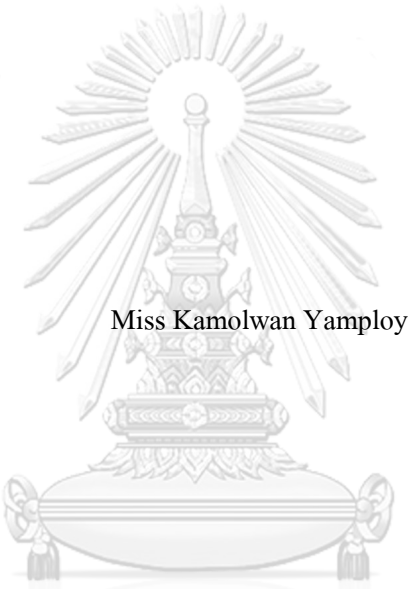
The Effect of Bank Competition on Bank Stability in Thailand

Miss Kamolwan Yamploy



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ผลกระทบของการแข่งขันต่อเสถียรภาพของธนาคารในประเทศไทย

น.ส.กมลวรรณ แย้มพลอย

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาศิลปศาสตรมหาบัณฑิต
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กมลวรรณ แย้มพลอย : ผลกระทบของการแข่งขันต่อเสถียรภาพของธนาคารในประเทศไทย. (The Effect of Bank Competition on Bank Stability in Thailand) อ.ที่ปรึกษาหลัก : รศ. ดร.โสตถิธร มัลลิกะมาส

งานวิจัยนี้ศึกษาผลกระทบของการแข่งขันต่อเสถียรภาพของธนาคาร ด้านความเพียงพอของเงินทุน สินเชื่อที่ไม่ก่อให้เกิดรายได้ ความเสี่ยงของรายได้จากอัตราดอกเบี้ย และความเสี่ยงของรายได้ที่ไม่ใช่อัตราดอกเบี้ย โดยใช้ดัชนี Lerner index เพื่อวัดระดับการแข่งขันรายธนาคารแบบไม่ใช่เชิงโครงสร้างตลาด และใช้ข้อมูลของธนาคารพาณิชย์ไทย 11 ราย ในช่วงปี 2553-2561 และวิเคราะห์แบบ Panel Least Square Regression

จากผลการวิจัย พบว่า ธนาคารที่มีอำนาจตลาดมาก จะมีพฤติกรรมการปล่อยสินเชื่อที่มีความเสี่ยงลดลง ส่งผลให้ธนาคารสามารถรักษาระดับเงินทุนในระดับต่ำและมีความเสี่ยงของการลงทุนที่ก่อให้เกิดรายได้ที่ไม่ใช่อัตราดอกเบี้ยเพิ่มมากขึ้นได้ ในทางกลับกัน การเพิ่มขึ้นของกระจุกตัวของธนาคารใหญ่ 5 ราย ซึ่งเป็นการวัดระดับการแข่งขันแบบเชิงโครงสร้าง ส่งผลให้ธนาคารจะมีพฤติกรรมการปล่อยสินเชื่อที่มีความเสี่ยงเพิ่มมากขึ้น นอกจากนี้พบว่า ขนาดของธนาคารมีผลดีต่อเสถียรภาพ โดยเพิ่มระดับเงินกองทุนและลดความเสี่ยงด้านการปล่อยสินเชื่อ ความเสี่ยงของรายได้ดอกเบี้ยและความเสี่ยงของรายได้ที่ไม่ใช่ดอกเบี้ย ในขณะที่ ธนาคารที่มีสัดส่วนเงินกู้ต่อสินทรัพย์สูงจะทำให้มีความเสี่ยงด้านการปล่อยสินเชื่อและความเสี่ยงของรายได้ที่ไม่ใช่อัตราดอกเบี้ยลดลง

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This research studies the impact of competition on bank stabilities, which are capital adequacy, non-performing loans ratio, interest income risk, and non-interest income risk. Lerner index is used to proxy degree of non-structural bank competition. We use data on 11 Thai commercial banks from the year 2010 to 2018 and employ Panel Least Square regression.

Our results show that banks with higher market power tend to have lower risk lending behaviors. As a result, this allows them to have lower level of capital and higher level of risk in non-interest income activities. On the other hand, higher concentration ratio 5, measuring degree of structural competition, could lead to higher risk lending behavior. In addition, bank size has positive impact on stabilities by increasing capital level and decreasing credit risk, interest income risk and non-interest income risk. while high loan-to-asset ratio tend to lower credit risk and non-interest income risk.

Field of Study:	International Economics and Finance	Student's Signature .....
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Kamolwan Yamploy

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Chapter 1

Introduction

1.1 Background of study

Commercial banks are considered financial institutions that play an important role in saving and they are the largest and most important source of money to businesses, governments, and households, which will create production and employment as the main driving force for economic growth and stability. The main activity of the banks is lending which generates income in the form of interest rate, accounting for around two-thirds of total revenue.

Financial institutions face various risks in their operations such as credit risk, market risk, operation risk, and liquidity risk. Credit risk is resulting from a borrower's failure to repay a loan or meet contractual obligations. Also, it is associated with the core business of banks, which involve loan lending and deposit activities. It is being known as a non-performing loan, which the debtor has not made the scheduled payments for a specified period that reduce their stability. Market risk is that a commercial bank may be damaged due to changes in the price or asset value, liabilities and obligations which is caused by fluctuations in market factors such as interest rates, exchange rates, securities prices, and commodity prices. Operation risk may damage to commercial banks due to lack or inadequate in employment, laws, and operation system. Liquidity risk is the risk that commercial banks may not be able to pay debts and obligations due to not being able to earn enough money or earn money at a higher cost than acceptable levels, which may affect the income and capital of commercial banks both current and future. So, the bank must manage the Capital Adequacy Requirement to maintain its stability.

As the commercial bank plays the main role in driving the country's financial economy by acting to mobilize and allocate funds to the real economy, goods and service payment, risk management Including providing financial information for decision making. If the bank lacks stability either from profit losses or insufficient working capital at any given time including the risks mentioned above, it may affect people's confidence in the financial and economic system. Therefore, the banks must give credit with caution to prevent credit quality problems. Additionally, ensuring that the operations of financial institutions are efficient, transparent, with

good governance and risk management appropriately to protect the public deposits are very important to its stability.

Nowadays the competition among the commercial banks is increasing and affects the bank's performance. The competition can be divided into two types: banks and non-banks.

For the competition from other banks, the new challenge for banks is the advancement of technology that drives the bank to focus on strategies to strengthen relationships with customers through digital channels to be a leader in digital banking and support Thailand into a cashless society. The Bank continues to expand its ability to provide services through digital channels such as Internet Banking or Mobile Banking which will benefit the cash management costs of banks and customers as well as lower operating costs for long-term economic systems. According to McKinsey & Co., bank will be required to use technology to improve efficiency and fend off the threat from "digital attackers" such as Alibaba and Google. The Startup companies such as Fintech and Blockchain, may extend their ability to collect deposits, lending and have the e-currency known as Cryptocurrency, further eroding the market share of the region's bank.

For the competition from non-banks, bank also have the impact from the competition among capital market, other financial market, venture capital and funds. After the global financial crisis (GFC) of 2007-2008 also known as Hamburger crisis, banks were more restricted by the government supervision and regulation of the bank's activities. Moreover, the interest rate is relatively lower since the Quantitative Easing (QE) from the central bank. Therefore, investor and household tend to invest and saving through the capital market which have higher returns (Asset management). On the other hand, the business was also funding the capital to use in their business instead of relying on bank loans which makes business more flexible and did not have the interest payment on time to the bank but have to pay only a dividend payment according to the performance.

The impact of bank competition on bank stability has always been controversial over two decades, especially since the 2007-2008 financial crisis (Danisman & Demirel, 2019; Fu, Lin, & Molyneux, 2014; Kasman, 2015) Under traditional economics, the perfect competition is the most efficient market compared to monopoly market structure since the competition drives the business

to improve the product quality, innovation, efficiency in order to survive in the market. In the context of the financial market, competition helps people easier to access credit because it pushes banks to set lower interest rates. The borrower will be able to repay the loan then bank will get higher stability. On the other hand, aggressive competition reduces the bank's profits. Then, the competition will stimulate excessive risk-taking by reducing the lending standard to get more customers. This results in higher credit default risk or the non-performance loan which cause the fragility in the bank.

In the context of Thailand, (Fu et al., 2014) studied on the impact of competition and concentration on the bank stabilities which were the probability of bankruptcy and Z-score. They measured from 2003 to 2010 for 14 Asia Pacific. Thailand had the 3-Concentration ratio at 45.50% on average, which were roughly equal as Japan, China, and Indonesia. While the averaged E-Lerner index was 0.31 equal to Korea. They found out that the increased in market power would increase the individual bank stability while bank in more concentrated market would increase the bank fragility.

Therefore, this study will deeply measure and analyze the competition in Thailand during 2010 to 2018 and investigate broader relationship between bank competition and the bank stability which is not only dimension of bank's capitalization but also the non-performing loan risk and income risk. In addition, we will analyze and suggest the policy implication on the competition regulation to increase bank stability.

1.2 Objectives

The objective of this study is to examine the effect of bank competition on the bank stability and risks which are banks' capitalization level (Z-score of ROA), non-performing loan ratio (NPL), interest income risk, and non-interest income risk.

1.3 Scope of the study

This study uses the Lerner index as the proxy for the market power, the higher the value means the bank has more market power or the market is lower competition. For the bank stability, we divide into 4 parts: banks' capitalization level (Z-score of ROA), non-performing loan ratio (NPL), interest income risk, and non-interest income risk.

The banks' capitalization level (Z-score) measures the capital level and risk-adjusted return, the high value of z-score represents a low risk of insolvency or a highly stable. The non-performing loan (NPL) is the credit risk or a risk of holding the poor-quality asset, the higher values mean the less bank stability. The interest income risk and the non-interest income risk measure the income volatility and reflect the bank's strategic of banking activities whether they focus on core business or non-traditional activities.

This study used the sample from Thailand financial institute data; Quarterly data on the balance sheet and income statement which are obtained from the Stock Exchange of Thailand, The Settrade, the Bloomberg Terminal, and the CEIC for the normal period from 2010 to 2018. We focus on public banks listed in the Stock Exchange of Thailand comprising 11 banks in the financial industry as the following

1. Bangkok Bank (BBL)
2. Siam Commercial Bank (SCB)
3. Kasikorn Bank (KBank)
4. Krungthai Bank (KTB)
5. Bank of Ayudhya (BAY)
6. Thanachart Capital (TCAP)
7. Thai Military Bank (TMB)
8. TISCO Bank (TISCO)
9. CIMB THAI Bank (CIMBT)
10. Kiatnakin Phatra Bank (KKP)
11. LH Financial Group (LHFG)

Chapter 2

Literature Review

Measuring of bank competition is very crucial for the policymakers and banks to determine how banks in the industry compete each other. There are two types of banking competitive measures: structural and non-structural approach, which people commonly use the structural approach such as Hirschman-Herfindahl (HHI). To research on the relationship of the bank competition on bank stability in the context of Thailand, we review the past empirical literature on its relationship which are two perspectives: stability view and fragility view. The several studies support on the fragility view over stability view, which explains that higher competition in the bank industry has made banks less stability.

Besides the bank's competition, bank stability depends on other bank-specific variables such as size of the bank, the asset composition ratio, and the number of foreigner shares. In the last section, we summarize the literature on relationship of bank stability and industry competition ratios as well as macroeconomic indicator.

2.1 Measurement of bank stability

Banks should maintain own stability and manage the risks, which are key driver behind profitability and confidence in the economy. It can be defined in a various dimension such as default risk, liquidity risk, credit risk, market risk, and operational risk.

For the default risk, Z-Score is the most popular measure for overall stability. it is a measure of the expected capital level in the next period or the bank's capital level plus the ROA against the fluctuation of its return (Li, Tripe, & Malone, 2017). It can be interpreted as the number of the standard deviations by which they loss and deplete their capital (Kasman, 2015). In the case that a bank has low capital and high return volatility, the bank is at high risk of bankruptcy as bank suffers a loss and results in a loss of shareholder capital. Z-score consists of two components (Danisman & Demirel, 2019): the leverage ratio and portfolio ratio. Leverage ratio is proxied by the equity to total assets ratio and divided by the standard deviation of ROA. It measures how much effect from change in one standard deviation of ROA on their equity. For portfolio ratio, it is proxied as the ROA divided by standard deviation of ROA. A high value

means the bank has a high ROA or low ROA fluctuation. Moreover, Altman Z-score is also widely used in the evaluation of company. It uses the financial ratios such as liquidity, leverage, profitability, and sale generating ability to calculate the Z-score. (Altman, 2000) However, we have not found any the literatures related to the bank's competition. This may be because the Altman Z-score was unable to analyze its effects separately on each of the risks.

For liquidity risk, it can be measured by the ratio of liquid assets to total assets. The high values mean banks have high liquidity or high stability. Due to, they can generate the cash from their current asset. (Fu et al., 2014)

For credit risk, many literatures used the non-performing loan ratio to measure the risk. The high ratio means bank has low quality loan portfolio. Then it increases the cost of banks because borrowers are unable to repay their loans (Berger, Klapper, & Ariss, 2009; Kasman, 2015). However, non-performing loan ratio is the binary variable, it is suitable for logistic regression model. So, they used the log-odds transformation to transform the variable from unit interval to real line (Danisman & Demirel, 2019).

For market risk and operation risk, (Danisman & Demirel, 2019) and (Kohler, 2015) used the Non-interest income risk and interest income risk to measure the volatility of income. This is due to either the market interest rate, the return on other markets from the investment rate and set the rate by themselves.

2.2 Measurement of bank competition

bank competition can be measured from the industrial economics in two approaches; the structural approach focuses on the bank industry such as the k-firm concentration ratio, the Hirschman-Herfindahl (HHI). The concentration ratio is the sum of the market share of the largest k firm in the industry which market share is the share of loan to a total loan of the banking system (Fu et al., 2014). The typical values of k are 4, 8, and 20. This is easy to find the market share and can classify of market structure such as if CR is more than 0. 7, the market structure is the monopoly. The limitation is it does not consider all firms in the industry and does not provide information about the distribution of market share. The Hirschman-Herfindahl (HHI) is the sum of squares of the market share of each bank I n the market. It considers the relative size and

distribution of bank in the market. the HHI is close to zero when a market consists of many firms of relatively equal size.

The non-structural approach observes the actual competitive behavior of banks such as the Boone indicator and Lerner index. The Boone indicator overcomes the shortcomings of structural measures of competition since it can capture the interaction among banks (Kasman, 2015). It is measured from the coefficient of marginal cost in which model that market share is the dependent variable. If the coefficient is negative, it is expected that the rise in competition reduces the marginal cost then raises the market share of the more efficient bank relative to a less efficient one. In the case of the coefficient is positive, the market has a high level of collusion or bank is competing on quality as the higher marginal cost will raise the market share of the bank. The Lerner index is the most popular competition indicator in the several works of literature by calculating the difference between price and marginal cost divided by its price (Danisman & Demirel, 2019; Fu et al., 2014; Kasman, 2015). It measures the degree of competition that given range between 0 and 1. In case the value is close to 1, meaning that the bank has high market power, or the market has low competition. From (Koetter, Kolari, & Spierdijk, 2012), they used the efficiency-adjusted Lerner index (E-Lerner) instead of the Lerner index since the banks in the real market may not be profit efficiency and cost efficiency. Moreover, the banks may not take advantage from price opportunities. Therefore, in E-Lerner index, the price is substituted by the profit and total cost of the bank.

In this paper, we choose the E-Lerner index to measure the competition as it easily can capture the competitive in each bank than the overall market structure. Moreover, we consider that the rival of the bank is not only from the other bank in the loanable market, but it also has the rival from the other players in the financial market such as the non-bank, the stock market, and the bond market that they can be the sources of funds. In addition, there are several external factors that also affect the competitiveness of the bank such as changes in technology that will force banks to improve their efficiency to compete with other players in the market. Therefore, we will not only use the market share to measure competition.

2.3 Bank competition and Bank stability

In economic theory and empirical evidence cannot be concluded about the impact of increasing market power of bank on its financial stability. There are two points of view on its relationship; competition-fragility view and competition-stable view.

2.3.1 The competition and financial fragility view

Under the more competition or less market power of bank will contribute to more fragile in their bank (Berger et al., 2009; Fu et al., 2014; Kasman, 2015; Saif-Alyousfi, Saha, & Md-Rus, 2020). (Allen & Gale, 2004) explained about the excessive competition made agent problem during the crisis due to the more competition in financial system decreased the interest rate or reduced their monopoly rents (Danisman & Demirel, 2019). Therefore, bank would have more incentive to take more risky activities as they had nothing to lose. Conversely, if banks had some market power and have franchise value or be extraordinary than other banks, bank manager and shareholder would be more prudent behavior by holding more equity capital (Keeley, 1990) and using more derivatives to hedge the loss from the fluctuation in interest rate and foreign exchange rate (Demsetz, Saidenberg, & Strahan, 1996). In additionally, banks were able to diversify their loan-portfolios due to the economies of scale (John H Boyd & Prescott, 1986) and had an information comparative advantage on credit monitoring (Danisman & Demirel, 2019). So, they could get the high quality of client that created the future return with lower risk which reduced the non-performing loan in bank. Therefore, the competition might harm for the financial stability.

2.3.2 The competition and financial stability view

There are also some studies on the competition lead to increase the stability in financial sector (Fiordelisi & Mare, 2014). (John H. Boyd & Nicolo, 2005) showed the more competition in financial sector led to decrease in the interest rate on loan. So, the borrower would invest less in the risky investment. On the other hand, the less competition tended to increase the interest rate. The borrowers were not able to pay high interest rate, or they could take the money to invest in high risk to get high return (Berger et al., 2009) which called "Moral Hazard". Moreover, if financial sector had high concentration or low competition, the larger banks would be supported from the government which might increase the risk-taking behavior in banks (Fu et al., 2014).

2.4 Bank specific factors and Bank stability

Bank size ($Size_{st}$) is defined as the natural logarithm of total asset. From (Danisman & Demirel, 2019; Fu et al., 2014; Kohler, 2015), the larger banks were the less stable. They dared to face risky activities or moral hazard more than the smaller banks because they were protected and bailed out by the government because of "too big to fail" subsidiaries. From (Laeven, Ratnovski, & Tong, 2016), the large banks would pay less attention to the risk. they took risk and created externalities when they distressed that might lead to greater systemic risk. While From (Kasman, 2015) and (Saif-Alyousfi et al., 2020) got the opposite results, the larger banks were more stable.(Jittima Tongurai & Chaiporn Vithessonthi, 2020), they might be able to diversify loan-portfolio risks due to the higher economies of scale and scope.

The loan to asset ratio (LR_{st}), as a proxy for the asset composition, it is measured by the ratio of total loan to the total asset. the high value of the loan to total asset ratio indicates that the banks are more focusing on lending activities. (Kohler, 2015) and (Zhou, 2014) argued that the lending specialization provided information advantage which might have more stability than the bank that expanded product line such as insurance and investment as well as associated with the larger shares of non-interest rate income which were riskier and might have high-income volatility. In addition, (Saif-Alyousfi et al., 2020) found that the higher degree of loan exposure decreased the bank risk-taking and enhance stability. On the other hand, (Kasman, 2015) and (Danisman & Demirel, 2019) found that the higher the ratio of loan to the asset, the more bank exposed to credit risk. So, the bank would have less bank stability.

Foreign ownership ($Foreign_{st}$) is the type of ownership of the bank. In general, foreign ownership occurs when the foreign bank or multinational corporation inject long-term investment through foreign direct investment or acquisition. We classify the bank as foreign if the share of foreign capital exceed 50% of the total capital during the sample period. (Kasman, 2015) found that foreign ownership was significantly negative related to Z-score. (Berger et al., 2009) suggested that the foreign banks had more income volatility than the domestic banks, as they limited their financial products and services to only companies that came from their country. In addition, the taxation also drove foreign bank to transfer their earning back to home country

related to currency exchange rates. On the other hand, (Berger, Ghoul, Guedhami, & Roman, 2015) found that the bank holding company membership was significantly negative related to credit risk or NPL ratio. The bank had more stability because the bank would be supported by its holding company when they needed the capital. Therefore, the bank could reduce risky behavior.

2.5 Industrial factors, Macroeconomic indicators, and Bank stability

The 5-bank concentration ratio measures the competition in the structural approach which is the sum of the market share of the 5 largest banks in the bank industry and can classify of market structure such as CR is more than 0.7 means the market structure is the monopoly. From (Fu et al., 2014) and (Kasman, 2015), the large banks were protected and bailed out by the government because of "too big to fail". Therefore, this led bank to involve in risk-taking behavior or moral hazard behavior which increased the non-performance loan in their bank.

The rate of real economic growth ($RGDP_t$) is measured by the growth of the gross domestic product (GDP) adjusted by inflation. The rate of real economic growth is used as a proxy for the fluctuation in economic activities or business cycle. There are 4 phrases of the business cycle: peak, contraction, trough, and expansion. In an expanding economy, the real GDP growth rate will be positive because the businesses are growing and creating the jobs for greater productivity. Whereas the period of contraction in the economic growth, the businesses will hold off on the investment and hiring, since the consumers have less money to spend. Moreover, the country may be stuck in the recession during the growth rate turns negative. From (Kasman, 2015), the rate of real GDP growth and bank stability were negative correlation since the loan develop in line with the business cycle, bank would have more the problem of loan or credit risk during the economic expansion. On the other hand, (Danisman & Demirel, 2019) and (Kohler, 2015) found that the higher of the real GDP growth, the less risk-taking in bank activities and get higher profitability. So, bank would have higher stability during the economic expansion.

Table 1 the relationship between bank stability and independent variable

Independent variable	Relationship with bank stability	Literatures
Competition	-	(Berger et al., 2009)
		(Fu et al., 2014)
		(Kasman, 2015)
		(Saif-Alyousfi et al., 2020)
		(Allen & Gale, 2004)
		(Danisman & Demirel, 2019)
		(Keeley, 1990)
		(Demsetz et al., 1996)
	+	(Fiordelisi & Mare, 2014)
		(John H. Boyd & Nicolo, 2005)
		(Berger et al., 2009)
		(Fu et al., 2014)
Bank size	-	(Fu et al., 2014)
		(Danisman & Demirel, 2019)
		(Kohler, 2015)
		(Laeven et al., 2016)
	+	(Kasman, 2015)
		(Saif-Alyousfi et al., 2020)
		(Jittima Tongurai & Chaiporn Vithessonthi, 2020)

Independent variable	Relationship with bank stability	Literatures
Asset composition (LR)	+	(Kohler, 2015)
		(Zhou, 2014)
		(Saif-Alyousfi et al., 2020)
	-	(Kasman, 2015)
		(Danisman & Demirel, 2019)
Foreign ownership	-	(Kasman, 2015)
		(Berger et al., 2009)
	+	(Berger et al., 2015)
The 5-bank Concentration ratio (CR5)	-	(Kasman, 2015)
		(Fu et al., 2014)
The rate of real economic growth	-	(Kasman, 2015)
	+	(Danisman & Demirel, 2019)
		(Kohler, 2015)

Chapter 3

Research Methodology

Banks compete by planning business strategies and setting the competitive interest rate on loans. This competition causes the stability and risk in the bank through the asymmetric information problem between bank and its customer or borrower. For the example, the low competition brings high interest rate in the loan market, which attracts clients to invest in high risk and return activity. Hence, the bank will have higher risk in the case that borrower losses in their businesses and unable to repay loan to the bank.

To investigate the relationship between bank competition and bank stability, we first calculate the Efficiency Adjusted Lerner index as in equation (5) refer to (Koetter et al., 2012), then we use the Hausman Test in each Models as in equation (1) to test the cross-section random and fixed effect as in Annex 2. Finally, we use the model as in equation (1) from (Kasman, 2015) with the Panel OLS regression. In this chapter, we explain the definition and measurement in all variables, the hypothesis for the relationship between bank stabilities and other independent variables, and data collection.

3.1 Conceptual framework

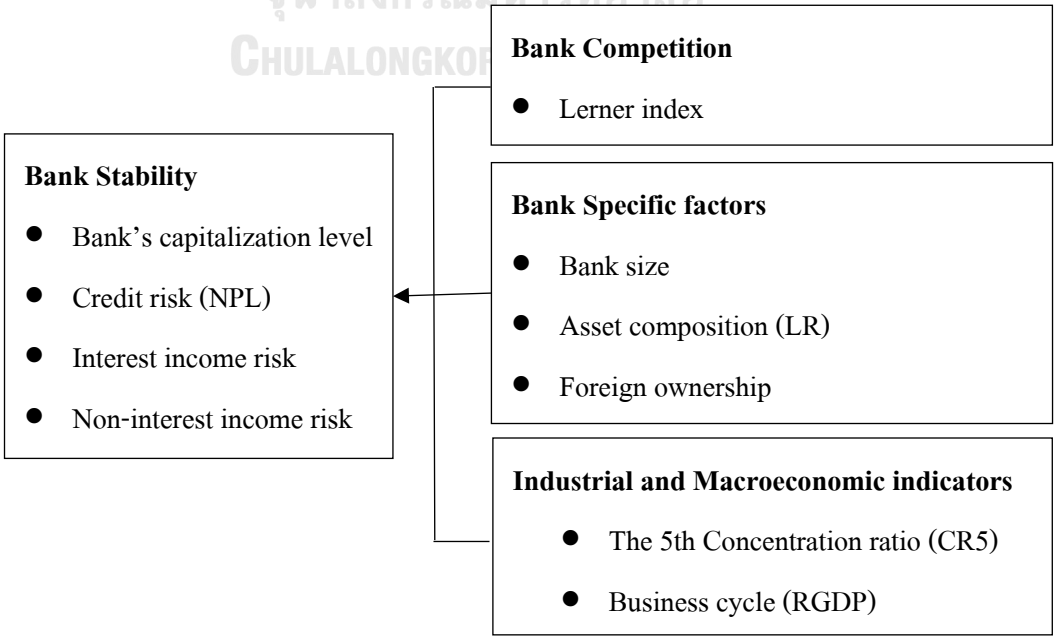
Banks must maintain stability by maintaining the capitalization level, mitigating their credit risk as well as reducing their income volatility to maintain the public's deposit, stabilize the economy and strengthen public and investor confidence in the Thai financial system. To illustrate the conceptual framework, shown in Figure 1, we can separate the factors that affect the bank's stability into three groups: Bank competition, Bank specific factor, Industrial factor, and Macroeconomic indicator.

For the bank competition, it relates with the profitability and cost efficiency in each bank. if there are high competition, the interest rate of loan decrease and bank have less market power. Bank may behave more risky action by lend money to the bad quality borrows because bank have less profit and have nothing to lose, this is also contributing the high credit risk or non-performing loan. On the other hand, when interest rate is low, borrowers will use money in low-risk investment and are able to pay back money to bank. Then, bank will have more credit stability.

For the bank specific factors, large banks may be able to diversify loan-portfolio risk from the economy of scale and scope. On the other hand, large banks expect the government to bail out because of "Too big to fail". Then, they dare to invest in risky activities which increase credit risk and income volatility. The loan-to-asset ratio indicates that they focus more on their lending activities. They may be more proficient and less volatile in their non-interest income but also exposure to credit risk. The foreign ownership affects bank operation. Foreign banks could be more stable given more support for innovation and funding from holding companies. However, they may be more exposed to other currency risks or income volatility.

For the Industrial factors and Macroeconomic indicators, the 5th concentration ratio indicates the structural competition of the banking sector. A high CR5 ratio means the market is more concentrated and the five big banks are the stronger businesses than other banks. on the other hand, they may have risky behaviors due to government support. For RGDP, it indicates the fluctuation in economy or business cycle. During an expanding economy, banks may become more profitable improving their stabilities. However, the credit risk can also increase with the credit growth during economic expansion.

Figure 1 the impact of bank competition on bank stability



3.2 Model

According to (Kasman, 2015) and other literatures, we decide to use the Panel Ordinary Least Squares regressions (panel OLS). Our panel data has the following baseline specification:

$$\textbf{Bank stability}_{st} = \beta_0 + \beta_1 \textbf{Lerner index}_{st} + \beta_2 \textbf{Size}_{st} + \beta_3 \textbf{LR}_{st} + \beta_4 \textbf{Foreign}_{st} + \beta_5 \textbf{CR5}_{t} + \beta_6 \textbf{RGDP}_{t} + \varepsilon_{st} \quad (1)$$

Where the subscripts s and t denote the bank and year, respectively.

3.3 Definition and Measurement of variables

Bank stability $_{st}$	1) Banks' capitalization level (Z-scored)
	2) Credit risk (Non-performing loan ratio)
	3) Interest income risk (INT)
	4) Non-interest income risk (Non-INT)
Lerner index $_{st}$	Bank competition or Bank's market power
	measured by Lerner index (The non-structural approach)
Size $_{st}$	Size of bank s (the natural logarithm of total assets)
LR $_{st}$	Asset composition of bank s (the total loan to total asset).
Foreign $_{st}$	Foreign ownership of bank s
	(the foreign shares to total shares)
CR5 $_{t}$	the concentration ratio (The structural approach)
	(the sum of total loans of five major banks
	over the total banking sector's loan)
RGDP $_{t}$	the real economic growth or business cycle
	(the annual growth rate of real GDP).

We must calculate, banks' capitalization level (Z-scored), the non-performing loan ratio (NPL), interest income risk, non-interest income risk, and adjusted Lerner index which are the main dependent and independent variables in this study

1. Measurement of the bank stability; Z-score of ROA, non-performing loan ratio (NPL), interest income risk, and non-interest income risk, which is the banks'capitalization, bank risk taking, respectively.

$$\mathbf{Z-score_{st}} = \frac{\mathbf{ROA_{st}} + \frac{\mathbf{E}}{\mathbf{TA_{st}}}}{\sigma_{\mathbf{ROA_{st}}}} \quad (2)$$

The subscript s and t are bank and year. Z-score measures the risk-adjusted return and banks' capitalization level. It is computed as the equity ratio plus the return on an asset which will support the bank in case of loss or failure, adjusted by the standard deviation of return on asset. Where the return on assets (ROA) is computed as the net profit after tax divided by the average total asset. The equity to total asset(E/TA) is the shareholders' equity divided by the total asset. The standard deviation of return on asset σ(ROA) is calculated in five-quarter rolling time.

Z-score indicates the number of the standard deviation of a banks' asset return must drop before they become insolvent or a banks' distance from insolvency. Therefore, the high Z-score means greater bank stability or less default risk.

$$\mathbf{The\ non-performing\ ratio}_{st} = \mathbf{ln}\frac{\mathbf{NPL_{st}}}{\mathbf{100-NPL_{st}}} \quad (3)$$

The subscript s and t are bank and year. The non-performing loan is the proxy of credit risk or risk of holding the poor-quality loans in the loan portfolio. It is calculated from the percentage of non-performing loan to gross loan. Bank must control the level of NPL to maintain bank stability. The high value of NPL ratio may lead to bank failure as well as it means the bank manager takes high-risk behavior to lend to borrowers who are unable to repay. In this study, we use the log-odds transformation (ln [NPL/(100-NPL)]) to transform the variable from unit interval to real line.

$$\textbf{The interest income risk}_{st} = \ln(\textbf{Sd. of interest income growth})$$

The subscript s and t are bank and year. The interest income risk is the proxy for the volatility of interest income which is the core income or 75% of the total income on average. High value means the high risk or less stable in interest income. It measured by the standard deviation of interest income growth with Three-quarter rolling time window and implemented with natural logarithm transformation. (Danisman & Demirel, 2019)

$$\textbf{The non} - \textbf{interest income risk}_{st} = \ln(\textbf{Sd. of non} - \textbf{interest income growth})$$

The subscript s and t are bank and year. The non-interest income risk is the proxy for volatility of non-interest income. The non-interest income includes Trading gains (losses) in foreign exchange, Commission, and fees such as ATM debit and credit card, gain and loss on sale of investment, and Income from Non-consolidated affiliates or joint venture. High value indicates the high risk or less stable in non-interest income. It measured by the standard deviation of non-interest income growth with Three-quarter rolling time window and implemented with natural logarithm transformation. (Danisman & Demirel, 2019)

2. Measurement of competition; Adjusted Lerner index (Market power)

$$\textbf{Lerner index}_{st} = \frac{P-MC}{P} \quad (4)$$

The Lerner index is widely used to measure the market power in each bank (Lerner, 1934). It measures the mark-up that bank can charge over its marginal cost, which P is the price of output (average of revenue) and MC is the marginal cost. It has range from 0 to 1. the higher value means the banks can set the price above the marginal cost which means that bank has more market power, or the market is lower competition. While the lower value means the market is high competition and the bank has low market power. So, the bank can charge only at price equal to the marginal cost. (Koetter et al., 2012) argued that the Lerner index assumed both profit efficiency and cost efficiency and failed to consider that bank may not take advantage in pricing opportunities from market

power. Therefore, they suggested to calculate the market power in form of the efficiency-adjusted Lerner index which was more correct in the real market.(Kasman, 2015)

$$\textbf{Efficiency Adjusted Lerner index}_{st} = \frac{\pi_{st}+C_{st}-mc_{st}.Q_{st}}{\pi_{st}+C_{st}} \quad (5)$$

The subscript s and t are bank and year. Where π_{st} is the profit of bank, C_{st} is the total cost, mc_{st} is the marginal cost and Q_{st} is the total output (total asset). The marginal cost is obtained by differentiating the translog cost function of bank with respect to one output (total asset) which is commonly used to measure the bank cost efficiency. We use a stochastic frontier model that measure by the following regression from

$$\ln C_{st} = \alpha_0 + \beta_1 \ln Q_{st} + \sum_{j=1}^{3} \beta_j \ln W_{jst} + \frac{1}{2}\left[\alpha_{QQ}(\ln Q_{st})^2 + \sum_{j=1}^{3}\sum_{m=1}^{3} \beta_{jm} \ln W_{jst} \ln W_{mst}\right] + \sum_{j=1}^{3} \beta_{Qj} \ln Q_{st} \ln W_{jst} + \varepsilon_{st} \quad (6)$$

Where C is total costs, Q is total output (total asset), and W are the vector of input prices: price of labor, price of fixed assets, price of fund. The price of labor (W_1) is calculated from the personal expenses divided by number of employees. The price of fixed assets (W_2) is given by operating cost net of personal expenses over total assets. The price of fund (W_3) is calculated by the ratio of total interest expense to the sum of total deposits and money market funding.

Then we substitute the coefficient from cost of bank equation into the model below. Finally, we obtain the marginal cost equation that can put in the adjusted Lerner index to find the bank competition. (Saif-Alyousfi et al., 2020)

$$MC_{st} = \frac{\partial \ln C_{st}}{\partial \ln Q_{st}} = \frac{C_{st}}{Q_{st}}[\beta_1 + \alpha_{QQ} \ln Q_{st} + \sum_{j=1}^{3} \beta_{Qj} \ln W_{jst}] \quad (7)$$

3.4 Hypothesis

According to the competition and fragility view, we expect the higher competition will reduce the bank stability and increase the bank risk both credit risk and income risk. On the other hand, the less competition or higher market power will increase the bank stability and reduce bank risks. (As in Table 3)

Table 2 The expectation of the relationship between bank stability and independent variables

Variables	(1) Z-Score	(2) NPL	(3) INT	(4) Non-INT	Explanation for the sign
Lerner index $_{st}$	+				The higher market power, the more profit and franchise value that increased the bank stability and its capital. (Keeley, 1990)
		-			The higher market power, the more information comparative advantage on credit monitoring and got the high quality of client. Therefore, bank with high market power would have less credit risk. (Danisman & Demirel, 2019)
			-	-	The higher market power, the less incentive to take the risky behavior. Therefore, bank with high market power would have less fluctuation in interest income and non-interest income. (Danisman & Demirel, 2019)

Variables	(1) Z-Score	(2) NPL	(3) INT	(4) Non-INT	Explanation for the sign
$Size_{st}$	+	-	-	-	The large bank would have higher stability due to hold more capital. In addition, the large bank would have more prudent behavior and had diversify advantage on loan portfolio because of the economy of scale and scope. (Jittima Tongurai & Chaiporn Vithessonthi, 2020; Kasman, 2015; Saif-Alyousfi et al., 2020)
LR_{st}	+	-	-	-	The higher loan to total asset ratio indicated that bank focused on lending activities and had more lending specialization. Therefore, bank would have the higher stability and less in credit risk and income risk. (Kohler, 2015; Saif-Alyousfi et al., 2020; Zhou, 2014)
$Foreign_{st}$	-	+	+	+	The higher foreign ownership or international bank would have less stability, higher credit risk and higher income risk than domestic bank due to the income volatility from product and service limitation and the transaction across the country with their holding company which was high exposure to exchange rate risk. (Berger et al., 2009; Kasman, 2015)

Variables	(1) Z-Score	(2) NPL	(3) INT	(4) Non-INT	Explanation for the sign
$CR\ 5_t$	-	+	+	+	The large bank was protected and bailed out by the government because of "too big to fail". Therefore, this led bank to involve in risk-taking behavior or moral hazard behavior. (Fu et al., 2014; Kasman, 2015)
$RGDP_t$	+	-	-	-	The higher of the real GDP growth, the less risk-taking in bank activity and got higher profitability from their client. So, bank would have higher stability during the economic expansion. (Danisman & Demirel, 2019; Kohler, 2015)

3.5 Data collection and Estimation methodology

We mostly collect the quarterly data on the revenue, cost, and asset composition in each bank from the balance sheet and income statement. the Stock Exchange of Thailand, the Settrade, the Bloomberg Terminal are the primary source of data for all dependent variables, competition, bank specific factors, and foreign ownership. For the Real economic growth rate of Thailand, we use the indicator which is calculated by from the CIEC database. After we transform the data into indicators, we use the Panel Ordinary Least Squares methodology to investigate the impact of competition on bank stability and risks which contain four models with different dependent variables: Z-score, NPL Ratio, interest income risk, and non-interest income risk. In each model, we also use the Hausman statistic to test the cross-section random effect test as in Annex 2

Chapter 4

Research Results

After we transform the data to the variables, we summarize the descriptive statistic for each variable using in the regression which are mean values, minimum values, maximum values, and standard deviation of all sample data as in Table 2. We also describe the bank competition in Thailand which are Lerner index (non-structural approach) and the concentration ratio 5 (structural approach). For the Lerner index, we separate into three groups of banks which are upward trends, downward trends, and inconclusive groups. For concentration ratio 5, we calculate the sum of loan market share from KTB, BBL, SCB, KBank and BAY, which are the five largest banks in the banking sector. the CR5 fell in 2010 from 83% to 79% and tended to be higher from 2013 to 2018, meaning the market was more concentrated or the five biggest banks had more market power.

Finally, we explain the result from the regression. There are four models with four different dependent variables or bank stabilities which are banks' capitalization level (Z-score of ROA), non-performing loan ratio (NPL), interest income risk, and non-interest income risk as shown in the Table 5.

4.1 Description statistics

4.1.1 Summary description statistics

The summary descriptive statistics for all variables are presented in the Table 2. The total number of observations is 391 for each variable, which come from 11 banks in Thailand and quarterly data over 2010 to 2018 except for LHFG Bank which has data from the 2nd quarter of 2011 to 2018 only.

Table 3.1 Descriptive Statistics

		Mean	Min	Max	Med	Std. Dev.
Bank stability and risks	Equity to total asset	0.1072	0.0612	0.1789	0.1062	0.0239
	ROA	0.0164	0.0005	0.1748	0.0032	0.0420
	Sd. Of ROA*	0.0003	0.0000	0.0012	0.0003	0.0002
	Non-performing loan (%)	3.3636	0.9510	12.1200	2.9000	1.6218
	Odds of non-performing loan***	0.0351	0.0096	0.1379	0.0299	0.0179
	Interest income to total income	0.7568	0.5414	0.9979	0.7607	0.1454
	Sd. of interest income growth**	0.0431	0.0009	0.2137	0.0286	0.0415
	Non-Interest income to total income	0.2378	0.0021	0.5556	0.2355	0.1168
	Sd. of non-interest income growth**	0.5998	0.0009	16.8418	0.0895	1.8113
Lerner index	Profit and total cost (MTHB)	20,318	737	51,792	15,697	15,806
	Marginal cost (MTHB)	0.0122	0.0008	0.0231	0.0122	0.0046
	Total asset (MTHB)	1,268,743	71,297	3,187,340	967,254	1,017,992

** 5-quarter rolling window, **3-quarter rolling window, ***Odds of NPL = NPL/(100-NPL)*

Table 3.2 Descriptive Statistics for all variables used in the regression model

	N	Mean	Min	Max	Std. Dev.
Bank stability and Risks[1]					
Bank Capitalization level (Z-Score)	391	477.05	83.74	2183.38	344.99
Credit risk (NPL)	391	-3.45	-4.65	-1.98	0.45
Interest income risk (INT)	391	-3.55	-6.96	-1.54	0.93
Non-interest income risk (Non-INT)	391	-2.02	-6.08	2.82	1.49
Bank specific factors					
Lerner index	391	0.26	-0.67	1.18	0.29
Size	391	13.59	11.17	14.97	1.07
Loans to assets ratio (LR)	391	0.73	0.56	1.00	0.09
Foreign ownership	391	0.43	0.00	0.98	0.23
Industrial factors and Macroeconomic indicators					
Concentration ratio 5 (CR5)	391	0.80	0.78	0.84	0.01
Real GDP growth (RGDP)	391	3.75	-4.07	15.30	3.16

** the result is from the calculation*

There are four dependent variables: Z-score of ROA, NPL ratio, interest rate risk, non-interest rate risk. The average Z-Score of ROA is 477.05 for entire samples and most banks hold the equity to total asset at 10%-11%. This mean bank has 477.05 of standard deviation of ROA that can be absorbed by capital in case of loss. The KBank has the least average on Z-score (average Z-score = 229) because the volatility of the rate of return on asset (ROA) is relatively high compare to other banks (average of s.d. of ROA = 0.00063) even KBank has the high value of the rate of return on asset (ROA). Therefore, KBank has the less stability or more overall insolvency risk than the others, while the BBL and LHFG had the highest average Z-score

[1] We referred the calculation from section 3.3 Definition and Measurement of variables.

(average Z-score = 677) due to the volatility in the rate of return on asset (ROA) lower than other banks. (average of s.d. of ROA = 0.0002).

The average non-performing loan ratio[2] or credit risk in our sample is – 3.45 and the average Odds of non-performing loan ratio[3] is 0.035. This indicates that the probability of NPL is 0.035 times or 3.5% of the probability of good-credit loan on average. In addition, the average non-performing loan is 3.36% of total loan. Over 2010-2018, the KKP, CIMBT and TMB have the highest credit risk with an average of -3.12. While the TISCO, LHFG and SCB have the lowest credit risk with an average at -3.87. This indicates that TISCO LHFG and SCB have more prudent behavior than other banks by holding good credit quality in their credit portfolio or better lending standards.

The average of interest income risk and non-interest income risk are -3.55 and -2.02, respectively. This indicates that bank mostly have the risk from the fluctuation in non-interest income than interest income. For the interest rate income risk, CIMBT have the highest risk at -2.66 on average, while KBank and KTB have the lowest interest rate risk or are the most stable in interest income. For the non-interest income risk, CIMBT is also highest Non-interest risk at -0.26 on average, whereas KBank and BBL are lowest Non-interest risk at -3.53 and -2.93, respectively.

For the bank specific factors, the average calculated E- Lerner index is 0.26 for the entire bank. This indicates that Thai bank have the market power or ability to mark up the price above marginal cost at 26% of its price under the competition. Our E-Lerner index is similar to (Fu et al., 2014), which is equal to 0.31 for Thailand during 2003-2010. Compared to other countries, Thailand has an average E-Lerner index lower than Singapore (0.44), China (0.38) and Hongkong (0.38), but higher than India (0.25), Japan (0.25) and Indonesia (0.22) referred from (Fu et al., 2014).

The average size of Thai bank is 13.59 (or 798,108 million baht), which is estimated from the logarithm of total asset. From 2018, SCB is the largest bank and have the total asset at

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[2] The Non-performing loan ratio = ln [NPL/(100-NPL)]

[3] Odds of NPL = NPL/(100-NPL) = EXP (The Non-performing loan ratio) = EXP (ln [NPL/(100-NPL)])

14.97 (or 3,187,300 million baht). KBank and BBL are also have substantial asset at 14.96 (or 3,145,002 million baht) and 14.95 (or 3,116,745 million baht) respectively, while LHFG is the smallest bank with total asset of 12.41 (or 245,929 million baht).

The loan-to-asset ratio shows how the bank focus on lending activity which is the core of business. The average loan-to-asset ratio is 0.73 or 73% of total asset as a loan which includes both consumer loans and business loan. TISCO has the highest loan-to-total asset ratio at 91% with the greatest emphasis on lending activities and exposure to credit risk. On the other hand, KBank has the lowest loan to asset ratio at 0.64 or 64% of all asset as a loan. This indicates that KBank focuses on non-lending activity such as interbank loans, trade, and other investments more than other banks.

For the foreign ownership, Thai bank mostly have the average foreign shares to total shares less than 50% except BAY and CIMBT which are 63% and 97% respectively. MUFG bank (Mitsubishi UFJ Financial Group), Japan's largest banking group, has taken over BAY (Krungsri) to be the majority shareholder by holding at 76.88% of shares since 2014. CIMBT is held by their holding company, which is CIMB Group Holdings Berhard from Malaysia, at 94.83% of the total shareholders. On the other hand, KTB has the lowest of the foreign shareholder at 13.6% because its majority holder at 55.07% is Financial Institutions Development Fund (FIDF) which is managed by the Bank of Thailand and the Ministry of Finance and established to support and promote the stability of the financial institution during the Tom Yum Kung crisis of 1997s.

The 5th concentration ratio, we use the total market share of loans from the 5 largest banks in Thailand, which are SCB, KTB, BBL, KBank and BAY. The average 5th concentration ratio from 2010 to 2018 was 80%, indicating that financial market structure is relatively concentrate and five out of the 11 banks are the major players in banking industry with the total market share at 80 % of the total loan market.

For the real GDP growth ratio, we use the quarterly data calculated from CIEC Global Database. Thailand has the real GDP growth ratio at 3.75% on average, during 2010-2018. This indicates the economic growth adjusted by inflation is 3.75%. In addition, the average standard

deviation is relatively fluctuation at 3.16%. In the end of 2011, the real GDP growth was lowest at -4.072% due to Flood disaster in Thailand that damaged to industrial estates and tourism and spread through many provinces of Northern, Northeast, and Central of Thailand. In 2012, the real GDP is highest growth at 15.3%. Whereas in 2013-2014, The real GDP growth became relatively low again because of political instability and protestation. The latest Real GDP growth for 2018 is on the downward trend at 2.33% and lower than the average from year 2010-2018.

4.1.2 Bank competition in Thailand

Figure 2 and Table 4 show the bank competition measured by a non-structured approach or the Lerner index, which is obtained from 11 Thai banks quarterly in the period 2010-2018. The average Lerner index of all banks is in an uptrend from 0.18 to 0.33. This indicates that banks tend to become more competitive (with high market power) or the market tend to be less competition. The Lerner index in each bank can be described in three groups: uptrend, downtrend, and no conclusion.

Figure 2 the Lerner index for 11 banks in Thailand during 2010 to 2018

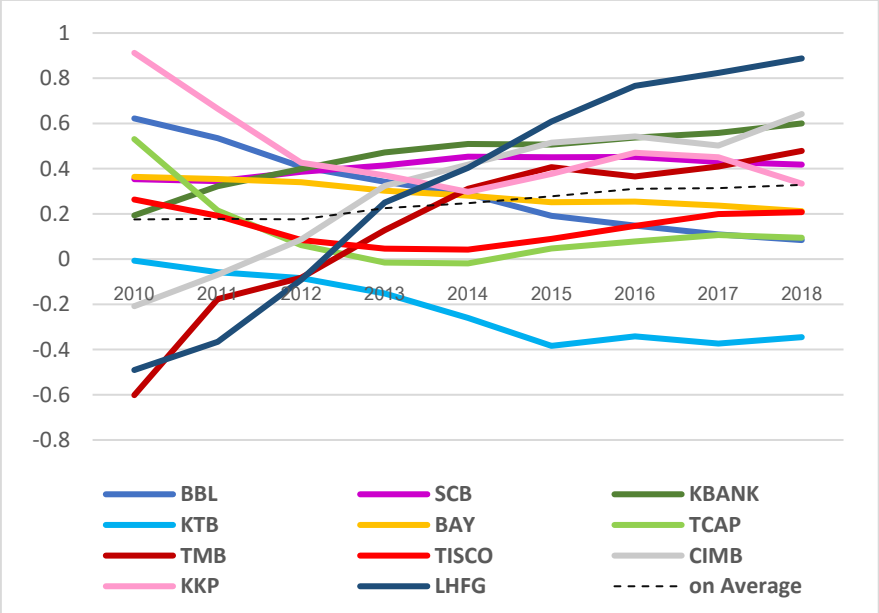


Table 4 the Lerner index for 11 banks in Thailand during 2010 to 2018

Bank	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
BBL	0.62	0.54	0.41	0.34	0.29	0.19	0.15	0.11	0.08
SCB	0.35	0.34	0.39	0.41	0.45	0.45	0.45	0.43	0.42
KBANK	0.19	0.32	0.40	0.47	0.51	0.51	0.54	0.56	0.60
KTB	-0.01	-0.06	-0.08	-0.15	-0.26	-0.38	-0.34	-0.37	-0.35
BAY	0.36	0.35	0.34	0.30	0.28	0.25	0.25	0.24	0.21
TCAP	0.53	0.21	0.06	-0.02	-0.02	0.05	0.08	0.11	0.09
TMB	-0.60	-0.18	-0.08	0.13	0.31	0.41	0.37	0.41	0.48
TISCO	0.26	0.19	0.08	0.05	0.04	0.09	0.15	0.20	0.21
CIMBT	-0.21	-0.07	0.09	0.32	0.42	0.51	0.54	0.50	0.64
KKP	0.91	0.67	0.43	0.37	0.30	0.38	0.47	0.45	0.33
LHFG	-0.49	-0.37	-0.09	0.25	0.40	0.61	0.77	0.82	0.89
Average	0.18	0.18	0.18	0.23	0.25	0.28	0.31	0.31	0.33

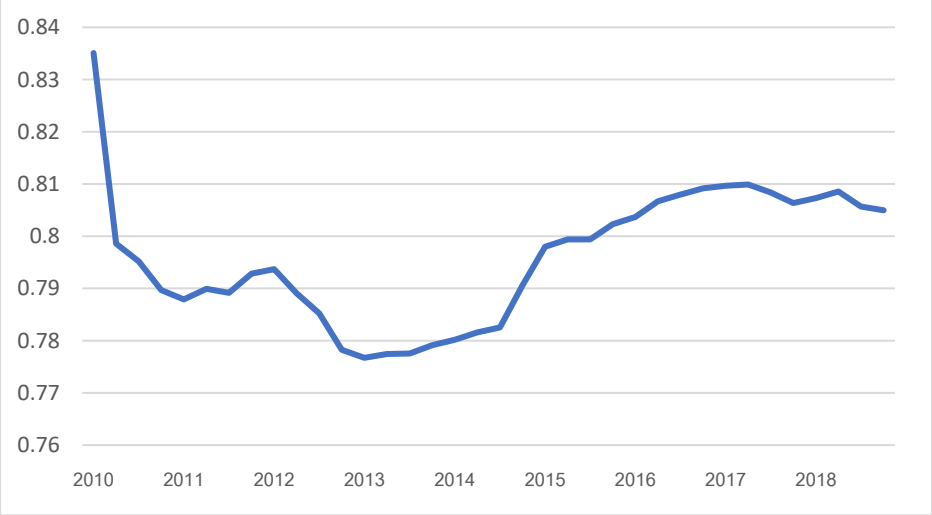
** the result is from the calculation*

Firstly, the banks with Lerner index in upward trends are KBank, TMB, CIMBT and LHFG. KBank become more competitive or market power over time because they can maintain their marginal cost multiplied by total asset along with increased profit. In 2018, Kbank had a very high Lerner index at 0.6 which means that Kbank performed well and could charge the price more than their marginal cost to 60% of its price. While TMB, CIMB and LHFG had the higher competitive because they could reduce their marginal cost multiplied by total asset as well as enhanced the profit. In 2018, LHFG had the highest Lerner index at 0.89 due to a significant drop in marginal costs.

Secondly, the banks with Lerner index in downward trend are BBL and KTB. Their competitiveness had declined from the past as marginal costs increased significantly more than profit growth which reduced their markup. By the way, KTB had the negative value of Lerner index implying that bank was in non-optimal state or they set the price of their product and service lower than their suitable marginal cost as described in (Saif-Alyousfi et al., 2020)

Third, the result cannot be concluded for SCB, BAY, TCAP, TISCO and KKP. For SCB, BAY and KKP were stable Lerner index at 0.42, 0.21, and 0.33, respectively. The Lerner index was stable because their growth in marginal cost multiplied by asset was balancing with growth in their total cost and profit. This means they had the stability in their market power or competitiveness. While Lerner index of TCAP and TISCO were in U-shape. In year 2013-2014, they had lowest Lerner index at -0.2 and 0.4, respectively, Due to their marginal cost multiplied by asset were rising rapidly at year 2013-2014.

Figure 3 The 5th Concentration ratio in Thailand during 2010 to 2018

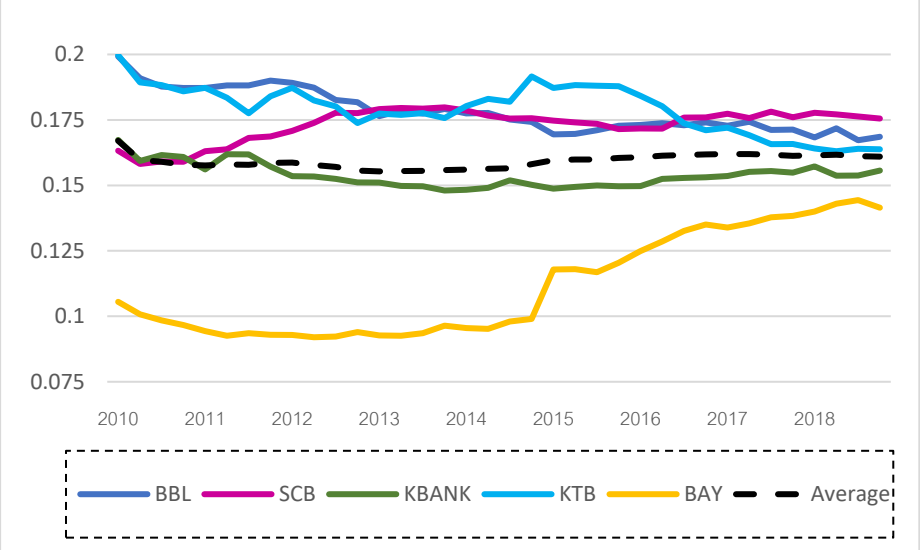


For bank competition measures by structural approach, this can be explained by 5th concentration ratio of the loan market. As in Figure 3, we calculate the sum of loan market share from 5 biggest Thai banks which are KTB, BBL, SCB, KBank and BAY, the average of market share in each bank are 17.92%, 17.82%, 17.30%, 15.38% and 11.16%, respectively.

In 2010, the 5th concentration ratio or market share dropped from 83% to 79% because the smaller banks which were TCAP and TISCO had more market share in the total loan market. In addition, LHFG had entered the stock market (SET or The Stock Exchange of Thailand) since 2011. Hence, the market was becoming less concentration because the smaller banks competing for market share from the five biggest banks.

From 2013 to 2018, the 5th concentration ratio was an uptrend from 77.6% to 80.6% on average indicating that the market was becoming to more concentrated during that time. As shown in Figure 4, BBL and KTB had less market share from 17.7% to 16.6%. Therefore, SCB returned to be the largest player or had most market share in the market at 17.5%. In addition, BAY's market shares sharply rose from 0.92% to 14.7% as it has been integrated with MUFG Japanese bank since 2014 enabling it to expand the market share for corporate and SME banking, while KBANK maintained their market share of 15.2% on average.

Figure 4 Market share of the five largest banks during 2010 to 2018



4.2 Regression result

This section shows regression results of the equation 1 in chapter 3. As shown in Table 5, the Lerner index has a significant negative impact to NPL ratio at the 99% confidence level, meaning banks with high market power or in less competition cause the higher profitability, cost efficiency, and economy of scale. Then banks have a less incentive to lend at risk. They will have better credit monitoring, analyze of portfolio quality, and get the high quality of client. Thus, banks with high market power will have less credit risk. While banks with less market power will receive less interest income from lending and less monopoly rents then they will nothing to lose and take more risky activities as well as less monitoring to reduce their cost. Thus, banks with low market power will have more non-performing loan ratio or credit risk. Consistent with the hypothesis and literature in the competition and fragility view, the bank competition increased credit risk. (Danisman & Demirel, 2019)

On the other hand, The Lerner index has a significant negative impact to Z-score and has a significant positive impact to non-interest income risk at the 99% confidence level, indicate that banks with high market power will have less stability from maintaining lower capitalization and having high non-interest rate income risk. Due to, banks with high market power have more prudent behavior in lending activities causing the less in non-performing loans. Therefore, they can reserve less capital for preventing bankruptcy and able to invest and operate in high-risk activities such as foreign exchange currency trading, joint venture capital investment that result in higher volatility in non-interest income.

Table 5 The result from Panel Ordinary Least Square regression at the bank level in 2010-2018[4]

Variable	(1) Z-Score of ROA	(2) NPL	(3) INT	(4) Non-INT
Bank specific factor				
C	-8201.92***	-5.32***	5.1	26.05***
	(0.0000)	(0.0000)	(0.0878)	(0.0000)
Lerner index	-354.02***	- 0.27***	0.28	0.65***
	(0.0000)	(0.0001)	(0.1171)	(0.0090)
Size	251.51***	-0.19***	-0.36***	-0.95***
	(0.0001)	(0.0001)	(0.0000)	(0.0000)
LR	-290.37	-2.43***	-1.62	-6.83***
	(0.5067)	(0.0000)	(0.0696)	(0.0000)
Foreign	239.70	-0.22	-0.24	- 0.21
	(0.2464)	(0.2059)	(0.4683)	0.7025
Industrial factors and Macroeconomic indicator				
CR5	6901.61***	8.07***	-3.15	-12.87***
	(0.0000)	(0.0000)	(0.3557)	(0.0043)
RGDP	-8.63	0.00	0.00	0.01
	(0.0788)	(0.3277)	(0.7433)	(0.4748)
R2	0.34	0.24	0.06	0.17
F-Test(P-Value)	0.0000	0.0000	0.0004	0.0000
Fixed/Random	Fixed	Random	Random	Random

*** *Statistical significance at the 1% level.*

[4] we have a diagnostic test before running the regression such as no multicollinearity exist in the model.

For the bank specific factors, the size of bank has strong positive relationship with the Z-score and negative relationship with NPL ratio, interest income risk and non-interest income risk, at the 99% confidence level. Our result is consistent with the hypothesis and result in the several studies (Jittima Tongurai & Chaiporn Vithessonthi, 2020; Kasman, 2015; Saif-Alyousfi et al., 2020). This indicates the large banks have more stability in equity capitalization than small banks and reduce risky behavior by lending to high-quality credit client that reduce the non-performance loan ratio and more stable in interest income. Additionally, larger banks have less credit risk because they have more a comparative advantage in credit monitoring and can diversify their loan-portfolio. Moreover, larger bank tends to reduce risky invest in non-lending activities and more stable in non-interest income. Therefore, larger bank has high capitalization level, high quality credit portfolio and high stability in both Interest income and non-interest income.

The loan to asset ratio has the negative impact to the NPL ratio and non-interest income risk at the 99% confidence level. (Kohler, 2015; Saif-Alyousfi et al., 2020; Zhou, 2014) also find the similar result, indicates banks that focus on lending activities will decrease in the NPL ratio because the bank has more expertise in granting loans and has more the information advantage on credit's borrower then they will have lower NPL ratio or higher stability, consistently with (Kohler, 2015) and (Freixas, 2005). Additionally, bank that focus on lending activities which is their core-business more than the non-lending activities are less volatility in non-interest income or more stable in non-interest income.

For the macroeconomic indicators, the CR5 has positive impact on Z-score and non-performing loan ratio but it has negative impact on non-interest income risk at the 99% confidence level. For the Z-score, the high concentration of 5 major banks in the bank industry or the sum of 5 major bank's market share in lending market increases the bank stability because large banks have benefit on capital buffer and enjoy the high return on investment or lending. Then they will have higher stability on capitalization. In addition, the higher concentration ratio drive bank to concentrate and more focus to compete the rival in credit market to gain more market share. So, they will rarely focus on risky non-lending activities resulting in higher non-

interest income stability. On the other hand, the large banks in the high concentration or low competition market will be protected by the government and central bank to avoid “too big to fail” situation or systemic risk. Therefore, large banks may take imprudent lending and lead to moral hazard behavior then the NPL ratio will increase in this situation. This finding is consistent with hypothesis and other studies (Fu et al., 2014; Kasman, 2015)

However, the coefficient of foreign ownership and RGDP are insignificant across all models at the 95% confidence level. Since quarterly data is not available for foreign ownership in some banks, we use annual data instead while we use quarterly data for other variables. while RGP is the country level data then it possible unrelate to the stability, which is bank level data.

To conclude, the results are consistent with the hypothesis and literatures in the competition and fragility view that the banks with high market power will have more stability by having less non-performing loan or credit risk. Due to the less competition, banks are more profitability and less motivated to lend to risky debtors. Then they will have better analyze of portfolio quality, better credit monitoring, and prudent behavior causing the lower non-performing loan ratio. As a result of this, banks with a high market power can maintain lower capital level (or less capitalization) and are able to invest in high-risk activities to generate the higher non-interest income.

Chapter 5

Summary, Recommendations, and Limitations

The perfect competition seems to be the most efficiency market structure that drives the company to improve and develop their businesses to compete with competitors, while it might opposite result in the banking system. In the competition market environment, bank has less market power to set the prices and other fees on their loans and services. Thus, banks may be forced to engage in the risky behaviors such as low-quality lending and other risky investments that will cause destabilize in their banks or contribute to bankruptcy. In addition, Thailand has more advanced in technology such as a cashless society and fintech trends that drive the competition in banking system from the other banks, non-bank financial institutions and capital markets. Therefore, this study will measure the competition to understand the competition of the banking system in Thailand as well as examine the impact on bank's stability.

This paper examines the impact of bank competition on bank stability by using data quarterly from 11 Thai commercial banks listed in the Stock Exchange of Thailand over the periods 2010-2018. The bank stability and risks are proxied in accounting-based measured by banks' capitalization level (Z-score of ROA), non-performing loan ratio (NPL), interest income risk, and non-interest income risk. We use efficiency-adjusted Lerner index to measure the bank competition (Market power) in each bank. We employ the Panel Least Square methodology these models with other bank specific variable and Macroeconomics variable such as Bank's size, Loan to asset Ratio (LR), Foreign ownership, Concentration ratio 5, real GDP. From the calculation, we find out that BBL and LHFG have the highest average Z-score or highest stability in bank's capitalization due to the lower volatility in ROA than other banks. Whereas, CIMBT has the highest credit risk, Interest rate income risk and non-interest rate income risk because of the fluctuation in their income. For the bank competition, the average E-Lerner index is 0.26 for entire banks. Compared to other countries, Thailand has an E-Lerner lower than Singapore (0.44), China (0.38), but higher than India (0.25), Japan (0.25) referred from (Fu et al., 2014)

The empirical study indicates that the banks with high market power are more stable due to the lower in non-performing loans or credit risk. This is because they have better profitability and cost efficiency than others causing the less motivated to lend at risk. Therefore, they become more prudent behavior on credit standards and monitoring resulting in less non-performing loan ratio. While the bank competition will increase the non-performance loan because bank may expand their lending at risk by reducing loan standards and credit monitoring to save their costs. Even though, over the past 20 years, the banks become more conservative after the economic crisis of 1997 by accumulate more reserve capital and maintain high equity capital level and high non-interest income stability according to prevent themself from the risk of bankruptcy. Moreover, we found that the large bank will increase their stability by maintain more capital adequacy, reduce in non-performing loan ratio, interest-income risk, and non-interest income risk. While the bank with high loan to asset ratio will reduce non-performing loan ratio and non-interest income risk. Finally, concentration ratio increases the bank's capitalization and non-interest income stability but also increase in non-performing loan ratio as well.

Recommendations

Since the results of the study show that banks with high market power tend to have lower credit risk which allows them to have lower capital level, the Bank of Thailand should monitor the non-structural degree of competition among Thai banks to maintain stability of credit risk.

In addition, we find that the degree of structural concentration could lead to a moral hazard in higher credit risk due to "too big to fail". In addition, size of bank has positive impact of stabilities. As the result, we recommend that the Bank of Thailand should prevent excessive concentration in bank system, by expanding small and middle banks to improve bank stabilities.

Limitations

In this research, the sample groups are only 11 major banks which are public banks and listed on the stock exchange. Due to, we have the limitation on accounting data. Therefore, the model may not consider competition for all industry, such as Government Savings Bank, Government Housing Bank, Bank for Agriculture and Agricultural Cooperatives, and other non-banking companies such as fintech and nano finance loan companies. In the further study, we can increase the sample group to cover the entire financial industry.

Annex 1

The Translog cost function for 11 banks are derived from a regression model with equation (6) as follow. We remove some variables from the model to avoid the multicollinearity problem in regression and use the Ordinary Least Squares method. Then we use the coefficients from the result to calculate the marginal costs according to equation (7) for each bank and substitute in the Efficiency Adjusted Lerner index as in equation (5).

$$\mathbf{lnC_{st}} = \boldsymbol{\alpha_0} + \boldsymbol{\beta_1 lnQ_{st}} + \sum_{\mathbf{j=1}}^{\mathbf{3}} \boldsymbol{\beta_j lnW_{jst}} + \frac{\mathbf{1}}{\mathbf{2}}\left[\boldsymbol{\alpha_{QQ}}(\mathbf{lnQ_{st}})^{\mathbf{2}} + \sum_{\mathbf{j=1}}^{\mathbf{3}}\sum_{\mathbf{m=1}}^{\mathbf{3}} \boldsymbol{\beta_{jm} lnW_{jst} lnW_{mst}}\right]$$
$$+ \sum_{\mathbf{j=1}}^{\mathbf{3}} \boldsymbol{\beta_{Qj} lnQ_{st} lnW_{jst}} + \boldsymbol{\varepsilon_{st}} \quad (6)$$

Where the subscripts s, t, and j denote the bank, year, and input prices, respectively.

1. Bangkok Bank (BBL)

Dependent Variable: LNC
Method: Least Squares
Date: 10/15/19 Time: 22:15
Sample: 2009Q3 2019Q2
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	128.1092	97.35970	1.315834	0.1970
LNQ	-16.78975	13.24690	-1.267448	0.2136
_0_5LNQ2	1.217731	0.903004	1.348534	0.1864
LNQ_LNW	0.021708	0.007640	2.841522	0.0075
LNQ_LNOC	0.008685	0.002022	4.295524	0.0001
LNQ_LNINT	0.019603	0.003924	4.995544	0.0000

R-squared	0.989383	Mean dependent var	10.10688
Adjusted R-squared	0.987822	S.D. dependent var	0.233799
S.E. of regression	0.025801	Akaike info criterion	-4.339351
Sum squared resid	0.022633	Schwarz criterion	-4.086019
Log likelihood	92.78703	Hannan-Quinn criter.	-4.247754
F-statistic	633.6996	Durbin-Watson stat	2.137827
Prob(F-statistic)	0.000000		

2. Siam Commercial Bank (SCB)

Dependent Variable: LNC
Method: Least Squares
Date: 10/15/19 Time: 22:29
Sample: 2009Q3 2019Q2
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-35.26118	52.01200	-0.677943	0.5024
LNQ	5.474290	7.143389	0.766344	0.4488
_0_5LNQ2	-0.298851	0.493204	-0.605938	0.5486
LNQ_LNW	0.018116	0.010091	1.795303	0.0815
LNQ_LNOC	0.015886	0.004068	3.904876	0.0004
LNQ_LNINT	0.012614	0.004429	2.847819	0.0074

R-squared	0.980737	Mean dependent var	10.11972
Adjusted R-squared	0.977904	S.D. dependent var	0.303611
S.E. of regression	0.045131	Akaike info criterion	-3.221029
Sum squared resid	0.069250	Schwarz criterion	-2.967697
Log likelihood	70.42058	Hannan-Quinn criter.	-3.129432
F-statistic	346.2087	Durbin-Watson stat	1.732359
Prob(F-statistic)	0.000000		

3. Kasikorn Bank (KBank)

Dependent Variable: LNC
Method: Least Squares
Date: 10/15/19 Time: 22:32
Sample: 2009Q3 2019Q2
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-90.00667	78.19516	-1.151052	0.2577
LNQ	12.96055	10.71906	1.209112	0.2350
_0_5LNQ2	-0.825764	0.744596	-1.109009	0.2752
LNQ_LNW	0.017036	0.013759	1.238121	0.2242
LNQ_LNOC	0.009776	0.013129	0.744635	0.4616
LNQ_LNINT	-0.001367	0.007937	-0.172284	0.8642

R-squared	0.941481	Mean dependent var	10.19818
Adjusted R-squared	0.932875	S.D. dependent var	0.273432
S.E. of regression	0.070842	Akaike info criterion	-2.319249
Sum squared resid	0.170632	Schwarz criterion	-2.065917
Log likelihood	52.38498	Hannan-Quinn criter.	-2.227652
F-statistic	109.4017	Durbin-Watson stat	1.881202
Prob(F-statistic)	0.000000		

4. Krungthai Bank (KTB)

Dependent Variable: LNC
Method: Least Squares
Date: 10/15/19 Time: 22:43
Sample: 2009Q3 2019Q2
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	67.61931	110.2276	0.613452	0.5437
LNQ	-9.270101	15.05308	-0.615828	0.5421
_0_5LNQ2	0.757704	1.029116	0.736267	0.4666
LNQ_LNW	-0.005535	0.012386	-0.446897	0.6578
LNQ_LNOC	0.024241	0.008381	2.892391	0.0066
LNQ_LNINT	0.012284	0.004957	2.478047	0.0183

R-squared	0.961602	Mean dependent var	10.11673
Adjusted R-squared	0.955956	S.D. dependent var	0.338292
S.E. of regression	0.070997	Akaike info criterion	-2.314890
Sum squared resid	0.171377	Schwarz criterion	-2.061559
Log likelihood	52.29781	Hannan-Quinn criter.	-2.223294
F-statistic	170.2945	Durbin-Watson stat	1.070174
Prob(F-statistic)	0.000000		

5. Bank of Ayudhya (BAY)

Dependent Variable: LNC
Method: Least Squares
Date: 10/15/19 Time: 22:48
Sample: 2009Q3 2019Q2
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	21.89724	23.81487	0.919478	0.3643
LNQ	-2.400465	3.367672	-0.712797	0.4808
0 5LNQ2	0.248895	0.239800	1.037926	0.3066
LNQ LNW	-0.002985	0.003177	-0.939546	0.3541
LNQ_LNOC	0.021655	0.007888	2.745175	0.0096
LNQ_LNINT	0.017986	0.004466	4.026856	0.0003

R-squared	0.975699	Mean dependent var	9.873008
Adjusted R-squared	0.972126	S.D. dependent var	0.270303
S.E. of regression	0.045129	Akaike info criterion	-3.221122
Sum squared resid	0.069244	Schwarz criterion	-2.967790
Log likelihood	70.42243	Hannan-Quinn criter.	-3.129525
F-statistic	273.0294	Durbin-Watson stat	1.322866
Prob(F-statistic)	0.000000		

6. Thanachart Capital (TCAP)

Dependent Variable: LNC
Method: Least Squares
Date: 10/15/19 Time: 22:54
Sample: 2009Q3 2019Q2
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	165.7406	37.85305	4.378526	0.0001
LNQ	-23.72525	5.672983	-4.182147	0.0002
_0_5LNQ2	1.813581	0.426157	4.255668	0.0002
LNQ_LNW	-0.003020	0.006496	-0.464805	0.6450
LNQ_LNOC	0.005493	0.003556	1.544579	0.1317
LNQ_LNINT	0.018138	0.002897	6.260714	0.0000

R-squared	0.784710	Mean dependent var	9.401145
Adjusted R-squared	0.753050	S.D. dependent var	0.117853
S.E. of regression	0.058566	Akaike info criterion	-2.699853
Sum squared resid	0.116618	Schwarz criterion	-2.446521
Log likelihood	59.99706	Hannan-Quinn criter.	-2.608256
F-statistic	24.78537	Durbin-Watson stat	0.964811
Prob(F-statistic)	0.000000		

7. Thai Military Bank (TMB)

Dependent Variable: LNC
Method: Least Squares
Date: 10/15/19 Time: 22:57
Sample: 2009Q3 2019Q2
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-261.9643	157.9341	-1.658693	0.1064
LNQ	39.22237	23.49049	1.669713	0.1042
_0_5LNQ2	-2.809303	1.749376	-1.605889	0.1175
LNQ_LNW	0.005716	0.009197	0.621489	0.5384
LNQ_LNOC	0.019831	0.009546	2.077364	0.0454
LNQ_LNINT	0.010714	0.006692	1.601030	0.1186

R-squared	0.890409	Mean dependent var	9.051286
Adjusted R-squared	0.874292	S.D. dependent var	0.203942
S.E. of regression	0.072308	Akaike info criterion	-2.278278
Sum squared resid	0.177768	Schwarz criterion	-2.024946
Log likelihood	51.56557	Hannan-Quinn criter.	-2.186682
F-statistic	55.24876	Durbin-Watson stat	1.827447
Prob(F-statistic)	0.000000		

8. TISCO Bank (TISCO)

Dependent Variable: LNC
Method: Least Squares
Date: 10/15/19 Time: 23:00
Sample: 2009Q3 2019Q2
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.815291	33.77048	0.201812	0.8413
LNQ	-0.912551	5.484022	-0.166402	0.8688
_0_5LNQ2	0.170363	0.448723	0.379661	0.7066
LNQ_LNW	-0.029930	0.008779	-3.409167	0.0017
LNQ_LNOC	0.014345	0.006117	2.344871	0.0250
LNQ_LNINT	-0.001994	0.002990	-0.666847	0.5094

R-squared	0.952943	Mean dependent var	8.241484
Adjusted R-squared	0.946023	S.D. dependent var	0.276957
S.E. of regression	0.064345	Akaike info criterion	-2.511619
Sum squared resid	0.140772	Schwarz criterion	-2.258287
Log likelihood	56.23238	Hannan-Quinn criter.	-2.420022
F-statistic	137.7052	Durbin-Watson stat	1.869784
Prob(F-statistic)	0.000000		

9. CIMB THAI Bank (CIMBT)

Dependent Variable: LNC
Method: Least Squares
Date: 10/15/19 Time: 23:04
Sample: 2009Q3 2019Q2
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-82.76054	24.39020	-3.393188	0.0018
LNQ	14.06841	3.971092	3.542706	0.0012
_0_5LNQ2	-1.066377	0.323768	-3.293649	0.0023
LNQ_LNW	0.018340	0.011189	1.639129	0.1104
LNQ_LNOC	0.017012	0.010188	1.669717	0.1042
LNQ_LNINT	0.000110	0.005636	0.019432	0.9846

R-squared	0.966343	Mean dependent var	8.105861
Adjusted R-squared	0.961393	S.D. dependent var	0.330617
S.E. of regression	0.064961	Akaike info criterion	-2.492565
Sum squared resid	0.143480	Schwarz criterion	-2.239233
Log likelihood	55.85129	Hannan-Quinn criter.	-2.400968
F-statistic	195.2377	Durbin-Watson stat	1.590691
Prob(F-statistic)	0.000000		

10. Kiatnakin Phatra Bank (KKP)

Dependent Variable: LNC
Method: Least Squares
Date: 10/15/19 Time: 23:07
Sample: 2009Q3 2019Q2
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	78.80367	54.69281	1.440842	0.1588
LNQ	-11.92371	8.889819	-1.341277	0.1887
_0_5LNQ2	1.046309	0.729415	1.434449	0.1606
LNQ_LNW	0.050636	0.011434	4.428521	0.0001
LNQ_LNOC	0.000262	0.007924	0.033102	0.9738
LNQ_LNINT	0.040356	0.008121	4.969169	0.0000

R-squared	0.933243	Mean dependent var	8.124645
Adjusted R-squared	0.923426	S.D. dependent var	0.298907
S.E. of regression	0.082714	Akaike info criterion	-2.009382
Sum squared resid	0.232613	Schwarz criterion	-1.756051
Log likelihood	46.18765	Hannan-Quinn criter.	-1.917786
F-statistic	95.06186	Durbin-Watson stat	1.696948
Prob(F-statistic)	0.000000		

11. LH Financial Group (LHFG)

Dependent Variable: LNC
Method: Least Squares
Date: 10/15/19 Time: 23:09
Sample (adjusted): 2010Q4 2019Q2
Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-97.63779	15.54545	-6.280797	0.0000
LNQ	17.27219	2.749807	6.281236	0.0000
_0_5LNQ2	-1.346782	0.238994	-5.635221	0.0000
LNQ_LNW	0.009423	0.015177	0.620870	0.5395
LNQ_LNOC	0.058877	0.021825	2.697703	0.0115
LNQ_LNINT	0.008093	0.004502	1.797740	0.0826

R-squared	0.982409	Mean dependent var	7.274515
Adjusted R-squared	0.979376	S.D. dependent var	0.412944
S.E. of regression	0.059303	Akaike info criterion	-2.657501
Sum squared resid	0.101989	Schwarz criterion	-2.390870
Log likelihood	52.50626	Hannan-Quinn criter.	-2.565460
F-statistic	323.9123	Durbin-Watson stat	1.416272
Prob(F-statistic)	0.000000		

Annex 2

The general specification for studying the effect of bank's competition on bank's stability are shown as equation (5). There are four models with different dependent variables or bank's stability and risk: Z-score, NPL Ratio, interest income risk, and non-interest income risk. First, we test the cross-section random effect using the Hausman test then, we apply the fixed effect for Z-score model and random effect for the other models as following.

$$\text{Bank stability}_{st} = \beta_0 + \beta_1 \text{Lerner index}_{st} + \beta_2 \text{Size}_{st} + \beta_3 \text{LR}_{st} + \beta_4 \text{Foreign}_{st} + \beta_5 \text{CR5}_{t} + \beta_6 \text{RGDP}_{t} + \varepsilon_{st} \quad (1)$$

Where the subscripts s and t denote the bank and year, respectively.

Model 1

a. Investigate the effect of bank competition on the banks' capitalization level (Z-score)

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	14.5413	6	0.0241

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var (Diff.)	Prob.
LERNER	-354.0221	-296.0896	438.5178	0.0057
SIZE	251.5171	90.9672	2393.8215	0.0010
LR	-290.3741	-159.3352	45516.1420	0.5391
FOREIGN	239.7038	269.7409	16296.3698	0.8140
CR5	6901.6123	7451.9003	45597.3729	0.0100
RGDP	-8.6345	-11.7021	0.9556	0.0017

Cross-section random effects test equation:
Dependent Variable: Z_SCORE
Method: Panel Least Squares
Date: 04/13/20 Time: 20:44
Sample: 2010Q1 2018Q4
Periods included: 36
Cross-sections included: 11
Total panel (unbalanced) observations: 391

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-8201.9280	1213.4330	-6.7592	0.0000
LERNER	-354.0222	71.27900	-4.9667	0.0000
SIZE	251.5172	64.29845	3.9117	0.0001
LR	-290.3742	436.8983	-0.6646	0.5067
FOREIGN	239.7038	206.4665	1.160982	0.2464
CR5	6901.612	1219.209	5.660732	0.0000
RGDP	-8.634569	4.898386	-1.762738	0.0788

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.347090	Mean dependent var	477.0507
Adjusted R-squared	0.319158	S.D. dependent var	344.9865
S.E. of regression	284.6593	Akaike info criterion	14.18297
Sum squared resid	30305556	Schwarz criterion	14.35552
Log likelihood	-2755.770	Hannan-Quinn criter.	14.25136
F-statistic	12.42624	Durbin-Watson stat	0.782030
Prob(F-statistic)	0.000000		

b. Cross-section Fixed Effects

No.	Firms	Effect	No.	Firms	Effect
1	BBL	-84.09	7	TMB	-107.50
2	SCB	-331.77	8	TISCO	124.61
3	KBANK	-481.19	9	CIMBT	308.00
4	KTB	-470.23	10	KKP	275.31
5	BAY	33.05	11	LHFG	732.43
6	TCAP	103.10			

Model 2

a. Investigate the effect of bank competition on the non-performing loan ratio

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	0.0000	6	1.0000

* Cross-section test variance is invalid. Hausman statistic set to zero.
Cross-section random effects test comparisons:

Variable	Fixed	Random	Var (Diff.)	Prob.
LERNER	-0.2340	-0.2759	0.0002	0.0097
SIZE	-0.2747	-0.1945	0.0016	0.0499
LR	-2.4881	-2.4352	0.0269	0.7471
FOREIGN	-0.3373	-0.2260	0.0101	0.2704
CR5	8.2678	8.0741	0.0312	0.2733
RGDP	0.0031	0.0046	0.0000	0.0560

Cross-section random effects test equation:
Dependent Variable: NPL
Method: Panel Least Squares
Date: 04/13/20 Time: 20:47
Sample: 2010Q1 2018Q4
Periods included: 36
Cross-sections included: 11
Total panel (unbalanced) observations: 392

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.3038	1.2002	-3.5858	0.0004
LERNER	-0.2340	0.0697	-3.3572	0.0009
SIZE	-0.2747	0.0633	-4.3372	0.0000
LR	-2.4881	0.4330	-5.7460	0.0000
FOREIGN	-0.3373	0.2049	-1.6455	0.1007
CR5	8.2678	1.2099	6.8332	0.0000
RGDP	0.0031	0.0048	0.6501	0.5160

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.6200	Mean dependent var	-3.4560
Adjusted R-squared	0.6038	S.D. dependent var	0.4490
S.E. of regression	0.2826	Akaike info criterion	0.3530
Sum squared resid	29.9549	Schwarz criterion	0.5252
Log likelihood	-52.1964	Hannan-Quinn criter.	0.4213
F-statistic	38.2496	Durbin-Watson stat	0.3651
Prob(F-statistic)	0.0000		

Dependent Variable: NPL
Method: Panel EGLS (Cross-section random effects)
Date: 04/15/20 Time: 01:19

Sample: 2010Q1 2018Q4
Periods included: 36
Cross-sections included: 11
Total panel (unbalanced) observations: 392
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.3285	1.1377	-4.6833	0.0000
LERNER	-0.2759	0.0677	-4.0710	0.0001
SIZE	-0.1945	0.0483	-4.0213	0.0001
LR	-2.4352	0.4007	-6.0772	0.0000
FOREIGN	-0.2260	0.1783	-1.2669	0.2059
CR5	8.0741	1.1969	6.7456	0.0000
RGDP	0.0046	0.0047	0.9800	0.3277

Effects Specification	S.D.	Rho
Cross-section random	0.2655	0.4688
Idiosyncratic random	0.2826	0.5312

Weighted Statistics

R-squared	0.2491	Mean dependent var	-0.6070
Adjusted R-squared	0.2374	S.D. dependent var	0.3299
S.E. of regression	0.2872	Sum squared resid	31.7623
F-statistic	21.2897	Durbin-Watson stat	0.3415
Prob(F-statistic)	0.0000		

Unweighted Statistics

R-squared	-0.0087	Mean dependent var	-3.4560
Sum squared resid	79.5272	Durbin-Watson stat	0.1364

b. Cross-section Fixed Effects

No.	Firms	Effect	No.	Firms	Effect
1	BBL	0.0178	7	TMB	0.0881
2	SCB	-0.0048	8	TISCO	-0.3203
3	KBANK	-0.0721	9	CIMBT	0.1087
4	KTB	0.2011	10	KKP	0.4235
5	BAY	0.2094	11	LHFG	-0.9502
6	TCAP	0.2986			

Model 3

a. Investigate the effect of bank competition on the interest income risk

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	0.0000	6	1.0000

* Cross-section test variance is invalid. Hausman statistic set to zero.
Cross-section random effects test comparisons:

Variable	Fixed	Random	Var (Diff.)	Prob.
LERNER	0.3860	0.2877	0.0081	0.2759
SIZE	-0.0715	-0.3646	0.0274	0.0768
LR	-2.7124	-1.6208	0.7732	0.2144
FOREIGN	-1.7336	-0.2477	0.2335	0.0021
CR5	-5.1275	-3.1558	0.5548	0.0081
RGDP	0.0108	0.0044	0.0000	0.0603

Cross-section random effects test equation:
Dependent Variable: INT
Method: Panel Least Squares
Date: 04/13/20 Time: 20:49
Sample: 2010Q1 2018Q4
Periods included: 36
Cross-sections included: 11
Total panel (unbalanced) observations: 391

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.0768	3.4765	1.1726	0.2417
LERNER	0.3860	0.2042	1.8906	0.0594
SIZE	-0.0715	0.1842	-0.3885	0.6978
LR	-2.7124	1.2517	-2.1670	0.0309
FOREIGN	-1.7336	0.5915	-2.9307	0.0036
CR5	-5.1275	3.4930	-1.4679	0.1430
RGDP	0.0108	0.0140	0.7759	0.4383

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.2693	Mean dependent var	-3.5506
Adjusted R-squared	0.2380	S.D. dependent var	0.9342
S.E. of regression	0.8155	Akaike info criterion	2.4726
Sum squared resid	248.7580	Schwarz criterion	2.6451
Log likelihood	-466.3946	Hannan-Quinn criter.	2.5410
F-statistic	8.6136	Durbin-Watson stat	0.7743
Prob(F-statistic)	0.0000		

Method: Panel EGLS (Cross-section random effects)
Date: 04/15/20 Time: 01:21
Sample: 2010Q1 2018Q4

Periods included: 36
Cross-sections included: 11
Total panel (unbalanced) observations: 391
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.1084	2.9848	1.7114	0.0878
LERNER	0.2877	0.1831	1.5708	0.1171
SIZE	-0.3646	0.0805	-4.5262	0.0000
LR	-1.6208	0.8908	-1.8194	0.0696
FOREIGN	-0.2477	0.3411	-0.7260	0.4683
CR5	-3.1558	3.4127	-0.9247	0.3557
RGDP	0.0044	0.0136	0.3276	0.7433

Effects Specification	S.D.	Rho
Cross-section random	0.2668	0.0967
Idiosyncratic random	0.8155	0.9033

Weighted Statistics			
R-squared	0.0607	Mean dependent var	-1.6184
Adjusted R-squared	0.0460	S.D. dependent var	0.8417
S.E. of regression	0.8237	Sum squared resid	260.5641
F-statistic	4.1394	Durbin-Watson stat	0.7348
Prob(F-statistic)	0.0004		

Unweighted Statistics			
R-squared	0.1661	Mean dependent var	-3.5506
Sum squared resid	283.8562	Durbin-Watson stat	0.6745

b. Cross-section Fixed Effects

No.	Firms	Effect	No.	Firms	Effect
1	BBL	0.0171	7	TMB	0.0734
2	SCB	0.1964	8	TISCO	0.1688
3	KBANK	-0.4578	9	CIMBT	0.4034
4	KTB	-0.0313	10	KKP	-0.0858
5	BAY	-0.0151	11	LHFG	-0.2593
6	TCAP	-0.0098			

Model 4

a. investigate the effect of bank competition on the non-interest income risk

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	0.0000	6	1.0000

* Cross-section test variance is invalid. Hausman statistic set to zero.
Cross-section random effects test comparisons:

Variable	Fixed	Random	Var (Diff.)	Prob.
LERNER	0.7707	0.6575	0.0085	0.2205
SIZE	-0.8069	-0.9556	0.0394	0.4541
LR	-8.7198	-6.8337	0.8730	0.0435
FOREIGN	-0.7411	-0.2105	0.2947	0.3283
CR5	-14.4549	-12.8744	0.7646	0.0707
RGDP	0.0143	0.0128	0.0000	0.7012

Cross-section random effects test equation:
Dependent Variable: NON_INT
Method: Panel Least Squares
Date: 08/14/20 Time: 09:35
Sample: 2010Q1 2018Q4
Periods included: 36
Cross-sections included: 11
Total panel (unbalanced) observations: 391

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	26.8599	4.5451	5.9096	0.0000
LERNER	0.7707	0.2669	2.8869	0.0041
SIZE	-0.8069	0.2408	-3.3506	0.0009
LR	-8.7198	1.6364	-5.3284	0.0000
FOREIGN	-0.7411	0.7733	-0.9584	0.3385
CR5	-14.4549	4.5667	-3.1652	0.0017
RGDP	0.0143	0.0183	0.7819	0.4347

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.5119	Mean dependent var	-2.0219
Adjusted R-squared	0.4911	S.D. dependent var	1.4946
S.E. of regression	1.0662	Akaike info criterion	3.0086
Sum squared resid	425.1893	Schwarz criterion	3.1812
Log likelihood	-571.1931	Hannan-Quinn criter.	3.0770
F-statistic	24.5235	Durbin-Watson stat	0.6379
Prob(F-statistic)	0.0000		

Dependent Variable: NON_INT
Method: Panel EGLS (Cross-section random effects)
Date: 08/14/20 Time: 09:36

Sample: 2010Q1 2018Q4
Periods included: 36
Cross-sections included: 11
Total panel (unbalanced) observations: 391
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	26.0515	4.0711	6.3990	0.0000
LERNER	0.6575	0.2504	2.6252	0.0090
SIZE	-0.9556	0.1361	-7.0211	0.0000
LR	-6.8337	1.3435	-5.0864	0.0000
FOREIGN	-0.2105	0.5507	-0.3822	0.7025
CR5	-12.8744	4.4822	-2.8723	0.0043
RGDP	0.0128	0.0179	0.7153	0.4748

Effects Specification	S.D.	Rho
Cross-section random	0.5417	0.2052
Idiosyncratic random	1.0662	0.7948

Weighted Statistics

R-squared	0.1744	Mean dependent var	-0.6312
Adjusted R-squared	0.1615	S.D. dependent var	1.1668
S.E. of regression	1.0696	Sum squared resid	439.3447
F-statistic	13.5265	Durbin-Watson stat	0.6050
Prob(F-statistic)	0.0000		

Unweighted Statistics

R-squared	0.3744	Mean dependent var	-2.0219
Sum squared resid	545.04	Durbin-Watson stat	0.4877

a. Cross-section Fixed Effects

No.	Firms	Effect	No.	Firms	Effect
1	BBL	-0.2801	7	TMB	-0.2643
2	SCB	0.0462	8	TISCO	0.0718
3	KBANK	-1.1082	9	CIMBT	0.4034
4	KTB	0.5591	10	KKP	0.3632
5	BAY	0.2546	11	LHFG	-0.5872
6	TCAP	0.5413			

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