteristics. In terms of credit risk for all listed commercial banks, GDP growth (GDP), benchmark lending interest rate (OLR) and concern loan ratio (SLR) have all proved to be significant factors. There is a positive correlation between GDP growth and the distance to default, indicating that this index is negatively correlated with bank credit risk. The increase in GDP represents the improvement of the overall social productivity level and a good macroeconomic situation. In the period of good economic situation, when the income of individuals and enterprises increases, commercial banks will not introduce high-risk projects due to the pursuit of high returns, thus reducing the credit risk of commercial banks. There is a negative correlation between the loan benchmark interest rate and the default distance, indicating that the index is positively correlated with the bank credit risk. The benchmark lending interest rate reflects the macro policy of the banking sector for some time. When the index rises, it will increase the financing cost of the loan enterprises and the financial cost of the independent debtors. In order to expand customer groups and obtain high profits, commercial banks may introduce high-risk projects, thus increasing the credit risk of banks. There is a negative correlation between concern loan ratio and default risk, which indicates that this indicator has a positive correlation with bank credit risk. The alleged concern loan means that although the borrower currently has sufficient capacity to pay off the principal and interest of the loan, there may be some potential factors that may adversely affect the repayment. The loan ratio of concern reflects the asset quality of the bank. When the asset quality of the bank is poor, the loan ratio of concern is high and the risk attached to the asset is high, so the credit risk of the bank is also high.

Different types of commercial banks are differently affected by the fluctuation of macroeconomic level. The GDP growth rate of state-owned commercial banks, joint-stock commercial banks and city commercial banks is significant at 5%, 1% and 5% respectively, indicating that joint-stock commercial banks are more sensitive to the credit risk of changes in national economic level than the other two types of banks. At the same time, the benchmark interest rate and concerned loan ratio of different types of commercial banks are significant at 1%, indicating that they are differently sensitive to changes in banking policy and asset quality. It is worth noting that the impact of asset-liability ratio on state-owned commercial banks is not significant. Combined with the descriptive statistical data, it can be seen that the change range of the asset-liability ratio of state-owned commercial banks is small, which may be the reason for the non-significant impact.

4. SUMMARIES AND RECOMMENDATIONS

4.1 Summary

This paper introduces the main problems of credit risk, and introduces the application situation of modern credit risk measurement, and evaluates the default distance of each sample model, and the comparative analysis of asset value, asset value volatility and default distance. According to the classification standards of the China Banking and Insurance Regulatory Commission, it will be divided into state-owned commercial banks, joint-stock commercial banks and city commercial banks. The research points out that the state-owned commercial banks have the highest asset value and the lowest credit risk, while the city commercial banks have the lowest asset value and the highest credit risk. The asset value volatility of these three types of commercial banks shows a similar change trend, and the difference between different types of commercial banks is relatively small.

At the same time, with the default distance as the dependent variable, 9 indicators were selected as independent variables from the three aspects of macro economy, enterprise self-operation and ownership structure to discuss their influence on the default distance. The research results show that the profitability level of national economy and enterprises is positively correlated with the default distance, that is, when the profitability level of national economy and bank is increased, the default distance will also increase and the credit risk will decrease. At the same time, the money supply, loan benchmark interest rate, interest loan ratio and asset-liability ratio are negatively

correlated with the default distance. Increasing the money supply could lead to some degree of inflation, which then increases bank risk. Raising the benchmark loan interest rate may increase the financing cost of lending enterprises in the short term, and commercial banks may introduce high-risk projects in order to obtain profits, thus enhancing the credit risk. The increase of concerned loan ratio indicates the decline of bank asset quality and the increase of non-performing assets, which will lead to the decrease of the default distance of commercial banks and the increase of credit risk. The rising asset-liability ratio means that banks' solvency declines and their credit risk increases.

In general, it is crucial to effectively manage the credit risk of Chinese banks. At present, Chinese banks still mainly rely on interest rate income, which indicates that credit risk will remain one of the main challenges facing the banking industry for a long time in the future. In addition, financial institutions implement strict separate supervision and operation, which limits the flexibility of banks in investment portfolio. At the same time, financial assets account for a large proportion in the total assets of banks. Due to these factors, one of the core problems that China's commercial banks urgently need to solve is still credit risk.

4.2 Suggestions

Based on the above analysis, the following suggestions are given:

At present, China's banking industry usually evaluates the credit risk level of commercial banks by using the non-performing loan ratio. This evaluation method mainly relies on the financial data of commercial banks, and ignores the impact of stock market fluctuations on listed commercial banks, resulting in the failure of timely warning when credit risks occur. Some Chinese scholars have proved the validity and accuracy of some analytical models and theories adopted by western scholars in the field of credit risk through a large number of empirical studies. Among them, many Chinese scholars have verified the effectiveness of the KMV model in evaluating the credit risk of listed enterprises in the empirical research. KMV model uses the option theory and transforms the credit risk into default distance and default probability by combining the default data and open market data of enterprises, which can reflect the credit risk status of listed enterprises in real time. After parameter modification, the KMV model shows good adaptability in the credit risk identification of listed commercial banks in China. However, due to the late start of China's credit system, the infrastructure construction in all aspects is not perfect, and there is a lack of a unified standard default database. In this context, the KMV model is difficult to play a full role in identifying and preventing the credit risks of China's listed commercial banks. Therefore, it is suggested that relevant departments should actively take effective measures to assist commercial banks to establish a default database, enhance their credit risk management ability, improve the overall operation efficiency of commercial banks, and promote the healthy and stable development of the banking industry.

In modern times, risk management is regarded as a highly technical and extremely complex emerging management discipline, which requires professional practitioners. More advanced models also need more excellent talents to play. In foreign banking institutions, many professionals in the financial field gather, among which intermediate risk managers usually have international banking experience or work experience in insurance, investment banking and other fields, and have accumulated rich practical knowledge. Although the level of financial risk management in China has not reached the complexity of western countries, under the requirements of modernization, China still has a large demand for professionals proficient in risk theory and risk measurement technology, while the supply is relatively insufficient. Therefore, it is necessary to strengthen the training of talents in China's banking industry.

Since the accuracy of KMV model is affected by the authenticity and accuracy of sample data, banks need to disclose true financial data in a timely manner. Therefore, the financial regulatory authorities should strengthen the supervision of the listed commercial banks and assist them to improve the information disclosure system. Improving supervision can effectively restrain commercial banks and promote them to strengthen their own credit risk management. Timely disclosure of financial information can provide more sufficient data for the study of credit risk of China's listed commercial banks, provide support for the research in the field of credit risk in China, and help commercial banks to effectively identify and prevent credit risk.

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