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Impacts of Bank Competitions on Bank System Risks in China

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Abstract

Since China's reform and opening up, the banking industry has developed very rapidly, and the banking industry has also become the core foundation of China's financial industry. However, with the continuous development of the financial and banking industries, the degree of competition in the banking industry is also increasing. Combined with the current situation of the Bank of China, this paper will use the quarterly financial statement data of 20 listed banks from 2007 to 2020 to measure the relationship between banking competition and banking system risk. First, I will get the corresponding data from the financial statements of different banks, such as operating income, ROA, etc. Then, I will use R and SPSS to analyze and build the model. Finally, after analyzing the relationship between bank competition and banking system risk, this paper will put forward corresponding suggestions according to this relationship.

Introduction

China's banking industry has made significant contributions to China's economy. According to previous research, Zha et al. (2015) claimed that the total market value of China's banking system composed of Bank of China, Agricultural Bank of China, China Construction Bank, and industrial and Commercial Bank of China was 2.5 times the domestic GDP at that time. However, the competition in China's banking industry is becoming more and more fierce. Therefore, the research on the competition of China's banking industry is significant.

However, different financial theories put forward various ideas on the consequences of banking competition. Titko et al. (2015) stated that, according to the competitive stability hypothesis, when the competition between banking industries intensifies, it would reduce systemic risk and improve the stability of the financial industry. While Keeley (1990) claimed that too fierce market competition might erode market power, reduce interest rates, and cause systemic risks due to the competition vulnerability hypothesis. But in the paper of Martinez and Repullo (2010), it is argued that banking competition and banking system risk are a U-shaped relationship; that is, a nonlinear relationship and an MMR model are proposed. Therefore, the test of these three different hypotheses is the focus of my research experiment.

According to previous research, Su et al. (2021) used the market structure and concentration of several different banks to measure the degree of market competition. Moreover, in the test, Granger and sub-sample relationship tests were used to test the relationship between the degree of market competition and the non-performing loan ratio. In its experiment, there was a positive and negative relationship between banking competition and system risk; stability and fragility coexist. While Yang and Shao (2018) used structural and nonstructural technologies to measure the degree of competition and evaluate

competitive behavior and concluded that bank competition is positively correlated with loans, stronger competition may lead banks to set lower loan policies to attract borrowers.

In addition to different methodologies used by various researchers, many experts studying the banking industry will use different indexes to measure the degree of competition and systemic risk of the banking industry. Sarkar and Sensarma (2016) took Lerner Index is an important index to measure the competition in the banking industry in the research on Indian banks. In the study of Spanish banks, Jimenez et al. (2013) regarded market concentration, i.e., HHI index, as the most important index to measure banking competition. In terms of measuring the systematic risk of the banking industry, due to the research from Boyd and Nicolo (2005), the loan interest rate of the bank can be used to measure the bank's stability. According to Repullo (2010), the Z index and non-performing loan ratio can be used to measure the systematic risk of the banking industry.

This paper will study and adopt the research methods and variable use in the above research, and then integrate to study the relationship between the competitiveness and systemic risk of China's top 20 banks in recent ten years. This paper will first take the overall 20 banks as the research object and then divide the 20 banks into two categories: state-owned commercial banks and non-state-owned commercial banks. This paper will use HHI, namely the Herfindahl-Hirschman index, as the standard to measure the competitiveness of the banking industry. The Herfindahl-Hirschman index is an index to measure market concentration and the competitive effect of banks (Rhoades, 1993). To measure the banking system risk, this paper will mainly use the Z index to measure bank bankruptcy risk.

As for the research method, this paper will first put raw data into Excel to calculate the HHI index and Z index and then use R to make a univariate linear graph. Finally, the Z index is the explanatory variable, the HHI index is the explanatory variable, and control

variables are added, such as GDP growth rate, to establish a multivariate model. At the end of this paper, this paper will put forward corresponding suggestions according to the model.

Literature Review

Banking is a booster to promote the progress and development of the financial industry and a carrier of risk. Since the main business of the banking industry is about loans and deposits, if the bank has an unbalanced loan relationship or the bank yield is too low, it will lead to the systematic risk of the banking industry. This paper will divide the literature into three categories from the theoretical level of the different relationship between the degree of competition and the risk of the banking system, namely, the theory of competitive fragility, the theory of competitive stability, and the theory of nonlinear relationship.

The Theory of Competitive Fragility

The research from Keeley (1990) puts forward the competition fragility hypothesis, that is, the increasing competition in the banking industry will reduce the value of banks' obtaining concessions, which will also lead to some speculative risks increase of banks' systemic risk. By constructing a dynamic model of moral hazard, this study found that fierce competition may lead to the erosion of bank rent price, increased banking system risk, and social unrest.

In the paper from Sarkar and Sensarma (2016), it is argued that India's financial reform will impact the competitiveness and systemic risk of the banking industry at the same time. By establishing an empirical model, this study found that competition will intensify with the development of reform. With the intensification of competition, some banks with weak supervision ability may favor some borrowers, which will also lead to the increase of bank system risk with the intensification of competition.

The research of Matutes and Vives (2000) studies the relationship between deposit competition and risk-taking incentives. This study evaluates the welfare impact of bank competition under different insurance systems through an incomplete competition model. The

study found that when the cost of social failure is too high or the social competition is too fierce, it will lead to the problem of too high a deposit interest rate, which will also lead to the systematic risk of the banking industry. In other words, the study takes the bankruptcy social cost as the explanatory variable. Market competition will lead to the intensification of banking system risk through regression analysis.

This theory seems to be applicable to China's banking industry in the past two decades. Guo et al. (2011) used the HHI index as the variable and the data of 14 commercial banks in China from 1997 to 2008 as the sample. This study uses the PR model, a non-structural model, to test the relationship. Finally, the study found that the more fierce the competition among banks, the gradual increase of the non-performing loan ratio owned by banks led to the increase of the systematic risk of the banking industry. Zhang and Ma (2019) used the data of Chinese listed banks from 2002 to 2016 to study the impact of the competitiveness of Chinese listed banks on the systematic risk of the banking industry through the GMM method. Finally, the study found that the increase in bank competition will aggravate the systematic risk of the banking industry.

In a word, the competition fragility theory holds that there is a positive relationship between the competitiveness of the banking industry and the banking system risk; that is, the deepening of the competition of the banking industry will lead to the intensification of the banking system risk.

The Theory of Competitive Stability

Due to the research from Berger et al. (2009), fierce market competition will reduce market risk and increase the banking system's stability. The study used more than 8000 banks and used regression analysis to study the sample data. According to this study, fierce competition will reduce the systematic risk of the banking industry. In other words, due to the

security sensitivity of the banking industry, although the competition in the banking industry intensifies, most banks will take positive factors to avoid some unnecessary risks to reduce market risks.

In another paper from Fiordelisi and Mare (2014), it is argued that the scale of the banking industry determines the system risk. The study uses the HHI index to measure the market size and concentration of dozens of listed banks and then measures the systematic risk of banks through the non-performing loan ratio. Through the establishment of the model, the study found that the larger the scale of the bank, the lower the systematic risk of the bank. On the contrary, in the high monopoly banking industry, the systematic risk of the banking industry is higher. With the increase of the scale of the banking industry and the continuous upgrading of banking competition, it will ensure the stability of the economy. At the same time, due to the continuous support of government policies, the risk of bank failure will be reduced, and the loss of banks will be reduced so as to reduce the systematic risk of the banking industry.

For China's banking competition, many economists also support this hypothesis. Li et al. (2015) studied 50 Chinese commercial banks from 2000 to 2012. The fixed-effect model is used in this study, and the results are robustly tested. The results show that large-scale commercial banks will trigger the risk transfer effect when they encounter strong competition; that is, large-scale commercial banks will learn to avoid risks in the process of competition. Therefore, the research results show that the more fierce the bank competition, the higher the stability and security of the bank. Zha and Pu(2016) studied 14 national commercial banks in China and took a sample of 16 years from 1999 to 2015. By establishing a model, the study found that the more intense the deposit competition, the less likely the bank is to have liquidity risk.

In a word, the theory of competitive stability holds a reverse relationship between banking competition and banking system risk; that is, with the intensification of banking competition, banking system risk will decline. In other words, the competition in the banking industry plays a role in promoting the development of the banking system.

The Theory of Nonlinear Relationship

Due to a paper from Martinez and Repullo (2010), there is a nonlinear relationship between banking competition and banking system risk, and this nonlinear relationship is mainly a U-shaped structure. This study examines the U-shaped relationship between competition and banking system risk through the MMR model. In other words, within a certain threshold, there is a positive relationship between competition and banking system risk; that is, banking competition will increase banking system risk. On the other threshold, there is a reverse relationship between competition and banking system risk; that is, banking competition will lead to the banking system's stability.

Jimenez et al. (2013) studied dozens of Spanish banks. This study uses market concentration, i.e., the HHI index, to measure the degree of market competition. Through modeling, it is found that there is a nonlinear relationship between competition and bank risk; that is, there is no significant interaction relationship between competition and bank risk.

Li and Zhou (2015) used the Lerner Index to measure the banking industry's competitiveness, the non-performing loan ratio, and the Z index to measure the risk of the banking system. Through the research and analysis of the model, it is found that there is a nonlinear relationship between China's banking competition and banking system risk. However, suppose the studied banks are classified. In that case, the researchers find that banks' competition with large market share has a positive relationship with the risk level. In contrast, banks' competition with small market share has a reverse relationship with the risk

level. In other words, for some large-scale banks, bank competition can promote the banking system's stability. For some small banks, bank competition may lead to the instability of the banking system.

Consequently, due to Berger et al. (2009), the theory of competitive stability and competitive fragility are not contradictory. The relationship between banking competition and banking system risk is not determined by single factors, which must consider many factors.

Methodology

In general, this paper will use SPSS to conduct multiple regression analysis on various factors such as the degree of competition of the banking industry and the systematic risk of the banking industry.

This paper will collect the data of all 20 banks. After that, this paper will separate all banks into two different types of banks: state-owned commercial banks and non-state-owned commercial banks. Finally, this paper will sort out and analyze three different regression models: all banks, state-owned commercial banks, and non-state-owned commercial banks.

This paper uses the Z index as the explanatory variable to measure the systematic risk of the banking industry. HHI index is used as an explanatory variable to measure the degree of bank competition. In addition, this paper will use the asset-liability ratio, debt to owner's equity ratio, and ROA as the control variables at the bank level, during the quarterly growth rate of GDP as the control variables at the macroeconomic level. The specific names and definitions of various variables are obtained from the following table：

Variable type	Variable name	symbol	Formula
Explained variable	Z index	$Z_{i,t}$	$Z = \frac{ROA + E/A}{\sigma}$
Explanatory variable	HHI index	$H_{i,t}$	$H = \sum_{i=1}^{n} (MSi)^2$
Control variable	Asset-liability ratio(%)	$ALR_{i,t}$	Financial report
Control variable	debt to owner's equity ratio(%)	$DER_{i,t}$	Financial report
Control variable	ROA	$ROA_{i,t-1}$	Financial report
Control variable	quarterly growth rate of GDP	$GGDP_{i,t-1}$	Financial report

For the explained variable Z index, Z represents bank risk. When Z is larger, the risk is smaller, and the banking system's stability is better. ROA represents the sum of the return on assets of all banks in the current year. E / A represents the sum of the ratio of capital to assets of all banks in the current year. Variance represents the variance of ROA for all current years.

$$Z = \frac{ROA + E/A}{\sigma}$$

For the explanatory variable HHI index, H refers to the degree of competition in the banking system. When H is higher, the market will become more concentrated, and the competition will become less fierce. Its calculation method is to square each company's market share in the market and then add the results.

$$H = \sum_{i=1}^{n} (MSi)\text{^}2$$

For the control variable data at the company level, this paper directly obtains the quarterly financial statements of these 20 banks from 2007 to 2020 in Net Ease Finance and Yahoo Finance. For the macroeconomic control variable, namely the quarterly growth rate of GDP, this paper uses China's National Bureau of statistics data.

After obtaining all the above data, this paper will use SPSS to establish a multiple regression model. The specific form of the model is as follows:

$$Z_{i,t} = \delta + \beta_1 H_{i,t} + \beta_2 ALR_{i,t} + \beta_3 DER_{i,t} + \beta_4 ROA_{i,t-1} + \beta_5 GGDP_{i,t-1}$$

By modeling all banks, state-owned commercial banks, and Non-state owned Commercial Banks, this paper can analyze the relationship between the degree of competition of different banks and the risk of the banking system.

Analysis and Findings

All the raw data about bank data in this paper are from the quarterly financial statements of 20 listed banks in China from 2007 to 2020 in NetEase Finance and Yahoo Finance. The raw data of the quarterly GDP growth rate in this paper comes from China's National Bureau of statistics. The raw data used in this paper include asset, equity, ROA, operating revenue, etc. This paper first puts these data into an excel table, then carries out preliminary processing, and finally uses SPSS for modeling. The following table is an example of my raw data about ROA:

roa	2020/12/31	2020/9/30	2020/6/30	2020/3/31	2019/12/31	2019/9/30	2019/6/30
BOC	0.84	0.63	0.45	0.23	0.89	0.76	0.55
ABC	0.8	0.61	0.41	0.25	0.86	0.73	0.51
ICBC	0.95	0.69	0.45	0.26	1.04	0.83	0.56
CCB	0.97	0.73	0.5	0.3	1.06	0.93	0.64
BOCOM	0.74	0.5	0.35	0.21	0.79	0.61	0.44

After obtaining all the original data, this paper will analyze and model three different data of all banks, state-owned commercial banks, and Non-state owned Commercial Banks.

The first step is to use descriptive statistics to describe three different banking systems. This paper will analyze the differences between the three different banking systems. Also, the paper will analyze on Z index trend of these systems. The second step is to use R to establish the univariate model graphics of the HHI index and Z index to analyze the positive and negative relationship. The third step is to use SPSS to detect the Pearson correlation of the data of three different banking systems. This paper will compare and analyze the correlation of different variables in the three banking systems. The fourth step is the establishment of a relational multivariate model. This paper uses SPSS to establish the model and compares the model differences of three different banking systems. The fifth step is the robustness test. This paper will replace the ROA data in the original model with ROE data for the robustness test.

Step one: Analyze descriptive statistics and Z index trend

From the following descriptive statistics, this paper can make a simple analysis of three different banking systems. From the perspective of Z index, the Z index of state-owned commercial banks is the highest among the three systems, which means that the system risk of state-owned commercial banks is the lowest among the three systems. The Z index of non-state-owned commercial banks is the least among the three systems, that is to say, the system risk of non-state-owned commercial banks is the highest among the three systems.

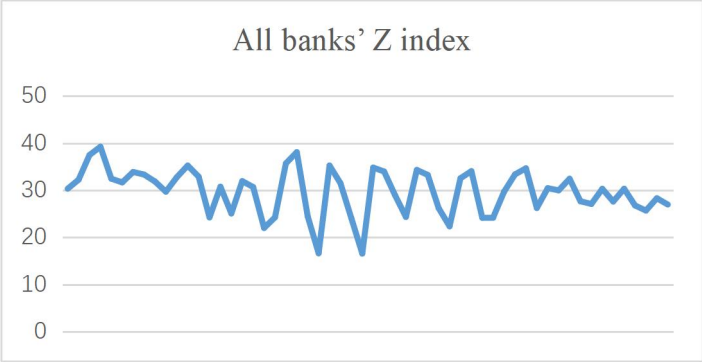
From the HHI index analysis, the HHI index of the banking system composed of all banks is the largest, while the indexes of state-owned commercial banks and non-state-owned commercial banks are relatively small, but it may be related to the small samples selected by the latter two systems.

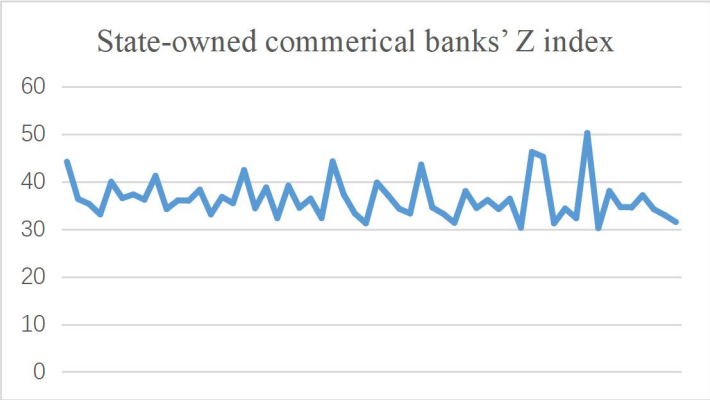
As for the Z index trend chart of the three banks, this paper analyzes that the Z index of the three different systems fluctuates more frequently in different quarters, but the Z index of the three systems fluctuates in the range of 20-50 except for individual quarters. This shows that the risk coefficient of China's banking system changes continuously in different quarters, but the change range is small.

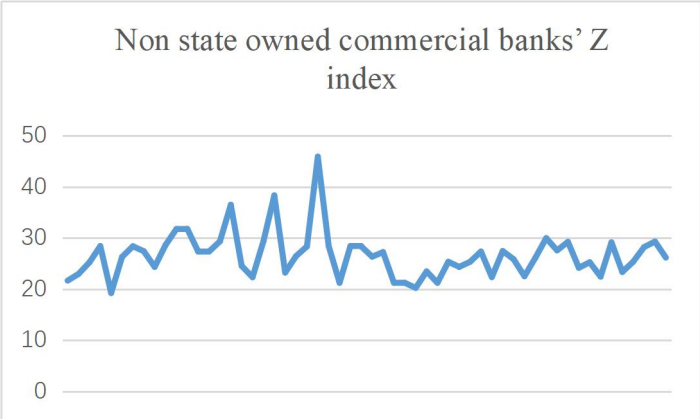
All banks						
Variable	Average	Std. Dev	Maximum	Minimum	Kurtosis	Skewness
$Z_{i,t}$	29.7191	4.892	39.223	16.548	0.0272	-0.573
$H_{i,t}$	1568.081	218.327	1932.324	1120.321	-0,543	-0.117
$ALR_{i,t}$	93.341	0.995	95.270	91.790	-1.222	0.467
$DER_{i,t}$	1438.409	251.856	2012.350	1117.540	-0.732	0.760
$ROA_{i,t-1}$	0.612	0.269	1.110	0.210	-1.088	0.148
$GGDP_{i,t-1}$	0.035	0.114	0.210	-0.257	-0.357	-1.026

State-owned commercial banks						
Variable	Average	Std. Dev	Maximum	Minimum	Kurtosis	Skewness
$Z_{i,t}$	36.368	4.23	50.232	30.234	11.663	-1.749
$H_{i,t}$	2605.482	360.876	3315.472	2000.323	6.906	-1.555
$ALR_{i,t}$	93.608	1.758	103.215	91.595	56.182	-7.361
$DER_{i,t}$	1541.382	560.233	3750.480	234.685	5.128	1.804
$ROA_{i,t-1}$	0.637	0.206	1.030	0.145	-0.460	-0.241
$GGDP_{i,t-1}$	0.035	0.114	0.210	-0.257	-0.228	-1.016

Non-state-owned commercial banks						
Variable	Average	Std. Dev	Maximum	Minimum	Kurtosis	Skewness
$Z_{i,t}$	26.593	4.510	45.900	19.232	5.641	1.717
$H_{i,t}$	1850.139	28.278	1914.344	1800.321	-0.380	0.381
$ALR_{i,t}$	93.047	0.869	95.500	90.910	0.262	-0.138
$DER_{i,t}$	1361.023	190.380	2120.730	999.760	3.152	0.947
$ROA_{i,t-1}$	0.618	0.280	1.140	0.200	-0.939	0.225
$GGDP_{i,t-1}$	0.035	0.114	0.210	-0.257	-0.357	-1.026

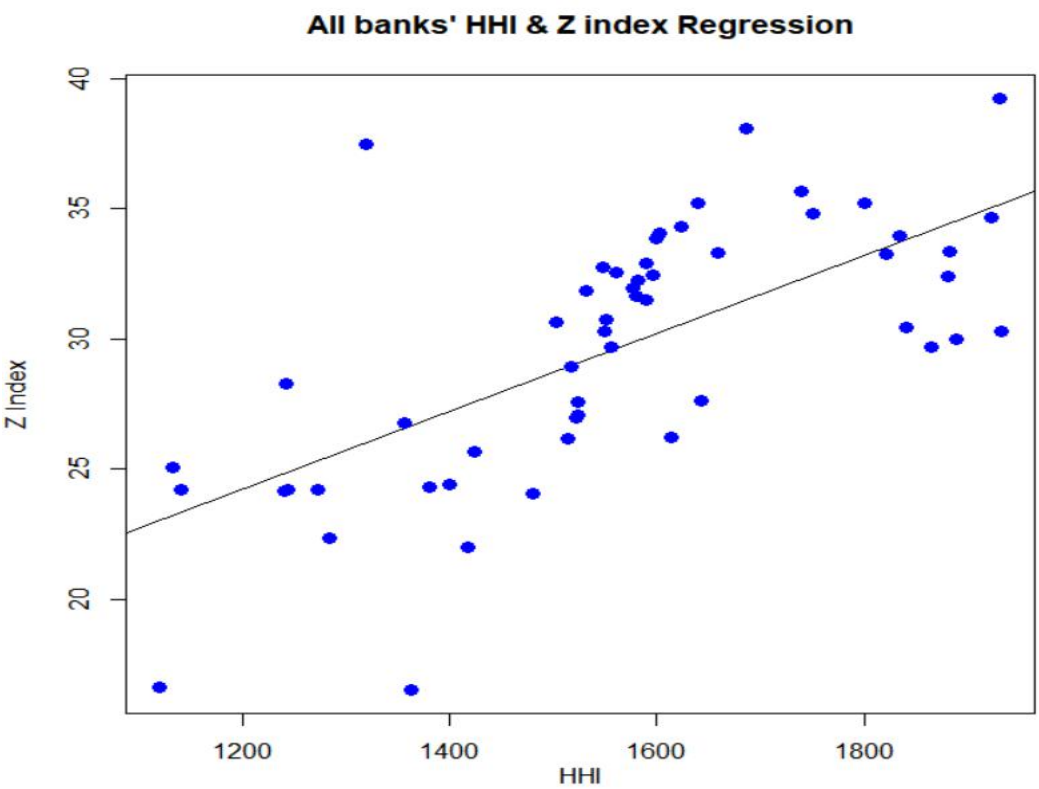


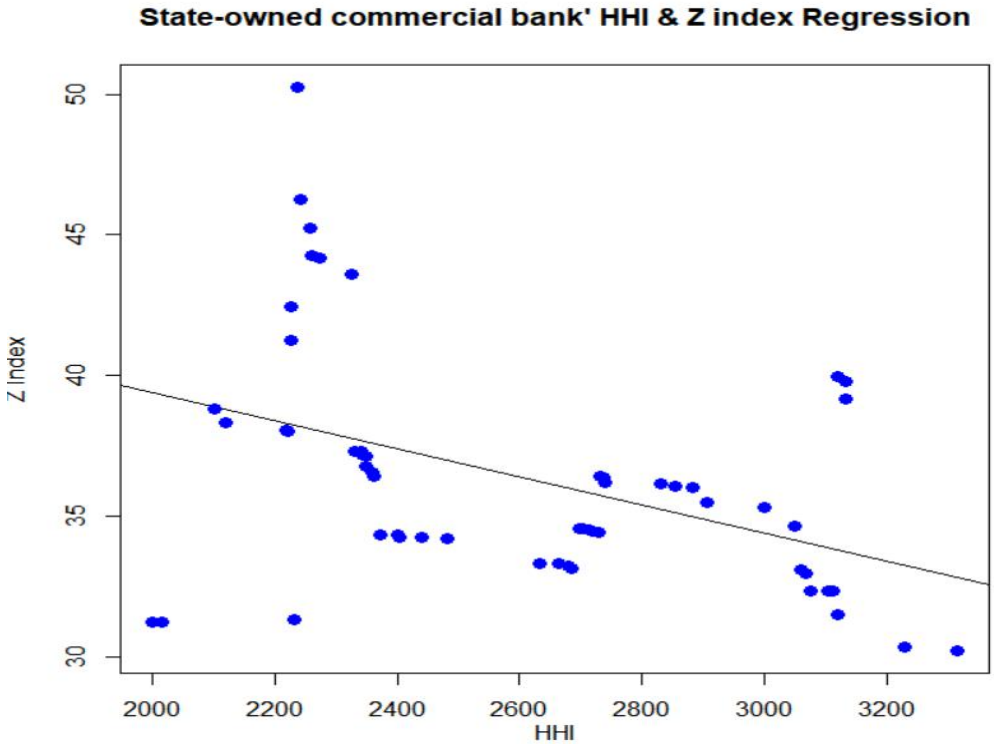


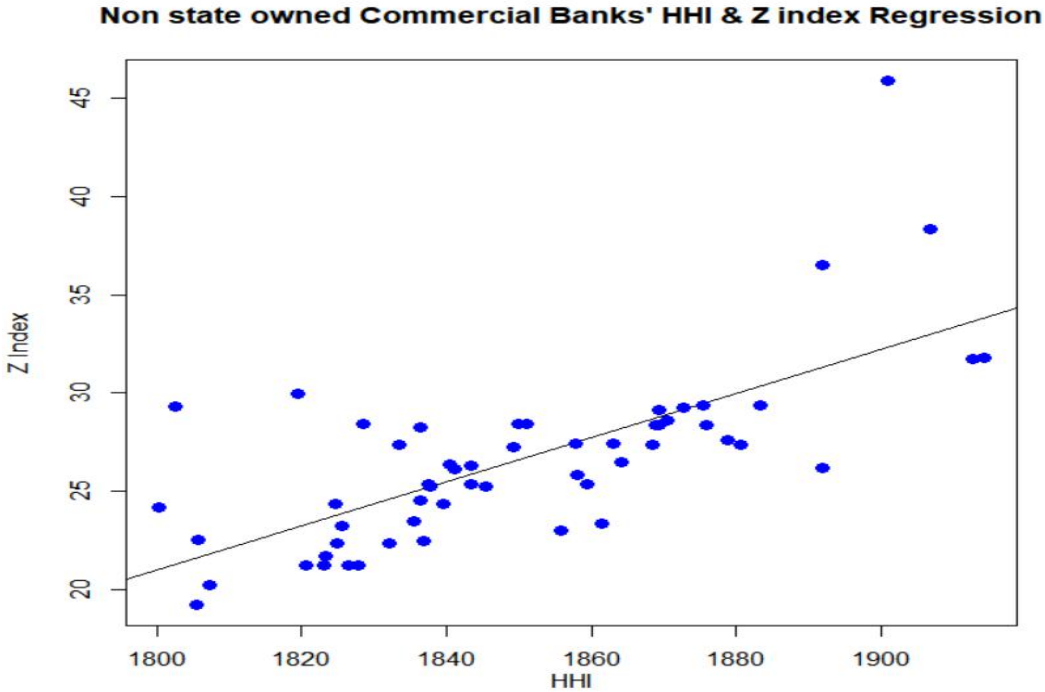


Step two:Analyze univariate model graphics

From the following three pictures of the univariate regression model generated by R, this paper analyzes a certain linear relationship between the three banking systems. For all banking systems and non-state-owned commercial banking systems, the linear relationship between the HHI index and the Z index is positive; when the HHI index increases, the Z index will also increase. In other words, with the fierce competition in the banking market, the risk of the banking system will increase. In these two systems, the linear relationship between non-state-owned commercial banks seems to be more obvious; that is, the HHI index has a greater impact on the Z index. The linear relationship between the HHI index and the Z index is reversed; when the HHI index decreases, the Z index will increase instead. This also indicates that when the banking industry is highly competitive for state-owned commercial banks, the banking system will become stable.




State-owned commercial bank' HHI & Z index Regression
Z Index
30
35
40
45
50
2000
2200
2400
2600
2800
3000
3200
HHI


Non state owned Commercial Banks' HHI & Z index Regression
Z Index
20
25
30
35
40
45
1800
1820
1840
1860
1880
1900
HHI

Step three: Analyze Correlation Matrix

From the following correlation matrix table generated by SPSS, this paper can analyze the relationship between different variables of the three systems. In the three tables, * * * indicates that the data has a significant relationship within 1%, * * indicates that the data has a significant relationship within 5%, and * indicates that the data has a significant relationship within 10%. In the tables of all banking systems, the coefficient with a significant relationship is the least among the three tables, which may be related to the large sample taken. Among the three tables, the HHI index and Z index have the most significant relationship, which shows a close relationship between bank competitiveness and banking system risk in all banking systems. In the tables of all and non-state-owned commercial banks, the relationship index between HHI and Z indices is positive. In the tables of state-owned commercial banks, the relationship between the HHI index and Z index is negative, which corresponds to the picture analysis in step 2. In addition to the close relationship between the HHI index and the Z index, this paper finds that the three tables' ROA and Z index have a close relationship. This indicates that ROA and Z index will also have a linear relationship, which is also one of the focuses of this paper in the following multivariate model analysis.

All banks						
	$Z_{i,t}$	$H_{i,t}$	$ALR_{i,t}$	$DER_{i,t}$	$ROA_{i,t-1}$	$GGDP_{i,t-1}$
$Z_{i,t}$	1.000	0.668***	-0.193*	-0.170	0.347**	0.306
$H_{i,t}$	0.668***	1.000	0.203	0.234**	0.374**	0.157
$ALR_{i,t}$	-0.193*	0.203	1.000	0.993	0.307	0.042
$DER_{i,t}$	-0.170	0.234**	0.993	1.000	0.022	0.035
$ROA_{i,t-1}$	0.347**	0.374**	0.307	0.022	1.000	0.651
$GGDP_{i,t-1}$	0.306	0.157	0.042	0.035	0.651	1.000

State-owned commercial banks						
	$Z_{i,t}$	$H_{i,t}$	$ALR_{i,t}$	$DER_{i,t}$	$ROA_{i,t-1}$	$GGDP_{i,t-1}$
$Z_{i,t}$	1.000	-0.553***	-0.447***	-0.184**	-0.140**	-0.007
$H_{i,t}$	-0.553***	1.000	0.742	0.615**	-0.170**	-0.001
$ALR_{i,t}$	-0.447***	0.742	1.000	0.265	0.058	0.011
$DER_{i,t}$	-0.184**	0.615**	0.265	1.000	-0.304	0.019
$ROA_{i,t-1}$	-0.140**	-0.170**	0.058	-0.304	1.000	0.538
$GGDP_{i,t-1}$	-0.007	-0.001	-0.011	0.019	0.538	1.000

Non-state-owned commercial banks						
	$Z_{i,t}$	$H_{i,t}$	$ALR_{i,t}$	$DER_{i,t}$	$ROA_{i,t-1}$	$GGDP_{i,t-1}$
$Z_{i,t}$	1.000	0.705***	0.093	0.090	-0.391***	-0.287**
$H_{i,t}$	0.705***	1.000	0.134	0.138**	-0.326***	-0.266**
$ALR_{i,t}$	0.093	0.134	1.000	0.979***	-0.008	-0.069
$DER_{i,t}$	0.090	0.138**	0.979***	1.000	-0.014	-0.080
$ROA_{i,t-1}$	-0.391***	-0.326***	-0.008	-0.014	1.000	0.613
$GGDP_{i,t-1}$	-0.287**	-0.266**	-0.069	-0.080	0.613	1.000

Step4: Analyze multiple regression model

In this paper, taking Z index as the dependent variable, HHI index as an independent variable, asset-liability ratio, debt to owner's equity ratio, ROA, and quarterly growth rate of GDP as control scalars, the multivariate equation generated is as follows:

$$Z_{i,t} = \delta + \beta_1 H_{i,t} + \beta_2 ALR_{i,t} + \beta_3 DER_{i,t} + \beta_4 ROA_{i,t-1} + \beta_5 GGDP_{i,t-1}$$

After importing the data into SPSS, SPSS outputs the following three regression model results about different banking systems. In the three tables, * * * indicates that the data has a significant relationship within 1%, * * indicates that the data has a significant relationship within 5%, and * indicates that the data has a significant relationship within 10%. Through analysis, this paper finds that the overall model linearity of all banks is the most obvious; that is, the adjusted R square is the largest. Among the models of all banks, the linear relationship between the HHI index and the Z index is the most significant. In addition, there is also an obvious linear relationship between quarterly GDP growth rate and Z index. In the models of state-owned and non-state-owned commercial banks, the linear relationship between the HHI and Z index is also the most significant. However, through these two models, this paper finds that there is also a linear relationship between ROA and Z index, which corresponds to the analysis of correlation in step 3. There is a positive relationship between the competitiveness and system risk of all banking systems and non-state-owned commercial banking systems in these three models. The competition degree of the state-owned banking system is inversely related to system risk. This is also consistent with the research results of the previous steps.

All banks' Regression Model	
Intercept	115.401
	(340.424)
H $_{i,t}$	0.016***
	(0.002)
ALR $_{i,t}$	-1.153
	(3.874)
DER $_{i,t}$	-0.002
	(0.015)
ROA $_{i,t}$	-1.549
	(2.369)
GGDP $_{i,t}$	11.179**
	(5.097)
Obs.	56
Adj-R^2	0.566

State-owned commercial banks' Regression Model	
Intercept	35.831
	(35.807)
H $_{i,t}$	-0.009***
	(0.003)
ALR $_{i,t}$	0.288
	(0.433)
DER $_{i,t}$	0.001
	(0.001)
ROA $_{i,t}$	-6.413**
	(2.958)
GGDP $_{i,t}$	5.791
	(4.992)
Obs.	56
Adj-R^2	0.342

Non-state-owned commercial banks' Regression Model	
Intercept	-233.538
	(215.181)
H $_{i,t}$	0.103***
	(0.017)
ALR $_{i,t}$	0.822
	(2.452)
DER $_{i,t}$	-0.004
	(0.011)
ROA $_{i,t}$	-2.843*
	(2..038)
GGDP $_{i,t}$	-0.335
	(4.914)
Obs.	56
Adj-R^2	0.480

Step5 : Analyze robustness test

This paper replaces ROA in the original formula with roe for robustness test to further test the regression model. That is, after replacement, the formula of this model will become:

$$Z_{i,t} = \delta + \beta_1 H_{i,t} + \beta_2 ALR_{i,t} + \beta_3 DER_{i,t} + \beta_4 ROE_{i,t-1} + \beta_5 GGDP_{i,t-1}$$

In the following three tables, * * * indicates that the data has a significant relationship within 1%, * * indicates that the data has a significant relationship within 5%, and * indicates that the data has a significant relationship within 10%. This paper finds that the model is relatively robust through the test, and the significance of the HHI index and Z index has hardly changed.

All banks						
	Coefficients	St. Error	t	P-value	Lower 95%	Upper 95%
Intercept	119.218	340.664	0.350	0.728	-565.024	803.461
$H_{i,t}$	0.016	0.002	6.950	0.000***	0.012	0.021
$ALR_{i,t}$	-1.198	3.876	-0.309	0.759	-8.983	6.587
$DER_{i,t}$	-0.002	0.015	-0.130	0.897	-0.033	0.029
$ROE_{i,t-1}$	-1.307	2.155	-0.078	0.547	-5.636	3.022
$GGDP_{i,t-1}$	10.996	5.071	0.256	0.035**	0.811	21.180

State-owned commercial banks						
	Coefficients	St. Error	t	P-value	Lower 95%	Upper 95%
Intercept	48.340	37.197	1.300	0.200	-26.372	123.052
$H_{i,t}$	-0.009	0.003	-3.266	0.002***	-0.014	-0.003
$ALR_{i,t}$	0.082	0.445	0.184	0.855	-0.812	0.976
$DER_{i,t}$	0.002	0.001	1.662	0.103	0.000	0.004
$ROE_{i,t-1}$	-0.423	2.264	-0.187	0.853	-4.971	4.126
$GGDP_{i,t-1}$	0.233	5.687	0.041	0.967	-11.190	11.657

Non-state-owned commercial banks						
	Coefficients	St. Error	t	P-value	Lower 95%	Upper 95%
Intercept	-162.257	44.267	-3.665	0.001***	-251.127	-73.386
$H_{i,t}$	0.108	0.016	6.605	0.000***	0.075	0.141
$ALR_{i,t}$	0.000	0.000	0.000	0.000	0.000	0.000
$DER_{i,t}$	-0.004	0.011	-0.346	0.731	-0.027	0.019
$ROE_{i,t-1}$	-0.812	2.474	-0.328	0.744	-5.779	4.155
$GGDP_{i,t-1}$	-4.306	4.043	-1.065	0.292	-12.423	3.812

Conclusion

This paper mainly studies the relationship between the competitiveness of China's banking industry and systemic risk. Firstly, this paper selects the data of 20 listed banks in China and divides the 20 plus banks into state-owned commercial banks and non-state-owned commercial banks. Finally, three different banking systems are modeled. In this paper, the HHI index is used to measure the degree of market competition, while the Z index is used to measure system stability. Also, in this paper, ROA, monthly GDP growth rate, other bank-level control variables, and macroeconomic level control variables to build a multivariate model.

Through the above analysis, this paper finds that there is a positive relationship between the HHI index and Z index for all banking systems and non-state-owned commercial banking systems; that is, with the increasing competition among banks, the systematic risk of the banking industry is also increasing. It is also in line with the theory of fragile competition. From the model of the state-owned commercial bank system, it is found that in this system, the HHI index and Z index have a reverse relationship, that is, with the increasing competition between banks, the bank's system risk will continue to reduce, and the banking system will be more stable. It is in line with the theory of stability competition. By comparing the financial statements, this paper finds that the scale of state-owned commercial banks is much larger than that of non-state-owned commercial banks, which seems to be similar to the research results of Li and Zhou (2015), that is, for the large-scale or large market share banking system, the competition between banks will strengthen the stability of the system. And as For the small-scale or small market share banking system, the competition between banks will reduce the system's stability.

In addition, the results of this paper show that in addition to the significant linear relationship between bank competitiveness and bank systemic risk, some indexes may also

affect bank systemic risk. From the whole banking system model, the monthly growth rate of GDP also has an obvious positive relationship with the risk of the banking system. From the models of state-owned commercial banks and non-state-owned commercial banks, there is also an obvious reverse relationship between ROA and banking system risk.

Limitations and Contributions

Limitations

There are some limitations to this paper. These limitations mainly exist in two aspects. The first aspect is the selected data, and the second aspect is the established model.

As for the limitations at the data level, the first is about the size of the sample. This paper uses the data of 20 listed banks in total. Although the market share of these 20 banks is the leader of China's banking industry, this sample is still too small for the existing more than 100 banks in China's banking industry, so the research results may not be universal. Moreover, among all the selected banks, only five are state-owned commercial banks. So the test model of state-owned commercial banks has only five large samples, which may lead to the contingency of the experimental results.

The second limitation of data is on the time level. Since most of China's non-state-owned commercial banks were listed around 2007, obtaining these banks' earlier financial statement data isn't easy. Therefore, this paper only uses the quarterly financial statement data of all 20 banks from 2007 to 2020. Therefore, only 56 samples are used in this paper, which may lead to the non-universality of the research results.

From the perspective of establishing the model, this paper mainly establishes a multivariate model and a robustness test model. The model in this paper mainly uses four control variables such as HHI, an explanatory variable, and ROA. Finally, the results show that only ROA and GDP quarterly growth rate has a certain linear relationship with the Z index among the controlled variables. Therefore, if this paper uses more control variables, such as non-performing loan ratio and operating expenses, this paper may establish a perfect model. In addition, this paper uses fewer models. If this paper can use more test models such as KMO and Bartlett's test and interaction term analysis, the test results of this paper will be better.

Contributions

The contribution of this paper mainly has two aspects. The first aspect is the index used, and the second aspect is the classification of the banking system. In terms of index, this paper mainly adopts the HHI index and Z index. Compared with the complex formula of the Lerner Index, this paper adopts a relatively simple HHI index which can well describe the degree of market competition. At the same time, the Z index also has many advantages over the non-performing loan ratio, a commonly used index in other studies. Firstly, the formula of the Z index is relatively simple and convenient for operation. Secondly, the Z index mainly measures the risk of the whole banking system, while the non-performing loan ratio mainly measures the loan risk. Therefore, the risk coefficient described by the Z index is more representative. In a word, the main contribution of this paper to the selection of index is that it can make readers learn more simple index formulas faster to help readers better understand the construction of the whole model.

For the classification of the banking system, compared with most previous studies, which only listed banks owned by a country are studied, this paper divides all research samples into two categories, namely state-owned commercial banks and non-state-owned commercial banks. And these two categories plus all banks to build three different systems. Through the analysis of this study, it is found that the three systems are different from each other. Therefore, this also confirms the possibility that different studies by previous scholars lead to different results.

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