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**COMPETITION IN THE EUROPEAN BANKING SECTOR BEFORE AND AFTER
THE FINANCIAL CRISIS IN 2008**

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THE EXAMPLES OF GERMANY AND PORTUGAL

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Abstract

This paper studies the level of banking competition in two European countries, Germany and Portugal, for the period from 2006 to 2015 in order to draw indications on its impact on economic and financial stability. Banking competition is measured using the Panzar-Rosse test and the Lerner Index, two statistical tests developed for this matter. The results of the tests illustrate a consistently higher level of competition in the German banking sector than in the Portuguese around the financial crisis. Following from this, this paper supports the assumption that higher bank competition might be seen as an indicator for increasing financial stability.

Keywords: banking competition, financial crisis, financial stability, Germany, Portugal

I. Introduction

The development of competition and concentration in the banking industry and its impact on financial stability has been a topic of discussion for decades. It has particularly been questioned how far different states of competition in banking markets foster or alleviate financial fragility and economic stability. Whereas positive effects of competition like increased levels of innovation and efficiency within financial products are widely accepted, academic literature has not yet reached an agreement upon adverse impacts on stability. As the most recent financial crisis of 2008 has once more reinforced the relevance of the topic, this paper aims to contribute to the empirical literature by regarding the relationship between competition in banking and financial instability. Therefore, a cross-country comparison between Germany and Portugal has been conducted on the competitive behaviour of the two banking markets in order to take indications on the hypothesis that different levels of competition influenced the impact of the financial crisis and the ability to recover from it. To analyse the impact of competition on the

stability of banking markets, it is necessary to measure competition in an adequate manner, which is the objective of this paper. For future research it is necessary to establish an empirical connection between levels of competition and financial stability.

The reason to investigate this research question for the stated countries is twofold. Foremost, the existing empirical literature on the topic reveals a gap with regards to studies analysing banking competition in Europe after the financial crisis. Although some studies have assessed this issue also after the crisis, they have focussed either on a single country or have analysed data on an aggregate EU level without distinguishing between competition in different EU countries. However, due to the substantially different impact the financial crisis had on EU countries, a direct comparison between two countries can reveal relevant information on the effect of banking competition on financial stability. Hence, this paper can contribute to fill this gap, as, to the best knowledge of the author, no study comparing two countries has been performed for the mentioned period. Secondly, the cause for observing data from Germany and Portugal lies in the specific characteristics and differences between the countries. First of all, while Germany is the EU's largest net creditor country (i.e. a country, that holds more financial assets abroad than liabilities), Portugal is one of the largest net debtors in the EU¹ (Obrzut, 2016). Moreover, Portugal has been one of the countries most affected by the recent financial crisis and has consequently received support in a joint rescue operation by the European Commission, the European Central Bank and the International Monetary Fund, the so-called Troika (European Commission, 2011). In addition to this, a major geographical and size difference separates both countries' economies, as Germany is the largest European economy and accounts for over 20% of the GDP of the EU, whereas the significantly smaller Portuguese economy amounts to only 1.2% of the EU's GDP (Eurostat, 2017). Considering these factors could lead to empirical results potentially providing noteworthy indications for other EU

¹ In 2015 Germany registered a net international investment position (IIP) within the EU of 1,482 billion Euro (49% of the country's GDP), while Portugal's net debt amounted to 196 billion Euro (109.6% of the country's GDP) (Obrzut, 2016).

countries, such as general competition disparities between economies of different size or economies in different creditor-debtor positions.

The remainder of this paper is structured as follows. In Section II a short overview will be given on the state of empirical literature on the relationship between banking competition and financial stability. Moreover, different methodologies for measuring competition will be introduced and briefly discussed, before the respective methodology and data selection underlying this paper will be explained in more detail in the Section III. Section IV contains the empirical results and analysis of the study in context of the research question and Section V will conclude this paper by highlighting the main findings and implications for the topic.

II. Literature review and empirical evidence

The extensive literature on the interdependence between banking competition and systemic financial stability can historically be classified into two opposing groups, namely the “competition-fragility” and the “competition-stability” theories (Berger et al., 2009). The former is based on the traditional idea of the “charter value hypothesis” as introduced by several authors (Keeley, 1990; Saunders & Wilson, 2001), which states that competition decreases banks’ market power and hence leads to shrinking profit margins. Hellmann et al. (2000) note that the following erosion of the banks’ franchise value² leads to decreasing opportunity costs of bankruptcy, which potentially incentivises excessive risk-taking behaviour and jeopardises individual bank’s and systemic stability. For this reason, proponents of the theory contend that competition in the banking segment is leading to increased financial instability (Allen & Gale, 2000; Keeley, 1990). An additional argument is that banks operating in less competitive markets and thus earning higher profits from interests, are more willing to monitor their respective borrowers, while a smaller number of banks enables better monitoring by regulators as well, which would have a risk decreasing effect (Allen & Gale, 2000). Furthermore, it is

² Hellmann, Murdock, & Stiglitz (2000) define franchise value as “the capitalized value of expected future profit”.

argued that large sized banks can diversify their business risk more effectively, implying that it is favourable to establish a system featuring a small number of large banks in order to prevent fragility (Allen & Gale, 2004; Beck, 2008). Finally, this idea of competition being detrimental for stability in the banking industry is supported by the evidence found in several empirical studies (Berger et al., 2009; Jiménez et al., 2013; Repullo, 2004).

In contrast to that, proponents of the “competition-stability” theory counter that increasing banking market competition decreases both the risk of individual banks’ failure as well as the systemic risk for several reasons. First, it is argued that in a system dominated by a few banks, the existing market power enables these banks to charge higher interest rates to firms and other clients. Consequently, these clients are incentivised to take on greater risk to compensate for the increased costs, leading to a more fragile financial system due to the borrowers’ behaviour (Boyd & De Nicoló, 2003; Boyd et al., 2010). In addition, large banks are often seen as being system-relevant and have profited from government bailout subsidies following their own distorted risk-taking behaviour in the past. The underlying “Too Big to Fail” assumption in correlation with the increasing complexity of large banking organisations can be seen as another reason to support the stability promoting impact of banking competition (Acharya et al., 2011; Restoy, 2017). Moreover, a more competitive banking system is less fragile to shocks, due to the fact that banks operating in this system are forced to diversify their risk exposure (Anginer et al., 2014). These ideas have been complemented by numerous empirical studies, which support the hypothesis of bank competition being conducive to stability in financial systems (Akins et al. 2016; Fernández et al., 2016; Leroy & Lucotte, 2017; Schaeck et al., 2006).

Proponents of these theoretical streams have tried to assess the degree of competition in the banking industry using different methodologies, which can be divided into the two major groups of structural and non-structural techniques. Structural approaches make use of

concentration measures describing the structure of a market as an indication for market power and competition. Several empirical studies are based on structural approaches with general concentration ratios (Akins et al., 2016; Casu & Girardone, 2009; Koetter, 2013) and the Hirschman-Herfindahl Index (Berger et al., 2009; Carbó et al., 2009; Jiménez et al., 2013; Koetter, 2013) being the most widely used techniques. However, these structural indicators have delivered ambiguous results in the past and are seen as a weak measure for banking competitiveness (Berger et al., 2004). For example, several studies have illustrated situations in which concentrated banking markets were found to display highly competitive behaviour, while certain unconcentrated markets have shown signs of considerable market power of single banking organisations. The implied assumption that concentrated markets are not competitive is therefore at least questionable and raises legitimate doubts about the validity of structural metrics to measure banking competition (Claessens & Laeven, 2004; Shaffer, 2004).

Following from that, the majority of recent empirical literature is based on non-structural competition measures such as the Lerner Index (Anginer et al., 2014; Berger et al., 2009; Cruz-García et al., 2017; Leroy & Lucotte, 2017; Spierdijk & Zaouras, 2017) or the Panzar-Rosse H-statistic (Amaral, 2015; Amaral & Machado, 2017; Apergis et al., 2016; Bikker & Haaf, 2002; Claessens & Laeven, 2004; Koetter, 2013; Schaeck et al., 2006; Weill, 2013). These approaches assess banking competition by directly analysing banks' behaviour and their consequential market power in relation to other market participants' behaviour. By doing so, these measures take into consideration that factors such as the general contestability of a market, entry and exit barriers or potential outside competition might not be reflected in the market structure and concentration (Casu & Girardone, 2009; Panzar & Rosse, 1987). Hence, non-structural techniques have the advantage of eliminating the beforementioned source of error arising from the assumption that the degree of competition can directly be derived from market structure information (Moch, 2013; Weill, 2013). In this study banking competition will

be assessed using both the non-structural Panzar-Rosse statistic and the Lerner Index. The combination of these two tests is anticipated to enhance the validity of the results compared to using only one test.

The existing empirical analyses based on non-structural competition measures are diverse with regards to their regional focus and the observed time periods. Whereas most of the studies consider data from years up to the financial crisis, only a few like Barbosa et al. (2015), Koetter (2013) or Weill (2013) have extended their sample to the period after the financial crisis, while utilising the Panzar-Rosse methodology. However, in terms of geographical focus, these studies have only measured competition in single countries. Combining the attributes of regional focus and considered time frame, to the best of the author's knowledge no existing empirical study using the Panzar-Rosse approach is incorporating a cross-country comparison of banking competition in the EU after the financial crisis. Thus, this paper can make a contribution to the existing literature by comparing and analysing the competitive structure in two EU member countries, Germany and Portugal, in the period between 2006 and 2015.

III. Data and methodology

The first test used in this paper to assess the level of banking competition is the Panzar-Rosse model as adopted by Amaral (2015) and Amaral & Machado (2017) based on the propositions of Panzar and Rosse (1987), Bikker and Haaf (2002) and Bikker et al. (2007). The approach defines three models of oligopolistic, competitive and monopolistic markets and distinguishes between these using the test statistic H . This test statistic is defined to be a measure of banks' competitiveness in a certain market and is retrieved using a reduced-form revenue equation on the basis of two assumptions. First, it is assumed that a bank's operations can, similar to other firms, be expressed by a production function $y_i = f(x_i, \dots, x_n)$, where y_i are outputs and x_i denotes all inputs, while operating in a long-term equilibrium. In relation to that, the bank's profits are described by $P = R - C = R(y_i, z_i) - C(y_i, x_i, w_i, t_i)$, with $R(y_i, z_i)$ corresponding

to the revenue function, which is affected by various exogenous variables z_i . Similarly, the cost function $C(y_i, x_i, w_i, t_i)$ contains several input prices (w_i) and exogenous variables (t_i) influencing the bank's costs. Following from that, the second assumption implies that a bank maximizes its profit when marginal revenue equals marginal cost (asterisk refers to marginal values) in a perfectly competitive market with free entry and exit:

$$R^*(y_i, z_i) - C^*(y_i, x_i, w_i, t_i) = 0 \quad (1)$$

The model measures the market power of a bank by verifying the extent to which a change in input prices ∂w_i affects equilibrium revenue ∂R_e . More specifically, the alteration rate of revenues to collective changes of input prices is assessed by $\sum_{i=1}^n \frac{\partial R_e}{\partial w_i}$. Based on this, Panzar and Rosse define the test statistic H as a competition measure, which equals the elasticity of revenue as a result of aggregated changes in input prices:

$$H = \sum_{i=1}^n \frac{\partial R_e}{\partial w_i} \frac{w_i}{R_e} \quad (2)$$

They proved that in existence of a monopoly H will be zero or negative because increasing input prices will increase marginal cost and consequently reduce both equilibrium output and revenues. The same applies for a perfectly colluding oligopoly. In contrast, a perfectly competitive market implies that input price increases do not negatively influence revenue and output, hence H is larger or equal to 1 in this case. This assumes that in perfect competition the least efficient firms will exit the market as a result of rising input prices, which increases outputs and revenues of all other firms. A situation featuring an H in between of these limits illustrates a form of oligopoly, which only in the long run displays certain features similar to perfectly competitive markets. This state is referred to as monopolistic competition and it implies an intermediate behaviour in the interaction of input prices, outputs and revenues.

Following this framework, Amaral (2015) and Amaral & Machado (2017) established an empirical panel data test, which is used in this paper. The baseline specifications of this regression model are:

$$\ln IRA_{it} = \alpha + \delta_1 \ln W_{L_{it}} + \delta_2 \ln W_{K_{it}} + \delta_3 \ln W_{F_{it}} + \gamma_1 \ln DTD_{it} + \gamma_2 \ln LA_{it} + \gamma_3 \ln IBL_{it} + \gamma_4 \ln OBSA_{it} + \gamma_5 \ln AB_{it} + \gamma_6 \ln KA_{it} + \gamma_7 \ln OIIR_{it} + \varepsilon_{it} \quad (3)$$

While the dependent variable in (3) is the natural logarithm of interest revenue divided by total assets (*IRA*), the test has also been conducted using the natural logarithm of interest revenue without dividing it by total assets (*IR*). The independent variables can be divided into input prices and various exogenous variables, which are included to capture the differing costs, risks and structural components of all banks. With regards to input prices it was necessary to use proxies due to data constraints. The variable for labour costs (W_L) would have been described best using the ratio of total wage expenditures to the total workforce. However, as information on personnel could not consistently be extracted especially in the case of smaller banks, the ratio of total wage expenditures to total assets was used as a proxy. Similarly, the price of physical capital (W_K), which is defined as the capital expenditures of a bank related to the assets used for production, needed to be proxied as well. Due to missing immediate figures for these expenditures on physical capital, the variable was estimated by a residue between total costs excluding interest and wage expenses, which was divided by fixed assets. The last variable for input prices is the average funding cost (W_F). As it is derived from the ratio of interest paid to interest bearing debt, it is a comparably better estimate for the true variable. Based on this, the *H*-statistic corresponds to the sum of coefficients of all three input price variables so that: $H = (\beta_1 + \beta_2 + \beta_3)$.

The first exogenous variable is related to the funding mix and is indicated as the ratio of a bank's demand deposits to total debt (*DTD*). In addition to that, two variables are introduced to measure both the credit risk as well as the credit mix. While the former variable divides loans

by total assets (*LA*), the credit mix variable is retrieved when dividing interbank deposits by loans (*IBL*). An additional variable is implemented to account for the banks' activities transcending mere financial intermediation and is measured as the ratio of off-balance sheet activities to total assets (*OBSA*). Furthermore, branching is quantified as total assets divided by total branches (*AB*), whereas the banks' assumed risk is measured by the capital-assets ratio (*KA*). Finally, the ratio of other revenue to interest revenue (*OIR*) is introduced, in which other revenue includes all reported income items next to interest revenue such as return on foreign exchange operations or commissions revenue. The model is complemented by an error term ε . The test was moreover conducted using dependent variables described by both total revenue (*TR*) and total revenue divided by total assets (*TRA*), while maintaining all other specifications.

Although the Panzar-Rosse model has been widely applied in empirical literature, some of its specifications and interpretations have been a topic for discussion. First of all, the above-mentioned use of total assets in the dependent variable has been opposed by certain authors. While the introduction of total assets was meant to be a practical solution to scale the dependent variable in order to consider a bank's size, the suitability of this specification has been questioned. The reason for this is that a scaled dependent variable must be interpreted as the bank's lending rate, which subsequently "transforms the revenue equation into a price equation" (Bikker et al., 2007). Following from this, the model only measures price competition without regarding other forms of competition, which leads to a serious misspecification (Bikker et al., 2007; Goddard & Wilson, 2009). Many recent studies have adopted this interpretation (Bikker et al., 2012) and this paper similarly responds to the criticism by using both scaled and unscaled dependent variables. Another criticism of the model is related to the interpretation of its test statistic H . As described before perfect competition in a long-term equilibrium would present $H = 1$, whereas a situation of monopoly would equal a test statistic of $H \leq 0$. However, Bikker et al. (2012) have shown that it is possible to obtain a negative value for the H -statistic in a

situation of highly competitive conduct in the short run, whereas the actual interpretation of the result would be to assume a monopoly or perfectly colluding oligopoly. At the same time, Shaffer & Spierdijk (2013 and 2015) introduced several theoretical scenarios based on a situation of monopoly or colluding oligopoly, which exhibit positive values for the *H*-statistic and therefore contradict the original interpretation.

Due to these potential limitations of the Panzar-Rosse approach, other models have been used to test for the degree of bank competition by the beforementioned authors. However, these other measures such as the Lerner Index or the Boone indicator entail validity compromising problems as well. For example, the Lerner Index only incorporates price related competition without acknowledging other possible competition factors like product and service variation or accessibility (Léon, 2014). In addition, the Lerner Index uses marginal costs as a variable. Since these costs are not directly observable from bank accounting data but are retrieved using varying econometric calculations, the resulting statistics are heavily depending on the underlying techniques and assumptions (Amaral & Machado, 2017). Similarly, the more recent Boone indicator implies certain problems such as an ambiguity within the interpretation of its results much like in the case of Panzar-Rosse tests (Léon, 2014). Therefore, none of the proposed measures can produce absolutely sound results and be seen as preferable to other methods. Instead, each test needs to be used and interpreted against the background of its flaws. Thus, this paper uses the Panzar-Rosse approach in the full knowledge of its potential problems, while also conducting the Lerner Index in order to compare the outcomes and hence address any potential limitations of both tests.

The Lerner Index is calculated on individual bank level and is defined as “the difference between price and marginal cost as a percentage of price” (Leroy & Lucotte, 2017). When comparing these figures, Lerner (1934) assumes that a situation of “social optimum [...] is reached in perfect competition” and is illustrated by output prices and marginal costs being

equal. Therefore, a high index figure corresponds to a state of low competition and vice versa. More precisely, the index ranges between zero and one, and while an index value of zero indicates perfect competition, a monopoly is assumed when the index is equal to one. As stated by Leroy and Lucotte (2017), the Lerner index has one substantial advantage over other measures, which is the ability to assess the development of competition over time at the individual bank level. Hence, the use of this test index cannot only enhance the findings of this paper by reassessing the results of the main Panzar-Rosse test but moreover by adding information on the progression of banking competition in both countries.

In this paper the author follows the methodological approach proposed by Anginer et al. (2014), estimating the following log cost function with price of funds (W_F), price of labour (W_L) and price of physical capital (W_K) as input prices:

$$\begin{aligned} \ln C_{it} = & \alpha + \delta_1 \ln Q_{it} + \delta_2 (\ln Q_{it})^2 + \delta_3 \ln W_{F_{it}} + \delta_4 \ln W_{L_{it}} + \delta_5 \ln W_{K_{it}} + \\ & \delta_6 (\ln Q_{it} \times \ln W_{F_{it}}) + \delta_7 (\ln Q_{it} \times \ln W_{L_{it}}) + \delta_8 (\ln Q_{it} \times \ln W_{K_{it}}) + \\ & \delta_9 (\ln W_{F_{it}})^2 + \delta_{10} (\ln W_{L_{it}})^2 + \delta_{11} (\ln W_{K_{it}})^2 + \delta_{12} (\ln W_{F_{it}} \times \ln W_{L_{it}}) + \\ & \delta_{13} (\ln W_{F_{it}} \times \ln W_{K_{it}}) + \delta_{14} (\ln W_{L_{it}} \times \ln W_{K_{it}}) + \varepsilon_{it} \end{aligned} \quad (4)$$

While W_F and W_L are the same ratios as for the Panzar-Rosse test, W_K in this test is calculated using total assets instead of fixed assets. Furthermore, C_{it} represents the banks' total costs and Q_{it} is expressed by total assets as a measure for the output quantity of each bank. Several of the resulting coefficient estimates from the regression in (4) are then used to compute the banks' marginal cost estimates by applying the following equation:

$$MC_{it} = \frac{C_{it}}{Q_{it}} \times (\delta_1 + 2 \times \delta_2 \ln Q_{it} + \delta_6 \ln W_{F_{it}} + \delta_7 \ln W_{L_{it}} + \delta_8 \ln W_{K_{it}}) \quad (5)$$

Finally, the Lerner Index is defined as:

$$LI_{it} = \frac{P_{it} - MC_{it}}{P_{it}} \quad (6)$$

with P_{it} representing the output price expressed as the ratio of total revenue to total assets.

The dataset for both countries consists of commercial banks operating at a nation-wide level, which include typical retail banking features such as demand or savings deposits. While this includes subsidiaries of foreign banks, locally restricted banks are not considered. In the case of Germany, these restricted banks include publicly owned savings banks as well as cooperative banks, as they possess certain privileges such as the right to consider loans to other public savings banks or cooperative banks as risk-free, effectively leading to underestimated capital requirements compared to other banks (International Monetary Fund, 2011; Wilson et al., 2012). In addition to that, all member banks of the “Savings Banks Finance Group” are secured under the Institutional Protection Scheme, which means that in case a public savings bank is under financial distress, all other savings banks are obliged to provide financial support (Savings Banks Finance Group, n.d.). Hence, these local savings and cooperative banks are not considered due to their significantly different risk exposure and strategic objective compared to other banks, while publicly owned state banks are included if they operate country-wide similar to other retail banks. The datasets for both countries lack data for several banks for which the relevant reports could not be retrieved. However, as most of these banks are foreign subsidiaries and of small importance due to their size, their absence in the sample does not have a crucial impact on the test results.

The data for Portuguese banks was extracted directly from the bank’s financial statements as presented in the respective annual reports, while data for German banks has been retrieved from the *Bundesanzeiger*, an official publication by the German department of Justice. Hence, it was possible to derive an unbalanced panel of annual data with 173 observations for Portugal and 575 observations for Germany. A bank fixed effects OLS regression was used to estimate both models and the resulting descriptive statistics are presented in Tables 3 and 4 for the Panzar-Rosse test and in Table 5 for the Lerner Index.

IV. Test results & implications

In order to ensure the effectiveness of the Panzar-Rosse model it is necessary to test if the respective market is in long-run equilibrium, as pointed out by Panzar and Rosse (1987). Following the proposals of Shaffer (1982) and Molyneux et al. (1994) this requirement is assessed by conducting the beforementioned Panzar-Rosse test with the banks' return on assets (*ROA*) constituting the dependent variable. Using the assumption that rates of return should not show a correlation to input prices in a situation of long-run equilibrium, it was tested whether the respective *H*-statistic is significantly different from zero or not. Hence, in the latter case the existence of a long-run equilibrium can be assumed. The results displayed in the first two rows of Tables 3 and 4 respectively highlight that the *H*-statistic for Germany and Portugal does not significantly differ from zero, so that a long-term equilibrium can be assumed for both countries' bank markets.

Therefore, it is possible to assess the level of competition for Germany and Portugal using the Panzar-Rosse approach. The overall period was divided into the two sub-periods, 2006-2008 and 2009-2015, to draw possible conclusions on the state of competition before and after the financial crisis. For both periods it was tested for monopoly or a perfectly colluding oligopoly as well as for perfect competition. The test for a monopoly featured a one-sided test based on the null hypothesis that $H \leq 0$ with the alternative hypothesis being $H > 0$. Similarly, perfect competition was tested for using a two-sided test in which $H = 1$ was the null hypothesis and $H \neq 1$ described the alternative hypothesis. All test results are shown in Tables 3 and 4 as well.

The results for Germany are ambiguous and dependent on the specifications underlying the test. When the test is conducted using one of the scaled dependent variables *IRA* or *TRA*, both null hypotheses can be rejected for the sub-periods (see rows 5-6 and 9-10 of Table 3). Following from this, it could be said that the German banking sector was in a state of consistent

monopolistic competition between 2006 and 2015. However, considering the nowadays generally accepted interpretation of Bikker et al. (2007) that a dependent variable scaled using total assets coincides with a price equation, these results only describe the level of competition with regards to pricing. Hence, using these specifications it becomes apparent that price competition between German banks was on a moderate level in the period.

In order to draw conclusions on the overall level of competition, one needs to consider the test results with a non-scaled variable. As shown in rows 3-4 and 7-8, the null hypotheses for a perfectly colluding oligopoly are rejected for all sub-periods, regardless if tested for total returns or interest returns. This highlights that the German banking sector did not feature a perfectly colluding oligopoly at any point during this time. On the other hand, the test results reveal that it is not possible to reject the hypothesis of $H = 1$ for both dependent variables, thus the existence of perfect competition cannot be rejected. These results are partly differing from existing works in the current literature, which have assessed banking competition in Germany for earlier periods (Casu & Girardone, 2009; Claessens & Laeven, 2004; De Bandt & Davis, 2000; Weill, 2013). While these studies also rule out a situation of monopoly, they simultaneously reject the existence of perfect competition with the prevailing results suggesting that banks in Germany face monopolistic competition. However, it needs to be considered that the bank samples for these studies are different from the sample used in this test. Whereas publicly owned savings banks and cooperative banks have not been considered in this paper, the other works included those banks. As these banks focus on very restricted local markets they often operate in rather uncompetitive surroundings exhibiting features of monopolies or perfectly colluding oligopolies, which could explain why the results of this study indicate higher competition. Moch (2013) supports this explanation by illustrating that competition for large banks has been higher than for small banks in Germany in the years up to 2009. In fact, the

results of his study revealed that it was not possible to reject the hypothesis of perfect competition for a sub-sample of only larger banks, which is line with the results of this work.

Analysing the test results for the Portuguese dataset, it becomes apparent that the outcomes are similar to the beforementioned results for Germany when a scaled dependent variable is used for the test. As can be seen in rows 5-6 and 9-10 in Table 4, the hypothesis for a perfectly colluding oligopoly and the hypothesis for perfect competition are rejected for most tests using *IRA* and *TRA* as dependent variables. Only the test using *IRA* for the period before the crisis shows a moderate significance for a state of perfectly colluding oligopoly. As a result, the Portuguese banking sector probably also featured a state of monopolistic price competition with a potential tendency towards a perfectly colluding oligopoly.

However, the outcomes for the *H*-statistic in the Portuguese banking industry strongly differ from the German results when the non-scaled variables *TR* and *IR* are used. The test statistic is distinctly smaller than zero in both periods irrespective of the variable, which leads to rejection of the null hypothesis for perfect competition (see rows 3-4 and 7-8). In contrast to that, it is not possible to reject the hypothesis for perfectly colluding oligopoly in the Portuguese banking market for the two periods between 2006 and 2015. This outcome is different from the results of other studies such as the ones from Claessens & Laeven (2004) or Carbó et al. (2009), who find the bank market in Portugal to be of monopolistic competition. However, these studies observe different time periods and bank samples, wherefore the results cannot be directly compared to the outcomes of this study. On the other hand Amaral & Machado (2017) likewise find that a perfectly colluding oligopoly cannot be rejected for the Portuguese banking market and findings from Schoenmaker (2011) also reveal a negative *H* statistic for Portugal before 2005, both conforming with the results of this study.

In order to address possible deficiencies of the Panzar-Rosse statistic, the Lerner Index was computed for both countries as a comparable test statistic. Table 5 shows the average yearly Lerner Index for German and Portuguese banks between 2006 and 2015. As can be retrieved, these results support the outcomes for the Panzar-Rosse test to a certain extent. First, it needs to be said that the Lerner Index measures competition only at the price level, which is similar to the Panzar-Rosse test when using scaled-dependent variables. Hence, the Lerner Index supports the existence of monopolistic competition in Germany and Portugal as it is between zero and one and therefore conforms with the Panzar-Rosse test in this regard. Moreover, in conjunction with the outcomes of other studies it becomes apparent that bank market power in the Portuguese banking sector has mostly been above the European average in the past as well as in the observed period (Coccorese, 2014; Fernández et al., 2016)³. Hence, although these results do reveal a situation of monopolistic competition, they indicate a comparatively low bank competition in Portugal, which is nonetheless partly supportive to the findings of the Panzar-Rosse test in this paper. Furthermore, the results indicate that the level of average bank market power was consistently and significantly lower in Germany than in Portugal over the whole period, which also indicates distinctly higher banking competition in Germany. These results are in accordance with findings of other studies using the Lerner index, which observe levels of bank market power for the two countries similar to the ones found in this study (Cruz-García et al., 2017; Weill, 2013).

Regarding the development of competition, it can be stated that bank market power decreased in both countries from 2006 to 2011 before increasing back to near pre-crisis levels until 2015. These findings contradict the H-statistic results to a certain extent, which revealed a constant situation of perfect competition in Germany and perfectly colluding oligopoly in Portugal. This might be due to the fact that the year on year differences as shown by the Lerner

³ Coccorese (2014) states that the average LI for Portugal is 0.16 as compared to a LI of 0.09 for Southern Europe and 0.08 for Western Europe for the period 1994-2012. Fernandez et al. (2016) find the LI for Portugal to be 0.38, while the European average is 0.25 in their sample period 1989-2008.

index are not substantial enough to have a major influence on the average state of competition in the sub-periods. For instance, the results illustrate two significant drops in bank market power for Portuguese banks in 2008 and 2011. However, as the Panzar-Rosse test was conducted for the average competition over the periods from 2006 to 2008 and 2009 to 2015, these decreases are possibly offset by the considerably higher market power indicators for the other years in the period. While it could still be interesting to analyse the causes for certain changes in the development of the Lerner index, these irregularities hence do not compromise the significance of the results for the H-statistics. In general, it can therefore be stated that both the Panzar-Rosse test as well as the Lerner index deliver congruent results. However, as the Lerner Index only measures price competition, the additional results of the Panzar-Rosse test indicating a perfectly colluding oligopoly in Portugal and perfect competition in Germany would need to be validated with another form of test in the future. Nevertheless, the observation of both tests' findings illustrates a significant difference in the level of banking competition in Germany and Portugal.

In order to draw conclusions on these results it seems vital to answer two main questions. First, it is of particular interest to identify the drivers of the different states of competition in both countries. Secondly, it needs to be assessed how and to what extent the competition level has influenced financial stability and the process of recovery from the financial crisis. The first question seems to be answered in large part by the significantly different levels of concentration in the countries. Although concentration cannot always be seen as a good proxy for competition, it can still often be a pivotal explanation for the difference in banking competition, which also seems to be true when comparing these two countries. The German market is highly overbanked not only compared to Portugal but also in a Europe-wide consideration (Cermak, 2017), which subsequently leads to low concentration and distinct competitive pressure. The Portuguese banking market by contrast entails considerably higher concentration, which has even been

increasing throughout the course of the financial crisis (European Central Bank, 2017)⁴. Due to this major difference in concentration between the countries, it seems adequate to assume this to be one of the drivers of the varying levels of competition between Germany and Portugal.

Regarding the second issue the answer does not appear to be as evident. First of all, it needs to be considered that both countries have faced significant turmoil in the aftermath of the financial crisis. Germany was one of the first countries to be affected by the outburst of the American subprime crisis leading to a major bailout programme for the financial sector as well as a general economic downturn (Reiermann & Reuter, 2009; Bloomberg, 2008). On the other hand, Portugal incurred a situation of financial instability at the start of the European sovereign debt crisis a couple of years later, following from which the country applied for support from the Troika and several banks needed to be bailed out as well (Almeida, 2017; Reuters, 2011). However, the implications of these crises on the respective banking sector and overall economy have been vastly different. While German banks experienced a major drop in returns after 2008, the average return on equity remained positive throughout the crisis years (Morsink & Pradhan, 2016). Similarly, the country's economy quickly recovered from the major setback in 2009 and economic output exceeded pre-crisis levels as early as 2011 (Spiegel, 2011). Contrary to that, the Portuguese banking sector recorded almost constantly negative returns until 2016 and the overall number of employees in the industry decreased by as much as 20% as compared to 8% in Germany (Associação Portuguesa de Bancos, 2017; Oliver Wyman, 2017). Moreover, the Portuguese economy yielded negative growth rates until 2014 and has only left the Euro area's "excessive deficit procedure" in 2017 (Brunsdon et al., 2017). Combining these factors with the beforementioned results on the nature of competition, it might be reasonable to state that a

⁴ The European Central Bank report (2017) on financial integration highlights that the share of the five largest banks' total assets on the overall banking sector was around 70% in Portugal compared to approximately 25% in Germany in 2015.

higher level of competition in banking as observed in Germany can be assumed to be an indication for superior financial stability and economic recovery.

However, in order to make a definite statement on this relationship one would need to introduce a test, which clearly defines the state of financial instability and directly measures the influence of competition on this financial instability. Moreover, it is necessary to pay attention to factors outside of competition that might also have influenced the different consequences of the financial crisis in both countries. As an example, the loan quality of German banks is better not only compared to Portugal but to most other EU countries as well, wherefore German banks did not suffer as much from non-performing loans in the course of the crisis (Kiene & Hessmert, 2016). Similarly, German banks traditionally hold more long-maturity assets with interest rates being fixed for a longer time, which has helped to withstand the last years of historically low interest rates (Koch et al., 2016). At the same time, these low interest rates and the weak Euro have paved the way for the success of German companies' exports, which was the main driver for the country's economic recovery. The banking sector also benefitted heavily from this development as lending to both enterprises as well as households increased due to the positive economic outlook (Koch et al., 2016).

V. Conclusion

This paper aimed to find the best way to measure competition having in mind the relationship between banking competition and financial stability on the example of the financial crisis in 2008. In order to investigate the research hypothesis that competition in banking influenced a country's financial stability during this time as well as its economic recovery, a cross-country comparison between Germany and Portugal has been executed measuring the respective levels of competition in banking markets. The level of bank competition in both countries has been measured and classified using two different statistical models, namely the Panzar-Rosse test and the Lerner Index. While the results from both tests congruently illustrated that German

banking market has been in a situation of almost perfect competition, the results for Portugal diverged to a certain extent. The Panzar-Rosse test delivered results showing a situation where a perfectly colluding oligopoly could not be rejected for the Portuguese bank market, whereas the Lerner Index also highlighted an above average competition level but revealed more moderate results. Nevertheless, both tests combined highlighted a significantly higher level of competition in the German banking sector between 2006 and 2015 as compared to Portugal.

Hence, it seems to be reasonable to propose that the level of competition is a potential indicator for the ability of a country's banking sector and overall economy to absorb and overcome a situation of financial instability as a hypothesis to be further tested in the future. As illustrated by its results, this paper is consonant with the "competition-stability" view, whose proponents support that competition in banking fosters financial stability. However, since the relationship was not empirically tested in this paper all results must be seen as indications. Moreover, other specific factors influence the financial resilience of a country, which thus also need to be considered when assessing in how far the relation between banking competition and financial stability is described by a causality as opposed to mere correlation. Hence, in future research on the topic it would be beneficial to introduce a test measuring the direct relationship between banking competition and financial stability. Furthermore, increasing the number of observed countries as well conducting a larger variety of empirical tests in future research would enhance the validity of the results.

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Appendix

Table 1: Summary statistics - Germany

Statistic	N	Mean	St. Dev.	Min.	Max.
ROA	575	0.005	0.013	-0.160	0.094
TR	575	5,554.607	16,434.010	0.700	85,278.000
IR	575	4,401.450	14,194.790	0.031	64,675.000
TRA	575	0.059	0.046	0.013	0.369
IRA	575	0.040	0.020	0.001	0.123
WL	575	0.008	0.008	0.0003	0.079
WK	575	59.286	191.354	0.261	2,230.556
WF	575	0.036	0.043	0.002	0.280
DTD	575	0.317	0.237	0.001	0.946
LA	575	0.560	0.236	0.012	0.985
IBL	575	0.231	0.686	0.001	8.693
OBSA	575	0.283	0.286	0.000	0.516
AB	575	5,135.235	16,019.840	12.938	147,788.000
KA	575	0.061	0.043	0.007	0.654
OIR	575	0.783	2.772	0.008	14.839

Table 2: Summary statistics - Portugal

Statistic	N	Mean	St. Dev.	Min.	Max.
ROA	173	0.004	0.016	-0.062	0.061
TR	173	1,415.833	2,109.201	5.000	10,486.000
IR	173	1,024.355	1,476.053	0.800	7,326.000
TRA	173	0.064	0.027	0.017	0.230
IRA	173	0.041	0.016	0.007	0.093
WL	173	0.010	0.006	0.003	0.043
WK	173	3.782	2.754	0.578	17.889
WF	173	0.046	0.326	0.002	0.180
DTD	173	0.192	0.151	0.007	0.945
LA	173	0.595	0.230	0.024	0.970
IBL	173	0.276	1.182	0.002	13.850
OBSA	173	0.433	0.609	0.004	3.713
AB	173	171.983	373.805	15.934	2,761.057
KA	173	0.078	0.082	0.019	0.515
OIR	173	0.779	1.493	0.069	11.692

Table 3: Equilibrium Tests and Panzar-Rosse Test Results - Germany

	α	$\ln(W_L)$	$\ln(W_K)$	$\ln(W_F)$	$\ln(DTD)$	$\ln(LA)$	$\ln(BL)$	$\ln(KA)$	$\ln(OIR)$	$\ln(OBSA)$	$\ln(AB)$	H statistic	p-value ($H \leq 0$)	p-value ($H=1$)	R ²	N
(1)	$\ln(ROA)$ (2006–2008) 0.031** (0.013)	-0.002 (0.002)	-0.001 (0.001)	0.004 (0.003)	0.003*** (0.001)	0.001 (0.002)	-0.002 (0.002)	0.003 (0.002)	0.006*** (0.001)	-0.0003 (0.0002)	-0.001 (0.001)	0.001	0.6939 ^a	-	0.211	170
(2)	$\ln(ROA)$ (2009–2015) 0.011 (0.008)	-0.002* (0.001)	0.0003 (0.0004)	0.003*** (0.001)	0.002*** (0.001)	0.004 (0.002)	-0.002** (0.001)	0.001 (0.001)	0.001 (0.001)	0.000 (0.00004)	-0.001* (0.0005)	0.001	0.6383 ^a	-	0.069	404
(3)	$\ln(IR)$ (2006–2008) 4.202*** (1.578)	-0.020 (0.231)	-0.188** (0.091)	1.002*** (0.316)	-0.099 (0.157)	-0.221 (0.223)	-0.222 (0.160)	-1.211*** (0.254)	0.045 (0.150)	0.045** (0.024)	0.222** (0.096)	0.795	0.0015	0.5273	0.505	170
(4)	$\ln(IR)$ (2009–2015) 4.486*** (1.025)	-0.288** (0.172)	-0.234*** (0.058)	1.260*** (0.134)	0.380*** (0.083)	-0.246 (0.199)	-0.464*** (0.100)	-1.200*** (0.189)	0.312*** (0.112)	0.002 (0.005)	0.258*** (0.062)	0.738	0.0008	0.5311	0.490	404
(5)	$\ln(IRA)$ (2006–2008) -0.732*** (0.212)	0.184*** (0.031)	0.048*** (0.012)	0.329*** (0.042)	0.017 (0.021)	0.023 (0.039)	-0.068*** (0.021)	0.188*** (0.034)	-0.111*** (0.020)	-0.001 (0.003)	-0.027** (0.013)	0.561	0.0000	0.0000	0.706	170
(6)	$\ln(IRA)$ (2009–2015) -1.111*** (0.187)	0.199*** (0.031)	0.075*** (0.011)	0.296*** (0.024)	0.055*** (0.015)	0.160*** (0.036)	-0.047*** (0.018)	0.054 (0.035)	-0.208*** (0.020)	-0.003*** (0.001)	-0.057*** (0.011)	0.571	0.0000	0.0000	0.682	404
(7)	$\ln(TR)$ (2006–2008) 4.691*** (1.568)	0.015 (0.229)	-0.152* (0.090)	0.975*** (0.313)	-0.149 (0.156)	-0.261 (0.291)	-0.211 (0.159)	-1.267*** (0.253)	0.301** (0.149)	0.055** (0.024)	0.217** (0.095)	0.839	0.0010	0.6172	0.456	170
(8)	$\ln(TR)$ (2009–2015) 5.233*** (1.019)	-0.204 (0.171)	-0.200*** (0.058)	1.240*** (0.133)	0.378*** (0.082)	-0.229 (0.198)	-0.486*** (0.099)	-1.270*** (0.188)	0.680*** (0.111)	0.002 (0.005)	0.274*** (0.062)	0.836	0.0001	0.4519	0.454	404
(9)	$\ln(TRA)$ (2006–2008) -0.242 (0.213)	0.219*** (0.031)	0.084*** (0.012)	0.302*** (0.043)	-0.033 (0.021)	-0.017 (0.040)	-0.058*** (0.022)	0.132*** (0.034)	0.145*** (0.020)	0.005 (0.003)	-0.032** (0.013)	0.605	0.0000	0.0000	0.735	170
(10)	$\ln(TRA)$ (2009–2015) -0.364* (0.204)	0.243*** (0.034)	0.110*** (0.012)	0.276*** (0.027)	0.053*** (0.016)	0.176*** (0.040)	-0.070*** (0.020)	-0.015 (0.038)	0.160*** (0.022)	-0.003*** (0.001)	-0.041*** (0.012)	0.629	0.0000	0.0000	0.604	404

Table 5: Average Lerner Indices for the German and Portuguese banking sector

Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	\emptyset
Germany	0,101	0,072	0,017	0,020	0,076	0,042	0,084	0,099	0,108	0,113	0,073
Portugal	0,278	0,219	0,128	0,190	0,154	0,084	0,163	0,178	0,193	0,209	0,180

Table 4: Equilibrium Tests and Panzar-Rosse Test Results – Portugal

	α	$\ln(W_L)$	$\ln(W_K)$	$\ln(W_F)$	$\ln(DTD)$	$\ln(LA)$	$\ln(BL)$	$\ln(KA)$	$\ln(OIR)$	$\ln(OBSA)$	$\ln(AB)$	H statistic	p-value ($H \leq 0$)	p-value ($H=1$)	R ²	N
(1)	$\ln(ROA)$ (2006–2008) 0.003 (0.019)	0.0002 (0.005)	-0.0002 (0.002)	-0.002 (0.002)	0.002 (0.002)	-0.001 (0.003)	-0.002 (0.002)	0.003 (0.004)	0.004 (0.002)	-0.001 (0.001)	0.002 (0.001)	-0.002	0.6554 ^a	-	0.298	49
(2)	$\ln(ROA)$ (2009–2015) -0.021 (0.020)	-0.003* (0.004)	-0.007*** (0.002)	0.003 (0.002)	0.010*** (0.002)	-0.006* (0.004)	-0.003* (0.003)	0.007* (0.003)	0.008*** (0.003)	-0.002 (0.001)	0.007*** (0.002)	-0.007	0.3014 ^a	-	0.397	124
(3)	$\ln(IR)$ (2006–2008) 3.322 (3.624)	-0.516 (0.890)	-0.014** (0.407)	0.665** (0.320)	0.047 (0.320)	1.328** (0.571)	-0.054 (0.318)	-1.156 (0.697)	0.514 (0.475)	0.153 (0.220)	0.287 (0.290)	-0.864	0.5822	0.0000	0.650	49
(4)	$\ln(IR)$ (2009–2015) -2.581* (1.530)	-2.525*** (0.332)	-0.584*** (0.184)	1.023*** (0.181)	0.311** (0.181)	1.517*** (0.278)	0.175 (0.147)	-1.321*** (0.223)	0.422** (0.202)	-0.048 (0.095)	-0.150 (0.152)	-2.086	0.6903	0.0000	0.795	124
(5)	$\ln(IRA)$ (2006–2008) -2.408*** (0.404)	0.076 (0.099)	0.039 (0.0045)	0.134*** (0.036)	-0.0004 (0.036)	0.063 (0.064)	0.005 (0.035)	-0.065 (0.078)	-0.134*** (0.053)	0.075*** (0.024)	-0.016 (0.032)	0.248	0.0306	0.0000	0.700	49
(6)	$\ln(IRA)$ (2009–2015) -1.573*** (0.296)	0.206*** (0.064)	-0.055 (0.036)	0.258*** (0.035)	0.044 (0.028)	0.086 (0.054)	-0.041 (0.028)	0.120*** (0.043)	-0.149*** (0.039)	-0.042** (0.018)	0.056* (0.029)	0.409	0.0028	0.0000	0.769	124
(7)	$\ln(TR)$ (2006–2008) 5.274 (3.439)	-0.313 (0.845)	-0.947** (0.386)	0.631** (0.304)	-0.028 (0.304)	1.421** (0.542)	-0.054 (0.301)	-0.871 (0.662)	0.739 (0.451)	0.135 (0.208)	0.321 (0.275)	-0.629	0.5076	0.0009	0.620	49
(8)	$\ln(TR)$ (2009–2015) -1.356 (1.489)	-2.456*** (0.323)	-0.563*** (0.179)	1.050*** (0.176)	0.331** (0.142)	1.501*** (0.271)	0.227 (0.143)	-1.288*** (0.217)	0.769*** (0.197)	-0.057 (0.092)	-0.112 (0.148)	-1.970	0.6529	0.0000	0.758	124
(9)	$\ln(TRA)$ (2006–2008) -0.456 (0.367)	0.279*** (0.090)	0.105** (0.041)	0.099*** (0.032)	-0.075** (0.032)	0.156** (0.058)	0.005 (0.032)	0.220*** (0.071)	0.090* (0.048)	0.058** (0.022)	0.018 (0.029)	0.484	0.0015	0.0020	0.796	49
(10)	$\ln(TRA)$ (2009–2015) -0.348 (0.305)	0.275*** (0.066)	-0.033 (0.037)	0.284*** (0.036)	0.063** (0.029)	0.070 (0.055)	0.011 (0.029)	0.154*** (0.044)	0.198*** (0.040)	-0.051*** (0.019)	0.094*** (0.030)	0.525	0.0003	0.0005	0.645	124

Results are significant for: * p < 0.1 ** p < 0.05 *** p < 0.01
a = Test was conducted using H = 0 as the null hypothesis.