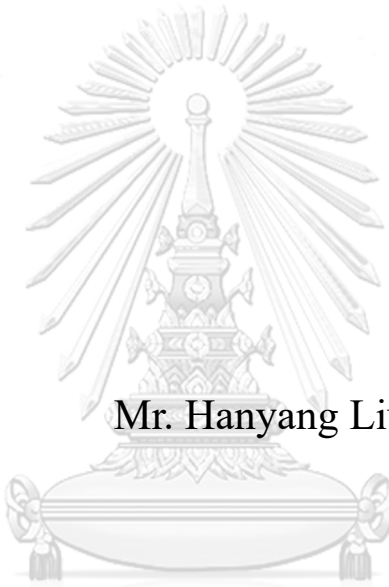
Impact of Bank Competition on Bank Stability in China

Mr. Hanyang Liu



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นายหานหยาง หลิว

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาศิลปศาสตรมหาบัณฑิต

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By	Mr. Hanyang Liu
Field of Study	International Economics and Finance
Thesis Advisor	Associate Professor Dr. SOTHITORN MALLIKAMAS, Ph.D.

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งานวิจัยนี้ศึกษาผลกระทบของการแข่งขันของธนาคารต่อความมั่นคงของธนาคารโดยใช้ข้อมูลแผงแบบไม่สมดุลจากธนาคารพาณิชย์ของจีนจำนวน 38 แห่ง ในช่วงปี 2006-2019 การวัดเสถียรภาพทางการเงินอาศัย 2 ตัวแปร ได้แก่ ลอการิทึมธรรมชาติของคะแนนมาตรฐานของเงินกองทุนสำหรับความมั่นคงของธนาคาร และอัตราส่วนหนี้ไม่ก่อให้เกิดรายได้สำหรับความเสี่ยงของพอร์ตสินเชื่อ สำหรับระดับการแข่งขัน วัดด้วยวิธีการ Panzar-Rosse H-statistic งานวิจัยอาศัยสมการถดถอยทั้งในแบบจำลองเชิงเส้นตรงและไม่เป็นเชิงเส้นตรง และยังศึกษาผลกระทบของการเปิดเสรีอัตราดอกเบี้ยในประเทศจีน

ผลการวิจัยแสดงว่าระดับการแข่งขันในอุตสาหกรรมการธนาคารของจีนมีแนวโน้มเพิ่มขึ้น การแข่งขันที่มากขึ้นส่งผลให้เสถียรภาพทางด้านเงินกองทุนลดลง ซึ่งสนับสนุนทฤษฎีการแข่งขัน-เปราะบาง ผลลัพธ์ของแบบจำลองแบบไม่เป็นเชิงเส้นตรงแสดงว่ามีความสัมพันธ์แบบตัวยูระหว่างการแข่งขันและความเสถียรภาพด้านเงินกองทุน การเปิดเสรีอัตราดอกเบี้ยยังขยายผลกระทบด้านลบของการแข่งขันต่อเสถียรภาพ. อย่างไรก็ดี การแข่งขันก็ส่งผลเสียต่อความเสี่ยงด้านเครดิตหนี้เสีย สนับสนุนททฤษีการแข่งขัน-เสถียรภาพ

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ปีการศึกษา 2563 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

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Hanyang Liu : Impact of Bank Competition on Bank Stability in China. Advisor: Assoc. Prof. Dr. SOTHITORN MALLIKAMAS, Ph.D.

This study investigates the impact of bank competition on bank stability of China over the 2006–2019 period. We use unbalanced panel data from 38 Chinese commercial banks. We employ the natural logarithm of the Z-score to measure bank stability, and the NPL ratio to measure bank credit risk. Meanwhile, the competition was measured through Panzar-Rosse H-statistic. The study uses both the linear and non-linear regression models and investigates effect of the interest rate liberalization in China.

The results show that the degree of bank competition in China is on a rise trend. More competition has caused a decrease in stability measured by the Z-score. This result supports the “competition-fragility” theory. The results of the nonlinear model shows that there is a “U-shaped” relationship between competition and stability. In addition, the completion of interest rate liberalization expands the negative impact of bank competition on bank stability in China. However, more competition also has a negative impact on credit risk (NPL), supporting the “competition-stability.”

Field of Study:	International Economics and Finance	Student's Signature .....
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Hanyang Liu

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Chapter 1 Introduction

1.1 Overall introduction

The effect of bank competition on bank stability has been debated a lot in the past decade years. Particularly after the 2008 financial crisis, the subject of whether bank competition is conducive to bank stability has attracted more attention from policymakers and scholars.

Existing literature on banking competition and stability regards two opposing views. The traditional "competition-fragility" view considers that more competition leads to less stable in banking sector (Beck, 2008). The "competition-stability" view is that more competition leads to more bank stability. Based on the "competition-stability" view, Martinez-Miera & Repullo (2010) suggest that bank competition also have a nonlinear impact on bank risk-taking, result in an inverse "U-shaped" relationship. However, the majority of extant empirical research focus on Europe, the US, or other developed regions or countries. Unlike the more sophisticated banking systems in developed countries, the structure of Chinese banking industry is changing with the banking reform and implementation of financial liberalization, as well as rapid economic growth. As a huge banking system in the process of change, China offers a particularly interesting case to explore the impact of bank competition on bank stability.

1.2 Background of Banking Sector in China

Since the 1980s, the market structure of China's banking system has undergone

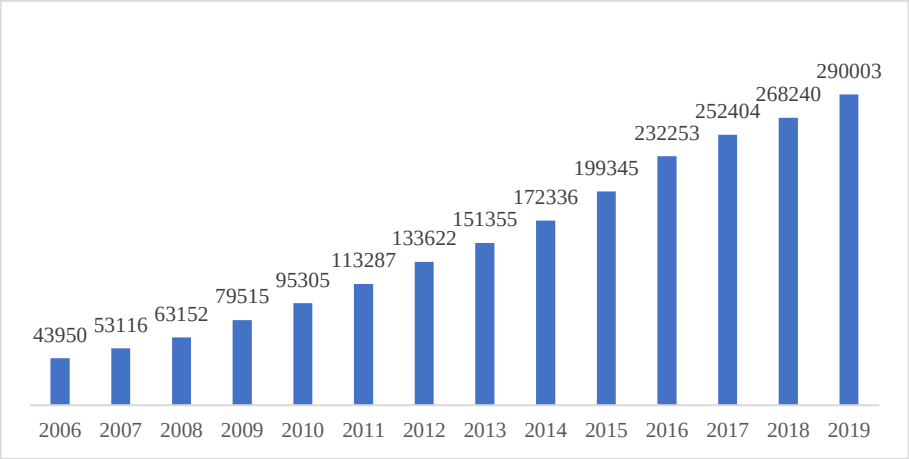
significant transforms, mainly reflected in the expansion of commercial banks. Since 1994, many new commercial banks with small size were established to encourage greater competition among banks. After 2004, the four largest state-owned banks started the ownership reforms. At the meantime, as financial market liberalizing, ownership change, foreign investors entry appeared (Berger et al., 2009)

On the other side, in 1996, the reform of interest rate liberalization began, the Shanghai Interbank Offered Rate (SHIBOR) was officially launched in 2007. In August 2011, the deposit and loan interest rates also achieved the phased objective of "loan management lower limit and deposit management upper limit". In July 2013, the Central Bank decided to fully deregulate loan interest rates. This move marked the basic finalization of China's interest rate market reform. In October 2015, the Central Bank decided to free the floating ceilings for financial institutions on deposit interest rates, which marked the Chinese interest rate reform has been completed. During the gradual advancement of interest rate reform, the mode of bank competition has shifted from scale competition to price competition.

"With the speeding up Chinese banking reform and interest rate liberalization, commercial banks' traditional business model, based on deposit-loan spread income, is becoming unsustainable (Tan et al., 2016)." Therefore, to boost competitiveness, banks try to find new business model and service diversification (Su et al., 2021). As continue of the financial reforms, the overall scale of China's banking industry has grown rapidly and enormously. Figure 1 illustrates the total asset of the Chinese

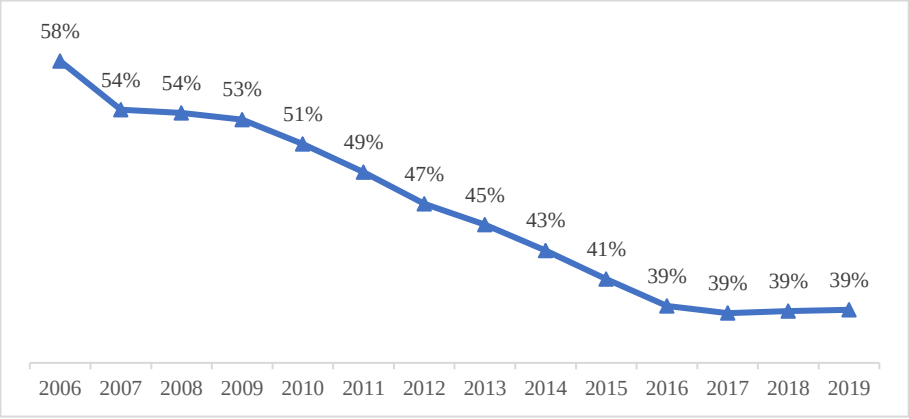
banking sector. The scale in 2019 is 6.6 times that in 2006. In the meantime, the market share of the big five state-owned banks has been eroded. Figure 2 shows the concentration ratio of the big five state-owned banks (CR5), the CR5 has decreased since 2006, after 2016 it remained at 39%. The market structure of China's banking industry has gradually transformed from a monopoly system to a competitive market structure in which different types and different scales of commercial banks coexist.

Figure 1: Total Asset of Chinese Banking Industry (Billion RMB)



Sources: People's Bank of China

Figure 2: CR5



Source: Calculated by author $Concentration_{5,t} = \sum_{i=1}^{5} \frac{Total\ Assets_{i,t}}{Total\ Assets_t}$.

1.3 Object and Scope

Our object is to find out the new trend of bank's competition level and the impact of bank competition on stability in China. We choose the sample covering 38 Chinese commercial banks from 2006 to 2019. Using Z-score, NPL to inverse measure the bank stability, using P-R H-statistic as bank competition measure. In addition, macroeconomic and bank-specific are controlled. Furthermore, we considered interest rate liberalization to reflect the moderate effect on bank competition and bank stability in China.

1.4 Contribution

There are a few contributions of our work. First, we introduced the interest rate liberalization as a moderating variable. We found the completion of interest rate liberalization expands the negative effect of competition in China's banking industry on stability.

Second, we considered both linear model and non-linear model to better investigate the relationship between bank competition and stability. We did a nonlinear test and found that the degree of competition and stability of the Chinese banking industry is in the "U-shaped" relationship. Since the actual competition value in our sample is less than the threshold of the empirical results, the left side of the "U-shaped" relationship has practical significance.

Third, we use different stability measurement methods Z-score and NPL and get opposite results. Competition has a negative impact on Z-score, also a negative impact

on NPL. Consider of NPL only proxy bank credit risk simply, and the strong supervision of banks' NPL by the Chinese regulatory authorities, as well as the bank's cleanup and active evasion of NPL in the reform process. NPL may not fully reflect the bank's risk level in the Chinese banking industry.

Chapter 2 Literature Review

In chapter 2, we present previous literatures relevant to the impact of bank competition on financial stability. Also, literatures about China and bank competition theories are included.

2.1 Competition-fragility

2.1.1 Theoretical literature

Under the “competition-fragility” theory, higher competition leads less stability. The competition-fragility hypothesis is based on the theory that competition may erodes market power in banking sector, then lowers the bank profits, results in bank charter value decrease, that promotes banks to use risk-taking strategies (Noman et al., 2017). Marcus (1984) demonstrates the value of the bank charter will influence bank risk-taking. Keeley (1991) expounds and prove that bank’s charter values will decline when competition level increase. Bank size and monitor are also important reasons for "competition-fragility". When the competition in bank market is high, the number of banks is relatively large and the scale is relatively small, and it is difficult for the government to conduct effective supervision, which increases the risk of banks. Meanwhile, "a few numbers of banks with large size are easy to monitor in high concentration market (Allen & Gale, 2000)." They also suggest that banks get lower information rents from borrowers when the market competition is high. Result in banks have less incentive to supervise the borrowers then increase the moral hazard and adverse selection problems.”

2.1.2 Empirical literature

In cross-country cases, Leroy & Lucotte (2016) take into account both the individual and systemic aspects of risk. The findings show that bank competition pushes banks to take more risks, which leads to increased bank fragility. Using 800 banks data in 48 countries over 1995–2007, Forssbæck & Shehzad (2015) support the traditional "competition-fragility" theory. In the one country cases, Kasman & Kasman (2015) find high competition have a negative impact on bank stability in Turkish, which support the competition-fragility theory. Kick & Prieto (2015) suggest that in higher competition market, the banks pricing ability will decrease, leads to bank risk increase in German universal banks. Tongurai & Vithessonthi (2020) empirically test the connection between bank competition and bank risk in Japan in the period of 1993–2016, suggesting that bank competition have positive r nexus with bank risk-taking.

2.2 Competition-Stability

2.2.1 Theoretical literature

The “competition-stability” theory suggest that more competition imply more stability of the bank industry. This hypothesis originally came from Mishkin (1999) argues that the government will protect large financial institutions from bankruptcy, because a large bank's fail will put serious pressure on the financial system, also erodes the health of other banks. Contagion happens when a modest shock spreads throughout the financial system, causing a systemic problem (Allen & Gale, 2004). Big banks increase the pressure to follow the "too big to fail" policy, which protects

depositors from any losses. Acharya et al., (2012) argue that in less competition market, large banks will receive government subsidies through "too-big-to-fail" systems which increase their risk-taking intentions, increase their fragility. Furthermore, large banks in a more concentration banking sector will increase contagion risk, resulting in a competition and stability have a positive nexus.

Boyd & De Nicolo (2005) propose the "risk-shifting effect". When the average size of banks decrease, the risk-shifting effect arises from fixed bankruptcy costs. Banks' bankruptcy costs are growing at the margin as competition increases, prompting banks to take on less risk. Also, proponents of the competition-stability theory suggest banks with large size are difficult to monitor.

2.2.2 Empirical literature

The competition-stability hypothesis also has been supported by empirical studies. Alin & CĂPRARU, (2011) demonstrate that in the period of 2003-2009 the competition had a positive impact in maintaining financial stability in EU. Jayakumar, et al., (2019) shows that bank competition and bank stability have a long run relationship, and bank competition is driving bank stability, in Single European countries, support the “competition-stability” theory. Liu, et al., (2012) also find that bank risk-taking behavior will not increase by bank competition in Southeast Asian countries. Schaeck, et al., (2009) find that there are fewer systemic crises in financial systems that are more competitive. Li (2019) also suggests more market power, more

bank fragility which is constants with the "competition-stability" view for transition countries.

There are also some studies focus on one single country. Goetz (2018) uses information on U.S commercial banks' stability to examine removal of entry barriers can rise the bank competition, then increase bank stability, also support "competition-stability" theory. Besides, Anginer et al., (2014) show bank competition could reduce the systemic risk in US banks.

Except for these two views, Martinez & Repullo (2010) argue that higher bank competition decreases the interest payments, which provide a buffer to cover loan losses. Result in a margin effect. In monopolistic market, the risk-shifting effect is dominant; in competitive market, the margin effect is dominant, result in bank competition and the bank risk have a U-shape relationship. Ahi, et al., (2019) suggest a "U-shape" link between bank competition and stability in the European region. Besides Clark, et al (2018) suggest a "hump-shaped relationship between market power and stability." Noman, et al., (2017) showed both competition-stability view and non-linear relationship for ASEAN countries over 1990 – 2014. Saif-Alyousfi et al., (2020) find support to "competition-fragility" also "competition-stability" theories in GCC countries. Jiménez et al., (2013) test the "U-shape" theory of MMR, investigate both loan and deposit market in Spanish banking system and find support for this nonlinear relationship.

Table 2-1 summarized the mainly measure of bank stability and bank competition that used by previous literatures.

Table 2-1: Research methodologies used by previous literatures

Author	Region	Mainly measure of bank stability	Mainly measure of bank compeition
Leroy and Lucotte (2016)	EU	Z-score	Lerner
Liu, et al (2012)	Southeast Asian	Z-score	PR H-statistic
Phan, Hien Thu, et al. (2019)	East Asian	Z-score	Lerner
Forssbæck and Shehzad (2015)	57 countries	Z-score	Lerner
Kasman S and Kasman A (2015)	Turkish	Z-score, NPL	Lerner
T. Kick and E. Prieto (2015)	German	Z-score, NPL	Lerner,Boone
Tongurai and Vithessonthi (2020)	Japan	Z-score, NPL	Lerner,Boone
Liu (2017)	China	Z-score	CR
Alin and Bogdan (2011)	EU	Z-score	Lerner
Jayakumar, et al (2019)	EU	Z-score, NPL	Lerner,Boone,H-statistic
Soedarmono, et al (2013)	Asian emerging country	Z-score	Lerner
Schaeck, et al (2009)	45 countries	duration model	H-statistic
S Li (2019)	22 transition countries	Z-score	Lerner
Anginer et al. (2014)	63 countries	distance-to default	Lerner
Liu, et al (2012)	Southeast Asian	Z-score	PR H-statistic
Hu and Xie (2016)	China	Z-score	Boone
Liu, et al (2013)	EU	Z-score	Lerner
Ahi, et al (2019)	EU	Z-score	Lerner,Boone
Clark, et al (2018)	EU	Z-score, ROA ROE	Lerner

Table 2-2: Continued

Noman, et al. (2017)	ASEAN countries	Z-score, NPL	Lerner, H-statistic
Saif-Alyousfi et al. (2020)	GCC	Z-score, NPL	Lerner,Boone
Jiménez, Lopez and Saurina (2013)	Spanish	NPL	Lerner

2.3 Literatures about China

Relative studies provide different results on the impact of bank competition on bank stability in China. Some cross-country cases include Chinese banks. Phan et al., (2019) find China banking system is not stable, their results support the competition–fragility view. Soedarmono, et al., (2013) investigates the impact on the bank stability of bank competition in Asian emerging markets, which include 103 Chinese banks. Their results support "competition-stability" theories.

There are also some single-country studies focus on China. Using the semi-annual data over the period 2005-2016 in China, Liu (2017) provides that the more sufficient bank competition will increase the bank's bankruptcy probability and reduce the bank stability, support the competition-fragile hypothesis. Hu & Xie (2016) use data from the Chinese banking industry find a negative effect of bank competition on bank risk-taking.

2.4 Measuring of bank competition

2.4.1 Structural approach

The structural approach infers the competition level from bank size or numbers in the market. There are two methods of structural measurement that are most widely

used, "the concentration ratios" and the "Herfindahl Hirschman index (HHI)". The concentration ratio is computed as the total assets of the N largest banks/the total assets of the whole banking industry. HHI is computed as the sum of all squared market shares of banks based on their total assets. Structural methods are widely used because of their simple requirements for data and better performance for concentration.

2.4.2 Non-structural approach

The non-structural approach reflects the competition level directly by the specific behavior of banks in the market. Lerner index, and P-R H-statistic are two mainly non-structural methods,

The Lerner index is used to measure bank competition in empirical research which reflect bank competition by market power. The wider the difference between the price of the bank's product and the actual marginal cost of the bank's input, the stronger the bank's pricing power, and the more profit it earns, showing that the bank has strong market power and a high degree of monopoly, indicate a higher Lerner index.

The P-R H-statistic is also a widely used non-structural competition measurement method (Li. 2019; Jayakumar, et al., 2019; Noman, et al., 2017) which was proposed by Panzar & Rosse (1987), "PR model explores the extent to which a change in factor input prices is reflected in revenues earned by bank. "

There are several studies use both structure and non-structure method to examine the link between concentration and competition indicators. Beck (2007) find that higher concentration ratio and higher competition all lead to the decrease of systemic risk. Casu & Girardone (2006) suggest that bank concentration and bank competition have no significant nexus in European countries. Also, Beck (2008) argue that bank concentration ratios is inappropriate measure of bank market power because it does not account for differences in bank strategies. Kasman & Kasman (2015) show that "banks are more stable in a less competitive and less concentrated environment." This contrasts with the traditional view that more concentration proxy less competition. In general, the degree of concentration cannot accurately measure the level of competition. To get a more accurate result, we do not consider concentration measurement Instead, we choose PR model to measure bank competition.

Chapter 3 Methodology

In chapter 3, the commonly used non-structural model PR H-statistic is selected to measure the competition in Chinese banking industry. Also, the stability measurement methods, Z-score and NPL, are listed. In the end, linear and non-linear models are established respectively to test the relationship between the degree of ban competition and stability in China.

3.1 Model

3.1.1 Bank Competition Measurement

We use nonstructural PR H-statistic to measure the degree of competition in China's banking sector. "The H-statistic is computed from a reduced form revenue equation and equals the sum of elasticities of bank revenue with respect to input prices (Panzar & Rosse, 1987)." The model of H-statistic is as shown in Equation (1):

$$ln(REV_{i,t}) = \alpha_i + h_1 ln\,(PF_{i,t}) + h_2 ln\,(PL_{i,t}) + h_3(ln\,(PK_{i,t}) + \sum_k \beta_k ln\,(BSF_{k,i,t}) + \varepsilon_{i,t} \quad (1)$$

The ln indicates the natural logarithm, i denotes bank, t denotes time, $REV_{i,t}$ is is calculated by the ratio of total interest revenue to total assets, which measure the output price, and $\varepsilon_{i,t}$ is the error term.

PF, PL and PK are the price factors of bank inputs. PF is the ratio of interest expenses to total deposits which reflect the price of fund.PL is the ratio of personnel

expenses to total assets which reflect price of labor. PK is the ratio of non-interest expenses to fixed assets which reflect price of capital.

BSF represents several control variables, k indicates control variables. These factors are the ratio of equity to total assets (EQ), proxy the leverage ratio of the bank; net loans (LOAN), and the ratio of liquidity capital to total asset (LIQUID), proxy the liquidity of bank.

We will conduct cross-sectional regression on the annual data from 2006 to 2019 to obtain the annual H statistic. The H-statistic at time t is given by the following expression:

$$H_t = h_{1,t} + h_{2,t} + h_{3,t} \quad (2)$$

The value of H-statistic may take a range from -1 to +1. A higher H-statistic shows that changes in input prices have a greater impact on total revenue and indicate that there is more competition in the market. When the value of H-statistic equal to one indicate a perfect competition. That is, the increase of input prices and total revenue is the same. Because if banks can not cover their input prices, have to exits the market. In this situation, a proportional increase in factor input prices results in the same change in revenues without altering any individual bank's optimal output.

Under a monopoly market, the H-statistic could be zero or negative, indicating that an increase in input prices lowers the bank's overall revenue. H-statistic has a value within 0-1 under monopolistic competition. Increases in input prices will raise

marginal costs, lower equilibrium output, and lower overall revenues. (Claessens & Laeven, 2004)

Table 3-1: Competitive Environment Test

H value	Competitive Environment
H≤0	Monopolistic markets
0<H<1	Monopolistic competition
H=1	Perfectly competitive market

3.1.2 Impact of bank competition on stability

The section will provide a model to measure the impact of bank competition on stability. Z-score and NPL ratio are used to measure bank stability. Z-score is the primary measure of bank stability which is commonly used in relative literature (see: Leroy & Lucotte 2017; Lapteacru 2017; Clark, et al., 2018; Azmi W, Ali et al., 2019). Z score displays how many standard deviations returns must fall for a bank's equity to be depleted. Higher Z score imply more bank stability, also a lower probability of insolvency. Z-score is estimated as follows equation (3):

$$Z_{i,t} = \frac{ROA_{i,t}+E_{i,t}/TA_{i,t}}{\delta ROA_{i,t}} \quad (3)$$

Where, $Z_{i,t}$ is a measure of financial stability of bank i, at time t; $ROA_{i,t}$ stands for the return on assets of bank i, at t time t; $E_{i,t}/TA_{i,t}$ is a ratio of equity to total assets of bank i, at t time t; σ_{ROA} is the standard deviation of ROA computed from time t to t-2 (we consider a three-year rolling window period).

NPL (non-performing loans) ratio is an inverse measurement of bank stability. The "NPL ratio measures a bank's loan portfolio risk or credit risk position (Noman, et al. 2017)." There are a number of previous studies that use NPL ratio to measure bank credit risk, such as Jiménez et al., (2013), Saif-Alyousfi et al., (2020), Leroy & Lucotte (2016). The increase of NPL ratio results in more non-performing loans in the bank's loan portfolio. A high NPL, if not controlled properly, can lead to bank failure. As a result, a large NPL suggests more riskier loan portfolio in the bank, affecting the bank's viability.

We specify the following model equation (4) to study the impact of bank competition on stability in the Chinese banking system and equation (5) for non-liner model.

After the non-linear model, the interest rate liberalization variable is introduced as a moderating variable to analyze the effect of China's interest rate liberalization on the relationship between bank competition and stability. In model (6), the interaction term $LIRM_t * H_t$ is added to construct the model (6). $LIRM_t$ represents the time dummy variable before and after the completion of the interest rate marketization reform. It is set to 1 after 2015 and 0 in 2015 and before.

$$Stability_{i,t} = \alpha + \beta_1 H_t + \beta_2 LnTA_{i,t} + \beta_3 ROA_{i,t} + \beta_4 LDR_{i,t} + \beta_5 GDP\_g_t + \beta_6 CPI_t + \varepsilon_{i,t} \quad (4)$$

$$Stability_{i,t} = \alpha + \beta_1 H_t + \beta_2 {H_t}^2 + \beta_3 LnTA_{i,t} + \beta_4 ROA_{i,t} + \beta_5 LDR_{i,t} +$$

$$\beta_6 GDP\_g_t + \beta_7 CPI_t + \varepsilon_{i,t} \quad (5)$$

$$Stability_{i,t} = \alpha + \beta_1 H_t + \beta_2 LIRM_t + \beta_3 LIRM_t * H_t + \beta_4 LnTA_{i,t} +$$

$$\beta_5 ROA_{i,t} + \beta_6 LDR_{i,t} + \beta_7 GDP\_g_t + \beta_8 CPI_t + \varepsilon_{i,t} \quad (6)$$

Where i=1~N, t = 1~T, N refers the number of individual banks; T refers to time. $Stability_{i,t}$ represents the financial stability of bank i at time t, as measured by the Z-score, and NPL ratio. H_t represents the level of bank competition at time t, as measured by Panzar-Rosse H-statistic. $LnTA_{i,t}$ denotes total assets with a natural logarithm, $ROA_{i,t}$ represents the return on total assets (ROA) for bank i at time t and $LDR_{i,t}$ represents the ratio of bank loan to deposit for bank i at time t. GDP_g_t denotes real GDP growth rate of China at time t and CPI_t denotes CPI of China at time t. $LIRM_{dumt}$ is a dummy variable that denotes the year of China's interest rate liberalization.

3.2 Variable Definition and Hypothesis

We use Z-score and NPL as the dependent to represent bank stability, in the model, a natural logarithm of Z is considered. The bank competition H-statistic is used as the main explanatory which refers to the results.

We also considered the Bank-level control variables. A natural logarithm of total assets to control bank size, the return on total assets (ROA) to control the profitability

of a bank, the ratio of bank loan to deposit to control bank liquidity. Also, since China's interest rate liberalization in 2015, this study considered a time dummy variable to test the different impacts of bank competition on stability before and after interest rate liberalization.

For macroeconomic control, we consider a real GDP growth rate, implies fluctuations of economic environment, and business cycle, which is likely to affect banks' performance in China. We also consider the consumer price index to control the inflation.

Based on the "Competition-Fragility" and "Competition-Stability" theories and previous literature we present in Chapter 2, we set two hypothesizes as follows:

Hypothesis 1: A negative impact of bank competition on bank stability in the Chinese banking industry.

Hypothesis 2: A positive impact of bank competition on bank stability in the Chinese banking industry.

To test the non-linear relationship, hypothesis 3 is set:

Hypothesis 3: A U-shaped relationship between competition and stability in the Chinese banking industry.

We also consider the moderate effect of China's interest rate liberalization on bank competition and stability. "The process of interest rate liberalization is supposed to have an impact on their competitive conditions (Tan, 2017)." (Detragiache & Demirgüç-Kunt, 1998) suggest that the cancel of interest rate ceilings and reduce the

entry barriers may erodes bank's franchise values, then increase moral hazard problems, lead to more fragility in the banking sector. Cubillas and González (2014) also put forward that "in developed countries, financial liberalization fosters increased bank competition, which enhances risk-taking incentives, whereas in developing countries, it increases bank risk by increasing risk-taking options." Therefore, we set hypothesis 4 as follow:

Hypothesis 4: The completion of interest rate liberalization in China has a moderate effect on the impact of bank competition on stability.

Table 3-2 shows the summary of the variables and expect sign.

Table 3-2: Variables Description and Hypotheses

Variable	Description	Expect Sign	
Dependent Variables: Financial Stability Measures		***Z***	***NPL***
Z-score	Overall bank stability measurement		
NPL ratio	Bank's non-performing loans ration, to measure credit risk		
Independent Variables: Competition Measures			
H	H-Statistic, bank's competition measure based on PR model	+/-	+/-
H^2	Square of H	+/-	+/-
Control Variable: Bank level			
LnTA	A natural logarithm of bank total assets	+	-
LDR	The ratio of bank loan to deposit	+	-
ROA	The return on total assets is a measure of the profitability of a bank	+	-
Control Variable: Macro-economic			
GDP-g	Real growth rate of GDP as the representative index of the economic cycle	+	-
CPI	The consumer price index's annual growth rate	-	+
Dummy Variable: Interest rate liberalization			
LIRM:	A time dummy variable for divide the time into before and after China lift restrictions on banks' lending rates	+/-	+/-

3.3 Data and Estimation Method

3.3.1 Data

This study selects 38 major commercial banks in China as a sample. Including 5 state-owned commercial banks, 10 joint-stock banks, 23 Urban and Rural Commercial Banks that cover different types of banks. The total assets of whole sample account for 65% of the industry. The sample period is from 2006 to 2019, and the financial data from the bank's annual report. Table 3-3 reports the name of 38 sample banks and their market shares based on total assets in 2019.

Table 3-3: Bank Sample and Market Shares

Bank Sample and Market Shares based on Total Assets 2019	
State-owned commercial banks	
Agricultural Bank of China	8.58%
Bank of Communications	3.42%
ICBC	10.38%
China Construction Bank	8.77%
Bank of China	7.85%
	39.00%
Joint-stock banks	
Ping An Bank	1.36%
Shanghai Pudong Development Bank	2.42%
HSBC Bank	1.04%
Minsheng Bank	2.30%
China Merchants Bank	2.56%
Industrial Bank	2.46%
Postal Savings Bank	3.52%
Everbright Bank	1.63%
Zheshang Bank	0.62%
CITIC Bank	2.33%
	20.25%
Urban and Rural Commercial Banks	
Bank of Ningbo	0.45%
Jiangyin Bank	0.04%
Zhangjiagang Branch	0.04%
Bank of Zhengzhou	0.17%

Table 3-3: Continued

Bank of Qingdao	0.13%
Qingnong Commercial Bank	0.12%
Bank of Suzhou	0.12%
Bank of Wuxi	0.06%
Bank of Jiangsu	0.71%
Hangzhou Bank	0.35%
Bank of Xi'an	0.10%
Bank of Nanjing	0.46%
Chongqing Rural Commercial Bank	0.36%
Changshu Bank	0.06%
Bank of Beijing	0.94%
Bank of Xiamen	0.09%
Shanghai Bank	0.77%
Bank of Changsha	0.21%
Bank of Chengdu	0.19%
Zijin Bank	0.07%
Bank of Chongqing	0.17%
Bank of Guiyang	0.19%
Sunong Bank	0.04%
	5.86%
Total	65.10%

3.3.2 Estimation Method

The sample data in this article is panel data, which contains 38 cross-sectional dimensions and 14 time dimensions, so the panel model regression method should be used. This article is the unbalanced panel data of big N and small T (N>T)

There are three regression methods for panel data, mixed panel regression, fixed effects regression, and random effects regression. We use series of tests to choose the regression method: First, use the F test to decide whether to choose mixed panel model regression or a fixed-effects model regression. If the F test cannot reject the null hypothesis (P>0.1), use the mixed regression model, if it rejects (P<0.1), choose

the fixed-effects model or random-effects model; Second, use Hausman test to decide whether to choose fixed-effects or random-effects model. If the null hypothesis ($P<0.1$) is rejected, the fixed-effects model is used. If the null hypothesis cannot be rejected ($P>0.1$), the random-effects model is selected for regression. After F-test and Hausman test, both linear and nonlinear models choose the fixed-effects model.

Chapter 4 Results

This chapter gives the results of the competition level, and stability in China, also the results of the impact of competition on stability in the Chinese banking system.

4.1 Descriptive Statistics

Table 4-1 reports full sample data descriptive statistics. The average value of the bank's stability measure LnZ is 4.3, the standard deviation is 1.102, and there is a huge gap between the min and max of LnZ. Indicating that the stability of various banks has greatly differences. The standard deviation of NPL is 0.023, which is bigger than the average value, indicates the NPLs of different bank samples are relatively scattered. The standard deviation and extreme value of LDR are small, which suggest the LDR has a concentrate distribution, represent the ratio of loan to the deposit of sample banks are stable. The macroeconomic control variables, GDP growth, and CPI all have large standard deviations and extreme values, indicating that the domestic economic environment fluctuates greatly from 2006 to 2019.

Table 4-1: Total Descriptive Statistics

variable	N	mean	p50	sd	min	max	range
lnz	474	4.330	4.405	1.102	0.400	7.385	6.985
npl	497	0.0170	0.0130	0.0230	0	0.303	0.303
h	532	0.415	0.422	0.121	0.135	0.643	0.508
lnta	513	11.77	11.69	0.835	10.18	13.48	3.301
roa	499	0.0100	0.0100	0.00300	0.00100	0.0280	0.0280
ldr	532	0.698	0.700	0.148	0	1.210	1.210
gdp g	532	0.0880	0.0780	0.0230	0.0590	0.142	0.0830
cpi	532	0.0270	0.0230	0.0170	-0.00700	0.0590	0.0670

Finally, Table 4-2 illustrates the correlation of variables used in our models. The table clearly shows that the variables correlation coefficients are less than 0.50, indicates they are not highly correlated. As a result, the regressors are not affected by multicollinearity.

Table 4-2: Correlation

	lnz	npl	h	lnta	roa	ldr	gdp g	cpi
lnz	1							
npl	-0.163***	1						
h	0.137***	-0.372***	1					
lnta	0.459***	-0.068	0.234***	1				
roa	-0.290***	-0.234***	0.100**	-0.172***	1			
ldr	0.182***	0.155***	-0.112***	0.203***	-0.096**	1		
gdp_g	-0.427***	0.319***	-0.621***	-0.340***	0.101**	0.001	1	
cpi	-0.157***	0.032	-0.056	-0.102**	0.249***	0.005	0.336***	1

(***, ** and * indicating the coefficient are significant at 1 percent, 5 percent, and 10 percent respectively.)

4.2 Results of Bank Competition and Stability Measurement

4.2.1 Bank Competition

Refer equations (1) and (2), The results of H-statistic are reports in Table 4-3. According to the number of the H-value in Table 4-3, we can see a fluctuating upward trend of the competition level in China's banking sector. From 2006 to 2011, the H value rose from 0.135 to 0.643, reaching the highest point in the entire sample period in 2011. In this period, the market-oriented reform of Chinese banking sector has progressed smoothly, the scale and number of Chinese commercial banks have increased to a large extent, which has promoted the increase in the overall competitiveness of the banking industry. From 2011 to 2014, the H value dropped

slightly to 0.375. Since then, the H value has continued to rise, reaching 0.528 in 2016. It represents the competition of China's banking industry is in a rising trend.

Table 4-3: Results of H-statistic in China

Results of H-statistic in China during 2006-2019				
Year	h1	h2	h3	H
2006	0.176	-0.078	0.036	0.135
2007	0.188	0.023	0.060	0.271
2008	0.207	0.002	0.072	0.281
2009	0.276	0.169	0.029	0.474
2010	0.211	0.162	0.012	0.385
2011	0.326	0.304	0.013	0.643
2012	0.215	0.258	-0.008	0.465
2013	0.198	0.205	0.014	0.417
2014	0.162	0.195	0.018	0.375
2015	0.193	0.187	0.039	0.419
2016	0.240	0.278	0.010	0.528
2017	0.231	0.278	-0.002	0.507
2018	0.209	0.200	0.016	0.424
2019	0.242	0.231	0.010	0.482

4.2.2 Bank Stability

Table 4-4 reports the yearly average of Z-Score and NPL in different types of banks for China during 2006-2019. Z score of banks in China is showing an upward, which represents the increasing stability. From 2005 to 2011, the average NPL ratio of the Chinese banking industry continued to decline and rose after reaching the lowest point in 2011. However, the NPL remained at a relatively low level with small changes after 2015. That shows the credit risk of China's banking industry has decreased in recent years.

Table 4-4: Yearly average of Z-Score and NPL

Yearly average of Z-Score, NPL for China during 2006-2019		
Year	z	NPL
2006	17.281	0.038
2007	5.143	0.029
2008	6.058	0.019
2009	9.941	0.012
2010	9.490	0.008
2011	12.158	0.007
2012	16.089	0.009
2013	29.769	0.009
2014	26.470	0.012
2015	13.967	0.015
2016	10.858	0.015
2017	17.276	0.015
2018	27.208	0.015
2019	47.175	0.014

4.3 Results of impact of bank competition on stability

Tables 4-5 present Fixed effects regression results of models specified in Eq (4), Eq (5) Eq (6). The lnZ-score and NPL are used as the dependent variables, respectively.

Table 4-5: Results of Full Sample Model

	Equation (4)		Equation (5)		Equation (6)	
	(1)	(2)	(3)	(4)	(5)	(6)
	lnz	npl	lnz	npl	lnz	npl
h	-1.737***	-.032***	-5.598***	-.166***	-1.263***	-.039***
	(.465)	(.009)	(2.097)	(.043)	(.475)	(.01)
h22			4.491*	.155***		
			(2.379)	(.049)		
lirm					.537**	-.016***
					(.212)	(.004)
Lirm*h					-7.504***	.131***
					(1.967)	(.039)
lnta	1.348***	.002	1.429***	.004	1.214***	.01*
	(.275)	(.006)	(.277)	(.006)	(.31)	(.006)
roa	-60.643***	-1.764***	-53.083***	-1.54***	-65.391***	-1.986***
	(16.467)	(.336)	(16.899)	(.34)	(17.343)	(.359)
ldr	.64	.072***	.547	.07***	.302	.088***
	(.452)	(.01)	(.453)	(.01)	(.495)	(.011)
gdp_g	-9.127**	.343***	-11.266***	.27***	-9.302**	.373***
	(4.182)	(.085)	(4.321)	(.088)	(4.154)	(.085)
cpi	2.399	-.013	1.594	-.045	1.351	.009
	(2.771)	(.056)	(2.795)	(.056)	(2.746)	(.055)
_cons	-9.933***	-.053	-9.934***	-.046	-8.229**	-.161**
	(3.575)	(.073)	(3.564)	(.072)	(3.984)	(.081)
Observations	474	483	474	483	474	483
R-squared	.338	.312	.343	.327	.36	.333

4.3.1 Results of Linear Model

Model (1) of Table 4-5 illustrates the impact of bank competition (H-statistic) on stability(lnZ). The results show that the coefficient of H-statistic is negative and significant. Suggesting that any increase in the degree of bank competition makes the banking industry of China less stable, which supports the "competition-fragility" theory.

Model (2) of Table 4-5 uses NPL as the dependent variable to inverse proxy bank

stability. The results show that the coefficient of H-statistic is negative and significant. That suggests an increase in the degree of bank competition leads to a decrease in bank credit risk, which supports the "competition-stability" theory.

Unusually, H-statistic has a negative coefficient with both lnZ and NPL. Suggesting increase bank competition will lead to a decrease in bank stability also a decrease in NPL which inverse measures bank stability. The possible reasons are as follows: During the sample period, Chinese banking system has a number of reforms and changes, and the bank's average NPL has been greatly reduced from 0.038 to 0.014. On the one hand, the regulatory authorities have important requirements for banks' non-performing loan ratios, banks have deliberately strengthened their control over non-performing loan ratios and credit risks in the competition. Also, Bashir, Usman, et al (2017) found the Chinese government injected a large number of money to fix the NPLs problems of banks. This has led to a decline in the non-performing loan rate even though the competitiveness of China's banking industry is on the rise. On the other hand, in the process of bank reform, many banks were reorganized and restructured, the banks may cleanup and active evasion of NPL. NPL may not fully reflect the bank's risk level in the Chinese banking industry.

The overall results from equation (4) could be summarized as higher competition has a negative impact on stability in China which supports the "Competition – fragility" theory. In the meantime, higher competition also has a negative impact on bank's credit risk, which supports the "competition-stability" theory. Therefore,

hypothesis 1 and hypothesis 2 are both valid.

4.3.2 Result of Non-Linear Model

After the linear model, we also performed a nonlinear test of the bank competition and stability. The results of the nonlinear test are referred to in equation (5). Model (3) uses lnz as ependent variable and detects the quadratic term of H-statistic. The results show H and the quadratic term of H are all significant. The coefficient of H is -5.598, the coefficient of H^2 is 4.491 which indicates a U-shape relationship between H-statistic and lnZ.

Figure 3 shows the U-shape between H-statistic and lnZ and the inflection point. The inflection point in the model (3) is at 0.623. When the H score reaches the Inflection points, the bank's Z value reaches the minimum, indicates the lowest level of bank stability when other conditions remain unchanged. When the competition degree of the bank is lower than this inflection point, the increase of the competition degree of the bank can significantly reduce the Z value of the bank, that is, increase the commercial bank’s risk-taking behaviors and reduce their stability. But when the bank's H score exceeds the inflection point, as the degree of competition increases, the bank's risk exposure will decrease, and stability will increase. Since 2006-2019, only year 2011's H value is close to the inflection point 0.623. Therefore, the competition level of the Chinese bank industry is on the left side of "U-shape", suggest more competition, less stability, which is consistent with the "competition - fragility" theory.

Figure 3: U-shape of H and lnZ

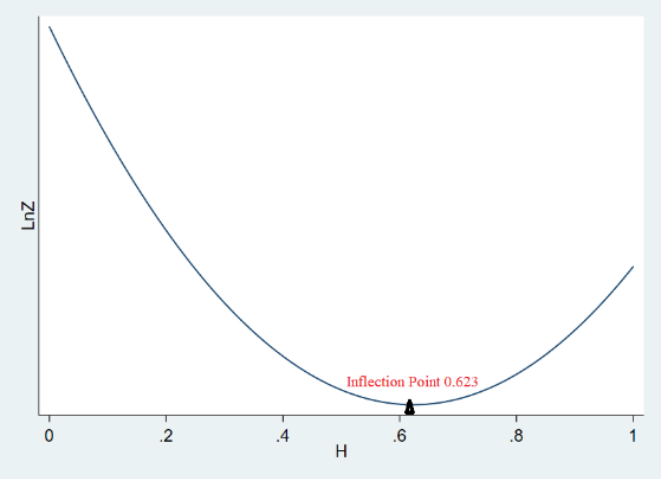


Figure 4: U-shape of H and NPL

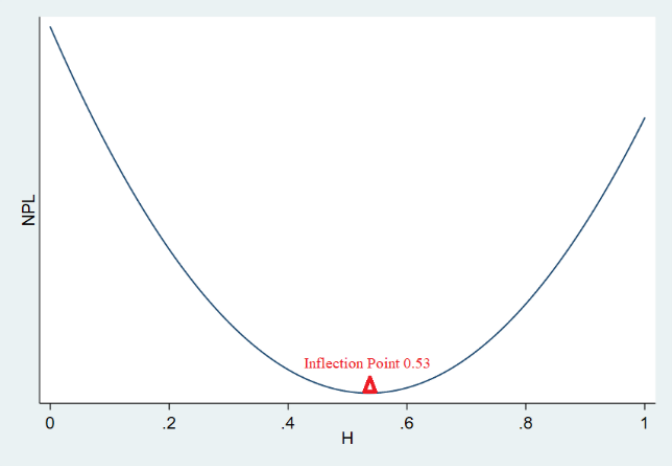


Figure 4 shows the U-shape between H-statistic and NPL and the inflection point. When NPL is the dependent variable, H and the quadratic term of H are also significant. The coefficient of H is -0.166, the coefficient of H^2 is 0.155 which also indicates a U-shape relationship between H-statistic and NPL. The inflection point is 0.53.

The overall results of the nonlinear model suggest the relationship of bank

competition and stability in China is "U-shape" which is consistent with the "U shape theory" of MMR. That means hypothesis 3 is valid. But as the sample of this study, bank competition data in China is on the left side of the inflection point, indicate the increase of bank competition decreases bank stability in China. This result is in line with the linear model, which supports the "Competition-Fragility" theory. At the same time, there is also a “U-shape” relationship between bank competition and credit risk.

4.3.3 Result of Moderating Effect Model

Equation (6) introduces the dummy variables of interest rate liberalization to study the moderating effect on the impact of bank competition on stability. Model (5) and (6) report the results that liberalization of interest rate itself increase lnZ by 0.537 and decrease NPL by 0.016. Therefore, liberalization of interest rate increases bank stabilities also decreases bank credit risk. This means after interest rate liberalization, the Chinese banking industry become more stable. We also consider h*lirm to investigate the interest liberalization’s moderating effect. Before liberalization, the impact of H on lnZ is -1,263 and the impact of H on NPL is -0.039, after liberalization, the impact of H on lnZ is -8.767 and the impact of H on NPL is 0.92. As the result, Figure 5 shows the moderating effect of China's interest rate liberalization on the impact of H on lnZ. After liberalization, the impact of H on lnZ is more negative intense which means after the completion of interest rate liberalization, competition has a stronger negative impact on stability. Figure 6 shows the moderating effect of China's interest rate liberalization on the impact of H on NPL. The impact of H on

NPL is positive after liberalization and negative before liberalization. Suggesting after the completion of interest rate liberalization, competition has a stronger positive impact on bank credit risk. In general, the completion of interest rate liberalization expanded the negative impact of competition in China's banking industry on stability, hypothesis 4 is valid.

With the interest rate liberalization, bank deposits and loan spreads have narrowed, profit margins have fallen, and banks' overall risk-resistance capabilities have declined. At the same time, price competition dominates. The increase of bank competition has weakened the market power of large banks, result in the revenue of commercial banks has fallen sharply. To pursue profits, banks have relaxed their loan approval standards and increased the proportion of risky asset investments, which has led to an increase in bank credit risk and a decline in stability.

Figure 5: Moderating effect of China's interest rate liberalization on the impact of H on lnZ

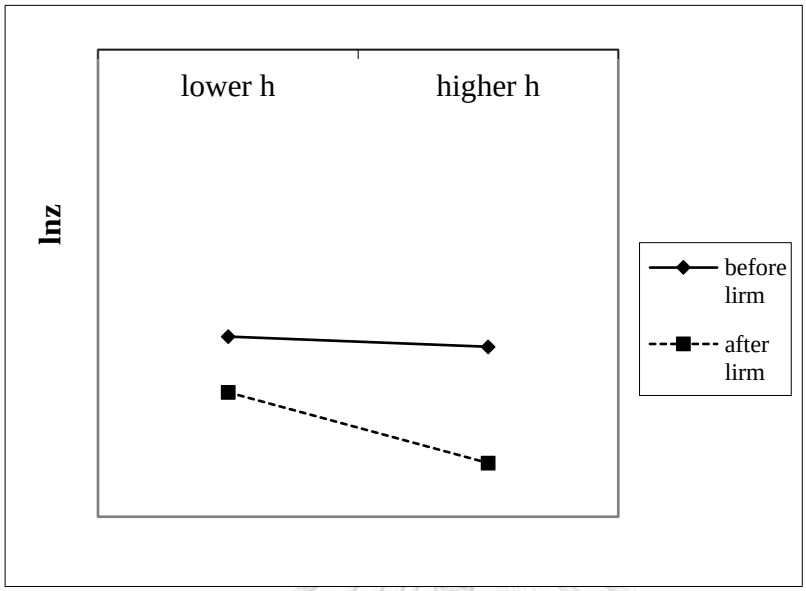
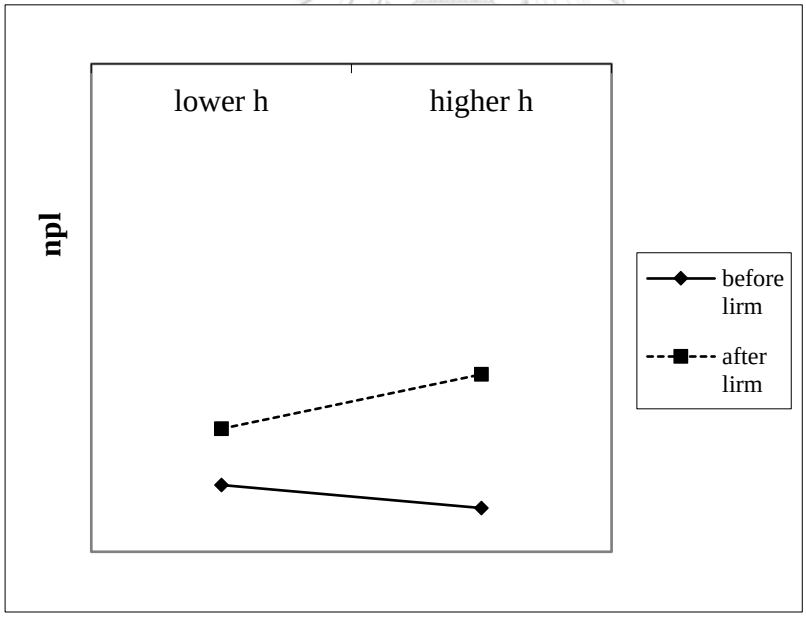


Figure 6: Moderating effect of China's interest rate liberalization on the impact of H on NPL



The results of our control variables are as follows. The total asset of the bank is significantly positively correlated with the Z value, indicating that the larger the bank's assets, the lower the bank risk. That strongly supports the "too big to fail" theory. Bank’s ROA is significantly negatively correlated with LnZ. It represents that

bank with good profitability will have less stability, which is contrary to our hypothesis. LDR is only significantly positively correlated with NPL. Suggesting that an increase of LDR leads to higher credit risk, less stability. Higher LDR means that the total amount of loans lent by banks has increased and liquidity has decreased so that the non-performing loan ratio is increased. GDP_growth is significantly negatively correlated with lnZ, and significantly positively with NPL. That is not consistent with our hypothesis. China's GDP growth rate began a downward trend after reaching a peak of 14% in 2007, and the decline expanded after 2011. In 2012, China's GDP growth rate was less than 7%. Meanwhile, the stability of Chinese banking system has shown an upward trend, which has led to a negative relationship between GDP growth rate and stability. Also, the finding is in line with the research by Phan, Hien Thu et al., (2019), Soedarmono et al., (2011), and Amidu & Wolfe (2013). Amidu & Wolfe (2013) suggested "throughout periods of greater GDP growth, banks in emerging and developing countries appear to be more unstable. In other words, banks may loosen their supervision functions during economic booms, increasing the risk of insolvency."

Chapter 5 Conclusion and Discuss

5.1 Conclusion and Discuss

This study investigates the impact of bank competition on bank stability using unbalanced panel data from 38 commercial banks of China over the 2006–2019 period. The main results are as follows:

From 2006 to 2019, China's H value shows a fluctuating upward trend, the H value rose from 0.135 to 0.482. Li, S (2019) measured the bank competition of 22 transition countries from 1998 to 2016, the result shows the average H-statistic is 0.311, ranging from 0.153 to 0.848. Noman, et al., (2017) used H-statistic to measure the bank competition of 5 ASEAN countries, during 2008 to 2014, the H-statistics of 5 ASEAN countries are above 0.6 and keep a rising trend. Fungáčová, et al., (2017) shows the bank competition of 20 European countries from 2001 to 2011, the H-statistic range from 0.286 (Ireland) to 0.717 (Estonia). Therefore, comparing to other countries in the same period, even the bank competition of China has increased, still less than ASEAN countries and European countries.

In China's banking industry, more competition has caused a decrease in stability, which strongly supports the “competition-fragility” theory, which is consistent with Liu Y (2017), Phan H T et al. (2019). With the reform and rapid development, the degree of competition in China's banking system continues to increase. In the process of bank reform and competition, in order to pursue more profits, banks may adopt radical strategies. Therefore, the control of risks is weak, and the stability of the bank

is reduced.

The results of the nonlinear model show that there is a “U-shaped” relationship between competition and stability. The sample of bank competition data in China is on the left side of the inflection point, also consistent with the "competition-fragility" theory. That means, as the degree of competition increases, the "risk transfer" effect will increase, and the overall stability will increase. Ahi, et al (2019) find a U-shape link between bank competition and stability in the European region. But the level of competition in the EU sample has decreased significantly over time, especially during and after the 2008 financial crisis, which is opposite with China’s rising trend of bank competition. That means the decrease of bank competition is eroding the bank stability in the European region. At present, the bank competition in China is lower than most European countries, with the further reform of China’s banking system, bank competition may keep rising, when the competition changes to the right side of the inflection point, bank stability in China will increase.

In the meantime, we found competition has a negative impact on credit risk whether in the linear or non-linear model. Consider of NPL only proxy bank credit risk simply, the strong supervision of banks' NPL by the Chinese regulatory authorities, and capital support from the Chinese government, as well as the bank's cleanup and active evasion of NPL in the reform process. NPL may not fully reflect the bank's risk level in the Chinese banking industry.

The results of the interest rate liberalization model show that after the completion

of interest rate liberalization, competition has a stronger negative impact on stability, also a stronger positive impact on bank credit risk. In general, the completion of interest rate liberalization expands the negative impact of competition in China's banking industry on stability.

5.2 Policy Recommendation

The findings lead to policy recommendations for Chinese banks. First, seeking differentiated competition. Competition among banks has become increasingly fierce. Banks need to use a series of financial innovations such as strategic transformation and product research and development to get rid of homogenized competition and a single profit structure to improve market competitiveness. When external risks occur, banks have different abilities to resist risks. Therefore, differentiated competition can reduce risk contagion, thereby improving the stability of the overall banking industry. Second, banks need to improve their risk control system. The research results show that high-yield banks will reduce stability. Banks should choose appropriate development strategies according to their conditions, and control risks while pursuing high profits.

For supervisors, with the advancement of China's banking reform, competition in the banking industry has gradually increased. The research results show that the degree of competition and stability of the Chinese banking industry is in a U-shaped relationship. As the degree of competition increases, the "risk transfer" effect will increase, and the overall stability will increase. At present, the bank competition

degree in China is still not fierce, the government does not need to restrict bank competition. The government should improve the market restraint mechanism, such as requiring the banking industry to disclose information to limit banks' greater risk-taking behavior.

After the reform of interest rate liberalization is completed, China's bank industry trends to less stable. "Only remove the celling and floor of interest rate is not enough, if the quantitative restrictions on credit and structural reforms related to market discipline are not changed accordingly, it will lead to undesirable consequences, such as banking crises. (Tan, et al 2016)." The central bank should keep working on reforms in commercial banks' pricing capability, make the banks are real ability to decide the lending and deposit interest rates. At the same time, one of the potential risks is that banks are susceptible to interest rate fluctuations. The supervisory authority should improve the supporting measures in the later stage of the reform of interest rate liberalization. For example, improve the risk early warning mechanism, conduct regular stress tests and risk assessments on banks, track and grasp the risk status of banks on time, and control bank risks within the early warning line to maintain the stability of the banking industry.

5.3 Further study

We chose the PR model as a method to measure the degree of competition. For future research, we can choose other methods to measure the degree of competition for comparison. Also, we selected 38 banks, with a sample interval of 2006-2019,

which has certain limitations. For future research, the sample size and sample interval can be expanded.

The other limitation is the endogeneity problem. NPL and Z score may determine the bank lending and ROA. In the further study, we could use endogeneity test or one period lag of variables to get rid of this problem.

We did not make a comparative analysis of different types of banks. The degree of competition and stability of different types of banks may have different results. In the further study, we could investigate the impact of completion on stability by different bank groups.

We use a dummy variable to indicate China's interest rate liberalization, since China's interest rate reform was implemented gradually, the time dummy variable may not reflect the reform process. Therefore, in the further study, a gradual approach could be considered to proxy the interest rate liberalization.

There could be some non-bank factors which impact the level of bank competition. For example, insurance, mutual fund, and fintech. In the further study, non-bank factor could be considered in the measure of bank competition.

We did not consider the influence of foreign banks on the competitiveness and stability of China's banking industry. With the gradual opening of China's financial industry, the proportion of foreign banks in China has also increased. It should be meaningful to study the degree of competition and stability of foreign banks in China's banking industry.

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