Proceedings of the 2nd International Conference on Financial Technology and Business Analysis
DOI: 10.54254/2754-1169/97/20230564

Monetary Policy, Capital Regulation and Systemic Risk in Commercial Banks: Evidence from in China

Kaiyue Zhou[1,a,*]

[1]*Management School, University of Sheffield, Sheffield, S10 1FL, England*
a. kzhou19@sheffield.ac.uk
**corresponding author*

Abstract: This paper examines the impact of monetary policy and capital regulation on commercial banks' systemic risk using a fixed panel model with data from 16 listed commercial banks in China from Q1 2011 to Q4 2019. The results show that both quantity-based monetary policy instruments, represented by currency issuance, and price-based monetary policy instruments, represented by interest rates, affect systemic risk. And they both show that accommodative monetary policies amplify commercial banks systemic risk. Besides, capital regulation has a dampening effect on systemic risk, and the intensity of regulation moves inversely with systemic risk. In addition, there is a synergistic effect between monetary policy and capital regulation. Furthermore, a symbiotic relationship exists between monetary policy and capital regulation. The findings of this study assist nations in managing systemic financial risks through macroeconomic policies.

Keywords: Monetary Policy, Capital Regulation, Systemic Risk, Bank

1. Introduction

Since the outbreak of the Covid-19 epidemic, different measures to deal with the crisis caused the misalignment of the economic cycle between China and the U.S. In 2020, China was ahead of the U.S. out of the stagflation caused by the epidemic, and the country also introduced the corresponding loose monetary policy to guide the recovery of the economy. However, the loose monetary policy has also inevitably brought about problems such as credit contraction and debt defaults of some enterprises. In order to cope with the increasingly complex global economic situation, the 20th National Congress of the Communist Party of China (CPC) has called for the strengthening of the financial stability guarantee system and the holding of the bottom line of not incurring systemic risks, which once again points out that the prevention of systemic financial risks has become one of the goals of macro-control of all countries. Therefore, as the main body of the financial system, controlling the systemic risk of banks has become the key task of risk control.

2. Literature Review and Hypothesis

Early research on bank risk focused on the perspective of risk-taking of individual banks. Borio and Zhu [1] pointed out that when traditional scholars studied institutional risk-taking, they ignored the response and bearing capacity of economic entities under macro-monetary policies. In fact, the policy represented by the interest rate can greatly affect the risk-bearing capacity, which leads to the lack of

DOI: 10.54254/2754-1169/97/20230564

stability in the entire system. Along with the emergence of Black-Swan Events such as the financial crisis, the Covid-19 epidemic, and the Russia-Ukraine conflict, scholars began to pay attention to the phenomenon of inter-institutional risk contagion, i.e., systemic risk. Kaufman [2] regarded systemic risk as the probability of a chain of defaults in financial institutions triggered by a certain event (e.g., credit default). Reasons that trigger the emergence of this phenomenon include correlated movements in asset prices and investment expectations caused by macroeconomic cycles [3], contagion of real losses due to similarities in banking operations [4], and contagion of information led by investor sentiment.

Monetary policy is considered an important instrument of macro policy to control financial markets because the level of interest rate is highly related to the level of systemic risk. For example, an overly optimistic bank risk appetite brought about by a low-interest rate environment not only affected the insolvency risk borne by individual banks [5], but also contributed to the spreading and diffusion of systemic risk [6]. The ultra-loose monetary policies that countries would adopt, including after a crisis, actually somewhat foreshadowed the next crisis [7]. In addition to risk appetite changes due to the interest rates, Delis and Kouretas [8] pointed out that the action of bank staff was highly related to their salary incentive plan. And the increased competition across the banking sector due to falling interest rates will stimulate banks to be forced to look at assets that are not less risky. In summary, this paper proposes hypothesis 1.

Hypothesis 1: Whether regulated by quantitative or price-based tools, loose monetary policy will increase the level of systemic risk of commercial banks.

The main core of the CBRC's bank supervision is the assurance of bank solvency, which covers a series of regulatory systems, including the market access system and the capital regulatory system. The capital regulation system is designed to enable banks to maintain a minimum level of capital holdings, which means that in the event that a bank faces an operational crisis, it can guarantee its level of solvency and prevent bankruptcy surprises from occurring, thus ensuring that the entire financial system operates in an orderly manner [9]. The study by Laeven and Levine [10] also showed that capital adequacy ratios, which represent the level of capital regulation, reduce the probability of the occurrence of systemic risk in banks. In this paper, it is argued that a higher capital adequacy ratio suppresses the level of risk of individual banks and thus achieves risk control of the whole system. Accordingly, this paper proposes hypothesis 2:

Hypothesis 2: Strict level of capital regulation reduces the level of systemic risk in commercial banks.

The academic community is inconclusive about whether there is a synergistic effect between the level of capital regulation and monetary policy. Aikman et al. [11] constructed a model to explore the possible overlapping effects of both monetary policy and macroprudential policy represented by capital regulation. It simulated the synergistic effects between policies under external shocks as well as under different parameter settings, and the results showed that the level of capital regulation and monetary policy varies under different scenarios. Suh [12] pointed out that the difference between the two is that monetary policy needs to take into account the decisions of lenders and depositors at the same time, so it is not as effective as regulatory policy, which takes into account the decisions of lenders. And China is a country with strong regulatory efforts in the financial sector, centralized regulation decentralization as well as rapid implementation, so regulation should be effective. If the economy is not suitable for the over-expansion of monetary policy, then loose capital regulation can be used to achieve the ultimate goal of stimulating the economy. Apergis et al. [13] researched 593 banks, and it showed that macro-prudential and regulatory policies would reduce the systemic risk of commercial banks. So this paper proposes hypothesis 3.

Hypothesis 3: The synergistic effect of the level of capital regulation and monetary policy will further reduce the level of systemic risk in banks.

DOI: 10.54254/2754-1169/97/20230564

3. Methodology and Data

3.1. Measurement of Systemic Risk

Value at Risk is widely used in risk management. It measures the maximum possible loss of an individual asset at a certain time in the future at a certain confidence level, calculated by the following formula:

$$P_r\left(r_i \le VaR_q^i\right) = q \tag{1}$$

However, since this indicator ignores the existence of risk correlations between institutions, Adrian and Brunnermeier [4] propose the ΔCoVaR indicator. This indicator uses the tail covariance so that it can measure, with a certain probability, the maximum loss that one financial institution could experience in the event of a crisis in another institution or in the market as a whole.

$$P_r\left(X^j \le CoVaR_q^{j|i} \middle| r_i \le VaR_q^i\right) = q \tag{2}$$

The 50 percent quartile level is generally defined as the level of business as usual. If j denotes the financial system, then the degree to which the institution i contributes to the overall risk of the financial system is:

$$\Delta CoVaR_q^{j|i} = CoVaR_q^{j|i} - CoVaR_{50\%}^{j|i} \tag{3}$$

3.2. Systemic Risk of Chinese Commercial Banks

As of December 31, 2021, there are 41 listed banks in China, of which the top ten banks with the largest market capitalization account for more than 80% of all listed banks. Among them, the data selected in this paper starts from January 2011 because the Agricultural Bank of China and Everbright Bank were both listed in 2010, and their market capitalization occupies an important proportion in the banking industry. The final selection of banks is city commercial banks (Bank of Beijing, Bank of Nanjing, Bank of Ningbo), joint-stock commercial banks (Huaxia Bank, Ping An Bank, China Everbright Bank, China Minsheng Bank, Pudong Development Bank, *Industrial Bank*, China Merchants Bank, CITIC Bank), and state-owned commercial banks (Bank of Communications, Industrial and Commercial Bank of China, Bank of China, Agricultural Bank of China, and China Construction Bank). The data source is the wind database, and △CoVaR is calculated using Stata 16.0.

4. Discussion

4.1. Design

The data of quarterly financial information of banks are obtained from the wind database and quarterly financial statements of the bank. The regression analysis is also conducted using Stata16.0. Since the highest statistical frequency of financial data is quarterly, the model is constructed by transforming the systematic risk calculated based on daily stock price data to quarterly frequency. The selection of variables is shown in table 1 below.

DOI: 10.54254/2754-1169/97/20230564

Table 1: Selection of variables

Research variables	variable name	Variable Meaning	Variable Definition
Dependent variable	△CoVaR	Systemic Risk	Quarterly average of individual bank systemic risk contribution
Independent variables	M2	M2 Year-on-year	Broad money growth rate
	RP	Interbank Offered Rate (IBOR)	Quarterly average of daily interbank lending rates
Control variables	CAP	Core Capital Adequacy Ratio	Core capital/total weighted risk assets
	NI	Percentage of Non-interest Income	Non-interest income/total operating income
	CI	Cost-to-income Ratio	Operating expenses/total bank operating income
	NPL	Non-performing Loan Ratio	Non-performing loans/total bank loans
	IM	Net Interest Margin (NIM)	Net interest income/interest-earning assets
	PC	Provision Coverage Ratio	Actual provision for loan losses/non-performing loans
	DL	Loan-to-deposit Ratio	Total bank loans/total bank borrowings

Based on the previous assumptions and variable selection, the following model is constructed:

$$\Delta\mathrm{CoVaR}_{i,t} = \beta_0 + \beta_1 \mathrm{M2} + \beta_2\ \mathrm{Control}_{i,t} + \mu_i + \gamma_t + \varepsilon_{i,t} \quad (4)$$

$$\Delta\mathrm{CoVaR}_{i,t} = \beta_0 + \beta_1 \mathrm{RP} + \beta_2\ \mathrm{Control}_{i,t} + \mu_i + \gamma_t + \varepsilon_{i,t} \quad (5)$$

$$\Delta\mathrm{CoVaR}_{i,t} = \beta_0 + \beta_1 CAP + \beta_2\ \mathrm{Control}_{i,t} + \mu_i + \gamma_t + \varepsilon_{i,t} \quad (6)$$

$$\Delta\mathrm{CoVaR}_{i,t} = \beta_0 + \beta_1 \mathrm{M2} + \beta_2 \mathrm{CAP} + \beta_3 \mathrm{M2} * \mathrm{CAP} + \beta_4 \mathrm{Control}_{i,t} + \mu_i + \gamma_t + \varepsilon_{i,t} \quad (7)$$

$$\Delta\mathrm{CoVaR}_{i,t} = \beta_0 + \beta_1 \mathrm{RP} + \beta_2 \mathrm{CAP} + \beta_3 \mathrm{RP} * \mathrm{CAP} + \beta_4 \mathrm{Control}_{i,t} + \mu_i + \gamma_t + \varepsilon_{i,t} \quad (8)$$

The core explanatory variable of the model (1) is the monetary policy, which contains the price-based monetary policy instrument RP (interbank lending rate) and the quantity-based monetary policy instrument M2 (M2 year-on-year). The core variable in the model (2) is CAP (Core Capital Adequacy Ratio). Control variables, i.e. bank-level control variables, include NI (Non-Interest Income Ratio), CI (Cost to Income Ratio), NPL (Non-Performing Loan Ratio), IM (Net Interest Margin) , PC (Provision Coverage Ratio), and DL (Loan to Deposit Ratio). Model (3) adds the cross-multiplier terms of monetary policy instruments and capital regulation as the explanatory variables.

4.2. Results

As shown in Table 2, the empirical results of models (1) and (2) represent the impact of monetary policy instruments on the level of systemic risk among commercial banks. The empirical results of model (3) represent the effect of capital regulation on the level of systemic risk among commercial banks.

DOI: 10.54254/2754-1169/97/20230564

Table 2: Regression analysis table (1)

VARIABLES	(1)△CoVaR	(2)△CoVaR	(3)△CoVaR
M2	0.0209***		
	-0.0034		
RP		-0.0289***	
		-0.0109	
CAP			-0.0099*
			-0.0058
NI	-0.0017	-0.0025*	-0.0035***
	-0.0011	-0.0011	-0.00105
CI	-0.0011	0.0009	-0.0001
	-0.0018	-0.0019	-0.0019
NPL	0.1204***	0.0256	0.0700***
	-0.0340	-0.0345	-0.0257
IM	-0.0198	0.0127	-0.0020
	-0.0216	-0.0213	-0.0048
PC	0.0001	-0.0002	0.0000
	-0.0001	-0.0001	0.0000
DL	0.0001	-0.0022***	-0.0006*
	-0.0009	-0.0009	-0.0004
Constant	-0.1099	0.4568***	-0.095
Observations	576	576	576
Number of id	16	16	16

Note: *, **, *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively

The results show that the money supply growth rate M2 is significantly and positively correlated with the systemic risk of commercial banks at the 1% level, which is consistent with the hypothesis of the previous theoretical analysis. That is, under the loose monetary policy, the higher the money supply, the higher the asset valuation will produce a certain bubble, while the credit relationship between banks and investors grows unhealthily, which leads to the increase of commercial bank systemic risk. For another monetary policy tool, the interbank lending rate is also significantly negatively correlated with commercial bank systemic risk, also in line with the previous hypothesis at 1% level. The same suggests that the looser the monetary policy, the lower the interbank lending rate, and the more the banking sector will increase its reliance on the rest of the funds in the market and, at the same time, increase the proportion of risky asset holdings, which leads to an increase in the systemic risk of interbank. Faia and Karau [14] point out that the interbank lending rate can be an effective representation of the outcome of the transactions between the banking sector in the market, and therefore, it has a significant negative impact on the systemic risk of commercial banks, as compared to the other price-based monetary instruments (e.g., lending rates).

The proxy variable for capital regulation, core capital adequacy, shows a negative relationship with commercial bank systemic risk at the 10% level. The higher capital adequacy ratio indicates the higher degree of capital regulation, and since China has increased the penalty for capital regulation since 2008, the shareholders of banks will be hesitant to make decisions, thus reducing the systemic risk of the banking industry. However, once the banking industry has a higher capital adequacy ratio, the risk tolerance capacity increases, the opportunity cost increases, and will hold similar investment portfolios, which inadvertently increases the systemic risk. The empirical results of this paper show

DOI: 10.54254/2754-1169/97/20230564

that the reduction of banking sector risk due to regulatory efforts is stronger than the enhancement of banking sector risk induced by opportunity cost.

Table 3: Regression analysis table (2)

VARIABLES	(4)△CoVaR	(5)△CoVaR
M2	0.0501***	
	-0.0135	
RP		0.2435***
		-0.0760
M2*CAP	-0.0026**	
	-0.0012	
RP*CAP		-0.0272***
		-0.0075
NI	-0.0006	-0.0016
	-0.0013	-0.0012
CI	-0.0002	0.0006
	-0.0020	-0.0019
NPL	0.1422***	0.0341
	-0.0369	-0.0356
IM	0.0082	0.0289
	-0.0232	-0.0220
PC	0.0002	-0.00024*
	-0.0001	-0.0001
DL	0.0006	-0.0021**
	-0.0010	-0.0009
Constant	-0.1069	-0.0855
Observations	576	576
Number of ID	16	16

Adding the cross-multiplier terms of capital regulation and monetary policy, as shown in the results of the regression analysis table 3, the result implies that the sign of the cross-multiplier term is negative, which indicates that the relationship between capital regulation and monetary policy is not a substitute but has some complementarity in the same period. If monetary policy is used alone, loose monetary policy can effectively alleviate the economic downturn, expand the scale of credit operations, and increase the investment behavior in the entire economic environment, making a capital run in the economy. However, an excessively loose monetary policy can easily cause banks to lose control of credit risks and blindly expand, resulting in an increase in the non-performing loan ratio. At this time, by setting the capital adequacy ratio, certain restrictions can be imposed on banks to prevent the occurrence of the above unfavorable situation, thus promoting the stable development of the industry. This also confirms the feasibility of the two-pillar policy of macroprudential policy and monetary policy formulated by China.

5. Conclusion

Using fixed effects, this paper describes and analyzes the systemic risk of listed commercial banks in China from 2009 to 2019, and examines the impact of quantitative and price-based monetary policy instruments and capital regulation on the systemic risk of commercial banks, and the interaction of

DOI: 10.54254/2754-1169/97/20230564

monetary policy and capital regulation on the systemic risk of listed banks. The main findings show that both quantitative and price-based monetary policy instruments affect the systemic risk of commercial banks, and loose monetary policy increases the level of such risk. The increase of capital regulation can effectively reduce the occurrence of systemic risk level.

China is still using the two traditional quantitative monetary policy tools of money supply and interest rates and price-based monetary policy tools as the main tools for macro-control of the financial market. Although loose monetary policy can promote investment, stimulate the economy and alleviate the pressure brought about by the downturn of the economy, the systemic risk of the banks will also rise significantly. Countries can consider transitioning from quantity-based to price-based monetary policy tools, which can reduce the amplifying effect of loose monetary policy on banking risks. In addition, through the exploration of innovative monetary policy tools, as far as possible in order to achieve the stimulation of economic development under the premise of mitigating the trend of banking, systemic risk will also rise significantly, so as to achieve the efficient state of monetary policy.

Although this paper investigates the impact of monetary policy tools, capital regulation, and the cross terms of the two on commercial bank systemic risk, the systemic risk itself is more complex in its mechanism of action, and there is still more room for exploration of this issue. First, models such as △CoVaR require the use of high-frequency trading data, which is not available for non-listed banks, but it is also unreasonable not to consider the systemic risk association between non-listed and listed banks. Second, in the future, the relationship between the real economy and banks can be taken into account in the study of the impact of monetary policy and capital regulation on systemic risk, so as to obtain a more complete and comprehensive analysis of the impact mechanism.

References

[1] *Borio, C., & Zhu, H. (2012). Capital regulation, risk-taking and monetary policy: a missing link in the transmission mechanism? Journal of Financial stability, 8(4), 236-251.*

[2] *Kaufman, G. G. (1996). Bank failures, systemic risk, and bank regulation. Cato J., 16, 17.*

[3] *Borio, C. (2014). The financial cycle and macroeconomics: What have we learnt? Journal of Banking & Finance, 45, 182-198.*

[4] *Adrian, T., & Brunnermeier, M. K. (2011). CoVaR (No. w17454). National Bureau of Economic Research.*

[5] *Adrian, T., & Shin, H. S. (2010). Financial intermediaries and monetary economics. In Handbook of monetary economics (Vol. 3, pp. 601-650). Elsevier.*

[6] *Dewachter, H., & Wouters, R. (2014). Endogenous risk in a DSGE model with capital-constrained financial intermediaries. Journal of Economic Dynamics and control, 43, 241-268.*

[7] *Farhi, E., & Tirole, J. (2009). Leverage and the central banker's put. American Economic Review, 99(2), 589-593.*

[8] *Delis, M. D., & Kouretas, G. P. (2011). Interest rates and bank risk-taking. Journal of Banking & Finance, 35(4), 840-855.*

[9] *Dewatripont, M., & Tirole, J. (1994). The prudential regulation of banks (Vol. 6). Cambridge, MA: MIT press.*

[10] *Laeven, L., & Levine, R. (2009). Bank governance, regulation and risk taking. Journal of financial economics, 93(2), 259-275.*

[11] *Aikman, D., Bridges, J., Kashyap, A., & Siegert, C. (2019). Would macroprudential regulation have prevented the last crisis? Journal of Economic Perspectives, 33(1), 107-130.*

[12] *Suh, S. (2012). Measuring systemic risk: A factor-augmented correlated default approach. Journal of Financial Intermediation, 21(2), 341-358.*

[13] *Apergis, N., Aysan, A. F., & Bakkar, Y. (2021). How do institutional settings condition the effect of macroprudential policies on bank systemic risk? Economics Letters, 209, 110123.*

[14] *Faia, E., & Karau, S. (2019). Banks' systemic risk and monetary policy. Centre for Economic Policy Research.*