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BANK COMPETITION, CONCENTRATION AND CREDIT RISK

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Abstract: *The purpose of this study is to investigate the nexus between the banking sector structure and credit risk. Unlike many other studies that address internal and external factors affecting credit risk, the study addresses banking competition, as the banking sector structure has an impact on banks' loan portfolios. It also employs macro-level data which provides important implications for regulatory authorities. The study utilizes a fixed-effects model to explore the impact of banking competition on credit risk using a panel dataset comprising 52 countries during the period of 1998-2016. In the study, non-performing loans to total gross loans ratio (NPL) is employed as a proxy of credit risk. Lerner index, Boone indicator, and five-bank asset concentration are used for the measurement of banking competition. The empirical findings show that competition and concentration have different impacts on credit risk. Consistent with the relationship lending literature, increased market power alleviates credit risk. On the other hand, concentration does not have a significant impact on credit risk. In particular, banking competition has a more significant impact on credit risk in countries with high non-performing loan volatility. Given higher market power causes less credit problems, policy makers, especially those who officiate in developing economies, should reassess the pro-competition policies. In addition, increasing income and higher foreign ownership diminish credit risk, whereas higher unemployment and a larger amount of credit trigger credit risk. Therefore, bank managers should follow up macroeconomic factors in their lending decisions. Lastly, it should be kept in mind that these results are obtained from cross-country data and the banking regulations in a specific country may affect the relationship between banking competition and credit risk.*

Keywords: *Credit risk, Banking competition, Bank screening.*

JEL Codes: *G21, G32, C23*

1. Introduction

One of the main functions of the financial system is to facilitate the allocation of financial resources across economic units (Merton and Bodie, 1995). Financial intermediaries, especially banks, constitute an important part of the financial system, and financial resources, more specifically the credits, are allocated through these financial intermediaries. Banks as delegated monitors efficiently allocate financial resources since they have a cost advantage in collecting information that is useful for eliminating incentive problems (Diamond, 1984). The empirical findings linking the development of the banking sector to economic growth support the banks' competency of efficient resource allocation (Levine, Loayza and Beck, 2000; Demirguc-Kunt and Maksimovic, 1998; Greenwood and Jovanovic, 1990). However, the banking sector structure may influence credit allocation efficiency as it affects the banks' operations.

Competition is beneficial for efficiency and social welfare maximization, therefore as in other sectors; competition in the banking sector is also desirable. For instance, increasing competition in the banking sector results in lower loan rates (Van Leuvensteijn et al., 2013; Chortareas et al., 2012; Rice and Strahan, 2010), a higher amount of credit, (Guzman, 2000), and less financing obstacles (Claessens and Laeven, 2005; Beck, Demirguc-Kunt, and Maksimovic, 2004).

Despite these advantages, increased competition can be detrimental to credit allocation efficiency since it decreases the banks' informational rents. Put differently, even though greater bank competition leads to expansion of credit as interest rates fall, it causes lower quality loans (Biswas and Koufopoulos, 2020). Banks have an incentive to screen borrowers since they can reuse the borrower specific information. However, the incentive depends on the cost and benefit of screening (Chan et al., 1986). Competition decreases banks' screening, which acts as a protection mechanism against bad loans since greater competition reduces the benefit from screening (Vives, 2016). Furthermore, greater competition in the lending market causes increase in banks' screening costs (Papanikolaou, 2019). In addition, competition in the banking sector is detrimental to the formation of the mutually beneficial relationship between creditors and lenders (Petersen and Rajan, 1995) and reduces banks' incentive to offer relationship services (Cetorelli and Peretto, 2012). In addition, a competitive banking system makes borrower-specific information more dispersed since each bank contains information for a smaller pool of borrowers (Marquez, 2002). Besides, in the case of several banks operating in the same market, a rejected borrower does not give up applying for credit; he or she applies to the second and third bank on an ongoing basis. This re-application process also worsens the pool of applicants and increases the possibility of unqualified borrowers getting credit (Chiesa, 1998). In contrast, market power encourages banks to establish a long-run relationship with creditors since banks with market power can easily internalize the benefit of assisting creditors. A longer relationship provides more accurate and more detailed information regarding borrowers and enables the bank to reduce credit risk by screening out bad borrowers. There are empirical studies supporting that market power increases credit quality. Braggion et al. (2017), for instance, find that greater banking concentra-

tion improves the quality of loan applicants even though it restricts credit. Jayaratne and Strahan (1996) also reveal that U.S. interstate branch reform leads to higher per capita income growth through bank monitoring and screening improvements rather than an increased volume of credit.

On the other hand, banks with more market power tend to charge higher rates on loans to earn more rents. Higher interest rates may affect the riskiness of the loan portfolio. Put differently, higher interest rates result in riskier loan portfolios due to adverse selection and incentive problems in the credit market (Stiglitz and Weiss, 1981). Boyd and De Nicoló, (2005) state that decreasing competition leads to higher borrowing costs, which in turn exacerbates the incentive of borrowers to invest in riskier projects. Moreover, the higher borrowing cost causes banks to deal with a riskier pool of borrowers since higher loan rates exclude qualified borrowers from the credit market. In addition, if banks believe they are too big to fail and the government will offer support in possible turmoil, they take more risk (Afonso et al., 2014). Furthermore, large banks are more complex to manage due to either overly extended business scope or increased organizational complexity (Wu et al, 2019) and this complexity also causes higher risk. Conversely, the tighter competition will decrease the rates that borrowers pay for the loan which in turn enhances the average quality of applicants. Furthermore, competition forces banks to adopt advanced risk management techniques (Bülbül et al. 2019).

Considering all these, there is no consensus on how bank competition affects credit risk, with conflicting results. The current study has two objectives: (1) to investigate the nexus between banking sector structure and credit risk and (2) to reveal whether this nexus is similar across different country groups. The study offers significant implications for regulatory and supervisory authorities concerned with banking stability as well as bank managers. *First*, the findings ascertain that competition and concentration have different impacts on credit risk. The higher market power diminishes credit risk, confirming that increased competition decreases banks' informational rents. On the other hand, bank concentration does not have a statistically significant impact on credit risk. Therefore, regulatory authorities should treat competition and concentration differently. Given the fact that higher market power diminishes credit problems, they should also revisit the pro-competition policies and prudential banking regulation. *Second*, the impact of banking sector structure on credit risk differs across country groups. The impact of banking competition on credit risk is more significant in economies with high NPL volatility. Accordingly, regulatory authorities acting in developing economies should pay more attention to the banking sector structure. Besides, supervisory institutions can adopt policies such as higher equity capital requirements to prevent banks from taking excessive risk. *Third*, macroeconomic variables also affect credit risk. The increase in GDP per capita and share of foreign-owned banks decrease credit risk while increased unemployment and a higher amount of loans deepen credit risk. Consequently, bank managers should also follow up macroeconomic variables along with internal factors in their lending decisions.

The study contributes to the literature in two aspects. *First,* the study extends the limited empirical literature on the relationship between banking competition and credit

risk. Even though many studies address internal (such as profitability, capital structure, size, and technology) and external determinants (such as GDP, unemployment, and inflation) of credit risk (Barra and Ruggiero, 2020; Cheng and Qu, 2020; Gulati et al., 2019; Yuksel, 2017; Yurdakul, 2014; Louzis et al., 2012; Espinoza and Prasad, 2010; Boudriga et al., 2009; among others), the impact of banking competition on credit risk has been neglected. Several studies analyze the impact of competition on bank risk, however, these studies focus on overall bank risk rather than credit risk. Nevertheless, a few studies use loan loss ratio as a bank overall risk by stating that credit risk is the main factor that triggers bank risk (Jimenez et al., 2013). However, credit risk is a different concept than bank overall risk, and it does not necessarily have to be a linear relationship with bank overall risk (Berger et al., 2017; Boyd et al., 2009). Besides, credit risk is determined by banks' internal incentives and difficult to regulate by external authorities, while bank risk is regulated externally with risk limitation measures such as minimum capital requirements (Salas and Saurina, 2003). *Second,* NPL is an ex-post measure of credit risk and it shows how successful the banking system is for selecting the right borrowers; more specifically selecting good borrowers or at least avoiding bad ones. The success of banks in selecting the right borrowers is connected with screening intensity which depends on the benefit of screening. However, both NPL and its volatility may have an impact on screening intensity. If the NPL is high, it is more imperative for banks to monitor borrowers. On the other hand, low NPL may reduce banks' incentive to use screening mechanisms. Similarly, if there is no major change in NPL over the years, banks can make more accurate estimations regarding credit risk and may keep their monitoring at a low level. On the contrary, if the change in NPL is high, banks need to screen borrowers more intensely. The volatility in NPL is much more important than NPL itself since banks can make provisions for loan loss as long as they predict it correctly[1]. Given the volatility in NPL, it is expected that the impact of competition on credit risk is much higher in economies where volatility in NPL is high. From this point of view, the impact of competition on credit risk is analyzed for two different samples (i.e. economies with high NPL volatility and economies with low NPL volatility). Most high-income economies rank in the low NPL volatility group while low-income and middle-income economies generally fall into the high NPL volatility group (See Appendix B).

The study proceeds as follows. The next section discusses the theoretical and empirical literature. The third section describes the data and methodology. The fourth section presents empirical results, and the fifth section concludes the study.

2. Literature Review

Bank risk has been at the center of academic and policy discussions especially following the subprime mortgage crisis. In parallel, factors affecting bank risk have been widely discussed. The competition is considered as one of the factors that would affect bank risk, and the impact of competition on bank risk is analyzed both theoretically and em-

1 Nevertheless, the correlation between NPL and NPL volatility is quite high as 0.76.

pirically. However, there is no consensus regarding the impact of competition on bank risk, with the two opposing views, the competition-fragility view, and the competition-stability view.

The competition-fragility view argues that higher competition results in more fragility (Keeley; 1990; Chan, Greenbaum and Thakor, 1986; Marcus, 1984). This view is based on the idea that when banks capture monopoly rents their charter is valuable, thereby they avoid excessive risk-taking as they do not want to lose this value. In another perspective, increased competition forces banks to take more risk since it damages the franchise value. Keeley (1990), for instance, detects that increased competition in the U.S. banking sector declined the charter value of banks and exacerbated the incentive of banks to take more risk, and therefore resulted in higher default risk. Similarly, Hellman et al. (2000: 148) contend that financial liberalization increases competition, which in turn decreases franchise value and exacerbates moral hazard problems. The competition-stability view, on the other hand, states that increasing competition in the banking sector leads to more stability. Schaeck et al. (2009), for instance, ascertain that a more competitive banking system is less likely to experience a crisis and have a longer time enacting resistance to the crisis. Put differently, the competition-stability view claims that more market power in the banking sector increases the cost of borrowing, which in turn strengthens borrowers' incentive to invest in riskier projects (Boyd and De Nicoló, 2005). In addition, a more concentrated market leads to more fragility because the promise of government support causes too-big-to-fail banks to take more risk (Afonso et al., 2014).

The competition-financial stability literature, however, focuses on bank overall risk rather than credit risk and analyzes the impact of competition on the banks' probability of default. Most of the studies conducted on the subject employ bank Z-score as an inverse measure of bank overall risk while a few studies use NPL as a measure of banks' risk-taking. For instance, Boyd et al. (2009) investigate the association between bank competition and bank risk-taking using bank risk measures and loan loss measures. They find that competition is negatively related to both bank overall risk and credit risk. Similarly, Jimenez Lopez and Saurina (2013) examined the relationship between banking competition and bank risk using NPL as a measure of bank overall risk. The results indicate that there is a nonlinear relationship between concentration both in loan and deposit markets and bank risk-taking. When market power measures, such as the Lerner index, are employed to measure bank competition, there is a linear association between competition in the credit market and bank risk, supporting the competition-fragility view. Davis et al. (2020) also analyzed the banking competition-risk nexus by using four risk measures including NPL. Their results largely support the competition-fragility view rather than the competition-stability view. Nevertheless, NPL is related to loan risk rather than overall risk. Put differently, NPL measures risk related to the bank's loan portfolio but does not capture the risk related to the other bank assets. Furthermore, these two measures do not necessarily move in the same direction. Berger et al. (2017), for instance, assert that banks with market power tend to hold riskier loan portfolios while they can control overall risk by engaging risk-mitigating techniques.

Few studies directly investigate the relationship between banking competition and credit risk. These studies explore the aforementioned relationship at the country level, mostly the USA. Jayaratne and Strahan (1998), for instance, investigate the impact of branching deregulation on the US banking sector. They find that removing restrictions on bank expansion improves bank performance. They also ascertain that increased market power following interstate branching reform leads to a decline in operating costs and loan losses in the USA. In a similar vein, Dick (2006) examines the effects of nationwide branching deregulation in the 1990s on the banking market structure, service, and performance. She ascertains that concentration at the regional level increased significantly after the deregulation while there is no significant change in concentration at the urban level. She also finds that credit risk is increased following deregulation. Salas and Saurina (2003) analyze the impact of deregulation on credit risk in the context of the Spanish banking sector. The findings show that decreasing market power leads to higher credit risk. More recently, Martín-Oliver et al. (2020) investigate the nexus between banking competition and credit risk for Spain by using loan-level data. Their findings are parallel to the moral hazard view that suggests more competition mitigates credit risk. Bofondi and Gobbi (2004) examine the association between entry into the credit market and the default rate of the credit provided by entrants of the Italian banking sector. The results show that banks entered into Italian local markets have a higher default rate than incumbent banks. It is also determined that both winner's curse effect and asymmetric information cause entrants to have a higher loan default rate. Chemmanur et al. (2020) also analyze the impact of increased competition in China on bank screening and elicit that greater banking competition leads to an increase in the stringency of bank screening of borrowers.

Several studies also address the competition-credit risk nexus at the cross-country level. Brei et al. (2020), for instance, investigate the relationship between banking competition and credit risk for 33 countries in Sub-Saharan Africa. Their findings indicate a U-shaped relationship between competition and credit risk. Karadima and Louri (2020) also address banking structure-credit risk nexus for the Euro area. They reveal that competition decreases the growth of new NPL. In another study, Karadima and Louri (2020) analyze the moderating role of bank concentration in the relationship between economic policy uncertainty and non-performing loans. The results show that economic policy uncertainty has a positive effect on non-performing loans; however, bank concentration moderates this effect.

In summary, although many studies have investigated the impact of competition on bank risk, most of these studies focused on bank overall risk. Few studies have addressed the relationship between banking competition and credit risk, and most of them have examined the relationship for a single country. This study investigates the impact of bank competition on credit risk using macro-level data from 52 countries.

3. Data and Methodology

The purpose of the study is to explore the relationship between banking competition and credit risk. The efficient banking sector less likely provides loans to unqualified borrowers and therefore will be less exposed to credit risk (Morck, Yavuz, and Yeung, 2011).

In the study, credit risk is modeled as a function of banking sector structure, business environment factors, and banking environment factors:

$$Credit\ Risk_{ct} = f\ (Banking\ Structure_{ct}, Business\ Environment_{ct}, Banking\ Environment_{ct})$$

In the related literature, loan loss measures are often used to gauge credit risk. Parallel to the literature, the study uses NPL as a measure of credit risk. On the other hand, measuring competition is more complicated than measuring credit risk. The literature has several criteria for the measurement of bank competition. The early studies have used concentration ratios such as market share of the largest three or five banks or the Herfindahl-Hirschman Index to measure bank competition. The idea behind the use of concentration measures for bank competition is that fewer and larger institutions are more likely to engage in anticompetitive behavior. Within this context, concentration is adversely related to bank competition. However, concentration measures do not fully capture the concept of market contestability determined by entry and exit barriers (Yildirim and Philippatos, 2007; Panzar and Rosse, 1987). Therefore, recent studies use measures that directly focus on bank pricing behavior or market power such as H-statistics, Lerner Index, or Boone Indicator. In addition to these measures, different indicators such as formal and informal entry barriers and activity restrictions are used to measure competition in the banking sector. In the study, three measures; Lerner Index (lerner), Boone Indicator (boone), and five-bank asset concentration (conc) are employed for the measurement of banking competition. The first competition measure, *lerner,* denotes the market power in the banking sector and is calculated as the difference between output prices and marginal costs relative to prices. Higher values of the *lerner* reflect less competition in the banking sector. *Boone* is another direct measure of competition and is calculated as the elasticity of profits to marginal costs. The indicator is based on the idea that higher profits are obtained by more efficient banks. Therefore, the more negative indicator shows a higher degree of competition. The last measure, *conc*, is estimated as the share of assets held by the largest five banks in the economy. The higher share indicates the dominance of a few banks and implies less competition. Several control variables are also considered in the analyses. Economic conditions in the country may affect the repayment of loans. When the economic condition is poor, loans will be less likely to repay. On the contrary, when the economic condition is good, loans are more likely to repay. Gross Domestic Product (GDP) per capita (income) and unemployment rate (unemp) are used to control the overall economic condition. The amount of credit is another factor that has an impact on credit risk. Providing too much credit will reduce banks' screening ability. It also increases the likelihood of unqualified borrowers getting loans. Bank credit to bank deposit ratio (cred) is employed to control credit size. Lastly, foreign ownership in the banking sector may affect credit risk. It is argued that foreign banks are better at monitoring hard information compared to their domestic peers (Detragiache, Tressel, and Gupta, 2008) and therefore they tend to cherry-pick (finance less opaque large businesses) (Beck and Martinez Pierra, 2008). The cherry-picking made by foreign banks may worsen the remaining credit pool and causes domestic banks to work with a riskier pool

of borrowers. Nevertheless, domestic banks have more information regarding opaque small businesses (Beck, Demirguc-Kunt, and Maksimovic, 2004) since they have a comparative advantage in relationship lending (Berger, Klapper, and Udell, 2001: 2131). As a result, increasing foreign ownership in the banking sector will lead to banks working with the pool of borrowers, where they have a comparative advantage, and will ensure that the banking system is less exposed to credit risk. The ratio of foreign banks to the number of the total banks in the economy (foreign) is used to measure foreign ownership in the banking sector (Detailed information regarding the dependent, explanatory, and control variables is provided in Appendix A).

In short, three different models are used based on the competition measure in the study. Model I utilizes the Lerner index as a measure of banking competition along with the business environment and banking environment factors. Model II uses the Boone indicator as a competition measure. Unlike the previous two models, Model III employs five-bank asset concentration regarding the banking sector structure. Detailed model specifications are as follows:

$$\text{Model I.} \quad \begin{aligned} NPL_{ct} = {} & \alpha_0 + \sum_{c=1}^{n} \alpha_1 \, lerner_{ct} + \sum_{c=1}^{n} \alpha_2 \, income_{ct} + \sum_{c=1}^{n} \alpha_3 \, unemp_{ct} + \\ & \sum_{c=1}^{n} \alpha_4 \, cred_{ct} + \sum_{c=1}^{n} \alpha_5 \, foreign_{ct} + \varepsilon_{ct} \end{aligned} \tag{1}$$

$$\text{Model II.} \quad \begin{aligned} NPL_{ct} = {} & \alpha_0 + \sum_{c=1}^{n} \alpha_1 \, boone_{ct} + \sum_{c=1}^{n} \alpha_2 \, income_{ct} + \sum_{c=1}^{n} \alpha_3 \, unemp_{ct} + \\ & \sum_{c=1}^{n} \alpha_4 \, cred_{ct} + \sum_{c=1}^{n} \alpha_5 \, foreign_{ct} + \varepsilon_{ct} \end{aligned} \tag{2}$$

$$\text{Model III.} \quad \begin{aligned} NPL_{ct} = {} & \alpha_0 + \sum_{c=1}^{n} \alpha_1 \, conc_{ct} + \sum_{c=1}^{n} \alpha_2 \, income_{ct} + \sum_{c=1}^{n} \alpha_3 \, unemp_{ct} + \\ & \sum_{c=1}^{n} \alpha_4 \, cred_{ct} + \sum_{c=1}^{n} \alpha_5 \, foreign_{ct} + \varepsilon_{ct} \end{aligned} \tag{3}$$

where c denotes countries and t denotes time dimension. α_0 indicates the constant term while ε_{ct} represents the random error term.

The relationship between banking competition and credit risk is investigated using the macro-level data covering 52 countries during the period of 1998-2016. The use of macro-level data provides important implications for regulatory authorities undertaking macroprudential policies since such data gives more weight to large systemic institutions than bank-based data (Davis et al. 2020). The fixed-effects panel data model is used to investigate the impact of competition on credit risk. The analyses are conducted for three groups: the whole sample, the low NPL volatility sample, and the high NPL volatility sample.

4. Empirical Results

This section provides descriptive statistics and estimation results. Table 1 reports the mean, standard deviation, and minimum and maximum values of the variables. The average NPL is 6% while the average value of the Lerner index, Boone indicator, and bank concentration is 0.24, -1.40, 0.78 respectively. The value of NPL ranges from a minimum value of 0.10% to a maximum value of 48.60%. Table 1 also reveals that control variables, especially credit to deposit ratio and foreign ownership, differ significantly across economies.

Table 1. *Descriptive statistics*

Variable	Observations	Mean	Std. Dev.	Min.	Max.
NPL	938	5.98	6.36	0.10	48.60
lerner	817	0.24	0.15	-1.61	1.08
boone	823	-1.40	13.34	-281.25	11.34
conc	927	0.78	0.16	0.28	1.00
income	988	9.68	1.11	6.63	11.62
unemp	967	8.20	4.45	1.50	27.50
cred	959	110.13	52.19	8.64	367.07
foreign	816	34.95	26.04	0.00	96.00

Table 2 also reports the correlation matrix. The competition measures except Boone indicator are inversely related to credit risk. The correlation between concentration and two direct measures of competition is quite low. This low correlation confirms the view that concentration measures do not fully capture banking competition. Besides, the correlation between concentration and credit to deposit is 0.39. This positive correlation does not support the view which propounds that higher market concentration causes lower credit supply. Income and credit size are negatively correlated with credit risk, while unemployment and foreign ownership are positively correlated with credit risk.

Table 2. *Correlation matrix*

Variable	1	2	3	4	5	6	7	8
1. NPL	1.00							
2. lerner	-0.08	1.00						
3. boone	0.11	0.08	1.00					
4. conc	-0.05	0.05	0.22	1.00				
5. income	-0.47	-0.06	-0.19	0.22	1.00			
6. unemp	0.36	-0.07	0.11	0.12	-0.29	1.00		
7. cred	-0.15	-0.01	0.20	0.39	0.28	0.05	1.00	
8. foreign	0.05	0.06	-0.27	-0.07	-0.09	0.18	-0.27	1.00

The relationship between banking competition and credit risk is investigated with the panel data analysis. The point to be considered here is that the analysis conducted with stationary series offers more accurate and consistent results. For this reason, the series are tested for stationary before proceeding to the analyses. Im-Pesaran-Shin (2003) unit root test is employed to check for stationary. In the IPS unit root test, the null hypothesis where the series has a unit root is tested against the alternative hypothesis; that the series does not have a unit root. The IPS test results reported in Table 3 show that the variables NPL, lerner, boone, unemp, cred, and foreign are stationary

at level. On the other hand, conc and income have a unit root and become stationary in their first differences. Therefore, the first differences of the latter two variables are employed in the estimations.

Table 3. *IPS unit root test results*

Variable	Level	IPS
NPL	Level	-6.047***
	1st Difference	-8.748***
lerner	Level	-4.043***
	1st Difference	-26.400***
boone	Level	-6.250***
	1st Difference	-14.242***
conc	Level	-0.215
	1st Difference	-9.193***
income	Level	0.800
	1st Difference	-8.944***
unemp	Level	-4.173***
	1st Difference	-9.930***
cred	Level	-4.141***
	1st Difference	-9.805***
foreign	Level	-3.365***
	1st Difference	-6.868***

At the first stage, the impact of banking competition on credit risk is analyzed for the whole sample. According to the estimation results reported in Table 4, there is a negative and statistically significant relationship between Lerner and NPL, confirming that banks with higher market power are better at selecting the right borrowers. The relationship between Boone and credit risk is also negative but not statistically significant. On the other hand, the results show that increased bank concentration deepens credit risk. However, this relationship is not statistically significant either. Further, as expected increasing per capita income alleviates credit risk, whereas unemployment triggers credit risk. These findings explain why the banking systems in developed countries have lower NPL. Regarding the banking environment variables, a higher amount of credit triggers credit risk by either decreasing banks' screening ability or increasing the probability of unqualified borrowers getting credit. On the other hand, increased foreign ownership in the banking sector mitigates credit risk.

Table 4. *The relationship between banking competition and credit risk for the whole sample*

Dependent Variable / Explanatory Variables	Model I	Model II	Model III
	NPL	NPL	NPL
Lerner	-9.590***		
Boone		-0.004	
D(Concentration)			0.049
D(lncome)	-32.250***	-33.889***	-33.056***
Unemployment	0.649***	0.788***	0.791***
Credit to deposit	0.038***	0.030***	0.034***
Foreign ownership	-0.163***	-0.180***	-0.202***
Constant	4.858***	3.151***	3.514***
Observations	667	702	651
R^2	0.553	0.566	0.602
F-statistic	16.294***	17.987***	19.561***
Durbin-Watson statistic	0.485	0.467	0.490

*, ** and *** represent statistical significance levels of 10%, 5% and 1%, respectively.

Screening intensity, which largely depends on the benefit of screening, is one of the main factors that affect credit risk. However, NPL and its volatility may also affect the screening intensity. Given the fact that NPL itself affects banks' screening intensity, the relationship between banking competition and credit risk is analyzed for two country groups (i.e. low NPL volatility group, and high NPL volatility group). The low NPL volatility group consists of high-income countries while low-income countries are generally in the high NPL volatility group.

Table 5 reports the regression results with respect to the low NPL volatility sample. According to table 5, Lerner and Boone are negatively related to credit risk. However, only the relationship between Lerner and credit risk is statistically significant. On the contrary, the relationship between concentration and credit risk is positive, but not statistically significant. Regarding business cycle variables, income negatively affects credit risk while unemployment positively affects credit risk. Besides, higher amount of credit increases credit risk while higher foreign ownership alleviates.

Table 5. *The relationship between banking competition and credit risk for the low NPL volatility sample*

Dependent Variable / Explanatory Variables	Model I	Model II	Model III
	NPL	NPL	NPL
Lerner	-1.719**		
Boone		-0.002	
D(Concentration)			-0.013
D(Income)	-9.992***	-9.103***	-12.597***
Unemployment	0.430***	0.432***	0.393***
Credit to deposit	0.009**	0.008**	0.005
Foreign ownership	-0.048***	-0.040***	-0.036***
Constant	0.378	-0.196	0.231
Observations	326	344	319
R^2	0.518	0.493	0.553
F-statistic	13.480***	12.936***	15.196***
Durbin-Watson statistic	0.426	0.388	0.453

*, ** and *** represent statistical significance levels of 10%, 5% and 1%, respectively.

The estimation results of the high NPL volatility sample presented in Table 6 show that there is a negative and statistically significant relationship between Lerner and credit risk. The magnitude of Lerner is higher compared to regression results from both overall and low NPL volatility samples. This result shows that market power plays a significant role in credit risk in countries with high NPL volatility. On the other hand, Boone and concentration are positively related to credit risk. However, none of these relationships are statistically significant. The results also reveal that income is inversely related to credit risk. Similarly, there is a negative relationship between foreign ownership and credit risk. On the other hand, the results show that unemployment and credit size increase credit risk.

Table 6. *The relationship between banking competition and credit risk for the high NPL volatility sample*

Dependent Variable / Explanatory Variables	Model I	Model II	Model III
	NPL	NPL	NPL
Lerner	-19.857***		
Boone		0.221	
D(Concentration)			0.068
D(Income)	-44.338***	-49.810***	-43.583***

Dependent Variable / Explanatory Variables	Model I	Model II	Model III
	NPL	NPL	NPL
Unemployment	0.766***	0.924***	0.949***
Credit to deposit	0.071***	0.048***	0.069***
Foreign ownership	-0.217***	-0.251***	-0.279***
Constant	9.514***	7.265***	6.650***
Observations	341	358	332
R^2	0.488	0.460	0.510
F-statistic	11.823***	11.170***	12.908***
Durbin-Watson statistic	0.594	0.505	0.537

*, ** and *** represent statistical significance levels of 10%, 5% and 1%, respectively.

5. Conclusions and Discussion

The impact of banking competition on credit risk is a popular, but still unsettled research and policy question. There are two confronting views regarding the banking competition-credit risk nexus. The information-based view argues that less competition is better for credit risk because banks with market power are better at collecting information and establishing long-term relationships with borrowers. On the other hand, the moral hazard view claims that banks with market power tend to charge higher rates which cause borrowers to take more risk, thereby resulting in higher credit risk.

The purpose of the study is to explore the relationship between banking competition and credit risk and analyze whether this relationship is similar across different country groups. The study utilizes the fixed-effects model to explore the aforementioned relationship using macro-level data. The use of macro data provides important implications for regulatory authorities undertaking macroprudential policies since such data gives more weight to large systemic institutions than bank-based data. The study employs loan loss measured as a share of nonperforming loans to total gross loans for credit risk. Lerner Index, Boone Indicator, and five-bank asset concentration are used to gauge banking competition. The business cycle and banking structure controls are also added.

The results reveal that banking competition and concentration affect credit risk in different ways. Lerner index, an inverse measure of banking competition, is adversely related to credit risk. On the other hand, no significant relationship is found between banking competition and credit risk when Boone and concentration are used as a competition measure. Accordingly, regulatory authorities should treat competition and concentration in different ways. In addition, results also reveal that the impact of banking competition on credit risk is more significant for countries with high NPL volatility. Therefore, policy makers, especially those who officiate in developing economies where NPL volatility is high, should reassess the pro-competition policies in light of the advantages

competition provides. Given the greater competition leads to more credit problems, they should also push banks operating in a fierce competitive environment to intensify higher monitoring activities. In addition, supervisory authorities can apply rigid policies such as higher capital requirements andmore frequent banking inspection in order to inhibit banks' excessive risk-taking behavior. Regarding business cycle variables, income decreases credit risk while unemployment exacerbates credit risk. For banking structure variables, foreign ownership seems to be inversely related to credit risk, whereas credit size is positively related to credit risk. These results suggest that credit risk is affected by macroeconomic factors. Therefore, bank managers should also consider macroeconomic variables in their lending decisions.

Lastly, the study has some limitations. First, it employs cross-country data and ignores the banking rules and guidelines in a specific country that directly affect credit risk such as minimum equity capital requirements, loan loss provisioning practices, etc. Therefore, futures studies may address the moderating role of banking regulations in the banking competition-credit risk nexus. Second, the current study assumes a linear relationship between banking competition and credit risk. Researchers can address nonlinearity regarding the banking competition-credit risk relationship.

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Appendix A. *Definition of variables*

Variables	Definition
Dependent Variable	
Non-performing loan ratio (NPL)	The share of nonperforming loans divided by the total gross loans. The lower value indicates less credit risk, whereas higher values reflect higher credit risk.
Explanatory Variable	
Lerner Index (lerner)	The market power in the banking sector measured by the Lerner index. Higher values indicate less bank competition.
Boone Indicator (boone)	The degree of competition in the banking sector measured by the Boone indicator. The more negative indicator shows higher a degree of competition.
five-bank asset concentration (conc)	The share of the five largest banks' assets to assets of all banks in an economy. The higher values imply less competition.
Control variables	
GDP per capita (income)	The log values of GDP per capita in 2010 US$.
Unemployment (unemp)	The share of the labor force unemployed to the total labor force.
Credit Size (cred)	The share of bank credit to bank deposits.
Foreign ownership (foreign)	The share of the number of banks whose 50 percent or more shares owned by foreigners to the number of the total banks in the economy.

Source: *Global Financial Development Database (World Bank, 2020), World Development Indicators Database (World Bank, 2020)*

Appendix B. *Low NPL volatility sample vs. High NPL volatility sample*

Low NPL volatility group			High NPL volatility group		
Country	**Mean**	**Std. Dev.**	**Country**	**Mean**	**Std. Dev.**
Finland	0.54	0.25	Croatia	10.05	3.79
Luxembourg	0.45	0.35	Slovenia	7.21	3.97
Norway	1.21	0.39	Portugal	5.51	4.02
Austria	2.66	0.45	Kuwait	7.4	4.22
Netherlands	2.51	0.53	India	6.71	4.3
Sweden	1.1	0.58	Tunisia	17.6	4.42
Australia	0.98	0.61	Italy	10.24	4.45
Chile	1.7	0.61	Latvia	5.27	4.79
Belgium	2.86	0.81	Jordan	9.66	5.11
France	4.21	0.91	Iceland	4.66	5.32
Germany	3.66	1.02	Hungary	6.98	5.33
United Kingdom	2.33	1.07	Morocco	11.34	5.68
United States	1.95	1.31	Egypt	15.62	5.94
Estonia	1.66	1.57	Poland	8.89	5.96
Denmark	2.37	1.83	Malaysia	8.28	6.35
Malta	7.32	2.00	Turkey	6.69	6.36
Japan	3.38	2.12	Lithuania	9.21	7.22
Brazil	4.45	2.18	Czech Republic	8.22	7.52
Hong Kong	2.54	2.46	Bulgaria	9.75	7.63
Singapore	3.04	2.47	Slovak Republic	7.91	7.66
Mexico	3.66	2.53	Ecuador	7.78	7.79
Israel	3.36	2.54	Philippines	9.02	7.83
Georgia	4.12	2.74	Albania	12.34	8.23
Korea	2.44	2.89	Ireland	7.88	9.05
Spain	3.47	2.91	Greece	14.83	11.53
Colombia	5.26	3.59	Indonesia	11.72	14.61

Source: *Author's calculation*