Competition and Stability in the European Global Systemically Important Banks[1]

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Abstract

This paper aims to analyse the stability of the global systemically important banks located in European countries between the 2008 and 2017, to find out whether the changing competitive environment affects the stability of these banks, and to determine variables with a significant impact on their stability. The stability is estimated by two proxies, Z-score and loan loss provisions, while the level of competition is estimated inversely by two indexes (market share and the Lerner index) expressing the market power of specified bank. We obtained the four main results. First: we provide evidence in line with the competition--fragility paradigm when we use Z-score as a proxy of overall bank stability. Second: we provide evidence in line with the competition-stability paradigm when loan loss provisions measured loan stability. Third: our nonlinear investigation shows that around a specific turning point, the level of market power is likely to exacerbate the individual-risk-taking behaviour, and could be detrimental to the stability of the banking sector. Fourth: we showed that the increasing share of fixed assets on total assets, increasing bank liquidity, economic growth, and lagged stability measure had a positive impact on bank stability.

Keywords: *bank competition, bank stability, global systemically important banks*

JEL Classification: G21, G32

Introduction

In the past years, we can see that banks are doing their activities not only within one country, but they make their business international. Together with this phenomena, we can see that risk in one country can be more easily transferred to

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other countries. The global systemically important institutions (G-SIIs) are banks whose systemic risk profile could be deemed to be of such importance that the banks' failure would trigger a more comprehensive financial crisis and threaten the global economy. Despite their importance, we know only a little about the relationship between their stability and competition. That is why we decided to test for the presence of a competitive paradigm on a sample of the global systemically important institutions which are under the direct supervision of the European central bank. We analyse a sample of 32 banks from European countries during the period after the financial crisis (2008 – 2017). While examining this relationship, we will try to find answers to the following research questions: 1. Does the level of competition on the market affect the stability of the global systemically important banks? 2. Does the stability of banks increase or decrease when the competition is higher? 3. What are the other factors that affect the stability of these banks?

After the global financial and debt crisis, when European banks had to be bailed out, the regulation authorities started to look for answers to these questions and started to analyse the relationship between competition within the banking sector and stability of commercial banks. For example, Badarau and Lapteacru (2020) present literature review seeking to provide some insights on how changes affected by global financial crisis and environment of low interest rates affected the competitive and risk-taking behaviour of banks.

The literature offers two opposing views: "competition-fragility" paradigm and the "competition-stability" paradigm. The competition-fragility paradigm argues that high level of competition in the banking sector may lead to higher fragility of banks. In a more competitive banking sector bigger banks can afford to give low interest rates, can access better conditions in the international markets, what can make smaller banks less competitive and force them to provide loans under unsatisfactory conditions (lower interest rates) or accept clients with higher credit risk not accepted by bigger banks (Beck, Demirgüc-Kunt and Levine, 2006; Bergantino and Capozza, 2013). Bank managers in smaller banks are forced to take more-risk operations to get profit. This way, they create a more-risk portfolio of assets, which may end up in bankruptcies if there is a case of financial distress. On the other hand, in a less competitive banking market, banks tend to do less aggressive operations and can create higher capital buffers, enhancing the stability of the whole banking sector. This situation is more manageable for the financial authorities to monitor the banking sector with fewer and bigger banks.

The competition-stability paradigm argues that a low level of competition may allow bigger banks to increase interest margin inadequately. In this case, clients will have to bear a higher borrowing cost, while banks tend to pay a lower price

for deposit. In the environment with increasing interest rates for loans, the probability of client failure increase, what leads to higher credit risk and lower loan stability of the banking sector. Also, big banks may believe that they are "too big to fail", in line with moral hazard theory when authorities provide a bailout to big banks when problems arise (Mishkin, 1999). Whereas the big banks believe in rescue by the financial authorities, they are not afraid to undertake riskier activities. On the other hand, in a more competitive banking market, the clients can get access to lower interest rates for loans, what can reduce credit risks and enhance loan stability.

According to Berger, Klapper and Turk-Ariss (2009), the two competitive paradigms need not necessarily yield opposing predictions regarding the effect of competition on stability in banking. Even if less competition in the loan markets results in riskier loan portfolios, the overall stability of banks need not decrease as the bank can protect its overall stability with other methods (more equity capital, or risk-mitigating techniques). This argument suggests that it is essential to study the effects of competition on bank stability that depends on variables chosen to reflect both loan stability (e.g. nonperforming loans, or loan loss provisions) and overall bank stability (e.g. by Z-score), distinguishing whether one or both of the theories may be operative simultaneously.

As the competitive environment in the analysed countries (Austria, Belgium, Germany, Denmark, Spain, France, United Kingdom, Italy, Netherlands, Sweden, and Norway) after 2008 is relatively stable with a moderately concentrated market level, the question is if the global systemically important institutions within these countries are performing activities enhancing or reducing their loan and overall stability and thus the stability of the whole banking sector. Therefore, this paper aims to analyse the stability of the global systemically important banks and to find out if the changing competitive environment affects the stability of these banks. A further issue in testing the competition paradigms is the effect of bank-specific variables and macroeconomic variables. Therefore, we include data on fixed assets to total assets ratio, non-interest income to total income ratio, bank size, total loans to total assets ratio, gross domestic product, and inflation index. This paper uses Thomson Reuters data of 32 global systemically important banks from 2008 to 2017. We include two proxies for banking stability, including a measure of overall bank stability (Z-score) a measure of loan stability (the ratio of loan loss provisions to gross loans). We compute and consider two proxies for bank competition, including the Lerner index and market share. We analyse a potential relationship between competition and stability through the linear model. However, we also follow the theoretical predictions from Martinez-Miera and Rupello (2010) who pointed to the possibility of the

U-shaped or inverse U-shaped relationship between these two variables. The identification of non-linear relationship could let us identify and the optimal degree of competition, and may indicate that both the competition-fragility and the competition-stability paradigms are appropriate, depending on the level of competition. It can be useful from a policy point of view, as it allows us to identify an optimal turning point around which bank competition can enhance or reduce the stability of the whole banking sector. Our findings could have policy implementations for designing and implementing regulations that enhance the overall stability of the banking system and in particular of the global systemically important banks.

The paper is structured as follows. We provide a review of the literature on competition and stability in banking in section 1. Section 2 defines the methodology. Section 3 describes the data and presents the results.

1. Literature Review

Some studies have attempted to answer the question of whether highly competitive banking markets have an impact on banking stability. The results of these studies are far from conclusive and are different for different periods or the analysed countries. Therefore, the literature offers two opposing views: "competition-fragility" paradigm (see, e.g. Agoraki, Delis and Pasiouras, 2011; Beck, De Jonghe and Schepens, 2013; Kick and Prieto, 2013; Leroy and Lucotte, 2017; Albaity, Mallek and Noman, 2019; Azmi et al., 2019; Ijaz et al., 2020) and the "competition-stability" paradigm (see, e.g. Uhde and Heimeshoff, 2009; Amidu and Wolfe, 2013; Fiordelisi and Mare, 2014; Schaeck and Cihák, 2014; Clark, Radić and Sharipova, 2018; Noman, Ge and Isa, 2018; Ahi and Laidroo, 2019; Minh et al., 2020). It highlights the importance to study what is the effect of bank competition on the risk-taking behaviour of banks and thus on the banking stability.

Berger, Klapper and Turk-Ariss (2009) pointed to the fact that two competition paradigms need not necessarily yield opposing predictions regarding the effects of competition on stability in banking. Even if competition in the loan market results in riskier loan portfolios, the overall risks of banks need not increase if banks protect their portfolio by increasing their equity or engaging in other risk-mitigating techniques. They tested these theories by regressing measures of loan risk, bank risk and bank equity on several measures of competition, using bank-level data in 23 developed countries. They found out that banks with higher market power also had less oval risk exposure, which is in line with the competition-fragility paradigm. They also supported one element of the competition-stability paradigm, when they found out that higher market power increased loan

portfolio risk. They concluded that both theories had received some degree of empirical support using different measures of bank or loan risk and the level of competition in the banking market.

Uhde and Heimeshoff (2009) used aggregate balance sheet data from banks across the EU-25 over the period from 1997 to 2005. They found out that national banking market concentration has a negative impact on banks' stability measured by Z-score, which is in line with the competition-stability paradigm. When controlling macroeconomic, bank-specific, regulatory and institutional factors using a panel regression model, they found out the negative relationship between stability and cost-to-income ratio and loan loss provisions; and negative relationship between stability and credit growth, and GDP per capita.

Beck, De Jonghe and Schepens (2013) documented considerable cross-country variation in the relationship between bank competition and stability and explored the market, regulatory and institutional features that can explain this variation using a sample from 79 countries from 1994 to 2009. By panel regression analysis they proved that an increase in the competition had an impact on bank's fragility in countries with more strict activity restrictions, better-developed stock exchanges, lower systemic fragility, more effective systems of sharing information about credit, and more generous deposit insurance.

Fiordelisi and Mare (2014) assess the dynamic relationship between competition and bank stability among the European banks between 1998 and 2009. They applied the Granger causality approach and found out that the bank market power negatively Granger-caused banks' stability, which is in line with the competition-stability paradigm and this relationship was not influenced by the financial crisis. The causality approach was also applied by Jayakumar et al. (2018). They found out that both banking competition and stability were significant long-term drivers of economic growth in the European countries. According to them, the economic policies should reorganize the differences in the relationship between competition and stability in order to maintain the sustainable economic performance of these countries.

Schaeck and Cihák (2014) examined the effect of competition on banking stability using the Boone indicator as a proxy of competition and Z-score as a proxy of a banking stability. They studied a sample of banks in ten European countries over the period 1996 – 2005 and found out that competition is stability-enhancing, and that stability-enhancing effect is more significant for healthy banks. They also used a panel regression model to analyse the relationship between bank stability, competition, bank-specific and country-specific variables. They found a negative relationship between stability and bank size, loan loss provisions, diversification index and Herfindahl-Hirschman index; and a positive relationship between stability and size of the banking system and GDP per capita.

Leroy and Lucotte (2017) investigated the relationship between bank risk and bank competition across a sample of European banks over the period 2004 – 2013. Bank risk was measured by a Z-score and the distance-to-default, while the Lerner index measured the competition. They used panel regression to control the impact of bank-specific and macroeconomic factors on bank stability. They found out that competition encourages bank risk-taking and then increases bank fragility, which is in line with the competition-fragility paradigm. They also found out the positive relationship between Z-score and bank size, the share of a fixed asset over total assets, GDP growth, and inflation while the share of non-interest income on total income had a negative impact on stability.

In previous studies, the authors from the European countries try to analyse the link between competition and stability using the correlation analysis, the traditional linear regression analysis considered only contemporaneous relationships, or Granger causality approach. There is a lack of studies pointing to the possibility of an U-shaped or inverse U-shaped relationship between these two variables.

Martinez-Miera and Rupello (2010) pointed to the fact that there may exist two separate effects on banking operations. One is the risk-shifting effect presented by Boyd and De Nicoló (2005) where the risk is reduced as competition increases, as in the more competitive market there is a tendency to decrease the loan interest rates which reduce the credit risk. The second effect is the margin effect, wherein a more competitive market, the banks tend to reduce buffers against the losses, what increases the credit risk. Therefore, it is not suitable to analyse the relationship between competition and risk-taking only by linear regression analysis, but they try to include the quadratic term in a standard regression model to test the presence of U-shaped relationship. It helps to find out a certain point (turning point) in which the direction of action of the individual effects is changed. Also, Jiménez, Lopez and Saurina (2013) test the hypothesis presented by Martinez-Miera and Rupello (2010) using data from the Spanish banking system. After controlling for macroeconomic conditions and bank characteristic, they found support for a nonlinear relationship.

Cuestas, Lucotte and Reigl (2020) assessed the potential nonlinear relationship between competition and risk for a sample of banks in the Baltic countries over 2000 – 2014. They found an inverse U-shaped relationship between competition and stability. They set up the value of the turning point, about which the lack of competition is likely to exacerbate the individual risk-taking behaviour of the bank, and could be detrimental to the stability of the banking sector in the Baltic countries.

Kanas et al. (2019) analysed banks from the United States, United Kingdom and Canada in 2009 – 2015 to provide evidence that the competition determines the banking stability in a non-linear way. They showed that stability was not

monotonic against the competition, and could increase and decrease at the high competition, had a mixed behaviour at the medium competition, and increased at the low competition. This non-monotonic stability behaviour at different competition levels was attributed to the intervention quality, which was found to be an important determinant of the competition-stability relation.

Also, Ahi and Laidroo (2019) analysed the association between bank stability and competition in Europe by employing a Boone indicator, the Lerner index and the Herfindahl-Hirschman index as competition measures. Bank stability was measured by the Z-score and loan loss reserves ration. They analysed a panel of banks from 27 European Union countries throughout 2004 – 2014. The results confirmed that when a linear association between bank stability and the competition was assumed, competition-stability argument prevailed. However, when potential non-linearity was assumed, the results appeared more diverse and complex across different competition measures. They observed a U-shape association between bank stability and Boone indicator and inverse U-shape between bank stability and the Lerner index. They concluded that before taking policy measures, it is important to consider the potentially non-linear association between bank stability and competition and to define which aspect of competition the regulators want to address. Clark, Radić and Sharipova (2018), Noman, Gee and Isa (2018), Albaity, Mallek and Noman (2019), and Minh et al. (2020) also analysed the non-linear relationship. They used Generalised Method of Moments (GMM) estimator to analyse the relationship between competition and stability in the Commonwealth of Independent States (during the period 2005 – 2013), Southeast Asian countries (throughout 1990 – 2014), MEMA countries (during the period 2006 – 2015), and in Vietnam (over 2008 – 2017).

The literature review becomes an inspiration to realise the study on the sample of a global systematically important institution, stability of which is crucial for the stability of the whole banking sector in the European Union countries. We look at the potential nonlinear relationship between competition and stability to estimate a confidence interval for the competition turning point (value of a market share, or the Lerner index). It can be useful for policymaking, as it lets the information for regulatory authorities when the financial institution has passed the interval boundary and become riskier from the stability point of view.

Our contribution to the literature can be defined as follows. First, unlike the most of the previous papers using bank-level data within one country or group of countries, we focused on the relationship between competition and stability on the sample of European global systemically important institutions, whose systemic risk profile could be deemed to be of such importance that the banks' failure would trigger a more comprehensive financial crisis and threaten the global

economy. That is why the regulatory authority should know how a change in the competition can affect their stability. Second, we do not apply only a linear model, but we also look for the potential non-linear relationship between competition and stability based on GMM estimator. It can be useful as it brings information, that after specified turning point the increasing competition can be dangerous for the stability of banks. Therefore, the regulatory authorities should analyse this turning point and then regulate the level of competition by adjusting the competition rules. Third, we apply different proxies for bank competition and bank stability, to point to the fact that different methodologies can bring different results. It can help in understanding why it is not suitable to make a decision based on only one methodology, and comparing of results obtained from multiple approaches is necessary.

2. Methodology

There is no consensus regarding the best measure to capture the competition and stability. The previous studies use various proxy measures of competition and stability. There were considered two main approaches for defining and measuring competition in the banking sector: the structural and non-structural approach. The structural approach provides competition measures based on the structural characteristics of the market such as the market share of the largest banks or the Herfindahl-Hirschman index (HHI). The structural measures were applied in the study of Uhde and Heimeshoff (2009), or Schaeck and Cihák (2014). The second approach related to non-structural measures is linked to the idea that competition measures should be based on the economic explanations of bank behaviour, especially when concentration measures fail to gauge competition on contestable markets. The most frequently applied measures are the Lerner index and the Boone indicator. The Lerner index is a measure traditionally used in the literature dealing with the testing of competitive hypotheses (e.g. Pruteanu-Podpiera, Weil and Schobert, 2008; Agoraki, Delis and Pasiouras, 2011; Beck, De Jonghe and Schepens, 2013; Zigraiova and Havranek, 2016; Leroy and Lucotte, 2017; Clark, Radić and Sharipova, 2018; Ahi and Laidroo, 2019; Albaity, Mallek and Noman, 2019; Kanas et al., 2019; or Minh et al., 2020). As mentioned by Badarau and Lapteacru (2020), although generally applied in a complementary and interchangeable way, they are fundamentally different and sometimes provide opposite results. Therefore we decide to use both a structural and non-structural measure of bank-level competition (a similar approach was also applied by some authors mentioned above, like Berger Klapper and Turk-Ariss, 2009; Amidu and Wolfe, 2013; Jiménez, Lopez and Saurina, 2013; Fiordelisi

and Mare, 2014; Cuestas, Lucotte and Reigl, 2020; Azmi et al., 2019). The structural approach used to measure competition through the market share describing the market power of an individual bank on the market. The structural approach will be represented by the market share of an individual bank, which can be expressed as a percentage value of selling or purchasing of specific goods or services, controlled by the business, on the relevant market in a particular calendar year. In the banking market, the market share could be analysed from the different point of views (e.g. assets, loans, deposits). The market share from total assets is the percentage of an individual commercial bank asset within a defined geographic market for a specific period. We decide to apply standard market share on total assets instead of on total loans or deposits, as we compare the competition of a global systemically important banks, which could be characterised as large size and traditional banks. In case of these banks the average share of fixed assets on total assets is only 2%, and other assets are created by loans (around 50% of total assets) and other financial assets (around 36% of total assets), interbank loans (around 4% of total assets), cash and other assets (around 8% of total assets). As the market strategy of these banks could be considered as comparable, we consider a standard market share on total assets to be a suitable indicator. This ratio can reach values between 0 and 1 and is negatively related to the degree of bank competition, meaning that a high value indicates a low degree of competition and vice versa. The market shares ($MS_{i,t}$) of individual banks ($I = 1, 2, \ldots, N$) operating in the banking market in the specified year ($t = 1, 2, \ldots, T$) could be defined as follows:

$$MS_{i,t} = \frac{q_{i,t}}{Q_t} = \frac{q_{i,t}}{\sum_{i=1}^{N} q_{i,t}} \tag{1}$$

where

Q_t – the sum of assets of all N individual banks within the market in specified year t,
$q_{i,t}$ – the value of assets of bank i in year t.

Within the group of non-structural measures, we will apply the Lerner index (LI) presented by Lerner (1934) as a proxy for market power. The Lerner index is also an inverse proxy for competition. It can take value from 0 to 1, where the value equals to zero indicates perfect competition (the price of output is equal to marginal cost, which indicates that the bank has no pricing power) and value equals to one indicates monopoly. The Lerner index closer to one indicates the higher mark-up of price over marginal cost and hence, higher market power for the bank. However, in the real market situation, its value can be negative, indicating the problematic trend for the specific bank in a specific year. According to Pruteanu-Podpiera, Weil and Schobert (2008), the negative value of the Lerner

index can come from the fact that in average the marginal cost was higher than the price of assets due to the high interbank rates triggered by the financial turmoil. However, the indicator should not be negative for a long time (either for a bank or a country). Formally, we can define the index as the difference between price (P) and marginal costs (MC) divided by price for bank i in year t:

$$Lerner_{i,t} = \frac{P_{i,t} - MC_{i,t}}{P_{i,t}} \tag{2}$$

In our case, the P is given as a price of assets and is equal to the ratio of total revenue (the sum of interest income, non-interest income and operating income) to total assets. We can obtain the marginal cost (MC) by employing a conventional approach in the literature that consists of estimating translog cost function. In line with most banking studies (Berger, Klapper and Turk-Ariss, 2009; Řepková, 2012; Leroy and Lucotte, 2017), we consider production technology with three inputs and one aggregate output proxy. Due to the low number of observations, the translog cost function is not estimated separately for each year, but we estimated it on the whole sample of commercial banks (r, where $r = 1, \ldots, N$xT) during the whole analysed period using a panel regression model. Then the following translog cost function can be formulated:

$$\begin{aligned} \ln TC_r = \beta_0 + \beta_1 \ln TA_r + \frac{\beta_2}{2}(\ln TA_r)^2 + \sum_{k=1}^{3} \gamma_k \ln W_{k,r} + \sum_{k=1}^{3} \phi_k \ln TA_r \ln W_{k,r} \\ + \sum_{k=1}^{3}\sum_{j=1}^{3} \rho_{k,j} \ln W_{k,r} \ln W_{j,r} + \varepsilon_r \end{aligned} \tag{3}$$

where TC_r corresponds to the total costs of bank r and is equal to the sum of interest expenses, personal expenses, and other operating expenses. TA_r is measured as the total assets of bank r and represents a proxy for the bank output. $W_{1,r}$, $W_{2,r}$ and $W_{3,r}$ are prices of three inputs of bank r, where the price of first input $W_{1,r}$ is the ratio of interest expenses to total assets, price of second input $W_{2,r}$ is the ratio of personnel expenses to total assets, and price of third input $W_{3,r}$ is the ratio of other operating expenses to total assets.

Furthermore, to reduce the influence of outliers, all variables are winsorised at the 1st and 99th percentile levels (see, e.g. Berger, Klapper and Turk-Ariss, 2009; Cuestas Lucotte and Reigl, 2020). The coefficients β_1, β_2, ϕ_1, ϕ_2, and ϕ_3 estimated from the translog cost function can be used to estimate the marginal costs for each bank i in year t:

$$MC_{i,t} = \frac{TC_{i,t}}{TA_{i,t}}\left[\beta_1 + \beta_2 \ln TA_{i,t} + \sum_{k=1}^{3} \phi_k \ln W_{k,i,t}\right] \tag{4}$$

where

$TC_{i,t}$ – corresponds to the total costs of bank i in year t,
$TA_{i,t}$ – measured as the total assets of bank i in year t,
$W_{1,i,t}$, $W_{2,i,t}$ and $W_{3,i,t}$ – prices of three inputs of bank i in year t,
β and ϕ – coefficients are estimated by model (3).

As mentioned by Zigraiova and Havranek (2016), banking stability is often measured in an indirect way: that is, by considering individual or systemic banking distress, effectively the negative of stability. In line with this, the non-performing loan ratio, or ratio of loan loss provisions are often used as a fragility indicator (Berger, Klapper and Turk-Ariss, 2009; Jiménez, Lopez and Saurina, 2013; Schaeck and Cihák, 2014; or Kanas et al., 2019). These indicators only cover credit risk and cannot be directly linked to the likelihood of bank failure. Another measure of individual bank stability is Z-score (e.g. Uhde and Heimeshoff, 2009; Beck, De Jonghe and Schepens, 2013; Fiordelisi and Mare, 2014; Zigraiova and Havranek, 2016; Ahi and Laidroo, 2019; Azmi et al., 2019; Ijaz et al., 2020; or Minh et al., 2020). This measure indicates how many standard deviations in return on assets of a bank is away from insolvency and from the likelihood of failure. As in the case of competition, also these measures can bring the opposite results. Thus we decided to consider two alternative proxies for measures of bank stability: Z-score and the loan loss provisions as a percentage of gross loans (a similar approach was also applied by some authors mentioned above like Agoraki, Delis and Pasiouras, 2011; Amidu and Wolfe, 2013; Cuestas, Lucotte and Reigl, 2020; Leroy and Lucotte, 2017; Clark, Radić and Sharipova, 2018; Noman, Gee and Isa, 2018; Albaity, Mallek and Noman, 2019; or Ijaz et al., 2020). The loan loss provisions are a measure of credit risk and the inverse proxy for loan stability, as we suppose that bank obliged to create higher loss reserves has a riskier loan portfolio. Therefore, the probability of client default is higher in the case of this bank, which indicates a lower level of loan stability. Z-score is traditionally used to measure overall bank stability. It rises with higher profitability and level of capitalisation and decreases with higher volatility of return on assets within the whole sample.

$$Z - score_{i,t} = \frac{ROA_{i.t} + \frac{E_{i,t}}{TA_{i,t}}}{\sigma_{ROA_T}} \tag{5}$$

where

$\mathrm{ROA}_{i,t}$ – the return on assets for bank i in year t,
$E_{i,t}/TA_{i,t}$ – denotes the equity to total assets ratio for bank i in year t,
σ_{ROA_T} – the standard deviation of return on assets over the full sample period (T years).

The results are estimated with a fixed-effect estimator to control the cross--sectional heterogeneity and GMM methodology to control the problem of endogeneity. As mentioned by other authors (e.g. Noman, Gee and Isa, 2018; Ahi and Laidroo, 2019; Albaity, Mallek and Noman, 2019; Azmi et al., 2019; Ijaz et al., 2020) GMM controls the reverse causality which may be running from stability to competition and other independent variables. The application of GMM estimator can help us to remedy possible endogeneity problems related to the variable market power concerning the stability variables. Endogeneity problems can arise when variables are simultaneously identified, or there is reverse causality. In our case market power can be influenced by Z-score. For instance, if the bank increases its Z-score, the incentives for gaining more market power, such as pursuing a growth strategy and mergers with other banks, may be caused by expectations of higher future returns.

$$Stability_{i,t} = f(Competition_{i,t}, Stability_{i,t-1}, Bank\ Control_{i,t}, Macroeconomic_{i,t}) \quad (6)$$

where *i* denotes bank and *t* denotes time, *Stability* represents one of the stability measures (Z-score or Loan loss provisions), *Competition* represents one of the competition measures (Market share or the Lerner index), *Bank Control* is the vector of bank-specific variables (share of fixed assets to total assets, the share of non-interest income to total income, bank size, the share of total loans to total assets) and *Macroeconomic* is the vector of macroeconomic variables (gross domestic product, inflation index).

The estimated model needs to be tested to see if it meets model assumptions (whether it is a fixed-effect model with significant time and individual effects) and whether it meets the statistical assumptions made on such a type of econometric model. It is a test of poolability (whether it is appropriate to use a panel data structure, or it is sufficient to use a simple least-squares method ignoring panel data grouping), testing the significance of time, individual, or both types of effects (Breusch and Pagan test), cross-sectional dependency testing (Pesaran cross-sectional dependence test), serial correlation (Breusch-Godfrey test), and heteroskedasticity (Breusch-Pagan test). In practice, the Hausman test is often used to decide whether a random effect test or a fixed effect test is appropriate. If there is a cross-sectional dependency or serial correlation in the model, the Hausman test estimate may be distorted. It is also true in our model, so we will use the fixed-effect model, which assumes that unobservable effects are correlated with the explanatory variables. (Baltagi, 2014).

Following the methodology presented by Martinez-Miera and Rupello (2010) besides the linear regression model also, the nonlinear model was estimated. To test the nonlinear relationship, we add the squared term of the competition measure:

$$Stability_{i,t} = f(Competition_{i,t}, Competition^2_{i,t}, Stability_{i,t-1}, Bank\ Control_{i,t}, Macroeconomic_{i,t}) \quad (7)$$

where *i* denotes bank and *t* denotes time, *Stability* represents one of the stability measures, *Competition* represents one of the competition measures, *Bank Control* is the vector of bank-specific variables, and *Macroeconomic* is the vector of macroeconomic variables.

3. Data and Empirical Results

We consider global systemically important institutions (G-SIIs), which are determined based on four main criteria: size, cross-border activities, complexity, and substitutability. The list of G-SIIs is published by European banking authority (EBA). We used lists prepared by EBA in 2017 and 2018. It gives an unbalanced panel data of 32 banks over the period 2008 – 2017. Our sample contains one bank in Austria, one bank in Belgium, two banks in Denmark, four banks in France, five banks in Germany, two banks in Italy, three banks in Netherland, one bank in Norway, four banks in Spain, four banks in Sweden, and five banks in the United Kingdom. We take all the bank-level data from the Thomson Reuters database, and macroeconomic data are taken from Eurostat. All results are calculated using the software MS Excel and the program R.

T a b l e 1

Summary Statistics

	Acronym	Average	Standard deviation	Minimum	Maximum
Loan Loss Provision (% of Gross Loans)	Loss	0.6539%	0.0062	–0.3700%	3.8400%
Z-score	Z-score	10.2416	5.4315	2.0427	58.0085
Lerner index	LI	0.2252	0.1703	–0.2795	0.8297
Market share (%)	MS	20.3064%	0.1243	1.1960%	54.6354%
Fixed assets to total assets (%)	FA/TA	1.3940%	0.0096	0.0218%	5.1953%
Non-interest income to total income (%)	NII/TI	33.9473%	0.1689	–15.061%	77.7997%
Log of total assets (bank size)	Size	5.7548	0.3651	4.6385	6.4002
Total loans to total assets (%)	TL/TA	50.8589%	0.1587	2.6439%	90.1694%
Log of real gross domestic product (in millions of PPS)	GDP	5.9820	0.3888	5.2259	6.4789
Log of HICP index	HICP	1.9869	0.0193	1.9279	2.0245

Source: Author's calculations.

Table 1 shows descriptive statistics of all variables used in our main regressions. The bank averages all bank-level variables over the period 2008 – 2017, and macroeconomic variables are overaged by country over the period under study. We control the effect of bank-specific variables and macroeconomic variables on

bank stability. Bank-specific variables include the ratio of fixed assets to total assets, the ratio of non-interest income to total income, the log of total assets (bank size), and the ratio of total loans to total assets. The macroeconomic variables include the log of real gross domestic product (in millions of PPS), and a log of HICP index.

Table 2 reports the average of bank competition and bank stability measures for G-SIIs for specific years and the overall period. We can consider the development of market share as relatively stable. On the other hand, between 2008 and 2010, the Lerner index increased from 0.1378 to 0.276, indicating a reduction in competition within the analysed banks. Since 2011 there can be seen a slight increase in the Lerner index, which indicates increasing market power of the global systemically important bank and this way worsening of the competitive environment. From the stability point of view, both indicators signalise the slight increase in banking stability.

T a b l e 2
Evolution of Market Share, the Lerner Index, Loan Loss Provisions and Z-score in G-SIIs

	Market share	Lerner index	Loan loss provisions	Z-score
2008	0.2194	0.1378	0.0072	9.0163
2009	0.1974	0.2500	0.0109	10.0919
2010	0.1976	0.2760	0.0072	11.2687
2011	0.1993	0.1985	0.0078	8.8558
2012	0.2042	0.2021	0.0078	9.2865
2013	0.2050	0.2001	0.0080	9.7582
2014	0.2038	0.2179	0.0059	10.1753
2015	0.1988	0.2344	0.0043	10.9500
2016	0.2011	0.2350	0.0041	11.0045
2017	0.2062	0.2870	0.0028	11.7477
2008 – 2017	0.2033	0.2239	0.0066	10.2155

Source: Author's calculations.

Part of our analysis also includes calculation of the correlation between bank competition measures and between bank stability measures. There was confirmed a low correlation between our two proxies for bank competition (correlation coefficient = 0.1017) and between our two proxies for bank stability (correlation coefficient = 0.0026). It is in line with the finding of Bikker and Haaf (2002), Lapteacru (2014), or Leroy and Lucotte (2017), who found out that these measures are mostly uncorrelated with each other. It encourages our choice of considering two alternatives measures of bank competition and bank stability.

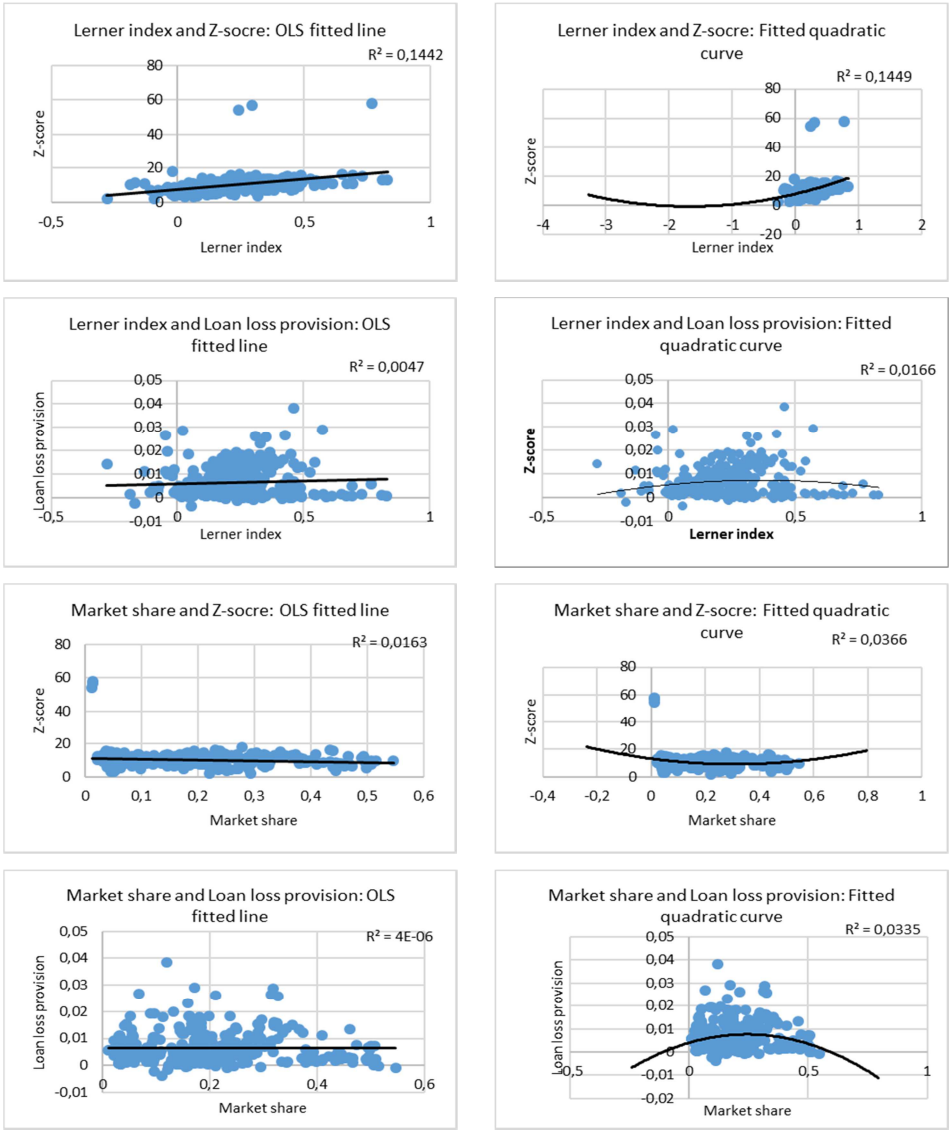
In Figure 1, we plot the Lerner index and the market share against the loan loss provisions and Z-score. In each case, we consider both linear and nonlinear (quadratic) fitted values. As can be seen, there exists a relatively tight relationship

between the Lerner index and Z-score, while the link is less clear when we consider the Lerner index and loan loss provisions and market share and both bank stability measures.

More importantly, scatter plots reported in Figure 1 indicate a potential nonlinear link between bank competition and stability. Therefore, the next section provides panel nonlinear regression analysis.

F i g u r e 1

Scatterplots between Alternative Measures of Bank Competition and Bank Stability



Source: Author's calculations.

We use two depended variables to proxy of the bank stability. All regressions include either the Lerner index or market share as a measure of bank competition, and bank-specific and macroeconomic variables. In all cases, lower values of the Lerner index and market share imply lower degrees of market power and hence a more competitive environment. As we discussed above, we estimate both the linear and non-linear model by including the quadratic term in the estimated equations. As mentioned by Želinský (2013), the coefficients are estimated with a fixed--effect model through the robust variance-covariance matrix as the cross-sectional dependency, serial correlation and heteroskedasticity were detected in models.

Table 3 provides the results when we consider the loan loss reserves as the proxy of bank stability. In the first column (Model 1), we present the results of the linear model using the Lerner index as a proxy of the bank competition. The coefficient on the linear term is positive and statistically significant, indicating a positive relationship between bank competition and bank stability (loan stability). Model 3 also presents the results of the linear model and indicates a negative but statistically insignificant relationship between market share and loan loss provisions, indicating a negative relationship between bank competition and bank stability (loan stability). We can conclude that the results of the linear Model 1 are in line with the "competition-stability" paradigm. After adding a quadratic term into the model (Model 2), the linear term is negative and statistically insignificant while the quadratic term is positive and statistically significant, indicating U-shape of function. In order to assess the relationship between the competition and stability, we calculated the turning point of the quadratic function, and we compared it with the distribution of the data. For example, in Model 2, the turning point is 0.1018. When we look on the distribution of the Lerner index, we can see that 77.60% of values are over the turning point, implying that 77.27% of the data are in the part of the curve where with the increase of the Lerner index the loan loss provisions also increase. Only 22.40% of values are under the turning point, implying banks where with the increase of the Lerner index the loan loss provisions decrease. With most of the data lying over the turning point, a significant and positive relationship is established between bank competition and loan stability, which is in line with the "competition-stability" paradigm. In Model 4 is used the quadratic term to evaluate the potential nonlinear relationship between market share measures and loan stability. The results show that the linear term is positive and statistically insignificant, while the quadratic term is negative and also statistically insignificant. It indicates inverse U-shape of a function where the turning point occurs the value of 0.2857. When we look on the distribution of market share, we can see that 77.27% of values are under the turning point, implying that 77.27% of the data are in the part of the

curve where with the increase of market share the loan loss provisions also increase. Only 22.73% of values are above the turning point, implying banks where with the increase of market share the loan loss provisions decrease. With 77.27% of data lying below the turning point, a significant and positive relationship is established between bank competition and loan stability.

T a b l e 3

The Effect of Competition on the Loan Loss Provisions

Dependent variable: Loan loss provisions	**Bank competition measure**			
	Model 1	*Model 2*	*Model 3*	*Model 4*
	Lerner index	Lerner index	Market share	Market share
Competition	0.0046 (0.0023)**	–0.0023 (0.0045)	–0.0071 (0.0145)	0.0338 (0.0433)
Competition^2		0.0111 (0.0063)*		–0.0591 (0.0589)
Loan loss(t – 1)	0.1933 (0.0604)***	0.2030 (0.0604)***	0.2159 (0.0597)***	0.2062 (0.0605)***
FA/TA	–0.1363 (0.0741)*	–0.14033 (0.0738)*	–0.1271 (0.0748)*	–0.1315 (0.0749)**
NII/TI	0.0041 (0.0035)	0.0039 (0.0035)	0.0049 (0.0035)	0.0045 (0.0036)
Size	0.0050 (0.0032)	0.0054 (0.0032)*	0.0057 (0.0041)	–0.0024 (0.0052)
TL/TA	0.0036 (0.0044)	0.0044 (0.0044)	0.0030 (0.0045)	0.0022 (0.0046)
GDP	–0.0668 (0.0165)***	–0.0674 (0.0164)***	–0.0595 (0.0165)***	–0.0581 (0.0166)***
HICP	–0.0502 (0.0282)*	–0.0517 (0.0604)*	–0.0630 (0.0281)**	–0.0652 (0.0605)**
Individual effects Time effects CD test BPG test BP test	Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes
R-Squared Adj. R-Squared	0.3791 0.2765	0.3873 0.2830	0.3692 0.2649	0.3719 0.2650
Unbalanced Panel	n = 32, T = 5 – 9, N = 276			
Turning point		0.1018		0.2857
% over TP % under TP		77.60% 22.40%		22.73% 77.27%
Shape	Increasing line	U-shape	Decreasing line	Inverse U-shape

Note: * Robust standard errors appear in parentheses below estimated coefficients. CD test – Pesaran CD test for cross-sectional dependence in panels, BPG test – Breusch-Godfrey/Wooldridge test for serial correlation in panel models, BP test – Studentized Breusch-Pagan test for heteroscedasticity. Signif. codes: '***' 0.01 '**' 0.05 '*' 0.01.

Source: Author's calculations.

These results are in line with the "competition-stability" paradigm, and the findings indicate that more market power is associated with riskier loan portfolios. These results are in line with Uhde and Heimeshoff, 2009; Amidu and Wolfe, 2013; Fiordelisi and Mare, 2014; Schaeck and Cihák, 2014; Clark, Radić and

Sharipova, 2018; Noman Gee and Isa, 2018; Ahi and Laidroo, 2019; or Minh et al., 2020, who found a positive link between stability and competition. Our results suggest that bank risk-taking (in the form of loan loss provisions) is affected by the level of competition in a non-linear way. As mentioned by Kanas et al. (2019), this indicates that managing risk-taking by policymakers would require a non-linearly behaved hedging instrument, like rules based on intervention quality. The role of policymakers is to design an optimal intervention quality policy, which can maximise banking stability at various levels of bank competition.

We want to test the argument of Berger, Klapper and Turk-Ariss (2009), that even if market power in banking results in riskier loan portfolios (lower loan stability), the overall bank's stability need not decrease. The results are reported in Table 4 where we consider the Z-score as the proxy of overall bank stability. The results of the linear model (Model 5, Model 7) indicate a negative relationship between competition and overall bank stability, as the linear terms of the Lerner index and market share are positive and in this case the Lerner index also statistically significant. We can conclude that the results of the linear model are in line with the "competition-fragility" paradigm. In Model 6, the linear term is positive and statistically significant while the quadratic term is negative, indicating inverse U-shape of function with the turning point in 1.0673. When we look on the distribution of the Lerner index, we can see that 100% of values are under the turning point, implying that 100% of the data are in the part of the curve where with the increase of the Lerner index the Z-score also increase. Given that the relationship between the bank competition and overall bank stability can be considered as negative and significant. In Model 8, the quadratic term is used to evaluate the potential nonlinear relationship between market share and overall bank stability. The results show that the linear term is positive and statistically significant, while the quadratic term is negative and statistically significant. It indicates inverse U-shape of a function where the turning point occurs the value of 0.3714. When we look on the distribution of market share, we can see that 87.01% of values are under the turning point, implying that 87.01% of the data are in the part of the curve where with the increase of market share the Z-score also increase. Only 12.99% of values are over the turning point, implying banks where with the increase of market share the Z-score decrease. With 87.01% of data lying below the turning point, a significant and negative relationship is established between bank competition and overall bank stability. These results are in line with the "competition-fragility" paradigm, and the findings indicate that more market power is associated with higher overall bank stability. These results are in line with Agoraki, Delis and Pasiouras, 2011; Beck, De Jonghe and Schepens, 2013; Kick and Prieto, 2013; Leroy and Lucotte, 2017; Albaity, Mallek and Noman, 2019; Azmi et al., 2019; or Ijaz et al., 2020, who found a negative link

between stability and competition. This result can be a signal for policymakers. Some entry barriers for new domestic and foreign entrants are needed to maintain the stability of the banking system. The regulation authority should take care of the stability, solvency and credibility of those new players. The policymakers should moderate pro-competitive policies to ensure that competition does not lead to the fragility of global systemically important banks. To promote overall bank stability, the regulators might accelerate the consolidation process among the existing banks through merger and acquisition initiatives. Consolidation could strengthen the market power of small and medium-sized banks and make them stable in a less competitive environment.

T a b l e 4

The Effect of Competition on the Z-score

Dependent variable: Z-score	**Bank competition measure**			
	Model 5	*Model 6*	*Model 7*	*Model 8*
	Lerner index	Lerner index	Market share	Market share
Competition	4.7776 (0.9253)***	6.6845 (1.8063)***	4.9748 (6.1291)	74.0927 (17.4856)***
Competition^2		–3.1316 (2.5486)		–99.7591 (23.7448)***
Z-score(t – 1)	0.2053 (0.0321)***	0.2082 (0.0321)***	0.2266 (0.0335)**	0.2299 (0.0324)***
FA/TA	221.6430 (30.0592)***	222.7936 (30.0414)***	219.7148 (31.7329)***	214.3034 (30.6965)***
NII/TI	2.0479 (1.4245)	2.1033 (1.4236)	3.0583 (1.4887)**	2.3576 (1.4484)
Size	–18.5287 (1.4702)***	–18.6143 (1.4703)***	–19.2111 (1.8723)***	–24.8259 (2.2496)***
TL/TA	–18.3367 (1.8088)***	–18.5245 (1.8133)***	–17.9108 (1.9498)***	–19.2034 (1.9094)***
GDP	21.3032 (6.5124)***	21.5817 (6.5093)**	24.2465 (6.9113)***	27.6619 (6.7289)***
HICP	16.2001 (11.3910)	16.5585 (11.3825)	5.7014 (11.8815)	2.5184 (11.5083)
Individual effects	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes
CD test	Yes	Yes	Yes	Yes
BPG test	Yes	Yes	No	No
BP test	Yes	Yes	Yes	Yes
R-Squared	0.8356	0.8366	0.8175	0.8303
Adj. R-Squared	0.8084	0.8088	0.7874	0.8014
Unbalanced Panel	n = 32, T = 5 – 9, N = 276			
Turning point		1.0673		0.3714
% over TP		0%		12.99%
% under TP		100%		87.01%
Shape	Increasing line	Inverse U-shape	Increasing line	Inverse U-shape

Note: * Robust standard errors appear in parentheses below estimated coefficients. CD test – Pesaran CD test for cross-sectional dependence in panels, BPG test – Breusch-Godfrey/Wooldridge test for serial correlation in panel models, BP test – Studentized Breusch-Pagan test for heteroscedasticity. Signif. codes: '***' 0.01 '**' 0.05 '*' 0.01.

Source: Author's calculations.

We do not interpret these results as a contradiction to the previous finding that more market power leads to a riskier loan portfolio. Banks with higher market power also enjoy greater overall bank stability, which suggests that they protect themselves with other risk management methods.

Finally, we briefly consider our control variables. According to the results, we can see that the stability indicators in the previous period had a significant impact on the level of stability in the next period. We can see that increasing level of overall bank stability will also lead to an increase in overall stability in next year. On the other hand, loan stability decrease can predict a decrease also in the next year. Therefore, we can see, that the previous information about bank stability influences the current level of bank stability, which is in line with the study of Agoraki, Delis and Pasiouras (2011), Jiménez, Lopez and Saurina (2013), Noman, Gee and Isa (2018), Ahi and Laidroo (2019), Kanas et al. (2019), Ijaz et al. (2020). With the increase in the share of fixed assets to total assets the overall bank stability increases (coefficients in Model 5, 6, 7, and 8 are positive and statistically significant) and loan stability also increased (coefficients in Model 1, 2, 3, and 4 are negative and statistically significant), which is in line with the study of Leroy and Lucotte (2017). The share of non-interest income to total income has a positive and statistically significant impact on overall bank stability in the case of Model 7. The effect on loan stability is negative but statistically insignificant. We can suppose that with the application of additional fees, the probability of client default increases as overall loan cost increase, and therefore, banks have to create a higher value of loan loss provisions. On the other hand, the additional fees increase the overall income of commercial bank and therefore positively influence the performance indicators like ROA, which can increase the overall bank stability. The bank size is statistically significant only in case of models where we applied Z-score as a proxy of bank stability. We can see that bank size has a negative effect on overall bank stability, which is in line with the study of Berger, Klapper and Turk-Ariss (2009), Schaeck and Cihák (2014), Noman, Gee an Isa (2018), Albaity, Mallek and Noman (2019). It confirmed the findings of inverse U-shape where the biggest banks are in the part of the curve where with increasing market share the overall bank stability decrease. The share of total loans to total assets is also significant only in Models 5 – 8. We use the ratio of total loans to total assets as a measurement of liquidity, where the largest ratio indicates a lower level of liquidity. As we can see in Models 5 – 8, the sign of the coefficient is always negative, which was found out also by Berger, Klapper and Turk-Ariss (2009). It indicates that banks with a larger percentage of loans (relative to total assets) have higher fragility (lower stability). From the macroeconomic variables, the gross domestic product was

significant and negative in Models 1 – 4, indicating that during the period of economic growth, the loan loss provisions decrease. We can suppose that during the period of economic growth, the probability of client default is lower as there is a higher level of employment and the level of wags usually also increase. On the other hand, during the recession, the probability of client default increases, and therefore, the level of loan loss provisions have to increase. Within the Models 5 – 8, the gross domestic product was significant and positive, indicating the increase in overall bank stability during the period of economic growth (or decrease in overall stability during the recession), which is in line with the study of Berger, Klapper and Turk-Ariss (2009), Amidu and Wolfe (2013), Jiménez, Lopez and Saurina (2013), Schaeck and Cihák (2014), Leroy and Lucotte (2017), Noman, Gee and Isa (2018), Ahi and Laidroo (2019). Inflation is significant in Models 1 – 4, and the sign of the coefficient is always negative (Leroy and Lucotte, 2017; Noman, Gee and Isa, 2018). It can be affected by the decision of the central bank to increase the level of inflation by setting up a lower level of interest rates. Also, the commercial banks have to change the level of their interest rates on loan and deposits. The decrease in loan rates is usually more significant than in case of deposit rates, which do positively influence the level of client default probability and therefore, the loan stability of the commercial bank increase.

Conclusions

This paper focused on the analysis of the sample of global systemically important institutions (G-SIIs) located in the EU countries over the 2008 – 2017 period. We wanted to assess the relationship between bank competition and bank stability, to determine variables with a significant impact of their stability. We use two proxies of bank competition: the Lerner index and a market share, and two proxies of bank stability: loan loss provisions and the Z-score. In examining this relationship, we tried to find answers to the three research questions. Within the first research question (Does the level of competition on the market affect the stability of global systematically important banks?) we have identified that the level of competition had a significant impact on bank stability in case of global systematically important banks also in case of the linear relationship as well as in the case of non-linear relationship.

To answer the second research question (Does the stability of banks increase or decrease when the competition is higher?) the results are not clear and differ for different measures of stability. In the case of linear analysis, the results were in line with the "competition-loan stability" paradigm and in line with "competition-fragility" paradigm when the overall stability was considered. In the case of

non-linear analysis, our empirical results pointed to U-shape between the Lerner index and loan loss provisions and inverse U-shape between the Lerner index and Z-score. In the case of the market share, we have found out inverse U-shape between the market share and both proxies of bank stability. It means that a higher degree of the Lerner index was associated with an increase in the overall bank stability and with a decrease in loan loss provisions up to a certain turning point, after which the relationship between competition and bank stability turned negative. We could see that 100% of banks were under the turning point implying that 100% of the data were in the part of the curve where with the increase of the Lerner index Z-score increased. In case of loan stability, 77.60% of banks were over the turning point, implying that 77.60% of data were in the part of the curve where with an increase of the Lerner index the loan loss provisions also increased. The result related the market share indicates that a higher degree of market share was associated with an increase in overall bank stability and with a decrease in loan stability (increase in loan loss provisions) up to a certain turning point, after which the relationship between competition and bank stability turned negative. We could see that more than 87% (respectively 77.27%) of banks were under the turning point implying that more than 87% (respectively 77.27%) of the data were in the part of the curve where with the increase of market share Z-score increased (respectively loan stability decreased). This way, we can conclude that also in the case of non-linear analysis, we confirmed the "competition-stability" paradigm when loan stability is considered and "competition-fragility" paradigm when the overall stability is considered. We do not interpret these results as a contradiction to the previous finding. Banks with higher market power used to create riskier loan portfolio, but these banks also enjoy more excellent overall bank stability, which suggests that they protect themselves with other risk management methods.

Regarding policy implications, the policymakers should aim at monitoring and regulate the banking industry. They should put greater emphasis on mergers and acquisitions, to avoid a significant decrease of the bank competition, and also mitigate potentially adverse effects of high market power on banking stability (Leroy and Lucotte, 2017).

They also have to regulate and monitor small banks on the market, because "too much" competition may result in greater instability of the whole banking sector. The regulators should have in mind the strong linkage between market power and risk-taking, which should have an impact on the whole banking sector. The results are essential for regulating authorities, showing that after the defined turning point the level of competition can endanger the stability of the whole banking sector. We could see that today an only small number of banks is

located above the turning point and in the case of these banks, increase of market share can lead to decrease of the overall bank stability. Therefore, these banks should be under more profound oversight of regulatory authorities as the instability in case of global systemically important banks can lead to instability in the banking sector of all the EU countries.

And finally, the answer to the third research question (What are the other factors that affect the stability of these banks?) pointed to the fact that increasing share of fixed assets on total assets, increasing bank liquidity, economic growth had and lagged stability had a positive impact on bank stability.

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