

Research on Impact of Macroeconomic Uncertainty on Credit Supply of Commercial Banks in China

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ABSTRACT: Compared with the developed countries, the development of the capital markets in China are relatively backward. And indirect financing based on bank credit is still the main way of social financing. A lot of uncertain factors of the international markets have interposed in Chinese domestic markets, which increasing the uncertainty of the macroeconomic, with the deepening of China's reform and opening-up policy. This study applies GARCH model to measures the uncertainty of Chinese macroeconomic and panel data model to analyze the impact of macroeconomic uncertainty on the credit supplies of commercial banks. The results show that macroeconomic uncertainty has a significant negative impact on the credit supplies of commercial banks in China and a greater impact on unlisted commercial banks than listed banks. Besides, negative effects of macroeconomic uncertainty on the credit supplies of commercial banks can be reduced by improving the confidence of entrepreneurs in the future investment. In addition, the improvement of profitability of commercial banks can help to reduce the impact of macroeconomic uncertainty on its credit supplies, but the degree of decrease was weak.

Keywords: Macroeconomic Uncertainty; Commercial Banks; Credit Supplies; Impact

1. Introduction

The Chinese economy has become more and more open and its relationship with the world economy has been more and more close since the reform and opening period (1970s). This accelerated economic globalization has brought many opportunities to China, while the Chinese economy has also been deeply affected by many international factors. Economic imbalances and trade frictions among countries, especially the outbreak of financial crises, have increased macroeconomic uncertainty during the process of economic globalization. Bank credit financing has had an essential role in the development of Chinese economy, although its proportion in various ways of corporate finance has tended to decline in recent years. Meanwhile,

bank credit is deeply affected by many economic factors. With the gradual opening of capital account and the progress of interest rate marketization, Chinese commercial banks have had to withstand a larger impact from the external and internal environment. Therefore, it worth studying the impact of macroeconomic uncertainty on the credit supply of Chinese commercial banks. Firstly, it can be helpful for commercial banks to better understand the uncertainty of macroeconomics and its impact on bank credit so as to adjust their credit structure in time and to strengthen prudent operation and risk management and to promote the steady operation. Secondly, it would helpful for the Chinese government to realize the deep problems in financial system reform, especially banking reform, and make macroeconomic policies more effective, which could help stabilize and promoting China's economic and financial development.

The goal of this paper is to study the impact of macroeconomic uncertainty on the credit supply of Chinese commercial banks. Our study extends previous work in several directions. First, we apply the GARCH model to measure the extent of macroeconomic uncertainty in China and panel data model to examine the impact of macroeconomic uncertainty on the credit supply of commercial banks. Second, we compare listed banks and non-listed banks and the more profitable banks and the less profitable banks. Third, we examine the ways that macroeconomic uncertainty affects the credit supply of commercial banks.

2. Literature review

The literature on macroeconomic uncertainty is gradually increasing, so our study pays more attention to two existing strands: measurement uncertainty and the impact on bank credit supply. The first strand of literature focuses on modeling to measure macroeconomic uncertainty, while the other concentrates more on the impact on bank credit supply.

2.1 Measurement of Macroeconomic Uncertainty

Many researchers believe that measuring macroeconomic uncertainty is necessary before analyzing its impact and the conditional variance of the ARCH family model is an ideal proxy variable because it uses the information set of the last period. The GARCH (1,1) model is most commonly used in the ARCH family model. Examples of this literature include Baum et al (2009) , Quagliariello (2009) and Talavera et al (2012). Baum et al (2009) build a GARCH (1,1) model with the inflation index and the industrial growth index to obtain the conditional variance as

the macroeconomic uncertainty index. Quagliariello (2009) also gets the macroeconomic uncertainty index from the conditional variance of the GARCH (1,1) model. But the data he chooses are the OECD monthly comprehensive leading indicator series, the industrial production index and the consumer price index. Talavera et al (2012) use the variance of the money supply indicator, the consumer price index and the volatility of the production price index. In recent years, many Chinese researchers have done similar studies, selecting other indicators including the GDP growth rate (Yizhong Wang and Frank M. Song, 2014; Hua Zhang and Caili Wu, 2014), the growth rate of industrial added value (Hongbo Liang and Yuanliang Liu, 2012; Lin Zhang et al., 2015), the leading macroeconomic index (Quanxi Liang et al., 2012; Haiming Liu and Tingqiu Cao, 2015), CPI (Qingchun Lu and Xiaoxiao Zhu, 2013), the growth rate of money supply (Binghai Xin et al., 2015). Baker and other American economists combine economic policy uncertainty and other factors to build an economic policy uncertainty index of the world's major economies including the United States, Canada, India, China. Some studies (Donadelli, 2015; Fengyu Li and Mozhu Yang, 2015; Lijing Lu et al., 2016) directly use this economic policy uncertainty index to represent the macroeconomic uncertainty in recent years.

2.2 The Impact of Macroeconomic Uncertainty on Bank Credit Supply

The theoretical literature on macroeconomic uncertainty has devoted a significant amount of attention to the impact on bank credit supply. For instance, Baum et al (2002) establish a simple analytical framework whose result shows that the increase of macroeconomic uncertainty can result in more homogeneous behavior by banks. After that, Baum et al (2009) study the US banking industry by using 1979-2003 quarterly panel data to find that the more the degree of macroeconomic uncertainty increase, the more the banks' judgement of the profitability of investment is affected, which may decrease the ratio of loan to total assets of the banks and finally result in banks' business behavior becoming more stable than in the economic stability period. In addition, the impact of bank credit is different for banks of different sizes. Quagliariello (2009) develops a theoretical analysis framework for commercial bank credit selection based on macroeconomic uncertainty, taking the Italian bank as the object of her/his study. His result confirms that macroeconomic uncertainty factors have a significant impact on bank investment decisions when controlling for other factors. In the period of economic instability, banks can not accurately predict future profitability, therefore 'herding behavior' often occurs.

Somoye et al. (2009) primarily examine the impact of macroeconomic uncertainty on bank lending behavior in Nigeria from 1986 to 2005. Their study finds that when macroeconomic uncertainty becomes smaller or the economy is in the growing period, banks will increase the amount of loans issued. Conversely, banks will tighten credit in a period of stagnation or decline. In addition, the scale of bank credit, capital structure and capital investment will be affected by macroeconomic uncertainty. Talavera et al (2012) establish a dynamic model of bank's profit maximization, which predicts a non-monotonic relationship between bank lending and macroeconomic uncertainty. Then they test this proposition using a panel of Ukrainian banks over the 2003Q2–2008Q2 period. The estimates indicate that banks decrease their lending ratio in times of substantial economic volatility, which could be explained by higher risk aversion by bank managers. Additionally, smaller and less profitable banks are less likely to be affected by changes in the macroeconomic environment than their larger and more profitable peers. This outcome is robust with respect to the different measurements of macroeconomic uncertainty. Valencia (2013) builds a model in which a commercial bank maximizes its own interests. Commercial banks are affected by macroeconomic uncertainty in this process. The increase in macroeconomic uncertainty will increase the probability of the bank's ruin. Banks are generally risk neutral, so as the uncertainty increases, credit growth will be reduced to achieve self-insurance. Bordo et al (2016) find that macroeconomic policy uncertainty has a significant negative impact on bank credit growth, especially under the premise of controlling the relevant factors, will make the impact of uncertainty more significant. The results also suggest that higher economic policy uncertainty may limit overall credit growth through bank lending to slow the process of US economic recovery.

Chinese researchers have also carried out a lot of useful exploration in this field. For instance, Zhaoxiang Qiu did a relatively early study of bank credit under circumstances of macroeconomic uncertainty, which confirms that macroeconomic uncertainty will affect the credit behavior of banks. He and Baodong Wang (2008) demonstrate the theoretical relationship between macroeconomic uncertainty and bank credit. And then through the actual data of China's commercial banks' balance sheets, they conclude that the cross-sectional variance of the loan-to-asset ratio of banks will become smaller when macroeconomic uncertainty increases. After that, he and Yuanliang Liu (2010) also construct a portfolio model, using the relevant Chinese data to do an empirical test, and the results show that: the increase in macroeconomic

uncertainty will make the bank asset allocation in the proportion of loans decrease and the cross-sectional variance of the loan-to-asset ratio will also become smaller, thereby resulting in a "Herd Effect". Hongbo Liang and Yuanliang Liu (2012) use the panel data of Chinese commercial banks to carry out empirical research, which concludes that when macroeconomic uncertainty increases, the risk of bank credit risk will be significantly increased and the non-performing loan ratio will increase, leading banks to reduce the supply of credit. Huahe Zhang and Caili Wu (2014) show that macroeconomic uncertainty has a significant negative impact on bank credit, whether macro-view or micro-view, and macroeconomic uncertainty will have an impact on bank credit which can be measured using a banker confidence index. In addition, the negative impact of macroeconomic uncertainty on state-owned banks is less than that of non-state-owned banks and less for large-scale banks than for small-scale banks. Lin Zhang et al (2015) use the unbalanced panel data of 89 Chinese commercial banks from 1998 to 2012 to empirically test the heterogeneous effects of macroeconomic uncertainty on the credit supply of different banks. The analysis indicates that both statistically and economically, the rise of macroeconomic uncertainty significantly reduces bank credit growth, and the effects are smaller for banks with higher capital adequacy ratio, higher asset liquidity ratio and bigger scale. Binghai Xin et al (2015) empirically test the effect of economic uncertainty on credit growth in China based on the panel data of financial institutions for the 2001-2013 period. The results show that: under the condition of controlling the relevant variables, economic uncertainty has a negative impact on credit growth; bank credit growth is more sensitive to aggregated macroeconomic uncertainty and less sensitive to bank level microeconomic uncertainty; and Chinese banks credit growth is more sensitive to economic uncertainty than that of foreign banks.

In summary, there is quite a rich extant literature considering that macroeconomic uncertainty has a negative impact on the credit supply of commercial banks, but there are inconsistent conclusions in the magnitude and direction of the impact of macroeconomic uncertainty on the supply of bank credit. This paper contributes to the literature in various way. First, it examines whether improving the profitability of banks can increase their ability to resist macroeconomic uncertainty by comparing profitable and less profitable banks. Second, it studies on whether Chinese commercial banks going public can affect the impact of macroeconomic uncertainty on bank credit supply. Finally, it addresses the differing impact of macroeconomic

uncertainty on Chinese listed banks and non-listed banks, which hasn't been studied before.

3. Model and indicators

In general, the greater the uncertainty of economic is, the future prospect of the enterprise is less clear. Thereby the rational enterprise will not blindly increase the scale of investment and then maintain or reduce the scale of operation, which means the demand for bank credit funds is relatively reduced. At the same time, the increase in uncertainty may also increase the probability of corporate credit default. The same is true for banks, and the increase of uncertainty will reduce the accuracy of the bank's forecast of future credit returns. Rational business banks will adjust the allocation of assets, which will reduce the supply of credit funds and increase bonds and other risk-free or less risky investments to minimize credit risk. Many researchers have demonstrated that with the increase in macroeconomic uncertainty, the proportion of loan in bank asset allocation will decline through empirical evidence (Talavera et al., 2012; Zhaoxiang Qiu et al., 2010). Therefore, this paper first investigates the magnitude and direction of macroeconomic uncertainty on the credit supply of Chinese commercial banks, and establishes the first model:

$$y_{i,t} = \alpha_i + \beta_1 m_{1i,t} + \gamma_1 lr_{i,t} + \gamma_2 roa_{i,t} + \gamma_3 npl_{i,t} + \gamma_4 m_{i,t} + u_{i,t} \quad (1)$$

In order to test the robustness of this benchmark model, we establish the second model:

$$y_{i,t} = \alpha_i + \beta_1 m_{2i,t} + \gamma_1 lr_{i,t} + \gamma_2 roa_{i,t} + \gamma_3 npl_{i,t} + \gamma_4 m_{i,t} + u_{i,t} \quad (2)$$

With the four major state-owned commercial banks completing share reform and going public, joint-stock commercial banks, urban commercial banks and rural commercial banks have also followed. The number of the commercial banks listed in China's A-share had reached 24 by the end of the year 2016. Commercial banks listed are often affected more by uncertain factors than non-listed banks, especially on their credits. However, commercial banks need to have certain conditions to list, from the listing of commercial banks in China's real point of view, the size of listed commercial banks relative to non-listed commercial banks is relatively large, with better ability to resist risks. In the existing literature, there is no article devoted to the comparative study on the impact of macroeconomic uncertainty on the listed commercial banks in China and the non-listed banks, but there are some articles examined influences of macroeconomic uncertainty on different sizes of commercial banks. Although some scholars have come to the conclusion that the larger the size of

the commercial banks will be subject to macroeconomic uncertainty greater impact (Talavera et al, 2012), but the vast majority of Chinese scholars have come to the conclusion that: the greater the size of the capital, the greater the impact of macroeconomic uncertainty (Zhang Lin et al., 2014). Therefore, this article will conduct comparative study between the listed banks and non-listed banks. The model used is the above model (1).

All business nature of the enterprise has a common goal, that is, the pursuit of maximizing their own interests, commercial banks are the same, but commercial banks must pursuit profit maximization under the premise of the safety of assets, financial liquidity. So, we can imagine, with the profitability of China's commercial banks to enhance, can reduce the impact of macroeconomic uncertainty on its impact? Talavera et al (2012) concluded that the stronger the profitability of commercial banks would be subject to greater macroeconomic uncertainty, while Chinese scholars Hua Zhang and Caili Wu (2015) to study the profitability of this Whether the level of the impact of macroeconomic uncertainty on the impact of bank credit, the results are positive, but not significant. Therefore, this paper separates banks with better profitability from banks with less profitable ability to study whether commercial banks can increase their ability to withstand macroeconomic uncertainties by enhancing their profitability. The model used is the above model (1).

Many literatures have proved that macroeconomic uncertainty has a significant negative impact on the supply of bank credit through theoretical and empirical evidence, but less study how macroeconomic uncertainty affects the credit of commercial banks by means or by way. Bruneau et al (2012) argues that macroeconomic shocks can affect the company's financial system and increase bankruptcies. Yizhong Wang and Song Min (2014) show that higher macroeconomic uncertainties diminish the positive role of external demand, liquidity demand and long-term capital demand channel in corporate investment. Korea High and Wenming Hu (2016) argue that macroeconomic uncertainty has a significant inhibitory effect on fixed asset investment. The real economy is the demand side of the funds, and the bank is the supply side of the funds, and a large part of the credit supply is the real economy, in general, the greater the macroeconomic uncertainty, the future business prospects of the enterprise is not clear, rational enterprises will not blindly increase the scale of investment, and will maintain or reduce the scale of operation, and thus the demand for bank credit funds is relatively reduced. Therefore, this paper

establishes models (3) and (4) to study the ways in which macroeconomic uncertainties affect the credit supply of commercial banks in China. Based on the model (1), the $ec_{i,t}$ added in the model (3) is the entrepreneur confidence index, and the influence of the entrepreneur confidence index on the bank credit supply is investigated. In the model (4), the interaction between the macroeconomic uncertainty variable and the entrepreneur confidence index is added, and the influence of the interaction on the bank credit supply is investigated:

$$y_{i,t} = \alpha_i + \beta_1 mu_{1i,t} + \beta_2 ec_{i,t} + \gamma_1 lr_{i,t} + \gamma_2 roa_{i,t} + \gamma_3 npl_{i,t} + \gamma_4 m_{i,t} + u_{i,t} \quad (3)$$

$$y_{i,t} = \alpha_i + \beta_1 mu_{1i,t} + \beta_3 mu_{i,t} * ec_{i,t} + \gamma_1 lr_{i,t} + \gamma_2 roa_{i,t} + \gamma_3 npl_{i,t} + \gamma_4 m_{i,t} + u_{i,t} \quad (4)$$

In the above four models, i is the individual bank¹, t is the year, the time range of the data used in this paper is from 2005 to 2015, α_i represents the bank's individual heterogeneity, and $u_{i,t}$ is the random perturbation term. Specific empirical model index system in Table 1.

Table 1 Empirical Model Indicator System

Index type	Index code	Indexcontent	Specific indicators
Explained variable	$y_{i,t}$	Credit supply	Total amount of loans / total assets
Core explanatory variable	$mu_{1i,t}$	Macroeconomic uncertainty variables	The GARCH (1,1) model is used to obtain the conditional variance in the first index of China's macroeconomic prosperity index, and then the mean
		Economic Policy Uncertainty Index	Using the Baker and other scholars to establish the China Economic Policy uncertainty index, the monthly data for the average and take the natural logarithm
Explanatory variables	$ec_{i,t}$	Entrepreneur confidence index	Natural Logarithm of Entrepreneur Confidence Index
		Interactive items	Interaction between Macroeconomic Uncertainty Variables and Entrepreneur Confidence Index

¹ According to the availability and completeness of the sample bank data, this paper chooses 45 commercial banks as research samples, of which 20 are listed commercial banks, including Industrial and Commercial Bank of China, China Construction Bank, Agricultural Bank of China, Bank of China, Transportation Bank of China, Minsheng Bank, CITIC Bank, China Everbright Bank, Huaxia Bank, Industrial Bank, Ping An Bank, Shanghai Pudong Development Bank, Bank of Nanjing, Bank of Beijing, Bank of Jiangsu, Bank of Jiangsu, Hangzhou Bank, Guiyang Bank, Shanghai Bank. The other selected commercial banks are Cangzhou Bank, Chengdu Bank, Dalian Bank, Dongguan Bank, rich Yunnan Bank, Guangdong Development Bank, Guangzhou Rural Commercial Bank, Harbin Bank, Hankou Bank, Huishang Bank, Leye Bank, Luoyang Bank, Ningxia Bank, Qingdao Bank, Rizhao Bank, Xiamen Bank, Shanghai Agricultural Bank, Shaoxing Bank, Tianjin Bank, Wenzhou Bank, Yantai Bank, Yingkou Bank, Zheshang Bank, Zhengzhou Bank, Chongqing Bank. It should be noted that the listed banks are listed on the A-share and are listed before the end of 2016.

Table 1, cont.

Micro control variables	$lr_{i,t}$	fluidity	Liquidity ratio
	$roa_{i,t}$	Profitability	Return on assets
	$npl_{i,t}$	safety	Nonperforming loan rate
Macro control variable	$m_{i,t}$	Monetary Policy	M2 growth rate

Source: Bank level data from the Bankscope database and flush iFinD, the other data mainly from the National Bureau of Statistics database.

As shown in the table above, the explanatory variable is the credit supply of commercial banks, expressed as the ratio of the total amount of loans to the total assets of each commercial bank, that is $isy_{i,t}$. The main explanatory variable in this paper is the macroeconomic uncertainty, with $mu_{1i,t}$ said, the specific measure given by the following. $mu_{2i,t}$ is the economic policy uncertainty index, using the Baker and other scholars to establish the Chinese economic policy uncertainty index to construct the macroeconomic uncertainty variables in China for comparative study, the introduction of this variable is mainly for robustness testing. Control variables are divided into macroscopic aspects of control variables and microscopic control variables. Micro-control variables control the liquidity, profitability and security, respectively, the proportion of liquidity, with $lr_{i,t}$ to represent, the return on assets, with the $roa_{i,t}$, non-performing loan rate is expressed by $npl_{i,t}$; the macroscopic control variable is about the implementation of the national monetary policy. The M2 growth rate is chosen, expressed by $m_{i,t}$.

4. Empirical process and results

4.1 Measurement of Macroeconomic Uncertainty

The macroeconomic uncertainty is measured before the regression model established, many researchers believe that the conditional variance of the ARCH family model makes use of the information set of the last period, which is an ideal proxy variable to measure the macroeconomic uncertainty. In the ARCH family model, the most commonly used is the GARCH (1,1) model, which can be expressed as:

$$\text{Mean equation: } y_t = \beta x_t + \varepsilon_t$$

$$\text{Variance equation: } h_t = a_0 + a_1 \varepsilon_{t-1}^2 + \lambda_1 h_{t-1}$$

If the coefficients of the ARCH and GARCH terms are significant in the model estimation results, the h_t can be used to represent the macroeconomic uncertainty.

The consensus index in the macroeconomic prosperity index is a reflection of the basic trend of the current economy, which is composed of four aspects: industrial

production, employment, social demand and social income. The first index is synthesized by a group of leading indicators ahead of the consensus index. According to the research of Chinese scholars, it is very appropriate to select the index of the first index in China's macroeconomic prosperity index, which is based on the variance of the model to represent the macroeconomic uncertainty index.

First of all, the smoothness of the test is conducted for the first index, the most commonly used test method is ADF test, through the test, found that the selected index is a smooth sequence. Then, by observing the autocorrelation and partial autocorrelation graph of the first index in the macroeconomic prosperity index, it is observed that the autocorrelation graph has the tailing feature, and the partial autocorrelation graph has the truncated characteristic. The mean equation should establish the AR (1) model. Before establishing the GARCH model, it is necessary to perform the ARCH LM test on the residuals of the mean equation, and the results of the inspection are obtained. Then, the GARCH (1, 1) model is established. When the mean equation is set to AR (1), the mean value equation and the ARCH and GARCH terms in the variance equation are significant. Finally, The ARCH LM test for the residuals of the GARCH (1,1) model, the results show that the model has accepted the residual sequence does not exist ARCH effect of the original hypothesis, so the model can be a conditional variance on behalf of macroeconomic uncertainty indicators. Since the panel data model created below is the annual data, so the monthly data obtained by the frequency conversion can be obtained annual data.

4.2 Panel data model

In this paper, we use the stata12.0 software to establish the fixed effect panel model and the random effect panel model. The results of the two models include an F test. The original hypothesis of F test is that mixed regression is acceptable for the mixed regression. Since the p-value of the F-test is less than 0.01, the test result rejects the original hypothesis, and it is considered that the establishment of the fixed-effect model or the random effect model is better than the mixed regression. Whether to choose the fixed effect regression model or the random effect regression model is generally judged by the Hausman test. The original hypothesis of the Hausman test is that the individual effect is independent of the explanatory variable, that is, the original hypothesis can be said to establish a random effect model. Through the Hausman test, each P value in the test results is less than 0.01, so reject the original hypothesis, select the fixed effect regression model to do parameter

estimation. Specific regression results are shown in Tables 2 and 3.

Table 2 Regression results

	model 1	model 2	model 3	model 4
$\mu_{1i,t}$	-0.0731*** (-2.78)		-0.0502** (-2.05)	-2.8161*** (-8.27)
$\mu_{2i,t}$		-0.0355*** (-5.82)		
$ec_{i,t}$			0.2729*** (8.11)	
$\mu_{1i,t} * ec_{i,t}$				0.5764*** (8.08)
$lr_{i,t}$	-0.0024*** (-5.93)	-0.0022*** (-5.67)	-0.0030*** (-7.75)	-0.0030*** (-7.74)
$roa_{i,t}$	0.0099 (10.09)	0.0200** (2.21)	0.0150* (1.77)	0.0149* (1.75)
$npl_{i,t}$	0.0082*** (6.51)	0.0062*** (4.82)	0.0060*** (5.05)	0.0060*** (5.06)
$m_{i,t}$	0.0045*** (7.49)	0.0051*** (8.89)	0.0052*** (9.24)	0.0053*** (9.32)
c	0.4849*** (21.41)	0.6035*** (18.86)	-0.8449*** (-5.11)	0.4637*** (21.94)
F-statistic	31.19***	38.39***	41.28***	41.17***
R ²	0.31	0.33	0.39	0.39

Note: * indicates significant at 10% significance level, ** indicates significant at 5% significance level, *** indicates significant at 1% significance level, it is the z-statistic in ().

Model 1 examines the impact of macroeconomic uncertainty variables on bank credit supply. Model 2 examines the impact of economic policy uncertainty index on bank credit supply. Which can be said to be the robustness of Model 1. Model 3 examines the impact of entrepreneur confidence index on bank credit supply, it can be said that the establishment of model 3 is the basis for the analysis of model 4; Model 4 examines the interaction between entrepreneur confidence index and macroeconomic uncertainty on the impact of bank credit supply. It can be seen from the above regression results that the F values of the regression results in the four models are relatively large, indicating that each model has a good statistical significance; R²'s value is between 0.3 and 0.4, indicating that the fitting effect of each model is good.

(1) Through model 1, we can find that the regression coefficient of $\mu_{1i,t}$ is -0.0731 and is very significant, indicating that the level of macroeconomic uncertainty for each additional 1 percentage point, the bank credit supply will be reduced by

0.0731 percentage points. Model 2 is mainly for the robustness test of Model 1, and the coefficient of the economic policy uncertainty index of the model 2 is also negative, and in the other two models, the regression coefficients of the macroeconomic uncertainty are negative and are both significant. We can conclude that the macroeconomic uncertainty has a significant negative impact on the credit supply of commercial banks in China.

(2) In Model 3, the entrepreneur confidence index $ec_{i,t}$ was added with a regression coefficient of 0.2729 and was statistically significant, indicating that for every one percentage point increase in the firm's confidence index, bank credit would increase 0.2729 percentage points, the entrepreneur confidence index can represent the indicators of funding needs, that is, this indicator has a positive impact on bank credit. We focus on the model 4, In Model 4, the interaction between entrepreneur confidence index and macroeconomic uncertainty variables was added, which regression coefficient is positive, indicating that improving entrepreneurial confidence will reduce impact of macroeconomic uncertainty on the bank credit.

(3) Concerning the coefficient of control variable, the coefficient of the macro control variable $m_{i,t}$ is positive and very significant, indicating that the growth rate of M2 has a positive effect on the bank credit supply, with the M2 growth rate increases, Banks will also increase the corresponding credit supply. Bank's liquidity indicators of Micro-control variables have negative effects on bank credit and non-performing loan rate has a positive effect on bank credit, these two indicators in these two models are very significant. Credit is a risky investment, if the business is not good, it will not be able to repay the loan, which will produce bad loans, so that in order to maintain a high liquidity and security, we must reduce the credit supply. The impact of bank profitability on bank credit is positive, although it is not statistically significant, but it is economically important. Banks make profits by making loans to companies, the more proceeds, the banks will increase the supply of credit.

Then we build the model 5 to 8, in which the macroeconomic uncertainty variables we have chosen are all $mu_{1i,t}$. First, the whole sample is divided into listed commercial banks and unlisted commercial banks. The sample in model 5 is listed commercial banks. The sample banks in model 6 are unlisted commercial banks. We conduct a comparative study between listed banks and non-listed banks. After that, the whole sample bank is divided into the banks with better profitability and the banks with less profitable ability based on the return on assets in 2015. If the asset yield is

greater than 1%, it means that the bank's profitability is better, if less than 1%, said the profitability is poor. The sample in model 7 is commercial banks with better profitability. The sample in model 8 is commercial banks with poor profitability. It is the objective that examines whether the size of the profitability of commercial banks will affect the impact of macroeconomic uncertainty on the credit. The results of the specific regression are shown in Table 3.

Table 3 Regression results

	model 5	model 6	model 7	model 8
$mu_{1i,t}$	-0.0566* (-1.68)	-0.0807** (-2.03)	-0.0658* (-1.83)	-0.0695* (-1.83)
$lr_{i,t}$	-0.0020*** (-3.50)	-0.0026*** (-4.40)	-0.0029*** (-4.47)	-0.0021*** (-3.77)
$roa_{i,t}$	-0.0293 (-1.75)	0.0214* (1.83)	-0.0064 (-0.52)	0.0292** (2.13)
$npl_{i,t}$	0.0063*** (4.25)	0.0088*** (3.67)	0.0059*** (3.79)	0.0118*** (5.70)
$m_{i,t}$	0.0041*** (5.24)	0.0045*** (4.89)	0.0049*** (5.58)	0.0042*** (5.00)
c	0.5280*** (16.46)	0.4728*** (13.95)	0.5029*** (16.55)	0.5029*** (13.62)
F-statistic	20.18***	13.95***	15.24***	17.82***
R ²	0.36	0.28	0.30	0.31

Note: * indicates significant at 10% significance level, ** indicates significant at 5% significance level, *** indicates significant at 1% significance level, it is the z-statistic in ().

From the above regression results, we can find that the test coefficients are good, the F value in the above models are all relatively large, indicating that the model has a good statistical significance; R²'s value is around 0.3, indicating that each model has a good fit effect.

(4) We compare the model 5 and model 6 to find that the absolute value of the regression coefficient of the $mu_{1i,t}$ in model 6 is larger, the coefficient is -0.0807, and the regression coefficient of the $mu_{1i,t}$ in model 5 is -0.0566. It shows that macroeconomic uncertainty has a greater impact on unlisted commercial banks than listed commercial banks.

(5) We compare the model 7 and model 8 to find that the regression coefficients of $mu_{1i,t}$ in model 7 is -0.0658, and the regression coefficients of $mu_{1i,t}$ in model 8 is -0.0695. The gap between two regression coefficients is only 0.0037, indicating that the difference is not significant. In general, the impact of macroeconomic uncertainty on the credit supply of commercial banks with better profitability is less than that of

commercial banks with poor profitability. Increasing the profitability of banks can reduce the impact of macroeconomic uncertainty, but the intensity is small.

5. Concluding remarks

This paper has examined the impact of macroeconomic uncertainty on the credit supplies of Chinese commercial banks. Unlike most previous studies, we make comparative studies between listed banks and non-listed banks and between the better profitable banks and the worse profitable banks to examine the ways how macroeconomic uncertainty affects the credit supply of commercial banks.

By eight models in this study, the coefficients of the macroeconomic uncertainty variables are proved negative, and the absolute value of the coefficient is large, and the statistical sense is also very significant, which show that macroeconomic uncertainty has a significant negative impact on the credit supply of commercial banks in China. In this regard, the relevant departments should be fully aware that in the development of various economic policies or economic analysis, only taking into account the macroeconomic uncertainty factors have practical significance. Specifically, in the formulation of monetary and other relevant policies, we can consider the macroeconomic uncertainty and its impact on the bank credit supply, so as to improve the macro-control role of our monetary policy, at the same time, use the corresponding fiscal policy and other means of regulation to ensure the smooth operation of the economy, take the initiative to grasp and lead the new normal of the economic development, to guide the formation of good social expectations, properly deal with major risk challenges, and provide a good decision-making environment for economic entities.

The empirical results show that the impact of macroeconomic uncertainty on the credit supply of unlisted commercial banks is greater than that of listed commercial banks. Because of the strong strength of listed commercial banks in China, it also shows that the strong commercial banks have stronger ability to resist the macroeconomic uncertainty than commercial banks with smaller assets. At present, the overall non-performing loan ratio of China's banks has increased, and the overall capital adequacy ratio and profitability of the banks are low. The risk management ability of China's commercial banks, especially non-listed commercial banks, needs to be improved. With the continuous improvement of the level of marketization in China, the risks faced by banks are becoming more and more complicated, and it is very important to improve the bank's own risk prevention ability. Therefore, China's

commercial banks should learn from the advanced risk management model of foreign countries, establish a risk measurement method and evaluation model in line with the development of China's banks, and use the established model to act in the process of credit activities, and then urge the bank to take measures to maximize the risk to a lower level.

Macroeconomic uncertainty will influence the credit supply of commercial banks through the way of capital demand, and the negative effect of macroeconomic uncertainty on the credit supply of commercial banks can be reduced by improving the confidence of entrepreneurs in the future investment. This study uses the entrepreneur confidence index, which represents the demand for funds, through empirical evidence, the entrepreneur confidence index has a positive impact on bank credit, indicating that the improvement of entrepreneurial confidence will increase the business operation, thus increasing the demand for funds, bank loan supply also will increase. The regression coefficient of entrepreneur confidence index and macroeconomic uncertainty variables is positive, indicating that increasing entrepreneurial confidence will reduce the negative effect of macroeconomic uncertainty on bank credit, which proves that macroeconomic uncertainty does have a way to influence the supply of bank credit through funding needs. Currently, in the various channels of corporate finance in China, bank loan channels are still the most important channel. Therefore, the relevant departments should speed up the capital market construction process, make enterprises get rid of excessive dependence on bank lending channels, create a good operating environment for enterprises, thus minimizing the negative impact of macroeconomic uncertainty.

Our study finds that the impact of macroeconomic uncertainty on the credit supply of commercial banks with better profitability is less than that of commercial banks with less profitability, but the difference is small, which shows that improving the bank's profitability can reduce the adverse impact of macroeconomic uncertainty, but the intensity is small. At present, the main source of profits in Chinese commercial banks is from loans, and the profitability is weak. If commercial Banks want to grab more market share and maintain their existing positions, they should be able to improve their ability to innovate. In the context of supply-side structural reform, commercial banks should also undertake internal supply-side structural reforms. On the basis of the successful achievements of foreign innovation, commercial banks should take into account the specific situation in China, deepen the changes in

customer demand under the new situation and formulate the financial products needed by the market, so as to take the initiative to release new demands and create new supply. At the same time, commercial banks should take the initiative to enhance the professional quality of staff, training professional financial solutions to solve the talent, and integrate with the international advanced banks gradually, in order to achieve the bank's own industrial upgrading, continue to enhance the modern competitiveness of commercial banks.

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