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Regulation of Leverage Ratio, Credit Expansion and Credit Risk of Commercial Banks

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Abstract

"Basel III" and "Measures for the Administration of Capital of Commercial Banks" propose to use leverage ratio as a supplement to capital adequacy ratio. Leverage ratio supervision and capital adequacy ratio supervision jointly supervise and manage commercial banks. Theoretically, leverage ratio regulation can inhibit the credit expansion of commercial banks and improve bank stability. However, it is also possible to increase the risk preference of commercial banks, and increase the proportion of high-risk assets. It can generate adverse selection problems, and increase the credit risk of commercial banks. This paper selects the data of 16 listed commercial banks in China from 2013 to 2018. The empirical results show that leverage ratio regulation will inhibit the credit expansion of commercial banks, but it will increase the credit risk of commercial banks. It has different impacts on different types of commercial banks.

Keywords

Leverage Ratio Supervision, Commercial Banks, Credit Expansion, Credit Risk

1. Introduction

In 2010, "Basel III" proposed the regulation of leverage ratio. In order to avoid the adverse effects caused by the too fast introduction, it proposed the transitional arrangement of leverage ratio. 2013-2017 is a parallel operation period, and 2018 is included as the first pillar. Subsequently, the CBRC issued the Measures for the Capital Management of Commercial Banks, which came into effect in 2013. It stipulates that the leverage ratio of commercial banks shall not be less than 4% and will be disclosed in 2015. According to the calculation formula of leverage ratio, the regulatory leverage ratio focuses on the total assets of

commercial banks, which has the effect of inhibiting the credit expansion of commercial banks. At the same time, the regulatory leverage ratio does not measure the risk level of banks. When only the capital adequacy ratio is regulated, commercial banks can hold a large number of low-risk assets to meet the regulatory requirements. However, the proposal of leverage ratio regulation will produce adverse selection behavior. Commercial bank assets will be transferred to high-risk assets, and banks reduce the asset scale of commercial banks in order to meet the regulatory requirements. The increase of high-risk assets, especially the increase of high-risk loans, will increase the non-performing loans and non-performing loan ratio of commercial banks. Thereby the credit risk of commercial banks will be increased.

As shown in Figure 1, since the implementation of the capital management measures for commercial banks in 2013, the leverage ratio of commercial banks has remained above 4% and continued to rise steadily, reaching a level of 7% over 6%. Under the supervision of leverage ratio, the leverage ratio of commercial banks has reached the regulatory requirements. The leverage ratio of large state-owned commercial banks is relatively high, while that of small non-state-owned commercial banks is relatively low and varies greatly. It shows that small non-state-owned commercial banks do not have sufficient capital for large state-owned banks and are greatly influenced by leverage ratio supervision.

As shown in Figure 2, the loan growth rate after 2013 has decreased as a whole compared with the previous two years, especially for large commercial banks. For small non-state commercial banks, it has increased in 2018, but it is lower than the level before the implementation of leverage ratio supervision, which shows that leverage ratio supervision has played a restraining role in credit expansion.

As shown in Figure 3, the level of non-performing loan ratio of commercial banks shows an overall upward trend, and the upward trend is obvious after

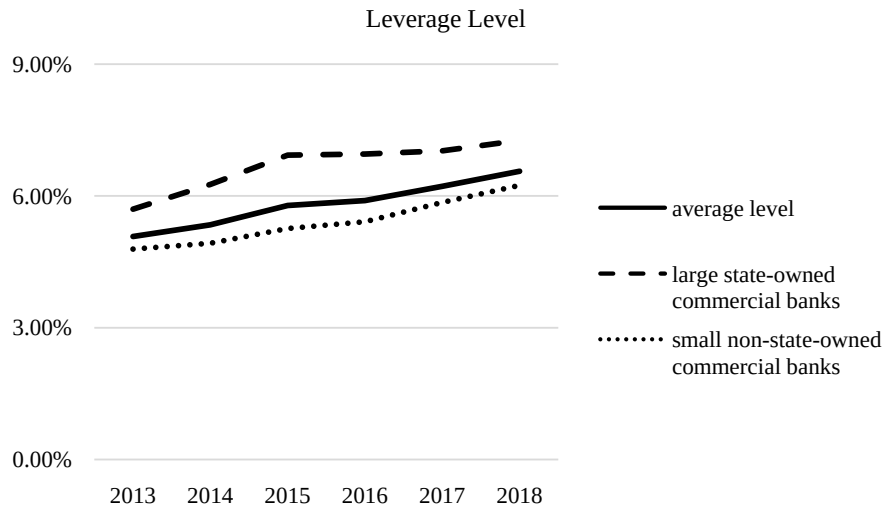

Figure 1. Leverage ratio level of commercial banks. Source: National Tai'an Database and Commercial Bank Annual Report.

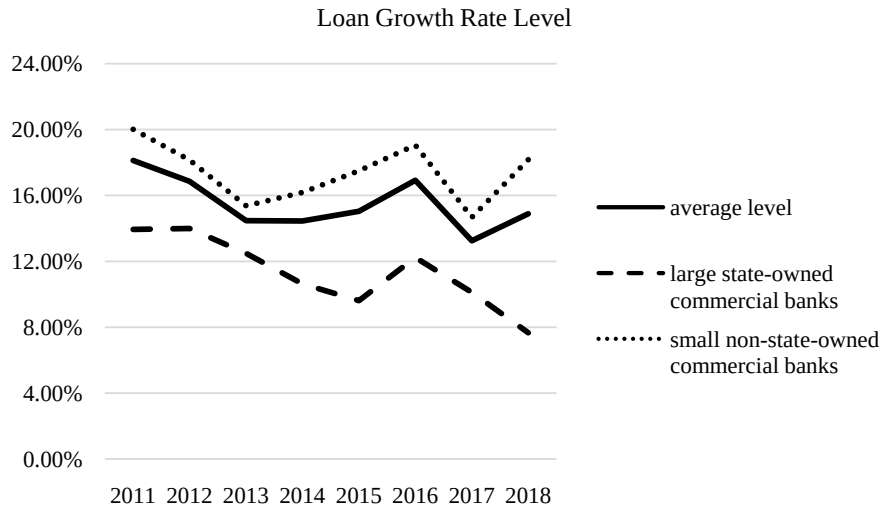

Figure 2. Growth rate of commercial bank loans. Source: National Tai'an Database and Commercial Bank Annual Report.

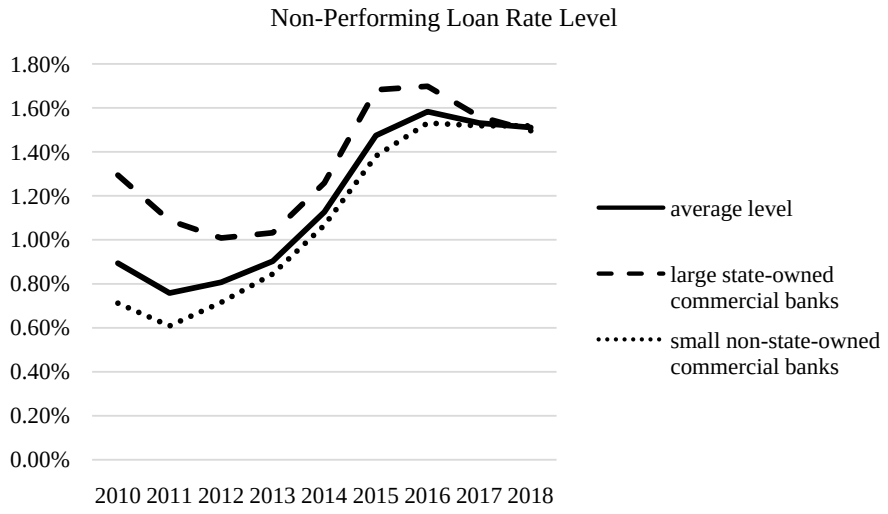

Figure 3. Non-performing loan rate level of commercial banks. Source: National Tai'an Database and Commercial Bank Annual Report.

2013. The non-performing loan ratio of large state-owned commercial banks has declined in the past two years, but it is always higher than that of small non-state-owned commercial banks. Some experts believe that the first decline in the NPL ratio in 2016 may be due to the steady liquidity of commercial banks and the steady growth of assets and liabilities. After the implementation of leverage ratio regulation, commercial banks increased the proportion of high-risk assets, resulting in non-performing loan ratio and non-performing loan both increased, which increased bank credit risk.

Through the above analysis, it can be seen that the leverage ratio of commercial banks has reached the regulatory requirements. Credit expansion has been suppressed, which is lower than before the implementation of leverage ratio regulation. However, the rate of non-performing loans has increased year by year.

Commercial bank assets are mainly composed of bank loans. The increase in non-performing loans indicates that the proportion of high-risk assets in banks has increased and the credit risk has increased. This phenomenon of adverse selection has different degrees of performance in different types of commercial banks. Therefore, this paper studies the impact of leverage ratio regulation on credit expansion and credit risk of commercial banks, and whether there are differences in the impact on different types of commercial banks. This paper selects the data of 16 listed commercial banks from 2013 to 2018, and selects leverage ratio of commercial banks as the explanatory variable. The loan growth rate is the agent variable of commercial bank credit expansion. Non-performing loan ratio is the proxy variable of credit risk. GDP growth rate, broad money supply growth rate, capital adequacy ratio of commercial banks, proportion of bank size, market share and return on equity are used as control variables for empirical research. The results show that leverage ratio regulation will inhibit the credit expansion of commercial banks, but will increase the credit risk of commercial banks. These conclusions have passed the significance test in OLS model, FE model, differential GMM model and system GMM model. At the same time, the total sample is divided into two sub-samples of large state-owned commercial banks and small non-state-owned commercial banks. It is found that leverage ratio regulation has greater influence on credit expansion and credit risk of small non-state-owned banks. Finally, this paper puts forward relevant suggestions on how commercial banks manage credit behavior and prevent credit risks under the background of leverage ratio supervision, and puts forward suggestions for different types of commercial banks.

2. Literature Review

After the regulation of leverage ratio is put forward, there are great doubts about whether the regulatory indicators of leverage ratio are actually effective. Most of the existing literatures tend to study the effectiveness of leverage ratio regulation. The research on the influence of leverage ratio regulation on credit expansion and credit risk started late and reached a consensus.

2.1. Research on the Effectiveness of Leverage Ratio Supervision

Some scholars compare leverage ratio regulation with other regulatory tools. Robert (2013) compares the impact of leverage ratio regulation and capital adequacy ratio regulation on bank risks and finds that leverage ratio regulation is superior to capital adequacy ratio regulation in bank risk control. Yang (2016) studied and analyzed 417 bank data from 2008 to 2012, and found that leverage ratio regulation has heterogeneity in predicting bank bankruptcy compared with capital adequacy ratio regulation, which is more effective for large banks. The research group of China Banking Regulatory Commission (2010) believes that the effectiveness of individual regulatory tools is limited. Leverage ratio regulation and capital adequacy ratio regulation complement each other and jointly

strengthen the supervision of commercial banks. Song Qin and Zheng Zhenlong (2011) analyzed the four major regulatory tools and found that the implementation of leverage ratio, capital adequacy ratio, liquidity and loan provision ratio is conducive to reducing the probability of bank bankruptcy and improving bank operating performance. Peng Jiangang and Ma Yanfang (2018) believe that the implementation of flexible leverage ratio regulation can make up for the mechanical defects of flexible capital adequacy ratio and rigid leverage ratio regulation. Some scholars also study the factors that influence the effectiveness of leverage ratio regulation. Binici and Koksal (2012) studied the monthly data of Turkish banks from 2011 to 2012 and found that the leverage ratio of commercial banks has a pro-cyclical Error: Reference source not found. Bruno et al. (2013) found that leverage ratio regulation should adapt to the external environment and effectively reduce the vulnerability of the financial system. Barth and Christian (2018) found that the implementation effect of leverage ratio regulation is affected by the quality level of bank assets. Jin Yuying and Jia Songbo (2016) analyzed the effect of leverage ratio regulation from the perspective of high and low risk spreads, and found that low spreads would increase the proportion of risky assets in commercial banks. Zhou Junyang He Lianfei (2019) established DSGE model to study the relationship between interest rate shock, leverage ratio and competition degree, and found that interest rate shock will reduce the leverage ratio level of commercial banks. There are also scholars who study the effectiveness of leverage ratio regulation from the perspective of term. Ba & Gao (2012), Yuan Qinglu (2014), Yuan Kun et al. (2014) and Fang Fang et al. (2016) believe that the new rod ratio regulation will not exert much short-term pressure on the Bank of China. However, it has long been a challenge. Wang Lianjun (2018) analyzed the data of 120 domestic commercial banks from 2003 to 2015 and found that in the short term, deleveraging will reduce bank stability. Long-term data show that bank stability will improve.

2.2. Research on the Impact of Leverage Regulation on Credit Expansion and Credit Risk

Scholars at home and abroad have generally found that the regulation of leverage ratio will lead to adverse selection, which will increase banks' high-risk assets. Koehn and Santomero (1980) found through the analysis of the asset portfolio model that the regulation of leverage ratio reduces the risk-taking of banks, but the allocation of credit resources of banks will lead to the problem of adverse selection Error: Reference source not found. Kiema and Jokivuolle (2014) believe that leverage ratio regulation will make banks adopt the strategy of transferring low-risk assets to high-risk assets, undermining the stability of banks. Huang Haibo et al. (2012) believe that leverage ratio regulation will make bank assets transfer from low-risk assets to high-risk assets, resulting in adverse selection problem. Some scholars also study the influence of leverage ratio regulation on bank credit expansion. Janda and Kravtsov (2017) conducted an empirical analysis on unbalanced panel data of 15 Czech banks from 2007 to 2014, and found

that leverage ratio regulation inhibited bank loan expansion, reduced bank profitability and improved bank risk appetite. Wang Lianjun (2019) analyzed the data of 120 commercial banks in China from 2003 to 2015, and found that leverage ratio is effective in the long run and will accelerate the expansion in the short run. Some scholars also study the impact of leverage ratio regulation on bank risks. Blum (2008) established an information asymmetry model based on banks and regulators, and found that leverage ratio regulation would expose the real risk level of banks. Dermine (2015) leverage ratio regulation is conducive to reducing the probability of bank runs and limiting bank risks under asymmetric information. Smith et al. (2017) analyzed the data of 655 European banks from 2005 to 2014, and found that leverage ratio regulation reduced the risk probability of banks. A study by Hudonnier and Morellec (2017) found that leverage ratio regulation and liquidity regulation simultaneously reduce the probability of bank default risk. Yu Jinliang and Zhu Jianlin (2018) combed the relevant literature based on theoretical research and empirical research, and believed that there were great differences on the impact of leverage ratio regulation on bank risk taking. Liu Yao and Zhang Ming (2019) believe that excessive deleveraging will lead to long-term credit risk and short-term liquidity risk for commercial banks. Jiang Hai et al. (2019) Empirical Research Found that Monetary Policy Affects Bank Risk Bearing through Bank Lever, and the Higher Lever Level, the Greater the Impact. Ma Bin and Fan Rui (2019) conducted an empirical analysis on the data of 16 listed commercial banks from 2007 to 2016, and found that leverage ratio regulation reduced the probability of credit risk of commercial banks. Zhang Qingjun and Chen Si (2019) use the data of 96 commercial banks in China from 2007 to 2016, and find that the introduction of leverage ratio has a slow-release effect on bank risk taking.

After sorting out and summarizing the research results of relevant scholars, it is found that most scholars tend to study the effectiveness of leverage ratio regulation and the factors affecting the effectiveness. There is little research on the effect of leverage ratio regulation on credit expansion and credit risk of commercial banks, and the development is relatively late and no consensus has been reached. Can leverage regulation effectively restrain credit expansion of commercial banks? Will it affect the credit risk of commercial banks? And how does it affect credit risk? These are all the problems to be explored and analyzed in this paper.

3. Theoretical Analysis

In this paper, the theoretical part is expounded from the text and simple mathematical derivation. Regulatory leverage ratio focuses on the total assets of commercial banks. Leverage ratio can inhibit the credit expansion of commercial banks. At the same time, the regulatory leverage ratio does not measure the risk level of banks. When only the capital adequacy ratio is regulated, commercial banks can hold a large number of low-risk assets to meet the regulatory re-

quirements. However, the proposal of leverage ratio regulation will produce adverse selection behavior, and commercial bank assets will be transferred to high-risk assets, reducing the asset scale of commercial banks, thus meeting the regulatory requirements. The increase of high-risk assets, especially the increase of high-risk loans, will increase the non-performing loans and non-performing loan ratio of commercial banks. Thereby the credit risk of commercial banks will be increased.

Suppose the total assets of a commercial bank are *Assert*. *Debt* is the total debt. Owner's equity is *Equity*. Therefore:

$$Assert = Debt + Equity \tag{1}$$

Assume that the commercial bank's profit is *Profit*. Return on total assets is: R_A. Assume that all bank liabilities are composed of deposits, and the deposit interest rate is: R_D. At this time, the commercial bank's profit is:

$$Profit = Assert * R_A - Debt * R_D \tag{2}$$

when there is leverage ratio regulation, assume that the minimum leverage ratio required by regulation is *LEV*. From this can be obtained:

$$Equity \geq Assert * LEV \tag{3}$$

Increasing leverage ratio can be achieved by increasing equity and reducing assets, the latter being easier to achieve. Considering the expansion of assets, the growth rate of assets is introduced, assuming that the growth rate is *Growth*, and the assets in the previous period are: $Assert_0$. Total assets for the current period are $Assert_0 * (1 + Growth)$. Then Equation (3) can be changed to:

$$Equity \geq Assert_0 * (1 + Growth) * LEV \tag{4}$$

In order to make the leverage ratio meet the regulatory requirements, the leverage ratio of commercial banks should be increased as quickly as possible by reducing the asset growth rate. In the short term, commercial banks have a high proportion of loans in their assets and their income is still dominated by traditional loan business. Therefore, it can be seen that the leverage ratio regulation has a restraining effect on the credit expansion of commercial banks.

Considering the credit risk of commercial banks. Introducing *NPL* and *Loss* as non-performing loan ratio and loan loss ratio. Equation (2) can be changed to:

$$Profit = Assert * R_A * (1 - NPL * Loss) - Debt * R_D \tag{5}$$

The sum of the owner's equity and profit of commercial banks should be greater than or equal to zero, which is sufficient to deal with risks. Therefore:

$$Equity + Profit \geq 0 \tag{6}$$

Substituting Equation (6) into Equation (5) yields:

$$Equity + Assert * R_A * (1 - NPL * Loss) - Debt * R_D \geq 0 \tag{7}$$

If both sides are divided by total assets at the same time:

$$LEV + R_A * (1 - NPL * Loss) - (1 - LEV) * R_D \geq 0 \tag{8}$$

That is:

$$R_A * (1 - NPL * Loss) + 1 \geq (1 - LEV) * (1 + R_D) \quad (9)$$

Assuming that there is no change in the rate of return on capital and the deposit interest rate, then commercial banks have raised the leverage ratio in order to meet the regulatory requirements, and the value on the right side of the equation will drop, then higher non-performing loan rate and loan loss rate can satisfy the equation. Commercial banks' risk preference will be increased, thus, the leverage ratio regulation will increase commercial banks' credit risk.

Considering the heterogeneity of banks, the changes in loan growth rate and non-performing loan rate will be different due to the different degrees of leverage ratio changes in commercial banks. The impact of leverage ratio regulation on credit expansion and credit risk of different banks will be different.

Therefore, the following assumptions are put forward:

1) Regulation of leverage ratio has a restraining effect on loan expansion of commercial banks.

2) Leverage ratio supervision will increase the credit risk level of commercial banks.

4. Research and Design

4.1. Sample Selection and Data Sources

This paper selects 16 listed commercial banks in China as research samples. The "Measures for Capital Management of Commercial Banks" began to be implemented in 2013, so this paper chooses the data from 2013 to 2018 for panel data model analysis. The data of commercial banks come from the annual financial reports disclosed by commercial banks every year and the national Tai'an database. The macro data come from the website of the National Bureau of Statistics. In the empirical part, Stata software is used to carry out descriptive analysis on survey data and regression analysis on panel data.

4.2. Variable Setting and Data Description

4.2.1. Explanatory Variables

This paper chooses leverage ratio of commercial banks as an explanatory variable. Basel III defines regulatory leverage ratio as follows:

$$LEV = \text{Tier-1 capital} / \text{Adjusted balance of assets inside and outside the table}$$

Among them, the numerator net tier-1 capital is tier-1 capital minus tier-1 capital deduction, and the denominator consists of on-balance-sheet asset balance, derivative asset balance, securities financing transaction asset balance and off-balance-sheet item balance. The greater the leverage ratio, the smaller the leverage ratio, the less the possibility of earning income, and the less the risk that commercial banks bear.

4.2.2. Interpreted Variables

Based on the literature research at home and abroad, this paper chooses the loan

growth rate of commercial banks as the proxy variable to measure the extent of loan expansion. The calculation formula is:

$$Loan = \left(Loanbalance_t - Loanbalance_{t-1}\right) / Loanbalance_{t-1}$$

Non-performing loan ratio is chosen as the proxy variable of credit risk to measure the credit risk level of commercial banks in China. The calculation formula is:

$$NPL = \text{Baddebt}/\text{Total loan balance}$$

4.2.3. Control Variables

According to the existing research literature, we will select control variables from macro and micro levels. Macro variables include GDP growth rate and broad money supply growth rate M2. Micro variables include capital adequacy ratio of commercial banks, proportion of bank size, market share and return on equity. As shown in Table 1.

4.3. Model Construction

According to the selection of the above variables, the following regression model is established:

$$\begin{aligned} LOAN_{i,t} &= \beta_0 + \beta_1 LOAN_{i,t-1} + \beta_2 LER_{i,t} + \beta_3 CAR_{i,t} + \beta_4 ASSET_{i,t} \\ &\quad + \beta_5 MS_{i,t} + \beta_6 ROE_{i,t} + \beta_7 GDPR_t + \beta_8 M_t + \varepsilon_{i,t} \\ NPL_{i,t} &= \beta_0 + \beta_1 NPL_{i,t-1} + \beta_2 LER_{i,t} + \beta_3 CAR_{i,t} + \beta_4 ASSET_{i,t} \\ &\quad + \beta_5 MS_{i,t} + \beta_6 ROE_{i,t} + \beta_7 GDPR_t + \beta_8 M_t + \varepsilon_{i,t} \end{aligned}$$

Table 1. Selection of variables and indicators.

Variable type	Variable name	Symbol	Variable definition
Interpreted variable	Loan growth rate	$LOAN_{i,t}$	$\frac{Loanbalance_t - Loanbalance_{t-1}}{Loanbalance_{t-1}}$
	Non-performing loan ratio	$NPL_{i,t}$	$\frac{\text{Baddebt}}{\text{Total loan balance}}$
Explanatory variable	Leverage ratio	$LER_{i,t}$	$\frac{\text{Tier-1 capital}}{\text{Adjusted balance of assets inside and outside the table}}$
	Capital adequacy ratio	$CAR_{i,t}$	$\frac{\text{Tier 1 capital}}{\text{Risk weighted assets}}$
	Proportion of bank size	$ASSET_{i,t}$	$\frac{\text{Balance of total assets at the end of the period}}{\text{Total assets of the sample bank}}$
Control variable	Market share	$MS_{i,t}$	$\frac{\text{Ending loan balance}}{\text{Total sample bank loans}}$
	Return on net assets	$ROE_{i,t}$	$\frac{\text{Net profit}}{\text{Owner's equity}}$
	Economic growth rate	$GDPR_t$	$\frac{GDP_t - GDP_{t-1}}{GDP_{t-1}}$
	Growth rate of money supply	M_t	$\frac{M2_t - M2_{t-1}}{M2_{t-1}}$

Source: National Bureau of Statistics website, National Tai'an Database and Commercial Bank Annual Report.

5. Analysis of Empirical Results

5.1. Descriptive Statistics and Correlation Test

Table 2 lists the descriptive statistical results of the main variables in the model. From this, we can notice several important statistics. The average loan growth rate is 14.84% and the standard deviation is 0.0561, which shows that the range of change between 2013 and 2018 is large and the stability is weak. The average non-performing loan ratio is 1.36%, and the standard deviation is 0.0038. The variation range is small. The average leverage ratio is 5.81%, and the standard deviation is 0.0089. The change is relatively stable. Moreover, there is a big difference between the maximum and minimum values of the three variables, which indicates that bank heterogeneity exists.

Table 3 lists the results of variable correlation test. The correlation coefficient between leverage ratio and loan growth rate is −0.447, which passed the test of 1% significance level. It means significant negative correlation. The correlation

Table 2. Descriptive statistics.

Variable	observed value	Average	Standard deviation	Minimum value	Maximum value
$LOAN_{i,t}$	96	0.14835	0.0576069	0.0358	0.438
$NPL_{i,t}$	96	0.01355	0.0037754	0.0065	0.0239
$LER_{i,t}$	96	0.0581219	0.0088582	0.0405	0.0805
$CAR_{i,t}$	96	0.1271875	0.0149752	0.099	0.1719
$ASSET_{i,t}$	96	0.0625063	0.0583073	0.0046	0.1989
$MS_{i,t}$	96	0.0625021	0.0655991	0.0034	0.2279
$ROE_{i,t}$	96	0.1470927	0.0283315	0.096	0.2119
$GDPR_t$	96	0.0209854	0.0032183	0.0129	0.0273
M_t	96	0.111	0.0226051	0.081	0.136

Table 3. Correlation test.

	$LOAN_{i,t}$	$NPL_{i,t}$	$LER_{i,t}$	$CAR_{i,t}$	$ASSET_{i,t}$	$MS_{i,t}$	$ROE_{i,t}$	$GDPR_t$	M_t
$LOAN_{i,t}$	1.000								
$NPL_{i,t}$	−0.221**	1.000							
$LER_{i,t}$	−0.447***	0.479***	1.000						
$CAR_{i,t}$	−0.327***	0.173*	0.772***	1.000					
$ASSET_{i,t}$	−0.508***	0.252**	0.669***	0.602***	1.000				
$MS_{i,t}$	−0.095	0.108	0.676***	0.611***	0.880***	1.000			
$ROE_{i,t}$	−0.529***	−0.591***	−0.446***	−0.214**	0.099	0.074	1.000		
$GDPR_t$	0.016	−0.270***	−0.326***	−0.147	0.123	0.061	0.611***	1.000	
M_t	0.053	−0.408***	−0.495***	−0.382***	0.000	−0.000	0.709***	0.635***	1.000

Note: *, ** and *** indicate that the regression coefficients are significant at the levels of 10%, 5% and 1%, respectively.

coefficient between leverage ratio and non-performing loan ratio is 0.479, which has passed the test of 1% significance level. That is significant positive correlation. Based on this data, we can preliminarily judge the correlation between leverage ratio, loan growth rate and non-performing loan rate. The increase in leverage ratio will inhibit credit expansion, but will increase credit risk. The correlation coefficient between bank size and loan volume is high, but considering that bank size reflects the bank's ability to resist risks and loan volume has an important impact on loan growth rate, these two control variables are still used. The correlation coefficient between other variables is good, and there is no serious multicollinearity problem in the model.

5.2. Analysis of Empirical Results

In this paper, the OLS model, the fixed effect model, the differential GMM model and the systematic GMM model are used to regress the total sample. Then the total sample is divided into two sub-samples of large state-owned commercial banks and small non-state-owned commercial banks to regress, to study the influence of leverage ratio on loan growth rate and non-performing loan rate.

5.2.1. Empirical Results of Leverage Regulation on Loan Growth Rate of Commercial Banks

According to Table 4, in the regression of the total sample, the leverage ratio in the four groups of models has a significant impact on the loan growth rate. The coefficients all pass the significance test and show negative correlation, indicating that the increase in leverage ratio inhibits the credit expansion of commercial banks. This is consistent with the assumption 1 in this paper. In the system GMM model and OLS model, the loan growth rate passed the 1% significance level test one stage later, but the regression results of FE and differential GMM models were not the same, indicating that the loan growth rate had a weak relationship with the previous year.

As for the control variables, the capital adequacy ratio only passed the 10% level significance test in OLS, indicating that the capital adequacy ratio has no obvious influence on the loan growth rate. The bank scale coefficient is negative, and the impact on loan growth rate is not very significant. Market share is significantly positively correlated with loan growth rate, indicating that the larger the bank loan scale, the higher the loan growth rate. The net return on capital is significantly negatively correlated with the loan growth rate. The higher the net return on capital is, the more reluctant commercial banks are to lend. However, the influence of macro-control variables passed the 10% significance level test, with little influence. For the model, the R-squared of OLS model and FE model is small and the goodness of fit is general. The differential GMM and the system GMM have passed the sequence correlation test and over-recognition test. There is no autocorrelation and the moment condition used is correct. The choice of this model is reasonable.

According to Table 5, for large state-owned commercial banks, except OLS

Table 4. Regression results of total samples.

	OLS	*FE*	*Differential GMM*	*Systematic GMM*
$L.LOAN_{i,t}$	0.3795***	−0.1865*	−0.0394	0.2295***
	(4.00)	(−1.33)	(−0.39)	(2.20)
$LER_{i,t}$	−2.2488**	−3.6892**	−6.4782*	−4.5659**
	(−1.68)	(−1.74)	(−1.48)	(−1.67)
$CAR_{i,t}$	0.7724*	0.0202	0.1511	−0.2228
	(0.88)	(0.02)	(0.16)	(−0.27)
$ASSET_{i,t}$	−0.0627	−1.4855	−4.3230*	−1.2186*
	(−0.32)	(−0.48)	(−1.19)	(−1.01)
$MS_{i,t}$	−0.2047*	4.0606***	6.4289***	1.0731*
	(−1.29)	(2.06)	(2.69)	(0.92)
$ROE_{i,t}$	−0.7228***	−1.7806***	−2.1249**	−1.5122***
	(−1.67)	(−3.28)	(−1.79)	(−1.86)
$GDPR_{t}$	−0.6738	3.3900*	0.7546	−2.5465*
	(−0.36)	(1.07)	(0.16)	(−0.70)
M_{t}	0.6209*	0.5262*	0.5845*	0.6374*
	(1.32)	(1.39)	(1.08)	(1.56)
C	0.1926*	0.3561*	0.6089*	0.6208***
	(1.66)	(1.39)	(1.50)	(2.93)
F	11.73	2.22		
$Prob > F$	0.0000	0.0391		
R-squared	0.4535	0.2410		
$AR\,2(P)$			0.1828	0.4849
$Sargan(P)$			0.8043	0.9887

Note: *, ** and *** indicate that the regression coefficients are significant at the levels of 10%, 5% and 1%, respectively.

Table 5. Return results of large state-owned commercial banks.

	OLS	*FE*	*Differential GMM*	*Systematic GMM*
$L.LOAN_{i,t}$	−0.0016	−0.2996*	−0.2996***	−0.1361*
	(−0.01)	(−1.43)	(−3.59)	(−2.17)
$LER_{i,t}$	−0.7283	−3.8879*	−3.8879***	−2.6285*
	(−0.62)	(−1.78)	(−2.82)	(−3.82)
$CAR_{i,t}$	−2.3252***	−3.1236***	−3.1236***	−2.4872***
	(−2.85)	(−4.00)	(−6.17)	(−3.27)
$ASSET_{i,t}$	0.4346*	0.3199	0.3199	0.3094*
	(1.42)	(0.22)	(0.48)	(0.93)
$MS_{i,t}$	−0.0836	0.4913	0.4913***	0.1882*

Continued

	(−0.46)	(0.40)	(2.18)	(1.80)
$ROE_{i,t}$	−0.4285*	−0.9823**	−0.9823***	−0.7732**
	(−0.99)	(−2.10)	(−4.71)	(−1.97)
$GDPR_t$	3.3279*	−0.8312	−0.8312	1.3065
	(0.90)	(−0.29)	(−0.23)	(0.33)
M_t	−0.1132	0.1510	0.1510*	−0.0027
	(−0.28)	(0.45)	(1.31)	(−0.03)
C	0.4415***	0.8815***	0.8815***	0.6698***
	(4.23)	(2.80)	(3.50)	(8.25)
F	8.93	6.64		
$Prob > F$	0.0001	0.0000		
R-squared	0.6917	0.8158		
$AR\,2(P)$			0.2014	0.2618
$Sargan(P)$			0.6845	0.7506

Note: *, ** and *** indicate that the regression coefficients are significant at the levels of 10%, 5% and 1%, respectively.

model, leverage ratio in the other three groups of models has significant influence on loan growth rate. The coefficient of differential GMM model passed the significance test of 1%, and the coefficient is −2.6285, indicating that the increase in leverage ratio inhibits the credit expansion of large state-owned commercial banks. Except OLS model, in the other three models, the loan growth rate lags behind by one period and passes the test of significance level. The loan growth rate has a negative correlation with the previous year, but the relationship is weak.

According to Table 6, for small non-state-owned commercial banks in the sub-sample regression, except the systematic GMM model, the leverage ratio in the other three models has a significant impact on the loan growth rate, with a negative coefficient, indicating that the increase in leverage ratio inhibits the credit expansion of small non-state-owned commercial banks. In the differential GMM model, the coefficients of large state-owned commercial banks and small non-state-owned commercial banks are both significant. The absolute value of the coefficient of large state-owned commercial banks is 3.8879, and the absolute value of the coefficient of small non-state commercial banks is 4.6587. The former absolute value of the coefficient is smaller than the latter, which indicates that leverage ratio regulation has a greater impact on the loan growth rate of small non-state-owned commercial banks. Small non-state-owned commercial banks do not have sufficient capital for large state-owned banks and are greatly affected by leverage ratio regulation.

5.2.2. Empirical Results of Leverage Regulation on Non-Performing Loan Rate of Commercial Banks

According to Table 7, in the regression of total samples, leverage ratio in the

Table 6. Small non-state-owned commercial banks.

	OLS	*FE*	*Differential GMM*	*Systematic GMM*
$L.LOAN_{i,t}$	0.1450*	−0.1808*	−0.1837***	0.1786***
	(1.11)	(−1.13)	(−3.62)	(2.19)
$LER_{i,t}$	−1.5574*	−2.9062*	−4.6587*	−2.4309
	(−0.98)	(−0.90)	(−1.15)	(−0.65)
$CAR_{i,t}$	1.3662*	0.9662*	0.5741	0.7712
	(1.47)	(0.91)	(0.53)	(0.52)
$ASSET_{i,t}$	2.2740*	−1.6682	−7.2755*	−4.8061*
	(1.16)	(−0.24)	(−0.88)	(−1.22)
$MS_{i,t}$	−3.4943**	17.2964***	23.2273***	4.5612*
	(−1.82)	(2.61)	(4.73)	(1.33)
$ROE_{i,t}$	−1.0466***	−1.1679*	−1.6147*	−1.4228***
	(−2.12)	(−1.23)	(−1.07)	(−2.14)
$GDPR_{t}$	0.0628	4.6766*	5.2781*	0.5404
	(0.02)	(1.21)	(1.00)	(0.13)
M_{t}	0.7219*	1.2063***	1.2879***	1.0013*
	(1.20)	(2.16)	(2.04)	(1.61)
C	0.1715*	−0.2726	−0.1006	0.2651
	(1.04)	(−0.54)	(−0.17)	(0.66)
F	3.40	2.37		
$Prob > F$	0.0038	0.0369		
R-squared	0.3877	0.3446		
$AR\,2(P)$			0.5967	0.3301
$Sargan(P)$			1.0000	0.9999

Note: *, ** and *** indicate that the regression coefficients are significant at the levels of 10%, 5% and 1%, respectively.

Table 7. Regression results of total samples.

	OLS	*FE*	*Differential GMM*	*Systematic GMM*
$L.NPL_{i,t}$	0.8344***	0.5952***	0.9627***	0.7753***
	(11.89)	(6.11)	(5.28)	(7.35)
$LER_{i,t}$	0.1412***	0.1744***	0.4095**	0.1997***
	(2.96)	(2.65)	(1.89)	(2.02)
$CAR_{i,t}$	−0.0946***	−0.0801***	−0.0560*	−0.0808***
	(−5.40)	(−2.97)	(−1.63)	(−2.35)
$ASSET_{i,t}$	0.0056	0.1374*	0.4163**	0.0103
	(0.44)	(1.32)	(1.85)	(0.57)
$MS_{i,t}$	−0.0033	−0.0522*	−0.2026***	−0.0272***

Continued

	(−0.28)	(−0.79)	(−1.97)	(−2.70)
$ROE_{i,t}$	0.0033	−0.0106	0.0900**	0.0048
	(0.33)	(−0.49)	(1.80)	(0.20)
$GDPR_t$	0.0113	−0.1664***	−0.3296***	−0.1813***
	(0.27)	(−1.72)	(−2.85)	(−2.21)
M_t	0.0523***	0.0624***	0.0876***	0.0785***
	(4.62)	(5.16)	(4.25)	(6.30)
C	0.0009	−0.0005	−0.0439*	−0.0015
	(0.29)	(−0.06)	(−1.42)	(−0.16)
F	73.59	22.87		
$Prob > F$	0.0000	0.0000		
R-squared	0.8579	0.7657		
$AR2(P)$			0.5504	0.4242
$Sargan(P)$			0.8556	0.9974

Note: *, ** and *** indicate that the regression coefficients are significant at the levels of 10%, 5% and 1%, respectively.

four groups of models has a significant impact on non-performing loan ratio. The coefficients have passed the significance test and are positively and negatively correlated, indicating that the rise in leverage ratio increases the credit risk of commercial banks. This is consistent with the assumption 2 in this paper. In the four groups of models, the non-performing loan rate has passed the significance level test of 1% with a positive coefficient, indicating that there is a significant positive correlation between the loan growth rate and the previous year. The coefficient of GMM model of the system is located between OLS model and FE model, which indicates that the selection of dynamic model is reasonable.

For the control variables, the capital adequacy ratio coefficient is significantly negative, indicating that the increase of capital adequacy ratio will reduce the non-performing loan ratio. The coefficient of bank size is positive, and the impact on the non-performing loan ratio is not very significant. The negative correlation between market share and NPL ratio indicates that the larger the total bank loan size, the lower the NPL ratio. Net return on capital is positively correlated with non-performing loan rate, but it is not very significant. The influence of macro-control variables passes the significance level test and has a greater influence. For the model, OLS model and FE model have larger R-squared and better goodness of fit. The differential GMM and the system GMM have passed the sequence correlation test and over-recognition test, that is, there is no autocorrelation and the moment condition used is correct. The choice of this model is reasonable.

According to Table 8, in the subsample regression, for large state-owned commercial banks, the leverage ratio in OLS model and system GMM model has

Table 8. Return results of large state-owned commercial banks.

	OLS	*FE*	*Differential GMM*	*Systematic GMM*
$L.NPL_{i,t}$	0.4629***	0.3957**	0.3957***	0.3789***
	(2.79)	(1.94)	(4.84)	(5.86)
$LER_{i,t}$	0.2715***	0.0492	0.0492	0.3164***
	(2.55)	(0.23)	(0.38)	(3.78)
$CAR_{i,t}$	−0.0637*	−0.0881*	−0.0881***	−0.1205***
	(−1.07)	(−1.14)	(−2.10)	(−2.85)
$ASSET_{i,t}$	0.0305**	0.0854	0.0854*	0.0480***
	(1.87)	(0.51)	(1.04)	(4.80)
$MS_{i,t}$	−0.0300**	−0.2212**	−0.2212***	−0.0447***
	(−1.99)	(−1.96)	(−2.55)	(−11.78)
$ROE_{i,t}$	−0.0074	−0.0340*	−0.0340*	0.0020
	(−0.28)	(−0.70)	(−1.29)	(0.17)
$GDPR_t$	−0.0751	−0.3410*	−0.3410***	−0.2701***
	(−0.52)	(−1.23)	(−2.78)	(−2.11)
M_t	0.0736***	0.1100***	0.1100***	0.0768***
	(2.90)	(3.66)	(2.62)	(2.46)
C	−0.0061*	0.0376*	0.0376***	0.0022
	(−1.12)	(1.06)	(2.42)	(0.28)
F	15.88	5.23		
$Prob > F$	0.0000	0.0055		
R-squared	0.8336	0.7772		
$AR\,2(P)$			0.1534	0.0867
$Sargan(P)$			0.6714	0.8489

Note: *, ** and *** indicate that the regression coefficients are significant at the levels of 10%, 5% and 1%, respectively.

a significant impact on the non-performing loan ratio, and has passed the 1% significance test with a positive coefficient. In the system GMM model, the coefficient is 0.3164, indicating that the increase in leverage ratio will increase the credit risk of large state-owned commercial banks. In the four groups of models, the non-performing loan rate lags behind by one period and all pass the test of significance level, that is, the non-performing loan rate has a significant positive correlation with the previous year.

According to Table 9, for small non-state-owned commercial banks, except FE model, leverage ratio in the other three models has a significant impact on NPL ratio, with a positive coefficient, indicating that the increase in leverage ratio will increase the credit risk of small non-state-owned commercial banks. In the four groups of models, the non-performing loan rate lags behind by one period and all pass the test of significance level. The non-performing loan rate has

Table 9. Return results of small non-state-owned commercial banks.

	OLS	*FE*	*Differential GMM*	*Systematic GMM*
$L.NPL_{i,t}$	0.7933***	0.5873***	0.8058***	0.7333***
	(9.13)	(5.34)	(4.44)	(5.58)
$LER_{i,t}$	0.0705*	0.0534	0.1921*	0.0584*
	(1.45)	(0.67)	(1.53)	(0.79)
$CAR_{i,t}$	−0.0823***	−0.0686***	−0.0495*	−0.0547***
	(−4.34)	(−2.60)	(−1.55)	(−2.51)
$ASSET_{i,t}$	−0.0243	0.0692	0.3333*	0.0949
	(−0.65)	(0.41)	(1.51)	(0.65)
$MS_{i,t}$	0.0619**	0.0583	−0.0131	−0.0189
	(1.83)	(0.35)	(−0.07)	(−0.16)
$ROE_{i,t}$	−0.0041	−0.0296*	0.0434*	−0.0113
	(−0.32)	(−1.07)	(1.11)	(−0.44)
$GDPR_t$	−0.0186	−0.0788*	−0.2479***	−0.0900*
	(−0.35)	(−0.83)	(−2.19)	(−1.46)
M_t	0.0404***	0.0421***	0.0632***	0.0501***
	(3.39)	(2.98)	(3.62)	(3.02)
C	0.0057*	0.0096*	−0.0174*	0.0042
	(1.33)	(0.75)	(−1.13)	(0.49)
F	66.48	24.03		
$Prob > F$	0.0000	0.0000		
R-squared	0.9156	0.8423		
$AR2(P)$			0.1600	0.3081
$Sargan(P)$			0.9999	1.0000

Note: *, ** and *** indicate that the regression coefficients are significant at the levels of 10%, 5% and 1%, respectively.

a significant positive correlation with the previous year. In OLS model and system GMM model, the coefficients of large state-owned commercial banks and small non-state-owned commercial banks are both significant. The coefficient of large state-owned commercial banks is 0.3164, and coefficient of small non-state commercial banks is 0.0584. The former absolute value of the coefficient is greater than the latter, which indicates that leverage ratio regulation has greater influence on the credit risk of large state-owned commercial banks. This is consistent with the theory put forward by some scholars. Larger banks are more likely to take high-risk actions, which leads to the accumulation of credit risks in commercial banks.

6. Conclusion and Policy Recommendation

6.1. The Conclusion of This Paper

Through the previous theoretical and empirical analysis, this paper draws the

following conclusions: 1) Leverage ratio regulation has a restraining effect on credit expansion of commercial banks, and has a greater restraining effect on small non-state-owned commercial banks. This is because small non-state-owned commercial banks do not have sufficient capital and are greatly influenced by leverage ratio regulation. 2) Regulation of leverage ratio will lead to adverse selection, thus increasing the credit risk of commercial banks and having a greater impact on the credit risk of large state-owned commercial banks. This is because in order to obtain profits, larger banks are more likely to take high-risk actions, resulting in the accumulation of credit risks in commercial banks.

6.2. Policy Suggestions

From the macro regulatory level, financial regulatory agencies need to strengthen the supervision of commercial banks, further promote the development of leverage ratio supervision, and create a good external environment for commercial banks. From the level of commercial banks, in the current face of diversified and complicated risks, under the background of leverage ratio supervision, commercial banks should pay attention to their own problems, and can further enhance their internal awareness and external hardware.

6.2.1. Financial Regulatory Agencies to Strengthen the Supervision of Commercial Banks

The core part of financial supervision is the supervision of commercial banks. At the same time, the supervision of commercial banks is also the part with the longest history and the most perfect development. With the rapid development of the banking industry, the risks faced by commercial banks are gradually diversified and complicated. Financial regulatory agencies should strengthen the supervision of commercial banks. The Basel III Agreement comprehensively revised the defects of the previous Basel Agreement, including the introduction of leverage ratio requirements, the establishment of macro-prudential regulatory framework and the introduction of new liquidity regulatory standards. China's version of Basel III draws on international experience and reform achievements, draws on China's practical experience in banking reform and supervision, and maintains consistency with international standards. At the same time, it implements supervision according to China's national conditions and actual market conditions. Financial regulators should strengthen the supervision of non-performing loans of commercial banks while supervising leverage ratio. While inhibiting the expansion of commercial bank credit, it is necessary to prevent the increase of commercial bank credit risk. We should strengthen and improve the information disclosure system and system, increase the examination of commercial banks' annual financial statements, standardize commercial banks' credit behavior, and strengthen the supervision of non-performing loans. In particular, the supervision of large state-owned commercial banks needs to be strengthened. Large state-owned banks should not be taken lightly because of this "protective cover" to prevent the large-scale increase of credit risks of commercial banks.

6.2.2. Commercial Banks Should Strengthen and Perfect the Credit Risk Management System

At present, the credit risk management of China's commercial banks is not perfect, and a complete credit risk management system has not been formed. With the implementation of leverage ratio supervision, China's commercial banks should gradually improve their credit risk management system. We will strengthen risk monitoring and establish a timely reporting system for abnormal situations and a risk emergency mechanism for transactions in the entire credit risk management system so as to standardize the business operation process and continuously improve the entire transaction system. Especially in the event of a crisis, an emergency team must be set up quickly, and the whole process of emergency handling, the responsibilities of various departments and the methods to solve the incident must be reflected in the daily rules and regulations, which is also part of a sound trading system.

Commercial banks urgently need a group of people with more professional knowledge and ability and enough professional talents to deal with credit risk management and control. Therefore, we can have two paths: internal cultivation and external introduction. First, provide professional training to people who already have some experience in foreign exchange derivatives trading. On the premise of having experience, they can accept professional knowledge faster and apply it flexibly in risk control. Second, because the foreign exchange derivatives market has developed much earlier than China's, and its scale and level of development are much higher than that of China's, they have already trained professionals in their own system, and we can fill the gap in China through external introduction.

In addition, large state-owned commercial banks should strengthen the management of their own loan scale and loan structure to prevent the occurrence of high-risk credit behaviors in order to prepare for the accumulation of non-performing loans and prevent large-scale increase of bank credit risks. Although the credit risk of small non-state-owned commercial banks is less affected, the loan expansion is greatly restricted. Therefore, on the premise of meeting the regulation of leverage ratio, the loan expansion should be carried out reasonably, and the method of "off-balance-sheet deleveraging and off-balance-sheet plus leverage" should be refused to reach the regulatory standard. At the same time, pay attention to the management of their own credit behavior, reduce high-risk loans, and effectively prevent credit risks.

6.3. Future Research Prospects

The shortcomings of this article are the following:

1) Due to the availability of data, this article only selects the data of 6 years from 2013 to 2018. The time span is short, and there is insufficient evidence to exclude the existence of U-shaped relationships.

2) This article simply studies the impact of leverage ratio regulation on credit expansion and credit risk. As for the impact mechanism and channels, further

research is needed.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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