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Research on the Impact of Heterogeneous Leverage Regulation on the Risks of China's Commercial Banks

Investigación sobre el impacto del apalancamiento heterogéneo. Reglamento sobre los riesgos de los bancos comerciales de China

基于异质性的杠杆率监管对中国商业银行风险影响研究

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Abstract: Based on the panel data of 75 commercial banks in China from 2008 to 2017, this paper uses four methods: mixed estimation, fixed effect, differential moment estimation and system moment estimation, to examine the impact of leverage ratio regulation on commercial bank risks and the influence of heterogeneity of commercial banks on regulatory effectiveness. We found that, first, the supervision of leverage ratio effectively reduces the risks of Chinese commercial banks; second, the heterogeneity of Chinese commercial banks will lead to differences in regulatory effects. For banks that are listed with lower capital levels and have higher risk preference, leverage ratio regulation has a stronger inhibitory effect on bank risks. On this basis, it is recommended that the regulators implement differentiated supervisory measures for commercial banks with different capital levels and risk reference while strengthening supervision of leverage.

Key Words: leverage regulation; heterogeneity; bank risk.

Resumen: Con una muestra de 75 bancos comerciales en China, desde 2008 a 2017, este artículo utiliza cuatro métodos, como son: estimación mixta, efecto fijo, estimación del momento diferencial y estimación del momento del sistema. Se examina el impacto de la regulación del coeficiente de apalancamiento sobre los riesgos de los bancos comerciales y la influencia de la heterogeneidad de los bancos comerciales en la eficacia regulatoria. Descubrimos que, en primer lugar, la supervisión del coeficiente de apalancamiento reduce eficazmente los riesgos de los bancos comerciales chinos; en segundo lugar, la heterogeneidad de los bancos comerciales chinos generará diferencias en los efectos regulatorios. Para los bancos que están listados con niveles de capital más bajos y tienen una preferencia de riesgo más alta, la regulación del coeficiente de apalancamiento tiene un efecto inhibitorio más fuerte sobre los riesgos bancarios. Sobre esta base, se recomienda que los reguladores implementen medidas de supervisión diferenciadas para los bancos comerciales con diferentes niveles de capital y referencia de riesgo, a la vez que se fortalezca la supervisión de apalancamiento.

Palabras clave: regulación del apalancamiento; heterogeneidad; riesgo bancario.

摘要：本文基于2008-2017年间中国75家商业银行的面板数据，采用混合估计、固定效应、差分矩估计、系统矩估计四种方法检验了杠杆率监管对商业银行风险的影响以及商业银行的异质性是否会对监管效果产生差异。我们发现，第一，杠杆率监管有效降低了中国商业银行的风险；第二，中国商业银行的异质性会导致监管效果出现差异。对于上市、资本水平较低、风险偏好较高的银行，杠杆率监管对银行风险的抑制作用更强。在此基础上，建议监管部门在加强杠杆率监管的同时对不同资本水平和风险偏好的商业银行实施差异化监管措施。

［**关键词**］杠杆率监管；异质性；银行风险

1. Introduction

The outbreak of the financial crisis in 2008 caused huge losses to European and American financial institutions that have overused high leverage. Based on this, the Basel Committee formulated a new regulatory standard, the Basel III, in 2010 to incorporate leverage into the international banking regulation system. In China, 3% is set as the minimum leverage standard. In June 2011, the China Banking Regulatory Commission

promulgated the Measures for the Administration of the Leverage Ratio of Commercial Banks, which determined the overall framework of China's banking industry's leverage ratio regulation policy, and set the minimum standard for commercial banks' leverage ratio at 4%.

The original intention of leverage regulation is to reduce the risk level of commercial banks. However, based on different model settings, research scopes and research stages, scholars have drawn different conclusions on the relationship between leverage regulation and commercial bank risk. Kiema and Jokivuolle (2010) and others believe that for assets with the same nominal value but different risks, the leverage requirement requires the same amount of capital to be held, which will form a reverse incentive for commercial banks and increase bank risk. Frenkel and Rudolf (2010), Kellermann and Schlag (2013), Allahrakha et al. (2018) used data from Commerz bank, Swiss Bank, and Bank of America, respectively, also found that leverage regulation will generate reverse incentives and increase the allocation of high-risk assets to increase bank risk. Huang Haibo (2012) and others used a multivariate linear programming method to analyze the impact of leverage regulation and capital adequacy regulation on bank risk from the perspective of bank asset holding behavior, and found that leverage regulation will increase bank risks to a certain extent.

However, other scholars believe that leverage regulation can reduce the probability of bank failure and the possibility of expected deposit losses, and enhance the risk absorption capacity of commercial banks, thereby reducing risk. Robert (2013) calculated the maximum leverage ratio, and compared and analyzed the effects of leverage and capital adequacy ratio regulation and bank risk. Research shows that leverage regulation can reduce bankruptcy expectations, and its ability to control bank risks is simpler and more direct, and it can more effectively control bank risks. Kiema and Jokivulle (2014) believes that there is additional loss absorption capacity in leverage, which can cover risks that are not covered under the risk capital framework, which is conducive to increasing the stability of banks. Yuan Yuan and Rao Sufan (2014) found that leverage regulation helps banks to disclose the true level of risk and avoid regulatory arbitrage. From a dynamic long-term perspective, it will form rigid constraints on the development model, risk management and capital quality of Chinese commercial banks. The combination of leverage ratio regulation and capital adequacy ratio can effectively reduce the risky behavior of banks and gradually reduce their risk level. Dermine (2015) established a new credit risk model based on short-term loans and incomplete information, proving that in an economic boom period, the leverage index can prevent

commercial banks from excessive credit expansion and can ensure that commercial banks have sufficient capital to cope with the crisis. Run. Smith et al. (2017) pointed out that the proposed leverage ratio will promote capital-constrained banks to increase their risks, but the bank 's risk-taking behavior will also increase the bank's capital, which will also increase the ability to absorb losses and promote the stability of the banks themselves.

Other scholars believe that the impact of leverage on commercial bank risk depends on relevant conditions. Ba Shusong et al. (2013) pointed out that in the face of banks with different average risk weights, conversion coefficients and ratios of on-balance sheet and off-balance sheet assets, the effectiveness of leverage regulation will be different. Jin Yuying and Jia Songbo (2016) believe that the introduction of leverage regulation has improved the banking supervision system, increased the proportion of commercial banks' own capital, and reduced the probability of bankruptcy. From the perspective of a commercial bank, the level of asset spreads affects the role of leverage ratio regulation on its asset structure. Only when the spread is small will the leverage ratio regulation increase the proportion of high-risk assets. Wang Li (2017) believes that China's low interest rate policy increases commercial banks' risk, while capital regulation and market constraints reduce risk. The final effect depends on the size of the two effects and the strength of the risk transfer effect.

Then, as a kind of ex-ante regulation indicator, does leverage regulation really achieve the effect of reducing the risk of commercial banks? Will the heterogeneity of commercial banks, such as whether they are listed, have different levels of capital, and have different risk reference, affect the effect of leverage regulation? This paper attempts to answer these two questions through empirical research based on panel data of 75 Chinese commercial banks from 2008 to 2017, and provides some suggestions for further improving and refining China's leverage ratio supervision system regulation.

2. Theoretical analysis

Theoretically speaking, leverage ratio regulation will cause changes in three aspects: the level of prudential regulation of regulators, the risk preference of commercial banks, and the transparency of information. These three changes will further affect the risk level of commercial banks. Therefore, this paper will employ micro-prudential channel, macro-prudential channel, risk preference channel, and information channel to specifically analyze how leverage ratio regulation influences the risk level of commercial banks.

2.1 Micro-prudential Channel

As a newly included micro-prudential management tool, leverage ratio regulation stipulates the minimum leverage ratio, and dynamically tracks the risk level of commercial banks. In order to meet the regulatory requirements, commercial banks can increase Tier 1 capital and reduce asset growth. Tier 1 capital accumulation not only improves the quality of bank-owned capital and the ability of banks to absorb losses, but also enables banks to maintain more sufficient liquidity. Under leverage ratio regulation, commercial banks tend to cut down the activity of loan transactions and step up the lending inspections, which also helps alleviate bank risk.

2.2 Macro-prudential Channel

Due to its counter-cyclical characteristic, leverage ratio regulation is not only a micro-prudential management tool, but also a macro-prudential management tool to control the risks of commercial banks. When the economy is in a prosperous period, commercial banks have a strong desire to expand rapidly, while in a period of economic recession, commercial banks are cautious about investment. As a counter-cyclical regulatory tool, leverage ratio regulation can effectively curb the excessive expansion of commercial banks during economic prosperity and reduce the systemic risks, which will lower the risk level of commercial banks.

2.3 Risk Preference Channel

The risk preference of a commercial bank is determined by its board of directors and management. If the board of directors and management prefers to be more risk-seeking, the commercial bank will invest in high-risk assets in order to pursue greater profits. Leverage ratio regulation reduces the risk preference of commercial banks by stipulating credit conversion coefficients and minimum capital requirements, thereby weakening commercial banks' desire to invest in high-risk assets, decreasing the scale of investment in high-risk assets, and ultimately reducing commercial bank risk.

2.4 Information Channel

Leverage ratio regulation reduces the risk of commercial banks by eliminating the asymmetry of information between commercial banks and creditors, and also between commercial banks and regulators. Leverage ratio regulation requires commercial banks to regularly disclose their leverage ratio levels, which can clearly reflect the scale of banks' leveraged assets, enable depositors to understand banks' conditions more intuitively, enhance depositors' confidence, and reduce the probability of bank runs. In addition, the leverage ratio regulation also requires commercial banks

to disclose their on- and off-balance sheet assets. This enables regulators to have a clearer and direct grasp of the scale of commercial banks' off-balance sheet assets, and can prevent commercial banks from participating in regulatory arbitrage by taking advantage of information asymmetry between the two parties and transferring assets to off-balance sheet. Therefore, bank risk generated by regulatory arbitrage will also be reduced.

3. Model setting and variable selection

Due to the dynamic adjustment of bank risk, this paper uses a dynamic panel model for estimation. The specific model is constructed as follows:

$$Z_{i,t} = a_0 + a_1 Z_{i,t-1} + a_2 lev_{i,t} + a_3 bank_{i,t} + a_4 macro_{i,t} + u_i + \varepsilon_{i,t} \quad (1)$$

Among them, the subscript i is the number of banks in the sample;t is the sample survey time;u_i is the unobservable individual effect;$\varepsilon_{i,t}$is the random disturbance term. The explained variable uses the bankruptcy probability index Z to measure bank risk, and the core explanatory variable measures the difference between the actual leverage ratio of the commercial bank is a and the regulatory requirement of 4% to measure the leverage index (lev). bank is a bank-level control variables, select bank asset growth rate (Agt), tier 1 capital (Toc), risk appetite (Riska), liquidity (Liq), provision ratio (Pro), loan-to-deposit ratio (Loa), cost-income ratio (Cost); macro is the control variables at the macro level, select the year-on-year growth rate of currency (M2) and nominal GDP growth rate (GDP). Equation (1) is to test the effect of regulation on the leverage of the entire sample.

Considering the differences between different types of banks, the full sample is divided into two categories: listed and unlisted. Formula (1) is used to examine the difference in the effect of leverage regulation of different types of banks.

Multiplying Tier 1 capital, risk reference, and leveraged regulatory variables as an interaction term is introduced into the measurement model to obtain Equation (2).

$$Z_{i,t} = a_0 + a_1 Z_{i,t-1} + a_2 lev_{i,t} + a_3 lev_{i,t} \times c_{i,t} + a_4 bank_{i,t} + a_5 macro_{i,t} + u_i + \varepsilon_{i,t} \quad (2)$$

In equation (2), the interaction term between the control variable and the leverage ratio regulation to be examined by lev×c, the analysis of the coefficient and significance of a_3 is focused, and the non-linear

characteristics of bank risk affected by Tier 1 capital and risk preference variables can be observed.

Table 1: Variable definition table

Variable type	Variable name	Representation
Explained variables	Bank risk	Z
Core explanatory variables	Leverage regulation	Lev
	Leverage regulation * Tier 1 capital	$Lev \times Toc$

Table 1: Variable definition table(continued)

Variable type	Variable name	Representation
	Leverage regulation * risk preference	$Lev \times Riska$
Control variables	Risk lag terms	$L.\ln z$
	Tier 1 capital	Toc
Control variables	Risk preference	$Riska$
	Bank Asset Growth	Agt
Control variables	Liquidity ratio	Liq
	Provisioning rate	Pro
	Loan-to-deposit	Loa
	Cost-to-income	Cost
	Money supply growth rate	$M2$
	GDP growth rate	GDP

This paper selects the data of 75 commercial banks in China from 2008 to 2017 as the research sample, including 35 listed banks and 40 unlisted banks. The sample financial data comes from the Wind Source Database, the Bankscope Database, and the annual reports of the banks, while the risk Z value and the leverage index are calculated from the original data. For the missing data of individual variables in individual bank years, interpolation is used to supplement them.

The descriptive statistical analysis of the main variables is shown in Table 2. It can be seen, first, the overall risk level of Chinese commercial banks is low, with an average risk Z value of 4.3777; second, the average leverage ratio of Chinese commercial banks is 6.632, which has clearly exceeded the standard value of 4% set by the Chinese regulatory authority This situation occurred because some banks had low leverage ratios before the 2011. After 2011, all banks have reached the 4% regulatory requirement.

Table 2: Descriptive statistical analysis of variables

Variable	Obs	Mean	Std.Dev.	Min	Max
Lnz	750.000	4.337	0.949	1.583	7.450
L.lnz	675.000	4.257	0.903	1.583	7.450
Lev	750.000	2.632	1.580	-0.908	12.670
Toc	750.000	9.595	1.716	5.475	14.562
Riska	750.000	0.615	0.095	0.304	0.885
Agt	750.000	0.250	0.254	-0.248	4.628
Loa	750.000	63.435	10.348	21.030	89.800
Liq	750.000	49.638	11.070	24.570	81.950
Pro	750.000	249.433	115.504	53.082	852.28
Cost	750.000	33.589	6.814	14.830	60.418
M2	750.000	15.424	5.379	8.110	28.420
GDP	750.000	8.270	1.334	6.700	10.600

4. Empirical Results

In order to control the endogeneity of the explanatory variables, the possible heteroscedasticity problem in the model, and the weak tool variable problem of the differential GMM method, this paper uses the systematic GMM method for estimation.

4.1 Leverage Regulation and Commercial Bank Risk

The full sample is used to study the relationship between leverage regulation and commercial bank risk. The empirical results are shown in Table 3.

The p-values of all sargan tests in Table 3 reject the null hypothesis at the 10% level, indicating that the model does not have an over-identification problem. Similarly, the P value corresponding to the second-order sequence correlation test in the table also shows that there is no second-order sequence correlation in the model, and the regression results are not affected by the residual sequence correlation, so the model setting is reasonable.

Table 3: Impact of leverage regulation on commercial bank risks

Estimation method	OLS	*E*	*Ð*	*GMM*
Dependent variable	*Lnz*	*Lnz*	*Lnz*	*Lnz*
L.lnz	0.445***	0.455***	0.422***	0.482***
	(0.0338)	(0.0336)	(0.0416)	(0.0337)
Lev	0.0597**	0.0586**	0.0782*	0.100***
	(0.0236)	(0.0229)	(0.0435)	(0.0342)
Riska	-1.196***	-0.918**	-1.816**	-1.307**
	(0.412)	(0.403)	(0.826)	(0.652)
Toc	0.0890***	0.0881***	0.393*	0.0985*
	(0.0216)	(0.0210)	(0.218)	(0.0536)
Agt	-0.0788	-0.0554	-0.117	-0.105
	(0.121)	(0.120)	(0.147)	(0.0970)
Loa	0.00413	0.00253	-0.0114*	-0.0102**
	(0.00311)	(0.00303)	(0.00673)	(0.00423)
Liq	-0.000617	-0.000912	-0.00172	0.000230
	(0.00280)	(0.00273)	(0.00479)	(0.00336)
Pro	0.000816***	0.000709**	0.00142***	0.00133***
	(0.000268)	(0.000283)	(0.000395)	(0.000272)
Cost	0.00512	0.00214	-0.0187**	-0.0214***
	(0.00478)	(0.00467)	(0.00924)	(0.00725)
M2	-0.0530***	-0.124***	-0.0384***	-0.0555***
	(0.00806)	(0.0249)	(0.0143)	(0.00730)

GDP	0.0621*	0.553***	0.0972*	0.0635**
	(0.0350)	(0.180)	(0.0501)	(0.0283)
Constant	1.881***	-0.581	-2.154	0.522
	(0.569)	(1.085)	(2.851)	(0.906)
N	673	673	597	673

Table 3: Impact of leverage regulation on commercial bank risks(continued)

Estimation method	OLS	*E*	*Ð*	*GMM*
R^2	0.29	0.34		
AR(2)			0.23	0.21
Sargan p			0.81	0.64

The explanatory variable lev coefficient in Table 3 is significantly positive, indicating that leverage regulation helps reduce bank risk. Leverage regulation reduces the risk of commercial banks by requiring them to enrich their capital and control asset expansion. In addition, all the results of the lagging phase coefficient (L.lnz) of the explanatory variables are significantly positive at the 1% confidence level, indicating that the choice of the dynamic panel model is reasonable, and the bank risk has a strong positive correlation with the previous year, but the effect will gradually Weaken. Among the effects of other control variables on bank risk, the Tier 1 capital coefficient, the provision ratio coefficient, and the GDP growth rate coefficient are significantly positive; the loan-deposit ratio coefficient, the cost-income ratio coefficient, and the M2 growth rate coefficient are significantly negative. The estimated coefficients and significance of these control variables are basically consistent with theoretical expectations.

4.2 Heterogeneity of Commercial Banks and Regulation of Leverage

To investigate whether the effect of leverage ratio regulation differs due to the heterogeneity of commercial banks, the empirical results are shown in Table 4.

Table 4: The impact of heterogeneity of commercial banks on the effect of leverage regulation

	Listed	Non-listed	Full Sample	Full Sample
Dependent variable	*Lnz*	*Lnz*	*Lnz*	*Lnz*
L.lnz	0.338***	0.530***	0.187***	0.184***
	(0.0447)	(0.0468)	(0.0510)	(0.0467)
Riska	-1.574**	-1.345	-2.238***	-2.225**
	(0.692)	(0.913)	(0.617)	(1.036)
Toc	-0.00229	0.283**	0.361***	0.177***
	(0.0535)	(0.122)	(0.0824)	(0.0455)
Lev×Toc			-0.0803***	
			(0.0295)	
Lev×Riska				0.0937**
				(0.0451)
Lev	0.120***	0.0743*	0.837***	0.126**
	(0.0431)	(0.0420)	(0.273)	(0.0532)
Agt	-0.618**	-0.0432	-0.139	-0.0778
	(0.273)	(0.110)	(0.158)	(0.125)
Loa	0.00649	-0.0113**	0.00537	0.00404
	(0.00602)	(0.00507)	(0.00683)	(0.00838)

Table 4: The impact of heterogeneity of commercial banks on the effect of leverage supervision (continued)

	Listed	Non-listed	Full Sample	Full Sample
Liq	0.00571	0.00236	0.00613	0.00718
	(0.00483)	(0.00417)	(0.00606)	(0.00556)
Pro	0.000729*	0.00131***	0.00153***	0.00170***
	(0.000424)	(0.000337)	(0.000529)	(0.000570)
Cost	-0.0568***	0.00448	0.0203	0.0218

	(0.0118)	(0.00841)	(0.0155)	(0.0139)
M2	-0.0668***	-0.0457***	-0.0529***	-0.0473***
	(0.00937)	(0.0123)	(0.00948)	(0.0103)
GDP	0.0421	0.0730*	-0.00530	0.000544
	(0.0384)	(0.0442)	(0.0436)	(0.0450)
Constant	1.904**	-1.043	6.089***	0.789
	(0.945)	(1.710)	(1.284)	(1.105)
N	315	360	675	675
AR(2)	0.23	0.18	0.31	0.26
Sargan p	0.83	0.72	0.78	0.73

From the first and second columns of Table 4, it can be seen that the leverage factor of both listed and unlisted banks is positive and significant. However, the regulatory coefficient of listed banks is greater than that of non-listed banks, which indicates that the positive effect of leverage regulation on listed banks is greater. The possible reason is that compared with non-listed banks, the listed banks are rich in human resources, business resources, and access to funds, which makes the intermediary business and innovative business develop better. In order to survive, non-listed banks have a stronger willingness to choose to run high-risk businesses, and will face more operational risks, credit risks, and liquidity risks, which will weaken the effectiveness of the regulation of leverage ratios to a certain extent.

In the third column, the coefficient of the interaction term between leverage supervision and Tier 1 capital is significantly negative, which means that with the expansion of Tier 1 capital, the positive effect of leverage regulation on commercial banks will decrease, while the positive effect on weak capital banks is relatively large. The possible reason is that sufficient capital enables commercial banks to have better capital quality and stronger liquidity, so that the banks themselves have a stronger ability to withstand risks, and at the same time, it makes it easier for commercial banks to meet regulatory requirements. That is to say, adequate capital will weaken the effectiveness of leverage regulation.

In the fourth column, the coefficient of leverage regulation and risk preference is positive, which means that the increase in risk preference

will increase the positive effect of risk on commercial banks, that is, the implementation of leverage regulation will affect banks with a high-risk preference. The positive effect is relatively large. The "Commercial Banking Leverage Management Measures (Amendment)" specifies the coefficients of the weights of various types of risky assets in the calculation of commercial banks 'leverage ratios, so commercial banks' enthusiasm for high-risk assets and businesses will decrease. In addition, the higher capital requirements make banks need to bear more of their own capital when losses occur, and the minimum losses borne by shareholders will increase accordingly. Therefore, for banks with high-risk reference, the effect of the leverage regulation will be relatively large.

5. Robustness Test

In order to ensure the validity of the model estimation results, this paper uses the non-performing loan ratio as the explanatory variable and the dummy variable (lev11) as the core explanatory variable in the robustness test. The dummy variable was set to 0 before 2011, and vice versa 1.

5.1 Leverage Regulation and Robustness Test of Commercial Bank Risks

The robustness test is performed on the relationship between the leverage effect and the risk of commercial banks. The results are shown in Table 5.

Table 5: Leverage Regulation and Robustness Test of Commercial Bank Risks

Estimation method	OLS	*E*	*Ð*	*GMM*
Dependent variable	*Non*	*Non*	*Non*	*Non*
L.non	0.458***	0.355***	0.380***	0.330***
	(0.0307)	(0.0364)	(0.0388)	(0.0289)
*Lev*11	-0.686**	-0.661**	-0.658**	-0.565**
	(0.292)	(0.312)	(0.331)	(0.241)
Riska	0.174	1.280	1.149**	0.798**
	(0.772)	(1.181)	(0.538)	(0.405)

Toc	0.00381	0.342	-0.505**	-0.309**
	(0.0452)	(0.340)	(0.252)	(0.137)
Control variable	Y	Y	Y	Y
N	675	675	600	675
R^2	0.21	0.22		
AR(2)			0.28	0.29
Sargan p			0.62	0.66

As shown in Table 5, the regression model does not include interaction terms. It mainly studies the relationship between leverage regulation and commercial bank risk. From the regression results in Table 5, it can be seen that the leverage ratio regulation coefficients are -0.686, -0.661, -0.658, and -0.565, respectively. The regression coefficients are significantly negative, indicating that leverage regulation can help reduce the risk of commercial banks. The results are consistent.

5.2 Leverage Regulation and Robustness Test of Bank Heterogeneity

The robustness test is performed to see if the effect of the leverage ratio regulation is different due to the heterogeneity of commercial banks. The results are shown in Table 6.

According to the first and second columns of Table 6, it can be seen that the regulatory coefficients of leverage of both listed and non-listed banks are negative and significant, but the regulatory factors of listed banks are greater than those of non-listed banks

Table 6: Robustness test of the effect of heterogeneity of commercial banks on the regulation of leverage

	Listed	Non-listed	Full Sample	Full Sample
Dependent variable	*Non*	*Non*	*Non*	*Non*
L.non	0.337***	0.344***	0.289***	0.294***
	(0.0155)	(0.0416)	(0.0304)	(0.0300)
Riska	0.0428	-3.396	0.464	4.355**
	(0.156)	(2.533)	(1.294)	(1.893)

Toc	-0.0549***	0.309	-0.583***	-0.0556
	(0.0136)	(0.490)	(0.213)	(0.167)
$Lev1 \times Toc$			0.527**	
			(0.206)	
$Lev1 \times Riska$				-7.498***
				(1.937)
$Lev11$	-0.913**	-0.319*	-0.625**	-0.461*
	(0.457)	(0.181)	(0.293)	(0.279)
Control variable	Y	Y	Y	Y
N	315	360	675	675
$AR(2)$	0.42	0.23	0.35	0.30
Sargan p	0.76	0.61	0.63	0.59

In the third column, the interaction coefficient between leverage regulation and Tier 1 capital is significantly positive, which means that the expansion of Tier 1 capital and the positive effect of leverage regulation on commercial banks will reduce the risk, that is, the implementation of leverage regulation will affect banks' capital level ,the positive effects of weak banks are relatively large.

In the fourth column, the leverage ratio regulation and risk reference are negative, which means that the increase in risk reference will increase the positive effect of risk on commercial banks, relatively bigger.

All the conclusions from the robustness test are consistent with the conclusions from the previous regression, so the basic conclusions of this paper are robust.

6. Conclusions and policy recommendations

Based on the panel data of 75 commercial banks in China from 2008 to 2017, this paper uses hybrid estimation, fixed effect, differential moment estimation, and system moment estimation to empirically test the impact of leverage regulation on the risks of Chinese commercial banks. The conclusions are as follows: (1) Leverage regulation effectively reduced the risks of Chinese commercial banks. (2) As far as the effect of leverage ratio regulation is concerned, the effect of leverage ratio regulation on

listed banks is better than that of non-listed banks. (3) The regulatory effect of leverage is affected by the bank's capital level and risk reference. Specifically, for banks with lower capital levels and higher risk reference, leverage regulation has a stronger inhibitory effect on bank risks.

This article accordingly proposes the following policy recommendations: (1) Regulators should continue to strengthen the regulation of commercial banks' leverage levels. The implementation of leverage regulation is beneficial to reduce the risks of commercial banks. Therefore, regulators should urge commercial banks to disclose their leverage levels and ultimately achieve the purpose of controlling the risks of commercial banks; (2) Implement differentiated leverage regulation for different commercial banks. Specifically, higher leverage requirement should be adopted for listed banks, while relatively low leverage requirement for non-listed banks. Similarly, higher leverage requirement should also be adopted for those banks with high risk reference and insufficient capital.

REFERENCES

Kiema I, Jokivuolle E.Leverage Ratio Requirement and Credit Allocation under Basel Ⅲ. *Bank of Finland Working Paper No.645*，December 2010.

Frenkel M, Rudolf M. *The implications of introducing an additional regulatory constraint on banks' business activities in the form of a leverage ratio*. German Banking Association，2010: 1-64.

Kellermann K, Schlag C. Occupy risk weighting：how the minimum leverage ratio dominates capital requirements. *Journal of Financial Regulation & Compliance*，2013，21 (21).

Allahrakha M, Cetina J., Munyan B. Do higher capital standards always reduce bank risk? The impact of the Basel leverage ratio on the U.S. triparty repo market. *Journal of Financial Intermediation*, 2018: S1042957318300147.

Huang Haibo, Wang Yan, Wang Jing 黄海波，汪翀，汪晶 2012. 杠杆率新规对商业银行行为的影响研(Research on the Impact of New Leverage Rules on the Behavior of Commercial Banks). 国际金融研究(*International Finance Research*), 7: 68-74.

Smith J A，Grill M，Lang J H.The LeverageRatio，*Risk- taking and Bank Stability*. European Central Bank Working Paper No.2079，April 2017

Jarrow, Robert. A leverage ratio rule for capital adequacy. Social Science Electronic Publishing 37.3(2013):973-976.

Kiema I, Jokivuolle E. Does a leverage ratio requirement increase bank stability? *Journal of Banking & Finance*，2014，39 (1): 240-254.

Yuan Yuan, Rao Sufan. Bank Capital, Risk Undertaking and Leverage Constraint: Based on Empirical Research of Chinese Listed Banks (2003-2012). *International Finance Research*, 2014, (8): 52 ~ 60.

Yuan Yan, Ruan Yongping, Rao Sufan袁鲲，阮永平，饶素凡2014. 巴塞尔协议、杠杆率约束及银行风险监管有效性(Basel Accord, Leverage Constraint and the Effectiveness of Bank Risk Supervision). 现代管理科学(*Modern Management Science*), 5: 39-41.

Dermine J. Basel III leverage ratio requirement and the probability of bank runs. *Journal of Banking & Finance*，2015 (53): 266-277.

Wang L i汪莉2017. 隐性存保、“顺周期”杠杆与银行风险承担(Implicit deposit insurance, “procyclical” leverage and bank risk commitment). 经济研究(*Economic Research*), 10: 67-81.

Jin Yuying, Jia Songbo靳玉英，贾松波(2016). 杠杆率监管的引入对商业银行资产结构的影响研究(Research on the impact of the introduction of leverage ratio regulation on the asset structure of commercial banks).国际金融研究(*International Finance Research)*, 6: 52 ~ 60.