Research on the Influence of Capital Buffer of Systemically Important Banks in China on Bank Total Factor Productivity

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Keywords: Systemically important banks, Capital buffer, Capital supplement.

Abstract: Against the background of the promulgation of Basel III and China's Additional Regulations on Systemically Important Banks (Trial), for Chinese commercial banks, especially the newly announced Chinese systemically important banks, their capital buffers and the capital replenishment method adopted is more and more worthy of attention and research. This paper calculates and sorts out the capital buffers of 19 systemically important banks in China, and uses the threshold panel model to explore the relationship between core tier 1 capital buffers and capital replenishment methods and bank efficiency. The findings are as follows: (1) the capital adequacy ratio of systemically important banks at all levels in China is constantly improving; (2) the core tier 1 capital buffer will weaken the negative impact of 4.28%on bank efficiency

1. The introduction

After the Financial Stability Board (FSB) released the list of Global Systemically Important Banks (G-SIBs) in 2011, China also established its own identification and supervision system for systemically important banks, and subsequently announced China's first on October 15. Batch list of systemically important banks.

This paper collects and organizes the panel data of 19 systemically important banks in China from 2015 to 2020 and the capital adequacy ratios supervision standards of systemically important banks in China, and measures the capital buffers of sample banks. On the basis of considering the non-radial factors, the bank’s total factor productivity is measured by the super-efficiency SBM-DEA Malmquist model, and the impact of the core tier 1 capital buffer size and the core tier 1 capital replenishment method on the bank's operating efficiency is measured through the threshold panel model for further discussion.

2. Statistics on capital adequacy ratio requirements and status quo OF CHINA'S systemically important banks at all levels

In order to explore the capital buffer situation of systemically important banks in China under the new regulatory standards, this article clarifies the differentiated regulatory capital requirements for systemically important banks at all levels, and subtracts the current corresponding requirements from the historical data of each bank. The capital buffers of 19 banks are measured and analyzed by using the capital supervision standards at all levels. When the difference is less than 0, the capital buffer is negative, and the larger the bank's capital buffer, the stronger the bank's capital adequacy, and vice versa.

To better explore the capital buffer situation of banks, the capital adequacy ratios of 19 Chinese systemically important banks at all levels from 2015 to 2020 were collected from the wind database. It is found that in 2016, the capital adequacy ratios of systemically important banks at all levels in China declined slightly, but most of them showed an upward trend. Among them, the capital adequacy ratio, Tier 1 capital adequacy ratio and core Tier 1 capital adequacy ratio of the fourth group of banks with a higher degree of systemic importance can reach an average of about 16%, 13% and 12% in 2020. The capital adequacy ratio, Tier 1 capital adequacy ratio and core Tier 1 capital adequacy ratio

of the first group of banks with a lower degree of systemic importance can reach an average of about 13%, 10% and 9% in 2020.

2.1 Capital buffers of systemically important banks

In 2015-2016, the relative value of capital buffers at all levels of China's systemically important banks was 0.06% for Industrial Bank and 0.54% for Postal Savings Bank in 2015, and 0.06% for China Guangfa Bank, 0.15% for Postal Savings Bank, and 0.47% for Bank of Jiangsu, and Industrial Bank's tier-1 capital buffer of 0.73%, as well as the indicators of the 19 systemically important banks at all levels in the rest of the year all meet the current regulatory standards. However, the ranking of capital buffers at all levels has a small change and is generally consistent.

The absolute value of the capital buffer of Postal Savings Bank and Industrial Bank in 2015 reached RMB 205,658,400 and RMB 170,262,810,000, respectively. Bank of Jiangsu, Industrial Bank, China Guangfa Bank, and Postal Savings Bank have tier-one capital buffer values of 1140759135 yuan, 2056589400 yuan, 8752845073 yuan, and 14819170500 yuan, respectively, ranking at the end of the 19 systemically important banks in China. At the same time, from 2015 to 2020, the buffer capital of each bank at all levels showed a certain growth trend.

In the overall ranking, the capital buffer rankings of banks at all levels showed a trend of large-scale stability and small-scale changes. In addition, banks have relatively small reserves in other tiers 1 capital and tier 2 capital, and their overall capital requirements and reserves are mainly met by their core tier 1 capital [1].

3. Capital buffers and sustainable development

Based on descriptive statistics on bank capital buffers, researches by Zong Liang, Zhang Youxian (2011), Wu Hao, Xiang Yao (2020), Zhang Chengxiang (2021) and others found that under increasingly stringent capital requirements, the future of banks' business management will have a certain degree of pressure[2][3]. Referring to Pang's (2021) related research methods on the core tier 1 capital of banks, this paper uses the super-efficiency SBM-DEA Malmquist model to measure the total factor productivity of banks and takes it as the explained variable. The core tier 1 capital buffer is calculated as the threshold variable by combining the relevant requirements of the regulatory authorities on the bank's core tier 1 capital adequacy ratio [4], and the threshold panel model is used to try to analyze the impact of the bank's capital status on the bank's sustainable development [5].

3.1 Model setting — Super-efficiency SBM-DEA Malmquist model

In the traditional DEA-Malmquist model, all the input and output of the bank are expanded in the same proportion, and the slack of the input and output of the bank is not taken into account, so the total factor productivity (MI_c) calculated by this model is different from the actual situation. There will be a difference between them. Therefore, this paper adopts the super-efficiency SBM-DEA Malmquist model to measure the production efficiency of commercial banks.

$$S^t = (x^t, y^t) \tag{1}$$

$$D^t(x^t, y^t) = inf\left\{\theta: \left(\frac{x^t, y^t}{\theta}\right) \in S^t\right\} \tag{2}$$

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \times \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t+1}(x^t, y^t)}\right]^{\frac{1}{2}} \tag{3}$$

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t+1}(x^t, y^t)} \times \left[\frac{D^t(x^{t+1}, y^{t+1})}{D^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D^t(x^t, y^t)}{D^{t+1}(x^t, y^t)}\right]^{\frac{1}{2}} \tag{4}$$

Formula (1) is called the production function of the technological frontier, namely the upper limit of production possibilities. (2) It represents the distance between the actual technological production level of the economy and the technological frontier, that is, the optimized space for the economy to achieve the optimal efficiency; (3) It is the total factor productivity of an economy measured by

Malmquist index function, where the first term represents the change in technical efficiency (EC) and the second term represents the change in technological progress (TC_c).

In the above formula, T represents the concept of time, x represents the input of the economy, and y represents the economy's output. Accordingly, it represents the input in phase T, represents the output in phase T, and is the scalar factor that can reach the technological frontier. When its production efficiency is higher than the technological frontier, Equation (2) is >1; otherwise, it is less than 1.

Formula (4) splits the first item of Formula (3) into two indicators, namely, change in pure technical efficiency (PEC) and change in scale efficiency (SEC).

$$MI\_c=EC\times TC\_c=PEC\times SEC\times TC\_c \quad (5)$$

If each item in the formula is greater than 1, it indicates that the item is developing in a positive direction and gradually approaching the upper limit of production possibility. On the contrary, if the item is between 0 and 1, it indicates that the item is developing in a negative direction.

3.2 Variable description

Table 1. Model variation scale.

Variable	Name	Symbol	Meaning
Input variable	Total assets	TA	Bank owned assets
	Interest payments	IE	Business investment
	Operating expenses	OE	Operation management related input
Output variable	Net interest income	II	Main business income
	Non-interest income	NI	Income from non-main business

3.3 Based on exponential decomposition and efficiency measurement of super-efficient SBM-DEA Malmquist model

According to the total factor productivity of the bank in the above formula, it can be divided into technical efficiency change and technological progress change, while the technical efficiency change can be further divided into pure technology and scale efficiency. Based on the existing data, this paper uses the super-efficiency SBM-DEA Malmquist model to decompose the total factor productivity of banks by various indexes. Measure its change rate based on 2015, and give the panel data of each index of 19 banks from 2016 to 2020.

Table 2. Total factor productivity (MI_c) table xix.

Type	Name	Content	Symbol
Explained variable	Bank efficiency	Total factor productivity	TFP
Explanatory variables	Core Tier 1 capital adequacy ratio component	Ln Core Tier one capital	HXY
		Ln risk-weighted assets	FXZC
Threshold variable	Core Tier 1 capital buffer	Core Tier 1 capital buffer	HYCC
Control variable	Level of economic development (Macro level)	Annual rate of change in GDP	GDP
	Bank size (Micro level)	Ln total assets	ZZC
	The capital structure (Micro level)	Asset-liability ratio	ZFL

	Risk resistance (Micro level)	Provision ratio for nonperforming loans	BLD

Combined with the data in the table, it can be seen that the total factor productivity of China's systemically important banks showed a downward trend in 2018-2020.

3.4 Variable Description

Control variables are selected based on the relevant research of Pang Yuwei (2021).

Table 3. Threshold panel model variable meaning table.

	2016	2017	2018	2019	2020
Agricultural bank of China	0.975	1.107	0.857	0.933	1.070
Construction bank	0.974	1.009	0.990	0.967	1.003
The bank of China	1.118	0.819	0.930	1.071	0.895
	2016	2017	2018	2019	2020
Industrial and commercial bank of China	1.018	0.976	0.984	0.950	1.001
...					
Everbright bank	0.934	0.997	1.235	0.786	0.935
Ping an bank	1.009	0.725	1.174	1.044	1.005
Mean	0.930	1.062	1.031	0.997	0.897

3.5 Descriptive statistics

The table shows the model's three main variables: the mean value of bank efficiency (TFP) is 0.9832, the standard deviation is 0.20291, and the volatility is small. Its maximum and minimum values are 1.63 and 0.50, respectively, with a span of 1.13. The mean value of Ln core Tier 1 capital (HXY) is 26.6583, with a standard deviation of 0.99806. Its maximum value is 30.63, and the sample value span is 3.64. The mean value of core Tier 1 capital buffer (HYZZ) is 0.0265, the volatility is 0.01354, the maximum value is 0.06, and the value span is 0.05.

Table 4. Descriptive statistics of threshold panel model.

	N	Mean	SD	Max	Min
tfp	95	0.98	0.20	1.63	0.50
hxy	95	26.66	1.00	28.61	24.53
fxzc	95	28.98	0.88	30.63	26.99
hycc	95	0.03	0.01	0.06	0.01
gdp	95	0.08	0.03	0.11	0.03
zzc	95	29.41	29.41	31.14	27.51
zfl	95	0.93	0.01	0.96	0.91
bld	95	2.19	0.93	5.24	1.32

3.6 Threshold effect and stability test results and analysis

In this paper, the core Tier 1 capital adequacy ratio (HYCC) is used as a threshold variable to test the threshold effect, and the influence of the numerator and denominator strategies for core Tier 1 capital adequacy ratio on the total factor productivity of 19 systemically important banks in China is studied.

As shown in Table 5, the single threshold panel regression model has a significant effect, and the threshold value is 0.0428, which indicates that when the capital buffer of tier 1 capital is 4.28%, the negative impact of bank efficiency on bank operating efficiency will be weakened. And the P value was 0.03, significant at the 5% significance level.

Therefore, the following analysis is based on a single threshold panel model. According to the negative core capital buffer value, the 19 systemically important banks were divided into two groups.

When the threshold value was less than 4.28%, c. hexy was 0, and the coefficient was -0.3370. When the threshold value is greater than 4.28%, c. hexy is 1, and the coefficient is -0.3137.

Table 5. Threshold effect test of the numerator and denominator strategies of core capital adequacy ratio.

	Threshold value	Critical value				
		F Value	P Value	1%	5%	10%
Single threshold	0.0428	13.51**	0.03	9.82	12.8528	15.21
Double threshold	0.0350	4.45	0.54	10.08	11.17	29.19

Note: ***, ** and * are significant at the level of 1%, 5% and 10%, respectively, the same below.

Table 6. Regression and robustness test results of threshold panel model.

Variable name	Single threshold panel model	OLS robustness test
GDP	2.93***	2.429***
	(2.47)	(3.18)
control variable	Yes	Yes
explanatory variable	Yes	Yes
sample capacity	95	95
F(7,69)	3.06	--
Prob>F	0.0072	--
F test that all u_i=0:F(18,69)	0.71	--
F(6,88)	--	2.46
Prob>F	--	0.0305
R-squared	--	0.1434
Adj R-squared	--	0.0850

Note: t values are in parentheses.

Robustness is shown in the table. By changing the model test, the regression results of this variable and the single threshold panel regression model are both significant, and the parameter values are all kept at about 2. The significance level of GDP is relatively high, indicating that the GDP growth rate has a significant role in promoting the bank efficiency, and the Banks efficiency is expected to increase by an average of 2.93 percentage points for every one percentage point increase. Therefore, the economic environment has an important impact on the operational efficiency of banks.

In addition, as for the core variable of the model, every 1% increase of the bank's core tier 1 capital will reduce the bank efficiency by 0.11. However, for every 1% increase in risk-weighted assets, bank efficiency will increase by 0.078.

4. Research conclusions

(1) The capital adequacy ratios of China's systemically important banks at all levels show an increasing trend. The capital buffers of the 19 banks were the same as their systemically important scores. In addition, the change of capital adequacy ratio of banks at all levels is closely related to the shift in core tier 1 capital adequacy ratio, which is largely met by banks' core capital [6].

(2) The core Tier 1 capital buffer will weaken the negative impact on bank efficiency at 4.28%. Considering the bank's liquidity and profitability as well as its capital security, the higher the capital adequacy ratio is, the bank's capital utilization ability and profitability will be weakened, but when the capital buffer of the bank's core tier 1 capital reaches more than 4.28%, its negative impact will be reduced by 2.33 percentage points.[7] In addition, a risk-weighted asset reduction of the same magnitude is more beneficial to bank efficiency than an increase in the bank's core tier 1 net capital [8][9].

5. Policy recommendations

(1) Enhance the ability to adapt to Basel III and China's new systemically important bank management indicators. Based on comprehensive consideration of the safety, liquidity and profitability of bank assets, we will increase the core tier 1 capital buffer of banks [10].

(2) The emphasis on the denominator adjustment strategy should be improved. On the basis of taking into account the market share of banks and the rigidity of reducing their risk assets, we should maintain the stability of the growth of traditional businesses, diversify operations, optimize the asset structure of banks, reduce the risk of bank assets and maximize shareholders' equity.

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