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Do the Capital Requirements Affect the Effectiveness of Monetary Policy from the Credit Channel?

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Abstract

This paper examines weather the capital requirements affect the effectiveness of monetary policy from the credit channel. According to the penal data of commercial banks listed on the A-share stock market in China from 2007 to 2017, I find that the capital requirements to the commercial banks affect the bank loans through the credit channel of monetary policy transmission, which is more obviously on the smaller banks. I further use issuance of preferred stocks of commercial banks instead of IPO to confirm the results again. Moreover, I compare the two kinds of monetary policy instruments in my results, which document that the price-based monetary policy instruments are more sensitive than the quantitative ones.

Keywords: Credit channel, monetary policy, transmission channel of monetary policy, capital adequacy ratios (CAR), preferred stocks.

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1. Introduction

"Banking plays a crucial role in China's financial system." Zhu, Chen, Zhou, Gai and Xiong (2020) said in their new book, The Jingshan Report: Opening China's Financial Sector. Because commercial bank is not only the crucial part of financial system in China, but also a carrier of monetary policy. Credit channel is considered to be the main transmission channel of monetary policy in China.

"Monetary policy transmission mechanism must coordinate with the national financial system. There are two different kinds of financial system, one is market-oriented, and the other is bank-dominated. Running in a typical bank-dominated financial system, Chinese commercial banks play a pivotal role in the transmission of monetary policy. Afterall, the behavior of commercial bank is the decisive factor to make sure that the monetary policy is smoothly transmitted." Sun Guofeng, head of the monetary policy department at the People's Bank of China (PBOC), said earlier 2019.

The credit availability doctrine began to show the Credit Transmit Channel of Monetary Policy in 1950s. As Roosa said in his book, the central bank uses interest rate as a tool to adjust the behavior of the commercial banks. When the central bank changes the interest rate, as a lender, the commercial bank will change its capital structure as well. As a result, the credit available to the enterprises and households are finally changed. Bernanke (1986) use a SVAR modal to document how the behavior of American commercial banks can affect the aggregate demand of a country, this is theorized as the credit transmission of monetary policy. Oliner and Rudebusch (1996) showed the borrowers will reduce their investments after the central bank tighten the monetary policy. Similar evidence has also been found in bank level data Kashyap and Stein (2000). Wang and Wang (2000), Suo and Fan (2007) focus on the Chinese monetary policy, and they all documented the credit channel of monetary policy exists in China. Rao and Jiang (2013) investigated monetary policy effects on the relationship between bank loans and business credit. They also provided micro evidence on Chinese monetary policy's credit transmission mechanism.

Although the proportion of direct financing increased, indirect financing still occupied a leading position in China. The Jingshan Report said, "In the future, the banking industry will continue to dominate Chinese financial system." According to the PBOC, the amount of social financing including credit financing, securities financing, insurance and other financing forms, increased by 22.5 trillion RMB yuan in the year of 2019. The new yuan loans increased by 16.8 trillion, which account for approximately 66 percent of the amount of total social financing. The new yuan loans have reduced from over 91% of the amount of social financing in 2002 to 66 % in 2019, but they still make up no less than 50 percentage of the total social financing.

In the last three years, loans accounts for over 60 percent of the assets in the balance sheet of financial institutions in China, other include portfolio investments, shares and other investments, foreign exchanges. Although the amount of loans is

decreasing in the past ten years, the loans always make the biggest and irreplaceable contribution to the financial institution's returns. As a country in the economic transition period, China's capital market, which is different from those of western countries, is immature. The loans of China's financial institution, especially for commercial banks, cannot be substituted with other kinds of assets. Even the commercial banks can sale the securities to increase liquidity, the amount of loans is far greater than their other securities. As an important finance intermediary, the commercial bank has become the main center of economic activity. Its antenna widely penetrates in each department and corner of the modern economy and society. On the one side, the commercial bank implementing the monetary policy, which made by the central bank. On the other side, the commercial banks provide money for enterprises and households at a price which pursue monetary policy objectives. As a monetary policy instrument, the credit always plays a leading role in the transmission channel of monetary policy in China. Sheng and Wu (2008) According to the balance sheets of China's financial institutions, the deposits are made up around 85 percent of the total fund sources in the recent three years, which is far more than the other items including financial bonds, currency and other liabilities. "Unlike other large global banks, Chinese banks continue to rely on savings and loan business. Consequently, interest remains the major source of income for Chinese banks." The Jingshan Report said.

Based on the macro time series data and micro survey data from January 2008 to June 2017, Guo, Dai and Peng (2018) examined the efficiency of China's monetary policy interest rate transmission to loan interest rates. In general, the benchmark interest rate is the main factor that affects the loan interest rates. Last year, China's central bank officially announced that the traditional benchmark lending rate was instituted by the loan prime rate (LPR) in Jan 1st 2020. This is considered a milestone in the 25-year process of market-oriented interest rate liberalization reform. The LPR will become the only benchmark rate for banks' new lending, which allows the financial institutions and their clients negotiate a floating rate higher or lower than the benchmark. The regulators expect that the reformation will make the companies able to get cheap loans to counter economic downside pressure. And the behavior of commercial banks is changed correspondingly. In addition, the reserve requirement ratio framework is always considered to be the most important and direct monetary policy instrument for the PBOC, which directly change the commercial bank's behavior. During 2019, China's central bank cut commercial banks' reserve requirements ratio for three times, which unleashed 2.7 trillion RMB yuan long-time capital to maintain the liquidity at a reasonable and ample level. When the reform of loan prime rate (LPR) is officially introduced, the PBOC is also need to cut the reserve requirement ratio to inject the liquidity in the financial system.

The transmission channel of monetary policy depends on the monetary policy tools, the credit decision of commercial banks and the investment decision of enterprises and households. Therefore, how the commercial banks manage their balance-sheet have significant impact on the effectiveness of monetary policy. For example, the

central bank will loosen monetary policy, but the commercial banks are striving to repair their overstretched balance-sheets, which make the banks reluctance to lend. That impair the effectiveness of monetary policy. In modern economy, the bank's operating pressure, earnings pressure, lending risk are growing day and day. Besides, the commercial banks face more supervision in China, and this cause the credit decision-making of banks are more complicated and highly variable. Despite the reforms over the past 30-plus years, the banking sector in China is still heavily regulated and inefficient. Song and Xiong (2018)

For commercial banks, the regulators are concerned most about their capital adequacy ratios (CAR), which play a significant role in mitigating bank solvency problems. It is considered to be a barometer of financial healthiness, which measures the proportion of a bank's capital to its risk-weight assets. Since the late 1980's G-10 and some other economies all over the worlds have begun to concentrate on bank adequacy ratios of their own banking sectors. In March 2004, Chinese Banking Regulatory Commission (CBRC) promulgated "Commercial Bank Capital Adequacy Ratio Management Method" according to The Basel Accord, which built up the capital regulatory framework of China's commercial banks. At that time the CAR of most commercial banks in China are far less than 8 percent. Towards this end, most studies pertain to the ways to improve the commercial banks CAR conforming to the new regulatory. The commercial banks are required to increase their capital to meet the regulatory, which can improve the soundness and safety of the banking sector. Benston and Kaufman (1996) and Dowd (2000) both argued that capital adequacy regulation might help to counter the effects of other given interventions such as the moral hazard created by the regulatory authorities. Furthermore, the CAR regulation is considered to increase market transparency, thereby enable the markets reward the well capitalized banks and punish the banks with low capital levels. Genschel and Plumper (1997)

According to the China Banking and Insurance Regulatory Commission (CBIRC), commercial banks are obliged to meet their capital ratio requirements by the end of 2018. They will need to maintain a minimum CAR of 9.5 percent and a core tier-1 CAR of 8.5 percent. At the end of 2019 the commercial banks' CAR inched up to 14.64 percent in China, which is above the minimum capital requirement ratio. Chinese banks' capital adequacy ratio and non-performing loan ratio were all kept within a safe limit, said by CBIRC. Although the CAR of commercial banks in China have met regulatory requirement the banks still face pressure in the long term. According to the 2019 semi-annual reports of the 33 listed commercial banks, the tier-one capital ratio of 19 listed banks declined compared to the same period last year. Moreover, 23 listed commercial banks with a declined core tier-1 capital ratio. The core tier-1 CAR and the tier-1 CAR both declined in the five large-scale state-owned commercial banks. Furthermore, the CAR and the core tier-1 CAR of the three main joint-stock commercial banks in China, are both lower than the last year, let alone the small banks. In addition, since the CAR of international leading banks is between 15 and 20 percent, the commercial banks in China still have the space to improve. It is also said that the risk of Chinese banking system is concentrated on

the rural and small banks, whose assets account for 10 percent of total assets.

During recent three years, 60 percent of the profits of commercial banks listed in A-share stock market is used to replenish capital, compared that 17 percent for tax and 23 percent for their stock dividends. The market value of commercial banks listed on the A-share stock market take occupied about 16.56 percent of the whole value of Shanghai stock exchange market, and the profits of commercial banks make up about 39.01 percent of the whole market by the end of the third quarter of 2019. It documents that the profits using for replenishing bank's capital are earning from the real economy, which in turn to feed back to the real economy with more expanding loans by means of the capital leverage. This virtuous circle promotes the economy develop steady and rapid.

Toward this end, the commercial banks devote themselves to improve their capital both from the internal channels and external channels. The major internal channels available for commercial banks to replenish their capital are retaining earnings, but they are facing a serious problem of the growth of profits slowing down. Comparatively, the external channels for capital supplement of commercial banks are more immediate and effective, such as stock issuance, preferred stocks, convertible bonds and tier-2 capital bonds.

From the 2003, the State Council injected US$45 billion from the foreign exchange reserves as capital supplement into the Bank of China (BOC) and the China Construction Bank (CCB) in order to make them prepare to list in the stock markets. After that, other stated-own commercial banks, joint-equity commercial banks and city commercial banks are successively reformed so that the CAR reported by more and more Chinese commercial banks are increased to exceed the regulatory threshold at that time. But the regulatory level of CAR is increased year by year. In the year 2011, the CBRC's new standards set the minimum capital adequacy ratio for banks of systematic significance are at 11.5 percent, while those for banks with non-systematic significance at 10.5 percent. After the year 2016, Macro Prudential Assessment (MPA) as a new regulatory framework on commercial banks are launched by PBOC in order to prevent systemic financial risks. According to the MPA framework, the regulator assesses seven aspects of banking financial institutions quarterly, including capital adequacy and leverage, assets and liabilities, liquidity, pricing, asset quality, foreign debt risks and policy implementation. The primary parameters of the MPA framework is capital adequacy.

Along with the increasing market competition and the strengthening of financial supervision, the commercial banks are eager to launch their IPO plans. By the end of 2019, 48 commercial banks have landed in the capital market, including 34 IPOs on the A-share stock market and 14 IPOs on the Hongkong stock market. Furthermore, the primary purpose of IPOs of these commercial banks is to replenish their capital disclosed by their prospectus. As more related policies are being put into play China will have an increasingly sound mechanism to supplement commercial banks capital and the banking industry will have more ability to support the real economy.

Another important reason for commercial banks to replenish capital is that

alleviating the capital pressure of commercial banks is important to ensure a smooth transmission of the monetary policy, thus makes the policy more effective and better serve the real economy. The financial system mainly relies on indirect financing where commercial banks play a major role. After the central bank loosing monetary policy, if commercial banks fail to transfer the liquidity into credit granted to the real economy the monetary policy would not be as effective as desired.

Narmeen, ISaba, Kouser and Khurram (2018) using panel data methodology documented CAR has impact on change in capital and change in loans. Jin, Zhang and Gao (2014) suggested that the central bank should take counter-cyclical capital regulation policy to offset the effect of monetary policy on the excessive risk-taking behavior of banks. But they only concerned about the risk-taking of banks. Ma and Ji (2016) elaborate that the loan-to-deposit ratio, loan limitation and the interest rate regulation are the main factors blocked the monetary policy transmission mechanism. They did not mention the effects of CAR. Liu, Yu, Yang and Zhu (2017) documented that capital adequacy ratios mostly affect the efficiency of small banks credit structure adjustment. Feng and He (2011) using the data of banks from 2003 to 2010 showed that the lending behavior of banks are significantly affected by the public financing of banks and the effectiveness of bank credit channel of monetary policy transmission mechanism is limited. But they didn't tell the differences between big banks and small banks hampered by a lack of enough quantitative data. Moreover, they experimented that the quantitative monetary policy instruments were more sensitive than the price-based ones in their article. But after these years interest rate liberalization reform, I find the opposite result according to the updated data. Besides, there are more other ways for the bank replenishing their capitals such as preferred stocks, which were not discussed in their article.

After modification of Feng and He (2011) model, this paper uses monetary policy proxy variables to analyze that the capital supplement of commercial banks can impair the effectiveness of monetary policy through the credit channel, which is more obviously on small banks. I also compared the two kinds of monetary policy instruments in my results, which document that the price-based monetary policy instruments are more sensitive than the quantitative ones. Then I use the issuance of preferred stocks instead of IPO as dummy variable to do the robust check. The results prove my point of view again. Furthermore, I also compared the results before and after 2016, when the MPA framework is implemented to increase the capital requirement of commercial banks.

The paper is organized as follows. Section 2 describes a theoretic model to experiment how the capital requirement of commercial banks can jam the credit channel of monetary policy transmission, while section 3 shows the data. In section 4 I present the empirical results and the conclusion is in section 5.

2. Theoretical Model

Following the finance literature Kopecky and Hoose (2004), I use a typical bank profit maximization model to examine the impact of deposit reserve as a monetary policy shock on bank credit behavior under the requirements of capital adequacy ratio. Furthermore, I take inter-bank entrusted loans and debts separately analyzed. Because the interbank loans are different with the other loans thus attributed to the shadow banks in China.

According to the commercial bank's balance sheet, the model is given by the following equation:

$$L_S + R + L_C + S = D + E + B \tag{1}$$

R is the bank reserve, which represents the reserves on the commercial bank's balance sheet. If the central bank loose the monetary policy, the reserve requirement is decrease while R will increase. L_C are the loans of the commercial bank. S shows the securities the commercial bank purchased including the treasury bonds and other risk-free securities, whose risk weight is 0%. L_S are the interbank loans, and B is the interbank debts. D is the deposit, and E is the bank's equity. For simplicity, I set the risk weight of all loans to 100%.

As the model of Kopecky and Van Hoose (2004), I assume the reserve interest rate to 0. The deposit interest rate r_D, the loan interest rate r_L and the return of securities r_S are all exogenously given. The return of the capital is r_E. All kinds of the assets on the bank' balance sheet have administrative cost, which are assumed as the quadratic function of the assets, that is, the administrative cost of securities $C_S = \frac{s}{2}S^2$, the capital cost $C_E = \frac{e}{2}E^2$. The quadratic function is easier to be solved than other forms of function. Moreover, it is also consisted with the economics interpretation. That is, the banks not only face more higher funding costs but also more expensive management costs along with the growing scale of loans. The marginal cost of loans is increasing when the loans have reached a certain scale, which is discussed by Dai (2006). For Chinese commercial banks, assets and debts are managed by the same department so that the management factor of loans and inter-bank loans is the same l, while the management factor of interbank debts and deposit is the same d. Accordingly, the costs of loans are $C_{L_S} = \frac{l}{2}{L_S}^2$ and $C_{L_C} = \frac{l}{2}{L_C}^2$, the deposit and inter-bank debts costs are $C_{D=}\frac{d}{2}D^2$ and $C_B = \frac{d}{2}B^2$. Besides, the commercial banks face required reserve constraint, $R \geq \rho(B + D)$, where ρ is the required reserve rate.

For the hypothesis of rational economic man, the commercial bank maximize its profits π,

$$\pi = r_O L_S + r_S S + r_L L_C - r_D D - r_B B - r_E E - \frac{l}{2}{L_S}^2 - \frac{l}{2}{L_C}^2 - \frac{s}{2}S^2 - \frac{d}{2}(B+D)^2 - \frac{e}{2}E^2 \quad (2)$$

$$\text{s. t.} \quad L_S + R + L_C + S = D + E + B \qquad R \geq \rho(D+B) \quad (3)$$

Without the capital constraint requirement, the bank choose L_S, L_C and S to maximize π subject to the reserve requirement constraint and equation (1). From the bank's optimization problem, they are given by

$$L_C{}^* = \frac{1}{\delta l}[esl\frac{1-\rho}{\rho}R + (sl+es+le)r_L - slr_E - ler_S - esr_O]$$
$$L_S{}^* = \frac{1}{\delta l}[esl\frac{1-\rho}{\rho}R + (sl+es+le)r_O - lsr_E - esr_L - elr_S]$$
$$S^* = \frac{1}{\delta}[le\frac{1-\rho}{\rho}R + (2e+l)r_S - er_O - er_L - lr_E]$$
$$E^* = \frac{1}{\delta}[-ls\frac{1-\rho}{\rho}R - (2s+l)r_E + sr_O + sr_L + lr_S]$$
where $\delta = 2es + el + sl$

From these equations I get：

$$\frac{\partial L_C}{\partial R} > 0 \qquad \frac{\partial L_S}{\partial R} > 0 \qquad \frac{\partial S}{\partial R} > 0 \qquad \frac{\partial E}{\partial R} < 0$$

In the absence of capital constraints and keep the other conditions remain unchanged, once the central bank decreases the reserves requirement, the R increases accordingly so that the optimal size of loans is increased as well. That shows the monetary policy transmission mechanism. When R is increased, the banks will reduce their optimal capital scale E. Without capital constraints, commercial banks will constantly reduce their capital adequacy level to meet the goal of maximizing profits, which enables commercial banks to choose many risky loans or securities assets. Finally, the expansionary monetary policy brings a rapid expansion of credit scale.

But in the real economy, the commercial banks not only comply with the reserve constrain, but also face the capital adequacy constrain. According to the CAR rules，the capital adequacy constraint must hold:

$$E \geq \theta(L_S + L_C) \quad (4)$$

I plug the equation (4) into the model, the L_S, L_C, E and S is now:

$$L_C{}^* = \frac{1}{\mu}[s(1-\theta)\frac{1-\rho}{\rho}R - (s\theta^2 - 2\theta s + s + e\theta^2)L_S{}^* + r_L - (1-\theta)r_S - \theta r_E]$$

$$L_S{}^* = \frac{1}{\mu}[s(1-\theta)\frac{1-\rho}{\rho}R - (s\theta^2 - 2\theta s + s + e\theta^2)L_C{}^* + r_O - (1-\theta)r_S - \theta r_E]$$

$$E^* = \frac{1}{\mu}[s\theta(1-\theta)\frac{1-\rho}{\rho}R + r_O\theta + (2\theta - \theta^2)r_S - \theta^2 r_E]$$

$$S^* = \frac{1}{\mu}[(e\theta^2 + l)\frac{1-\rho}{\rho}R + r_S(1-\theta)^2 - r_E\theta(1-\theta) - r_O(1-\theta) - r_L(1-\theta)]$$

where $\mu = l + (1-\theta)^2 s + e\theta^2$

Then I check the results again:

$$\frac{\partial L_C}{\partial R} > 0, \quad \frac{\partial L_S}{\partial R} > 0, \quad \frac{\partial E}{\partial R} > 0, \quad \frac{\partial S}{\partial R} > 0$$

Under the constraint of CAR rules, when the central bank implements an expansionary monetary policy with the expanded supply of reserve R, the optimal loans and securities scale of the bank expands. Furthermore, the optimal capital level of commercial banks increases, which is the opposite of the case without capital adequacy constraints.

Accordingly, the CAR constrain has an impact on the transmission mechanism of monetary policy. When the central bank eases the monetary policy, the commercial banks seek the maximized profits constraining by the CAR rules. As a result, the commercial banks will choose smaller scale of loans than the situations without the CAR constrains. However, once the central bank tightens the money supply, the commercial banks will reduce their capital and loans correspondingly. But to meet the CAR rules, the capital scale of commercial banks can-not be reduced less. Therefore, the scale of loan must be reduced more than the situations without the CAR regulations, which result in a greater credit crunch effect.

I do the comparative static analysis again to explore the indirect effects on the monetary policy by the minimum CAR θ, and I get the results at a certain parameter level:

$$\frac{\partial L_C}{\partial R \partial \theta} < 0 \tag{5}$$

$$\frac{\partial L_S}{\partial R \partial \theta} < 0 \tag{6}$$

The equations (5) and (6) document that once the CAR is increased, the elasticity of commercial banks loans to the monetary policy is decreased, which indicates that the effectiveness of monetary policy will be affected by the capital requirements.

3. Data and sample selection

There are 28 commercial banks listed on the A share market by the end of 2017, which include the five state-owned commercial banks, the joint-equity commercial banks, city commercial banks and rural commercial banks. According to the prospectus, the cashes financing from the IPOs are all used to replenish the capital of commercial banks. Since 2005 all the five Chinese state-owned commercial banks have gone public. For example, China Construction Bank raised 58.05 billion RMB in September 2007, while Bank of China priced its 20 billion RMB IPO in July 2006. Among listed state-owned commercial banks, the ICBC 's capital adequacy ratio increased significantly, from 9.89% before listing to 14.05% after listing, followed by China Communication bank from 10.83% to 14.44%. I summarized these on table 1. All the data comes from Wind database and I use interpolation method to estimate the missing data.

Table 1: The CAR of commercial banks before and after IPO

Name of Bank	Time for IPO	Total amounts of Financing (hundred million RMB)	CAR before Listed (percentage)	CAR after Listed (percentage)
Bank of Beijing	2007-09-19	150.0000	12.7800	20.1100
Changshu Rural Commercial Bank	2016-09-30	9.5133	13.5000	13.2200
Bank of Chengdu	2018-01-31	25.2496	13.6600	14.0800
Industrial and Commercial Bank of China	2006-10-27	466.4400	9.8900	14.0500
China Everbright Bank	2010-08-18	217.0000	10.3900	11.0200
Bank of Guiyang	2016-08-16	42.4500	13.5400	13.7500
Bank of Hangzhou	2016-10-27	37.6658	11.7000	11.8800
Huaxia Bank	2003-09-12	56.0000	8.500	10.3200
China Constuction Bank	2007-09-25	580.5000	12.1100	12.5800
Bank of Jiangsu	2016-08-02	72.3840	11.5400	11.5100
Jiangying Rural Commercial Bank	2016-09-02	9.7183	13.9900	14.1800
China Communication Bank	2007-05-15	252.0377	10.8300	14.4400
China Minsheng Banking Co.,	2000-12-19	41.3000	13.2100	21.4500
Bank of Nanjing	2007-07-12	69.3000	11.7100	30.6700
Bank of Ningbo	2007-07-19	41.4000	11.4800	21.0000
Agricultural Bank of China	2010-07-15	685.2918	10.0700	11.5900
Ping An Bank Co., Ltd	1991-04-03	0.1400	-	-
Shanghai Pudong Development Bank	1999-11-10	40.0000	-	-
Bank of Shanghai	2016-11-16	106.7000	12.6500	13.1700
Suzhou Rural Commercial Bank	2016-11-29	7.6155	13.5800	14.1800
Wuxi Rural Commercial Bank	2016-9-23	8.2611	12.6500	14.1200
Industrial Bank	2007-02-05	159.9598	8.7100	11.7300
Rural Commercial Bank of Zhangjiagang	2017-01-24	7.8992	13.4229	12.9307
Bank of Changsha	2018-09-26	27.3382	11.7400	12.2400
China Merchants Bank	2002-04-09	109.5000	10.2600	12.5700
Bank of Zhengzhou	2018-09-19	27.5400	13.5300	13.1500
Bank of China	2006-07-05	200.0000	10.4200	13.5900
China CITIC Bank	2007-04-27	133.5121	9.4100	15.2700
Ping An Bank and Shanghai Pudong Development bank are listed far earlier than the other banks, so that no data available for the CAR before and after their IPO. But it do not affect our results.				

I collected the characteristic items of commercial banks including the loan scales, assets, equities, CARs and year for IPO from the year 2007 to the year 2017. The period from 2007 to 2017 is almost an economic cycle in China especially in the change of monetary policy. The monetary policy in China remained basically the same from 1998 to 2007, the average annual newly increased bank lending was less than a quarter than that of the year 2009. Because the 2008 global financial crisis, the PBOC implemented the loose monetary policy responding to economic slowdown. Two years later, with the soaring prices of consumer goods, the PBOC returned to a normal monetary state which indicated an end of the moderately loose, essentially ultraloose monetary policy. After that, the monetary policy turn from "prudential" to "appropriately tightened" according to the changing situation of economy. Until the year of 2017, it is indicated a whole monetary policy adjustment cycle. Therefore, I choose the data between the year 2007 and the year 2017.

I obtain the proxy variables of monetary policy from the monetary policy report of PBOC. I separately use deposit reserve ratio, M2 and weighted average interest rate of lending to the non-financial firms as the proxy variables of monetary policy to check out the effects of monetary policy when the CARs of commercial banks are changed.

I follow Feng and He (2011) to use IPO dummy variable to represent the behaviors causing the capital changing of commercial banks. I further introduce the preferred shares issuing of commercial banks as a new dummy variable to replace the IPO dummy in the regression, which shows the more significant and meaningful results. The assets show the scale of commercial banks, while the equity and the CARs present the capital situation of commercial banks. I obtain the data from Wind database and the Almanac of China's Finance and Banking. And I use natural logarithm of bank assets and equities in the regression. Table 3 presents the summary statistics for the characteristics of the commercial banks.

Table 2: summary statistics for the characteristics of commercial banks

	Loan (hundred million RMB)	Asset (hundred million RMB)	Equity (hundred million RMB)	CAR %
Mean	19280.79	33255.43	2190.115	12.44
Std.	1.92	1.90	0.74	2.45
Variance	3.69	3.60	0.54	6.02
Median	5365.08	9777.224	501.8618	12.36
Largest	154199	260870.4	21410.56	30.67
Smallest	113.6504	133.27	-7276.05	3.4
Skewness	-0.015	-0.06	2.48	1.50

4. Empirical evidence

This section presents the empirical results of the effects of capital adequate ratio on the credit channel of monetary policy transmission. In the first section below, I show the empirical model and the hypotheses. Then the GLS regressions show the results. Furthermore, I use the issuance of preferred stocks instead of IPO as the dummy variable to check the results again. Specifically, I compare the results before and after the implement of MPA regulations. The results indicated that the implement of MPA regulations not only affect the lending behaviors of commercial banks directly, but also impact the effectiveness of monetary policy indirectly. It provides further evidences that the credit channel is jammed when the capital of commercial banks is forced to increase.

4.1 The empirical model and hypothesis

This section explores how the changes on capital of the commercial banks affect the credit channel of monetary policy transmission. The model is enlightened by Feng and He (2011), but it is simplified to focus on the effects of the monetary policy causing by the change of the banks' capital. I establish the empirical model as following:

$$\begin{aligned}\Delta \ln(L_{it}) = \alpha &+ \beta_1 \Delta \ln\left(asset_{i,t-1}\right) + \beta_2 \Delta \ln(equity_{i,t-1}) + \beta_3 CAR_{i,t-1} \\ &+ \beta_4 MA_{i,t-1} * CAR_{i,t-1} + \beta_5 \Delta \ln(GDP_{i,t-1}) \\ &+ \beta_6 \Delta \ln(CPI_{i,t-1}) + \beta_7 dummy + \beta_8 dummy * CAR_{i,t-1} + \varepsilon_{it}\end{aligned}$$

$\Delta \ln(L_{it})$ is the explained variable, which presents the amounts change of loans on commercial bank i at the year t. From the credit channel of monetary policy transmission, the amounts of bank loans show the direct effects of monetary policy. Because the explanatory variables have lag influence on the explained variable, I chose the explanatory variables at the year t-1 in my model, including the assets, the equities and the CARs of commercial banks. So do the control variables and the proxy variables of the monetary policy. According to the model, β_3 shows the direct effects of the commercial banks' CAR on the change of bank loans, while β_4

shows the joint effects on the change of bank loans by both the CAR and the monetary policy. According to the equations (5) and (6) in my theoretical model, β_4 is negative.

I have two kinds of dummy variables. The first one is the IPO, which is similar as Feng and He (2011)'s model. And the other one is the issuance of preferred stocks of the commercial banks, which is more sensitive than the IPO dummy. At last, I compared the effects before and after the year 2016 to check out how the MPA regulations affect the bank loans and the transmission of monetary policy. It is further improved that the credit channel of monetary policy transmission is jammed by the increased capital supplement regulation. I describe the variables of the model in the table 3.

Table 3: Description of the Variables

Dependent variable	The effect of monetary policy on commercial banks through the credit channel	The change of loans yearly
Independent variable	The proxy variables of monetary policy (MA)	Deposit reserve ratio (RR)
		M2
		Weighted average interest rate of lending to the non-financial firms (LR)
	Characteristic items of commercial banks	Asset
		Equity
		Capital adequacy ratio (CAR)
Dummy variables	The behavior leading to the change of banks' capital	IPO
		Preferred shares issue
Control variables	The proxy variables of real economy	GDP
		CPI

Based on the empirical model above, I provided two hypotheses below:

H1a: The credit channel of monetary policy transmission is jammed by the capital requirement of commercial banks. That is, when the central bank loose the monetary policy, the commercial banks will not increase the same magnitude of their lending because of the CAR requirements. And when the central bank tightens the monetary policy, the commercial banks will decrease more lending than the central bank' s demand to meet the CAR requirements. The joint effects of CAR and monetary policy on the commercial banks' lending is negative, which is consist with the equation (5) and (6) in the theoretical model of section 2.

H1b: The CAR constrains affect more on the smaller banks than the big ones.
H1c: Because of the capital requirements, the MPA regulations not only play important roles in affecting the bank loans directly, but also jam the credit channel of monetary policy transmission.

H2: The price-based monetary policy proxy variable LR makes more sense than the quantitative ones including deposit reserve ratio and M2. That means the price-based monetary policy instruments play more important role than ever before.

4.2 Main results

I obtain panel data of 28 commercial banks from 2007 to 2017, which include all the listed banks on the A-share stock markets by the year 2018. The IPO dummy is used in the model below:

$$\begin{aligned}\Delta \ln(L_{it}) = \alpha &+ \beta_1 \Delta \ln\left(asset_{i,t-1}\right) + \beta_2 \Delta \ln(equity_{i,t-1}) + \beta_3 CAR_{i,t-1} \\ &+ \beta_4 MA_{i,t-1} * CAR_{i,t-1} + \beta_5 \Delta \ln(GDP_{i,t-1}) \\ &+ \beta_6 \Delta \ln(CPI_{i,t-1}) + \beta_7 IPO + \beta_8 IPO * CAR_{i,t-1} + \varepsilon_{it}\end{aligned}$$

I use the three monetary policy proxy variables including the deposit reserve ratio (RR), M2 and the weighted average interest rate of lending to the non-financial firms (LR) to do the regressions. The FGLS estimation results present that the joint effect of the banks CAR and the monetary policy on the bank loans is -0.002 by using the LR as the proxy variable of monetary policy. And the coefficient estimate reported in the column 4 of table 4. The results support to the H1a. Moreover, the β_4 by using the other two proxy variables are -0.0003 and -0.00003 respectively, which are also both significant. But the results of LR are more obvious than using the other two, which support that the price-based monetary policy tools play more important role than ever before. The result consists with H2. And the other results of the regressions reported on the appendix A. β_4 is negative, which also consists with the results of the theoretical model I proved in the section 2. The elasticity of the loans of commercial banks to the monetary policy decreases when their CAR increase. However, according to the FGLS results, the effects of IPO on the bank loans is not significant. And this is because the commercial banks once launch their IPO plans, they will face tighter regulations. Although their capital is replenished, they tend to be more cautious about the risk of their lending. As a result, the commercial banks may not expand their loan amount, but decrease their lending in the year of their IPO. The two opposite effects offset each other so that the effect on banks loans of IPO is not significant, which is different with Feng and He (2011) article.

Table 4: Cross-sectional time-series FGLS regression using IR as the proxy variable of monetary policy of all the banks

Y	Coef.	St.Err.	t-value	p-value	95% Conf	Interval	Sig
β_1	0.089	0.031	2.85	0.004	0.028	0.150	***
β_2	0.020	0.004	5.10	0.000	0.012	0.028	***
β_3	0.013	0.002	5.28	0.000	0.008	0.018	***
β_4	-0.002	0.000	-5.39	0.000	-0.002	-0.001	***
β_5	0.969	0.102	9.48	0.000	0.769	1.170	***
β_6	-0.799	0.124	-6.42	0.000	-1.042	-0.555	***
β_7	-0.005	0.021	-0.23	0.815	-0.046	0.036	
β_8	0.001	0.002	0.65	0.514	-0.002	0.004	
Constant	-0.008	0.024	-0.35	0.728	-0.055	0.039	
*** p<0.01, ** p<0.05, * p<0.1							

I divide the sample into two groups. One group is consisted of the five state-owned commercial banks. The other include the joint-equity commercial banks, city commercial banks and rural commercial banks. It is generally known that the five state-owned commercial banks' credit activities are different with the other commercial banks. The regression result of big banks group reported in the column 4 of the table 5, and the coefficient estimate is negative either, which is consist with the results of the theoretical model and H1a. For the other banks, the coefficient estimate of the joint effects of CAR and monetary policy on the bank loans is negative ang significant, which reported in the column 4 of table 6. Compared the β_4 of the two groups, I find that the CAR's effect through credit channel of monetary policy transmission on the bank loans is far less in the big bank group than the other bank group. The results consist with H1b, which show the CAR constrains affect more on the smaller banks than the big ones. Because the small banks are more likely lack of capital than the big banks, they are more susceptible to the CAR constrains. As a result, the magnitude of jammed effects on the credit channel of monetary policy transmission is bigger than the big banks.

Table 5: Cross-sectional time-series FGLS regression in the big bank group

Y	Coef.	St.Err.	t-value	p-value	95% Conf	Interval	Sig
β_1	0.332	0.149	2.23	0.026	0.040	0.624	**
β_2	0.014	0.003	4.66	0.000	0.008	0.020	***
β_3	0.029	0.012	2.41	0.016	0.005	0.052	**
β_4	-0.00004	0.000	-2.39	0.017	0.000	0.000	**
β_5	0.338	0.207	1.63	0.103	-0.068	0.744	
β_6	-0.447	0.282	-1.58	0.113	-1.000	0.106	
β_7	0.183	0.132	1.38	0.168	-0.077	0.442	
β_8	-0.019	0.014	-1.38	0.168	-0.046	0.008	
Constant	-0.217	0.105	-2.07	0.038	-0.422	-0.012	**
*** p<0.01, ** p<0.05, * p<0.1							

Table 6: Cross-sectional time-series FGLS regression in the small bank group

Y	Coef.	St.Err.	t-value	p-value	95% Conf	Interval	Sig
β_1	0.028	0.031	0.88	0.377	-0.034	0.089	
β_2	-0.019	0.008	-2.43	0.015	-0.034	-0.004	**
β_3	0.014	0.003	5.44	0.000	0.009	0.019	***
β_4	-0.002	0.000	-5.79	0.000	-0.002	-0.001	***
β_5	1.130	0.109	10.39	0.000	0.917	1.343	***
β_6	-0.798	0.132	-6.05	0.000	-1.056	-0.539	***
β_7	-0.034	0.023	-1.46	0.144	-0.079	0.012	
β_8	0.004	0.002	2.08	0.037	0.000	0.007	**
Constant	0.003	0.025	0.12	0.909	-0.046	0.052	
*** p<0.01, ** p<0.05, * p<0.1							

4.3 Preferred stocks issue as the dummy variable

In this section I use the issuance of preferred stocks as the dummy variable instead of the IPO dummy. The model is as follows:

$$\ln(L_{it}) = \alpha + \beta_1 \Delta \ln(asset_{i,t-1}) + \beta_2 \Delta \ln(equity_{i,t-1}) + \beta_3 CAR_{i,t-1} + \beta_4 MA_{i,t-1} * CAR_{i,t-1} + \beta_5 \Delta \ln(GDP_{i,t-1}) + \beta_6 \Delta \ln(CPI_{i,t-1}) + \beta_7 PFD + \beta_8 PFD * CAR_{i,t-1} + \varepsilon_{it}$$

The regression result of the joint effects of CAR and monetary policy is negative, which is reported in the column 4 of table 7. Then I also get the regression results of the big group banks and the smaller ones. The coefficient estimate of joint effects of CAR and monetary policy on the bank loans of big bank group is -0.001, while that for the small bank group is -0.002. Therefore, the jammed effect on the credit channel of monetary policy transmission is more serious for small banks than the big ones. The results of sub-sample regressions are in the appendix B. It is worth

mentioned that coefficient estimate of the issuance of preferred stocks on the bank loans is positive and significant, which reported in the column 7 of the table7. But the CAR constrains reduce the effects so that the joint effects of both preferred stocks issue and CAR on the bank loans is negative, which reported in the column 8 of the table 7.

Table 7: Cross-sectional time-series FGLS regression of all the banks

Y	Coef.	St.Err.	t-value	p-value	95% Conf	Interval	Sig
β_1	0.079	0.031	2.52	0.012	0.018	0.141	**
β_2	0.020	0.004	5.30	0.000	0.013	0.028	***
β_3	0.015	0.002	6.46	0.000	0.011	0.020	***
β_4	-0.002	0.000	-5.88	0.000	-0.002	-0.001	***
β_5	0.939	0.101	9.27	0.000	0.740	1.137	***
β_6	-0.733	0.127	-5.78	0.000	-0.982	-0.485	***
β_7	0.272	0.086	3.17	0.002	0.104	0.440	***
β_8	-0.023	0.007	-3.34	0.001	-0.036	-0.009	***
Constant	-0.011	0.021	-0.53	0.595	-0.052	0.030	
*** p<0.01, ** p<0.05, * p<0.1							

4.4 After the implements of the MPA framework

This section explores how the MPA framework of the commercial banks affect the effective of monetary policy. The β_4 in table 8 is negative and significant as before, which proves the CAR constrains affect the bank loans through the credit channel of monetary policy again. Because the most important item of the MPA framework is the capital requirement, the commercial banks face more rigorous regulations on their capital after the year 2016. As a result, the joint effect of CAR and the monetary policy on the bank loans is negative and significant, which is consist with H1c. That is, when the central bank loose the money supply, the commercial banks may not increase their lending to the same extent because of the capital requirements. And when the central bank tightens the monetary policy, the credit of commercial bank will be much tighter. At last, the effective of monetary policy is affected, especially in the small banks. That is reported in the coefficient estimate in the column 4 of table 10.

Furthermore, the capital of the five state-owned commercial banks are more adequate than the other banks so that the effects on their lending by the implement MPA framework is not very significant. But for smaller banks, the coefficient estimate is significant and negative, which is reported in the column 8 of table 10.

Table 8: Cross-sectional time-series FGLS regression of implement of MPA regulation in all banks

Y	Coef.	St.Err.	t-value	p-value	95% Conf	Interval	Sig
β_1	0.073	0.031	2.34	0.019	0.012	0.133	**
β_2	0.020	0.004	5.26	0.000	0.013	0.027	***
β_3	0.019	0.003	6.59	0.000	0.014	0.025	***
β_4	-0.002	0.000	-6.01	0.000	-0.003	-0.002	***
β_5	0.966	0.104	9.26	0.000	0.761	1.170	***
β_6	-0.686	0.142	-4.84	0.000	-0.964	-0.408	***
β_7	0.244	0.057	4.30	0.000	0.133	0.355	***
β_8	-0.021	0.004	-4.77	0.000	-0.029	-0.012	***
Constant	-0.016	0.021	-0.76	0.447	-0.058	0.026	
*** p<0.01, ** p<0.05, * p<0.1							

Table 9: Cross-sectional time-series FGLS regression in the big bank group

Y	Coef.	St.Err.	t-value	p-value	95% Conf	Interval	Sig
β_1	0.386	0.139	2.78	0.006	0.113	0.659	***
β_2	0.016	0.003	4.98	0.000	0.010	0.022	***
β_3	0.023	0.005	4.88	0.000	0.014	0.032	***
β_4	-0.001	0.000	-2.95	0.003	-0.002	0.000	***
β_5	1.041	0.192	5.43	0.000	0.665	1.416	***
β_6	-1.040	0.269	-3.86	0.000	-1.568	-0.512	***
β_7	0.294	0.201	1.46	0.144	-0.100	0.688	
β_8	-0.023	0.014	-1.69	0.091	-0.050	0.004	*
Constant	-0.232	0.051	-4.56	0.000	-0.331	-0.132	***
*** p<0.01, ** p<0.05, * p<0.1							

Table 10: Cross-sectional time-series FGLS regression in the small bank group

Y	Coef.	St.Err.	t-value	p-value	95% Conf	Interval	Sig
β_1	0.009	0.031	0.30	0.766	-0.052	0.070	
β_2	-0.018	0.008	-2.30	0.022	-0.033	-0.003	**
β_3	0.021	0.003	6.99	0.000	0.015	0.027	***
β_4	-0.003	0.000	-6.10	0.000	-0.003	-0.002	***
β_5	1.114	0.116	9.62	0.000	0.887	1.341	***
β_6	-0.648	0.150	-4.33	0.000	-0.941	-0.354	***
β_7	0.135	0.072	1.87	0.061	-0.006	0.276	*
β_8	-0.013	0.006	-2.24	0.025	-0.024	-0.002	**
Constant	-0.009	0.022	-0.40	0.690	-0.051	0.034	
*** p<0.01, ** p<0.05, * p<0.1							

5. Conclusion

This paper examines weather the capital requirements affect the effectiveness of monetary policy from the credit channel. Using information about the commercial banks' IPO and issuance of preferred stocks as the methods for replenishing the banks' capital, I pose two hypotheses: the credit channel of monetary policy transmission is jammed by the capital requirement of commercial banks, which especially in the small banks; the price-based monetary policy tools play more important role in the credit channel of monetary policy transmission than ever before.

According to the theoretic demonstration and the empirical results above, I find that the IPO and the issuance of preferred stocks could improve the commercial banks' capitals, which expand the commercial banks' lending. But the capital requirements to the commercial banks will affect the credit channel of monetary policy transmission. That is, the capital requirements will weaken the effectiveness of expansionary monetary policy through the credit channel. When the central bank implements expansionary monetary policy by decreasing the deposit reserve or reducing the interest rates, the commercial banks constrained by the capital requirements will not expand their lending accordingly. And it will reduce the effectiveness of the expansionary monetary policy. On the contrary, when the central bank tightens the monetary supply, the commercial banks limited by their capital situation will cut more lending than the regulator's requirement. The lower of the commercial banks' CAR, the more lending they will cut. Overall, the credit channel of monetary policy transmission is jammed by the capital requirement of commercial banks in the real economy. So that the regulator should consider these factors when they make policy. Moreover, the evidence supports that the price-based monetary policy tools instead of the quantitative ones are playing more important roles in the credit channel of monetary policy transmission, which is consist with the Chinese monetary policy practice in the recent years.

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Appendix A

The regressions using RR and M2 as proxy variable of monetary policy

The FGLS estimation results present that the joint effect of the banks CAR and the monetary policy on the bank loans is -0.0003 by using the RR as the proxy variable of monetary policy. The coefficient estimate reported in the column 4 of appendix table 1. And the FGLS estimation results present that the joint effect of the banks CAR and the monetary policy on the bank loans is -0.00003 by using the M2 as the proxy variable of monetary policy. The coefficient estimate reported in the column 4 of appendix table 2. Both of the coefficient estimates are negative and significant.

Appendix Table 1: Cross-sectional time-series FGLS regression using RR as the proxy variable of monetary policy

Y	Coef.	St.Err.	t-value	p-value	95% Conf	Interval	Sig
β_1	0.120	0.032	3.74	0.000	0.057	0.183	***
β_2	0.021	0.004	5.79	0.000	0.014	0.028	***
β_3	0.008	0.002	3.13	0.002	0.003	0.013	***
β_4	-0.0003	0.000	-2.81	0.005	-0.001	0.000	***
β_5	0.594	0.101	5.88	0.000	0.396	0.793	***
β_6	-0.705	0.132	-5.34	0.000	-0.964	-0.446	***
β_7	0.007	0.021	0.31	0.756	-0.035	0.048	
β_8	0.000	0.002	-0.14	0.887	-0.003	0.003	
Constant	0.035	0.024	1.45	0.146	-0.012	0.083	
*** p<0.01, ** p<0.05, * p<0.1							

Appendix Table 2: Cross-sectional time-series FGLS regression using M2 as the proxy variable of monetary policy

Y	Coef.	St.Err.	t-value	p-value	95% Conf	Interval	Sig
β_1	0.083	0.034	2.44	0.015	0.016	0.149	**
β_2	0.021	0.004	5.68	0.000	0.014	0.028	***
β_3	0.004	0.002	2.37	0.018	0.001	0.008	**
β_4	-0.00003	0.000	-2.45	0.014	0.000	0.000	**
β_5	0.439	0.142	3.09	0.002	0.160	0.718	***
β_6	-0.540	0.160	-3.38	0.001	-0.854	-0.227	***
β_7	0.004	0.023	0.17	0.864	-0.041	0.049	
β_8	0.000	0.002	0.20	0.838	-0.003	0.004	
Constant	0.065	0.030	2.19	0.029	0.007	0.123	**
*** p<0.01, ** p<0.05, * p<0.1							

Appendix B

The regressions using the issuance of preferred stocks as dummy variable in the subsamples

The coefficient estimate of joint effects of CAR and monetary policy on the bank loans of big bank group is -0.001, which shows in the column 4 of appendix table 3. And the coefficient estimate for the small bank group is -0.002, which shows in the column 4 of appendix table 4. The coefficient estimates are all negative and significant. But the magnitude of the jammed effect for small banks are bigger than the small bank group because the absolute value of -0.002 is more than that of -0.001.

Appendix Table 3: Cross-sectional time-series FGLS regression of big bank group

Y	Coef.	St.Err.	t-value	p-value	95% Conf	Interval	Sig
β_1	0.435	0.141	3.09	0.002	0.159	0.712	***
β_2	0.016	0.003	5.08	0.000	0.010	0.022	***
β_3	0.017	0.005	3.87	0.000	0.009	0.026	***
β_4	-0.001	0.000	-1.80	0.072	-0.002	0.000	*
β_5	0.833	0.191	4.36	0.000	0.458	1.208	***
β_6	-0.899	0.276	-3.26	0.001	-1.439	-0.359	***
β_7	0.238	0.135	1.76	0.078	-0.026	0.502	*
β_8	-0.018	0.010	-1.85	0.065	-0.037	0.001	*
Constant	-0.184	0.050	-3.68	0.000	-0.282	-0.086	***
*** p<0.01, ** p<0.05, * p<0.1							

Appendix Table 4: Cross-sectional time-series FGLS regression of small bank group

Y	Coef.	St.Err.	t-value	p-value	95% Conf	Interval	Sig
β_1	0.026	0.032	0.82	0.411	-0.036	0.089	
β_2	-0.019	0.008	-2.46	0.014	-0.034	-0.004	**
β_3	0.017	0.002	6.91	0.000	0.012	0.022	***
β_4	-0.002	0.000	-5.68	0.000	-0.003	-0.001	***
β_5	1.105	0.111	9.92	0.000	0.886	1.323	***
β_6	-0.719	0.135	-5.33	0.000	-0.983	-0.454	***
β_7	-0.025	0.167	-0.15	0.881	-0.351	0.301	
β_8	0.001	0.014	0.10	0.917	-0.026	0.029	
Constant	-0.013	0.020	-0.66	0.510	-0.053	0.026	
*** p<0.01, ** p<0.05, * p<0.1							