Measures of Bank Competition and Bank Risk-Taking

Veronica Bayangos[1]

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1. Introduction

The array of empirical studies has highlighted the influence of bank competition on financial stability, credit growth, and the regulatory drivers of competition in banking markets (De-Ramon and Straughan 2020). Recent discussions have focused on the role of important reforms that have greatly reshaped the structure of the global financial system. Some banks have become big and interconnected while some have become generally risk takers. Studies suggest that financial sector reforms promote bank competition in most advanced and emerging market economies. As such, discussions on bank competition have intensified in recent past years particularly in constructing different measures of bank competition and in explaining factors driving the monetary authorities' policy mandates. However, some studies also find that bank competition in many emerging countries have declined despite the implementation of financial sector reforms. The impact of the COVID-19 pandemic on bank operations has contributed to the decline in bank competition. These findings are particularly evident in diverse banking industries where smaller banks also offer great services.

This study follows more closely the role of bank competition on banking stability. There is currently a debate in the banking literature regarding the effect of competition on the stability of banks. In the traditional "competition-fragility" view, Jimenez et al. (2013) explains that increased competition among banks could threaten the solvency of individual banks and endangers the stability of the banking system. This could erode the franchise value of a bank, that is the ongoing concern or market value of a bank beyond its book value. This in turn could encourage a bank to pursue riskier policies to maintain its profits. These riskier policies are expected to increase the probability of higher non-performing loan ratios and lead to bank failures.

By contrast, the "competition-stability" view posits that a less intensive competition could result in higher interest rates on loans, which may in turn raise the credit risk of borrowers due to moral hazard issues. The increased default risk could potentially lead to more problem loans and greater bank instability. However, such a situation allows a bank to protect its franchise value by pursuing safer policies that contribute to the stability of individual banks and the entire banking system (Boyd and De Nicolo 2005).

Empirical studies observe that competition in the banking industry can improve allocative, productive, and dynamic efficiencies through innovation, with the ultimate benefit being

[1] Director, Bangko Sentral ng Pilipinas Research Academy (BRAc). I am grateful to Deputy Governor Chuchi G. Fonacier (Financial Supervision Sector), Assistant Governor Lyn I. Javier (Financial Supervision Sector), Senior Director Raymond O. Estioko (Payment System Oversight Department), Director Noel C. Guinto (Department of Supervisory Analytics), Director Melchor T. Plabasan (Technology Risk and Innovation Supervision Department), officers and staff of the Supervisory Policy and Research Department (SPRD), colleagues in the BSP Research Academy (BRAc), Ms. Siti Hanifah Borhan Nordin (Bank Negara Malaysia and participants during the 14th Asia Research Network and Bank for International Settlements Research Workshop on 29 March 2022 for their insightful comments and suggestions. The views in this study are those of the author and are not necessarily the views of the BRAc or the Bangko Sentral ng Pilipinas (BSP).

stronger economic growth. These benefits compel central banks to provide a level-playing field for banks by ensuring that policies are fair to both big and small banks. However, it is also the responsibility of central banks to ensure that individual banks and the banking system are stable.

This paper examines the relationship between measures of bank competition and bank risk-taking following the global financial crisis using a single country setting. In this paper, I add to the literature on bank competition and stability by first constructing measures of market concentration in asset markets and market power to determine the extent of bank competition across the three banking groups in the Philippines and measure of bank efficiency using quarterly bank-level balance sheets and income statements of 542 Philippine banks from March 2010 to December 2020. To the best of my knowledge, this is the first time that a construction of measures of bank competition and an analysis of its impact on bank performance has used the source bank reports in the Philippines. The paper also determines the initial impact of the Covid-19 pandemic on measures of competition and on bank risk. The BSP requires banks to report their quarterly balance sheets and income statements to provide the BSP with a comprehensive view of the financial strength and soundness as well as potential financial risks and transmission channels emanating from counterparties of individual Philippine banks. The Philippine banking system is dominated by three banking groups – the universal and commercial bank (U/KB) industry is composed of 41 banks, the thrift bank (TB) industry of 55 banks and the rural and cooperative bank (R/CB) industry of 457 banks.

I estimate the impact of the different measures of bank competition on bank risk-taking activities focusing on the differences in responses among U/KBs, TBs and R/CBs. I would like to know how individual banks in the U/KB, TB and R/CB industries adjust their portfolio strategy to changes in financial innovation, financial sector reforms to maintain bank stability by looking at their balance sheets and income statements. I emphasize the importance of specific bank features such as the extent of diversification measures, asset quality, capital and liquidity positions of individual banks, macroeconomic fundamentals such as consumer price inflation, real Gross Domestic Product (GDP), policy interest rates as well changes in physical banking network brought about by merger, consolidation, entry of new banks, closure of banks and the rising digitalization in payment channels and how these factors eventually affect bank stability.

This study constructs four unique databases from March 2010 to December 2020 to help answer the research questions:

First, a quarterly database of Income Statements to determine details of profit and loss, including return on assets, return on equity of individual banks, cost-to-income ratio and extent of bank diversification.

Second, a quarterly database of bank-specific characteristics from the Financial Reporting Package such as asset size, loan portfolio, loan loss reserves, non-performing loan (NPL) ratio, NPL coverage ratio, deposits, and investments.

Third, a quarterly database containing information on the BSP's overnight policy rate, peso-dollar rate, real Gross Domestic Product (GDP) growth, and inflation based on Consumer Price Index.

Finally, a quarterly database on changes in the physical banking networks such as the number of mergers, consolidations, acquisitions, new banks, closure of banks and number of banks with payment channels such as InstaPay and PesoNet.

The rest of this paper is organized as follows. Section 2 briefly reviews the empirical findings of the studies on measures of bank competition and banking stability. Section 3 discusses databases used and empirical methodology, while Section 4 highlights the main findings of the paper. Section 5 concludes.

2. Survey of Empirical Findings

Research on bank competition has received considerable attention in the literature in recent years. Studies focus on evaluating the influence of bank competition on bank risk and stability (e.g. Schaeck and Cihak 2014; Dutta and Saha 2021) and credit growth (e.g. Cetorelli and Strahan 2006). A particularly important topic in this strand of research is the impact of efficiency on stability and the impact of competition on efficiency. Some studies delve on developing a better understanding of the underlying regulatory drivers of competition in banking markets (e.g. Casu and Girardone 2006). This area includes research on how regulatory, structural and technological changes in banking markets affect competition and economic outcomes (de-Ramon and Straughan 2020). This study follows more closely the strand of research on bank competition and efficiency and their impact on bank risk and stability and the impact of efficiency on bank competition.

There is currently a debate in the banking literature regarding the effect of competition on the stability of banks. Under the traditional "competition-fragility" view, Jimenez et al. (2013) explain that a standard principle in the banking literature is that increased competition among banks could threaten the solvency of individual banks and hamper the stability of the banking system at a broader level. Such a competition could erode the franchise value of a bank – the ongoing concern or market value of a bank beyond its book value. This in turn encourages a bank to pursue riskier policies to maintain its profits. Examples of riskier policies are taking on more credit risk in the loan portfolio, reducing capital levels, or both. These riskier policies are expected to increase the probability of higher non-performing loan ratios and possibly to more bank failures.

Boyd and De Nicolo (2005) initiate a contrary "competition-stability" view. They contend that less competition among banks could result in higher interest rates being charged on loans, which could raise the credit risk of borrowers as a result of moral hazard issues. This could possibly lead to more problem loans and greater bank instability. They further argue that under such a scenario, banks will take immediate actions to protect their franchise value by pursuing safer policies that contribute to the stability of the entire banking system. They call these measures a "risk-shifting" paradigm.

Martinez-Miera and Repullo (2010) show that a nonlinear relationship theoretically exists between bank competition and risk-taking in the loan market. They extend the Boyd and De Nicolo's (2005) model by allowing for imperfect correlation across individual firms' default probabilities. Their model also identifies a risk-shifting effect that accounts for fewer firm defaults when loan rates decrease in a more competitive banking environment. However, since imperfect correlation between firms is assumed, there is also a "margin" effect that reduces the interest payments from performing loans and bank revenues. These two effects work in opposite directions, so that the net effect on bank risk-taking and financial stability becomes unclear. In their model, the risk-shifting effect is shown to be dominated by the

margin effect in competitive banking environments, such that increased competition amplifies risk of bank failure. In a more concentrated banking market, the model suggests that the risk-shifting effect dominates and thus bank failure risk declines with more intense competition.

The empirical studies point to mixed findings. Using a cross-country panel of banks, Beck et al. (2013) show that competition has a strong positive relationship with bank fragility for distressed banks. Schaeck and Čihák (2014) find evidence consistent with the competition-stability hypothesis, but this relationship is less (more) pronounced for European banks closer to (farther from) insolvency. Using data on non-performing loans for Euro area banks, Karadima and Louri (2019) observe that profit margins[2] exert a positive impact on the change in non-performing loans for firms in the medium and upper quantiles of their distribution, supporting the competition-stability view. Liu and Wilson (2013) reveal that Japanese banks farther from insolvency take on more risk in response to more intense competition, consistent with the competition-fragility hypothesis, while those closer to insolvency reduce risk, consistent with the competition-stability hypothesis. Jimenez et al. (2013) test the competing theories of bank competition and bank risk using data from the Spanish banking system. After controlling for macroeconomic conditions and bank characteristics, they find support for this nonlinear relationship using standard measures of market concentration in both the loan and deposit markets. When direct measures of market power are used, the empirical results are more supportive of the franchise value hypothesis, but only in the loan market. Using data from the UK and multiple measures of bank competition and risk, de-Ramon et al. (2020) document relationships similar to those reported in Liu and Wilson (2013), further supporting the idea that the link between bank competition and risk may vary depending on the underlying solvency risk of the firm.

An important factor driving the link between bank profitability and concentration or market share is efficiency. However, the studies on this topic remain scant. The efficiency hypothesis (Berger 1995) maintains that more efficient banks are expected to gain market share. Hence, market concentration is endogenously driven by bank efficiency.

While empirical findings on the relationship between bank competition, bank efficiency, and bank risk-taking remain inconclusive, studies on how to measure bank competition using market concentration and market power continue to evolve. There are several approaches to measuring bank competition. These include decomposition of interest spreads, measures of bank concentration under the so-called "structure-conduct-performance" paradigm, regulatory indicators that measure the contestability of the banking sector, and direct measures of bank pricing behavior or market power based on the "new empirical industrial organization" literature.

An approach used by some studies to analyze bank competition is based on interest spread decomposition. But spreads are outcome measures of efficiency, and in addition to the competition environment, cross-country differences in spreads can reflect macroeconomic performance, the extent of taxation of financial intermediation, the quality of the contractual and judicial environment, and bank-specific factors such as scale and risk preferences. So these effects need to be controlled for in the analysis of competition.

The "structure-conduct-performance" paradigm assumes that there is a stable, causal relationship between the structure of the banking industry, firm conduct, and performance. It suggests that fewer and larger firms are more likely to engage in anticompetitive behavior.

[2] Which indicates market power.

In this framework, competition is negatively related to measures of concentration, such as the share of assets held by the top three or five largest banks.

Based on this approach, banking concentration can be approximated by the concentration ratio—the share of assets held by the largest banks (typically three or five) in a given economy—or the Herfindahl-Hirschman index (HHI), the sum of the squared market share of each bank in the system. The HHI accounts for the market share of all banks in the system and assigns a larger weight to the biggest banks. Instead, concentration ratios completely ignore the smaller banks in the system.

However, in many empirical studies, findings argue that concentration measures are generally not good predictors of competition. The predictive accuracy of concentration measures on banking competition is challenged by the concept of market contestability. The behavior of banks in contestable markets is determined by threat of entry and exit. Banks are pressured to behave competitively in an industry with low entry restrictions on new banks and easy exit conditions for unprofitable institutions - even if the market is concentrated.

Majority of recent research on the subject focused on direct measures of bank pricing behavior or market power based on the "new empirical industrial organization" (NEIO) literature. The aim of the NEIO measures is to assess the level of competition directly from the firms' conduct. These include the Panzar-Rosse-H-statistic, the Lerner index, and the Boone indicator. The H-statistic captures the elasticity of bank interest revenues to input prices. Another frequently used measure is based on markups in banking. The Lerner index is defined as the difference between output prices and marginal costs (relative to prices).[3] Higher values of the Lerner index signal less bank competition. Finally, the Boone indicator is a recent addition to this group of indices. It measures the effect of efficiency on bank performance in terms of profits. It is calculated as the elasticity of profits to marginal costs.[4] The main assumption behind the Boone indicator is that more efficient banks achieve higher profits. The more negative the Boone indicator is, the higher the level of competition is in the market because the effect of reallocation is stronger.

Studies use an array of measures to indicate bank competition. This study follows de-Ramon and Straughan (2020) who both use four indicators that provide different perspectives on bank competition. The intention is to help understand the nature and extent of competition in a single country setting. De-Ramon and Straughan (2020) compare the measures of market power such as the Panzar-Rosse-H-statistic, the Lerner index, and the Boone indicator and market concentration at the industry level (the Herfindahl-Hirschman Index) for the United Kingdom from 1989 to 2013. These comparisons allow them to identify periods when the signals from each indicator are yielding similar or contradictory inferences.

[3] Prices are calculated as total bank revenue over assets, whereas marginal costs are obtained from an estimated translog cost function with respect to output.

[4] To calculate this elasticity, the log of a measure of profits (such as return on assets) is regressed against a log measure of marginal costs. The elasticity is captured by the coefficient on log marginal costs, which are typically calculated from the first derivative of a translog cost function.

This paper is related to research on measures of bank competition and their impact on individual bank risk-taking using a single country setting. Bank competition in this study is defined as industry-wide competition. This research intends to shed light on the relationship between bank competition and bank solvency risk from the perspective of an emerging market economy, the Philippines. The focus on a single country in examining the relationship between various measures of competition and bank risk is expected to help ensure consistency in measures of the dependent and independent variables and to avoid having to control for potentially confounding factors that can influence the link (Beck et al. 2013). The study also attempts to understand how bank efficiency (Dutta and Saha 2021) and central bank reforms and policies affecting competition are transmitted across banks (de-Ramon et al. 2020).

There are broad similarities with de-Ramon and Straughan (2020), Dutta and Saha (2021), and Liu and Wilson (2013). The study looks at the universe of 542 banks as of December 2020 located in the Philippines to examine measures of bank competition and how these influence bank risk using the Financial Reporting Package from March 2010 to December 2020. The study shares the estimation approach used in de-Ramon and Straughan (2020) and is applied across the three banking groups – U/KB, TB and R/CB groups. The study adds another dimension by providing initial insights on the impact of bank efficiency, changes in the physical banking network, and the Covid-19 pandemic on bank solvency risk.

3. Data and Empirical Strategy

I compile three unique datasets on detailed balance sheets and income statements of 542 banks from the Financial Reporting Package (FRP) covering March 2010 to December 2020. Tables A1 to A4 in Annex A present the variables and variable names used in the study. The databases are briefly described here.

Bank-level balance sheet and income statements. As mentioned in the previous section, data are based on quarterly FRP. In the dataset, there are 41 U/KBs (composed of 14 UKBs, 4 commercial banks or KBs, and 23 FBs), 44 TBs and 457 R/CBs as of end-December 2020. To arrive at a balanced panel, I only include the surviving or the latest list of banks with minimum observation points of three years. To eliminate the effects of outliers, I winsorize all variables at the first and 99th percentiles.

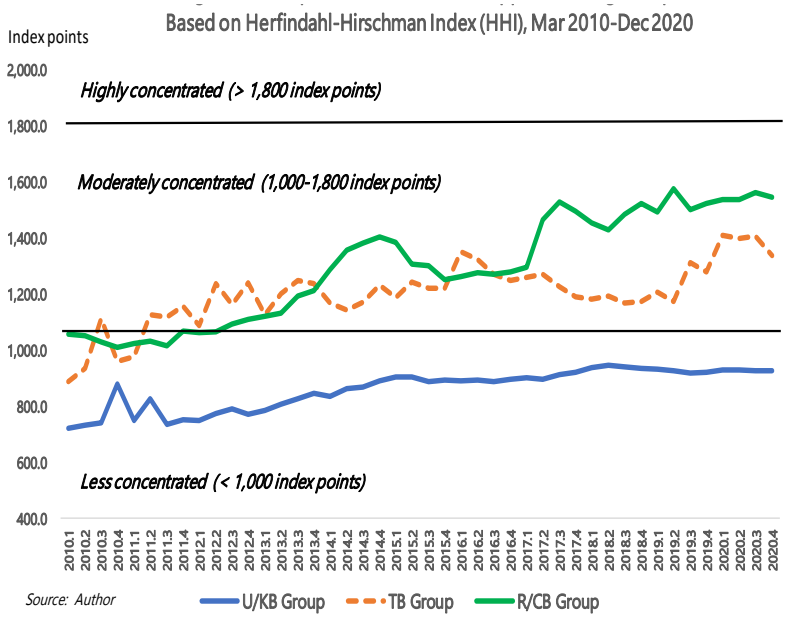
The bank-specific data include quarter-end data on the size of a bank (relative to total bank assets), credit growth, liquid assets relative to total assets, capitalization relative to total assets, funding composition using outstanding deposits relative to total liabilities, profitability of banks using annualized net income or loss, net interest margin (NIM), total operating income, interest income, non-interest income, Return on Equity (ROE), Return on Assets (ROA), and quality of bank loans using non-performing loans ratio (NPL), non-performing assets ratio (NPA), non-performing loan coverage ratio, and loan loss reserves (LLR). Other detailed bank accounts in the Income Statements of banks are also compiled such as cost-to-income ratio (a measure of bank efficiency), total expenses, input costs, total revenues, variable profits, and variable costs. In the study, I use financial reporting data on solo basis. I also include dummy variables for banks' business model or banking group.

Vector of controls. This dataset includes macro-financial indicators and the BSP policy actions. These indicators include real Gross Domestic Product (GDP) growth, inflation, monetary policy rate or overnight policy rate, bank lending rate, deposit rate, nominal peso-dollar rate, real effective exchange rates.

Measures of bank risk and bank competition. This database contains specific measures of individual bank risk and bank competition. Competition in this study refers to banking markets or banking groups, not in a specific product. I construct individual competition measures for the three banking groups – U/KB, TB and R/CB. The three groups show different market concentration based on HHI.

An expected strategy among BSFIs due to the adoption of financial reform initiatives are mergers and consolidations. Given the rapid pace of globalization and accelerating technological advancement, the BSP sees merger and consolidation as means to create stronger and globally competitive banking institutions. Mergers and consolidations are expected to help merged/consolidated banks harness with greater efficiency their collective experience, expertise and technological know-how. It is implicit that parties to mergers and consolidation have a strategic vision to make their merged enterprise more competitive, since mergers and consolidation will allow them to complement each other in terms of the markets they serve and the products and services they offer, allowing them to focus on core competencies. From March 2010 to December 2020, there were 28 episodes of mergers, consolidations and conversions, majority of these involve U/KBs and thrift banks, U/KBs and R/CBs, and TBs and R/CBs.

Figure 1: Competitive Structure of Philippine Banking Groups



To determine the effect of mergers and consolidations on market concentration, I construct a Herfindahl-Hirschman Index (HHI)[5] each for the three Philippine banking groups – U/KB, TB and R/CB industries – from March 2010 to December 2020. There are perceived shortcomings of the HHI as a measure of market concentration. However, I treat this measure as a first approximation of market concentration. Following Meyer 2018, the HHI has three key ranges and market classifications: less than 1,000 index points (less concentrated); 1,000-1,800 index points (moderately concentrated) and above 1,800 index

[5] The HHI is calculated by summing the square of the share of assets for each bank with the group total assets. For example, if there are five banks operating, each holding a 20 percent market share, the HHI will be 2,000. If the market has only one bank (a monopoly), the HHI will be 10,000.

points (highly concentrated). If the HHI value for a specific banking group exceeds 1,800, that group can be considered highly concentrated - that is, merger activity is severely limited. Figure 1 shows that the U/KB industry and R/CB industry are relatively far from being oligopolistic in terms of asset distribution. This means that there are numerous competitors with significant market shares. Figure 1 reveals that among the three groups, TB and R/CB industries, which both occupy about 7.2% of the banking sector's total assets as of end-December 2020, are moderately concentrated, while the U/KB industry which occupies 92.8% of the sector's assets, is less concentrated.

The decline in the HHIs of TB and R/CB industries from 2015 to 2017 can be attributed to the larger banks being able to establish branches in markets that were previously only served by UKBs, while the gradual rise in HHI after 2008 may be the result of post-GFC consolidation. This implies that there may be limitations in mergers among TBs and R/CBs. This may also mean that an out-of-group bank merger is a reasonable strategy.

I then compare the bank-level HHI with ROA over the same period. Estimates show that the ROA has been generally increasing with the HHI, although there are R/CBs with negative ROAs. This may also be attributed to the higher degree of diversification among U/KBs. A computation of diversification across banks shows that the range of diversification between interest and non-interest activities among U/KBs is higher than those of the TBs and R/CBs. Overall, the results show that banks are generally stable and that while recent big mergers and consolidation have increased market concentration, these are not enough to pose a threat to the overall competition levels since market shares remain relatively well dispersed among the remaining players. The results also confirm that the U/KB industry still has room for more mergers and consolidations without necessarily inhibiting efficient competition.

Following de-Ramon et al. (2020), I estimate the Z-score to represent stand-alone bank risk for all the banking groups. The relationship between the individual Z-scores and measures of bank competition are then estimated to examine the impact of these measures of competition on bank risk.[6]

The Z-score is an accounting-based measure of risk calculated at the bank level as,

$$Z_{b,t} = (ROA_{b,t} + c_{b,t})/\sigma ROA_{b,t} \quad , \quad (1)$$

where $ROA_{b,t}$ refers to Return on Assets of bank *b* at time *t* , $c_{b,t}$ is total capital to assets ratio of bank *b* at time *t* , and $\sigma ROA_{b,t}$ is the standard deviation of *ROA* of bank *b* at time *t*. Following episodes of mergers and consolidation, I use a four-quarter (one year) rolling window of *ROA* to calculate $\sigma ROA_{b,t}$.[7]

I construct three measures of market power to represent bank competition – Panzar-Rosse-H-statistic (H-statistic), the Lerner index (LI) and Boone indicator (BI).

Panzar-Rosse-H-statistic (H-statistic). The H-statistic captures the elasticity of bank interest revenues to input prices.[8] The H-statistic is calculated in two steps. First, running a

[6] See Boyd et al. (2006); Schaeck and Cihak (2014).
[7] In the initial estimation, bank-level ROE and NPL ratio are used. However, the results are not significant. In the future, forecasted bank-level ROA can be used. This is an area for future research.
[8] In the initial regression, I used the interest income to revenue ratio. However, the bank-level ratios are relatively small. There are also banks that registered losses from their interest-earning transactions. Hence,

panel regression with bank and time fixed effects of the logarithm of measures of banks' input prices on the logarithm of gross total revenues.[9] Second, adding the estimated coefficients for each input price. Input prices include the price of deposits (commonly measured as the ratio of interest expenses to total deposits), the price of personnel (as captured by the ratio of personnel expenses to assets), and the price of equipment and fixed capital (approximated by the ratio of other operating and administrative expenses to total assets).

Higher values of the H-statistic are associated with more competitive banking systems. Under a monopoly, an increase in input prices typically results in a rise in marginal costs, a fall in output, and a decline in revenues (assuming that the demand curve is downward sloping), leading to an H-statistic of less than or equal to 0. Under perfect competition, an increase in input prices generally raises both marginal costs and total revenues by the same amount (assuming that the demand curve is perfectly elastic); hence, the H-statistic will be equal to 1.

Lerner Index (LI). Following de-Ramon and Straughan (2020), the LI is seen in equation 2 as,

$$L_{b,t} = (A_{b,t} - MC_{b,t})/A_{b,t} \quad , \qquad (2)$$

as the ratio of the difference in output price $A_{b,t}$ of bank *b* at time *t* and marginal cost of bank *b* at time *t* $(MC_{b,t})$ to output price $(A_{b,t})$. The output price is proxied by total assets and is calculated as the sum of interest and non-interest revenue per unit of total output.[10] The marginal cost $(MC_{b,t})$ is not directly observable. In this study, the LI is calculated in two steps. First, running a panel regression with bank and time fixed effects of the logarithm of total cost on the logarithm of total assets and banks' input prices *(ln w)* in equation 3.[11] These input prices include bank personnel compensation, funding cost and other operating costs. Second, adding the estimated coefficients for each input price in equation 3. Equation 3 below approximates the $(MC_{b,t})$ as,

$$MC_{b,t} = \frac{TC_{b,t}}{A_{b,t}}\left[a_{1b,t} + a_{2b,t} lnA + \sum_{b=1}^{3} a_{3t} lnW\right]. \qquad (3)$$

The LI estimated for individual banks denotes its pricing power. Based on the theory, the LI can range between 0 and 1. However, in the actual estimation, the LI can exceed 1 when

there are challenges in using the ratio in regressions. Defined as the sum of interest and non-interest income, operating income has a bigger scope and therefore higher than interest income.

[9] The results of panel regression with bank and time fixed effects from March 2010 to December 2020 are as follows:

	Log (total revenues)		
	U/KBs	TBs	R/CBs
Log(total input prices)	0.671	0.238	0.632

Source: Author.

[10] The impact of competition based on differentiated products on risk can be explored. Also, by type of portfolio such as households, corporates. I take this as an area of future research.

[11] The results of panel regression with bank and time fixed effects from March 2010 to December 2020 are as follows:

	Log (total cost/total assets)		
	U/KBs	TBs	R/CBs
Log(input prices)	0.030	0.109	0.211

Source: Author.

the *MC* is positive or it can be negative. An LI with a value approaching to 1 indicates increasing level of market power or wider margins on the part of the bank.

Boone Indicator (BI). Following de-Ramon and Straughan (2020), I estimate BI in equation 4 below as,

$$LogP_{b,t} = \alpha + \beta_1 Log\, C_{b,t} + \beta_2 O_{b,t} + \mu_{b,t} \quad , \quad (4)$$

where $LogP_{b,t}$ is the logarithm of variable profits for bank *b* at time *t*, $Log\, C_{b,t}$ is the logarithm of average variable costs, $O_{b,t}$ are other control variables which include macro-financial indicators and other specific characteristics of bank *b*, and $\mu_{b,t}$ is the error term. For consistency with the specifications of H-statistic and Lerner Index, the baseline BI calculation excludes the $O_{b,t}$. The BI is seen in β_1 which is estimated for bank *b* at time *t*. To estimate equation 4, I calculate variable profits as the ratio of total revenue less variable costs (i.e., interest paid, personnel expenditure, other variable costs including occupancy of building) to total assets.[12] Average variable costs are measured as variable costs scaled by variable revenue derived directly from current activity (i.e., interest received, foreign exchange receipts, investment income, fees and other charges).

In the actual estimation, the computed BI is then regressed on a four-quarter rolling window of ROA and $O_{b,t}$. I use bank-level variables found in the literature in addition to variable profit and average variable cost as controls for macro-financial indicators and other bank-specific characteristics such as capitalization/total assets, outstanding deposits/total liabilities, and loan-to-asset ratio. As mentioned in the previous section, the main assumption behind the Boone indicator is that more efficient banks achieve higher profits. In practice, the Boone indicator is negative. The more negative the Boone indicator is, the higher the level of competition is in the market, because the effect of reallocation is stronger.

Measure of changes in the physical banking network. This database compiles the number of closed banks, entry of new banks (including entry of foreign and digital banks), mergers, consolidation, acquisition, and banks which applied for digital payment channels for banking services such as InstaPay and PESONet from March 2010 to December 2020. A dummy variable is assigned to a value of one (1) when a bank enters, merges, consolidates, and applies for digital payment services and, 0 otherwise. The measures are computed as the quarterly sum of banks to match the frequency of the dependent variables in the models. In the final regression results, only the measures on changes in the physical banking network are significant.

The BSP continues to leverage on the structural changes, including the financial sector reforms it has started even before the global financial crisis to promote a sound, stable and globally competitive financial system anchored on prudent risk management (Bayangos and Moreno 2021). In 2020, the BSP approved the Digital Banking License Framework under the BSP Circular No. 1105 series of 2020 to support the expansion and use of digital financial services in the country. The framework forms part of the BSP's three-year digital

[12] Equation 4 is estimated by panel regression with bank and time fixed effects from March 2010 to December 2020. The results are as follows:

	Log (variable profit/total assets)		
	U/KBs	TBs	R/CBs
Log(average variable costs)	0.010	0.098	0.110

Source: Author.

payments transformation roadmap which aims to achieve a shift of at least 50% retail payment transactions to digital and 70% of adult Filipinos having and using a transaction account by 2023. A digital bank is a bank offering financial products and services that are processed end-to-end through a digital platform and/or electronic channels with no physical branch/sub-branch or branch-lite unit offering financial products and services. The end-to-end processing of products and services distinguishes the operating model of digital banks vis-à-vis traditional banks that are in the process of digitally transforming their operations to improve efficiency and maintain competitiveness. As of December 2021, the BSP has granted six digital banking licenses to Overseas Filipino Bank, Tonik Digital Bank, UNObank, Union Digital Bank, GOtyme, and Maya Bank. The entry of digital banks is expected to enhance the competitive landscape in the Philippine financial sector by offering consumers with improved electronic banking services and customized financial solutions.

Financial technology (fintech) has also developed rapidly in the Philippines in recent years. Technologies such as Artificial intelligence (AI), big data, cloud storage and blockchain have been driving the digital transformation of financial institutions. In 2020, there are about 200 fintech players in the Philippines, majority of which are in the business of payments and lending, while the rest are into e-wallets, remittance services, blockchain/cryptocurrencies, e-commerce, insurance, and even regulatory technology services, based on the Philippines Fintech Report 2020. The same report highlights that fintech companies are heavily engaged in lending and payments, electronic wallets and remittance services.

Since 2019, the BSP has been seeing a growing interest from fintechs that are looking to provide enhancements to the domestic payments' ecosystem, with an increasing number of applicants aspiring to obtain authority to operate as electronic money issuers and virtual asset service providers. Newcomers and established financial institutions alike have started considering the acquisition of a digital banking license following the recently established framework for digital banks. For instance, there are reports that GCash, the most widely used fintech application, has partnered with a Malaysian foreign bank, CIMB. Another is the report that Union Bank of the Philippines continues to push for more financial inclusion through UBX, its fintech spin-off. The UBX's i2i platform aims to grow its network of digitized rural banks to help achieve greater financial inclusion, especially among rural Filipinos. Launched in 2019, i2i is a Distributor Ledger Technology (DLT)-based platform that links rural banks to the country's mainstream financial network. To date, the network has 106 bank members, representing TBs and R/CBs, making up a total of 2,000 branches nationwide.[13] Given an increasing number of smartphone users, the Philippines remains a key strategic area for fintechs to tap. Financial innovators can potentially thrive in the expanding market for digital finance services and secure a foothold in the Philippine financial system.

Another "force of change" in the landscape of the Philippine financial system has been the increasing digitalization in payment services. In November 2017, the BSP launched the Philippine electronic fund transfer (EFT) System and Operations Network ACH (PESONet), a batch electronic fund transfer service which replaced the paper-based check system. Unlike a check, the PESONet allows the receipt of funds on the same banking day the sender initiates the payment within a certain cut-off time. Meanwhile, InstaPay, a real time EFT facility that allows fund transfers at near-real time 24/7, went live in April 2018. Being a fast payment system, InstaPay addresses low value and urgent payment requirements. InstaPay caps each transaction at Php50,000 (approximately USD1,000). Hence, InstaPay

[13] Based on the Union Bank's Media Release, "Union Bank continues digitizing more rural banks", 30 November 2020.

enables the performance of person-to-person payments, domestic remittances, e-commerce transactions, bills payment and other immediate low value payments. Fund transfers through Instapay can be done with the use of QR codes which have been made interoperable following the BSP's policy requiring the adoption of a National QR Code Standard dubbed "QR Ph" by the payments industry. The Person-to-Person (P2P) QR Ph was subsequently launched in November 2019, while the full launch of the Person-to-Merchant (P2M) QR Ph was announced in the fourth quarter of 2021.

Since the launch of PESONet and Instapay, digital payments have exhibited sustained uptrend with broader adoption of digital payments following the outbreak of COVID-19 pandemic in March 2020. As of end-December 2020, the combined value of PESONet and InstaPay fund transfers reached Php 1.4 trillion. This is equivalent to 9.5% of the banking sector's total deposits. In terms of YoY growth, the combined value of InstaPay and PESONet grew by an annual average of 124.1% from December 2017 to December 2020. These developments indicate the consumers' growing sentiment towards the use of digital payments due to social mobility restrictions following the outbreak of the pandemic. The number of participating institutions also rose to 82 BSFIs participating in PESONet and 54 in InstaPay as of 30 June 2021. TBs and R/CBs as well as non-bank EMIs participate in these facilities, indicating a more diverse set of payment service providers.

Descriptive statistics. Looking at the descriptive statistics of the major variables used in the final estimation - H-statistics, Boone Indicators, and Lerner Indices - of U/KBs, TBs and R/CBs. The Z-score of U/KBs is the most volatile among these measures following the entry of new foreign banks and abrupt movements in their ROAs from March 2010 to December 2020. Among the bank-specific characteristics, the cost-to-income ratios (CI) of U/KBs and R/CBs are the more volatile indicators. I see large variations in the operating incomes of U/KBs and R/CBs particularly following the outbreak of the pandemic in March 2020.

Estimation method. To date, there is no generally accepted framework for analyzing the relationship between bank risk and competition. Many studies explored the use of standard regression techniques and instrumental variables using Generalized Method of Moments (GMM) to arrive at the average (mean) estimates or impact of competition on bank-level risk. Moreover, the results are sensitive to the details of model specification, notably the choice of control or instrument variables. In this study, the parameters in the models are estimated using panel fixed effects model at the industry level. This is a more appropriate empirical methodology to estimate the influence of various measures of bank competition on bank risk and the other parts of risk distribution using the median.

***Robustness checks*.** Diagnostic tests are used to check the stability of indicators in the study, including measures of competition, bank risk, and bank-specific characteristics. I use an alternative estimation method. While the panel quantile regression encourages a finer view of the potential heterogeneous effects across the conditional risk distribution, I use panel fixed effects model at the industry level to provide an estimate of the conditional mean effect. I also use one-year (4 quarters) and two-year (eight quarters) rolling average ROA to check the robustness of bank risk. Bank-specific characteristics such as the NPL ratio, NPL coverage ratio, loan loss reserves, liquid assets to total assets ratio, outstanding deposits to outstanding total liabilities ratio are used as factors driving ROA. However, the estimations yielded insignificant coefficients and were dropped in the final regression. I use 1%, 5%, and 10% levels of significance.

Empirical analysis. Equation 5 denotes the baseline model of the impact of bank competition on bank risk. On the left-hand side, $R_{b,t}$ represents a measure of risk of bank

b during quarter-end *t-j*. I use the Z-score based on a four-quarter (one year) moving average of ROA (see Annex A, Tables A1 to A4). Following de-Ramon and Straughan (2020), I interpret the Z-score as a measure of how many standard deviations a bank is away from exhausting its capital base. A higher value indicates lower probability of insolvency and therefore lower bank risk.

On the right-hand side, $K_{b,t-j}$ refers to a measure of competition of bank *b* during quarter-end *t-j*. $V_{b,t-j}$ represents a vector of macro-financial indicators and other bank-specific characteristics. $\varepsilon_{b,t}$ is a random error that has a normal distribution. The main coefficient of interest in equation 5 is that associated with competition, β_1.

$$R_{b,t} = a_b + \beta_1 K_{b,t-j} + \beta_2 V_{b,t-j} + \varepsilon_{b,t} \text{ . (5)}$$

I analyze the relationship between bank competition and bank-level risk using separate regressions for each measure of bank competition and for each banking group – U/KBs, TBs and R/CB. This paper recognizes that competition may be endogenous if weaker, less-efficient institutions increase leverage and balance sheet size (potentially raising return on assets) to avoid insolvency in periods instability. These actions can be misinterpreted as a sign of increased competition. I address this problem by using lags *(t-j)* in the competition measures and bank-specific characteristics (Liu and Wilson, 2013). The choice of lag length is supported by results of exogeneity tests that formally evaluate the null hypothesis that the specified endogenous regressor, i.e., competition in this case, can be treated as exogenous.

The study implemented a number of tests to highlight the dynamics between bank competition and bank risk. The focus of the discussions is the dynamics between bank competition and measures of bank risk such as the H-statistic (Table A1), Lerner index (Table A2) and Boone indicator (Table A4).

The test is on the overall significance of β_1 in equation 5. As implied in the previous section, β_1 in equations 5 implies that for the Boone indicator and the Lerner Index, a positive coefficient of β_1 suggests that more competition is associated with higher risk (lower Z-scores), consistent with the competition-fragility hypothesis. A negative coefficient, meanwhile, indicates that more competition is related with lower risk and supports the competition-stability hypothesis.

For H-statistic, a positive β_1 suggests that as more competition mounts, profitability and capitalization rises, bank risk declines and bank stability improves. This supports the risk-shifting paradigm and competition-stability hypothesis. A negative β_1 indicates that as competition intensifies, profitability and capitalization decreases, bank risk increases, and bank stability weakens. This supports the competition-fragility hypothesis.

Following Liu and Wilson (2013), the papers also include the square of Lerner index and the Boone indicator to address the potential non-linear relationship between measures of competition and bank risk. The results show that across U/KBs, TBs and R/CBs, there is no significant non-linear relationship between bank risk and competition.

Bank efficiency in this study refers to operational cost to income (CI) ratio.[14] It is defined as the ratio of annualized non-interest expenses (net of impairment losses) and annualized total operating income[15], I expect the CI ratio to be negatively related to bank risk as less efficient banks are likely to take on greater risk to generate returns and to improve their financial performance (Boyd et al. 2006). In the dataset, the CI ratios of U/KB, TB and R/CB groups are relatively high at more than 60%. Among the groups, the TB industry has the lowest average CI ratio at 62.2% from March 2010-December 2020, followed by the U/KB industry at 65.5% and the R/CB industry at 76.1%.

Moreover, the ratio of outstanding total bank loans to total assets (TLP) could be positively related to bank risk, since greater loan exposure may mean higher probability of a default risk. If TLP is low, however, profits (which could act as the buffer to default risk) may be reduced. I also assume that the size of a bank, measured by the logarithm of total assets, is negatively related to bank risk. The idea is that the benefits of economies of scale and market power may allow large banks to remain more stable than their smaller counterparts. However, it may be assumed that larger banks are prepared to accept more risk particularly when their capital buffers are healthy.

Finally, the degree of diversification may also affect the dynamics between competition and bank risk. Using risk distribution among banks in 48 countries from 1998 to 2018, Liang et al. (2020) find that higher diversification in bank portfolio reduces stand-alone bank risk but not the systemic risk as diversification tends to expose banks to a common risk in terms of activities and portfolio. Following Liang et al. (2020), I construct a bank-level diversification index (DV)[16] across the three banking groups.

To capture the effects of macroeconomic shocks on bank risk, I include Inflation (INF) and real GDP growth (RGDP) in the baseline model. Inflation is calculated as the percentage change in consumer price index (CPI). Inflation has been used in previous studies of banking performance to account for macroeconomic shocks, which have been found to affect the financial system and the real economy. Specifically, higher inflation could distort decision-making, exacerbate information asymmetry and introduce price volatility. Consequently, a positive relationship between inflation and bank risk is expected. Real GDP growth is included to capture movements in the business cycle. A significant strand of recent literature emphasizes the procyclical nature of the banking business, enhanced by a tendency of financial institutions to lend excessively during economic upturns, and to adopt cautious lending standards during downturns. Such lending patterns are likely to have implications for bank risk over the business cycle.

Components of the Z-score in equation (1) are used to shed light on the impact of competition on bank risk. These include the impact on profitability $(ROA_{b,t})$, bank capitalization ($c_{b,t}$) and volatility of bank profits ($\sigma ROA_{b,t}$). I also control for changes in the physical banking network *(DCHANGE).* I expect a positive relationship between Z-score (lower bank risk) and *DCHANGE*.

[14] Dutta and Saha (2021) suggest that bank efficiency could be measured by either efficiency index of net interest margin, working capital ratio, asset turnover ratio, and operating efficiency ratio constructed by Principal Components Analysis (PCA).
[15] Based on the Report on the Philippine Financial System, Second Semester 2020, BSP.
[16] Based on Liang et al. (2020), Diversification Measure = 1-[(Interest Income/Total Operating Income)^2 + (Non-Interest Income/Total Operating Income)^2].

To the best of my knowledge this is the first attempt to construct indicators on market concentration and market power using detailed bank-level balance sheet data and income statements from source reports in the Philippines.

The paper also determines the initial influence of the pandemic on measures of competition and on bank risk. The BSP issued regulatory and operational relief measures to the BSP supervised financial institutions (BSFIs) to help the household and business enterprises endure the adverse effects of the COVID-19 pandemic crisis. These relief measures aim to encourage BSFIs to extend financial relief to their borrowers, incentivize bank lending, promote continued access to credit/financial services, ensure continued delivery of financial services to enable consumers to complete financial transactions during the quarantine period and support the level of domestic liquidity during the pandemic (Bayangos et al. 2020). I use two approaches to capture the impact of pandemic on measures of competition and on bank risk. First, I assign a dummy variable for the pandemic period from March 2020 to December 2020 and estimate the interaction between the dummy variable for the pandemic and measures of competition on bank risk. The test is on the overall significance of the interaction term between the dummy for the pandemic and measures of competition on bank risk. Second, I estimate the baseline model in equation 6 prior to the pandemic (March 2010-December 2019) and compare the results of the model with the pandemic (March 2010-December 2020). I then summarize the estimates for β_1 in Table 1 in the next section to see the relative impacts of the pandemic on bank risk.

4. Results

Table 1 below provides the summary of detailed results (Tables A1, A2 and A4 in Annex A) of the baseline model. Following the diagnostics and robustness checks, the results are consistent with the results of the previous studies (de-Ramon et al. 2020; Liu and Mathison 2013).

Table 1: Summary of the Impact of Measures of Competition on Bank Risk, March 2010-December 2020

Banking Group	Pre-Pandemic Period (March 2010-December 2019)			With Pandemic Period (March 2010-December 2020)		
	H-Stat	Boone	Lerner	H-Stat	Boone	Lerner
	Coef.[1]	Coef.[1]	Coef.[1]	Coef.[1]	Coef.[1]	Coef.[1]
U/KB	-0.052 **	-0.302 **	0.022*	-0.118 **	-0.539 **	0.028*
TB	-0.162 *	-0.043 *	0.208**	-0.162 *	-0.031 *	0.019 **
R/CB	0.123 *	-0.125 *	0.104 ***	0.127***	-0.045***	0.456 **
Total Impact	-0.091	-0.470	0.334	- 0.153	- 0.615	0.503
Total impact (By period)			-0.227			-0.265
Difference [3]				-0.062	-0.145	0.169

*[1] The symbols *, **, and *** represent significance of regression coefficients at 10%, 5% and 1% levels of significance, respectively. [2]Difference from pre-pandemic period.*
Source: Author.

First, competition reduces bank risk taking activities at industry level. Table 1 shows that across the three banking groups, the Boone indicator significantly reduces bank-level solvency risk. The total impact of Boone indicator on bank risk is consistently higher than

the Lerner Index and the H-statistic across banking groups. This result is in line with the findings in previous studies by de-Ramon et al. 2020 and when using panel fixed effects models. This is also consistent with the competition-stability hypothesis. However, the H-statistic (except the R/CB industry) and Lerner index show a positive impact on bank risk that is consistent with competition-fragility hypothesis. This result may mean that banks are competing for quality of products and that there is a high degree of collusion among banks (Tabak et al. 2013). I take this as an area of future research.

Looking at the sum of coefficients of the H-statistic, Boone Indicator and Lerner Index, Table 1 shows that bank competition eases bank risk taking activities at the industry level. Among the banking groups, the U/KB group shows the highest impact on bank risk. This also implies that the banking sector continues to have adequate capitalization. Based on latest available data, total capitalization as a share of total assets stood at 12.5% as of end-June 2021, with the R/CB industry recording the highest ratio at 18.9%.[17]

Contrary to the previous findings by Liang et al. (2020), I find a negative impact of the diversification index (DV) on bank risk across banking groups. This means that the banking groups are not that well-diversified and that their portfolio strategy may need to be enhanced. When looking at the DV by banking group, the R/CB is the least diversified as its portfolio is largely skewed to interest income. However, in terms of the average net interest margin (NIM)[18] from March 2010 to December 2020, the R/CB industry's average NIM was higher at 12.5% compared to the TB industry at 9.1% and to the U/KB industry at 3.1%.

In the initial regressions, the NPL ratio, Return on Equity (ROE), Inflation and peso-dollar rate were included. However, these are consequently excluded from the final regression as the coefficients turned out to be insignificant. I checked the robustness of the coefficients for the Boone indicator and Lerner index across all quantiles. All coefficient estimates are statistically distinct using the Wald F-test. This finding indicates that the relationships are heterogeneous across the quantiles. This result is also consistent with a two-year rolling average of bank solvency risk.

I also show that the relationship between competition and risk is sensitive to other bank-specific characteristics related to size, funding source and capitalization (Liu and Wilson, 2013; Schaeck and Čihák, 2014) and macroeconomic factors that could potentially have further influences. Under each approach the coefficients on the macroeconomic and bank-level controls are consistent with expectations. For instance, across estimations, bank-level Z-scores increase (risk decreases) as real GDP growth rises. As expected, the impact of cost-to-income ratio on bank risk is negative across risk distributions in U/KB, TB and R/CB industries (Table A3). Moreover, it also appears that the joint effects of Boone indicator and CI ratio lead to lower bank solvency risk. This implies that the relatively high CI ratio across industries does not significantly affect the measure of bank competition and its joint impact on solvency risk.

Second, the impact of changes in the physical banking network (DCHANGE) on bank risk is positive and significant for large banks but negative for smaller banks. Results

[17] The corresponding ratios for the U/KB and TB industries are 12.5% and 13.9%. Data are based on the Balance Sheet of the Philippine Banking System as of 9 August 2021. BSP website.
[18] Defined as the ratio of net interest income to average earning assets. Report on the Philippine Financial System (Second Semester of 2020). BSP website.

in Tables A1, A2 and A3 show that *DCHANGE when* interacted with Lerner index has a positive and significant influence on the UKBs' Z-score. This means that *DCHANGE* has a positive impact on bank risk (lower risk). To some extent, this finding is consistent with observations by Altunbas and Marques (2008) and Sharma (2020) that merger has tangible benefits in areas such as profitability driven by diversification and utilization of economies of scale, technical progress (particularly in communication technology), deregulation, globalization and the resulting competition for banks. In the database, I account for 28 mergers and consolidations across the UKB, TB and R/CB industries from March 2010 to December 2020.[19] Based on separate regression runs, I find a positive relationship between *DCHANGE* and loans outstanding/total assets and outstanding deposits/total liabilities.[20] This indicates that changes in the banking network affect market concentration of the U/KB industry.

By contrast, the interaction between *DCHANGE* and bank risk (Boone indicator and Lerner index) is negative and significant for TBs and R/CBs. This means that the objectives of merger, acquisition and consolidation may not necessarily be favorable as discussed in Rezitis (2008)[21].

Third, the pandemic appears to have increased bank risk. Table 4 shows that bank risk increases following the onset of the pandemic. Table 4 summarizes the relative impact of measures of competition (H-statistic, Boone indicator and Lerner index) on Z-score prior and during the pandemic. I find that the pandemic affects bank solvency risk despite the introduction of relief measures in March 2020. The negative impact of the pandemic on bank risk rises by 0.038 percent (Table 4-Row Total Impact by Period and Excluding the HHI). Compared to December 2019, net profit of the banking system shrank by 32.8% in December 2020. The lower net profit in 2020 was primarily due to the increase in banks' provision for losses on loans and other financial assets. Nonetheless, the positive bottom line was mainly due to higher net interest income earned on lending activities. Results of a comparison between the four-quarter moving average of ROA prior to pandemic (March 2010-December 2019) and during the pandemic (March 2010-December 2020) show that U/KBs' and R/CBs' ROAs declined during the pandemic while those for TBs increased.

5. Conclusion

This paper constructs the measures of market power from a unique dataset of balance sheet and income statements for 542 banks operating in the Philippines from March 2010 to December 2020. These measures include the H-Statistic, Lerner Index, and the Boone Indicator. The impact of these measures on bank solvency risk is then estimated across the U/KB, TB, and R/CB industries by examining the presence of the "competition-fragility" and "competition-stability" views.

Following the diagnostics and robustness checks, the paper finds that, at the industry level, bank competition significantly reduces bank-level solvency risk. These findings imply that the impact of competition on bank risk depends crucially on the underlying individual bank

[19] The main reference is Factbook: The Philippine Banking System : 2010-2020. BSP publication.
[20] In Table A1, I also find a positive relationship between *DCHANGE* and HHI from March 2010 to December 2020.
[21] Using a Generalized Malmquist productivity index on five merged banks in Greece, Rezitis (2008) concludes that banks that participated in merging activity experienced a decline in technical efficiency and in total factor productivity.

risk. The results also mean that competitive opportunities remain for smaller U/KBs. Cost efficiency plays a significant role in reducing bank risk and improving stability and on bank competition across industries.

The study argues that the relationship between competition and risk is sensitive to other bank-specific characteristics and macroeconomic factors related to the extent of diversification strategy, funding source, capitalization and real GDP growth. Importantly, the findings show the positive and significant impact of changes in the physical banking network on bank risk for U/KBs, but negative for TBs and R/CBs. Finally, the paper initially reveals that the pandemic has increased bank risk across banking industries.

From the technical standpoint, the results of the study may be extended to examine the impact of bank competition on economic growth in the long run and on monetary policy transmission mechanism. Empirical findings on the existing theoretical frameworks on bank competition and economic growth remain inconclusive. This study provides a significant and positive influence of real GDP growth on bank solvency risk. It will be interesting to analyze the impact of bank competition and bank stability on economic growth.

Importantly, reliable, timely, complete, and readily accessible data are crucial for efficient and effective risk identification and assessment in financial sector supervision and enforcement. Such a database is particularly important for financial supervisors who face fast innovation and a regulatory perimeter that is getting bigger because of the growing digital financial services and the entry of digital banks. Questions such as which data should the supervisor collect? How frequently? In what format? Through which means? How should the supervisor improve data? What aspects should be considered? It may be useful and relevant to re-assess the approach to data collection, with the goal of further strengthening supervision while fostering digital transformation.

REFERENCES

Altunbas, Y. and D. Marques. 2008. Mergers and acquisitions and bank performance in Europe: The role of strategic similarities. *Journal of Economics and Business*, 60, 204-222.

Anginer, Deniz, A. Demirgüç-Kunt, and M. Zhu. 2012. How does bank competition affect systemic stability?. Policy Research Working Paper 5981, World Bank, Washington, DC.

Meyer, A. 2018. Market concentration and its impact on community banks. *Regional Economist*. First Quarter 2018. Federal Reserve Bank of St. Louis.

Bayangos, V. and Moreno, R. 2021. What drives cross-border bank flows. BSP Discussion Paper No. 04. BSP

Bayangos, V., Elloso, L., Hallig, J.M., Yeung, J.N., and Salamatin, A.M. 2016. The impact of foreign exchange liberalization reforms on the Philippine economy: An initial assessment. BSP Working Paper Series No. 2016-01. March 2016.

Bayangos, V., Briones, R.L., Suguitan, R. and Lucela, D. 2020. Chapter 5: How Philippine banks are holding up amid the pandemic, *BSP Unbound: Central Banking and the COVID-19 Pandemic in the Philippines.* BSP.

Beck, T., De Jonghe, O., and Schepens, G. 2013. Bank competition and stability: Cross-country heterogeneity. *Journal of Financial Intermediation*, Vol. 22, 218-244.

Berger, A., L. F. Klapper, and R. Turk-Ariss. 2009. Bank competition and financial stability. *Journal of Financial Services Research* 35: 99–118.

Boyd, J.H., and G. De Nicolo. 2005. The theory of bank risk taking and competition revisited. *Journal of Finance 60*, 1329–1343.

Boyd, J., De Nicoló, G. and Jalal, A. 2006. Bank risk-taking and competition revisited: New theory and new evidence. *IMF Working Paper*, WP/06/297.

Casu, B., and C.Girardone. 2006. Bank competition, concentration and efficiency in the single European market. *The Manchester School* 74 (4): 441–468.

Cetorelli, N., and P. E. Strahan. 2006. Finance as a barrier to entry: Bank competition and industry structure in local U.S. markets. *The Journal of Finance* 61 (1): 437–461.

Crisanto, J.C., Ehrentraud, J., Lawson, A. Restoy, F. 2021. Big tech regulation: what is going on? FSI Insights on policy implementation No 36, Financial Stability Institute. Bank for International Settlements. September 2021.

De-Ramon, S. and M. Straughan. 2020. The evolution of competition in the UK deposit-taking sector, 1989–2013. *The European Journal of Finance*, 26:10, 958-977.

de-Ramon, S., Francis, W., Straughan, M. 2020. The link between bank competition and risk in the United Kingdom: two views for policymaking. Bank of England Staff Working Paper No. 885. September 2020.

Dutta, K. D. and Saha, M. 2021. Do competition and efficiency lead to bank stability? Evidence from Bangladesh. Future Business Journal (2021) 7:6

Jimenez, G., Lopez, J. and Saurina, J. 2013. How does competition affect bank risk-taking?. *Journal of Financial Stability* 9 (2013) 185– 195.

Karadimi, M. and H. Louri. 2019. Non-performing loans in the euro area: Does market power matter? Bank of Greece Working Paper 271.

Liang, S., Moreira, F., Lee. J. 2020. Diversification and bank stability. *Economics Letters* 193(2020) 109312.

Liu, H., Wilson, J.O.S.. 2013. Competition and risk in Japanese banking. *The European Journal of Finance*, Vol. 19 (1), 1-18.

Martinez-Miera, D. and R. Repullo. 2010. Does competition reduce the risk of bank failure? *Review of Financial Studies* 23, 3638–3664.

Meyer, A. (2018). Market concentration and its impact on community banks. *Regional Economist*. Federal Reserve Bank of St. Louis.

Rezitis, A. 2008. Efficiency and productivity effects of bank mergers: Evidence from the Greek banking industry. *Economic Modelling* 25(2): 236-254.

Sharma, D. 2020. Merger and acquisition: A literature review. *Suresh Gyan Vihar University International Journal of Economics and Management*, Vol. 8, Issue 4.

Schaeck, K., and M. Cihak. 2014. Competition, Efficiency, and Stability in Banking. *Financial Management* 43 (1): 215–241.

Tabak, B.M, Fazio, D., Cajueiro, D.O. 2011. The relationship between banking market competition and risk-taking: Do size and capitalization matter? Working Paper Series 261. Banco Central do Brazil, November 2011.

Annex A

Table A1: Bank Competition and Bank Risk – Using H-Statistic March 2010-December 2020			
	Dependent variable	**Dependent variable**	**Dependent variable**

Independent variables	**(I)** UKB/KB Group Z-Score (ZSCORE)		**(II)** Thrift Bank Group Z-Score (ZSCORE)		**(III)** Rural/Coop Bank Group Z-Score (ZSCORE)	
	Coef.	Standard error	Coef.	Standard error	Coef.	Standard error
H-statistic	-0.118	0.259	-0.162	(0.017)***	0.127	(0.075)***
Bank-specific characteristics						
DEP (-1) (*Ratio of deposits/total liabilities*)	0.872	(0.275)***	0.179	(0.046)***		
TLP(-1)			0.226	(0.029)***	0.562	(0.830)***
LIQ(-1) *(Ratio of liquid assets/deposits)*						
CI (-1) *(Cost-to-income ratio)*	-0.008	(0.004)**	-0.179	(0.021)***	-0157	(0.003)***
DV (-1) *(Diversification index)*	-0.145	(0.132)*			-0.397	(0.082)***
CAP (-1) *(Ratio of total capitalization to total assets)*	0.265	0.364***	-0.132	(0.095)***	-0.157	(0.682)**
Macro and other indicators						
RGDP (*Real GDP growth*)	0.036	(0.172)*	0.202	(0.062)***	0.956	(0.324)***
POL (*BSP policy rate)*						
DCHANGE *(Dummy for changes in banking structure)*	0.049	(0.033)*	0.042	(0.201)*	-0.060	(0.002)***
DCHANGE*HSTA *(Interaction term)*	-0.564	0.118	0.169	(0.035)**	-0.045	(0.003)**
DCOV *(Dummy for pandemic)*	-0.109	0.274	0.054	0.012	0.154	(0.124)***
Diagnostics						
Adjusted R^2	*0.501*		*0.868*		*0.621*	
Sample period	*2010Q1-2020Q4*		*2010Q1-2020Q4*		*2010Q1-2020Q4*	
Banks	*41*		*44*		*457*	
No of bank observations	*1,365*		*1,044*		*14,167*	
Stability test [1]	*0.000*		*0.078*		*0.023*	
Residual test [2]	*0.123*		*0.167*		*0.176*	
Standard error of regression	*0.008*		*0.000*		*0.000*	

*Notes: Robust standard errors are reported in brackets. The symbols *, **, and *** represent significance levels of 10%, 5% and 1% respectively. [1] Reports p-values for the null hypothesis that the model has no omitted variables and is correctly specified using Ramsey RESET test. [2]Reports p-values for the null hypothesis that the data is normally distributed using Jarque-Bera test. [3] Reports p-values for the null hypothesis that the quantiles are symmetric using Wald test.*

Source: Author.

Table A2: Bank Competition and Bank Risk – Using Boone Indicator March 2010-December 2020			
	Dependent variable (I)	**Dependent variable**	**Dependent variable**

Independent variables	UKB/KB Group Z-Score (ZSCORE)		**(II)** Thrift Bank Group Z-Score (ZSCORE)		**(III)** Rural/Coop Bank Group Z-Score (ZSCORE)	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Boone	-0.539	(0.254)**	-0.031	(0.935)**	-0.045	(0.143)**
Bank-specific characteristics						
DEP (-1) (*Ratio of deposits/total liabilities*)	0.172	(0.103)*				
TLP(-1)						
LIQ(-1) *(Ratio of liquid assets/deposits)*						
CI (-1) *(Cost-to-income ratio)*			-0.517	(0.195)**	-0.193	(0.005)**
DV (-1) *(Diversification index)*	-0.039	(0.849)***	-0.127	(0.263)**	-0.112	(0.297)
CAP (-1) *(Ratio of total capitalization to total assets)*	-0.863	(0.233)***	-0.155	(0.624)***	-0.567	(0.117)**
NPLR *(Non-performing loan ratio)*	-0.027	0.026				
Macro and other indicators						
RGDP (*Real GDP growth*)	0.049	(0.098)*	0.110	(0.226)***	0.020	(0.115)**
POL (*BSP policy rate)*	0.027	(0.022)				
DCHANGE *(Dummy for changes in banking structure)*	-0.084	(0.063)*	0.179	(0.342)**	0.377	(0.009)**
DCHANGE*Boone (Interaction term)	0.162	(0.089)***	-0.178	(0.503)**	-0.507	(0.013)
DCOV *(Dummy for pandemic)*	-0.100	0.121	-0.095	0.181	0.787	(0.198)**
Diagnostics						
Adjusted R^2	*0.308*		*0.6552*		*0.574*	
Sample period	*2010Q1-2020Q4*		*2010Q1-2020Q4*		*2010Q1-2020Q4*	
Banks	*41*		*44*		*457*	
No of bank observations (after adjustments)	*1,227*		*968*		*15,081*	
Stability test [1]	*0.052*		*0.095*		*0.000*	
Residual test [2]	*0.210*		*0.201*		*0.178*	
Standard error of regression	*0.096*		*0.043*		*0.021*	

*Notes: Robust standard errors are reported in brackets. The symbols *, **, and *** represent significance levels of 10%, 5% and 1% respectively. [1] Reports p-values for the null hypothesis that the model has no omitted variables and is correctly specified using Ramsey RESET test. [2]Reports p-values for the null hypothesis that the data is normally distributed using Jarque-Bera test. [3] Reports p-values for the null hypothesis that the quantiles are symmetric using Wald test.*

Source: Author.

Table A3: Bank Competition, Bank Efficiency and Bank Risk – Using Boone Indicator March 2010-December 2020

Independent variables	**Dependent variable (I)** UKB/KB Group Z-Score (ZSCORE)		**Dependent variable (II)** Thrift Bank Group Z-Score (ZSCORE)		**Dependent variable (III)** Rural/Coop Bank Group Z-Score (ZSCORE)	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Boone	-0.323	(0.032)*	-0.031	(0.935)**	-0.042	(0.002)*
Boone^2 [a]	Linear		Linear		0.002	(0.001)**
Bank-specific characteristics						
DEP (-1) (*Ratio of deposits/total liabilities*)	-	-	-	-	-	-
TLP(-1)	-	-	-	-	0.152	(0.022)**
LIQ(-1) *(Ratio of liquid assets/deposits)*	-	-	-	-	-0.051	(-0.011)**
CI (-1) *(Cost-to-income ratio)*	-0.685	(0.351)***	-0.136	(0.023)***	-0.245	(0.024)**
Boone(-1) * CI(-1) (Interaction term)	-0.575	0.685	-0.495	(0.151)*	-0.024	(0.023)*
DV (-1) *(Diversification index)*			-0.043	(0.077)**	0.059	(0.032)*
CAP (-1) *(Ratio of total capitalization to total assets)*	-0.354	(0.036)***	-0.088	(0.009)***	-0.411	(0.037)**
NPLR *(Non-performing loan ratio)*	-0.027	0.026	-0.062	0.010	-0.047	(0.002)**
Macro and other indicators						
RGDP (*Real GDP growth*)	0.039	(0.016)***	0.161	(0.013)***	0.064	(0.019)**
POL (*BSP policy rate)*	-	-	-0.199	(0.034)***	-	-
DCHANGE *(Dummy for changes in banking structure)*	0.014	0.033	0.018	(0.034)**	0.069	(0.001)*
DCOV *(Dummy for pandemic)*	-0.055	(0.023)*	-0.102	(0.056)*	-0.017	(0.007)**
Diagnostics						
Adjusted R^2	*0.502*		*0.683*		*0.723*	
Sample period	*2010Q1-2020Q4*		*2010Q1-2020Q4*		*2010Q1-2020Q4*	
Banks	*41*		*44*		*457*	
No of bank observations (after adjustments)	*1,227*		*968*		*15,081*	
Stability test [1]	*0.011*		*0.026*		*0.001*	
Residual test [2]	*0.198*		*0.278*		*0.199*	
Standard error of regression	*0.008*		*0.056*		*0.041*	

*Notes: [a] Based on a separate regression run. Robust standard errors are reported in brackets. The symbols *, **, and *** represent significance levels of 10%, 5% and 1% respectively. [1] Reports p-values for the null hypothesis that the model has no omitted variables and is correctly specified using Ramsey RESET test. [2]Reports p-values for the null hypothesis that the data is normally distributed using Jarque-Bera test. [3] Reports p-values for the null hypothesis that the quantiles are symmetric using Wald test.*

Source: Author.

Table A4: Bank Competition and Bank Risk – Using Lerner Index

March 2010-December 2020						
Independent variables	**Dependent variable (I)** UKB/KB Group Z-Score (ZSCORE)		**Dependent variable (II)** Thrift Bank Group Z-Score (ZSCORE)		**Dependent variable (III)** Rural/Coop Bank Group Z-Score (ZSCORE)	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Lerner	0.028	(0.014)**	0.019	(0.244)*	0.456	(0.013)***
Bank-specific characteristics						
DEP (-1) (*Ratio of deposits/total liabilities*)					0.015	(0.142)***
TLP(-1) *(Ratio of total loans outstanding/total assets)*			0.127	(0.877)*		
CI (-1) *(Cost-to-income ratio)*	-0.449	(0.292)**	-0.150	(0.387)*	-0.185	(0.083)***
DV (-1) *(Diversification index)*	-0.021	(0.399)*	-0.095	(0.174)**	-0.011	(0.046)***
CAP (-1) *(Ratio of total capitalization to total assets)*	-0.361	(0.114)***	-0.266	(0.167)**	-0.031	(0.236)**
Macro and other indicators						
RGDP (*Real GDP growth*)	0.761	(2.517)*	0.117	(0.133)**	0.010	(0.159)**
POL (*BSP policy rate)*	0.016	(1.053)				
DCHANGE *(Dummy for changes in banking structure)*	-0.072	(0.037)*	0.125	(0.020)**	-0.177	(0.005)***
DCHANGE*Lerner *(Interaction term)*	0.009	(0.004)**	-0.128	(0.004)*	-0.029	(0.011)**
DCOV *(Dummy for pandemic)*	-0.198	0.236	-0.042	(0.254)**	0.090	(0.026)***
Diagnostics						
Adjusted R^2	*0.5*		*0.797*		*0.574*	
Sample period	*2010Q1-2020Q4*		*2010Q1-2020Q4*		*2010Q1-2020Q4*	
Banks	*41*		*44*		*457*	
No of bank observations	*1,804*		*998*		*15,081*	
Stability test [1]	*0.068*		*0.000*		*0.000*	
Residual test [2]	*0.120*		*0.211*		*0.231*	
Standard error of regression	*0.083*		*0.003*		*0.051*	

*Notes: Robust standard errors are reported in brackets. The symbols *, **, and *** represent significance levels of 10%, 5% and 1% respectively. [1] Reports p-values for the null hypothesis that the model has no omitted variables and is correctly specified using Ramsey RESET test. [2]Reports p-values for the null hypothesis that the data is normally distributed using Jarque-Bera test. [3] Reports p-values for the null hypothesis that the quantiles are symmetric using Wald test.*

Source: Author.