

# Competition and Financial Stability in the European Listed Banks

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## Abstract

The analysis of the relationship between bank competition and financial stability remains a controversial issue and widely discussed in the academic and political community. Using a sample of 117 listed banks in 16 European countries for the years 2011 to 2018, the article explores the impact of market power, measured by the Lerner index, on the bank stability, measured by distance-to-default and Z score. Our results show that for the overall sample, higher market power in banking decreases the risky behavior of banks, confirming the “competition-fragility” view. We do not find any support for a U-shaped relationship between competition and bank risk-taking. However, our findings differ from previous studies pointing out that the relationship between bank competition and risk-taking is differentiated depending on whether the bank is based in a country with a more stable banking system or a less stable one. In countries with a less financially stable banking system, increased competition leads to increased bank risk-taking. In countries with a more stable banking system, market power seems not to influence banks’ financial stability. Public policies must guarantee banking competition but limiting excessive bank risk-taking, especially in countries with less financially sound banking systems. The consolidation of European banking can be a key element for achieving these policies.

## Keywords

bank risk-taking, financial stability, bank competition, Lerner index, European banks

## Introduction

The impact of bank competition on financial stability has been widely discussed in the academic and political communities over the last two decades and particularly since the 2007 to 2008 global financial crisis (Clark et al., 2018; Fu et al., 2014). During the decades of the 70s and 80s in the last century, there was an intensification of financial deregulation that promoted the globalization of financial markets and the financial innovation, which in turn led banks to adopt much more aggressive policies, increasing the degree of competition (Cuestas et al., 2020; Danisman & Demirel, 2019). For many, this excessive risk-taking behavior by the banks was the key to the 2007 to 2009 crisis. This has led in Europe, as in the worldwide, in the past few years, a strengthening of prudential regulation via increased capital requirements and other obligations that incorporate aspects that can affect competition in the banking sector. Also, there was a reduction in the number of banks operating in most countries, with the troubled banks being bailed out by national governments or absorbed by other banks. These two phenomena may have modified the competitive conditions in which banks operate, relaunching the discussion about the relationship between

competition in the banking sector and its financial stability in the scientific community.

While it is agreed at an academic level that greater competition in the banking sector leads to greater innovation and efficiency (Schaeck & Čihák, 2010; Turk Ariss, 2010), there is still no consensus as to whether the impact of competition on the banking sector will lead to greater or lesser financial stability. The traditional banking literature supports a “competition-fragility” nexus. Under this hypothesis, bank competition will lower the net interest margin, eroding bank’s profits, which will lead to an increased probability of bankruptcy, and consequently, the overall disruption of the financial system (Allen & Gale, 2004; Keeley, 1990; Marcus, 1984). More recently, Boyd and De Nicoló (BDN; 2005)

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present arguments that support the competition-stability hypothesis, which states that banks with more market power tend to charge higher interest rates, which provides an incentive to borrowers to engage in riskier activities. So, under this theory, competition increases financial stability. Martinez-Miera and Repullo (2010) present a model that try to reconcile the two opposing views on the relationship between competition and financial stability of banks.

Although this topic has already been investigated in the European context, this research is of particular interest because it analyzes a sector in constant change and which is essential for the good functioning of the economy. The changes that took place in the different European banking sectors due to the 2008 financial crisis and the regulatory changes to stabilize them have led in recent years to great restructuring that has altered the conditions of competition. This reason justifies our work, which presents the following distinctive aspects from those previously carried out in Leroy and Lucotte (2017). First, we emphasize the fact that the relationship between bank competition and risk-taking can be differentiated depending on whether the bank operates in a more or less stable banking system. Second, to measure the bank risk-taking, we considered a new market measure, computed with market data, and not obtained from data provider services. Finally, to account for the persistence in the relationship between banking competition and risk-taking, we consider a dynamic panel data model, instead of the traditional static model, estimated by a method that allows us to obtain more efficient estimators.

Initially, as a proxy for individual bank risk, two alternative measures were considered. These measures, which have been intensively used in previous empirical investigations, are the Z score, an accounting measure, and the distance-to-default, a market measure. In robustness tests, we also considered a third measure, distance-to-insolvency, which, to the best of our knowledge, has never been used in previous empirical research studies to measure the bank's risk. To measure banking competition, we considered the Lerner index, which measures the bank's ability to keep its prices above its marginal costs.

Using a dynamic panel data model with a generalized method of moments (GMM) estimator, to control for endogeneity, the empirical analysis is carried out for 117 banks, in 16 Western European countries, between 2011 and 2018. The findings indicate that market power increases the bank's financial stability, which corroborates the traditional "competition-fragility" view and that relationship is only significant for countries with a less stable banking system. We also found evidence that banks with greater dimension, which are more well capitalized, and with more diversified earnings sources are more stable.

The remainder of the article is organized as follows. Section "Literature Review and Research Hypothesis" provides a review of the literature on competition and stability in banking and formulates the research hypotheses. Section

"Methodology and Data" describes the econometric methodology and the data used in the econometric tests. The results are reported and discussed in Section "Empirical Results and Discussion." A set of robustness tests are conducted in Section "Robustness Tests" and Section "Conclusion" concludes.

## Literature Review and Research Hypothesis

The literature on the study of the relationship between competition and stability in the banking sector is based on two different views: the competition-fragility view and the competition-stability view.

According to the traditional competition-fragility hypothesis, banks become more fragile when they operate in more competitive banking systems. Over time, several arguments have been suggested to support this hypothesis.

The first is based on the well-known "charter/franchise value" paradigm for bank risk-taking, which states that banks limit risk-taking to protect the quasi-monopoly rents granted by their governments' charters. Marcus (1984) and Keeley (1990) provide a theoretical framework that suggests in more competitive banking systems, due to a lower charter/franchise value, the bankruptcy costs are lower, leading banks to adopt riskier investment strategies deteriorating thereby the quality of the bank's assets and the financial stability.

Another argument of the competition-fragility view rests on the market structure in which banks operate. More concentrated banking systems are composed by large banks that benefit from economies of scale and/or scope and have more diversified portfolios, lowering that way the risk exposure (Williamson, 1986).

The competition-fragility hypothesis is also supported by the borrower-bank relationship. Several authors argue that in more competitive banking environments, the economic rents from intermediation decrease considerably, leading banks to reduce their screening of potential borrowers, and thus, overall portfolio credit quality declines (Chan et al., 1986; Marquez, 2002).

The competition-fragility hypothesis also finds support in the fact that the existence of deposit guarantee systems to mitigate liquidity risk introduces moral hazard by providing incentives to banks to engage in riskier activities, in more competitive banking environments (Matutes & Vives, 1996).

A last argument that supports the competition-fragility view is based on the fact that the stability of the banking system can also be affected by contagion. In a perfectly competitive market, banks are price takers and have no incentive to provide liquidity to troubled banks. If banks in difficulty eventually fail, this could have negative repercussions on the whole sector increasing the instability. In a more concentrated banking system, with a small number of large institutions, it is relatively easier to monitor banking activity by the supervisory authority and to obtain an agreement to rescue troubled banks, thus preventing contagion and increasing financial stability (Allen & Gale, 2000; Sáez & Shi, 2004).

The alternative and more recent competition-stability hypothesis states that more competitive and/or less concentrated banking systems are more stable. The main argument of this view is based on the risk-shifting effect introduced by BDN (2005). They developed a model based on the argument that banks operating in markets with uncompetitive banking systems tend to charge higher interest rates on loans granted. This may encourage borrowers to invest in high-risk projects, increasing the probability of default on loans. Consequently, the volume of nonperforming loans may increase, resulting in a higher probability of the bank's bankruptcy.

Another argument presented by proponents of the competition-stability hypothesis is related to the doctrine "too-big-to-fail." Mishkin (1999) and Barth et al. (2012) argue that in highly concentrated banking systems, largely made up of large banks, policymakers are more likely to "save" these banks in case of bankruptcy. This creates a moral hazard problem, encouraging risk-taking behavior by the bank managers and increasing financial fragility (Demirgüç-Kunt & Huizinga, 2013; Rosenblum, 2011).

Most of the empirical investigations found evidence supporting the view of competition-fragility. Beck et al. (2006), in a cross-country study of 69 countries over the period 1980 to 1997, using the concentration ratio as a measure of competition and a dummy variable indicative of a systemic crisis, found evidence that in economies with more concentrated banking systems, crises are less likely, which supports the competition-fragility view. Using data at the bank level for 23 developed countries, over the period 1999 to 2005, Berger et al. (2009) conclude that banks with more market power, measured by the Lerner index, present riskier loan portfolios but the overall bank risk, measured by the Z score index, is more reduced, which supports the competition-fragility view. Evidence of this view also can be found in more recent studies (Beck et al., 2013; Danisman & Demirel, 2019; Leroy & Lucotte, 2017).

Some but relatively fewer studies, using new measures for the competition, such as the Boone indicator, found evidence of the competition-stability view. Schaeck and Čihák (2010), using a panel data sample of banks from 10 European countries (covering the period 1995–2005) and a cross-section sample of U.S. local banks (for the year 2005), concluded that promoting competition improves banks' financial stability via an efficiency channel, which supports the competition-stability view. Similar results were found by Clark et al. (2018) for a bank's panel data set from 10 Commonwealth of Independent States countries in the period 2005 to 2013. They concluded that there was a statistically significant negative relationship between the Lerner index and the Z score, which supports the competition-stability view.

According to the European Banking Federation (EBF; 2019), since the financial crisis in 2008 until 2018, more than a quarter of credit institutions in the European Union have disappeared. In particular, the number of credit institutions in

the EU-28 decreased by 28.6% from 8,525 in 2008 to 6,088 in 2018, as shown in the Figure 1A, in Supplemental Appendix. This downward trend gave rise to considerable bank consolidation processes in countries such as Spain, Italy, and Greece. Consistent with this trend and the apparent stabilization of most banking systems in Europe in recent years, we expect, in line with the most recent empirical studies, to find results that support the competition-fragility view to the detriment of the competition-stability hypothesis. Based on this, we formulate Hypothesis 1 below:

**Hypothesis 1:** Bank competition decreases the stability in banking, indicating the competition-fragility view.

More recently, Martínez-Miera and Repullo (2010) developed a model that assumes an imperfect correlation in the loan's probability of default, to demonstrate the existence of a U-shaped relationship between competition and risk. Increased competition in the banking sector leads to a decrease in loans interest rates which potentially has two opposite effects on financial stability. The first is the already mentioned risk-shifting effect of the BDN model that decreases the loan portfolio risk. The second effect, defined as a "margin" effect, leads to a decrease in banks' revenues, given the reduction of interest payments by firms, which potentially increase the bank risk. Martínez-Miera and Repullo (2010) demonstrated that the "risk-shifting" effect dominates in markets with greater banking concentration (monopolistic markets) so that the entry of new banks in the sector can improve bank risk measures. In already highly competitive banking markets, the "margin" effect dominates in such a way that the entry of new banking entities into the sector tends to worsen bank risk. This leads the authors to conclude that the lowest degrees of bank risk occurs at moderate levels of competition and so a U-shaped relationship between competition and the risk of bank failure generally obtains.

In the context of European banking, despite the increase in banking concentration, quite different market structures still coexist. Countries such as Germany, Austria, Italy, and France whose share of total assets of the five largest credit institutions does not exceed 50%, at the end of 2018, and in countries like Greece, the Netherlands, and Finland, that value is greater than 80% (Figure 1A, in Supplemental Appendix). This diversity of market structures in European banking makes it possible to admit that both approaches, competition-fragility and competition-stability, may be appropriate, depending on the level of concentration and competition.

However, a nonlinear investigation could be useful from a policy point of view, as it allows an optimal threshold to be identified beyond which bank competition, or inversely a lack of competition, becomes dangerous for the stability of the banking sector.

Based on those arguments, we formulated the following hypothesis:

**Hypothesis 2:** There is a U-shaped relationship between competition and bank risk-taking.

Some recent empirical studies found evidence of Hypothesis 2. Jiménez et al. (2013), using a panel data sample of commercial and savings banks from Spain, in the period 1988 to 2003, concluded by a nonlinear relationship between competition in the loan market and bank risk-taking as in the Martínez-Miera and Repullo (2010) model. Empirical evidence of the U-shaped relationship between bank competition and risk-taking can also be found in the study of Cuestas et al. (2020) for banks operating in the Baltic countries over the period 2000 to 2014.

As previously mentioned, the 2007 to 2009 financial crisis and the eurozone sovereign debt crisis put many European banks under severe financial stress. This led the different European governments to adopt a set of measures to stabilize their countries' banking systems. Those set of measures can be grouped into three categories and, in general, they were implemented sequentially as the crisis worsened: (a) guarantees, (b) capital injections, and (c) asset restructuring/resolution. In countries with strong budgetary constraints and excessive levels of public debt, such as Italy, Portugal, and Greece, the implementation of Steps (b) and (c) was avoided or delayed as much as possible, resulting in an even less stable banking system. In those countries, where some banks present poor results and are not properly capitalized, increased competition may lead management to invest in riskier assets in an attempt to reverse the situation, amplifying the level of risk. In countries with more stable banking systems as a whole, where banks are not under so much pressure, increased competition could be more easily accommodated.

Motivated by these differences, in terms of financial stability, we investigate the influence of the stability of the banking system as a whole on the relationship between market power and bank risk-taking. In particular, we analyze the hypothesis that the relationship between competition and bank risk-taking is influenced by the fact that the bank operates in a more or less stable banking system as a whole. Emphasizing the role of the banking environment in which each bank operates, we formulate Hypothesis 3:

**Hypothesis 3:** The relationship between competition and bank risk-taking is differentiated depending on whether the bank operates in a less or more stable banking system as a whole.

To the best of our knowledge, this hypothesis never had been investigated until today and this will be the major contribution of this study to the recent state of the art.

## Methodology and Data

This section presents the methodology and the empirical model used to examine the effects of competition on the

financial stability of listed banks in Europe. Measures of competition and financial stability are also presented and discussed.

### Measuring Financial Stability

To measure individual bank risk, we used market- and accounting-based risk measures. The market measure considered in this work was distance-to-default (*DD*) derived from Black and Scholes (1973) and Merton's (1974) model. In this model, the equity of a bank can be viewed as a call option on the bank's assets, with a strike price and maturity equal to the book value and average maturity of the bank's debt, respectively. At the maturity of debt, if the value of the bank's assets is greater than the book value of debt, equity holders exercise their option and pay off the debt holders. Otherwise, equity holders do not pay the debt and the bank goes bankrupt, and the value of equity is zero.

Formally, the *DD* of the bank *i* in a particular year *t* is defined as follows (detailed formula's derivation in Vassalou and Xing (2004)):

$$DD_{it} = \frac{\ln\left(\frac{V_{A,it}}{D_{it}}\right) + \left(\mu_{A,it} - \frac{1}{2}\sigma_{A,it}^2\right)(T-t)}{\sigma_{A,it}\sqrt{(T-t)}}, \quad (1)$$

where  $V_{A,it}$  is the bank's assets market value,  $D_{it}$  is the book value of the bank's debt,  $\mu_{A,it}$  is the expected return on assets,  $\sigma_{A,it}$  is the standard deviation of market assets return (asset volatility), and  $T-t$  is the time to maturity of the debt. In Expression (1), the variables  $V_{A,it}$ ,  $\mu_{A,it}$ , and  $\sigma_{A,it}$  are not observable and have to be estimated. For this proposal, we follow the approach used by Moody's, Kealhofer, McQuown, and Vasicek (KMV) model, assuming that average maturity's debt is 1 year and that default point is equal short-term debt plus one half of long-term debt (Crosbie & Bonh, 2003). In this context, the *DD* can be defined as the difference between the current market value of a bank's assets and its estimated default point, weighted by the volatility of assets. An increase in the *DD* means that the bank is moving away from the default point and that bankruptcy becomes less likely.

In robustness tests, an alternative market measure, distance-to-insolvency (*DI*), proposed by Atkeson et al. (2017), was also considered, which is calculated as follows:

$$DI_{it} = \left(\frac{V_{A,it} - D_{it}}{V_{A,it}}\right) \frac{1}{\sigma_{A,it}}, \quad (2)$$

where variables  $V_A$  and  $\sigma_A$  were estimated in the same way as described above. This ratio can be interpreted by the drop in asset value that would render the bank insolvent, measured in units of the firm's asset standard deviation.

As accounting measure of bank soundness, we considered the *Z* score, originally introduced by Boyd and Graham (1986), which is widely used in the literature (e.g., Beck

et al., 2013; Berger et al., 2009; Leroy & Lucotte, 2017; Schaeck & Čihák, 2010). The  $Z$  score of the bank  $i$  in year  $t$  is defined as:

$$Z - score_{it} = \frac{\left(\frac{E_{it}}{A_{it}}\right) + ROA_{it}}{\sigma_{ROA,i}}, \quad (3)$$

where  $E_{it} / A_{it}$  is the equity to total assets ratio,  $ROA_{it}$  represents the return on assets, measured by the ratio between net income and total assets, and  $\sigma_{ROA,i}$  the volatility of return on assets. Because the sample period covered by the present investigation is relatively short, the estimate of the volatility of return on assets  $\sigma_{ROA,i}$  is assumed constant and given by the standard deviation of the return on assets in the period under analysis.

It should be noted that  $Z$  score is inversely related with the probability of the bank's insolvency, that is, a lower  $Z$  score implies a higher probability of insolvency. As noted by Schaeck and Čihák (2010), "the  $Z$ -score combines banks' buffers (capital and profits) with the risks they face (measured by the standard deviation of returns)." The  $Z$  score measures the number of standard deviations a return realization must fall to deplete equity. Because  $Z$  score is highly skewed, a natural logarithm transformation is used (Danisman & Demirel, 2019).

### Measuring Competition

In this study, as a proxy of competition, it was considered the Lerner index, a measure based on nonstructural approach. This indicator has been widely used in recent bank research (Clark et al., 2018; Fu et al., 2014; Leroy & Lucotte, 2017). It captures the capacity of price power by calculating the difference between price and marginal cost as a percentage of the price. It is an inverse proxy for bank competition, taking values between 0 and 1, with an index equal to 0 in the case of perfect competition and 1 in the case of monopoly. A low index indicates a high degree of competition, and a high index indicates a lack of competition.

The Lerner index presents several advantages when compared with other measures of competition. First, the Lerner index is the only time-varying measure of competition that can be computed at a disaggregated level, that is, at the bank level. Second, the calculation of the Lerner index does not imply a definition of the market where the bank offers its services. Finally, a substantial empirical bank literature has suggested that structural measures, as the concentration indexes, are not reliable measures of competition.

Formally, the Lerner index of the bank  $i$  in year  $t$  is defined as:

$$Lerner_{it} = \frac{P_{it} - MC_{it}}{P_{it}}, \quad (4)$$

where  $P_{it}$  is the price of total assets proxied by the ratio of total revenues (interest and noninterest income) to total assets and  $MC_{it}$  is the marginal cost of total assets.

To obtain  $MC_{it}$ , we used the intermediation approach (e.g., Beck et al., 2013; Berger et al., 2009; Clark et al., 2018; Fu et al., 2014), estimating a translog cost function with three inputs and one output, for each country to better address differences in technology:

$$\begin{aligned} \ln TC_{it} = & \alpha_0 + \beta_1 \ln TA_{it} + \frac{1}{2} \beta_2 (\ln TA_{it})^2 \\ & + \sum_{j=1}^3 \alpha_j \ln w_{it}^j + \sum_{j=1}^3 \phi_j \ln TA_{it} \ln w_{it}^j + \frac{1}{2} \sum_{j=1}^3 \sum_{k=1}^3 \theta_{jk} \\ & \ln w_{it}^j \ln w_{it}^k + \gamma_1 T + \frac{1}{2} \gamma_2 T^2 + \gamma_3 T \ln TA_{it} \\ & + \sum_{j=4}^6 \gamma_j T \ln w_{it}^j + \varepsilon_{it}, \end{aligned} \quad (5)$$

where  $TC_{it}$  is the bank's total costs and is equal to the sum of interest expenses, commission and fee expenses, trading expenses, personnel expenses, administrative expenses, and other operating expenses and  $TA_{it}$  is the bank's output, measured by the total assets.  $w_{it}^j$ , for  $j = 1, 2, 3$ , are the prices of the inputs of production, defined as follows:  $w_{it}^1$  is the price of purchased funds, measured by the ratio between interest expenses and the sum of total deposits and other sources of funding by debt,  $w_{it}^2$  is the price of labor, measured by the ratio between personnel expenses and total assets, and  $w_{it}^3$  is the price of other inputs, measured by the ratio of administrative and other operating expenses to total assets.  $T$  is a time trend that captures the influence of technological changes that lead to shifts in the cost function over time, and  $\varepsilon$  is the error term. We further imposed the following restrictions on regression coefficients to ensure homogeneity of degree one to input the prices:  $\sum_{j=1}^3 \alpha_j = 1$ ,  $\sum_{j=1}^3 \phi_j = 0$  and  $\sum_{j=1}^3 \sum_{k=1}^3 \theta_{jk} = 0$ .

Under these conditions, we can use the coefficient estimates from the translog cost function to estimate the marginal cost for each bank  $i$  at year  $t$ :

$$MC_{it} = \frac{\partial TC_{it}}{\partial TA_{it}} = \left[ \beta_1 + \beta_2 \ln TA_{it} + \sum_{j=1}^3 \phi_j \ln w_{it}^j + \gamma_3 T \right] \frac{TC_{it}}{TA_{it}}. \quad (6)$$

As referred by Turk Ariss (2010), one potential problem associated with the conventional Lerner index is that it assumes full bank efficiency, neither employing too many scarce resources (technical efficiency) nor allocating resources in suboptimal proportions given prices (allocative efficiency). Ignoring both cost and profit inefficiency at the same time, the conventional Lerner index calculation will be biased. In robust testing, to deal with both cost and profit inefficiencies in the empirical measurement of the Lerner index, we used the efficiency-adjusted Lerner index, proposed by Koetter et al. (2008), which is estimated using stochastic frontier analysis to account that banks are not fully efficient. The efficiency-adjusted Lerner index is obtained as follows:

$$E - Lerner_{it} = \frac{AR_{it} - MC_{it}}{AR_{it}}, \quad (7)$$

where  $AR_{it}$  denotes average revenues, which is obtained by the ratio between expected total revenues ( $\widehat{TR}_{it}$ ) and total assets ( $TA_{it}$ ). To estimate the total revenues, we considered the fact that  $\widehat{TR}_{it} = \widehat{TP}_{it} + \widehat{TC}_{it}$ , where  $TP_{it}$  represents the total profits and  $TC_{it}$  represents the total costs.  $TC_{it}$  was estimated from Equation (5) and the  $TP_{it}$  was estimated from an alternative profit function which is equal to Equation (5) but where the dependent variable is now  $\ln TP_{it}$ .

### Empirical Model and Estimation Method

To investigate the effects of competition on the financial stability of listed banks in Europe, we follow Beck et al. (2013) and Fu et al. (2014) who argue that in studies of panel data, a dynamic model should be used to estimate the time persistence in the bank risk. Thus, the equation of a dynamic linear model:

$$\begin{aligned} risk_{it} = & \beta_0 + \beta_1 * risk_{it-1} + \beta_2 * Competition_{it} + \beta_3 * \\ & Competition_{it}^2 + \sum_{k=1}^s \gamma_k Bank Control_{k,it} \\ & + \sum_{j=1}^m \delta_j Macro Control_{j,it} + \mu_i + \gamma_t + \varepsilon_{it}, \end{aligned} \quad (8)$$

where  $i$  and  $t$  are bank and time indicators, respectively;  $risk_{it}$  represents alternatively one of the measures of risk stated above;  $Competition_{it}$  represents one of the measures of bank competition described above;  $Bank Control_{k,it}$  represents a bank-level controls variables;  $Macro Control_{j,it}$  represents macroeconomic variables; and  $\mu_i$  and  $\gamma_t$  represent a bank-specific effect and time fixed effect, respectively. Following the literature (Berger et al., 2009; Cuestas et al., 2020; Turk Ariss, 2010), the quadratic term of the measure of bank competition is included in the model to account for the potential U-shaped relationship between competition and risk-taking (Martinez-Miera & Repullo, 2010). To test the U-shaped relationship formally, we use the U-shape test developed by Lind and Mehlum (2010).

The first bank-level variable considered is the ratio of equity to assets, as a measure of bank capitalization. Because banks are expected to trade-off higher levels of equity capital for risk assets, we considered this variable as being endogenous (Delis & Kouretas, 2011).

Second, we control the bank's size, measured by the natural logarithm of the total assets. The relationship between risk-taking and size is unclear because, on one hand, managers of large banks may be tempted to adopt higher risk policies in the case that governments are prepared to bail-out large problematic banks (Demirgüç-Kunt & Huizinga, 2013) and, on the other hand, larger banks can achieve economies

of scale that allow them to be more stable than small banks (Williamson, 1986). Third, we considered the noninterest income share, measured as the percentage of noninterest income in total operating revenues, to proxy the composition of bank revenues. It is expected that more diversified revenues imply less risk exposure. To account for the bank's debt structure, we considered the share of wholesale funding in total funding. While the wholesale funding includes money market funding plus other borrowings, total funding is calculated as a sum of wholesale funding plus total deposits. To measure bank's exposure to liquidity risk, we also include, as a control bank-level variable, the ratio between liquid assets and total assets. Finally, we control for asset composition, using the loans-to-assets ratio and for inefficiency using the cost-to-income ratio.

In terms of macroeconomic variables, we have considered two variables. First, gross domestic product (GDP) growth, to monitor the effect of fluctuations in the business cycle and the trend of economic growth in general in the bank risk-taking. In the previous literature, it has been already found evidence that economic growth encourages banks to reduce financial restrictions to increase lending, generating more risk (Berger & Udell, 2004). Given this, we expect a negative sign for the relationship between economic growth and banking stability. Second, as suggested in the work of Demirgüç-Kunt and Huizinga (2010), we also control for inflation. According to these authors, a higher inflation rate makes banks achieve a high return on assets but also carries a high level of risk. So, we expect that a higher inflation rate reduces the bank's stability.

Examining whether market power influences the bank's risk-taking raises the question of endogeneity bias. Indeed, Schaeck and Čihák (2010) argued that the level of risk-taking could affect competition between banks, which could then influence our measures of market power. When banks face a high probability of default, they might have an incentive to change the price of their products to access new financial resources and attract new customers, affecting the existing market power. To address the endogeneity problem between the bank competition measure and bank risk measures, as well as capitalization levels, we estimate Equation (8) using the GMM. According to Blundell and Bond (1998), the system GMM performs better than the difference GMM, developed by Arellano and Bond (1991) because it is more robust to capture efficiency gains and may reduce the finite sample bias. Namely, we use the two-step "system GMM estimator" developed by Arellano and Bover (1995), with Windmeijer (2005) corrected standard errors.

### Sample Description and Data Statistics

To evaluate the effects of bank competition on financial stability in Europe after the global financial crisis, we considered an unbalanced panel data set constituted by listed European banks, that covers the period from 2011 to 2018,

**Table 1.** Sample Descriptive Statistics of Variables Used in the Main Model (2011–2018).

Variable	Obs.	M	SD	Minimum	Maximum
<b>Dependent variables</b>					
Distance-to-default	860	3.837	3.030	-2.280	16.669
Ln Z score	860	3.515	0.927	1.215	5.278
Distance-to-insolvency	860	3.502	2.422	-1.038	15.888
<b>Independent variables</b>					
Lerner index	860	0.140	0.211	-0.959	0.440
E-Lerner index	860	0.236	0.212	-0.746	0.605
Capitalization	860	0.083	0.034	0.017	0.174
Size	860	10.425	2.224	5.788	14.529
Noninterest income share	860	0.428	0.167	0.060	0.919
Share of wholesale funding	860	0.380	0.192	0.007	0.763
Liquidity	860	0.185	0.128	0.023	0.607
Asset composition	860	0.608	0.186	0.133	0.875
Inefficiency	860	0.628	0.157	0.314	1.216
Real GDP growth	860	0.012	0.015	-0.040	0.045
Inflation	860	0.013	0.011	-0.011	0.036

Note. GDP = gross domestic product.

from the following countries: Austria (AU), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (GE), Greece (GR), Ireland (IR), Italy (IT), the Netherlands (NL), Norway (NO), Portugal (PT), Spain (SP), Switzerland (CH), Sweden (SE) and the United Kingdom (UK). We considered Western European listed banks for which balance-sheet and market data are available over the period of study. We only considered commercial banks, savings banks, cooperative banks, and bank holdings and holding companies, with at least 3 years of consolidated accounts available. Accounting and stock market information of the banks is obtained from BankFocus Database by Bureau van Dijk and Datastream, respectively (all monetary data have been converted into euros). Real GDP growth and inflation rate are obtained from the World Economic Outlook Database of International Monetary Fund. After excluding banks with (a) missing, negative, or zero values for the cost function needed to calculate the Lerner index, (b) missing data to estimate distance-to-default, and (c) missing Z score values, we obtain a final sample that includes unbalanced panel data for 117 banks, with 860 bank/year observations.

In the estimation of the Lerner index (and efficiency-adjusted Lerner index), the sample used was different. As discussed previously, the translog cost function was estimated for each country to better address differences in technology. To increment the number of observations that allowed the estimation of Equation (5) by country, we extended our sample to all listed and nonlisted European banks for which we have consolidated data.

The statistics of the variables that are used in the main regression are reported in Table 1. Considering the results obtained for the financial stability measures, it is verified that banks included in our sample present average values of

3.837 and 3.515 for the distance-to-default and the Ln Z score indicators, respectively. These values are substantially higher than those obtained by Leroy and Lucotte (2017) which is explained by the fact that their sample period was characterized by the occurrence of subprime crises. The sample average value of distance-to-insolvency is slightly lower than the value of the distance-to-default. Regarding the measures of bank competition, we observed mean values of 0.140 for the conventional Lerner index and 0.236 for the efficiency-adjusted Lerner index, which indicates relatively low market power by the banks included in our sample.

Between 2011 and 2018, the financial stability of the banks included in our sample improved considerably, with the average value of distance-to-default increasing, during the entire period, about 209% from 1.56 to 3.26, while the average value of Z score registered a more modest growth (see Figure 1). Regarding the evolution of the bank's market power, the trend for the conventional Lerner index is ascending suggesting an increase in pricing power of the European banks of our sample.

Comparing bank financial stability by country, using distance-to-default, we concluded that on average, listed banks of our sample that operate in Greece, Ireland, and Portugal are the most fragile, whereas the Austrian and Swedish banks are the most stable (see Figure 2). If we considered Z score, the French and the Swedish banks are the most stable. Looking for bank's market power, comparisons lead to conclude that Greek, Irish, and Portuguese banks present the lowest Lerner indexes, whereas at the opposite extreme, with the highest pricing power, are the banks of Sweden, Belgium, and Norway. We also observe a positive relationship between the average values of the measures of financial stability and market power.

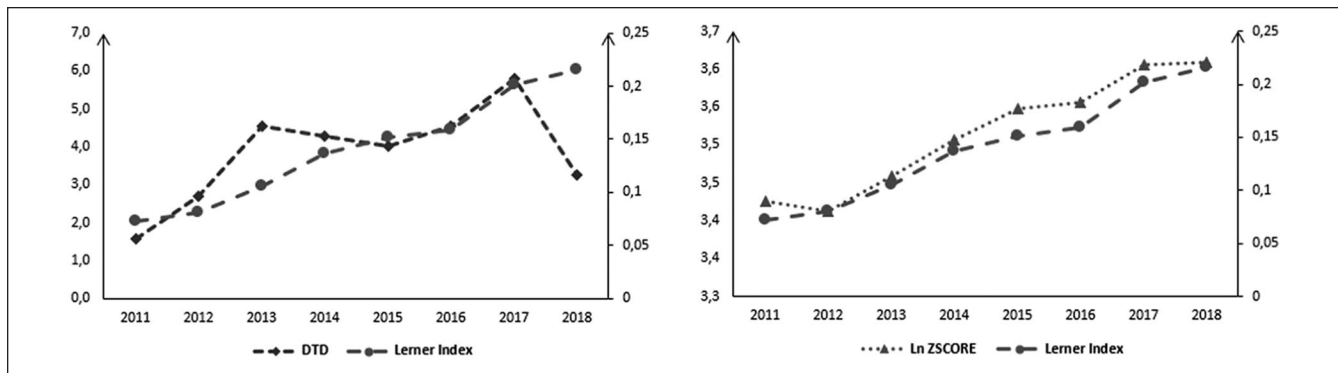


Figure 1. Distance-to-default, Ln Z score and Lerner index (average) 2011 to 2018.

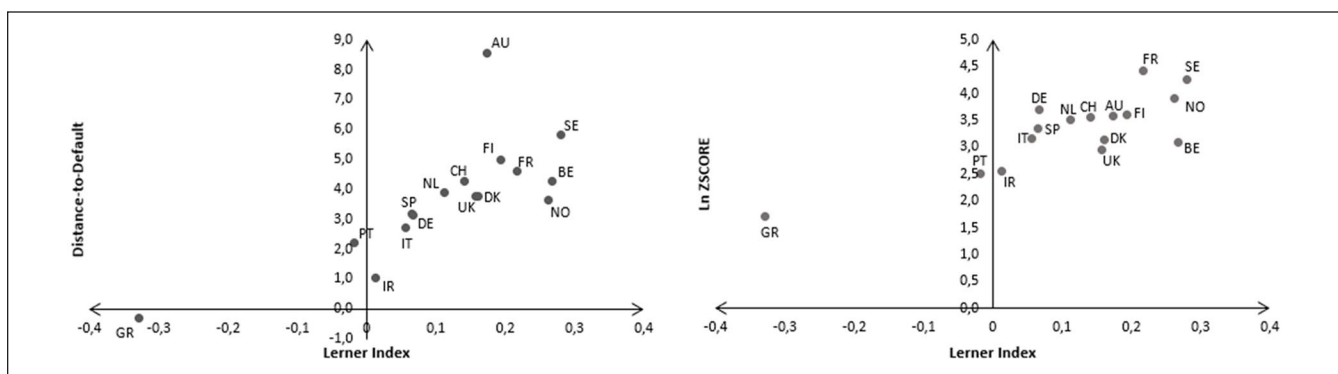


Figure 2. Distance-to-default and Ln Z score against Lerner index (average) by country.

## Empirical Results and Discussion

Columns (2) and (4) of Table 2 present the estimation results of Equation (8), by alternatively considering distance-to-default and Ln Z score as measures of financial stability. Results, for both the financial stability measures, do not support, for our sample, the U-shaped relationship between competition and risk (Hypothesis 2) of Martinez-Miera and Repullo (2010). Although the signs of coefficient estimates associated with the Lerner index and its square indicate the possibility of an inverse U-shaped relationship between the Lerner Index and the measures of financial stability, the U-shape test of Lind and Mehlum (2010) does not allow us to reject the null hypothesis of a monotone relationship in the model of Column (2) and indicate a turning point outside the sample range of the Lerner index for the model of Column (4).

Given these results, we reestimated Equation (8) excluding the quadratic term of the Lerner index (see Columns [1] and [3] of Table 2). For both market- and accounting-based stability measures, we find a positive and significant relationship with the Lerner index, which confirms the competition-fragility view (Hypothesis 1).

The obtained results allow us to conclude that an increase in the competition encourages individual bank risk-taking of

European listed banks, which confirms our Hypothesis 1 and the evidence found in the recent studies for European banking systems (Leroy & Lucotte, 2017).

Discussing now the impact of the other control variables on bank stability, we found a positive and statistically significant relationship between the Ln Z score and the levels of capitalization, size, noninterest income share, and asset composition (see Columns [3] and [4]). These results indicate that largest banks, best capitalized, with a higher loans-to-assets ratio, and with more diversification of their sources of income, are more financially stable. For the distance-to-default model (see Columns [1] and [2]), only noninterest income share and real GDP growth are significant at the 5% level of significance. We highlight the negative sign and the magnitude of the estimate of the coefficient associated with real GDP growth, indicating that the economic growth encourages banks to reduce financial restrictions to increase lending, generating more risk and consequently less stability.

To test Hypothesis 3, we divided our sample into two subsamples, one containing banks that are based in countries with less stable banking systems and the other with banks that belong to countries with more stable banking systems. For this purpose, using Z score data extracted from the World Bank's Global Financial Development Database, we calculated the average of that indicator, for each country, in the

**Table 2.** Bank Financial Stability and Competition (Whole Sample).

Dependent variable	Distance-to-default (DD)		Ln Z score	
	(1)	(2)	(3)	(4)
L1. Dependent variable	0.401*** (0.053)	0.417*** (0.056)	0.914*** (0.019)	0.908*** (0.018)
L2. Dependent variable	0.248*** (0.047)	0.274*** (0.043)		
Lerner index	3.036*** (0.927)	1.791* (0.976)	0.249*** (0.093)	0.146 (0.113)
Lerner index squared		-2.659** (1.246)		-0.010 (0.143)
Capitalization	6.087 (4.964)	2.966 (4.591)	0.750* (0.382)	0.720** (0.343)
Size	0.051 (0.051)	-0.012 (0.051)	0.015*** (0.005)	0.012* (0.006)
Noninterest income share	1.444** (0.630)	1.411** (0.626)	0.147* (0.080)	0.182** (0.083)
Share of wholesale funding	0.096 (0.441)	0.564 (0.472)	-0.013 (0.052)	0.027 (0.057)
Liquidity	0.663 (1.110)	0.415 (1.043)	0.067 (0.050)	0.127** (0.060)
Asset composition	1.448* (0.849)	0.894 (0.799)	0.186** (0.080)	0.194** (0.097)
Inefficiency	-0.000 (0.913)	-0.775 (0.897)	-0.109 (0.084)	-0.193* (0.105)
Real GDP growth	-29.388*** (8.814)	-24.878*** (9.118)	-0.409 (0.696)	-0.198 (0.749)
Inflation	13.489 (10.098)	13.241 (9.241)	0.752 (0.744)	0.603 (0.759)
Constant	-0.972 (1.381)	0.747 (1.439)	-0.019 (0.111)	0.049 (0.160)
U-shape test		0.300		Extremum
p value (U-shape test)		(.384)		outside
Turning point		0.337		interval
Number of observations	619	619	737	737
Number of banks	115	115	117	117
Number of instrumental variables	80	102	87	107
F test	58.71	55.84	1,512.00	1,349.86
p value (F test)	.000	.000	.000	.000
AR(2) test	1.195	1.045	1.427	1.199
p value (AR(2) test)	.232	.296	.154	.230
Hansen's J test	70.328	91.774	72.820	95.272
p value (Hansen's J test)	.219	.239	.353	.280

Note. The table reports the dynamic panel regression results. The two-step system GMM estimator (Arellano & Bover, 1995) is used with Windmeijer (2005) corrected standard errors. Some regressions include an additional lag of dependent variable as explanatory variable to remove second-order autocorrelation. Time dummies are included. The U-shape test is based on Lind and Mehlum (2010) and "Extremum outside interval" means that the extremum point (i.e., the turning point) is outside the interval; then, we cannot reject the null hypothesis of a monotone relationship. Arellano-Bond test for AR(2) is used to investigate the presence of serial correlation of order two. To analyze the validity of instruments, we used the Hansen's (1982) J test for overidentification. GDP = gross domestic product; GMM = generalized method of moments. \*, \*\*, and \*\*\* indicate statistical significance at 10%, 5%, and 1% levels, respectively.

period 2011 to 2017. Then, the countries were ranked in the ascending order of the Z score and split into two subsamples: the first group, of the countries with less stable banking systems, which includes banks from the eight countries with a lower average Z score (Italy, Portugal, Finland, the United

Kingdom, the Netherlands, Norway, Ireland, and Greece) and a second group, of countries with more stable banking systems, which includes banks from the eight countries with a higher average Z score (Austria, Germany, France, Spain, Denmark, Belgium, Switzerland, and Sweden).

**Table 3.** Bank Financial Stability and Competition: Less Versus More Stable Banking Systems.

Dependent variable	Distance-to-default (DD)		Ln Z score	
	(1)	(2)	(3)	(4)
<b>Less stable banking systems</b>				
Lerner index	5.700*** (2.031)	2.078 (1.446)	1.098*** (0.182)	0.486 (0.360)
Lerner index squared		-0.955 (1.620)		-0.994 (0.665)
Number of observations	364	364	305	305
Number of banks	58	58	57	57
U-shape test		Extremum		0.420
p value (U-shape test)		outside interval		(.338)
Turning point				0.244
<b>More stable banking systems</b>				
Lerner index	2.062 (4.245)	10.785* (5.449)	-0.456 (0.319)	-0.721* (0.405)
Lerner index squared		9.509 (6.239)		-0.279 (0.636)
Number of observations	314	314	373	373
Number of banks	58	58	59	59
U-shape test		0.730		Extremum
p value (U-shape test)		(.235)		outside interval
Turning point		-0.567		

Note. The table reports the dynamic panel regression results. The two-step system GMM estimator (Arellano & Bover, 1995) is used with Windmeijer (2005) corrected standard errors. Some regressions include an additional lag of dependent variable as explanatory variable to remove second-order autocorrelation. Time dummies are included. The U-shape test is based on Lind and Mehlum (2010) and "Extremum outside interval" means that the extremum point (i.e., the turning point) is outside the interval; then, we cannot reject the null hypothesis of a monotone relationship. Arellano-Bond test for AR(2) is used to investigate the presence of serial correlation of order two. To analyze the validity of instruments, we used the Hansen's (1982) *J* test for overidentification. GDP = gross domestic product; GMM = generalized method of moments. \*, \*\*, and \*\*\* indicate statistical significance at 10%, 5%, and 1% levels, respectively.

It is interesting to note that countries such as Finland, the United Kingdom, the Netherlands, and Norway, which traditionally have sustainable public finances, are part of the group of countries with less stable banking sectors, based on the Z score. On the contrary, countries like Spain and Belgium, which in the recent past had some problems with the sustainability of public finances, are part of the group of countries with more stable banking sectors. This finding allows us to conclude that the stability of a country's banking sector is not necessarily influenced by that country's public finances, reinforcing the hypothesis that the relationship between competition and risk-taking can be differentiated depending on whether the bank operates in a banking system more or less stable.

The estimation results of Equation (8), with and without the Lerner index quadratic term, for the two subsamples, are reported in Table 3 (the complete estimation results can be consulted in the Tables 3A and 3B of the Supplemental Appendix of this article). The results confirm a linear and positive relationship between market power and bank's financial stability, confirming the competition-fragility view (Hypothesis 1), in the countries with less stable banking systems. The same conclusion cannot be drawn for countries with more stable banking systems, where the relationship

between market power and financial stability is not statistically significant at a 5% level of significance. In both subsamples, there was no evidence of the U-shaped relationship between competition and risk.

## Robustness Tests

We test the robustness of our results in several ways. First, we considered an alternative measure of the Lerner index: the efficiency-adjusted Lerner index as outlined in Section "Methodology and Data". The estimation results, for the whole sample and subsamples of less and more stable banking systems, are reported in Tables 4A, 4B, and 4C of the Supplemental Appendix of this article, respectively. Second, we used distance-to-insolvency, described in Section "Methodology and Data," as a measure of a bank's financial stability in estimating Equation (8). The estimation results, for the whole sample and subsamples of less and more stable banking systems, are reported in Tables 5A, 5B, and 5C of the Supplemental Appendix of this article, respectively. Finally, we estimate a static version of Equation (8) using the fixed effects model and the random effects model. In these models, to consider the endogeneity issue, all explanatory variables are lagged one period. Estimation results for the

fixed effects model, for the whole sample and subsamples of less and more stable banking systems, are reported in Tables 6A, 6C, and 6E of the Supplemental Appendix of this article, respectively. For the random effects model, the results are reported, similarly, in Tables 6B, 6D, and 6F.

In general terms, the results obtained were the same, supporting the “competition-fragility” view for the whole sample and for the subsample of the banks that belong to countries with less stable banking systems. There is no evidence of the U-shaped relationship between competition and risk in the whole sample and in the two subsamples considered. For banks based in countries with more stable banking systems, market power does not appear to influence risk-taking.

## Conclusion

The beginning of the 21st century was marked by serious financial crises, such as the global financial crises and eurozone sovereign debt crises, which severely decreased the financial stability of banks worldwide. This forced the governments of several countries to adopt measures to rescue the banks, and thus, prevent the propagation of a systemic risk crisis. This set of public interventions has probably changed the relationship between competition and financial stability, which motivated this study. This work investigated the competition-stability nexus in the European banking systems using a sample of listed banks. We extend the existing literature by investigating if that nexus is differentiated depending on whether the bank operates in a more stable or less stable banking system as a whole.

We proxy competition with the Lerner index and focused on overall risk measures, such as distance-to-default, distance-to-insolvency, and Z score, for bank risk-taking. To deal with the persistence of bank risk-taking over time, we used a dynamic panel data model, which was estimated by a two-step GMM estimator to address the endogeneity problem between the bank competition measure and capitalization levels and the bank risk-takings measures. The results obtained do not confirm the U-shaped relationship between competition and bank risk-taking as predicted by Martínez-Miera and Repullo (2010). We find support for the competition-fragility view in European banking as a whole, indicating that additional market power decreases the individual risk-taking behavior of a bank. Perhaps because the competitive environment in European banking systems is already high, the “margin” effect dominates the risk-shifting effect. However, the competition-fragility view appears only to be valid in countries with less stable banking systems. In countries with more stable banking systems, the relationship between market power and financial stability did not prove to be statistically significant.

These results remained unchanged even when we considered the efficiency-adjusted Lerner index as a measure of competition and distance-to-insolvency as a measure of bank

risk-taking or when we estimated a static panel data model with fixed effects or random effects.

Our findings highlight several issues for policymakers and regulators. Public policies must guarantee banking competition, for welfare reasons, but limiting excessive bank risk-taking, especially in countries with less financially sound banking systems. This means that any attempt to increase competition in European banking should be accompanied by regulation that guarantees bank stability, for example, by increases in capital standards and limiting the risk exposure.

Consolidation of the European banking industry can lead to stronger and more resilient banks without compromising competition. However, this process of consolidation in Europe has a significant number of obstacles due to political, economic, regulatory, and cultural factors. Although the European Banking Union was created in 2014 to stimulate this integration, it remains unfinished and European banks—especially retail banks—still mostly operate on a national basis. Along with domestic mergers, European authorities and different national governments should promote cross-border mergers to deepen the integration and construction of a truly European banking sector. Cross-border banks would be able to offset losses in one country with income from other countries and would be better prepared to face the challenges posed by technological disruption.


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## Supplemental Material

Supplemental material for this article is available online.

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