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The impact of credit risk on commercial banks profitability in China

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by

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ABSTRACT

This study determined the relationship between credit risk and the profitability of commercial banks in China. It considered the credit risk (Non-performing loans, NPLs) as a key variable and the profitability of commercial banks (Net interest spread) as a dependent variable.

A descriptive-correlational research design was adopted in this quantitative research. Dataset is 12 Chinese commercial banks from owned commercial banks, city commercial banks, and joint-stock commercial banks for the period 2006 to 2016. Data has been collected from the wind database, and Bloomberg, and analyzed using panel data analysis, which is a fixed-effect model.

The finding of the study demonstrates that credit risk has a significant impact on the profitability of commercial banks in China, which means the relationship between them is positive. Thus, the study suggested that to improve financial performance, the managers for commercial banks of China need to focus on sustaining the Non-performing loans

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Introduction

In recent years, affected by the international financial crisis, the business environment of China's commercial banks has become even worse. The operation of commercial banks has also been affected by such factors as shadow banking and internet finance. Their profitability has been greatly affected. At the same time, the credit risk level of commercial banks has also shown a certain upward trend in recent years, which has also increased the operational risks of commercial banks to a certain extent.

The healthy development of commercial banks will be supported by a steady stream of profits and will also be affected by credit risk in the profit process of commercial banks. With the continuous advancement of China's reform process, commercial banks' independent pricing power is increasing, and they will also face greater credit risks. Then, how credit risk will affect the profitability of commercial banks in China is the core issue to be studied in this paper.

The purpose of the study is to analyze the impact of credit risk on the profitability of commercial banks in China. The hypothesis is that there is a positive relationship between credit risk and profitability. So, the null hypothesis is that there is no relationship between these two.

To test the hypothesis, the first step is to search the ways that commercial banks earn the profit. The second step is to select a key variable (credit risk) that can measure the

profitability of commercial banks and a dependent variable that can represent the profitability. Then, since the study is planning to choose different types of commercial banks, it has to avoid other effects and chooses control variables from macroeconomic, industry-specific, and bank-specific aspects. Finally, the study will use the fixed effect model to explore the relationship between credit risk and profitability.

By examining the impact of credit risk management on selected bank performance indicators, this study will bring significant benefits to the management of selected banks and other banks. The results of this study may encourage them to conduct a rigorous review of their risk management style by observing the bank's non-performing loan levels and make judgments about leadership capabilities. In essence, the findings can provide relevant information for subsequent future assessments of bank risk management. Also, it enables decision-makers and managers to have a more comprehensive and in-depth understanding of bank risk management and can help them with policy development and implementation monitoring.

Literatures review

The impact of credit risk:

There is hardly any banking operation without the risk. Credit risk, as known as default risk, is the risk that borrowers cannot pay back the requirement payments and it is associated with many important risks, such as reputational risk, market risk, liquidity risk so on. For determining bank performance, credit risk is an important factor, because credit risk or credit creation is created by financial intermediation, which is the main income of commercial banks.

Bhattarai (2017) states that "Non-performing loans have been an immense issue among banking organizations and academicians" because it can influence banks profitability. Non-performing loans (NPLs) is defined as the total amount of borrowing that the debtor has not repaid in accordance with the plan for at least 90 days, loans already included in non-accrual projects, and foreclosure or other immovable property acquired in lieu of foreclosure (Bholat, Lastra, Markose, Miglionico, & Sen, 2016). NPLs are including a lot of time and effort in bank management. Due to the poor quality of assets, this is the indirect cost the commercial banks must afford. Non-performing loan ratio (NPLR) is a crucial indicator of credit risk and financial stability, since if NPLR is increasing because of lacking risk management, it seems like a failure of bank credit policy, and it will reduce banks profitability and it is also the main cause of financial crisis (Saba, Kouser, & Azeem, 2012).

The equation for non-performing loan ratio (NPLR) is stated as:

$$\text{Non} - \text{performing loan ratio(NPLR)} = \frac{\text{Non} - \text{Performing Loans(NPLs)}}{\text{Total Loans}}$$

The profitability of commercial banks:

Increasing profitability is the main goad in commercial banks. All the activities and methods, policies are directly or indirectly related to their profitability. Profitability refers to the ability of a bank to generate revenue over a specified period deducts its cost. It represents the ability of banks to deal with related risks while increasing capital. It also demonstrates the effectiveness of interbank management and competitiveness.

There are a variety of methods to measure commercial bank profitability According to Bhattarai (2017), the study uses “return on asset, return on equity, net profit margin, net interest spread” to measures the profitability of banks. From Afanasieff et al. (2002) study, it uses interest spread to represent the profitability of banks. Net interest spread is the commonly used standard to measure the net interest income of commercial banks. It measures the difference between the sourcing cost of the bank’s funds and the income from the use, which is equivalent to the concept of gross profit margin.

The equation for net interest spread (NIS) is expressed as:

$$\text{Net Interest Spread} = \frac{\text{interest income} - \text{interest expense}}{\text{total bank asset}}$$

Were and Wambua (2014) say that in defining interest rate spreads, bank-specific determinant has a central role. Also, Tan (2016) finds that “bank-specific, industry-specific, and macroeconomic determinants influence bank profitability”. Thus, to avoid these determinants influence the study, previous researchers selected some variables to control these determinants.

Control variables:

Bank-specific determinants:

Liquidity: According to Tan (2016), the loan deposit ratio (LD) presents the liquidity. Tan (2016) states that LD is “total loans over total assets”. Besides, Lartey et al. (2013) find that higher liquidity will have higher bank profitability. Besides, Rengasamy (2014) investigates that LD and bank profitability have a positive correlation.

Diversification: Noninterest income ratio (NIR) is a good indicator to measure diversification, which is calculated by noninterest income divided by gross revenue (Tan, 2016). Goddard et al. (2014) suggest that diversification had a positive relationship with banks profitability.

Capitalization: Karim et al. use the capital adequacy ratio (CAR) and core capital adequacy ratio (CCAR) to capture capitalization. Köster and Zimmermann (2017) conclude that “higher capitalization is associated with increased profitability”.

Bank size: Tan (2016) uses total asset, total loan, and total deposit to show the bank size. Goddard et al. (2014) also propose that when bank size increases, the profit of the bank also rises.

Industry-specific determinants:

Stock development (SD) and bank sector development (BSD): Tan (2016) uses "the ratio of the market capitalization of listed companies over GDP" to Stock development. The study in Tan (2016) also uses "the ratio of banking sector assets over GDP" to test bank sector development. Tan and Floros (2012) show that SD and BSD with bank profitability are proportional.

Macroeconomic determinants:

GDP and Inflation: Tan (2016) exerts GDP growth rate and inflation rate to denote these two variables. Tan and Floros (2012) find that the higher GDP growth is associated with lower profitability of banks, but for the inflation rate, is opposite.

The relationship between credit risk and profitability of commercial banks:

There are extensive empirical findings on credit risks and the ability to earn money. Noman et al. (2015) analyze that "credit risk effects probability of the commercial banks negatively". However, Khawaja and ud Din (2007) explain that NPL, which measures credit risk, and interest rate spread is proportional. Moreover, Okeke and E (2018) also investigate that both have the same relationship.

Methodology

Research Design

This study is adopted a descriptive-correlational research design, evaluating the relationship between two variables. According to Zulueta and Costales(2003), the research design is to describe and determine whether the relationship we study is significant, high or not significant and weak.

Besides, the study uses panel data analysis in a fixed-effect model to examine the relationship between credit risk and the profitability of commercial banks in China.

Panel data comprises both time series data and cross-sectional data. Obgoi and Unuafe (2013) mentioned there are numerous advantages to using panel data. First, it provides suitable data, and it has superior variability when it is having greater freedom and low collinearity, permitting this study to have more well-organized approximations.

The fixed-effect model is used to study the effect of variables that only vary over time. Allison (2009) states that in the fixed-effect model, variables that are not observed can relate to observed variables. In the fixed-effects model, the intercept captures the differences between individuals, referred to as individual heterogeneity, to express individual-specific, but time-invariant characteristics. So, in the fixed-effect model, the intercepts may vary from bank to bank, but it will not change over time because it has time-invariant characteristics.

The subsequent model equation is used in the study:

$$y_{it} = u_i + \beta_1 X_{it} + \sum_{j=1}^{J} \beta_j X_{it}^{j} + \sum_{l=1}^{L} \beta_l X_{it}^{l} + \sum_{m=1}^{M} \beta_m X_{it}^{m} + e_{it}$$

Where

y_{it} = Independ variable, Net interest spread (NIS) in the year *t*

X_{it} = Key variable, Non-performing loans ratio (NPLR) in the year *t*

X_{it}^{j} = Bank specific variables *i* in the year *t*

X_{it}^{l} = Industrial specific variables *i* in the year *t*

X_{it}^{m} = Macroeconomic specific variables *i* in the year *t*

u_i = intercept terms for different banks *i*

β_1 = the coefficient for the key variable

β_j = the coefficient for banks specific variables

β_l = the coefficient for industrial specific variables

β_m = the coefficient for macroeconomic specific variables

e_{it} = error term for different banks *i* in the year *t*

The variable net interest spread (NIS) represents the financial performance of commercial banks in China, and the non-performing loans ratio (NPLR) represents the credit risk of

commercial banks. The rest of the variables are control variables. Loan deposit ratio (LD), noninterest income ratio (NIR), capital adequacy (CAR), core capital adequacy (CCAR) measure bank-specific variables. Stock development (SD), bank sector development (BSD) are variables of industrial specific aspects. GDP and inflation represent macroeconomic specific variables.

Data and basic information

Dataset is 12 Chinese commercial banks from state-owned commercial banks, city commercial banks, and joint-stock commercial banks for the period 2007 to 2016. Data has been collected from the annual report and quarterly reports of different commercial banks in Wind database, and Bloomberg. Table 1A, 1B, 1C, 1D and 1E present the descriptive data of NIS, NPLR, LD, NIR, CAR, CCAR, SD, BSD, GPD, and inflation. Some banks are not including because of lacking the central data, so the number of observations in the study is only 120. They are analyzed using panel data analysis, which is the fixed-effect model.

NIS		NPLR		TL/TD	
Mean	2.570167	Mean	1.23225	Mean	52.47584
Standard Error	0.03308	Standard Error	0.068531	Standard Error	3.615815
Median	2.485	Median	1.005	Median	49.0461
Mode	2.72	Mode	0.95	Mode	#N/A
Standard Deviation	0.362368	Standard Deviation	0.750725	Standard Deviation	39.60927
Sample Variance	0.131311	Sample Variance	0.563587	Sample Variance	1568.894
Kurtosis	0.263349	Kurtosis	18.39047	Kurtosis	104.8838
Skewness	0.482577	Skewness	3.438909	Skewness	9.928748
Range	2.18	Range	5.98	Range	442.2448
Minimum	1.52	Minimum	0.36	Minimum	26.61536
Maximum	3.7	Maximum	6.34	Maximum	468.8601
Sum	308.42	Sum	147.87	Sum	6297.1
Count	120	Count	120	Count	120
Largest(1)	3.7	Largest(1)	6.34	Largest(1)	468.8601
Smallest(1)	1.52	Smallest(1)	0.36	Smallest(1)	26.61536
Confidence Level(95.0%)	0.065501	Confidence Level(95.0%)	0.135699	Confidence Level(95.0%)	7.159674

Table 1A-Descriptive data of NIS, NPLR, LD

NII/GR		CCAR		CAR	
Mean	19.92063	Mean	9.873	Mean	12.61042
Standard Error	0.812964	Standard Error	0.271219	Standard Error	0.266952
Median	18.155	Median	9.425	Median	12.09
Mode	20.87	Mode	10.9	Mode	11.78
Standard Deviation	8.90557	Standard Deviation	2.971053	Standard Deviation	2.92431
Sample Variance	79.30917	Sample Variance	8.827156	Sample Variance	8.551589
Kurtosis	-0.62907	Kurtosis	11.13899	Kurtosis	13.77018
Skewness	0.269307	Skewness	2.416969	Skewness	2.786248
Range	42.1233	Range	22.96	Range	24.9
Minimum	-2.62	Minimum	4.42	Minimum	5.77
Maximum	39.5033	Maximum	27.38	Maximum	30.67
Sum	2390.475	Sum	1184.76	Sum	1513.25
Count	120	Count	120	Count	120
Largest(1)	39.5033	Largest(1)	27.38	Largest(1)	30.67
Smallest(1)	-2.62	Smallest(1)	4.42	Smallest(1)	5.77
Confidence Level(95.0%)	1.609749	Confidence Level(95.0%)	0.53704	Confidence Level(95.0%)	0.528591

Table 1B-Descriptive data of NIR, CCAR, CAR

ln(TA)		ln(TL)		ln(TD)	
Mean	9.971833	Mean	9.257417	Mean	9.607806
Standard Error	0.128621	Standard Error	0.133518	Standard Error	0.131897
Median	9.94	Median	9.339018	Median	9.603816
Mode	11.68	Mode	6.869046	Mode	7.384257
Standard Deviation	1.408975	Standard Deviation	1.462612	Standard Deviation	1.444861
Sample Variance	1.985212	Sample Variance	2.139233	Sample Variance	2.087624
Kurtosis	-0.57677	Kurtosis	-0.46608	Kurtosis	-0.5301
Skewness	-0.22481	Skewness	-0.31578	Skewness	-0.21439
Range	5.76	Range	6.023129	Range	5.833007
Minimum	6.63	Minimum	5.724532	Minimum	6.233077
Maximum	12.39	Maximum	11.74766	Maximum	12.06608
Sum	1196.62	Sum	1110.89	Sum	1152.937
Count	120	Count	120	Count	120
Largest(1)	12.39	Largest(1)	11.74766	Largest(1)	12.06608
Smallest(1)	6.63	Smallest(1)	5.724532	Smallest(1)	6.233077
Confidence Level(95.0%)	0.254683	Confidence Level(95.0%)	0.264378	Confidence Level(95.0%)	0.26117

Table 1C-Descriptive data of ln(TA), ln(TL), ln(TD)

SD		BSD		GDP	
Mean	0.475033	Mean	4.530708	Mean	8.9
Standard Error	0.021839	Standard Error	0.038035	Standard Error	0.195026
Median	0.379472	Median	4.457603	Median	8.455
Mode	1.09267	Mode	3.979577	Mode	14.16
Standard Deviation	0.239237	Standard Deviation	0.416653	Standard Deviation	2.136398
Sample Variance	0.057234	Sample Variance	0.1736	Sample Variance	4.564195
Kurtosis	1.82036	Kurtosis	0.026939	Kurtosis	1.10809
Skewness	1.65331	Skewness	0.692298	Skewness	1.29687
Range	0.82453	Range	1.449905	Range	7.46
Minimum	0.268139	Minimum	3.979577	Minimum	6.7
Maximum	1.09267	Maximum	5.429482	Maximum	14.16
Sum	57.00393	Sum	543.6849	Sum	1068
Count	120	Count	120	Count	120
Largest(1)	1.09267	Largest(1)	5.429482	Largest(1)	14.16
Smallest(1)	0.268139	Smallest(1)	3.979577	Smallest(1)	6.7
Confidence Level(95.0%)	0.043244	Confidence Level(95.0%)	0.075313	Confidence Level(95.0%)	0.38617

Table 1D – Descriptive data of SD, BSD, GDP

IR		CPI	
Mean	3.59	Mean	102.943
Standard Error	0.230033	Standard Error	0.171327
Median	3.25	Median	102.64
Mode	4.8	Mode	104.61
Standard Deviation	2.519884	Standard Deviation	1.876794
Sample Variance	6.349815	Sample Variance	3.522354
Kurtosis	-0.4354	Kurtosis	-0.50845
Skewness	0.248401	Skewness	-0.10311
Range	9.2	Range	6.58
Minimum	-0.7	Minimum	99.32
Maximum	8.5	Maximum	105.9
Sum	430.8	Sum	12353.16
Count	120	Count	120
Largest(1)	8.5	Largest(1)	105.9
Smallest(1)	-0.7	Smallest(1)	99.32
Confidence Level(95.0%)	0.455488	Confidence Level(95.0%)	0.339245

Table 1E – Descriptive data of IR, CPI

The selected banks include: three state-owned commercial banks, industrial and Commercial Banks (ICBC), China Construction Bank (CCB) and Bank of China (BOC), two city commercial banks, bank of Beijing (BOB) and Bank of Nanjing (BON), seven joint-stock commercial banks, China Minsheng Bank (CMBC), China Merchants Bank (CMB), Industrial Bank (CIB), China Everbright Bank (CEB), China CITIC Bank (CCB), Shanghai Pudong Development Bank (SPOB), and Hua Xia Bank (HXB).

Then, the study uses the multicollinearity test to test independent variables. Multicollinearity refers to the fact that the model estimates are distorted or difficult to estimate accurately due to the existence of exact correlations or high correlations between explanatory variables in linear regression models. If there is a linear relationship

between the independent variables, it will have a serious impact on the regression parameters.

In figure 1, the study chooses a 95% confidence interval, all the data present in the figure represent r-squares. The r-squares with star marks mean p is less than 0.05, other means p is more than 0.05, which stands for insignificant.

In figure 2, the study chooses the variance inflation factor (VIF) to measure the multicollinearity of independent variables. The empirical judgment method shows that when VIF is greater than 0, smaller than 10, collinearity can be ignored, and when VIF is greater than 100, there exists severe multicollinearity. In figure 2, all the data presents are smaller than 10, so the multicollinearity can be ignored.

Confidence Interval 95%											
	NPLR	TL/TD	NII/GR	CCAR	CAR	Ln(TA)	Ln(TL)	Ln(TD)	SD	BSD	GDP
NPLR	1.00										
TL/TD	0.00	1.00									
NII/GR	0.00	0.01	1.00								
CCAR	0.01	0.01	0.02	1.00							
CAR	0.01	0.01	0.02		1.00						
Ln(TA)	0.00	0.01	0.46*	0.04*		1.00					
Ln(TL)	0.01	0.01	0.42*		0.06*		1.00				
Ln(TD)	0.01	0.01	0.40*		0.05*			1.00			
SD	0.32*	0.00	0.23*	0.03	0.02	0.10*	0.08*	0.08*	1.00		
BSD	0.04*	0.01	0.41*	0.01	0.01	0.12*	0.09*	0.08*	0.42*	1.00	
GDP	0.16*	0.00	0.32*	0.02	0.01	0.11*	0.09*	0.08*	0.83*	0.53*	1.00
IR	0.05*	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.01	0.01	0.01
"*" means p<0.05, others means p>0.05											

Figure 1: Multicollinearity test - 1

VIF = 1/(1-r^2)											
	NPLR	TL/TD	NII/GR	CCAR	CAR	Ln(TA)	Ln(TL)	Ln(TD)	SD	BSD	GDP
NPLR	-										
TL/TD	1.00	-									
NII/GR	1.00	1.01	-								
CCAR	1.01	1.01	1.02	-							
CAR	1.01	1.01	1.02		-						
Ln(TA)	1.00	1.01	1.85	1.04		-					
Ln(TL)	1.01	1.01	1.72		1.06		-				
Ln(TD)	1.01	1.01	1.67		1.05			-			
SD	1.47	1.00	1.30	1.03	1.02	1.11	1.09	1.09	-		
BSD	1.04	1.01	1.69	1.01	1.01	1.14	1.10	1.09	1.72	-	
GDP	1.19	1.00	1.47	1.02	1.01	1.12	1.10	1.09	5.88	2.13	-
IR	1.05	1.00	1.00	1.01	1.02	1.00	1.00	1.00	1.01	1.01	1.01
If VIF < 10, collinearity can be ignored											

Figure 2: Multicollinearity test - 2

Results

Confidence Interval 95%									
	1	2	3	4	5	6	7	8	9
	coefficient	coefficient	coefficient	coefficient	coefficient	coefficient	coefficient	coefficient	coefficient
NPLR	0.204*	0.203*	0.175*	0.175*	0.178*	0.216*	0.223*	0.194*	0.166*
TL/TD		(0.001)*	(0.001)*	(0.001)*	-0.001	(0.001)*	(0.001)*	-0.001	-0.001
NII/GR			(0.018)*	(0.017)*	-0.018	-0.017	-0.011	-0.015	-0.016
CCAR				0.016		0.018		0.020	0.013
CAR					0.014		0.019		
Ln(TA)					0.011			0.075	0.048
Ln(TL)						-0.119			
Ln(TD)							0.02		
SD						-0.353	-0.304	0.247	0.287
BSD							-0.262		-0.37
GDP								-0.064	(0.084)*
IR									(0.036)*

Figure 3 – Regression on adding variables

This is robust processing. In figure 3, the researcher uses a 95% confidence interval, the coefficient with star marks mean the relationship with NIS is significant. In the first regression (the first line), the research uses one variable NPLR to regress. It is biased, which means E(β) is different from the true value and E(e) ≠ 0 because there are many influence factors not including in the first line. With adding variables one by one, let the expected value of NPLR become closer to the real value. Although the coefficient of NPLR is not stable at first, it is stable from the ninth line to the next group 1, group 2, group3.

From figure 4, compared to group 2 with group 1, group 2 uses CAR to represent capitalization and uses natural logs of the total loan (ln(TL)) to represents bank size. And compared group 3 with group 1, group 3 uses natural logs of total deposit (ln (TD)) to represents bank size and uses CAR to represent capitalization. Since the research wants to

find out if these variables represent a good performance in the commercial banks. In other words, the study does not sure which variables represent banks size better, ln (TA), ln(TL) or ln (TD).

From figure 4, indeed, the paper changes some control variables, but the coefficient of NPLR is still around 0.165, meaning that the bank increases 1% NPLR, NIS will increase by 0.165%. So NPLR plays an important role in the influence of bank profitability.

	Group1		**Group2**		**Group3**	
	coefficient	**t-statistic**	**coefficient**	**t-statistic**	**coefficient**	**t-statistic**
NPLR	0.166	4.14	0.163	3.86	0.155	3.35
TL/TD	-0.001	-0.78	-0.001	-5.11	-0.001	-4.54
NII/GR	-0.016	-1.16	-0.016	-1.10	-0.016	-1.21
CCAR	0.013	1.00			0.007	-0.53
CAR			0.007	0.78		
Ln(TA)	0.048	0.28				
Ln(TL)			0.0468	0.20		
Ln(TD)					-0.733	-0.41
SD	0.287	0.90	0.307	-2.12	0.462	1.27
BSD	-0.370	-2.21	-0.371	-3.26	-0.061	-0.38
GDP	-0.084	-3.24	-0.085	4.92	-0.105	-3.61
IR	0.036	4.97	0.036	2.40		
CPI					0.071	5.42
p-value of nplr	0.002		0.003		0.006	

Figure 4- Summary of Group 1, Group 2, Group 3 result

According to the result that the researcher has mentioned, the p-value is less than 0.05, so the research rejects the null hypothesis. It is clear to state that there is a significant and positive relationship between credit risk and the profitability of commercial banks in

China. That it is to say, increasing NPLR will increase NIS, meaning that if the bank of commercial banks in China increases the credit risk, their profit will increase.

The possible reason is explained with an example. Bank 1 has 100 people to loan with 10 % NPLR, and it has 10 people who do not payback. Compared with bank 1, bank 2 has the same amount of people with 20% NPLR, and it has 20 people who do not pay back, the remaining 80 people pay the loan with higher interest. It makes bank 2 have more return, and then increase profitability.

Conclusion

Indeed, there are some conflicts with some researches mentioned in the literature review part. Noman et al. (2015) state that credit risk affects the profitability of commercial banks negatively. The possible reason is that the key variable which is to measures the credit risk is not the same, as well as the dependent variable. Another reason is because of the region, Bangladesh, which has an economic situation different.

This paper finds out that there is a positive relationship between credit risk and the profitability of commercial banks in China. To be more specific, the impact of credit risk is that the bank increases 1% credit risk, the financial ability of commercial banks will increase by 0.165%. Based on the result of the study, decision-makers, and managers to have a more comprehensive and in-depth understanding of bank risk management and can help them with policy development and implementation monitoring.

Significance of the Study

Commercial bank stakeholders, such as management, financial institutions, and depositors who are using their funds, are concerned about the potential risks of the banking industry. Thus, the study focuses on credit risk, which measures the potential risk of the commercial banking industry.

This study encompasses preceding research by examining the relationship between credit risk and the profitability of the commercial banks in China, making the past studies

ampler. That is to say, this research links the previous study to the current one. Since only a few studies were analyzing the commercial banks in China, this research provides useful information for subsequent future research.

Besides, this study contains different types of commercial banks in China, so the result of the study is not biased, and is likely to provide appropriate and effective advice on credit risk management. Data the study analyzing is panel data, obtained from two-dimensional data simultaneously in time and cross-section, so several observations can be generated.

Limitations of the Study

There are some limitations in this study, but this provides a better research direction for future researchers and gives more targets for them to fill the gap, thus making the academic field on credit risk and profit of commercial banks more completely. There are some limitations as follows.

The first point is the bank number limitation. Certainly, the study chooses difference types of commercial banks of China and uses panel data to analyze, but it only selects 12 banks from 2006 to 2016, which are 120 observations, and each type of commercial bank contains three or four banks in China.

The second point is the selected variables limitation. The study only chooses non-performing loans ratio to represent the credit risk level, not choose other variables to

measure at the same time, to some extent, it may not necessarily good enough to express what the study to express.

Also, there is a model limitation. Although the study uses a fixed-effect model to analyze the relationship between the credit risk and the profit of commercial banks in China, it just uses one model, not uses a random effect model, which has no comparison between models.

Last but not least, evidence limitation is also concluded. To be more specific, the study did not analyze other financial markets, like the bond market, stock market and commodity market.

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Appendix A – Group 1 regression results

```
. xtreg nis nplr tltd niigr ccar lnta sd bsd gdp ir, fe robust

Fixed-effects (within) regression               Number of obs      =       120
Group variable: id                              Number of groups   =        12

R-sq:                                           Obs per group:
     within  = 0.4922                                         min =        10
     between = 0.1014                                         avg =      10.0
     overall = 0.2880                                         max =        10

                                                F(9,11)            =    179.78
corr(u_i, Xb)  = -0.1891                        Prob > F           =    0.0000

                                 (Std. Err. adjusted for 12 clusters in id)
```

nis	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
nplr	.165762	.0400874	4.14	0.002	.0775302	.2539937
tltd	-.0007128	.0009129	-0.78	0.451	-.0027221	.0012966
niigr	-.0162401	.0139546	-1.16	0.269	-.046954	.0144739
ccar	.0131977	.013252	1.00	0.341	-.0159699	.0423652
lnta	.0481297	.1726204	0.28	0.786	-.3318054	.4280647
sd	.2873118	.3175632	0.90	0.385	-.41164	.9862637
bsd	-.3697026	.1669793	-2.21	0.049	-.7372215	-.0021836
gdp	-.0840929	.0259283	-3.24	0.008	-.1411608	-.027025
ir	.0356935	.0071837	4.97	0.000	.0198823	.0515048
_cons	4.275378	1.633707	2.62	0.024	.6796122	7.871144
sigma_u	.21802214					
sigma_e	.24790751					
rho	.43612141	(fraction of variance due to u_i)				

Appendix B – Group 2 regression results

```
. xtreg nis nplr tltd niigr car lntl sd bsd gdp ir, fe robust

Fixed-effects (within) regression               Number of obs      =       120
Group variable: id                              Number of groups   =        12

R-sq:                                           Obs per group:
     within  = 0.4867                                         min =        10
     between = 0.1150                                         avg =      10.0
     overall = 0.2871                                         max =        10

                                                F(9,11)            =     86.93
corr(u_i, Xb)  = -0.1797                        Prob > F           =    0.0000

                                 (Std. Err. adjusted for 12 clusters in id)
------------------------------------------------------------------------------
             |               Robust
         nis |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        nplr |   .1635961   .0424358     3.86   0.003     .0701956    .2569967
        tltd |  -.0009684   .0001897    -5.11   0.000    -.0013858   -.0005509
       niigr |  -.0160932   .0146217    -1.10   0.295    -.0482754     .016089
         car |   .0073034   .0093282     0.78   0.450    -.0132279    .0278347
        lntl |   .0467985   .2295639     0.20   0.842    -.4584684    .5520653
          sd |   .3069438   .3443008     0.89   0.392    -.4508572    1.064745
         bsd |  -.3707328    .174609    -2.12   0.057    -.7550447    .0135791
         gdp |  -.0848788   .0260242    -3.26   0.008    -.1421577   -.0275998
          ir |    .036312   .0073831     4.92   0.000     .0200618    .0525621
       _cons |   4.373582   1.822692     2.40   0.035     .3618629    8.385301
-------------+----------------------------------------------------------------
     sigma_u |  .21650156
     sigma_e |   .2492342
         rho |  .43006389   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Appendix C – Group 3 regression results

```
. xtreg nis nplr tltd niigr ccar lntd sd bsd gdp cpi, fe robust

Fixed-effects (within) regression               Number of obs      =       120
Group variable: id                              Number of groups   =        12

R-sq:                                           Obs per group:
     within  = 0.5360                                         min =        10
     between = 0.0024                                         avg =      10.0
     overall = 0.2928                                         max =        10

                                                F(9,11)            =    103.80
corr(u_i, Xb)  = -0.3725                        Prob > F           =    0.0000

                                 (Std. Err. adjusted for 12 clusters in id)
```

nis	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
nplr	.1550245	.0462188	3.35	0.006	.0532975	.2567515
tltd	-.0008122	.000179	-4.54	0.001	-.0012061	-.0004184
niigr	-.0162958	.0134509	-1.21	0.251	-.045901	.0133094
ccar	.0067916	.0127664	0.53	0.605	-.021307	.0348902
lntd	-.0733348	.1790501	-0.41	0.690	-.4674215	.3207518
sd	.4616515	.3647994	1.27	0.232	-.3412665	1.264569
bsd	-.0613819	.1627164	-0.38	0.713	-.4195182	.2967545
gdp	-.1052308	.0291859	-3.61	0.004	-.1694686	-.040993
cpi	.0714317	.0131738	5.42	0.000	.0424363	.1004271
_cons	-2.974121	2.475664	-1.20	0.255	-8.423021	2.474778
sigma_u	.24075644					
sigma_e	.23697392					
rho	.50791719	(fraction of variance due to u_i)				