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Credit risk assessment and management for small and micro businesses of commercial Banks in the Yangtze River Delta region of Mainland China

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Abstract

In recent years, with the acceleration of China's economic development and the increasingly coordinated and reasonable adjustment of industrial structure, small and micro enterprises have been paid more and more attention in the process of promoting national economic development. They have played an increasingly prominent role in promoting economic progress, improving the employment rate of residents and increasing residents' income. Some excellent small and micro enterprises have become the representative growth points and highlights in the new economic development mode. Zhang Mao, director of the State Administration for Industry and commerce, said at the 2017 high level Forum on innovation and development of small and micro enterprises: "by the end of July 2017, there have been 73.281 million enterprises registered in the list of small and micro enterprises in China. According to the results of a sample survey conducted by the National Bureau of statistics, each small enterprise can bring about 7 to 8 people's employment, and an individual industrial and commercial household can bring about 2 to 3 people's employment. In particular, the emergence of a large number of innovative small and micro enterprises has become the power source to promote the development of innovation, and also provides new energy for the structural transformation under the new normal. At present, most of the small and micro enterprises in China are concentrated in the tertiary industry. The proportion of small and micro enterprises engaged in wholesale and retail, residential catering, resident services, repair and other services has reached 76.49%. These enterprises are usually closer to the market and users, face the most intense market competition, and are most sensitive to market changes. It can be said that small and micro enterprises have laid a micro foundation for the development of the whole market economy in some aspects.

Keywords: Credit risk; Assessment, Management

Introduction

The newly revised law of the people's Republic of China on the promotion of small and medium-sized enterprises was adopted at the 29th meeting of the Standing Committee of the 12th National People's Congress on September 1, 2017, and will come into force on January 1, 2018. The new measures set up a chapter of "financing promotion" independently, and put forward requirements from many aspects to improve the financing environment of small and medium-sized enterprises. In terms of macro-control policies, the people's Bank of China has made it clear that the people's Bank of China should promote and guide financial institutions to increase their support for small and micro enterprises through the use of various monetary policy tools, so as to further optimize the financing environment. In the aspect of financial supervision system, it is proposed that banking regulatory institutions should have different regulatory systems for financial services provided by financial institutions for small and micro enterprises, and adopt various reasonable methods and steps to encourage financial institutions to expand the credit scale and proportion of small and micro enterprises. (Hasan et al., 2020; Effiom & Edet, 2020; Faal, 2020)

In terms of Inclusive Finance, large state-owned commercial banks are required to set up inclusive financial institutions to serve small and micro enterprises more professionally. It is also clear that they should promote and support the construction of inclusive financial system, and guide banks to develop outlets and carry out business in areas where financial services for small and micro enterprises are relatively weak, such as counties or towns. In terms of financing methods, this paper puts forward that the capital market system should be multi-level sound, promote equity financing through various ways, promote the development of bond market and make it more standardized, and help small and medium-sized enterprises to realize financing directly through various ways. At the same time, the new measures complement the guarantee financing system, and support small and medium-sized enterprises to apply for guarantee financing from financial institutions with accounts receivable, inventory, intellectual property rights, equipment and machinery as collateral.

It is undeniable that the common problems existing in the development of small and micro enterprises are small production scale, low technology content, insufficient management standardization, weak capital accumulation and less capital sources. Once they want to expand the scale, improve technology, update equipment and optimize products, there will always be difficulties. Although the government of our country strongly supports the development of small and micro enterprises, and gives a certain degree of inclination in various aspects of policies, it is still the key to limit the sustainable development of small and micro enterprises whether they can fully and efficiently obtain relatively moderate cost financial support. For commercial banks, vigorously promoting the development of financing services for small and micro enterprises can not only drive the sustainable and healthy development of small and micro enterprises, but also provide a broader economic market for commercial banks. It is not only in response to the national policy call, but also the need of their own development to carry out financial services

and provide credit support for small and micro enterprises in an all-round way. In the process of serving small and micro enterprises, commercial banks have expanded their customer groups, optimized their customer structure, and obtained greater financial product innovation space while obtaining higher income. According to statistics, by the end of October 2017, the balance of domestic and foreign currency loans of financial institutions in China totaled 122.85 trillion yuan, of which, the loan balance of small and micro enterprises reached 29.74 trillion, accounting for 24.21% of the total loans. Compared with the beginning of the year, it increased by 3.04 trillion yuan, 15.36% compared with the same period in 2016, and 2.37% higher than the average growth rate of various loans; the total number of loans for small and micro enterprises was 14.6777 million, an increase of 1.4635 million compared with the same period in 2016; the loan acquisition rate of small and micro enterprises was 94.87%, which increased by 1.58% compared with the same period in 2016. The credit scale of small and micro enterprises is expected to continue to expand in the future. However, because the credit business management system of small and micro enterprises in China is not perfect, there are many practical problems in the actual operation process, and the credit risk level is still very high. Therefore, it is necessary to study the risk management in the research of small and micro enterprise credit business.

In order to promote and standardize the development of small and micro enterprises, China has issued many policies to guide and help the development of small and micro enterprises. The Banking Regulatory Committee, the people's Bank of China, commercial banks and other related industries attach great importance to the credit support for small and medium-sized enterprises, so that small enterprises and micro enterprises play an increasingly important role in economic development. However, the inherent disadvantages of small and micro enterprises are also very obvious, mainly including: small business scale, less investment, family management, financial chaos and opaque, etc. these problems lead to low market risk resistance ability of small and micro enterprises, difficult to monitor credit loan risk and high non-performing loan rate. Although the focus of loan development of commercial banks is inclined to small loans, the credit risk of small and micro enterprises is difficult to control, which leads to the decline of loan quality and the increase of non-performing loan rate. According to the CBRC website data, in the fourth quarter of 2016, the non-performing loan rate of China's commercial banks was 1.74%, and the non-performing loan rate of small and micro enterprises was much higher than that of other non-performing loans. Therefore, improving the credit risk management ability of small and medium-sized enterprises is the key to promote the development of small and micro enterprises and improve the sustainable development ability of banks.

The common problems of small and micro enterprises in China are small scale, extensive management, less self owned capital and low level of financial management. As a result, domestic commercial banks do not have a lot of motivation to carry out small and micro enterprise credit business, and the service level in this respect is relatively backward. State owned banks also have difficulties in developing business in this field. Small and micro

enterprises often have no reliable financial information disclosure system, which makes it difficult to understand their real business situation. With small loan amount and a large number of applicants, business management consumes a lot of manpower and material resources. However, state-owned commercial banks have fixed staffing, so they must try their best to avoid risks for the safety and stability of the financial system High risk projects, coupled with the traditional strategic planning tendency for large enterprises and large projects, lead commercial banks to bear great risks when carrying out credit services for small and micro enterprises, but they can only obtain relatively less income. As a result, the connection between commercial banks and small and micro enterprises in credit is not smooth. At present, when commercial banks carry out the credit service for small and micro enterprises, a manager has to track and serve dozens of small and micro enterprises, which often leads to the situation that it is difficult to deeply understand the enterprise situation before the loan, and the investigation and credit risk management are not fine enough. For banks, asset quality and safety is not only the guarantee for the survival and development of enterprises, but also the basic guarantee for the healthy development and stability of the whole financial and social economic system of the country. On the one hand, it is a market with high yield and great development potential; on the other hand, it is also a market with low single household income and high risk. Market expansion and risk control have become a contradiction. It is one of the main tasks for domestic commercial banks to provide more efficient credit service for small and micro enterprises while managing their credit risk.

At present, although commercial banks have made a lot of changes and simplifications in the form of credit risk management for small and micro enterprises, they still basically follow the credit risk management mode of large enterprises, that is, to evaluate the credit risk according to the financial statements and credit rating of the enterprises applying for credit. However, the financial management of small and micro enterprises is often chaotic, which makes it difficult to detect and early-warning risks, and the original credit risk control measures are very weak in this round of financial downturn. Therefore, the plan will focus on the shortcomings of traditional credit risk management of small and micro enterprises. Through the case study of the existing credit service data of small and micro enterprises in Zhejiang Province of Bank of Hangzhou, the correlation between non-performing assets and business of commercial banks is obtained; through the detailed analysis of the industry characteristics, business regions, sales, tax payment, settlement volume and credit rating of small and micro enterprises, the key factors are found out, and then the pre loan, mid loan and post loan services are analyzed Strengthen the management of each link, improve the efficiency and effect of credit risk management of small and micro enterprises, and provide a certain solution for optimizing the credit risk control of small and micro enterprises and solving the "financing difficulties and slow financing" of small and micro enterprises.

Problem Statement

This paper first introduces the concepts and characteristics of credit business and risk management of small and micro enterprises, and then takes the risk management of small and micro enterprises credit business of commercial banks as the research object, combined with its characteristics, development situation and examples, analyzes and discusses the main problems in operation process and business management by using relevant basic theory. In order to improve the quality of the bank's small and micro enterprise credit business risk management, this paper puts forward the scheme design from the system and technical level, and provides the corresponding supporting implementation measures for the overall scheme.

Based on COSO comprehensive risk management theory and credit business risk management theory, through the analysis of the current situation and examples of small and micro enterprises credit business of commercial banks, this paper studies the problems existing in the current risk management from two aspects of credit business process management and credit business management. In the aspect of credit business process management, according to the business process, the author sorts out the causes and analyzes the causes from three stages: pre loan investigation, loan approval and loan management. In the aspect of credit business management, the author explores the problems from three aspects, namely, assessment mechanism, personnel management and product innovation, and analyzes the reasons. Finally, according to the requirements of the security of credit assets, the author still from the credit business process management and credit business management these two aspects, starting from the current situation of small and micro enterprise credit business operation of commercial banks, combined with relevant theories, gives the corresponding optimization scheme and implementation measures. The author hopes that through the design of this kind of business risk management scheme, it can provide reference for improving and optimizing the credit business risk management of commercial banks. (Hung et al, 2020; Li et al., 2020; Cai & Zhang, 2020)

Research Question

The purpose of this paper is to study the effectiveness of capital constraints and the relationship between capital constraints and credit risk in China's commercial banks. Based on the theory of bank capital supervision, bank risk-taking incentive theory and bank credit risk theory, this paper defines the main concepts of capital supervision and commercial bank credit risk, reviews and combs the existing literature research, and analyzes the relationship between capital constraint and bank credit risk. Combined with the particularity of China's commercial banks, this paper focuses on whether there are differences in the impact of capital constraints on various types of commercial banks' credit risk. By adding corporate governance and market competition factors, this paper empirically tests whether the effect of capital constraint on bank credit risk changes. Finally, the paper draws the conclusion of the paper and puts forward the corresponding policy recommendations.

Literature Review

Credit Risk

Credit risk is one of the main forms of financial risk and the main risk faced by banks. In different periods, credit risk has different meanings. At first, credit risk refers to the possibility of bank loss caused by the debtor's failure to repay its debts on time, which will bring about the bank's operation risk. Generally speaking, there are external factors that can't be controlled by banks and internal factors that banks can control. (Nurmawati et al., 2020; Seymann, 2020)

With the change of modern risk environment and the continuous progress of risk management technology, the traditional definition can not reflect the essence of modern credit risk and its management. For example, in the past, the value of a bank's loan assets was usually measured according to the historical cost rather than the market value. It was only reflected in the balance sheet when the debtor defaulted. Therefore, the value of the bank's credit assets had no great relationship with the debtor's credit status and its changes. However, some events that affect the debtor's credit status, such as the reduction of credit rating and profitability, will bring risks to credit assets. The traditional meaning of credit risk obviously can not reflect this situation. At the same time, due to the rapid development of financial derivatives market, the market price of credit products is changing with the change of debtor's repayment ability. Therefore, the value of credit assets will be reflected in the derivative market in time with the change of the debtor's credit status. In this way, the bank can actively take measures against the risk of credit assets, and do not have to wait for the moment when the debtor defaults to take measures passively, so as to effectively reduce the credit risk. From these two aspects, the modern credit risk includes not only the possibility of bank loss caused by the debtor's failure to perform the contract when due, but also the risk of loss caused by the change of the value of credit assets due to the change of the debtor's credit status and performance ability. Therefore, the above credit risk relationship should be modified to add an unmeasurable factor, credit status.

To sum up, the credit risk in this paper refers to the negative impact on the bank credit assets caused by the decline of the debtor's credit rating, performance ability, default, interest rate, exchange rate and other financial market factors, leading to the loss of bank credit assets or income and eventually leading to the decline of the value of credit assets and even the overall value of the bank.

Previous Research

At present, western commercial banks have basically agreed that comprehensive management should be carried out on bank assets and liabilities, on balance sheet items and off balance sheet items;

On the choice of management strategy, we not only emphasize the special management of various risks, but also emphasize the portfolio management of these risks; on the premise of

ensuring the liquidity, safety and regulatory requirements, we should fully consider the effect of risk portfolio diversification and pay attention to improving the profitability of banks;

In the choice of management methods, it is emphasized that quantitative analysis is the main method and qualitative analysis is the auxiliary. The management of all kinds of risks is brought under the unified management framework and standards. The quantitative credit risk shows the following characteristics: (1) from qualitative analysis to quantitative analysis; (2) from index evaluation to model measurement analysis; (3) from measuring the risk of a single credit asset to measuring the risk of a credit portfolio; (4) the most cutting-edge achievements of modern financial theory, such as contingent pricing theory, capital asset pricing theory, and asset portfolio theory, are applied to the risk analysis of credit assets; (5) VAR model has become the mainstream model to measure credit risk.

The research on bank credit risk management in China started at the end of 1980s. Since the 1990s, both the government departments, the practical circles and the theoretical circles have had a strong interest in financial risks, such as translating and introducing credit risk theory, or writing books, or trying out western risk management methods, which have achieved great results. From the theoretical point of view, a large number of academic papers and works on financial risk, including commercial bank credit risk research, are emerging at an unprecedented speed. Scholars have carried out a more in-depth discussion from different perspectives of credit risk management, and have become increasingly rich and mature in research content, research scope and research methods.

Domestic scholars Xue Feng (1995) systematically analyzed the generation of credit risk from different perspectives of macro environment, economic subject and economic system, and made an empirical description of credit risk in China's real economic and financial operation, and put forward ideas and Countermeasures to solve the problem of bank credit risk; Zhong Wei and Li Xindan (1998) started from the inherent risk of financial system, which explains the formation mechanism of credit risk; Zheng Yaodong (1998) and others discussed the role of five level classification of credit assets in preventing credit risk; Han Ping and Xi Youmin (1999) analyzed the characteristics, specific performance and generation mechanism of credit risk of commercial banks in China during the economic transition period; Gao Ling (2000) believed that the key to the management of bank credit risk lies in the violation of borrowing enterprises and discusses the risk control and establishes the early warning model of China's Bank credit risk by using the analytic hierarchy process, which has a certain guiding significance for the bank credit risk management; Liang Qi and Huang Lijiao (2002) tentatively discussed the construction of the credit risk management system of China's commercial banks; Shi Hanxiang (2003) thinks that the main reasons for the credit risk of state-owned commercial banks are external factors such as administrative intervention, enterprise evasion and cancellation of debt, lagging development of financial market, and internal reasons such as low level of risk management, imperfect mechanism and low quality of employees. In order to deal with the credit risk of state-owned commercial banks, we must introduce the concept of comprehensive risk management, and

implement comprehensive governance from multiple levels of external environment governance and internal management; Jiang Fangming (2003) analyzed the internal mechanism of credit risk caused by backward risk management of commercial banks, and from the risk culture, risk monitoring mode, risk monitoring process, risk measurement and risk transfer, this paper puts forward the countermeasures and suggestions for China's commercial banks to comprehensively carry out credit risk management; Ouyang Weimin (2003) analyzed the current situation and characteristics of risk management of commercial banks in China and the problems existing in risk management on the basis of considering the basic principles and evolution process of risk management of commercial banks in China, and proposed ways and suggestions to accelerate the modernization of risk management of commercial banks in China; based on the impact of economic and financial globalization on the credit risk management of state-owned commercial banks, the research group of Shanghai Branch of industrial and Commercial Bank of China (2004) proposed that the state-owned commercial banks should establish a correct concept of risk management, and designed some principles, overall framework and strategic steps of credit risk management of state-owned commercial banks; the Hangzhou Finance Research Institute (2005) think that in order to improve our modern commercial bank credit assets risk management system, we must focus on three key elements of system, culture and human beings, and grasp the advanced principle, hierarchy principle, dynamic principle, gradualness principle, contingency principle and human nature principle; Zhao Zongjun and so on (2005) using asymmetric information theory as an analytical tool discussed the formation mechanism of credit risk management of commercial banks, and put forward suggestions for improving credit risk management of commercial banks in view of the credit risk caused by asymmetric information, so as to improve the level of credit risk management of commercial banks; sun Lingyun and Sun Lingyun and Wu Baohong (2006) pointed out that due to the rapid development of market economy and the reform of financial property rights system, the authorized operation of business management and the self-discipline system of internal control, many banks still have serious defects in the concept of credit risk control and poor behavior, As a result, the non-performing rate of credit assets is still at a high level, and puts forward specific suggestions on credit risk management and optimization of credit risk control.

Since the latest quantitative management model of credit risk was developed by international financial institutions and Western banks in recent years, the research and Analysis on quantitative management of credit risk in China is mainly focused on the introduction, evaluation and reference of foreign models. Some scholars have modified and improved these models and put forward the credit risk suitable for China Econometric model. For example, LV Yaoming et al. (1998) introduced some technical methods of credit risk management of western commercial banks, including credit derivatives trading, asset securitization, etc.; Pang Sulin et al. (2001) analyzed and studied the common situations and mathematical principles of credit capital loss or opportunity loss in credit market with asymmetric information, and established bank credit risk The decision-making model of insurance, through the given Kuhn Tucker condition, draws the following conclusion: when the collateral as a means to identify the type of enterprise risk is

invalid, in order to avoid credit risk, banks will have special requirements for the value of collateral provided by enterprises; Hao Liping et al. (2001) discussed the feasibility of artificial neural network and its application in credit risk analysis, This paper focuses on the construction of the artificial neural network model for credit risk analysis of commercial banks, and obtains a feasible neural network model for reasonable credit risk evaluation, which provides a scientific basis for credit decision-making; Liang Shidong, Guo Zhong et al. (2002) analyzed the reasons for the development of the new credit risk model, and analyzed the representative modern credit risk model in the West This paper makes a comparative analysis by using risk models; pan Weilin (2002) introduces in detail how to calculate the credit risk of commercial banks with VaR method; Wang Qiong and Chen Jinxian (2002) introduce the pricing of credit risk and the credit risk pricing model of KMV; Xiao Dongmei and Li Tao (2002) aim at the uncertainty of bank credit risk system model, application H ∞ control theory makes a systematic analysis of credit risk; Liu Wei and Chen Zhengzhi (2002) use principal component analysis, cluster analysis, discrimination, multiple regression, random sampling and statistical test methods of modern multivariate statistical theory to establish a more scientific and feasible credit asset management model that can meet the market requirements; Wang Yuanyue et al. (2003) introduced the most popular credit in the West This paper uses the factor method, which is the construction method of risk model, and briefly analyzes its application in the internal rating based approach of Basel Accord, credit metrics, According to fan Nan (2003), credit metrics is a typical quantitative method that can be compared among different industries, which is a good supplement to the traditional credit risk management methods of commercial banks in China. Yuan Guiqiu (2003) analyzed RAROC According to the principle of credit risk measurement, it is a feasible method for China's financial institutions to establish a credit risk pricing model by adjusting the credit rating transfer matrix that has been publicly used. Zhou Chunxi (2003) introduced the method of multi-level fuzzy mathematics in the bank performance evaluation to conduct comprehensive evaluation, combining qualitative and quantitative analysis Liu Fang (2003) proposed to use principal component analysis to evaluate the operating performance of banks, trying to avoid the problem that the comprehensive evaluation method is difficult to achieve fairness and objectivity in weight setting, and strive to make the evaluation results objective and fair; GE Chaohao and Ge Xuejian (2005) used cluster analysis and Fisher (2005) Discriminant analysis makes a quantitative assessment of bank credit risk, introduces the mathematical principle of the model, the pre-processing of indicators and data, and establishes the discriminant function of credit rating; Liang Qi (2005) studies the relevant measurement of credit loss of commercial bank asset portfolio, and on the basis of defining the correlation of bank loan loss, expounds the asset correlation of measuring default loss Fu Qiang and Li Yongtao (2005) established a logistic model of the credit situation of listed companies using the annual report data of listed companies, and found that interest cover ratio and inventory turnover rate were the key determinants of the credit of listed companies, and used the model to effectively evaluate the credit risk of listed companies one year later. Zou Xinyue (2005) made an empirical analysis on the credit risk of 184 listed companies in China, and clearly found that the typical linear discriminant model is

effective for Chinese market and can provide scientific decision-making for investors. According to the uncertainty of credit risk and return, Guo zhanqin and Zhou Zongfang (2006) established a parameter programming model based on interval number α. In order to obtain the maximum return under the given risk, long Haiming and Deng Taixing (2006) established a repayment ability model to solve the problem that the non-performing loan ratio at a certain time point can not reflect the real default level due to the delay of consumer credit risk exposure This paper discusses the quantitative relationship between the consumer debt ratio and the expected default rate of consumer credit, and compares the return and risk loss between the non-performing loan rate and the actual default rate, which provides a new idea for the consumer credit management of commercial banks. Wang Naijing and you Yonghua (2006) used the comprehensive financial data of 100 listed companies as samples, and used principal component analysis and Fisher discriminant analysis to evaluate the risk of enterprises. Zhai Dongsheng and Cao Yunfa (2006) used Fisher discriminant analysis model to analyze the trust of Listed Companies in China. (Hu et al., 2020; Liang & He, 2020)

METHODOLOGY

Research Design

Using the method of Zhou Kaiguo and Li Lin (2011) for reference, we first need to carry out Hausman test on the model. The data show that the p value of the test is greater than 0.05, so we can not reject the original hypothesis at the 5% significance level, so we choose the random effect model. The model is as follows:

$$risk_{it} = \alpha_0 + \alpha_1 cap1_{it} + \alpha_2 cap2_{it} + \alpha_3 size_{it} + \alpha_4 ea_{it} + \alpha_5 roaa_{it} + \alpha_6 roae_{it} + \alpha_7 zgdp_t + \alpha_8 zm2_t + \varepsilon_{it} \quad (3.1)$$

Where i=1，2，…N is the number of sample banks, t=1，2，…T is the number of years, a_i is the coefficient of variables, and ε_{it} is the random error term.

Referring to the research methods of shrives and Dahl (1992), this paper uses simultaneous equation model to study the relationship between capital changes and credit risk changes of commercial banks. Based on the research results of Dai junxun and Tao Chunxi (2016), this paper further studies the relationship between capital constraints, corporate governance and credit risk of commercial banks in China. The econometric model is established as follows:

$$\Delta CAP_{it} = \Delta CAP_{it}^{a} + \vartheta_{it} \quad (3.2)$$

$$\Delta RISK_{it} = \Delta RISK_{it}^{a} + \varepsilon_{it} \quad (3.3)$$

Where i = 1，…，N，N is the number of banks in the sample. ΔCAP_{it} and $\Delta RISK_{it}$ respectively represent the level of capital change and the change of bank credit risk in the T period. The sources of these changes are mainly the adjustment of commercial banks themselves and the impact of exogenous random variables. ΔCAP_{it} and $\Delta RISK_{it}$ are the adjustment of capital level and risk level voluntarily made by the bank in period T, which are the difference between the target level of T period and the actual level of period T-1. ϑ_{it} and ε_{it} is the random disturbance term caused by the exogenous shock, which follows the white noise distribution.

$$\Delta CAP_{it}^{a} = \alpha\left(\Delta CAP_{it}^{a} - \Delta CAP_{it-1}\right) \quad (3.4)$$

$$\Delta RISK_{it}^{a} = \beta\left(RISK_{it}^{*} - RISK_{it-1}\right) \quad (3.5)$$

Where α and β are the adjusting speed. CAP_{it}^{*} and $RISK_{it}^{*}$ represent the target level of the bank in period T, CAP_{it}^{*} and $RISK_{it}^{*}$ represent the actual level of period T-1. Considering the endogenous problems of capital level and credit risk adjustment, the above equations are added to each equation as explanatory variables in this paper.

$$\Delta CAP_{it} = \alpha\left(CAP_{it}^{*} - CAP_{it-1}\right) + \gamma\Delta RISK_{it} + \vartheta_{it} \quad (3.6)$$

$$\Delta RISK_{it} = \beta\left(RISK_{it}^{*} - RISK_{it-1}\right) + \delta\Delta CAP_{it} + \varepsilon_{it} \quad (3.7)$$

It can be seen from the above formula that when the capital level and credit risk are known, the bank will adjust the principal according to the target level, and can not directly observe the target value. Therefore, it is necessary to find relevant alternative variables. Considering that the heterogeneity of banks will affect the changes of bank credit risk under capital constraints, this paper introduces individual fixed effect variables μ_i that reflect the changes of commercial banks over time. At the same time, in order to control the impact of macroeconomic environment changes, the annual dummy variable π_i is introduced, and the control variable is represented by control. Therefore, the final form of simultaneous equation estimation model is as follows:

$$\Delta CAP_{it} = \alpha_0 + \alpha_1 CAP_{it-1} + \alpha_2\Delta RISK_{it} + \alpha_3 Control + \mu_i + \pi_i + \vartheta_{it} \quad (3.8)$$

$$\Delta RISK_{it} = \beta_0 + \beta_1 RISK_{it-1} + \beta_2\Delta CAP_{it} + \beta_3 Control + \mu_i + \pi_i + \varepsilon_{it} \quad (3.9)$$

On the basis of the above research, we add corporate governance variables to study the impact of capital constraints and corporate governance on the credit risk of commercial banks. The corporate governance alternative variables are represented by CG, and the following dynamic

panel GMM model is established:

$$RISK_{it} = \gamma_0 + \gamma_1 CAP_{it} + \gamma_2 CG_{it} + \gamma_3 CAP_{it-1} + \gamma_4 RISK_{it-1} + \gamma_5 Control_{it} + \delta_{it} \quad (3.10)$$

Among them, i is individual, t is time, bank credit risk is endogenous variable, and other explanatory variables are exogenous control variables, γ_0、γ_1、$\gamma_2 \cdots$, γ_n are coefficients to be estimated and δ_{it} is random error item.

The dynamic panel estimation equation is as follows:

$$Risk_{it} = C_1 + \alpha_1 Risk_{it-1} + \alpha_2 Cap_{it} + \alpha_3 Cap_{it-1} + \alpha_4 LERNER_{it} + \alpha_5 LERNER_{it-1} + \alpha_6 ZF_{it} + \alpha_7 Size_{it} + \alpha_8 EA_{it} + \alpha_9 D1_{it} + \alpha_{10} Nim_{it} + \alpha_{11} Zgdp_t + \alpha_{12} M2_t + \varepsilon_{it} \quad (3.12)$$

Among them, i is individual, t is time, bank credit risk is endogenous variable, and other explanatory variables are exogenous control variables, C_1、α_1、α_2、$\alpha_3 \cdots$、α_4 are coefficients to be estimated and ε_{it} is random error item.

1. Capital constraints and credit risk

Referring to the existing research, this paper selects the capital adequacy ratio (CAP) to measure the capital level of commercial banks, and selects the ratio of non-performing loans (risk1), bad debt reserve ratio (risk2) and the ratio of loans to total assets (risk3) to measure bank credit risk. The bad debt reserve ratio represents the prior measurement of the bank's credit risk, which is a good fund reserve to cope with the possible credit risk. The non-performing loan ratio is an ex post measurement of bank credit risk. As an effective supplement to the prior risk, the pre risk and post risk are combined to comprehensively analyze the measurement degree of bank credit risk. The ratio of loans to total assets reflects the level of capital utilization. The higher the ratio is, the higher the potential credit risk will be due to the over utilization of capital, otherwise, the lower the credit risk.

FINDINGS & DISCUSSIONS

Profile of Respondents

The sample of this paper is the annual unbalanced panel data of 151 commercial banks in China from 2009 to 2019. The sample micro data are processed and collated from Bankscope database, wind database and Commercial Bank annual report. Macroeconomic data are from the National Bureau of statistics and China economic network database. In order to ensure the reliability of the estimation results, we use Winsorize to reduce the outliers by 1% of the above and lower.

The data were analyzed by using the measurement software, and the results were descriptive statistical table 4.1.

Table 4-1 descriptive statistics

Variable	Definition	mean	standard deviation	minimum	maximum
RISK1	Non performing loan ratio	0.0181	0.0091	0.0004	0.1811
RISK2	Bad debt reserve ratio	0.0368	0.0243	0.0103	0.0522
CAP1	capital adequacy ratio	0.1300	0.0645	0.0340	0.2500
CAP2	Core capital adequacy ratio	0.0802	0.0567	0.0300	0.1677
D1	Shareholding ratio of the largest shareholder	0.6789	0.2187	0.2898	0.9092
D2	The square of the largest shareholder's shareholding ratio	0.0343	0.0329	0.0112	0.0456
D3	Shareholding ratio of the second to tenth largest shareholders	0.7723	0.6463	0.5632	0.9651
Salary	Logarithm of average remuneration of directors, supervisors and senior executives	4.7722	3.6521	1.9843	7.9863
Dsh	Number of board members	4.3321	3.2215	2.8723	8.8739

DL	Logarithm of independent directors	5.5652	4.7786	2.8872	8.6651
ZF	Government shareholding ratio	0.6722	0.3644	0.3287	0.9092
SIZE	Logarithm of bank size	5.5010	3.0006	2.5008	11.0070
EA	Equity capital / total assets	0.0927	0.0565	0.0390	0.2354
Loan	Loan ratio	0.5523	0.4387	0.4876	0.8798
Nim	Proportion of net interest income	0.7398	0.5767	0.5453	0.9043
ROAE	Average return on equity	0.3400	0.2300	0.0490	10.2200
ZGDP	GDP growth rate	0.1670	0.0860	0.0690	0.2200
ZM2	M2 growth rate	0.1200	0.1105	0.0900	0.2500

Note: micro data are compiled from Bankscope database, Wind database and annual reports of banks, while macro data are from China financial database and National Bureau of statistics.

Variable Correlation Test

In order to study the closeness between the main variables, Pearson correlation coefficient analysis was carried out in this section. Table 4-2 shows the Pearson correlation coefficient matrix of the main variables.

Table 4-2 correlation coefficient between explanatory variables

	Gl	Gcl	Gpl	Car	D1	D2	Size	Roa	Npl	Dcb	Gdp	M2
Gl	1.0000											
Gc	0.535	1.000										

l	0*	0										
Gpl	0.3016*	0.1066*	1.0000									
Car	0.2777*	0.1841*	0.1107*	1.0000								
D1	-0.0156	-0.0432	0.0007	-0.2493*	1.0000							
D2	0.0113	-0.0300	-0.0114	-0.2847*	-0.0359	1.0000						
Size	-0.2315*	-0.1665*	-0.0719*	-0.2403*	0.0382	0.0769*	1.0000					
Roa	-0.1039*	0.0006	-0.0438	0.2729*	-0.0282	-0.0537	-0.1263*	1.0000				
Npl	-0.1626*	-0.1186*	-0.1699*	-0.3608*	0.4828*	0.0986*	0.0785*	-0.3027*	1.0000			
Dcb	-0.2607*	-0.1697*	-0.1216*	-0.0812*	-0.0481	0.0380	-0.2860*	-0.0360	-0.0008	1.0000		
Gdp	0.1841*	0.2834*	0.1333*	-0.2570*	0.2107*	0.2926*	-0.0074	-0.2626*	0.4544*	-0.0309	1.0000	
M2	0.3298*	0.3088*	0.1662*	-0.0224	0.0251	0.0659*	-0.1392*	-0.0260	0.0419	-0.0521	0.4916*	1.0000

As can be seen from Table 4-2, the total credit growth rate, enterprise loan growth rate and personal loan growth rate of commercial banks have a significant positive correlation with capital adequacy ratio. The pressure of capital supervision is negatively related to the growth of total loans and corporate loans of commercial banks, but positively related to the growth of

personal loans. From the perspective of the relationship between capital and risk, there is a significant negative correlation between bank capital and non-performing loan ratio, which indicates that the original intention of capital constraint has been initially realized, and banks have reduced their risk-taking preference to a certain extent. There is a significant negative relationship between growth rate and bank loan scale. The above results show that there is a strong relationship between the promulgation and implementation of China's capital regulatory measures and the supply of bank credit resources.

Multicollinearity Test

If the explanatory variables are highly correlated, the estimation results will be distorted, and it is not easy to distinguish their individual influence on the explained variables. From the correlation coefficient between two variables, we can preliminarily judge the degree of correlation between variables, but it is not enough to judge only by the correlation coefficient. Even if the correlation coefficient is low, there may be "compounding" among variables. Therefore, in order to avoid the distortion of estimation results caused by multicollinearity among variables, the variance expansion factor is used to test the variables. Stata 12 is used to test the multicollinearity of three models with the total loan size of commercial banks, corporate loans and personal loans as explanatory variables. The results are shown in table 4-3.

Table 4-3 results of multicollinearity test (VIF value)

	Total scale（1）	Total scale（2）	Total scale（3）	Company（1）	Company（2）	Company（3）	individual（1）	individual（2）	individual（3）
Car	1.32	1.32	1.37	1.13	1.14	1.15	1.14	1.14	1.15
Reg		2.58	2.60		2.97	2.97		2.96	2.97
D1			1.43			1.04			1.04
D2			1.22			1.10			1.10
Size	1.12	1.12	1.12	1.12	1.12	1.13	1.12	1.12	1.13
Npl	1.36	1.39	1.72	1.09	1.09	1.17	1.09	1.09	1.17
Dcb	1.05	1.05	1.06	1.05	1.05	1.06	1.05	1.05	1.05
Roa	1.20	1.20	1.21	1.01	1.01	1.01	1.01	1.01	1.01
GDP	1.67	2.84	2.95	1.77	3.53	3.54	1.76	3.52	3.54

M2	1.44	1.60	1.61	1.81	1.82	1.82	1.80	1.81	1.81
The mean value of VIF	1.31	1.64	1.63	1.28	1.72	1.60	1.28	1.71	1.60

Empirical rules show that the maximum variance expansion factor (VIF) should not exceed 10, otherwise there may be multicollinearity between variables. The table above shows that the maximum VIF value is 3.54, far less than 10, so there is no multicollinearity.

Using measurement software to sort out the data, the following related indicators are obtained. The descriptive statistical results of each variable are shown in table 4.2.

Table 4.2 descriptive statistics

variable	Variable definition	Mean	standard deviation	minimum	maximum
Risk1	Non performing loans / total loans	0.0181	0.0091	0.0004	0.1811
Risk2	Provision for bad debts / total loans	0.0368	0.0243	0.0103	0.0522
Risk3	Current assets / total loans and deposits	0.1898	0.1778	0.0556	0.5089
CAP1	capital adequacy ratio	0.1300	0.0645	0.0340	0.2500
CAP2	Core capital adequacy ratio	0.0802	0.0567	0.0300	0.1677
SIZE	Logarithm of bank size	5.5010	3.0006	2.5008	11.0070
EA	Equity capital / total assets	0.0927	0.0565	0.0390	0.2354
ROAA	Average return on total assets	0.2600	0.1900	-1.7600	0.8900
ROAE	Average return on equity	0.3400	0.2300	0.0490	0.5200
ZGDP	GDP growth rate	0.1670	0.0860	0.0690	0.2200
ZM2	M2 growth rate	0.1200	0.1105	0.0900	0.2500

Note: micro data are compiled from Bankscope database, Wind database and annual reports of banks, while macro data are from China financial database and National Bureau of statistics.

As can be seen from the data in table 4.2, in recent years, due to the strengthening of China's banking regulatory institutions on the capital regulatory constraints of commercial banks and banks' attention to capital adequacy, the level of capital adequacy has generally been improved, and the average level of capital adequacy ratio has reached 13%, basically in line with the requirements of relevant international agreements and financial regulatory institutions for capital. In terms of credit risk, the average non-performing loan ratio was 1.81%, and the ratio decreased. The average bad debt reserve ratio was 3.68%, slightly higher than the average of non-performing loan ratio, and the average current ratio was 18.98%. This shows that the bank has strengthened its credit risk awareness and improved its risk management ability. Efforts should be made to reduce the non-performing loan ratio and maintain sufficient liquidity and provision.

Conclusion

This paper selects the non-equilibrium panel data of 151 commercial banks in China, and uses stochastic effect model, simultaneous equations and GMM The dynamic model empirically tests the impact of capital constraints on credit risk in China, including corporate governance and market competition factors respectively, and carries out group regression according to the actual situation in China, and draws the following conclusions: capital constraint and credit risk are significantly negatively related, improving capital adequacy ratio can significantly reduce credit risk; capital constraint and corporate governance and credit risk are closely related to each other Credit risk is significantly correlated. Improving corporate governance under capital constraints can reduce credit risk. Both of them have an effect on credit risk, Each cross item is significantly related to credit risk, and capital constraint and corporate governance play a complementary role; capital constraint and market competition are significantly related to credit risk. Strengthening market competition under capital constraint can effectively reduce credit risk. Both of them have a joint effect on credit risk. In the cross item test, cross items are significantly related to credit risk, and capital is about 0 Bundle and market competition play a complementary role. In the group test, for China's listed commercial banks, Capital constraint and corporate governance have a significant negative correlation with credit risk, capital constraint and corporate governance have a significant impact on credit risk, capital constraint and market competition have a significant impact on credit risk; for unlisted commercial banks, there is no significant relationship between capital constraint and credit risk, and the impact of capital constraint and corporate governance on credit risk is not statistically significant For joint-stock commercial banks, capital constraints and corporate governance have a significant impact on credit risk, capital constraints and market competition have a significant impact on credit risk; for large state-owned commercial banks and city commercial banks, capital constraints and credit risk have a significant negative correlation There is no significant correlation between loan risk, capital constraint, corporate governance and credit risk. There is no significant correlation between capital constraint, market competition and credit risk. (Su et al., 2020; Palomino-

Tamayo et al, 2020; Ngumo et al., 2020)

1. The influence of capital constraint on credit risk of commercial banks

This paper empirically verifies the impact of capital constraints on credit risk by selecting non-performing loan ratio, bad debt reserve ratio and current ratio as proxy variables of credit risk. In the total sample regression results show that there is a significant correlation between the capital adequacy ratio and the credit risk variables. The higher the capital adequacy ratio is, the lower the credit risk is. In the group test, there is a significant correlation between capital constraint and credit risk of listed commercial banks,

The higher the capital adequacy ratio is, the lower the credit risk is, but there is no significant relationship between capital constraint and credit risk of unlisted commercial banks; there is a significant correlation between capital constraint and credit risk of joint-stock commercial banks, but there is no significant relationship between capital constraint and credit risk of large state-owned commercial banks and city commercial banks. (Chen et al., 2020; Xu & Zhou, 2020)

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