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Yannick Lucotte

Address
Totoriu g. 4
LT-01121 Vilnius
Lithuania
Telephone +370 5 268 0107

Internet
http://www.lb.lt

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Is there a competition-stability trade-off in European banking?

Aurélien Leroy* Yannick Lucotte†

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Abstract

The trade-off between bank competition and financial stability has always been a widely and controversial issue, both among policymakers and academics. This paper empirically re-investigates the relationship between competition and bank risk across a sample of 54 European listed banks over the period 2004-2013. However, in contrast to most extant literature, we consider both individual and systemic dimension of risk. Bank-individual risk is measured by the Z-score and the distance-to-default, while we consider the SRISK as a proxy for bank systemic risk. Using the Lerner index as an inverse measure of competition and after controlling for a variety of bank-specific and macroeconomic factors, our results suggest that competition encourages bank risk-taking and then increases individual bank fragility. This result is in line with the traditional "competition-fragility" view. Our most important findings concern the relationship between competition and systemic risk. Indeed, contrary to our previous results, we find that competition enhances financial stability by decreasing systemic risk. This result can be explained by the fact that weak competition tends to increase the correlation in the risk-taking behavior of banks.

Keywords: Bank competition, Lerner Index, Financial stability, Bank-risk taking, Systemic risk, Competition policy
JEL Codes: G21, G28, G32, L51

*Laboratoire d'Economie d'Orléans (LEO), UMR CNRS 7322, Rue de Blois, BP 26739, 45062 Orléans Cedex 2, France. Corresponding author. E-mail: aurelien.leroy@univ-orleans.fr

†PSB Paris School of Business, Department of Economics, 59 rue Nationale, 75013 Paris, France. E-mail: ylucotte@esgms.fr / ylucotte@gmail.com

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1 Introduction

One of the main responses to the 2008 financial crisis has been to improve the prudential regulation via an increase of capital requirement as implemented in the Basel III agreements. However, prudential regulation can also take other forms and notably incorporates competition policy aspects. In practice, regulation can directly weaken competition through restrictions on bank entries, limitations on space and the scope of activities and high barriers with financial markets and non-bank institutions, and indirectly weaken them by creating incentives to merge due to ill-designed regulation scheme, for example. These types of regulation policies were abandoned prior to the financial crisis in favour of pro-competitive policies, justified by the fact that may lead to an improvement of efficiency and increased innovation. Conversely, the effects of competition on the risk-taking behaviour of financial institutions remain unclear and are a subject of active academic and policy debates.

In the traditional view, bank competition is seen as detrimental to financial stability. This view is supported by many theoretical contributions (Smith, 1984; Hellmann et al., 2000; Matutes and Vives, 2000) and based on the idea that competition erodes bank profits and thus the banks' franchise value. As a result, banks' incentives to take risk increase because the opportunity costs of bankruptcy for shareholders decrease. Other economic theories argue that this trade-off between competition and stability can be explained by higher ability to monitor borrowers when banks earn rents (Boot and Thakor, 1993; Allen and Gale, 2000), greater diversification (Beck, 2008) and better regulators' monitoring in concentrated markets. Keeley (1990) corroborates this idea of a destabilizing competition from an empirical point of view, noting that the intensification of competition in the U.S. banking industry has led to a decline in franchise value and increased risks. Other recent empirical studies also observe the existence of the same trade-off between competition and stability (Berger et al., 2009; Turk-Ariss, 2010; Jiménez et al., 2013; Fungáčová and Weill, 2013).

Contrary to the "competition-fragility" view, Boyd and De Nicolo (2005) demonstrate that market power increases bank portfolio risks. Following Stiglitz and Weiss (1981), as low competition increases loan rates, borrowers tend to shift to riskier projects. "Too Big To Fail" subsidies as a result of implicit or explicit government bailout insurances (Kane, 1989; Acharya et al., 2015) or lack of diversity of diversified bank portfolios (Wagner, 2010) are other arguments allowing the rejection of the competition stability trade-off hypothesis.[1] Recent empirical evidences support this thesis (Boyd et al., 2006; Schaeck et al., 2009; Uhde and Heimeshoff, 2009; Schaeck and Cihák, 2014; Pawłowska, 2015).

Finally, a third way reconciles the two strands of the literature by theoretically and empirically demonstrating the existence of a U-shaped relationship between competi-

[1] Political regulatory capture is another potential drawback of high market power banks.

tion and risk (Martinez-Miera and Repullo, 2010; Berger et al., 2009; Jiménez et al., 2013; Liu et al., 2013).

The conflicting results in the literature make difficult to know whether modification of competition policy and effective competition between financial intermediaries could constitute an alternative means of improving financial stability, complementary to capital requirement. This study re-addresses this traditional debate on the effects of bank competition on financial instability by taking into account the recent developments in the field of financial economics.

Indeed, the financial crisis has led to an overhaul in the risk approach (bottom-up vs. top-down) as well as risk measurements as the latter have been deficient because the regulation was only based on a micro-prudential foundation before the crisis. Therefore, it appeared necessary to complete this micro-prudential risk assessment, based on a partial equilibrium representation, by a macro-prudential assessment of these latter, taking into account a more general equilibrium (Borio, 2003; Aglietta and Scialom, 2010; Brunnermeier et al., 2009). The underlying aim is to no longer exclusively focus on the individual risk-taking of banks but also to consider banks' contribution to systemic risk. In other words, systemic risk externalities must be computed to eliminate systemic risk incentives via the regulation.[2] This study refers to the extensive literature recently developed to define such a Pigovian tax scheme and assess systemic risks.[3]

While most of the empirical literature using individual bank data has only focused on individual risk measures, ignoring the potential contribution to systemic risk, we contribute to the literature and assess the ambivalence of the effect of bank competition by considering both individual and systemic dimension of risk. To the best of our knowledge, only Anginer et al. (2014) have taken into account the systemic dimension of financial risks at the bank-level in the analysis of the effects of bank competition.[4] As for the regulations, concern for the systemic dimension of risk could help improve the efficiency of competition policy.

From an empirical perspective, this dual dimension of risk requires different risk measures. First, we proxy individual risk with two well-known and popular measures of risks: an accounting measure, the Z-score and a market-based measure, the distance-to-default derived from the Merton (1974) model. These measures are two inverse proxies of risk and represent overall measures of individual risk. These could be seen as the level of risk-taking, i.e., paid risk. Second, we proxy systemic risk by using

[2]In practice, for instance SIFI (Systemic Important Financial Institution) have to hold additional capital.

[3]For a very complete review, see Benoit et al. (2015).

[4]Note that our study differs from previous empirical papers that have investigated the competition-stability nexus at the country-level, by studying whether the level of the banking industry competition drives the level of risk or the probability that a systemic banking crisis occurs (see, Beck et al., 2006; Schaeck et al., 2009). Indeed, the analysis of systemic risk is made at the bank level and focuses on the individual contribution to systemic risk.

the recently developed SRISK measure (Brownlees and Engle, 2015; Acharya et al., 2012). Basically, the SRISK can be described as how much a given financial institution contributes to the deterioration of the soundness of the system as a whole. Even if SRISK computation requires market and accounting bank specific-data, it differs from the Z-score and the distance-to-default because the measure is mostly driven by correlations in returns between the bank and the financial system as a whole. The choice of a systemic risk measure can be a challenge because many different measures exist in the literature. However, the following four elements have led us to prefer the SRISK: (1) large acceptation, (2) large diffusion, (3) global measure of systemic risk, and (4) bank-specific risk measure.[5]

Similar to many previous studies (Berger et al., 2009; Turk-Ariss, 2010; Beck et al., 2013; Anginer et al., 2014), we use the Lerner index to measure banking competition. The Lerner index is a non-structural measure of competition that expresses banks' ability to drive their prices above their marginal costs. Compared to other measures, the indicator has the advantage of being dynamic and individual-based.

From a sample of exclusively European listed banks, our study highlights two main results. First competition leads to an increase of individual risk. This finding seems to corroborate the traditional "competition-fragility" view - bank stressed by competition take more risks. Second, we observe a positive effect of market power on systemic risk. Our results suggest that an increase in market power is associated with more systemic risk, i.e., in our case with an increase of the contribution of financial institutions to the deterioration of the system. These results are contrary to our first results and support the "competition-stability" view.

Highlighting a dual relationship between competition and stability must not be viewed as a discrepancy. Indeed, the two indicators do not share the same dimension. Thus, the indicators of individual risk refer to a partial equilibrium approach and describe the risks internalized by the bank, whereas the indicator of contribution to systemic risk corresponds to externalized risk. Economic theory and the franchise value paradigm in particular can explain these findings. Indeed, franchise value assumes that market power incites banks to take less risk. The first solution to reduce risk is to decrease individual risk-taking, which will result in a higher distance-to-default or Z-score, as our results demonstrate. However, a second solution to reduce its exposure to bankruptcy is to take correlated risks, and therefore increase its systemic risk contribution. This situation corresponds to the "too-many-to-fail" guarantee described by Acharya and Yorulmazer (2007). The Wagner's (2010) model can also explain our findings. Indeed, Wagner (2010) demonstrates that the willingness to reduce portfolio risks, that we explain by the franchise value paradigm, leads banks to diversify their portfolio by

[5] An other popular indicator of the exposure of a financial institution to systemic risk is the Marginal Expected Shortfall (MES). However, as shown by some recent studies (see, e.g., Idier et al., 2014), the MES is not a good predictor of capital shortfall during a systemic event.

holding the market portfolio. This action tends to reduce individual risk but increases systemic risk because the entire system has less diversity and more correlated institutions.[6]

Our results have implications for economic policy. As for prudential policy, competition policy should further consider a macroeconomic dimension when considering the impact of market power on risk-taking. This process is likely to lead to a complete change in the results and the implementation of competition policy. However, we do not support the adoption of one approach over another. Both approaches are complementary and can help refine competition policy implementation. Although the market power has a cost of increasing the systemic fragility, it also has a benefit in reducing the individual fragility. Thus, a sophisticated competition policy must arbitrate between these two types of fragility and take into account the influence of prudential regulations. Nevertheless, the important costs and the social aversion to the systemic crisis should guide competition policy toward an enhancing of competition.

The remainder of the study is structured as follows. Section 2 presents the methodology used to compute bank market power and both individual and systemic risks. In section 3, we present our empirical analysis, discussing the data used and estimation methodology. The results are reported and discussed in section 4, and we conduct a battery of robustness checks in section 5. Section 6 concludes.

2 Measuring bank competition and risks

This section presents in detail the measures of bank competition and bank risk considered in this study. As outlined in the introduction, we use the Lerner index as our main measure of banking competition, and we distinguish two levels of bank risk: the individual risk, proxied by Z-score and the distance-to-default, and the systemic risk, measured by the SRISK.

2.1 Competition Measure

Based on a non-structural approach, the Lerner index (Lerner, 1934) is used to measure the degree of bank competition. The Lerner index is a proxy for profits stemming from pricing power in the market and is measured by the mark-up of price over marginal cost. Therefore, it is an inverse proxy of bank competition. A low index indicates a high degree of competition, and a high index indicates a lack of competition. The Lerner index extends between 0 and 1, with the index being equal to 0 in the case of perfect competition, and 1 in the case of a pure monopoly. The Lerner index has two main benefits compared to the other competition indexes, such as the Boone indicator (Boone, 2008), the H-statistic (Panzar and Rosse, 1987), or the Herfindahl-Hirschman

[6]The main difference between our two explanations of systemic risk lies in the intentional or otherwise character of the contribution to systemic risk.

index. First, the Lerner index is the only time-varying measure of competition that can be computed at a disaggregated level, i.e. at the firm level. Second, the Lerner index appears to be a better proxy for gauging the level of competition among banks than structural measures, such as concentration indexes. A substantial empirical banking literature has suggested that concentration is not a reliable measure of competition (see, e.g., Claessens and Laeven, 2004; Lapteacru, 2014) which explains why several recent studies have used the Lerner index (Demirgüç-Kunt and Martínez Pería, 2010; Beck et al., 2013; Anginer et al., 2014). Formally, the Lerner index corresponds to the difference between price and marginal cost as a percentage of price, and it can be written as follows:

$$Lerner_{it} = \frac{p_{it} - mc_{it}}{p_{it}} \quad (1)$$

with p the price and mc the marginal cost for the bank i at the year t. In our case, p is the price of assets and is equal to the ratio of total revenue (the sum of interest and non-interest income) to total assets. To obtain the marginal cost, we adopt a conventional approach in the literature that consists of estimating a translog cost function and deriving it. Consistent with most banking studies, we consider a production technology with three inputs and one output (see, e.g., Angelini and Cetorelli, 2003; Fernandez de Guevara et al., 2005; Berger et al., 2009). We estimate the following translog cost function:

$$\begin{aligned} lnTC_{it} &= \beta_0 + \beta_1 lnTA_{it} + \frac{\beta_2}{2} lnTA_{it}^2 + \sum_{k=1}^{3} \gamma_k lnW_{k,it} + \sum_{k=1}^{3} \phi_k lnTA_{it} lnW_{k,it} \\ &+ \sum_{k=1}^{3}\sum_{j=1}^{3} \rho_k lnW_{k,it} lnW_{j,it} + \delta_1 T + \frac{\delta_2}{2} T^2 + \delta_3 T lnTA_{it} + \sum_{k=4}^{6} \delta_k T lnW_{k,it} + \varepsilon_{it} \quad (2) \end{aligned}$$

C_{it} corresponds to the total costs of the bank i at the year t, and is equal to the sum of interest expenses, commission and fee expenses, trading expenses, personnel expenses, admin expenses, and other operating expenses, measured in millions of Euros. TA_{it} is the quantity of output and is measured as total assets in millions of Euros. $W_{1,it}$, $W_{2,it}$ and $W_{3,it}$ are the prices of inputs. $W_{1,it}$ is the ratio of interest expenses to total assets. $W_{2,it}$ is the ratio of personnel expenses to total assets. $W_{3,it}$ is the ratio of administrative and other operating expenses to total assets. T is a trend. Furthermore, to reduce the influence of outliers, all variables are winsorized at the 1st and 99th percentile levels (see, e.g., Berger et al., 2009; Anginer et al., 2014). We further impose the following restrictions on regression coefficients to ensure homogeneity of degree one in input prices: $\sum_{k=1}^{3} \gamma_{k,t} = 1$, $\sum_{k=1}^{3} \phi_k = 0$ and $\sum_{k=1}^{3}\sum_{j=1}^{3} \rho_k = 0$.

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

$$mc_{it} = \frac{TC_{it}}{TA_{it}}[\beta_1 + \beta_2 TA_{it} + \sum_{k=1}^{3} \phi_k lnW_{k,it} + \delta_3 T] \quad (3)$$

The translog cost function is estimated on the whole sample of European banks using pooled ordinary least squares (OLS). We also include in the regression a trend (T) and country fixed effects to control for the differences in technology across time and space, respectively. Following Berger et al. (2009), we will also check the robustness of our results by estimating the cost function separately for each country in the sample.

2.2 Individual Risk Measures

Following Fu et al. (2014), we use two complementary individual bank risk measures: an accounting-based and a market-based risk measure. The accounting-based risk measure we consider in this study is the widely used Z-score. Because it measures the distance from insolvency, this index is generally viewed in the banking literature as a measure of bank soundness (see, e.g., Lepetit and Strobel, 2013; Laeven and Levine, 2009; Beck et al., 2013; Fu et al., 2014). The Z-score is calculated as follows:

$$Z_{it} = \frac{E_{it}/A_{it} + \mu_{ROA_{it}}}{\sigma_{ROA_{it}}} \quad (4)$$

where ROA_{it} is the return on assets, E_{it}/A_{it} is the equity to total assets ratio, and $\sigma_{ROA_{it}}$ is the standard deviation of return on assets.

The Z-score is inversely related to the probability of a bank's insolvency. A higher Z-score implies a lower probability of insolvency. Because a bank becomes insolvent when its asset value drops below its debt, the Z-score can be interpreted as the number of standard deviations that a bank's return must fall below its expected value to wipe out all equity in the bank and render it insolvent (Boyd and Runkle, 1993). This study opts for the approach used by Beck et al. (2013),[7] which consists of using a three-year rolling time window to compute the standard deviation of ROA rather than the full sample period, whereas the return on assets and the equity to total assets ratio are contemporaneous. As argued by Beck et al. (2013), this approach has two main advantages. First, it avoids the variation in Z-scores within banks that is exclusively driven over time by variation in the levels of capital and profitability. Second, given the unbalanced nature of our panel dataset, it avoids the computation of the denominator at different window lengths for different banks.

Concerning the market-based measure, we use the Merton (1974) distance-to-default model to estimate the insolvency risk of a bank. The distance-to-default is

[7] See Lepetit and Strobel (2013) for a review of different methodologies to compute the Z-score.

defined as the difference between the current market value of assets of a firm and its estimated default point, divided by the volatility of assets. The market equity value is modelled as a call option on the firm's assets. The level and the volatility of assets are calculated with the Merton (1974) model using the observed market value, volatility of equity, and the balance-sheet data on debt.

Formally, the distance-to-default is defined as follows:[8]

$$DD = \frac{ln(V_{A,it}/D_{it}) + (\mu - 1/2\sigma^2_{A,it})(T)}{\sigma_{A,it}\sqrt{T}} \tag{5}$$

where $V_{A,it}$ is the bank's assets value, D_{it} is the book value of the debt maturing at time T, μ is the expected return, and $\sigma_{A,it}$ is the standard deviation of assets (i.e., assets volatility). Thus, the distance-to-default increases when the value of assets increases and/or when the volatility of assets declines. An increase in the distance-to-default means that the company is moving away from the default point and that bankruptcy becomes less likely.

Conceptually, the Z-score and the distance-to-default are very close.[9] They represent the number of standard deviation moves, required to bring the bank to the default. These two insolvency indexes essentially differ in the data used for their construction. Whereas the Z-score is only based on accounting data, the distance-to-default also requires market data, and it can thus be viewed as a forward-looking measure of bank default risk, which reflects market perception of a bank's expected soundness in the future. Gropp et al. (2006) argue that the distance-to-default provides a better predictor of the probability of default than accounting-based indicators because the distance-to-default measure combines information about equity returns with leverage and asset volatility information, hence encompassing the most important determinant of default risk.

2.3 Systemic Risk Measures

In addition to individual bank risk measures, and contrary to most existing literature, this study also focuses on the systemic risk. The objective is to examine whether the competition influences the correlation in the risk-taking behaviour of banks. As our measure of bank systemic risk, we use the SRISK originally proposed by Acharya et al. (2012) and Brownlees and Engle (2015). The so-called SRISK, based on market data, corresponds to the expected capital shortfall of a given financial institution, conditional on a crisis affecting the whole financial system. From this perspective, the

[8] The derivation of distance-to-default is described in detail in (Gropp and Moerman, 2004; Gropp et al., 2009).

[9] Compared to the distance-to default, the Z-score is the most popular measure in the competition-stability literature. As shown by Havranek and Zigraiova (2015) in their meta-analysis, more than 45% of reported competition-stability estimates in the literature are calculated using the Z-score as a proxy for bank stability, while this only represents 6.5% for the distance-to-default.

contribution of each financial institution to the systemic risk is appreciated through its expected capital shortfall. The financial institutions with the largest capital shortfall are assumed to be the greatest contributors to the crisis, and the most systemically risky.

Formally, the SRISK is an extension of the marginal expected shortfall (MES) proposed by Acharya et al. (2010). The MES is the marginal contribution of a given financial institution to systemic risk, as measured by the expected shortfall of the market. Following Acharya et al. (2010), the expected shortfall of the market is the expected loss in the index conditional on this loss being greater than a given threshold C, and can be defined as:

$$ES_t = E_{t-1}(r_t \mid r_t < C) = \sum_{i=1}^{N} w_{it} E_{t-1}(r_{it} \mid r_t < C) \tag{6}$$

with N the number of firms, r_{it} the return of firm i at time t, and r_t the market return at time t. The market return is the value-weighted average off all firm returns, $r_t = \sum_{i=1}^{N} w_{it}(r_{it})$, where w_{it} denotes the relative market capitalization of the firm i at the period t.

Then, the MES of a financial firm can be defined as its short-run expected equity loss conditional on the market taking a loss greater than the threshold C, defined as its Value-at-Risk at $\alpha\%$. Formally, the MES corresponds to the partial derivative of the market expected shortfall (ES_t) with respect to the weight of the firm i in the market:

$$MES_{it} = \frac{\partial ES_t}{\partial w_{it}} = E_{t-1}(r_{it} \mid r_t < C) \tag{7}$$

The higher the MES, the higher the individual contribution of a bank is to the risk of the financial system.

However, contrary to the MES, the SRISK also takes into account both the liabilities and the size of the financial institutions. The SRISK is defined as:

$$SRISK_{it} = max[0; \overbrace{k(D_{it} + (1 - LRMES_{it})W_{it})}^{\text{Required Capital}} - \overbrace{(1 - LRMES_{it}W_{it}}^{\text{Available Capital}}] \tag{8}$$

$$SRISK_{it} = max[0; k - (1 - k)W_{it})(1 - LRMES_{it})] \tag{9}$$

where k is the minimum fraction of capital each financial institution needs to hold (i.e., the prudential capital ratio), D_{it} is the book value of total liabilities, and W_{it} is the market value of equity. $LRMES_{it}$ is the long-run marginal expected shortfall and aims to capture the interconnection of a firm with the rest of the system. It corresponds to the expected drop in equity value a firm would experiment if the market falls by more than a given threshold within the next six months. Acharya et al. (2012) propose to approximate the long-run marginal expected shortfall using the daily MES (defined for a threshold C equal to 2%) as $LRMES_{it} = 1 - exp(18 * MES_{it})$. Thus, this approximation represents the firm expected loss over a six-month horizon, obtained conditionally on the market falling by more than 40% within the next six months.[10] Thus, the SRISK is an increasing function of the bank's liabilities and a decreasing function of the market capitalization. Acharya et al. (2012) restrict SRISK to zero because they are interested in estimating capital shortages that by definition cannot take on negative values. Following Laeven et al. (2014), we do not restrict SRISK at zero, allowing it to assume negative values because they provide information on the relative contribution of the firm to systemic risk.

3 Data and methodology

In this section, we first describe the data used and offer some details concerning the composition of our sample. Then, we focus on the econometric strategy used to investigate the trade-off between bank competition and financial stability.

3.1 Data

To gauge the relationship between bank competition and risk, we consider an unbalanced panel data set that consists of 54 listed European banks and that covers the period from 2004 to 2013.[11] These banks are the largest banks in the European Union, and most are identified as systemically important financial institution (SIFI) by the Basel Committee. Table 1 provides more information about the banks included in our sample as well as their country of origin and the size of their balance sheets at the end of 2012 in millions of Euros. The total assets of the 54 banks at the end of 2012 were 22 trillion Euros, which represents approximately 60% of all European banking assets.

To compute the Lerner index and the Z-score, we need information on banks' balance sheets. We obtain such information from Bankscope, which is a database compiled by Bureau Van Dijk. As discussed in the previous section, the Lerner index is calculated by estimating a translog panel data cost function. To have a large number of observations and improve the asymptotic efficiency of the estimated parameters, we extended our sample to all listed and non-listed European banks for which we have consolidated data. Thus, our sample for estimating Eq. 2 is composed of 501 banks. Concerning the other measures of bank risk considered in our study, we use data from two different sources. The distance-to-default is obtained from the "Credit Research

[10] See Acharya et al. (2012) for more details.

[11] The choice of considering only the listed banks in our sample is driven by the fact that the distance-to-default and the SRISK measures are based on market data.

Table 1: Banks covered in the study

Bank	Country	Total assets	Bank	Country	Total assets
Deutsche Bank AG	DEU	2012329	Banco Popular Espanol SA	ESP	157618
BNP Paribas	FRA	1907290	Bank of Ireland	IRL	148146
Crédit Agricole S.A.	FRA	1842361	Raiffeisen Bank International AG	AUT	136116
Barclays Bank Plc	UK	1782921	Unione di Banche Italiane Scpa	ITA	132434
Banco Santander SA	ESP	1269628	Banco Popolare	ITA	131921
Société Générale	FRA	1250696	Allied Irish Banks Plc	IRL	122516
Lloyds TSB Bank Plc	UK	1127574	National Bank of Greece SA	GRC	104799
HSBC Bank plc	UK	975309	Banco Comercial Português	PRT	89744
UniCredit SpA	ITA	926828	Banco Espirito Santo SA	PRT	83691
ING Bank NV	NLD	836068	Mediobanca SpA	ITA	78679
Intesa Sanpaolo	ITA	673472	Piraeus Bank SA	GRC	70406
Bank of Scotland Plc	UK	671469	Eurobank Ergasias SA	GRC	67653
Banco Bilbao Vizcaya Argentaria SA	ESP	637785	Banca popolare dell'Emilia Romagna	ITA	61638
Commerzbank AG	DEU	635878	Alpha Bank AE	GRC	58357
Natixis	FRA	528370	Bankinter SA	ESP	58166
Standard Chartered Bank	UK	482090	Banca Popolare di Milano SCaRL	ITA	51931
Danske Bank A/S	DNK	466756	Banca Carige SpA	ITA	49326
Dexia	BEL	357210	Aareal Bank AG	DEU	45734
Skandinaviska Enskilda Banken AB	SWE	285875	Pohjola Bank Plc-Pohjola Pankki Oyj	FIN	44623
Svenska Handelsbanken	SWE	277776	Banco BPI SA	PRT	44565
Crédit Industriel et Commercial - CIC	FRA	235732	Permanent TSB Plc	IRL	40919
KBC Bank NV	BEL	224824	Jyske Bank A/S (Group)	DNK	34586
Banca Monte dei Paschi di Siena SpA	ITA	218882	Banca Popolare di Sondrio	ITA	32349
Swedbank AB	SWE	215195	Credito Emiliano SpA-CREDEM	ITA	30749
Erste Group Bank AG	AUT	213824	Credito Valtellinese Soc Coop	ITA	29896
Deutsche Postbank AG	DEU	193822	Sydbank A/S	DNK	20452
Banco de Sabadell SA	ESP	161547	Oberbank AG	AUT	17675

Source: Bankscope

Initiative" platform of the National University of Singapore.[12] The distance-to-default measure proposed by this source is based on the approach developed by Duan et al. (2012), known as a robust method in the evaluation of the probability of default of firms. Duan et al. (2012) have demonstrated that the Lehman Brothers default could have been predicted three to six months in advance. The SRISK is taken from the "Volatility Institute" (V-Lab) of NYU-Stern.[13] We consider the SRISK at the end of each period.

Finally, following Schaek and Cihak (2008), Schaeck et al. (2009), Laeven and Levine (2009), Berger et al. (2009), and Fu et al. (2014) among others, we also consider several bank-specific and macroeconomic control variables that can influence the level of bank risk. Concerning bank-specific factors, we consider five variables: the bank size measured by the logarithm of total assets, the ratio of non-interest income on total income, the ratio of fixed assets on total assets, the share of loans in total assets, and the liquidity ratio. Data for all these variables are taken from Bankscope. Concerning macroeconomic variables, we consider the annual gross domestic product (GDP) growth and the annual inflation. The GDP growth indicates the position of the economy in the business cycle, whereas inflation is an indicator of macroeconomic imbalances. These variables are taken from the World Bank's World Development

[12]http://www.rmicri.org/
[13]http://vlab.stern.nyu.edu/

Indicators (WDI).

3.2 Methodology

We use the following regression specification for our main analyses:

$$risk_{it} = \alpha + \beta_1 Lerner_{it-1} + \sum_{k=2}^{n} \beta_k X_{it-1} + \mu_i + \gamma_t + \varepsilon_{it} \tag{10}$$

where i and t are bank and time period indicators, respectively, $risk_{it}$ represents alternatively one of our measures of risk, $Lerner_{it}$ is the Lerner index, and X_{it-1} is the vector of control variables. The term μ_i is an individual specific effect, γ_t is an unobserved time effect included to capture common time-varying factors, and ε_{it} is the random error term. Throughout the study, we will be interested in the sign and significance of the estimated coefficient $\hat{\beta}_1$. This specification is similar in many ways to that considered by recent studies that have investigated the competition-stability trade-off (see, e.g., Berger et al., 2009; Anginer et al., 2014; Fu et al., 2014). Equation 10 is estimated using the fixed effects (FE) estimator, and using the random effects (RE) estimator when we include country-specific effects.

However, examining whether the market power influences the bank risk-taking raises the question of endogeneity bias. Indeed, as argued by Schaek and Cihak (2008), the level of risk-taking could affect the competitiveness of banks, and then our measure of market power. Banks could have incentives to "gamble for resurrection" when they face a high probability of default. Indeed, to access to new financial resources and attract new customers, banks could be more inclined to change the price of their products, thus affecting the existing power market. To address this potential endogeneity issue we further consider an instrumental variable approach using the two-stage least squares (2SLS) estimator. Following the precedents from previous studies, we consider three instrumental variables: the first lag of the Lerner index, the loan growth, and the net interest margin.

4 Results

In this section, we first present and discuss the empirical results concerning the relationship between bank competition and individual risk. Then, we turn to the results obtained by considering the SRISK as the dependent variable. Finally, in the last sub-section, we present several robustness checks.

4.1 Competition and bank individual risk

Tables 2 and 3 present the main results obtained by the estimation of equation 10 by alternatively considering our two measures of bank individual risk. Hence, table 2 reports the results with the Z-score as dependent variable, whereas table 3 refers to the results with the distance-to-default as the endogenous variable. In each table, specifications (1) to (3) present the coefficient estimates for the bank fixed effects regressions, with or without control variables and with or without year-fixed effects. Specification (4) presents the coefficient estimates when we include both year-fixed effects and country-fixed effects. Inclusion of country-fixed effects aims to capture differences in terms of the regulatory and institutional environment between European countries. Finally, specifications (5) and (6) present the results when we consider an instrumental variable approach.

For all specifications, we can observe a positive and significant relationship between the bank-level Lerner index and the Z-score and between the Lerner index and the distance-to-default. The Z-score and the distance-to-default are inverse proxies of bank-individual risk, which indicates that the banking market power decreases the individual risk. In other words, the lower the competition, the lower the bank risk-taking. Our results are consistent with previous empirical studies (see, e.g., Berger et al., 2009; Anginer et al., 2014; Fu et al., 2014; Kick and Prieto, 2015). According to the traditional "competition-fragility" view, our findings can be explained by the fact that more bank competition erodes market power, decreases profit margins, and results in reduced franchise value that encourages bank risk-taking.

We find more mixed results for the control variables. For all specifications, we find as expected that the ratio of fixed assets to total assets and the GDP growth negatively affects the bank risk exposure. We find the same result for the liquidity ratio when we consider the distance-to-default as the dependent variable, whereas we obtain the inverse result concerning the share of loans in total assets.

Table 2: Competition and bank individual risk: results obtained with the Z-score

Dependent variable	Z-score FE	Z-score FE	Z-score FE	Z-score RE	Z-score IV	Z-score IV
Lerner	3.981***	2.478***	3.122***	3.193***	8.687***	6.368***
	(0.938)	(0.915)	(0.822)	(0.766)	(1.931)	(1.643)
Size		-0.398	-0.243	-0.158**		-0.177
		(0.324)	(0.539)	(0.066)		(0.345)
Non-interest income / Total income		-0.823*	-0.244	-0.162		0.323
		(0.490)	(0.514)	(0.441)		(0.425)
Fixed assets / Total assets		55.396***	51.331***	44.819***		42.367***
		(13.882)	(13.586)	(8.969)		(16.012)
Liquidity		-0.000	0.004	0.002		0.002
		(0.006)	(0.006)	(0.003)		(0.004)
Loans / Total assets		-0.003	-0.004**	-0.004***		-0.005**
		(0.004)	(0.002)	(0.001)		(0.002)
GDP Growth		0.053*	0.227***	0.220***		0.225***
		(0.031)	(0.035)	(0.034)		(0.036)
Inflation		-0.161**	0.043	0.036		-0.007
		(0.064)	(0.066)	(0.066)		(0.084)
Constant	2.828***	7.824**	4.705	3.507***		
	(0.272)	(3.864)	(6.213)	(0.867)		
Year fixed effects	Yes	No	Yes	Yes	Yes	Yes
Country fixed effects	No	No	No	Yes	No	No
Observations	439	439	439	439	435	435
R-squared	0.22	0.2	0.35	0.42	0.18	0.35
Number of banks	54	54	54	54	54	54
Hansen test (p-value)	-	-	-	-	0.08	0.42

Note: This table shows the regression results with the Z-score as dependent variable. Robust standard errors are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used.
*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 3: Competition and bank individual risk: results obtained with the distance-to-default

Dependent variable	DD FE	DD FE	DD FE	DD RE	DD IV	DD IV
Lerner	3.657***	3.472***	3.736***	4.055***	8.632***	6.614***
	(1.179)	(1.033)	(0.882)	(0.782)	(2.100)	(1.941)
Size		-1.199***	-0.979**	-0.417***		-0.976***
		(0.306)	(0.399)	(0.130)		(0.332)
Non-interest income / Total income		-1.232***	-1.062***	-1.111***		-0.104
		(0.413)	(0.362)	(0.371)		(0.568)
Fixed assets / Total assets		28.703	27.987*	32.474**		15.176
		(17.428)	(15.462)	(15.280)		(15.806)
Liquidity		0.012**	0.016***	0.009***		0.011*
		(0.005)	(0.005)	(0.003)		(0.006)
Loans / Total assets		-0.002*	-0.002***	-0.003***		-0.002**
		(0.001)	(0.000)	(0.001)		(0.001)
GDP growth		0.093***	0.158***	0.157***		0.130***
		(0.027)	(0.035)	(0.039)		(0.031)
Inflation		-0.052	0.245***	0.241***		0.186**
		(0.046)	(0.053)	(0.054)		(0.075)
Constant	1.001*	14.581***	10.870**	5.051***		
	(0.501)	(3.678)	(4.510)	(1.823)		
Year fixed effects	Yes	No	Yes	Yes	Yes	Yes
Country fixed effects	No	No	No	Yes	No	No
Observations	500	500	500	500	446	446
R-squared	0.25	0.26	0.36	0.47	0.25	0.33
Number of banks	54	54	54	54	54	54
Hansen test (p-value)	-	-	-	-	0.06	0.85

Note: This table shows the regression results with the distance-to-default as dependent variable. Robust standard errors are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used.
*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

4.2 Competition and systemic risk

Now we turn to the results obtained by considering the SRISK as the dependent variable. As emphasized in the introduction, to the best of our knowledge, only the recent paper of Anginer et al. (2014) has previously investigated the link between competition and systemic risk at the bank level. However, unlike our study, Anginer et al. (2014) do not consider the SRISK as a measure of systemic risk, but use the $\Delta CoVar$ and a measure based on the correlation between the distance-to-default of each bank and the distance-to-default of the market. As above, specifications (1) to (3) present the coefficient estimates for the bank fixed effect regressions, with or without control variables and with or without year-fixed effects. Specification (4) presents the coefficient estimates when we include both year-fixed effects and country-fixed effects, whereas

specifications (5) and (6) reports the results when we consider the 2SLS estimator.
For all specifications, we find that the Lerner index has a positive and significant effect on the SRISK. This result is a priori contrary to our previous findings because it means that banking market power (i.e., low competition) increases financial instability. However, the fact that the systemic risk increases with the market power does not necessarily indicate that banks enjoying a higher degree of market power tend to display a riskier behaviour. It merely suggests that the market power increases the banks expected shortfall conditional to a stress in the system. Thus our results indicate that market power tends to increase the deterioration of the capitalization of the system as a whole during a crisis (Acharya et al., 2012; Brownlees and Engle, 2015), i.e., the health of the financial system, which is in line with the evidences of Anginer et al. (2014).

If we refer to the franchise value paradigm, which assumes that market power encourages banks to take less risks, two main arguments can be advanced to explain the positive relationship market power and SRISK. First, according to the "too-many-to-fail" theory (Acharya and Yorulmazer, 2007), the risk aversion of banks and their willingness to reduce their exposure to bankruptcy can lead them to take correlated risks, making the financial system more vulnerable to shocks. Second, as shown by Wagner (2010), the willingness of banks to reduce portfolio risks can lead them to diversify their portfolio by holding the market portfolio. This strategy undeniably increases the vulnerability of banks to financial stress, and then increases the systemic risk.

Finally, if we refer to the control variables, we find that larger banks, in particular, pose greater systemic risk, which is consistent with the results found by Anginer et al. (2014) and Laeven et al. (2014). This finding advocates the need to reduce "Too-Big-To-Fail" subsidies to improve stability (Farhi and Tirole, 2012; Stein, 2014). Moreover, contrary to Laeven et al. (2014), coefficient estimates in specifications (2) and (3) demonstrate that the relationship between the loans-to-assets ratio and the systemic risk is negative and statistically significant. This result indicates that banks that are more engaged in market-based activities contribute more to the systemic risk than traditional banks during a crisis. Indeed, they are more exposed to the boom-bust financial cycles and more interconnected through asset and short-term funding markets.

Table 4: Competition and bank systemic risk: results obtained with the SRISK

Dependent variable	SRISK FE	SRISK FE	SRISK FE	SRISK RE	SRISK IV	SRISK IV
Lerner	25.996**	29.445**	30.306**	30.431***	40.565***	61.837***
	(10.176)	(11.546)	(11.974)	(11.784)	(15.801)	(17.448)
Size		22.948***	17.916***	11.167***		22.864***
		(4.629)	(5.206)	(2.138)		(4.944)
Non-interest income / Total income		-9.490	-7.795	-8.188		-12.178**
		(5.704)	(5.379)	(5.659)		(5.925)
Fixed assets / Total assets		52.648	58.686	6.699		7.968
		(340.432)	(323.767)	(289.775)		(206.545)
Liquidity		0.062	0.102	0.136		0.094
		(0.099)	(0.115)	(0.090)		(0.086)
Loans / Total assets		-0.015**	-0.010*	-0.007		0.002
		(0.007)	(0.005)	(0.007)		(0.010)
GDP growth		-0.799**	0.310	0.246		0.375
		(0.351)	(0.439)	(0.442)		(0.309)
Inflation		2.268***	1.328*	1.414*		1.360*
		(0.740)	(0.785)	(0.795)		(0.772)
Constant	-8.937*	-272.405***	-218.419***	-143.154***		
	(4.589)	(56.198)	(61.177)	(26.039)		
Year fixed effects	Yes	No	Yes	Yes	Yes	Yes
Country fixed effects	No	No	No	Yes	No	No
Observations	500	500	500	500	446	446
R-squared	0.36	0.36	0.42	0.6	0.35	0.4
Number of banks	54	54	54	54	54	54
Hansen test (p-value)	-	-	-	-	0.44	0.82

Note: This table shows the regression results with the SRISK as dependent variable. Robust standard errors are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used.
*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

5 Robustness checks

We test the robustness of our results in three ways.

First, following Turk-Ariss (2010), we consider three alternative measures of the Lerner index. The first alternative measure is called adjusted-Lerner Index and considers profit and cost inefficiencies when computing the Lerner index. In our study, controlling for inefficiency is particularly important because it can affect the difference between price and marginal cost, and consequently, the value of the Lerner index. Indeed, banks with a high market power could adopt a "quiet life" and reduce their cost efficiency (Hicks, 1935; Berger and Hannan, 1998).[14] On the contrary, efficiency could

[14]Note nonetheless that empirical results obtained by Maudos and Fernandez de Guevara (2007) for a large sample of European banks do not confirm the so-called "quite life" hypothesis. On the contrary, they find a positive relationship between market power and the cost X-efficiency.

Table 5: Competition and bank risks: results obtained with efficiency-adjusted Lerner

Dependent variable	Z-score FE	Z-score IV	Distance-to-default FE	Distance-to-default IV	SRISK FE	SRISK IV
Lerner	1.192	3.273***	1.284*	2.343***	18.377***	54.048***
	(1.176)	(0.765)	(1.160)	(0.744)	(5.670)	(13.529)
Size	-0.433	-0.487	-1.063***	-1.251***	17.603***	19.288***
	(0.572)	(0.359)	(0.397)	(0.309)	(4.986)	(4.783)
Non-interest income / Total income	0.180	0.578	-0.362	-0.002	-4.609	-8.453
	(0.547)	(0.393)	(0.333)	(0.503)	(6.743)	(5.883)
Fixed assets / Total assets	55.399***	49.168***	34.242**	24.883*	96.983	35.931
	(12.564)	(13.998)	(15.417)	(13.846)	(298.711)	(188.460)
Liquidity	0.002	-0.002	0.012**	0.008	0.060	0.021
	(0.006)	(0.005)	(0.005)	(0.006)	(0.113)	(0.088)
Loans / Total assets	-0.004*	-0.005**	-0.001**	-0.001*	-0.006	0.011
	(0.002)	(0.002)	(0.001)	(0.001)	(0.005)	(0.011)
GDP growth	0.237***	0.196***	0.168***	0.108**	0.285	-0.597
	(0.035)	(0.042)	(0.038)	(0.044)	(0.434)	(0.446)
Inflation	0.039	-0.018	0.223***	0.186***	1.046	0.751
	(0.064)	(0.068)	(0.059)	(0.072)	(0.836)	(0.916)
Constant	7.236		12.288***		-211.001***	
	(6.577)		(4.526)		(58.375)	
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	438	435	499	445	499	445
R-squared	0.33	0.38	0.34	0.35	0.42	0.37
Number of banks	54	54	54	54	54	54

Note: Robust standard errors are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used.
*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

also lead to a market concentrated in the hands of the most efficient banks (Demsetz, 1973; Peltzman, 1977). As noted by Koetter et al. (2012), no adjustment for inefficiency could bias estimations of the Lerner index. Therefore, the authors propose a correction of the conventional Lerner index:

$$adjusted - Lerner_{it} = \frac{(\hat{\pi_{it}} + T\hat{C_{it}}) - \hat{mc_{it}}}{(\hat{\pi_{it}} + T\hat{C_{it}})} \tag{11}$$

where $\hat{\pi_{it}}$ is the estimated profit, $T\hat{C_{it}}$ the estimated total cost and $\hat{mc_{it}}$ the marginal cost.

To estimate this adjusted Lerner index, we follow Koetter et al. (2012) and first conduct a Stochastic Frontier Analysis (SFA) to estimate the translog cost function. We then obtain $T\hat{C_{it}}$ and $\hat{mc_{it}}$. Such an approach has the advantage of taking into account banks' cost inefficiency, defined as the distance of a bank from a cost frontier accepted as the benchmark.[15] Second, we specify an alternative profit function as in Berger and Mester (2003), that we estimate using SFA to obtain $\hat{\pi_{it}}$.

Another potential issue comes from the use of cost funding in the translog cost

[15]Formally, the SFA consists of decomposing the error term of the translog cost function into two components, such as $\varepsilon_{it} = v_{it} + \mu_{it}$. The random error term v_{it} is assumed iid with $v_{it} \sim N(0, \sigma_v^2)$ and independent of the explanatory variables. The inefficiency term μ_{it} is iid with $\mu_{it} \sim N(0, \sigma_\mu^2)$ and independent of the error term v_{it}. It is drawn from a non-negative distribution truncated at zero.

Table 6: Competition and bank risks: results obtained with funding-adjusted Lerner

Dependent variable	Z-score FE	Z-score IV	Distance-to-default FE	Distance-to-default IV	SRISK FE	SRISK IV
Lerner	2.572**	5.392***	3.296***	5.950***	21.929*	50.138***
	(0.982)	(1.457)	(0.939)	(1.878)	(11.280)	(16.667)
Size	-0.248	-0.294	-0.954**	-1.090***	17.115***	20.680***
	(0.544)	(0.345)	(0.413)	(0.321)	(5.112)	(4.951)
Non-interest income / Total income	-0.238	0.333	-1.134***	-0.089	-5.974	-8.088
	(0.561)	(0.413)	(0.391)	(0.531)	(5.529)	(6.165)
Fixed assets / Total assets	52.153***	42.859***	30.217*	18.377	83.826	51.400
	(13.273)	(15.916)	(15.683)	(15.162)	(318.587)	(198.693)
Liquidity	0.003	0.001	0.015***	0.010*	0.095	0.085
	(0.006)	(0.004)	(0.006)	(0.006)	(0.117)	(0.088)
Loans / Total assets	-0.004**	-0.005**	-0.002***	-0.002**	-0.008	0.001
	(0.002)	(0.002)	(0.000)	(0.001)	(0.005)	(0.009)
GDP growth	0.231***	0.227***	0.163***	0.130***	0.378	0.394
	(0.035)	(0.036)	(0.036)	(0.031)	(0.445)	(0.312)
Inflation	0.044	0.006	0.246***	0.199***	1.301	1.455*
	(0.066)	(0.083)	(0.054)	(0.075)	(0.799)	(0.786)
Constant	5.193		11.083**		-205.578***	
	(6.270)		(4.692)		(59.936)	
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	438	434	500	445	500	445
R-squared	0.33	0.34	0.35	0.33	0.41	0.39
Number of banks	54	54	54	54	54	54
Hansen test (p-value)	-	0.30	-	0.92	-	0.80

Note: Robust standard errors are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

function because it could partially reflect market power. Therefore, following Maudos and Fernandez de Guevara (2007), we opt for a two-input cost function wherein cost funding is excluded. Finally, following Berger et al. (2009) and Beck et al. (2013), the third alternative measure of the Lerner index consists of estimating the translog cost function separately for each country in the sample. As argued by Beck et al. (2013), such an approach allows us to take into account technology heterogeneity in the European banking industry more accurately than country fixed-effects. Results of estimates using these three alternative Lerner indexes are displayed in tables 5 to 7. Table 5 reports coefficient estimates when we consider the efficiency-adjusted Lerner index as the explanatory variable whereas results with the funding-adjusted Lerner index and the country-specific Lerner index are reported in tables 6 and 7, respectively. We report the results for each of our risk measures based on the fixed-effects and the 2SLS estimator. The relationship between the Lerner index and our two measures of individual bank risk, namely the Z-score and the distance-to-default, remains positive and statistically significant except for specification (1) in table 5. Concerning the SRISK, coefficient estimates in columns (5) and (6) of tables 5 to 7 demonstrate that the relationship between market power and bank systemic risk is robust to our different measures of the Lerner index. We still find a positive and significant relationship between these two variables.

The second means of testing the robustness of our empirical findings is to check whether

Table 7: Competition and bank risks: results obtained with country-specific Lerner

Dependent variable	Z-score FE	Z-score IV	Distance-to-default FE	Distance-to-default IV	SRISK FE	SRISK IV
Lerner	2.825***	5.925***	3.227***	6.051***	24.137**	51.275***
	(0.921)	(1.446)	(0.834)	(1.679)	(10.941)	(14.863)
Size	-0.253	-0.242	-0.957**	-1.036***	16.978***	21.121***
	(0.548)	(0.338)	(0.408)	(0.317)	(5.094)	(4.835)
Non-interest income / Total income	-0.125	0.552	-0.967**	0.114	-5.153	-6.161
	(0.534)	(0.425)	(0.370)	(0.539)	(5.349)	(6.084)
Fixed assets / Total assets	52.478***	42.852***	30.059*	16.037	70.306	18.556
	(13.431)	(15.831)	(15.750)	(15.651)	(322.171)	(203.744)
Liquidity	0.004	0.003	0.016***	0.011**	0.101	0.097
	(0.006)	(0.004)	(0.005)	(0.006)	(0.118)	(0.087)
Loans / Total assets	-0.004**	-0.005**	-0.002***	-0.002**	-0.008	0.002
	(0.002)	(0.002)	(0.000)	(0.001)	(0.005)	(0.010)
Gdp growth	0.225***	0.223***	0.158***	0.126***	0.318	0.357
	(0.036)	(0.036)	(0.035)	(0.031)	(0.454)	(0.311)
Inflation	0.053	0.030	0.255***	0.221***	1.388*	1.670**
	(0.064)	(0.080)	(0.054)	(0.074)	(0.796)	(0.779)
Constant	4.859		10.711**		-207.149***	
	(6.303)		(4.617)		(59.643)	
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	439	436	501	447	501	447
R-squared	0.34	0.34	0.35	0.33	0.41	0.40
Number of banks	54	54	54	54	54	54
Hansen test (p-value)	-	0.56	-	0.90	-	0.79

Note: Robust standard errors are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used.
*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

the non-Gaussian and skewed distribution of the SRISK drives our baseline results. To address this issue, we apply a zero-skewness log transformation to the SRISK series to obtain a normal distribution. Results displayed in table 8 confirm a positive and statistically significant relationship between the Lerner index and bank systemic risk.

Table 8: Competition and bank systemic risk: results obtained with the skew adjusted SRISK

Dependent variable	SRISK_skew	SRISK_skew	SRISK_skew	SRISK_skew	SRISK_skew	SRISK_skew
	FE	FE	FE	RE	IV	IV
Lerner	0.372**	0.477**	0.483**	0.458**	0.334*	0.755***
	(0.177)	(0.218)	(0.223)	(0.213)	(0.198)	(0.225)
Size		0.268***	0.221***	0.117***		0.274***
		(0.048)	(0.061)	(0.021)		(0.058)
Non-interest income / Total income		-0.107	-0.079	-0.073		-0.144**
		(0.089)	(0.080)	(0.083)		(0.071)
Fixed assets / Total assets		-3.492	-3.524	-3.517		-4.000
		(7.109)	(6.933)	(6.279)		(3.866)
Liquidity		0.002	0.003	0.003		0.003**
		(0.002)	(0.002)	(0.002)		(0.001)
Loans / Total assets		-0.000**	-0.000**	-0.000		0.000
		(0.000)	(0.000)	(0.000)		(0.000)
GDP growth		-0.013**	0.000	-0.001		0.002
		(0.005)	(0.004)	(0.004)		(0.004)
Inflation		0.026***	0.021	0.023*		0.021**
		(0.009)	(0.013)	(0.014)		(0.010)
Constant	4.038***	0.949	1.439*	2.632***		
	(0.072)	(0.600)	(0.725)	(0.243)		
Year fixed effects	Yes	No	Yes	Yes	Yes	Yes
Country fixed effects	No	No	No	Yes	No	No
Observations	500	500	500	500	446	446
R-squared	0.34	0.38	0.43	0.54	0.35	0.42
Number of banks	54	54	54	54	54	54
Hansen test (p-value)	-	-	-	-	0.14	0.17

Note: Robust standard errors are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used.
*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Finally, we replace the bank-specific Lerner index with a country-specific Lerner index. The national competitive environment could have a different effect on stability than individual market-power. Banks may be sensitive to both their own condition -estimated by an individual measure of market power- and to the overall condition of their market. This control is important because the banking industry is a network industry. This robustness check also allows us to report estimation results consistent with Schaeck and Cihák (2014), whose study links individual bank risk measures (Z-score) and country-specific competition measures. Our results, reported in Table 9, confirm the substance of earlier estimations.[16] Competition at the country-level has a divergent effect according to the dimension of risk considered.[17]

[16]We obtain these country-level measures by taking (1) the median of individual Lerner indexes, and (2) the weighted mean of the individual Lerner, with market shares as the weights.

[17]In a similar vein, we also tested the effects of concentration measures such as Herfindahl index. However, we do not obtain conclusive results which can be explained by the limitations of such indexes to measure competition as shown in the literature.

Table 9: Competition and risk: results obtained with country-level measure of competition

Dependent variable	Z-score	Distance-to-default	SRISK	Z-score	Distance-to-default	SRISK
	FE	FE	FE	FE	FE	FE
Lerner median	3.001*	3.961**	58.340***			
	(1.722)	(1.494)	(21.609)			
Lerner mean				3.276**	3.004	43.788***
				(1.436)	(2.106)	(12.544)
Size	-0.294	-0.992**	15.380***	-0.350	-0.933**	16.266***
	(0.535)	(0.424)	(4.946)	(0.541)	(0.462)	(5.005)
Non-interest income / Total income	-0.159	-0.830**	-6.119	-0.181	-0.724*	-4.533
	(0.547)	(0.369)	(5.047)	(0.550)	(0.404)	(5.618)
Fixed assets / Total assets	58.713***	40.364**	156.314	53.920***	36.955**	106.676
	(12.662)	(16.547)	(293.666)	(13.118)	(16.963)	(305.913)
Liquidity	0.002	0.012*	0.067	0.002	0.011*	0.061
	(0.006)	(0.006)	(0.106)	(0.006)	(0.006)	(0.108)
Loans / Total assets	-0.003	-0.002***	-0.008	-0.003	-0.001***	-0.006
	(0.002)	(0.001)	(0.007)	(0.002)	(0.000)	(0.006)
GDP growth	0.208***	0.153***	0.061	0.216***	0.168***	0.276
	(0.042)	(0.036)	(0.530)	(0.037)	(0.031)	(0.456)
Inflation	0.016	0.232***	1.196*	0.030	0.240***	1.318
	(0.070)	(0.055)	(0.713)	(0.066)	(0.055)	(0.808)
Constant	5.367	10.976**	-194.935***	5.974	10.474**	-202.482***
	(6.195)	(4.740)	(57.926)	(6.223)	(5.044)	(58.956)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	443	505	505	443	505	505
R-squared	0.31	0.33	0.42	0.32	0.33	0.42
Number of banks	54	54	54	54	54	54

Note: Robust standard errors are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used.
*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

6 Conclusion

This study aims to reconcile the conflicting empirical evidence regarding the relationship between banking competition and financial (in)stability. To this end, we have contributed to the existing literature by considering not only individual bank risk measures but also a measure of bank systemic risk with the SRISK. Similar to Anginer et al. (2014), our objective in this study is to examine whether the banking competition and the degree of market power also affect the bank's contribution to the deterioration of the soundness of the system as a whole. Results that we obtain from a large sample of European listed banks by using the Lerner index as an index of market power indicate that (1) bank market power decreases the individual risk-taking behaviour of bank because in European banking, greater market power is associated with lower Z-score and distance-to-default and (2) bank market power increases the bank's systemic risk contribution as seen in the positive and significant relationship between the Lerner index and the SRISK.

We argue that highlighting a dual relationship between the Lerner index and our two types of risk is not inconsistent. On the contrary, this result confirms that individual bank risk and systemic bank risk have two different dimensions and can mainly be explained by the franchise value paradigm. That can appear puzzling because this paradigm traditionally supports the "competition-fragility" view and not a dual relationship. However, we develop the idea that the willingness to reduce risk exposition when franchise value is high, as a result of bank market power, can take two forms: (1) a decrease of individual risk, as traditionally argued by the defenders of the "competition-fragility" view and (2) an increase of systemic risk contribution via an increase of correlation in risk. This can be a strategic choice in order to benefit from the "too-many-to-fail" guarantee (Acharya and Yorulmazer, 2007).This can also simply be the result of reduction in portfolio risks by complete diversification, which induces less diversity in the system and more correlated institutions (Wagner, 2010).

Our findings have important policy repercussions. First, the fact that competition has a divergent effect on individual and systemic risk implies that financial regulation and competition policy should complete both a micro-prudential and a macro-prudential exam when analysing the repercusions of bank competition. Second, and on a more practical level, our results suggest that pro-competitive policy should be undertaken in the European banking system to maintain macro-financial stability. In our view concerns about the potential negative effect of this type of policy on individual risk-taking behaviour should not arise because the Basel III regulatory framework well corrects incentives for individual risk-taking.

Appendix

Table A1: Variable definitions

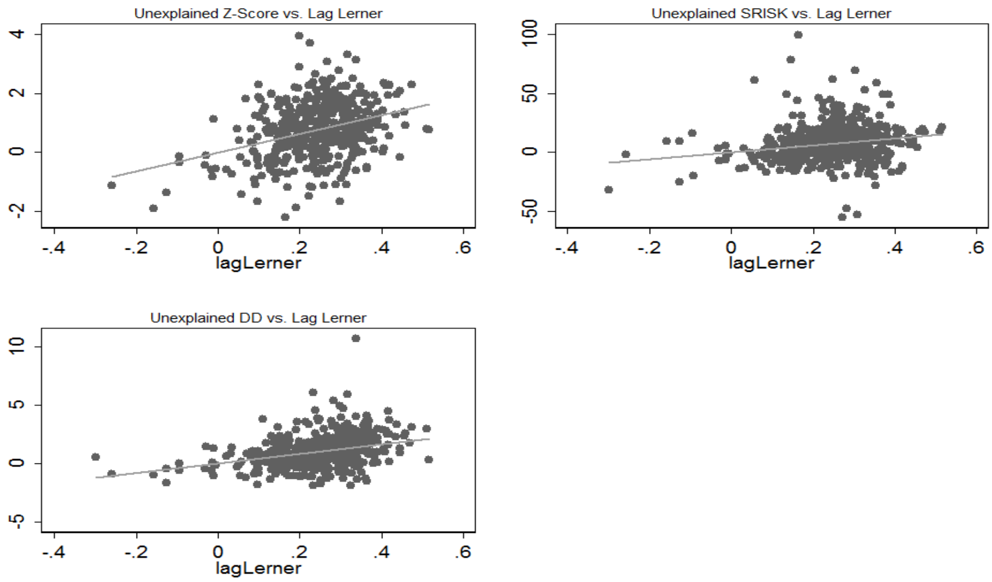
Variable	Definition
Dependent variables	
Z-score	An accounting bank-level measure of individual bank risk. A larger value indicates a higher bank stability and less bank risk-taking. Source: Authors' calculations, BankScope
Distance-to-defaut	A market-based bank-level measure of individual bank risk. A larger value indicates a higher bank stability and less bank risk-taking. Source: Credit Research Initiative of the National University of Singapore
SRISK	A market-based bank-level measure of contribution to systemic risk. A larger value indicates that the bank contribution to the deterioration of the soundness of the system as a whole increases. Source: "Volatility Institute" (V-Lab) of NYU-Stern
Explanatory variables	
Lerner index	A bank-level of bank market power. A higher value indicates more market power and less bank competition. Source: Authors' calculations, Bankscope
Efficiency-adjusted Lerner index	A bank-level of bank market power following the methodology proposed by Koetter et al. (2012). A higher value indicates more market power and less bank competition. Source: Authors' calculations, Bankscope
Funding-adjusted Lerner index	A bank-level of bank market power following the methodology proposed by Maudos and Fernandez de Guevara (2007). A higher value indicates more market power and less bank competition. Source: Authors' calculations, Bankscope
Bank size	The log value of Total Assets. Source: BankScope
Non-interest income / Total income	A bank-level measure of business diversification. Source: Bankscope
Fixed assets / Total assets	A bank-level measure of asset composition. Source: Bankscope
Liquidity	A bank-level liquidity indicator, which corresponds to the ratio of liquid assets over deposits and short term funding. A higher value indicates less liquidity risk. Source: Bankscope
Loans / Total assets	A bank-level measure of asset composition. Source: Bankscope
GDP growth	Annual percentage growth rate of GDP at market prices. Source: WDI, World Bank
Inflation	Annual percentage change of consumer prices index. Source: WDI, World Bank

Table A2: Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Conventional Lerner	0.24	0.10	-0.30	0.52
Efficiency-adjusted Lerner	0.26	0.13	-0.06	0.65
Funding-adjusted Lerner	0.14	0.11	-0.49	0.44
Country-specific Lerner	0.23	0.11	-0.37	0.51
Z-score	3.46	1.20	-0.96	7.65
Distance-to-default	1.18	1.70	-2.84	11.93
SRISK	10.78	23.79	-52.44	124.76
Size	11.97	1.32	9.26	14.61
Non-interest income / Total income	0.38	0.18	-1.40	1.00
Fixed assets / Total assets	0.01	0.01	0.00	0.06
Liquidity	39.24	27.48	5.24	170.78
Loans / Total assets	59.53	40.74	9.57	669.99

Source: Bankscope, Credit Research Initiative, Volatility Institute and authors' calculations

Figure A1: Scatter plots between Lerner index and Risk measures



Note: These figures plot the one-lagged Lerner index with the unexplained part of the Z-score, the distance-to-default, and the SRISK.

Bibliography

Acharya, V., Engle, R., and Richardson, M. (2012). Capital shortfall: A new approach to ranking and regulating systemic risks. *The American Economic Review*, 102(3):59–64.

Acharya, V. V., Anginer, D., and Warburton, A. J. (2015). The end of market discipline? Investor expectations of implicit state guarantees. *Mimeo*.

Acharya, V. V., Pedersen, L. H., Philippon, T., and Richardson, M. (2010). Measuring systemic risk. *Federal Reserve Bank of Cleveland WP 10-02*.

Acharya, V. V. and Yorulmazer, T. (2007). Too many to fail - An analysis of time-inconsistency in bank closure policies. *Journal of Financial Intermediation*, 16(1):1–31.

Aglietta, M. and Scialom, L. (2010). A systemic approach to financial regulation: An European perspective. *International Economics*, 123:31–65.

Allen, F. and Gale, D. (2000). *Comparing financial systems*. MIT press.

Angelini, P. and Cetorelli, N. (2003). The effects of regulatory reform on competition in the banking industry. *Journal of Money, Credit and Banking*, 35(5):663–684.

Anginer, D., Demirguc-Kunt, A., and Zhu, M. (2014). How does competition affect bank systemic risk? *Journal of Financial Intermediation*, 23(1):1–26.

Beck, T. (2008). Bank competition and financial stability: Friends or foes? *World Bank Policy Research Working Paper Series 4656*.

Beck, T., De Jonghe, O., and Schepens, G. (2013). Bank competition and stability: Cross-country heterogeneity. *Journal of Financial Intermediation*, 22(2):218–244.

Beck, T., Demirgüç-Kunt, A., and Levine, R. (2006). Bank concentration, competition, and crises: First results. *Journal of Banking & Finance*, 30(5):1581–1603.

Benoit, S., Colliard, J.-E., Hurlin, C., and Pérignon, C. (2015). Where the risks lie: A survey on systemic risk. *HEC Paris Research Paper*, FIN-2015-1088.

Berger, A. N. and Hannan, T. H. (1998). The efficiency cost of market power in the banking industry: A test of the "quiet life" and related hypotheses. *Review of Economics and Statistics*, 80(3):454–465.

Berger, A. N., Klapper, L. F., and Turk-Ariss, R. (2009). Bank competition and financial stability. *Journal of Financial Services Research*, 35(2):99–118.

Berger, A. N. and Mester, L. J. (2003). Explaining the dramatic changes in performance of US banks: Technological change, deregulation, and dynamic changes in competition. *Journal of Financial Intermediation*, 12(1):57–95.

Boone, J. (2008). A new way to measure competition. *The Economic Journal*, 118(531):1245–1261.

Boot, A. W. and Thakor, A. V. (1993). Self-interested bank regulation. *The American Economic Review*, 83(2):206–212.

Borio, C. (2003). Towards a macroprudential framework for financial supervision and regulation? *CESifo Economic Studies*, 49(2):181–215.

Boyd, J. H. and De Nicolo, G. (2005). The theory of bank risk taking and competition revisited. *The Journal of Finance*, 60(3):1329–1343.

Boyd, J. H., De Nicolò, G., and Jalal, A. M. (2006). Bank risk-taking and competition revisited: New theory and new evidence. *International Monetary Fund WP/06/297*.

Boyd, J. H. and Runkle, D. E. (1993). Size and performance of banking firms: Testing the predictions of theory. *Journal of Monetary Economics*, 31(1):47–67.

Brownlees, T. and Engle, R. F. (2015). SRISK: A conditional capital shortfall index for systemic risk measurement. *Mimeo*.

Brunnermeier, M. K., Crockett, A., Goodhart, C. A., Persaud, A., and Shin, H. S. (2009). The fundamental principles of financial regulation. Geneva Reports on the World Economy 11.

Claessens, S. and Laeven, L. (2004). What drives bank competition? Some international evidence. *Journal of Money, Credit and Banking*, 36(3):563–583.

Demirgüç-Kunt, A. and Martínez Pería, M. S. (2010). A framework for analyzing competition in the banking sector: An application to the case of Jordan. *World Bank Policy Research Working Paper Series 5499*.

Demsetz, H. (1973). Industry structure, market rivalry, and public policy. *Journal of Law and Economics*, 16(1):1–9.

Duan, J.-C., Sun, J., and Wang, T. (2012). Multiperiod corporate default prediction—a forward intensity approach. *Journal of Econometrics*, 170(1):191–209.

Farhi, E. and Tirole, J. (2012). Collective moral hazard, maturity mismatch, and systemic bailouts. *The American Economic Review*, 102(1):60–93.

Fernandez de Guevara, J., Maudos, J., and Perez, F. (2005). Market power in European banking sectors. *Journal of Financial Services Research*, 27(2):109–137.

Fu, X. M., Lin, Y. R., and Molyneux, P. (2014). Bank competition and financial stability in Asia pacific. *Journal of Banking & Finance*, 38:64–77.

Fungáčová, Z. and Weill, L. (2013). How market power influences bank failures: Evidence from Russia. *Economics of Transition*, 21(2):301–322.

Gropp, R. and Moerman, G. (2004). Measurement of contagion in banks' equity prices. *Journal of International Money and Finance*, 23(3):405–459.

Gropp, R., Vesala, J. M., and Vulpes, G. (2006). Equity and bond market signals as leading indicators of bank fragility. *Journal of Money, Credit and Banking*, 38(2):399–428.

Gropp, R. E., Duca, M. L., and Vesala, J. (2009). Cross-border bank contagion in Europe. *International Journal of Central Banking*, 5(1):97–139.

Havranek, T. and Zigraiova, D. (2015). Bank competition and financial stability: Much ado about nothing?

Hellmann, T. F., Murdock, K. C., and Stiglitz, J. E. (2000). Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough? *American Economic Review*, 90(1):147–165.

Hicks, J. R. (1935). Annual survey of economic theory: The theory of monopoly. *Econometrica*, 3(1):1–20.

Idier, J., Lamé, G., and Mésonnier, J.-S. (2014). How useful is the marginal expected shortfall for the measurement of systemic exposure? a practical assessment. *Journal of Banking & Finance*, 47:134–146.

Jiménez, G., Lopez, J. A., and Saurina, J. (2013). How does competition affect bank risk-taking? *Journal of Financial Stability*, 9(2):185–195.

Kane, E. J. (1989). *The S & L insurance mess: How did it happen?* The Urban Insitute.

Keeley, M. C. (1990). Deposit insurance, risk, and market power in banking. *The American Economic Review*, 80(5):1183–1200.

Kick, T. and Prieto, E. (2015). Bank risk and competition: Evidence from regional banking markets. *Review of Finance*, 19(3):1185–1222.

Koetter, M., Kolari, J. W., and Spierdijk, L. (2012). Enjoying the quiet life under deregulation? Evidence from adjusted lerner indices for US banks. *Review of Economics and Statistics*, 94(2):462–480.

Laeven, L. and Levine, R. (2009). Bank governance, regulation and risk taking. *Journal of Financial Economics*, 93(2):259–275.

Laeven, M. L., Ratnovski, L., and Tong, H. (2014). Bank size and systemic risk. *International Monetary Fund Staff Discussion Note 14/04*.

Lapteacru, I. (2014). Do more competitive banks have less market power? The evidence from Central and Eastern Europe. *Journal of International Money and Finance*, 46:41–60.

Lepetit, L. and Strobel, F. (2013). Bank insolvency risk and time-varying z-score measures. *Journal of International Financial Markets, Institutions and Money*, 25:73–87.

Lerner, A. P. (1934). The concept of monopoly and the measurement of monopoly power. *The Review of Economic Studies*, 1(3):157–175.

Liu, H., Molyneux, P., and Wilson, J. O. (2013). Competition and stability in European banking: A regional analysis. *The Manchester School*, 81(2):176–201.

Martinez-Miera, D. and Repullo, R. (2010). Does competition reduce the risk of bank failure? *Review of Financial Studies*, 23(10):3638–3664.

Matutes, C. and Vives, X. (2000). Imperfect competition, risk taking, and regulation in banking. *European Economic Review*, 44(1):1–34.

Maudos, J. and Fernandez de Guevara, J. (2007). The cost of market power in banking: Social welfare loss vs. cost inefficiency. *Journal of Banking & Finance*, 31(7):2103–2125.

Merton, R. C. (1974). On the pricing of corporate debt: The risk structure of interest rates. *The Journal of Finance*, 29(2):449–470.

Panzar, J. C. and Rosse, J. N. (1987). Testing for" monopoly" equilibrium. *The Journal of Industrial Economics*, 35(4):443–456.

Pawłowska, M. (2015). Changes in the size and structure of the European Union banking sector - the role of competition between banks. *National Bank of Poland WP 205*.

Peltzman, S. (1977). The gains and losses from industrial concentration. *Journal of Law and Economics*, 20(2):229–263.

Schaeck, K. and Cihák, M. (2014). Competition, efficiency, and stability in banking. *Financial Management*, 43(1):215–241.

Schaeck, K., Cihak, M., and Wolfe, S. (2009). Are competitive banking systems more stable? *Journal of Money, Credit and Banking*, 41(4):711–734.

Schaek, K. and Cihak, M. (2008). How does competition affect efficiency and soundness in banking? New empirical evidence. *European Central Bank WP 932*.

Smith, B. D. (1984). Private information, deposit interest rates, and the stability of the banking system. *Journal of Monetary Economics*, 14(3):293–317.

Stein, J. C. (2014). Regulating large financial institutions. What have we learned? Macroeconomic policy after the crisis, Vol. 1, chapter 10:135–142.

Stiglitz, J. E. and Weiss, A. (1981). Credit rationing in markets with imperfect information. *The American Economic Review*, 71(3):393–410.

Turk-Ariss, R. (2010). On the implications of market power in banking: Evidence from developing countries. *Journal of Banking & Finance*, 34(4):765–775.

Uhde, A. and Heimeshoff, U. (2009). Consolidation in banking and financial stability in Europe: Empirical evidence. *Journal of Banking & Finance*, 33(7):1299–1311.

Wagner, W. (2010). Diversification at financial institutions and systemic crises. *Journal of Financial Intermediation*, 19(3):373–386.