

Bank competition and risk-taking for loans and securities at the European Union level

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Abstract

The present study re-assesses the competition-risk link based on a sample of 3,680 commercial, cooperative and savings banks from EU28 countries during 2005-2015. We determine the bank-level competition for loans and securities using Lerner index, its efficiency-adjusted form and Boone indicator. Marginal costs (MC) are estimated with a translog cost function with two bank products (i.e. loans and securities) and three input prices (i.e. labour, borrowed funds and physical capital). We use OLS regression to estimate MC for Lerner index and DFA for its efficiency-improved form. The risk measures offer a complete perspective since they are accounting- (Z-score) and market-based (Distance to Default). We control for bank (i.e. size, growth of total loans, securities and total assets, share of total loans, customer deposits and securities in total assets, profitability and capital), country (i.e. inflation rate and GDP growth rate) and banking specific factors (i.e. entry and capital requirements, innovation degree, financial development, market power). Overall, the results confirm the U-inverted relationship, between competition and risk for loans and securities.

JEL codes: G21, G28, D4, P34.

Keywords: banking competition, risk management, financial policy, Distance to default

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1. Introduction

Last years have brought significant changes in the European banking sector. The drop-in profitability level has made financial institutions adjust their strategic directions by involving in consolidation processes and clean their balance of the significant amounts of non-performing loans. The current paper investigates the nexus between competition and risk in the European banking sector during 2005-2015.

In the extant literature, there are two main theories on the relationship between banking competition and risk: competition-fragility and competition-stability. Therefore, the available studies belong to three major categories: those that prove the presence of the competition-fragility relationship, those that confirm the competition-stability paradigm, and those that validate both perspectives.

Marcus (1984), Chan, Greenbaum and Thakor (1986), Keeley (1990), Hellmann, Murdock and Stiglitz (2000), Matutes and Vives (2000), Allen and Gale (2004), and Wagner (2010) support through their models the competition-fragility theory. In this case, even if banks have the possibility to choose the risk level of their portfolio, they prefer to transfer some risks to their depositors. When financial institutions are part of a competitive environment and profitability is a must, they do not obtain any informational advantages from their relationship with the borrowers, give up on an analysing them in-depth, take more risks and contribute to a more fragile banking system. If there are barriers to entry that limit competition, the banking entities have higher chances to enjoy their targeted profits and there is not enticement to put in place risky activities that increase the fragility of the entire banking sector.

Boyd and De Nicoló (2005) propose a new point of view, opposite to the competition-fragility paradigm. These two authors come up with the competition-stability perspective and consider that by assuming that banking competition contributes to profit generation and banking stability means ignoring the impact the market power has on the behaviour of financial institutions. Besides, clients, not the banking entities, choose the risk level of the assets included in the portfolio. Boyd and De Nicoló (2005) confirm empirically that the concentrated banking sectors stimulate competition that in turn facilitates higher interest rates for the borrowers. Consequently, debtors prefer to take risky decisions to repay their loans and bring with their actions more fragility in the banking system.

Developing the ideas expressed by Boyd and De Nicoló (2005), Martínez-Miera and Repullo allow for the presence of imperfect correlations between the probabilities of default of each bank and identify a transfer effect of the risks, that leads to bankruptcy and a marginal effect that ensures higher revenues for the financial institutions, as the remaining solvent borrowers are "punished" to pay higher interest. In conclusion, the banking competition-risk relationship is validated by both theories, since an increase in the number of bank translates into lower probability of default, at the beginning, a probability that gets higher and higher afterwards.

This topic is relevant for both researchers and practitioners, as the significant number of papers dealing with it proves. Banks play a central role in the economy since their primary task is to ensure the efficient allocation of funds among companies, households and government. In this way, resources are allocated to the most profitable activities. Before the outburst of Global Financial Crisis (GFC), the banking sector has been subject of continuous deregulation policies aiming at a superior efficiency and profitability. Therefore, new banks have entered the market and the competition has substantially increased. The higher competition has enticed financial institutions to take more risks to maintain their market position or to outperform their competitors. Though, the existing papers have not come to a common conclusion that more competition contributes to a more fragile and instable banking system.

As a matter of fact, the outcomes depend on several factors like the measures used for accounting for bank competition and risk, the states included in the sample or timeframe.

This paper marks its contribution to the literature in three ways. First, competition is measured at bank-level for each of the two major bank products: loans and securities. In the existing literature, the majority of papers focus on estimating an overall competition measure for all the bank products. Among the few exceptions, there are Bolt and Humphrey (2010) and Bolt and Humphrey (2015) that propose a competition efficiency frontier for each of the major bank segments: consumer loans, business loans, payment activities, investment banking and securities. Iveta (2012) estimates separately using a translog cost function the Lerner index for Czech bank credit and deposit markets during 2000-2010. In comparison with this research, our paper considers that total bank output consists in the sum between loans and securities, instead of total assets. At the same time, when choosing the inputs and outputs for the translog cost function, we follow the intermediation approach which assumes that banks use personnel, fixed assets and liabilities to generate loans and securities (Berger & Mester, 1997; Casu & Girardone, 2006; Bolt & Humphrey, 2015).

Moreover, adjusted Lerner index, Boone indicator and Distance to default (DtD) represent the most recent indices on the market power and risk taking of financial entities from Europe and they offer different perspectives on the degree of competition in the markets and for the banks under observation. The Lerner index adjusted for efficiency corrects the traditional Lerner by taking into account cost and profit inefficiencies of the banks enjoying the "quite

life". Distance to default complements the traditional individual bank risk measure by reflecting the market's perception on the probability that a certain financial institution defaults.

Lastly, the extended sample and timeframe offer the possibility of several more in-depth analyses. As European states are part of different groups like Eurozone and non-Euro countries,, several comparisons are available and provide insights on the differences in terms of integration level, economic development and economic policies. Besides, it is important to consider the effects of European banking regulations and whether changes should occur. The covered timeframe allows for investigation of various macroeconomic and financial conditions such as boom, financial crisis and recession.

2. Literature review

The extant literature provides three main directions regarding the relationship competition-risk: competition-fragility, competition-stability and a third hypothesis that supports both theories.

Competition-fragility

The more concentrated banking systems are more stable since the profits protect against fragility and stimulate banks to avoid risks.

Marcus (1984) proposes „franchise value" theory that states that fiercer competition on deposit markets leads to riskier decisions made by the bank, since franchise value diminishes. The author develops a theoretical model that encompasses relevant factors for the study of competition-risk relationship in United States.

Broecker (1990) confirms Marcus' hypothesis (1984), discovering a negative relationship between loan quality and the number of active banks on the market. This research is not based on a state sample, but it based on the development of a theoretical model. Besanko and Thakor (1993) suggest that high rivalry translates into lower informational advantage in the case of credits and implicitly, greater risks taken by banks, while Matutes and Vives (1996) show that market power reduces the bank default profitability.

Keeley (1990), Edwards and Mishkin (1995) and Hellmann et al. (2000) conclude that the liberalization of financial markets from US diminishes both the charter value and the total profits and implies taking more risks. Demsetz et al. (1996) claim based on a sample of US financial entities, that the strongest institutions are those that are solvent and those that hold portfolios with less risky assets.

Beside the papers focused on American banks, there are several researches that analyse European states. Capie (1995) investigates the stability and efficiency of the UK banking sector for the timeframe 1890-1940 and conclude that a less competitive banking system is more stable. On the other hand, Bofondi and Ghobi (2004) assert that growth in the number of banks in Italian banking sector worsens the default rate on loans. As for Spain, Salas and Saurina (2003) identify a significant robust relationship between Tobin Q, solvability rate and NPLs, whereas Jiménez et al. (2006) focus on banking competition and risks for 1988-2003, showing that there is a negative relationship between Lerner index and risk taking.

Moreover, some papers deal with the link between banking competition and risk based on an extended sample of countries. Boyd, De Nicoló and Al Jalal (2006) and De Nicoló and Loukoianova (2007) prove empirically the presence of a positive relationship between the market power and risk-taking. The first research is based on a sample of 2,500 banks from United States in 2003 and between 13,000 and 18,000 international financial institutions for the time period 1999-2004. The developed models continue the works belonging to Allen and Gale (2000, 2004) and Boyd and De Nicolò (2005), including, in addition, the option that banks invest in zero-coupon bond with a profitability $r \geq 1$. HHI measures competition, whereas Z-reflects the risks. Control variables refer to the factors that influence the bank (log of total assets), but also the state (labor market growth, unemployment rate and total revenues). The methodology used is OLS and GMM. In the second study, beside Z-score, other indicators such as ROE are utilized to measure the risk. HHI is the competition measure.

Boyd and Runkle (1993) identify an inverse relationship between bank size and risk. Z-score measures the risk. The sample includes 122 banks and the timeframe is 1971-1990.

De Nicolo (2000) shows that when the commercial value drops, the default risk is higher. This study focuses on 21 industrialized countries between 1988 and 1998. Insolvency risk is measured by Z –score. Micco and Panizza (2005) find a negative relationship between banking concentration and loan volatility. The analysis is based on 93 developed and developing countries for the timeframe 1990-2002.

Competition-stability

The competition-stability approach states that default probability gets higher in a more concentrated banking sector. The presence of big banks represents a potential risk for the stability of the entire banking system, because the default of such an institution exposes the entire banking sector to a systemic risk. Stiglitz and Weiss (1981) show that higher interest rates on loans, due to lower competition, increase the risk of the credit portfolio as a result of

moral hazard and adverse selection. Other recent studies that support these results are those written by Boyd et al. (2006) and Molyneux and Nguyen-Linh (2008).

Boyd and De Nicolo (2005) conclude that higher interest rates entice companies take higher risks, behaviour that leads to increasing nonperforming loans ratio. In addition, the two researchers argue that market concentration impacts positively banking fragility. At the same time, Caminal and Matutes (2002) consider that a drop-in competition decreases loan rationalization, higher credits and probability of default.

Regarding European banks, Uhde and Heimeshoff (2009) highlight that a more concentrated banking sector reduces the financial stability. At the level of the states from South-Eastern Asia, Liu et al. (2011) conclude that fiercer competition does not boost the risks.

Boyd, De Nicolo, and Jalal (2006), along with De Nicolo și Loukoianova (2006) prove that the default risk increases once the competition intensifies. Z-index measures risk, whereas HHI is the concentration indicator.

Competition-fragility and competition-stability

Though, Berger et al. (2009) consider that the two theories are not opposed, but they complement each other. The paper based on a sample of 23 states (Austria, Bahamas, Bahrain, Belgium, Canada, Denmark, France, Germany, Ireland, Italy, Japan, Kuwait, Luxembourg, Macau, Netherlands, Norway, Qatar, Sweden, Switzerland, Taiwan, United Arab Emirates, United Kingdom, USA) during 1999-2005 concludes that fiercer competition translates into increasing rate of NPLs, as the competition-stability hypothesis claims. At the same time, higher market power diminishes insolvency risks, exactly what competition-fragility paradigm proposes. The indicator used to measure competition is Lerner index, whereas loan and deposit HHI confirms the robustness of the results. The financial stability is defined using variables such as NPL ratio, Z-index and capital-asset ratio. In order to solve the endogeneity issue of the market power measure, the researchers make use of the GMM method.

Measuring competition

There is a long tradition in measuring competition. At the beginning, the focus has been on market structure-performance linkages starting from the structure-conduct-performance paradigm and Chicago Revisionist School. Afterwards, New empirical industrial organization (NEIO) allows for spotting the differences in competition across countries (Molyneux et al,1994; Claessens and Laeven,2004; Goddard and Wilson,2009), identify the barriers to

competition and information constraints impact the persistence of profitability (Berger et al., 2000; Goddard et al., 2004; Goddard et al., 2011).

Mason (1939, 1949) and Bain (1951, 1956, and 1959) propose the Structural-Conduct-Performance model that quantifies the structure-performance links among several industries and reflects the meaning of these connections for the company's behavior. The decisions and overall performance of firms depend on the structural characteristics of the industries and markets (i.e. number of business entities along with their absolute and relative sizes, extent of product differentiation and barriers to entry), where they are active. The market structure shapes the businesses' conduct in terms of setting the prices, R&D and advertising expenditures, whereas the profit, growth, technological progress and efficiency measure the firms' performance. The main take-away of this paradigm is that a fewer number of firms allows for increasing the market power and the profitability.

Hannah and Kay (1977) develop *n-firm concentration ratio*, a measure that refers to the market share of the top n firms in a certain industry. The market share refers either to total assets or to total deposits, while the number of firms considered can be three, five or ten. Hirschman (1945) and Herfindahl (1950) make use of all the points from the firm size distribution and calculate the sum of the squares of the market shares of all entities to obtain another competition measure called Herfindahl- Hirschman index.

Lerner index or price cost margin accounts for competition since it provides much more information on the firms' characteristics and compared to Herfindahl-Hirschman index, it does not demand exact definitions of geographic and product markets and it differentiates among small and large countries. The main disadvantages of price cost margin remain endogeneity since it changes only if there are variations in the firms' costs and the lack of solid theoretical foundation as Boone (2008) remarks. At the same time, the specific input on prices and costs for the banks' products needed in the computation of Lerner index, cannot be easily obtained. The possible solutions are relative profit differences, Panzar- Rosse model and Boone indicator. The first potential indicator for competition is difficult to be implemented using real data. Meanwhile, the index developed by Panzar and Rosse (1987) is concerned more with the competitiveness of all activities performed by banking sector as a whole. Additionally, Bikker et al. (2009) prove mathematically and empirically, based on a sample of 18,000 banks in 67 countries during 1986-2004, that Panzar-Rosse price function or scaled revenue equation is not a good measure of competition. Instead, an unscaled revenue equation should be used. In this case, Panzar- Rosse H-statistic must include information on cost, market equilibrium and

market demand elasticity. However, these facts are to be estimated since most of the time they are not ready for use.

Van Leuvensteijn et al. (2011) introduce the Boone indicator to measure the competition level for the banking sectors of five major European countries along with U.K., U.S. and Japan and identify several caveats of this index as well. Financial institutions share partially their profits with the clients. Further, design, product quality and effectiveness do not result in any differentiations among innovations. To eliminate these flaws, van Leuvensteijn recommends a different computational approach. Instead of using average variable costs, marginal costs are determined. Besides, market shares replace profits. As for results, over the period 1994-2004 the U.S. is the most competitive in terms of loan market. In Europe, Germany and Spain come first while the Netherlands is on a more intermediate position. In Italy, there is a significant decline in competition. Less competition occurs in the French, Japanese and UK loan markets. In Germany and U.S., commercial banks are more competitive than savings and cooperative banks.

Carbo et. al (2009) attempt to conduct a more thorough analysis by using several measures for innovation, namely H-statistic and Lerner index. The values of these indicators are interpreted in relationship with the outcomes of Herfindahl-Hirschman index, total asset ratio and return on assets. The sample includes Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom. Competition measures record different outcomes over 1995-2001. According to net interest margin, Luxembourg and Ireland are the most competitive. Lerner index shows that Luxembourg and United Kingdom register the highest level of competition. Luxembourg and Portugal have the most competitive banking sectors as H-statistic shows. Germany and Luxembourg are the best competitive judging by Herfindahl- Hirschman index. Overall, Luxembourg comes first regarding competition due to the fact that it represents an offshore financial center and its banking sector encompasses many international financial institutions. The inclusion of country specific factors ensures outcomes that are more reliable.

Measuring risks

The indicators used to model banking risk refer to either credit risk (NPL ratio), or are based on the balance sheets of the financial institutions (z-score) or focus on market value (Distance to default). The second option is used more often due to its easy implementation.

Z-score reflects the capacity of the financial institutions to absorb losses. That is why, a higher value for Z-score translates into a lower risks and more financial stability. Empirical studies such as Hesse and Cihak (2007), Iannotta et al. (2007), Liu and Wilson (2013) and Liu et al. (2013) include this indicator. Fang et al. (2011) consider that Z-score does not reflect the potential financial stability that the bank might have.

In this context, Aigner et al. (1977) and Meeusen and Van den Broeck (1977) develop a model of stochastic frontier where z-score is the dependent variable of a translog equation.

Distance to default is a risk measure computed with the Merton (1974) option model and shows how far a bank is from a default event: lower values signal a high probability of insolvency. It has been using for the pricing of deposit insurance (Duan and Yu, 1994; Ronn and Verma, 1986) or for the estimation of individual (Laeven, 2002; Vassalou and Xing, 2004; Chan-Lau et al., 2004) and systemic bank risk (Lehar, 2005).

Lapteacru (2016) proposes an improved version for the z-score that is based on a stable distribution function for banks' returns that is more flexible and accounts for skewness, sharpness and kurtosis of the data. Along with this indicator, Lapteacru (2017) uses distance to default to investigate the nexus between market power and risk in the banking sectors of the CEE countries.

3. Data and methodology

Based on financial data provided by Bankscope- Bureau von Dijk, we estimate the competition measures for commercial, cooperative and savings banks located in the 28 state members of European Union during 2005-2015. This paper focuses on these three types of financial institutions since they are involved in traditional activities such as taking deposits and granting loans, and therefore have similar business strategies.

In order to ensure high accuracy and relevance of the dataset several steps are implemented. Based on the consolidation code available in Bankscope, each financial institution is separately investigated to avoid double entries between parent banks and subsidiaries (Clerides et al., 2015). Besides, all banks are checked in order to see if they have been involved in an M&A process and afterwards only the merged entity or the acquiring bank is part of the sample after this event.

The figures have been winsorized at 1% and 99% and deflated to 2005 prices using the consumer price index from the Main Economic Indicators by OECD. We have initially

collected data on 8,447 financial entities, but after applying the cleaning procedure the final sample includes a total of 33,524 observations meaning 3,680 commercial, cooperative and savings institutions. Out of them there are 1,677 cooperative, 1,161 commercial and 842 savings banks (table I). Germany with a total of 1,631 financial institutions and Italy with 499 bank entities dominate the sample. In terms of total assets, the best-represented states are Greece (94 %), Belgium (89 %) and Estonia (82 %) as table II depicts.

As for competition, several indicators like Lerner index and adjusted Lerner index attempt to proof the validity of the results and offer different perspectives. All of them are part of previous studies such as Clerides et al. (2015), Van Leuvensteijn et al. (2011) or Carbó et al. (2009). Nevertheless, in the present paper, they are computed for two separate outputs: loans and securities.

The first competition indicator, the Lerner index, is widely applied in extant literature since it is based on easily available data and it is simple to estimate and interpret. Lerner (1934) defines this measure as an “index of the degree of monopoly power”. The form of Lerner index is:

$$Lerner_i = \frac{P_i - mc_i}{P_i} \quad (1)$$

where P_i represents firm i 's price whereas mc_i refers to marginal cost. The values of this index range between zero (i.e. perfect competition) and unity (i.e. monopoly).

In order to estimate the marginal costs, we make use OLS method separately including country fix effects and time trend. The specification of inputs and outputs follows the intermediation approach in which banks use three main inputs (i.e. labour, fixed assets and customer deposits) to finance their outputs (i.e. loans and securities). Production technology includes equity as a netput since it can serve to funding loans and show banks' risk attitudes (Mester 1996,1997). We assume that factor markets are complete and the bank chooses factor quantities at given factor prices in order to supply a desired output. We take the first derivative of the translog cost function below with respect to loans and securities in order to obtain the marginal cost for each of these two products:

$$\ln TC = \alpha_0 + \sum_{i=1}^2 \alpha_i \cdot \ln Q_i + 1/2 \cdot \sum_{i=1}^2 \alpha_i \cdot \ln(Q_i)^2 + 1/2 \cdot \sum_{i \neq j}^2 \alpha_{i,j} \cdot \ln Q_i \cdot \ln Q_j + \sum_{i=1}^2 \sum_{k=1}^2 \delta_{i,k} (\ln Q_i \cdot \ln P_k) + \sum_{k=1}^3 \beta_k \cdot \ln P_k + 1/2 \cdot \sum_{k=1}^3 \sum_{m=1}^3 \beta_{k,m} (\ln P_k \cdot \ln P_m) + \theta_1 \cdot \ln T + 1/2 \cdot \ln(T)^2 + \vartheta \cdot z,$$

$$S_k = \beta_k + \sum_{m=1}^2 \beta_{k,m} \cdot \ln P_m + \sum_{i=k}^2 \delta_{i,k} \cdot \ln Q_i \quad (2)$$

where $TC = LCOST + KCOST + FCOST$;

$Q_{i,j}$ = the value of the three output variables(loans, securities, deposits);

$P_{k,m}$ = three input prices (price of labour, physical capital and funding);

T =time trend;

S_k = cost shares of funding and labour inputs;

z = total equity;

The price of labour is equal to the ratio between the personnel expenditures and total assets of the banks, since the number of employees and branches is most of the time unavailable. The division of the costs represents the price of physical capital with premises by the value of fixed assets. The ratio between the total interest expenses and total funds represents the cost of borrowed resources. The prices of loans and securities are the result of the division of their respective interest by total interest earned by the bank.

Koetter et al. (2012) conclude that Lerner index suffers from several flaws as banks may “enjoy a quiet life” and not be efficient in terms of costs and profits. Therefore, Lerner index is altered for efficiency and turns into adjusted Lerner index:

$$\text{adjusted Lerner}_i = \frac{\pi_i + tc_i - mc_i \cdot q_i}{\pi_i + tc_i} \quad (3)$$

with the bank profit being π_i , total cost tc_i , marginal cost mc_i and total output q_i .

The adjusted Lerner index can take values between zero and one, higher results reflecting stronger market power. When computing this index, we estimate the translog cost function using Distribution Free Approach (DFA), depending on bank specialisation, along with cost and profit frontier. Given the fact that, banks do not report the profits and costs by products we have to perform some approximations. In the case of profits, we have followed Bolt and Humphrey (2015) that consider profits by service line as the difference between revenues and costs. More precisely, they divide the difference between service line revenues and funding costs for these revenues by overall operating costs. The service line revenues for loans and securities consists in the amount of interest earned for each of them. As for costs for loans and securities, we have adjusted the average total cost by the share of interest on loans/ securities on total interest.

Boone indicator is the newest technique to commensurate competition and replaces relative profit differences that is a theoretical construct difficult to be implemented in practice and proposed by Boone (2008). Actually, Boone et al. (2005) recommend profit elasticity (PE) or Boone indicator as empirical analogue of relative profit differences (RPD). Clerides et al.(2015) propose the following formula that enables the estimation of Boone index at bank level:

$$profit\ elasticity_i = \frac{q_i \cdot mc_i}{q_i \cdot mc_i - tc_i(1 - adjusted\ Lerner_i)} \quad (4)$$

where q_i refers to bank output (i.e. loans or securities), mc_i represents the marginal cost (for each bank product), tc_i -total costs and $adjusted\ Lerner_i$ -adjusted Lerner index previously estimated.

In this paper, the three competition measures have been chosen based on several reasons. Lerner index is a market power measure that can be estimated at bank level, across time and by taking into account different geographic and product markets. Its efficiency-adjusted form helps dealing with profit and cost inefficiencies. Boone indicator comes with the benefit of assessing competition for different bank outputs and specialisations.

The average value of Lerner index for loans in the current sample equals 0.746 with a standard deviation of 0.112, as table III shows. Hence, overall, the twenty-eight countries under scrutiny possess competitive financial systems and they are similar in terms of competition. The smallest value of Lerner index equals 0.220 and it belongs to *Banque Kolb SA*, a French commercial bank, in 2014. The lowest level of competition occurs for *Caisse Centrale du Cr dit Mutuel SA* in 2008, as this French cooperative bank has a score of 1.000. A lower level of competition registers for securities as the Lerner index has an average value of 0.833 with a standard deviation equal to 0.257. The competition indicator varies between -0.324 and 1.986, scores registered by *Cassa Rurale di Roncegno - Banca di Credito Cooperativo* and *Banca di Credito Cooperativo Privernate*, two cooperative Italian banks, in 2013 and 2008.

Adjusted Lerner index for loans and securities confirm the competitiveness of the banks included in the sample under observation as they are on average 0.474 and 0.821 and they do not vary significantly (i.e. standard deviation of 0.136 and 0.059, respectively). The lowest value for these indicators occur in 2013 for *Banif Bank* (-0.149), a commercial bank from Malta, and in 2008 for *Raiffeisenbank Heroldsbach eG*, a cooperative bank from the Netherlands (0.557), whereas *Dexia CLF Banque SA* and *Shawbrook Bank Limited* are the less competitive

banks with efficiency-adjusted Lerner index for loans and securities equal to 1.000 and 1.045, in 2014 and 2015.

Boone indicator highlights the level of competition present at the bank-level as well. The last index takes a mean of -0.024 for loans and -0.018 for securities and reflects no important discrepancies across countries (standard deviations of 0.009 and 0.007). The most competitive banking entities are *FM Bank PBP SA*, a Polish commercial bank and *Banque Degroof Petercam SA*, a commercial bank from Belgium, with a Boone score of -0.067 and 0.047, while the Italian savings bank *Cassa di Compensazione e Garanzia SPA* displays the lowest interest in competition (0.000).

According to table IV, on average, the strongest competition for loans occurs in Estonia, Sweden, Latvia, Austria and Portugal. In Denmark, Greece, the Netherlands, Czech Republic and United Kingdom, banks do not compete so intensively for granting loans. The fiercer competition for securities is present in Austria, Latvia, Slovakia, Luxembourg and Sweden whereas the lowest is encountered in United Kingdom, Poland, the Netherlands, Spain and Estonia. According to adjusted Lerner index for loans, the highest competition in banking sector is present in Finland, followed by Belgium, Germany, Bulgaria and Portugal. Greece, Poland, Ireland, Croatia and Estonia possess the least competitive banking systems for loans. In terms of securities, the values of adjusted Lerner show that the highest level of competitiveness exist in Malta, Austria, Greece, Lithuania and Hungary while the lowest is in Estonia, Spain, the Netherlands, United Kingdom and France. Boone indicator for loans suggests that Greece promotes the highest level of banking competition. On the next places, one finds Croatia, Poland, Cyprus and Romania. The least competitive banking sectors are in Belgium, Finland, Hungary, Denmark and Germany. Based on Boone index for securities, the strongest competition characterizes the banking sectors of Estonia, Cyprus, Bulgaria, Spain and Latvia. The lowest competition occurs in Malta, Sweden, Ireland, Austria and Lithuania.

The three indices vary across banks, given their specialization as table V shows. The most competitive financial institutions for loans are the commercial and cooperative banks (given the Lerner index and adjusted Lerner index scores), which is expected given the variety of products and services they provide to their clients and the fierce competition they are exposed to. Moreover, these banking entities are the most numerous as they are present in each country. Boone indicator for loans shows that the highest competition level characterizes cooperative banks. As for securities, each of the competition measure provides different results.

Given the values of Lerner index and Boone indicator, the non-systemically important institutions (N-SIIs), followed by the other-systemically ones (O-SIIs) are more interested in granting new loans and investing in securities than the global systemically (G-SIIs), as depicted in table V. N-SIIs and O-SIIs consist in medium banks or subsidiaries of banking groups that have to be active and acquire a significant share of the market in a specific country. These banks offer a wide variety of products and services as most of them are commercial banks. Consequently, their involvement in designing and implementing competitive strategies is normal. According to the values of adjusted Lerner index for loans, O-SIIs and G-SIIs are the most interested banks in acquiring market shares for this product.

There is a positive and significant correlation between Lerner indices for loans and securities and their efficiency-improved version at 5%, as figure 1 shows. These outcomes are in line with Clerides et al. (2015). A significant opposite correlation exists between adjusted Lerner and Boone indicator for the two bank products.

The measure of bank soundness, Z-score takes the form below:

$$Z_{it} = \frac{\frac{E_{it}}{A_{it}} + \mu_{ROA_{it}}}{\sigma_{ROA_{it}}} \quad (5)$$

where $\frac{E_{it}}{A_{it}}$ =equity to total assets ratio, $\mu_{ROA_{it}}$ =mean and standard deviation of ROA_{it} .

In calculating this indicator, we follow the approach of Beck et al. (2013) using a three-year time window to compute the standard deviation and the mean of ROA_{it} . At the same time, we replace ROA_{it} by $ROAA_{it}$ and $ROAE_{it}$. In the end, we take the natural logarithm of the outcome for the equation (5).

The values for the Distance to Default are taken from the “Credit Research Initiative” platform of the university of Singapore, where they are computed based on the methodology proposed by Duan et al. (2012).

In our sample, z-score based on ROAA ranges between -2.611 and 10.969 and has a mean value of 4.532 (table VI). The computations using ROAE result in a z-score of , on average, close to DtD, whose mean equals 2.048. Distance to default is the risk measure that varies the most, based on the standard deviation (i.e. 4.417). According to the two z-score indices, savings and cooperative banks have, on average, the highest probability of default

(table VII). On the contrary, the values of DtD show that savings and commercial banks are safer.

N-SIIs and O-SIIs are less exposed to taking increasing risks, judging the results for ROAE based z-score and DtD. Though z-score ROAA suggests the opposite (table VII).

Figure 2 shows that there is a positive and significant correlation between the three risk measures, at least 1%. The strongest correlation occurs between the two versions of z-score.

The model used has the following form:

$$Risk_{it} = \beta_1 C_{i(t-1)} + \beta_2 C_{i(t-1)}^2 + \gamma' Z_{i(t-1)} + \vartheta_t + \varphi_i + \varepsilon_{i(t-1)} \quad (6)$$

where the dependent variable is the risk, lagged competition represents the independent variable, γ' consists in a $1 \times n$ vector, Z_{it} is a $n \times 1$ vector that includes the lagged control variables, ϑ_t are time fixed effects, φ_i refers to bank fixed effects and ε_{it} shows the error term.

The control variables taken into account belong to three major categories: bank level (i.e. net interest margin, tier 1 ratio, cost-to-income ratio, share of fixed assets, loans, deposits and securities in total assets, annual growth of loans, securities and total assets, share of overheads in total assets), banking sector (i.e. HHI, entry and capital requirements, innovation, financial development) and country specific (i.e. annual inflation rate and GDP growth).

4. Results

4.1 Evolution of bank competition

Starting with 2005, market power decreases for the next three years according to all three competition measures (figure 3). After 2008, Lerner index and adjusted Lerner index get higher until 2011, while the decrease of Boone indicator drops by the end of 2008 and is followed by improvements in market power for 2009-2011. During years 2011 and 2012, Lerner index and its adjusted form reflect that the market power increases. Slower increases in Lerner index and efficiency adjusted-Lerner index occur in 2013 and 2014, followed by a drop in 2015. For 2011-2015, Boone indicator fluctuates. The movements of the three indicators coincide with the conclusions of Beck et al. (2012), Anginer et al. (2012), and Clerides et al. (2015) and follow the global business cycle. Bank efficiency is higher during the upward phase of the business cycles due to better information availability and decreasing adjustment

expenses. Since the resulting cost savings are not fully transferred to the prices charged for banking products, the market power gets up. At the same time, the higher competition before 2008 is due to financial globalization, mergers and acquisitions that have improved the efficiency of banking activities and processes. The financial crisis has brought lower market power since it has caused significant capital losses and higher volumes of non-performing loans.

As for OECD states, the three competition measures fluctuate across time as figures 4 and 5 suggest. Market power increases before 2009 and lowers during the next two years. In 2012, competition level decreases, whereas in 2013 slightly recovers. During year 2014, market power increases. These movements are in line with those of the Lerner index, adjusted Lerner index and Boone indicator computed for the entire sample on a yearly basis.

Similar outcomes characterize the non-OECD countries as well. The only differences are higher market power in 2009 and decreasing values for Lerner index during 2012-2014, along with more variability in Boone indicator and more stable adjusted Lerner index. The results are accounted by the fact that these states are later impacted by the global financial crisis and they need more time to fully recover. Based on the values presented by Clerides et al. (2015), the same conclusions can be drawn.

During 2005-2008, there is a decreasing competitive behaviour in Eurozone countries (figures 6 and 7). By the end of year 2011, market power declines and starting with 2012 until 2014, competition level gets higher. These changes are normal given the macroeconomic conditions.

The same fluctuations are present in the states with their own currency. Overall, the variations in competitiveness level exist no matter of national currency. Yet, Euro countries prove to be more competitive as their counter-parties. The result comes naturally since in Eurozone area there are always challenges that make banks act more willingly to attract new customers. Similar variations have been identified by Weill (2013) and Andrieş and Căpraru (2014), for shorter periods included in the present time window.

4.2 Bank competition and risk taking

The results of the OLS regression with fixed effects and macroeconomic control variables confirm that there is a statistical significant U-shaped relationship between competition, measured using Lerner index and risk taking, estimated with z-score (ROAE) and

DtD (table VIII). In all cases from table VIII annual GDP growth is shown to have a positive and significant impact on the competition-risk nexus.

Table VIII The impact of bank competition for loans on risk-taking, controlling for macroeconomic conditions

VARIABLES	Z-score ROAE	Z-score ROAA	DtD	Z-score ROAE	Z-score ROAA	DtD
	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects
<i>lagLernerloans</i>	2.647** (1.331)	1.872 (1.306)	-13.104* (7.822)			
<i>lagLernerlosquare</i>	-2.715*** (1.016)	-1.777* (0.992)	10.199* (5.541)			
<i>lagadjLernerloans</i>				-0.286 (0.706)	0.059 (0.573)	-2.439 (2.082)
<i>lagadjLernerlosquare</i>				1.683** (0.855)	1.312* (0.757)	6.513** (2.911)
<i>L.inflation</i>	0.076*** (0.014)	0.073*** (0.012)	0.038 (0.044)	0.020 (0.029)	0.036 (0.022)	0.037 (0.047)
<i>L.gdp</i>	0.025** (0.012)	0.049*** (0.011)	0.080*** (0.028)	0.043** (0.020)	0.063*** (0.017)	0.059** (0.026)
<i>Observations</i>	12,582	13,624	785	6,539	7,035	689
<i>R-squared</i>	0.059	0.091	0.293	0.038	0.046	0.312
<i>Number of Banks</i>	2,175	2,308	101	2,054	2,212	93
<i>Country FE</i>	YES	YES	YES	YES	YES	YES
<i>Year FE</i>	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

As for the impact of bank competitiveness for securities on risk, the model including adjusted Lerner index and DtD along with macroeconomic controls and country and year fixed effects confirms the inverse relationship (table IX).

Table IX The impact of bank competition for securities on risk-taking, controlling for macroeconomic conditions

VARIABLES	Z-score ROAE	Z-score ROAA	DtD	Z-score ROAE	Z-score ROAA	DtD
	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects
<i>lagLernersecurities</i>	0.039 (0.286)	-0.253 (0.223)	-3.828*** (1.071)			
<i>lagLernersecuritiessquare</i>	-0.028 (0.158)	0.125 (0.124)	1.497*** (0.531)			
<i>lagadjLernersecurities</i>				-4.966 (9.488)	-12.509 (9.270)	53.550*** (18.622)
<i>lagadjLernerseccsquare</i>				4.590 (5.970)	8.485 (5.830)	-35.587*** (13.315)
<i>L.inflation</i>	0.028 (0.058)	0.012 (0.052)	0.125** (0.052)	0.034 (0.059)	0.012 (0.050)	0.136* (0.072)
<i>L.gdp</i>	-0.033 (0.043)	-0.012 (0.030)	0.045 (0.048)	-0.093** (0.041)	-0.038 (0.034)	0.094 (0.076)
<i>Observations</i>	3,988	4,396	260	3,272	3,615	145
<i>R-squared</i>	0.028	0.012	0.401	0.086	0.031	0.357
<i>Number of Banks</i>	2,030	2,208	91	1,858	2,031	66
<i>Country FE</i>	YES	YES	YES	YES	YES	YES
<i>Year FE</i>	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

When accounting for bank and banking system characteristics, the U-shape relationship remains significant only for Lerner index loans and DtD as table X depicts. As expected, innovation and HHI impact negatively and significantly this relation.

Table X The impact of bank competition for loans on risk-taking, controlling for bank and banking sector

VARIABLES	Z-score ROAE	Z-score ROAA	DtD	Z-score ROAE	Z-score ROAA	DtD
	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects
<i>lagLernerloans</i>	-0.302 -1.337	-1.368 -1.252	-11.802* -6.857			
<i>lagLernerloanssquare</i>	-0.144 -1.01	0.931 -0.946	9.113* -5.023			
<i>lagadjLernerloans</i>				-0.341 -0.716	-0.005 -0.605	-1.025 -1.608
<i>lagadjLernerloanssquare</i>				1.475* -0.866	0.954 -0.805	4.665* -2.42
<i>loanfocalisation</i>	0.659* -0.348	1.069*** -0.305	-0.081 -1.476	0.889* -0.524	1.201** -0.493	-1.318 -1.371
<i>faoverassets</i>	3.599 -5.107	3.133 -4.624	33.484** -14.937	8.546 -5.325	4.632 -5.002	44.653*** -15.665
<i>depot</i>	-0.004	0.154	1.306	0.217	0.373	1.092

	-0.275	-0.265	-0.928	-0.415	-0.399	-0.995
<i>secfocalisation</i>	-0.126	0.039	-0.599	0.132	0.681*	-0.958
	-0.288	-0.272	-1.343	-0.435	-0.403	-1.444
<i>growthloans</i>	-0.011	-0.001	-0.058	0.159*	0.155	-0.022
	-0.013	-0.015	-0.516	-0.087	-0.104	-0.345
<i>growthsecurities</i>	0.000***	0.000***	0.000**	0	0	0.014***
	0	0	0	0	0	-0.004
<i>growthassets</i>	0.077	-0.142**	0.171	0.2	-0.057	0.469
	-0.078	-0.068	-0.59	-0.185	-0.18	-0.427
<i>overheadoverassets</i>	-8.976	-19.961***	1.984	-8.051	-10.622*	14.689
	-6.257	-5.631	-13.428	-5.976	-5.734	-14.426
<i>costtoincomeratio</i>	-0.006**	-0.006***	-0.002	-0.012***	-0.009***	-0.002
	-0.002	-0.001	-0.003	-0.003	-0.002	-0.004
<i>netinterestmargin</i>	0.201***	0.202***	0.203**	0.147**	0.109	0.097
	-0.051	-0.05	-0.096	-0.061	-0.066	-0.091
<i>tier1ratio</i>	0.007***	0.010***	0.011	0.004	0.014***	0.008
	-0.003	-0.003	-0.016	-0.005	-0.005	-0.015
<i>entry</i>	0.139***	0.187***	-0.136	0.13	0.170*	-0.188
	-0.034	-0.037	-0.171	-0.093	-0.098	-0.177
<i>capital</i>	0.033	0.029	-0.074*	0.015	0.008	-0.081*
	-0.035	-0.029	-0.044	-0.047	-0.039	-0.047
<i>foreign</i>	0.003	0.002	-0.015	0.019	0.017	-0.006
	-0.008	-0.007	-0.023	-0.013	-0.013	-0.022
<i>atm</i>	0.010**	0.006	0.012	0.024***	0.011	0.008
	-0.004	-0.004	-0.015	-0.007	-0.007	-0.017
<i>BR</i>	0.015*	0.013*	0.017	-0.001	0.014	0.026
	-0.008	-0.008	-0.02	-0.015	-0.016	-0.021
<i>stockpricevolatility</i>	-0.007	-0.003	-0.059***	-0.019*	-0.012	-0.053***
	-0.007	-0.006	-0.016	-0.011	-0.01	-0.016
<i>domesticcredit</i>	-0.006**	-0.002	-0.016**	0.002	0	-0.017**
	-0.003	-0.003	-0.007	-0.005	-0.005	-0.007
<i>innovation</i>	-0.518***	-0.551***	-1.002**	-0.661**	-0.525*	-1.214***
	-0.159	-0.164	-0.402	-0.28	-0.297	-0.417
<i>freedom</i>	0.015	0.016	-0.011	-0.03	-0.034	-0.026
	-0.015	-0.014	-0.029	-0.022	-0.023	-0.035
<i>crisis</i>	-0.007	0.033	-0.228*	0.243***	0.223***	-0.197
	-0.033	-0.033	-0.126	-0.068	-0.068	-0.136
<i>bankcapreqtoRWA</i>	-0.025	0.021	-0.045*	-0.011	0.034	-0.031
	-0.02	-0.017	-0.025	-0.037	-0.031	-0.027
<i>HHI</i>	-4.189***	-4.025***	-4.604*	-4.424**	-3.500**	-2.047
	-1.596	-1.24	-2.737	-1.947	-1.551	-2.682
<i>Observations</i>	12,532	13,566	781	6,520	7,012	685
<i>R-squared</i>	0.1	0.137	0.404	0.091	0.084	0.42
<i>Number of Banks</i>	2,166	2,299	101	2,043	2,200	92
<i>Country FE</i>	YES	YES	YES	YES	YES	YES
<i>Year FE</i>	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

These outcomes hold for securities as well, with the difference that innovation has not always a significant effect.

Table XI The impact of bank competition for securities on risk-taking, controlling for bank and banking sector

VARIABLES	Z-score ROAE Fixed Effects	Z-score ROAA Fixed Effects	DtD Fixed Effects	Z-score ROAE Fixed Effects	Z-score ROAA Fixed Effects	DtD Fixed Effects
<i>lagLernersecurities</i>	0.059 (0.293)	-0.164 (0.221)	-4.407*** (1.335)			
<i>lagLernersecsquare</i>	-0.062 (0.162)	0.060 (0.125)	1.810*** (0.676)			
<i>lagadjLernersecurities</i>				-3.933 (8.334)	-12.076 (8.482)	-16.764 (77.244)
<i>lagadjLernersecsquare</i>				3.783 (5.335)	8.253 (5.390)	11.746 (48.770)
<i>loanfocalisation</i>	1.577* (0.854)	1.806*** (0.694)	-1.609 (2.664)	-0.589 (1.024)	0.085 (0.853)	-10.368 (9.967)
<i>faoverassets</i>	4.503 (11.344)	9.687 (8.468)	-7.692 (48.759)	4.963 (9.365)	12.023 (8.838)	-42.511 (90.320)
<i>depot</i>	-1.764** (0.689)	-0.789 (0.552)	1.077 (1.833)	-1.635** (0.804)	-0.909 (0.593)	-1.507 (5.597)
<i>secfocalisation</i>	0.468 (0.660)	1.263** (0.575)	1.335 (3.410)	-0.152 (0.810)	0.765 (0.754)	-3.981 (9.648)
<i>growthloans</i>	0.126 (0.205)	0.269* (0.159)	0.063 (0.696)	0.257 (0.211)	0.123 (0.274)	-0.444 (1.835)
<i>growthsecurities</i>	0.000 (0.000)	0.000 (0.000)	-0.092 (0.101)	-0.000*** (0.000)	-0.000*** (0.000)	-0.081 (0.652)
<i>growthassets</i>	-0.247 (0.261)	-0.477* (0.245)	0.246 (0.764)	-0.219 (0.316)	-0.456 (0.323)	0.978 (3.203)
<i>overheadoverassets</i>	-8.304 (13.183)	-4.516 (9.243)	23.560 (38.390)	-7.752 (10.538)	-1.946 (7.952)	51.186 (122.156)
<i>costtoincomeratio</i>	-0.009*** (0.003)	-0.005*** (0.002)	-0.004 (0.005)	-0.010** (0.004)	-0.006** (0.003)	-0.003 (0.010)
<i>netinterestmargin</i>	-0.025 (0.103)	-0.046 (0.081)	0.009 (0.210)	0.251** (0.124)	0.144 (0.095)	0.556 (0.685)
<i>tier1ratio</i>	-0.002 (0.005)	0.008* (0.005)	-0.029 (0.018)	-0.003 (0.005)	0.008 (0.005)	-0.044 (0.091)
<i>entry</i>	0.899 (0.563)	0.658** (0.298)	-0.068 (0.246)	1.915*** (0.241)	0.665*** (0.232)	0.176 (0.299)
<i>capital</i>			1.522* (0.887)			2.192 (1.507)
<i>foreign</i>	-0.088 (0.054)	-0.055 (0.045)	0.172* (0.095)	-0.091* (0.054)	-0.059 (0.048)	-0.002 (0.238)
<i>atm</i>	-0.016 (0.022)	0.009 (0.016)	0.032 (0.038)	0.044 (0.034)	0.042 (0.026)	0.132** (0.056)
<i>BR</i>	-0.018 (0.040)	-0.010 (0.031)	-0.049 (0.062)	-0.100* (0.060)	-0.092 (0.057)	-0.289** (0.122)
<i>stockpricevolatility</i>	-0.099** (0.042)	-0.035 (0.029)	-0.124 (0.098)	-0.078 (0.049)	-0.037 (0.034)	-0.254* (0.148)
<i>domesticcredit</i>	0.004 (0.019)	-0.013 (0.010)	-0.003 (0.018)	-0.017 (0.019)	-0.014 (0.011)	0.063 (0.043)
<i>innovation</i>	-1.135*** (0.318)	-0.520** (0.215)	-0.501 (0.368)	-0.984*** (0.351)	-0.474* (0.261)	1.363 (2.642)
<i>freedom</i>	-0.083* (0.043)	-0.096*** (0.033)	-0.144 (0.091)	-0.146*** (0.045)	-0.101** (0.039)	-0.512*** (0.147)
<i>crisis</i>	0.705** (0.300)	0.542** (0.254)	0.123 (0.271)	0.701** (0.284)	0.693** (0.320)	0.085 (0.290)
<i>bankcapreqtoRWA</i>	0.458*** (0.144)	0.220** (0.105)	-0.012 (0.092)	0.031 (0.176)	0.131 (0.122)	0.276 (0.232)

<i>HHI</i>	0.332 (3.282)	-2.627 (2.519)	-4.590 (5.266)	-4.199* (2.457)	-4.657* (2.583)	-13.882*** (5.186)
<i>Observations</i>	3,969	4,372	255	3,253	3,591	140
<i>R-squared</i>	0.088	0.056	0.467	0.168	0.072	0.539
<i>Number of Banks</i>	2,017	2,193	89	1,846	2,017	64
<i>Country FE</i>	YES	YES	YES	YES	YES	YES
<i>Year FE</i>	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Taking into consideration all three categories of control variables, the U-inverted relation exists only in the models including DtD and Lerner index.

Table XII The impact of bank competition for loans on risk-taking, controlling for bank, banking sector and macroeconomic factors

VARIABLES	Z-score ROAE Fixed Effects	Z-score ROAA Fixed Effects	DtD Fixed Effects	Z-score ROAE Fixed Effects	Z-score ROAA Fixed Effects	DtD Fixed Effects
<i>lagLernerloans</i>	-0.299 -1.338	-1.385 -1.256	-12.326* -6.774			
<i>lagLernerloanssquare</i>	-0.140 -1.011	0.963 -0.95	9.597* -4.983	-0.269 -0.367	-0.353 -0.354	-1.796 -1.587
<i>lagadjLernerloans</i>				0.870** -0.406	0.811** -0.350	3.746*** -0.946
<i>lagadjLernerlosquare</i>						
<i>loanfocalisation</i>	0.637* -0.348	1.046*** -0.306	-0.173 -1.516	0.87 -0.561	1.024** -0.505	-1.926 -1.522
<i>faoverassets</i>	3.62 -5.115	3.221 -4.617	34.314** -14.668	15.773*** -5.932	9.951* -5.842	47.774*** -15.962
<i>depot</i>	0.025 -0.276	0.176 -0.266	1.292 -0.935	0.327 -0.429	0.478 -0.408	0.916 -0.985
<i>secfocalisation</i>	-0.132 -0.288	0.031 -0.271	-0.74 -1.348	0.246 -0.453	0.760* -0.421	-0.934 -1.449
<i>growthloans</i>	-0.011 -0.013	-0.002 -0.015	-0.074 -0.51	0.12 -0.124	0.167 -0.128	0.248 -0.45
<i>growthsecurities</i>	0.000*** 0	0.000*** 0	0.000** 0	0 0	0 0	0.016*** -0.004
<i>growthassets</i>	0.077 -0.078	-0.141** -0.068	0.177 -0.58	0.135 -0.195	-0.096 -0.186	0.19 -0.501
<i>overheadoverassets</i>	-9.05 -6.258	-19.866*** -5.661	1.454 -13.405	-22.303** -10.191	-19.820** -9.034	13.02 -12.633
<i>costtoincomeratio</i>	-0.006** -0.002	-0.006*** -0.001	-0.002 -0.003	-0.012*** -0.003	-0.008*** -0.002	-0.002 -0.003
<i>netinterestmargin</i>	0.199*** -0.051	0.197*** -0.05	0.199** -0.097	0.156** -0.063	0.114* -0.067	0.099 -0.096
<i>tier1ratio</i>	0.007*** -0.003	0.010*** -0.003	0.011 -0.015	0.003 -0.005	0.013*** -0.005	0.006 -0.014
<i>entry</i>	0.135*** -0.039	0.161*** -0.04	-0.153 -0.169	0.111 -0.094	0.133 -0.099	-0.191 -0.175
<i>capital</i>	0.027 -0.035	0.015 -0.03	-0.078 -0.049	-0.008 -0.049	-0.027 -0.04	-0.086 -0.053

<i>foreign</i>	0.001	0	-0.014	0.016	0.011	-0.009
	-0.008	-0.007	-0.024	-0.013	-0.013	-0.023
<i>atm</i>	0.010**	0.006	0.011	0.024***	0.01	0.006
	-0.004	-0.004	-0.016	-0.008	-0.007	-0.018
<i>BR</i>	0.013	0.01	0.017	-0.006	0.006	0.032
	-0.008	-0.008	-0.021	-0.016	-0.016	-0.022
<i>stockpricevolatility</i>	-0.008	-0.004	-0.056***	-0.022*	-0.015	-0.055***
	-0.007	-0.006	-0.016	-0.011	-0.011	-0.017
<i>domesticcredit</i>	-0.006*	-0.001	-0.015**	0.002	0.002	-0.017**
	-0.003	-0.003	-0.007	-0.006	-0.005	-0.007
<i>innovation</i>	-0.518***	-0.540***	-0.981**	-0.722**	-0.561*	-1.258***
	-0.158	-0.163	-0.406	-0.288	-0.295	-0.419
<i>freedom</i>	0.014	0.02	-0.004	-0.024	-0.023	-0.028
	-0.016	-0.015	-0.03	-0.022	-0.024	-0.035
<i>crisis</i>	0.003	0.05	-0.197	0.255***	0.268***	-0.191
	-0.033	-0.033	-0.122	-0.068	-0.066	-0.131
<i>bankcapreqtoRWA</i>	-0.026	0.024	-0.046*	-0.004	0.043	-0.035
	-0.021	-0.018	-0.026	-0.038	-0.032	-0.028
<i>HHI</i>	-4.271***	-4.047***	-4.641	-4.113**	-3.324**	-1.37
	-1.582	-1.231	-2.853	-1.979	-1.526	-2.821
<i>L.inflation</i>	0.017	0.017*	-0.01	0.024	0.033	0.007
	-0.011	-0.009	-0.043	-0.027	-0.02	-0.043
<i>L.gdp</i>	-0.002	0.023*	0.034	0.025	0.048***	0.002
	-0.014	-0.012	-0.026	-0.021	-0.019	-0.025
<i>Observations</i>	12,532	13,566	781	6,416	6,895	680
<i>R-squared</i>	0.1	0.138	0.405	0.093	0.088	0.423
<i>Number of Banks</i>	2,166	2,299	101	2,004	2,155	91
<i>Country FE</i>	YES	YES	YES	YES	YES	YES
<i>Year FE</i>	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table XIII The impact of bank competition for securities on risk-taking, controlling for bank, banking sector and macroeconomic factors

VARIABLES	Zscore ROAE Fixed Effects	Zscore ROAA Fixed Effects	DtD Fixed Effects	Zscore ROAE Fixed Effects	Zscore ROAA Fixed Effects	DtD Fixed Effects
<i>lagLernersecurities</i>	0.048 (0.293)	-0.165 (0.221)	-4.267*** (1.295)			
<i>lagLernersequare</i>	-0.054 (0.162)	0.062 (0.125)	1.738*** (0.649)	0.162 (0.370)	0.078 (0.320)	-1.986 (4.438)
<i>lagadjLernersecurities</i>				1.979 (1.237)	0.494 (1.191)	3.897 (6.126)
<i>lagadjLernersequare</i>						
<i>loanfocalisation</i>	1.572* (0.848)	1.774** (0.694)	-1.893 (3.003)	-0.133 (1.039)	0.104 (0.882)	-10.300 (9.516)
<i>faoverassets</i>	3.984 (11.292)	9.555 (8.537)	-16.463 (51.277)	0.853 (10.490)	10.391 (9.914)	-422.091** (182.276)
<i>depot</i>	-1.791*** (0.688)	-0.766 (0.551)	0.929 (1.869)	-1.578* (0.818)	-0.881 (0.587)	2.604 (6.898)

<i>secfocalisation</i>	0.427 (0.656)	1.204** (0.579)	1.124 (3.714)	0.086 (0.830)	0.848 (0.803)	-6.392 (9.762)
<i>growthloans</i>	0.128 (0.207)	0.279* (0.160)	0.032 (0.716)	0.321 (0.237)	0.343 (0.225)	-3.809 (2.906)
<i>growthsec</i>	0.000 (0.000)	0.000 (0.000)	-0.055 (0.111)	-0.000*** (0.000)	-0.000*** (0.000)	-0.709 (1.283)
<i>growthassets</i>	-0.254 (0.261)	-0.484** (0.246)	0.131 (0.791)	-0.273 (0.337)	-0.464 (0.338)	5.432 (5.262)
<i>overheadoverassets</i>	-8.013 (13.265)	-3.379 (9.308)	17.144 (38.990)	-9.522 (19.179)	2.363 (11.051)	220.089* (116.201)
<i>costtoincomeratio_win</i>	-0.009*** (0.003)	-0.005*** (0.002)	-0.003 (0.005)	-0.008* (0.005)	-0.005* (0.003)	-0.006 (0.014)
<i>netinterestmargin_win</i>	-0.033 (0.103)	-0.058 (0.082)	0.056 (0.209)	0.238* (0.126)	0.148 (0.102)	0.408 (0.726)
<i>tier1ratio_win</i>	-0.003 (0.005)	0.008* (0.005)	-0.031 (0.019)	-0.003 (0.005)	0.007 (0.005)	-0.134 (0.120)
<i>entry</i>	0.852 (0.559)	0.666** (0.294)	-0.292 (0.312)	1.906*** (0.241)	0.656*** (0.229)	-0.034 (0.430)
<i>capital</i>			1.054 (1.021)			1.624 (1.899)
<i>foreign</i>	-0.095* (0.051)	-0.049 (0.042)	0.105 (0.109)	-0.123** (0.062)	-0.063 (0.053)	0.146 (0.358)
<i>atm</i>	-0.015 (0.022)	0.011 (0.016)	0.024 (0.039)	0.034 (0.033)	0.041 (0.027)	0.141** (0.065)
<i>BR</i>	-0.013 (0.040)	-0.002 (0.032)	-0.040 (0.061)	-0.079 (0.063)	-0.082 (0.058)	-0.304*** (0.104)
<i>stockpricevolatility</i>	-0.085** (0.042)	-0.026 (0.029)	-0.084 (0.100)	-0.065 (0.057)	-0.037 (0.036)	-0.202 (0.125)
<i>domesticcredit</i>	0.000 (0.018)	-0.017 (0.010)	0.002 (0.015)	-0.019 (0.020)	-0.016 (0.011)	0.055 (0.043)
<i>innovation</i>	-1.222*** (0.330)	-0.567** (0.230)	-0.582 (0.386)	-1.097*** (0.387)	-0.520* (0.274)	1.474 (2.431)
<i>freedom</i>	-0.073 (0.044)	-0.097*** (0.035)	-0.092 (0.105)	-0.137*** (0.050)	-0.100** (0.042)	-0.432** (0.204)
<i>crisis</i>	0.684** (0.293)	0.538** (0.252)	0.045 (0.255)	0.653** (0.292)	0.680** (0.327)	0.396 (0.435)
<i>bankcapreqtoRWA</i>	0.483*** (0.149)	0.214** (0.108)	-0.005 (0.087)	0.047 (0.192)	0.144 (0.129)	0.036 (0.237)
<i>HHI</i>	1.093 (3.356)	-2.341 (2.551)	-6.205 (5.355)	-2.955 (2.657)	-3.722 (2.647)	-18.987*** (6.840)
<i>L.inflation</i>	0.023 (0.053)	-0.013 (0.054)	0.092 (0.087)	0.057 (0.067)	-0.002 (0.062)	0.285** (0.130)
<i>L.gdp</i>	-0.051 (0.036)	-0.042 (0.032)	0.061 (0.054)	-0.041 (0.043)	-0.041 (0.036)	0.089 (0.146)
<i>Observations</i>	3,969	4,372	255	3,152	3,488	130
<i>R-squared</i>	0.089	0.057	0.476	0.170	0.070	0.639
<i>Number of Banks</i>	2,017	2,193	89	1,783	1,954	57
<i>Country FE</i>	YES	YES	YES	YES	YES	YES
<i>Year FE</i>	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

5. Conclusions

To be written

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Appendix

Table I Number of banks by country and specialisation

Country	Commercial banks	Cooperative banks	Savings banks	Total
Austria	73	98	126	297
Belgium	21	6	4	31
Bulgaria	17	1	1	19
Croatia	25	1	1	27
Cyprus	15	2	1	18
Czech Republic	18	2	0	20
Denmark	32	7	30	69
Estonia	8	0	0	8
Finland	39	5	17	61
France	114	75	29	218
Germany	182	937	512	1631
Greece	7	1	0	8
Hungary	25	1	0	26
Ireland	11	14	0	25
Italy	86	380	33	499
Latvia	18	0	0	18
Lithuania	8	0	0	8
Luxembourg	64	13	3	80
Malta	16	1	1	18
Netherlands	28	1	1	30
Poland	90	72	1	163
Portugal	19	4	5	28
Romania	21	1	2	24

Slovakia	5	0	2	7
Slovenia	11	2	1	14
Spain	44	52	15	111
Sweden	30	0	54	84
United Kingdom	134	1	3	138
Total	1161	1677	842	3680

Table II Sample coverage by selected countries

Country	Total assets (th USD)	% total assets
Austria	875,090,909.09	68%
Belgium	1,320,636,363.64	89%
Bulgaria	1,176,363,636.36	41%
Croatia	50,009,090.91	62%
Cyprus	30,992,466.36	62%
Czech Republic	260,181,818.18	67%
Denmark	330,363,636.36	53%
Estonia	113,190,909.09	82%
Finland	872,909,090.91	73%
France	25,572,727.27	71%
Germany	60,081,818.18	80%
Greece	532,909,090.91	94%
Hungary	44,518,181.82	74%
Ireland	6,650,909,090.91	71%
Italy	5,150,000,000.00	51%
Latvia	558,909,090.91	41%
Lithuania	355,636,363.64	65%
Luxembourg	106,563,636.36	68%
Malta	2,795,454,545.45	59%
Netherlands	26,936,363.64	70%
Poland	2,639,090,909.09	62%
Portugal	22,372,727.27	71%
Romania	839,000,000.00	45%
Slovakia	18,854,545.45	31%
Slovenia	547,272,727.27	52%
Spain	169,909,090.91	81%

Sweden	4,163,636,363.64	32%
United Kingdom	67,981,818.18	68%
Total	29,737,365,193.64	

Table III Measures of bank competition (2005-2015) for the entire sample

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Lerner loans</i>	20,021	0.746	0.112	0.220	1.000
<i>Lerner securities</i>	7,908	0.833	0.257	-0.324	1.986
<i>Adjusted Lerner loans</i>	10,577	0.474	0.136	-0.149	1.000
<i>Adjusted Lerner securities</i>	6,235	0.821	0.059	0.557	1.045
<i>Boone loans</i>	10,529	-0.024	0.009	-0.067	0.000
<i>Boone securities</i>	6,098	-0.018	0.007	-0.047	0.000

Table IV Average values for bank competition (2005-2015), by country

Country	Lerner loans	Lerner securities	Adjusted Lerner loans	Adjusted Lerner securities	Boone loans	Boone securities
AUSTRIA	0.636	0.212	0.262	0.079	-0.015	-0.002
BELGIUM	0.727	0.264	0.143	0.223	-0.005	-0.004
BULGARIA	0.756	0.295	0.177	0.262	-0.012	-0.007
CROATIA	0.730	0.347	0.319	0.162	-0.026	-0.004
CYPRUS	0.781	0.320	0.291	0.205	-0.019	-0.007
CZECH REPUBLIC	0.787	0.304	0.278	0.140	-0.014	-0.003
DENMARK	0.834	0.351	0.219	0.227	-0.006	-0.003
ESTONIA	0.452	0.510	0.315	0.509	-0.014	-0.009
FINLAND	0.703	0.263	0.118	0.157	-0.005	-0.003
FRANCE	0.749	0.395	0.189	0.283	-0.008	-0.005
GERMANY	0.731	0.264	0.157	0.196	-0.006	-0.003
GREECE	0.830	0.339	0.439	0.090	-0.026	-0.002
HUNGARY	0.656	0.297	0.262	0.113	-0.006	-0.005
IRELAND	0.723	0.478	0.346	0.142	-0.012	-0.002
ITALY	0.722	0.467	0.251	0.259	-0.014	-0.004
LATVIA	0.596	0.233	0.207	0.249	-0.013	-0.006
LITHUANIA	0.760	0.278	0.262	0.104	-0.012	-0.002
LUXEMBOURG	0.719	0.243	0.224	0.127	-0.009	-0.002

MALTA	0.709	0.376	0.314	0.047	-0.012	-0.001
NETHERLANDS	0.827	0.560	0.186	0.352	-0.006	-0.006
POLAND	0.722	0.562	0.388	0.149	-0.024	-0.004
PORTUGAL	0.643	0.315	0.186	0.260	-0.008	-0.005
ROMANIA	0.717	0.349	0.240	0.167	-0.019	-0.006
SLOVAKIA	0.744	0.242	0.297	0.178	-0.018	-0.004
SLOVENIA	0.661	0.296	0.226	0.188	-0.013	-0.005
SPAIN	0.770	0.530	0.294	0.409	-0.010	-0.007
SWEDEN	0.528	0.247	0.233	0.124	-0.007	-0.001
UNITED KINGDOM	0.787	0.569	0.263	0.314	-0.009	-0.005

Table V Average values for bank competition (2005-2015), by subsample

Subsample	Lerner index loans	Lerner index securities	Adjusted Lerner index loans	Adjusted Lerner index securities	Boone indicator loans	Boone indicator securities
Bank specialisation						
<i>Commercial banks</i>	0.742	0.885	0.425	0.819	-0.025	-0.018
<i>Cooperative banks</i>	0.751	0.844	0.503	0.822	-0.024	-0.018
<i>Savings banks</i>	0.741	0.755	0.463	0.819	-0.023	-0.018
Systemically importance						
<i>G-SIIs</i>	0.762	0.938	0.495	0.836	-0.021	-0.016
<i>O-SIIs</i>	0.758	0.955	0.439	0.813	-0.024	-0.017
<i>N-SIIs</i>	0.744	0.819	0.476	0.821	-0.024	-0.018

Table VI Measures of bank risk-taking (2005-2015) for the entire sample

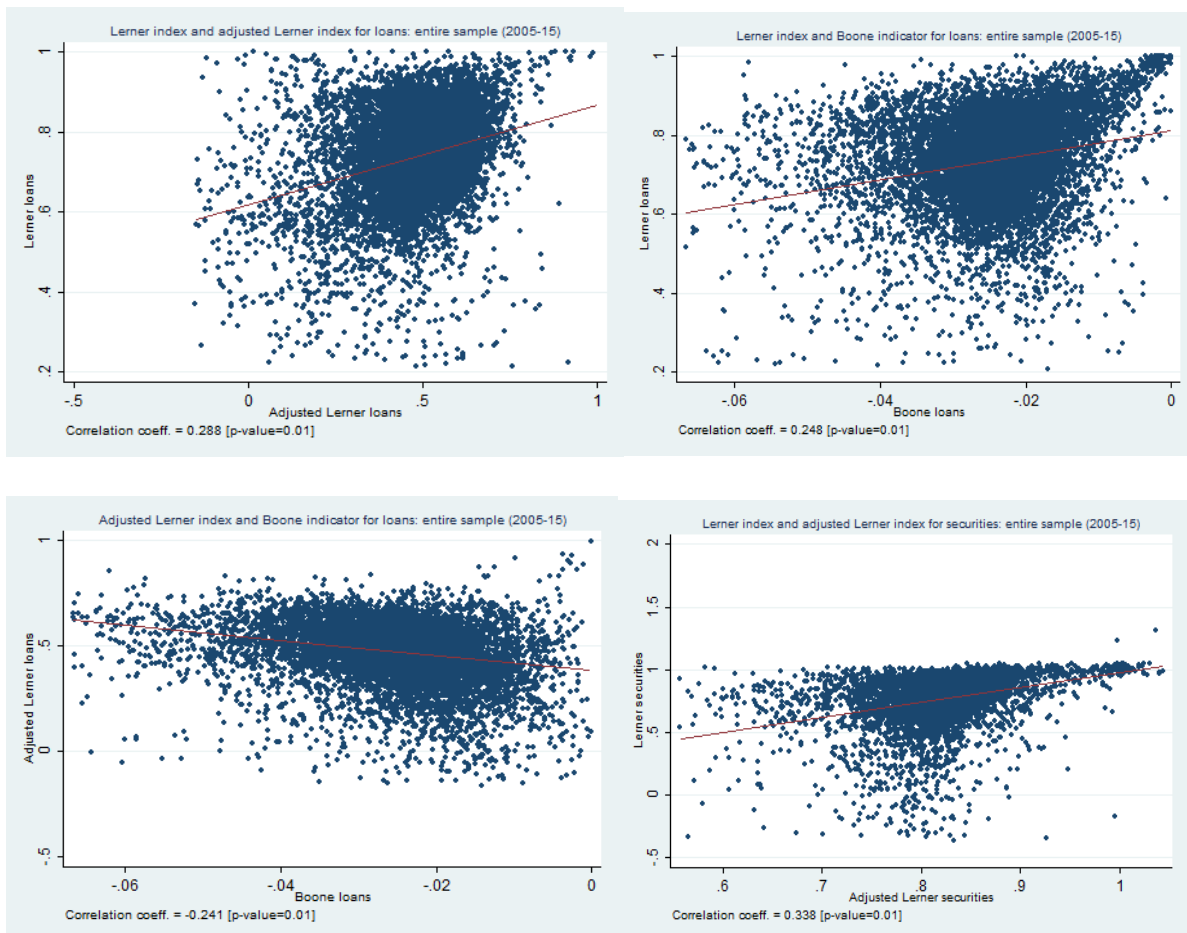
Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Z-score ROAA</i>	22,174	4.532	1.644	-2.611	10.969
<i>Z-score ROAE</i>	20,416	2.443	1.373	-3.982	8.809

<i>DtD</i>	947	1.802	1.631	-1.438	8.125
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Table VII Average values for bank risk-taking (2005-2015), by subsample

Subsample	Z-score ROAA	Z-score ROAE	DtD
Bank specialisation			
<i>Commercial banks</i>	3.457	1.858	1.810
<i>Cooperative banks</i>	4.753	2.542	1.184
<i>Savings banks</i>	2.859	2.501	1.350
Systemically importance			
<i>G-SIIs</i>	4.318	2.540	1.203
<i>O-SIIs</i>	3.527	1.845	1.789
<i>N-SIIs</i>	4.598	2.473	1.936

Figure 1 Correlation among bank competition measures (2005-2015), entire sample



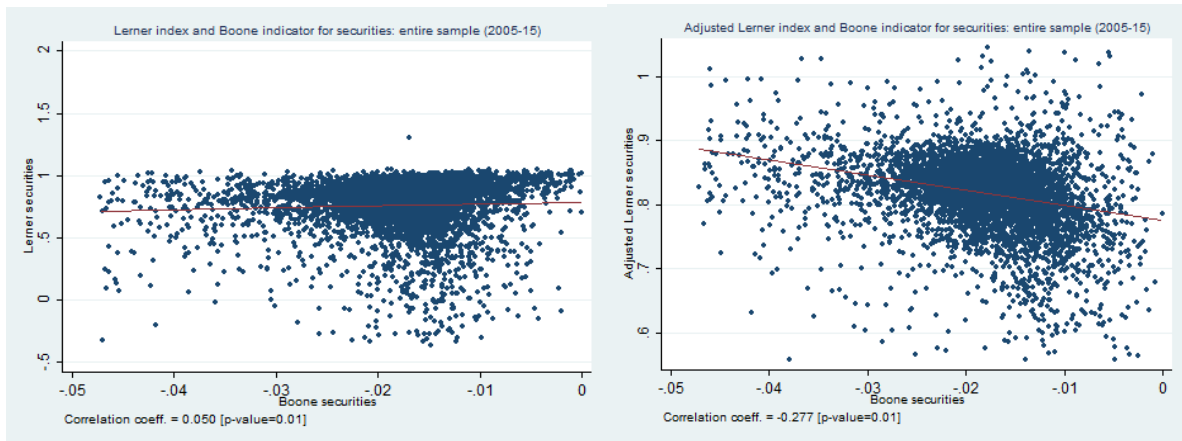


Figure 2 Correlation among bank risk-taking measures (2005-2015), entire sample

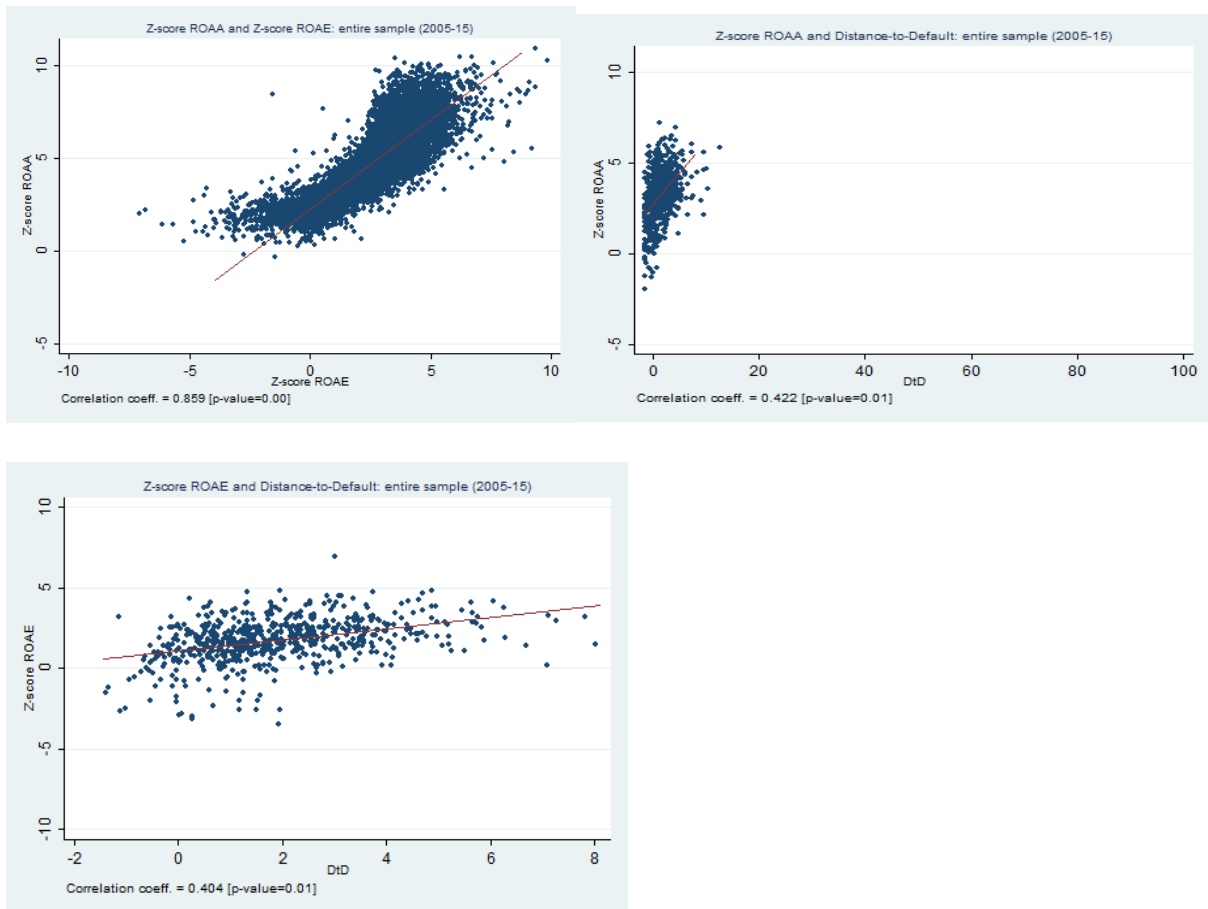


Figure 3 Evolution of bank competition for the entire sample, 2005-2015

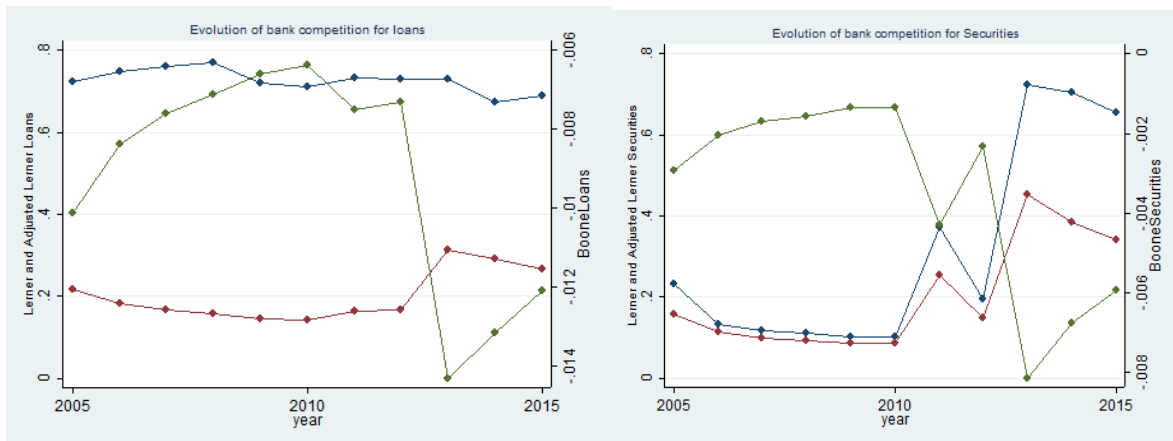


Figure 4 Evolution of bank competition for loans by OECD membership, 2005-2015

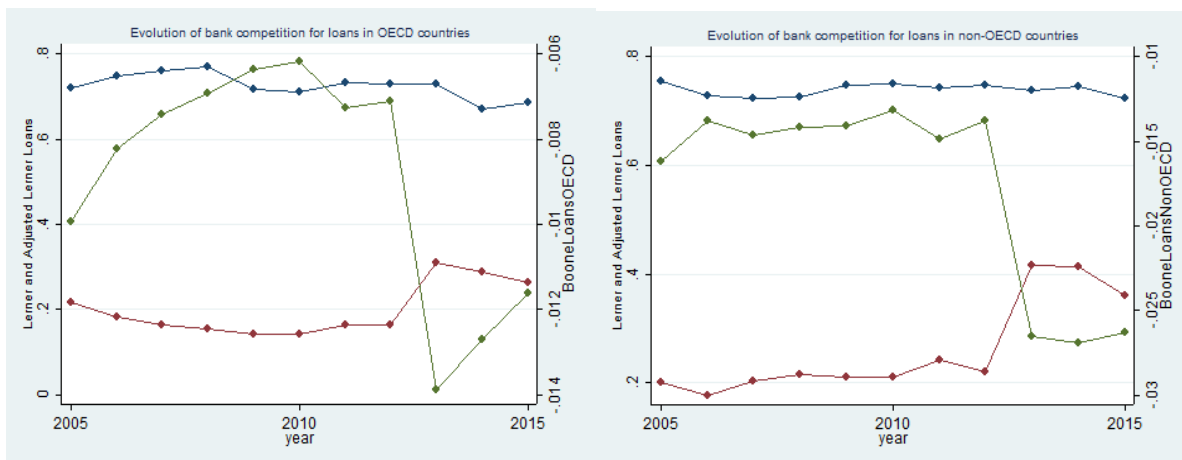


Figure 5 Evolution of bank competition for securities by OECD membership, 2005-2015

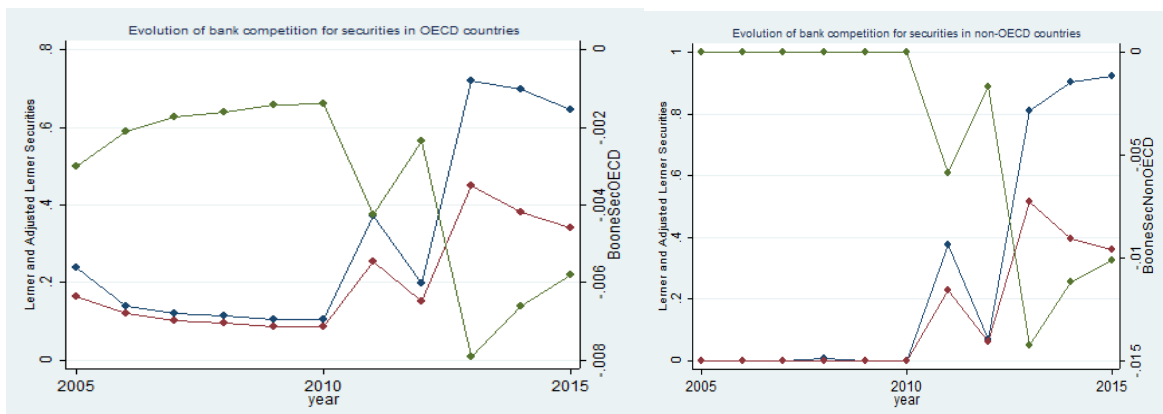


Figure 6 Evolution of bank competition for loans by Eurozone membership, 2005-2015

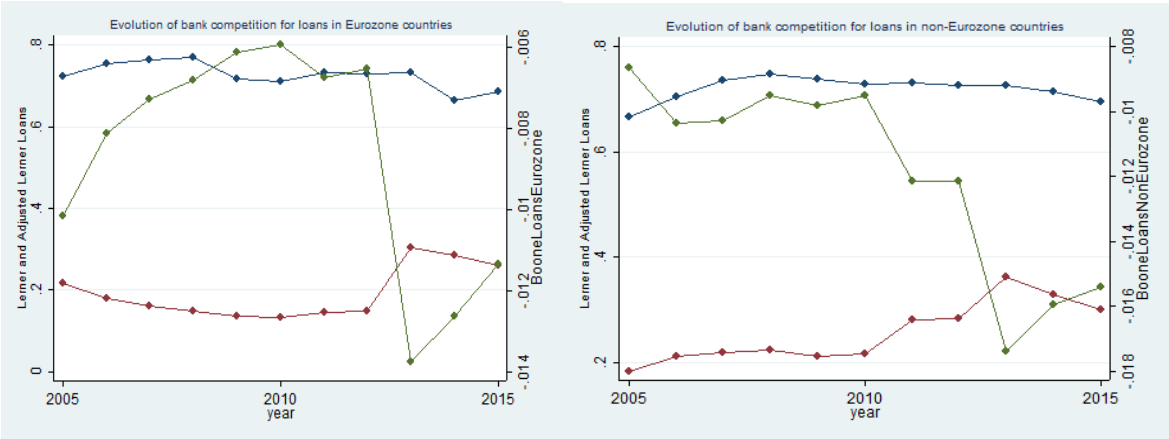


Figure 7 Evolution of bank competition for securities by Eurozone membership, 2005-2015

