Interbank Competition and Bank Credit Risk

An Investigation on the Euro Area

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Abstract: The recent financial turmoil renews the debate that bank competition improves or threatens bank soundness. In this thesis, we empirically explore this issue limiting our study to the countries within the Euro zone. As a first step, we employ advanced and precise measures to capture the competition and credit risk degree in the banking sector. Then we build the model specification based on existing theories and estimate it by various econometric methods. As shown by the results, there is strong evidence supporting the theory that higher bank competition would result in more bank credit risk especially for loan markets within the Euro zone.

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1 Introduction

The global financial crisis and its aftermath restart a debate revolving the banking system. One dimension of this debate is the effects of interbank competition on bank risk taking behavior and hence on bank credit risk. In fact, this has been an area of theoretical and empirical academic dedication since the 1990s where, however, no consensus has been reached yet. It therefore would be worthwhile to launch a further investigation for a better understanding of the relationship between interbank competition and bank credit risk.

Two competing views basically dominate the previous literature regarding the competition-stability relationship in the banking sector. The traditional view supports that greater bank competition reduces market power and profits margin, which essentially lowers the franchise value of banks. This as a result will increase banks' incentives to take on more risk for profits so as to make up the loss of declined franchise value. On the contrary, the revisionist view argues that more bank competition drags interest rates down, reducing moral hazard and adverse selection problems among borrowers and thus reducing loan default rates, which benefits bank soundness. On top of these two camps, Martinez, Miera and Repullo (2008) document a way to reconcile these two competing views and conclude a U-shaped relationship between bank competition and stability.

The objective of this thesis is to empirically examine the nature of the relationship between bank competition and bank credit risk---positive, negative or U-shaped---as suggested in theory. We conduct the investigation in the context of the banking system within the Euro zone. Among the previous studies, some papers opt for worldwide cross-country sample set to investigate the link between banking competition and stability while others concentrate on a single banking market in a particular country. The problem of the former analysis is a lack of comparability across variables due to

significant segmentation of banking sectors from one county to another. The later analysis, despite avoiding the concern of comparability, cannot be a convincing proof in general. The banking system within the Euro area provides a fertile ground to address these two weaknesses since increased integration, especially the introduction of the euro, levels the playing field which eliminates the separation of banking system to a large extent.

Another important issue in testing theories is the appropriate measures of bank competition and bank credit risk. As noted by many scholars, the structure approach (concentration ratio and Herfindahl-Hirschman index) would not suffice to capture the competition degree due to strong information asymmetry in the banking sector. As for bank credit risk measures, the effective measures are even more rare. This thesis differentiates itself from priori studies in two regards. First, we calculate multiple more precise indices to better capture and to compare the extent to which banks compete within the Euro zone. Second, we launch the empirical examination from the specialized perspective of bank credit risk and focus on countries within the Euro area where there are lack of detailed research.

By way of preview, we find reasonable evidence supporting the traditional view that greater bank competition leads to more bank credit risk. As both competition and credit risk measures put more emphasis on the lending market, the conclusion would hold especially for loan markets within the Euro zone. This implies a tradeoff for policymakers between competition and credit soundness in the banking industry.

The rest of the thesis is organized as follows. Chapter 2 contains a brief discussion of the theoretical and empirical literature relating to the nexus between bank competition, stability and risk based on which we develop our testable hypotheses. In Chapter 3 and Chapter 4, we calculate various indices measuring bank competition and bank credit risk. Chapter 5 concentrates on the empirical examination on the relationship

between bank competition and bank credit risk. Chapter 6 summarizes concluding remarks.

2 Literature Review

As noted in the Introduction, the nexus between bank competition and bank credit risk remains controversial despite the dedicated efforts that a large number of scholars have put on this issue. In this section, we will summarize the representative viewpoints both in the theoretical and empirical literature.

2.1 Theoretical Literature

The traditional competition-instability view, also called franchise value paradigm[1], was firstly developed by Keeley (1990). The main idea is that higher bank competition increases banks' risk-taking incentives. Suppose that the banking market is perfectly competitive, banks' current and future profits would be zero. Without potential to make future profits, i.e. zero franchise value, bankers will relax their investment selection requirements. They will have more incentives to take high-risk and high-yield projects as they have "nothing to lose". Conversely, if banks have some market power and hence a positive franchise value, they will be more prudent to take the risk as they have "something to lose".[2] Therefore, the franchise value paradigm suggests a tradeoff between bank competition and bank credit risk.

In support of the franchise value paradigm, an agent model developed in Keeley's seminal paper and used more recently in Allen and Gale (2004) shows that competition motivates banks to take more risk through reducing their franchise value. Matutes and Vives (1996, 2000) document that higher market power reduces a bank's

[1] See Jimenez (2007) for a review of franchise value paradigm.

[2] See Colvin (2009) for a comparative review of two different views on the nature of the relationship between bank competition and stability.

default probability in a dynamic model of imperfect competition. Likewise, Hellmann, Murdock, and Stiglitz (2000) assert that competition can exert a negative impact on the prudent behavior of banks.

The newly-emerged competition-stability view was built by Boyd and De Nicolo (2005) in challenge to the franchise value paradigm. They argue that less competition leads to higher interest rate for loans, which could increase the default possibility due to borrowers' moral hazard. As a result, banks have to deal with increased problem loans. Therefore, they support that there is a positive relationship between bank competition and stability. Boyd and De Nicolo (2005) develop the first model as a milestone in this strand of viewpoints, followed by Boyd, De Nicolo and Jalal (2006 and 2009) who further enrich the theory and moreover put forward empirical evidence.

Different from the two mainstream views above, Martinez-Miera and Repullo (MMR 2008) modify the model in Body and De Nicolo (2005) and demonstrate a U-shaped relationship between competition and bank failure risk. Specifically, the probability of bank failure first goes down but then goes up after a certain point as bank competition increases.

2.2 Empirical Literature

Degryse et al (2009) provides an excellent summary of empirical studies on the relationship between bank competition and bank stability. Similar to the theoretical debate, the conclusions of the extant empirical literature vary greatly and depend heavily on the measures chosen and data used.

Keeley (1990) uses Tobin's q which is defined as the ratio of a bank's equity market valuation to its book value to measure the degree of bank competition. He finds a positive relationship between Tobin's q and bank's solvency ratios, which on aggregate supports the franchise value paradigm. Beck, Demirgüç-Kunt and Levine

(2006) document that national banking systems are subject to a lower risk of systemic banking crisis, and hence are more stable, as the banking market becomes more concentrated. However, they cast doubts on the appropriateness of the C3 ratio and related measures as proxies for competition in a national banking system. Using the H-statistic to approximate competition, Levy-Yeyati and Micco (2007) find that an increase in bank competition leads to an increase in bank risk for eight Latin American countries.

In contrast, Boyd, De Nicolo and Al Jalal (2006) provide empirical evidence supporting a positive relationship between banks' market power and banks' failure risk. They employ Herfindahl-Hirschmann index to measure bank competition and capture bank risk using a z-score measure based on returns on assets. Schaeck, Cihak and Wolfe (2009) point out that more competitive national banking systems are less likely to undergo systemic crises according to their cross-country analysis including 38 countries. Moreover, Schaech and Cihak (2010) further support this result by showing that competition benefits bank soundness via the efficiency channel in their paper where Boone indicator is used to measure bank competition.

It is obvious that the biggest obstacle for empirical research is how to measure interbank competition and the degree of bank risk, which is part of reasons for the mixed conclusions on the exact relationship between bank competition and risk as well. Traditional indices such as concentration ratios and Herfindahl-Hirschmann index might not be accurate enough to reflect the competition degree in the banking sector due to the significant existence of information asymmetry. In terms of bank risk measures, the available measures are even more limited. And the worse thing is that most of them do not distinguish which aspect of risks they effectively approximate.

This thesis will contribute to the literature in two folds. One is that advanced measures of competition will be used to circumvent the problems associated with

Herfindahl-type indices. And the focus of bank risk will be placed on bank credit risk which is measured by the innovatively-built Credit Risk Indicator (CRI) by Wagner and Knaup (2009). The other contribution is to make up the empty land in the extant literature by investigating banks within the Euro zone where increased integration puts double competition pressure on banks.

In the end, we establish the following testable hypotheses based on the existing theories regarding the relationship between bank competition and bank credit risk.

Hypothesis 1 bank competition increases bank credit risk.

Hypothesis 2 bank competition decreases bank credit risk.

Hypothesis 3 a U-shaped relationship exists in terms of bank competition and bank credit risk.

3 Bank Competition Indices

In this section we will calculate two measures of bank competition----Lerner index and Boone indicator----both of them emphasize on different aspects of competition. In order to fulfill more accurate approximation, we first estimate the marginal cost of loans through estimating the translog cost function. Then we calculate two competition indices using estimated marginal costs.

3.1 Methodology

3.1.1 Lerner Index

Lerner index is a more accurate measure of market power than standard concentration measures. To compute Lerner index for commercial loans, we need in the first step to estimate the marginal cost of loans. In line with van Leuvensteijn et al (2007), we build the transcendental logarithmic (translog) cost function (TFC) for each country using individual bank observations. We specify a multi-product, three-output, three-

input translog cost function as follows:

$$\ln TC = \alpha_0 + \sum_{j=1}^{3} \alpha_j \ln Y_j + \sum_{i=1}^{3} \beta_i \ln X_i + \frac{1}{2} \sum_{j=1}^{3} \sum_{i=1}^{3} \gamma_{jk} \ln Y_j \ln Y_k + \frac{1}{2} \sum_{i=1}^{3} \sum_{h=1}^{3} \eta_{ih} \ln X_i \ln X_h + \sum_{j=1}^{3} \sum_{i=1}^{3} \delta_{ji} \ln Y_j \ln X_i + \varepsilon \quad (3.1)$$

where the dependent variable TC denotes the total cost of an individual bank in a certain year. Y_j are output variables including loans, other earning assets and other services (approximated by other operating income). X_i are input prices variables incorporating wage rates, deposit rates and the ratios of other operating expenses to fixed assets. The parameters α , β , γ , η and δ are to be estimated. On top of that, there are several restrictions on the parameters of the translog cost function. The symmetric restriction requires $\gamma_{jk} = \gamma_{kj}$, $\eta_{ih} = \eta_{hi}$. Furthermore, the linear homogeneity restriction requires the sum of all input price elasticities equal to 1 whereas the coefficients of the square of input prices and of cross terms have to be added up to zero respectively, i.e. $\sum_{i=1}^{3} \beta_i = 1, \sum_{i=1}^{3} \gamma_{ih} = 0, \sum_{i=1}^{3} \delta_{ji} = 0$.

According to the simplification made by van Leuvensteijn et al (2007), we derive the marginal cost MC of loans for a certain country in a particular year as follows:

$$MC_l = \frac{\partial TC}{\partial Y_l} = \frac{TC}{Y_l} * \frac{\partial \ln TC}{\partial \ln Y_l} \quad (3.2)$$

The term $\frac{\partial \ln TC}{\partial \ln Y_l}$ is the first-order derivative of Equation (3.1) of the total cost to loans.

Substituting the first-order derivative into Equation (3.2), the marginal cost of output category loans l in the banking sector within a certain country can be obtained in the following equation:

$$MC_l = \frac{TC}{Y_l} * (\alpha_l + \sum_{k=1}^{3} \gamma_{lk} \ln Y_k + \sum_{i=1}^{3} \delta_{li} \ln X_i) \quad (3.3)$$

In a nutshell, we initially estimate a separate translog cost function for the banking sector in each country based on Equation (3.1). As a next step, we calculate the

marginal cost in the loan market of each country using Equation (3.3). And eventually we obtain Lerner index by the formula $L = \frac{p - mc}{p}$, where p is the price of loans. To approximate the price of loans, we collect the ratio of interest income on loans to average gross loans for each bank of each country from the database. The ratio of interest income on loans to average gross loans reflects the average rate of interest that a bank charges on its loans. We aggregate these bank-specific ratios into country-level rates by taking the average, which approximates the interest rate of loans for each country.

3.1.2 Boone Indicator

The intuition underlying Boone indicator is that more efficient banks, i.e. banks with lower marginal costs, obtain higher profits at the expense of inefficient competitors. This profit-shift effect increases as market competition increases.

As noted in Boone et al (2005) and Schaeck and Cihak (2010), the demand curve in the banking sector where bank i produces one product (or product portfolio) q_i can be written as follows:

$$P(q_i, q_{i \neq i}) = a - bq_i - d\sum_{j \neq i} q_j \tag{3.4}$$

where each bank is assumed to have constant marginal cost c_i. The parameters a, b and d are presumed to satisfy the condition that is $a > c_i$ and $0 < d \leq b$. It is noteworthy that b denotes the market elasticity of demand and that d measures the extent of substitutability of different products in the banking sector from the viewpoint of consumers. The bank chooses the optimal output level q_i in order to maximize its profits $\pi_i = (p_i - c_i)q_i$. (3.5)

Then in the equilibrium, we get the first order condition:

$$a - 2bq_i - d\sum_{j \neq i} q_j - c_i = 0 \tag{3.6}$$

Likewise, for the banking industry with N individual banks which all produce positive output levels, we can write down the N first-order conditions:

$$q_i(c_i) = [(2b/d - 1)a - (2b/d + N - 1)c_i + \sum_j c_j]/[(2b + d(N-1))(2b/d - 1)] \quad (3.7)$$

It is assumed that profit π_i is variable profit excluding entry costs ε, which means a bank enters the market if and only if $\pi_i > \varepsilon$ in equilibrium. The intuition is that competition can increase in two ways. One is that competition increase as services and products provided by different banks become closer substitutes, i.e. the bigger d ($0 < d \leq b$). The other way to increase competition is to decline entry cost ε. Combining Equation (3.5) with Equation (3.7), the profit π_i can be expressed in a quadratic way of marginal cost c_i. $\pi_i(c_{it}) = b[q(c_{it})]^2$ (3.8)

In an attempt to calculate Boone indicator, we establish the following specification in accordance with Boone (2004 and 2008), Leuvensteijn et al (2007), and Schaeck and Cihak (2010).

$$\pi_{it} = \alpha + \beta \ln(c_{it}) + \varepsilon_{it} \quad (3.9)$$

Where π_{it} and c_{it} denote the profit and the marginal cost of bank i at time t respectively. The slope coefficient β is Boone indicator which is expected to be negative. It represents the percentage decrease (increase) in profits of bank *i* caused by one percentage increase (decrease) in marginal costs. The larger the beta is in its absolute value, the stronger the competition exists in the market.

According to Schaeck and Cihak (2010), we control a bank-specific effect to allow for heterogeneity and adjust Equation (3.9) to estimate Boone indicator across countries over time. The modified Boone indicator is based on the following equation:

$$\pi_{it} = \alpha + \sum_{t=1...T} \beta_t d_t \ln(c_{it}) + \sum_{t=1...(T-1)} \gamma_t d_t + u_{it} \quad (3.10)$$

In this setup, we use ROA (Return on Asset) as a proxy for the profit π_{it}. We get the

marginal cost of each bank from the previous estimation of translog cost function. d_t is a time dummy variable from 1999 to 2010.

3.2 Data

The translog cost function to be estimated are incorporated three variable groups: total costs, outputs and input prices. Total costs consist of interest expenses and non-interest expenses. We employ loans, other earning assets and non-interest income to approximate outputs of a typical bank while using wages, deposits and other operating expenses to measure corresponding inputs. This approach is widely considered to be an appropriate way to capture the nature of modern banks. (Green et al 2004 and Leuvensteijn 2007). The variables and their empirical proxies are summarized in Table 3.1.

[Insert Table 3.1]

In the estimation, we use annually bank-specific data from the Bankscope database covering 1999-2011. Due to a large amount of missing data, our focus is abstracted on 10 countries within the Euro area excluding Cyprus, Estonia, Finland, Greece, Malta, Slovakia and Slovenia. Also we include Switzerland, United Kingdom, Sweden and Denmark which enables us to extend the investigation to the EU. Considering data sufficiency, we include all types of bank in the data set except central bank and clear & custody bank in each investigated country. Table 3.2 gives a description of the number of banks involved in the estimation for each year.

[Insert Table 3.2]

As for Lerner index, the bank-specific ratio of interest income on loans to average gross loans is available in the Bankscope database. We take average of these ratios to approximate the country-level interest rate of loans. In terms of calculating Boone indicator, the marginal cost data is obtainable from the translog cost function. We

further calculate ROA as a proxy for profits which is defined as the ratio of net income to total assets. We estimate Equation (3.10) using ordinary least squares (OLS) adjusted for heteroskedasticity.

3.3 Empirical Results

3.3.1 Lerner Index

The marginal cost of loans for each country during 1999 to 2011 is described in Table 3.3. In Appendix 1 we present the estimated results for Germany in 2010. It is obvious that for each country the marginal cost of providing loans decreases with the process of time although the speed and magnitude of this decline vary across countries. This might be due to different development in banking technology, legislation and supervision in each country. As for countries within the Euro zone, the marginal costs are very similar except Belgium which has the highest marginal cost of loans about 6.3%. The marginal cost in Netherlands, Portugal and France are relatively high compared to the low marginal cost around 3.3% in Germany, Ireland and Spain. Among the EU group, euro countries are apparently higher than the rest of state members in terms of marginal costs of providing loans.

[Insert Table 3.3]

The intuition behind Lerner index is that greater competition in the market pushes the price of loans close to its marginal cost resulting in a smaller Lerner index. Table 3.4 presents Lerner index for each country over time. Generally speaking, Lerner indices fluctuate significantly across countries, which indicates the competition level in the loan market for each country differs considerably. Lerner indices are relatively high for Luxembourg, Germany and Ireland, meaning that the banking sectors in these countries are less competitive. By contrast, Portugal, Netherlands and France with lower Lerner indices are considered to have more competition in their lending markets. It is noteworthy that for Belgium the marginal cost of loans is very high during 2007

to 2009 which leads to the abnormal negative Lerner indices in these years. Compared to state members outside the Euro zone, the inside markets tend to be more competitive than the outside ones on average.

[Insert Table 3.4]

3.3.2 Boone Indicator

Table 5 indicates Boone indicators across countries from 1999 to 2011. In general, Boone indicators for each country are negative and significant albeit only a few positive but insignificant indicators in certain years. A possible explanation for these positive coefficients is that we do not correct for other explanatory variables such as the quality of loans. As a consequence, the estimates of Boone indicator might be lack of robustness. However, the approach that we use is proved to be effective by many studies which should be fair enough to be used in our paper.

Our results suggest on average Dutch, Austrian and Italian banking sector remain comparatively high level of competition in contrast to less competitive market in Sweden and Belgium. Furthermore, the competition in the lending market within the Euro zone is, on average, higher than that of other EU members such as Sweden, United Kingdom and Denmark. In terms of the evolution trend, our estimates of Boone indicator show a declining trend for Spain, Portugal, France, Ireland and Italy, which suggests the increasingly intensive bank competition in these countries. However, Switzerland, United Kingdom and Luxembourg have been experiencing an upward trend while Netherlands and Sweden remain rather stable when it comes to Boone indicators.

[Insert Table 3.5]

3.3.3 Correlation

It is interesting to have a look at the correlation between these two competition measures as they reflect competition degree in common but are based on different

rationales. The correlation between Lerner index and Boone indicator is about -0.12 which is rather weak. As we discussed earlier, Lerner index and Boone indicator are derived from different rationales and emphasize on different aspects of competition; therefore, the correlation could not be strong. In addition, we rank each country in terms of competition degree by both indicators (See Table 3.6). In order to make comparisons, we roughly divide these countries into two groups by average (i.e. above average and below average). We can see that most countries fall into the same group by both indices except Belgium, Austria, Sweden and Portugal. It should be noticed that the raw data for such small countries are quite limited and the estimated results fluctuate considerably, which would heavily influence their averages over years and hence their rankings. Taking this explanation into consideration, we are confident that both indices yield consistent results.

[Insert Table 3.6]

4 Bank Credit Risk Indicators

In this section we will estimate two empirical measures of bank credit risk. One is the traditional measure of loan quality, Non-performing loan ratio (NPL). And the other is Credit Risk Indicator (CRI) innovatively designed by Wagner and Knaup (2009).

4.1. Methodology

4.1.1. Non-performing loan ratio

The non-performing loan ratio (NPL) is a widely-used measure of loan quality in the priori literature. Different from Credit Risk Indicator which is a rather direct proxy for bank credit risk, the NPL indirectly reflects bank credit risk through the ratio of impaired loans relative to gross loans. In our empirical work, we use this indictor for two reasons. One is that the NPL can be obtained in the entire sample period of time, which makes up the disadvantage of short availability of Credit Risk Indicator. The

other is that we use multiple indices to capture the degree of bank competition and bank credit risk so that we could better check the robustness of our results in Section 5.

According to the standard formula, the non-performing loan ratio equals to the impaired loans divided by gross loans.

$$NPL = \frac{impairedloans}{grossloans} \tag{4.1}$$

It is worth noting that we further aggregate the bank-level non-performing loan ratio into the country-level data by taking the weighted average of each ratio, where the weight is given by the ratio of every bank's gross loans in a certain country to the whole banking sector's gross loans in this country.

4.1.2 Credit Risk Indicator

According to Wagner and Knaup (2009), the rationale of Credit Risk Indicator (CRI) stems from the balance sheet of a bank. On the asset side of a balance sheet are loans (L) and securities (S) while on the liability side are equity (E) and debt (D). These two sides are supposed to be equal in terms of market value (V (.)) which can be indicated in unit of shares as follows:

$$V(E)+V(D)=V(S)+V(L) \tag{4.2}$$

V(E) equals to a bank's share price p. V(D) can be approximated by its discounted book value at an appropriate interest rate. As for the market value of loans, we need to consider the risk of default. Suppose that PD is the probability of default and LGD is the loss given default. Therefore, the expected loss on a loan EL can be expressed as $EL = PD * LGD$. It is further assumed that there are two types of loans, high risk and low risk loans. We use h and l to denote the amount of each type of loans respectively. The value of the loan portfolio is given by:

$$V(L) = h(1-EL^h) + l(1-EL^l) \tag{4.3}$$

The Credit Risk Indicator (CRI) is defined as the share of high risk loans in the loan portfolio.

$$CRI = \frac{h}{h+l} \tag{4.4}$$

In a successful attempt to measure the expected losses on high and low risk loans, Wagner and Knaup (2009) use the prices of Credit Default Swaps (CDS) indices as proxies, denoting $EL^h = CDS^h$ and $EL^l = CDS^l$. We follow this strategy in our estimation of the CRI.

Next we write Equation (4.2) in the form of changes from which the CRI can be derived.

$$\Delta V(E) = \Delta V(S) + \Delta V(L) \tag{4.5}$$

Where Δ represents the absolute change from t-1 to t and where the debt of a bank is assumed to be constant. Furthermore, we opt for the change of a market index M as a proxy for the change of the security portfolio in accordance with Wagner and Knaup (2009) and hence we get $\Delta V(S) \approx \Delta M \frac{S}{M}$. Then substituting the proxies of loans portfolio and of security portfolio into Equation (4.4), we get the following equation:

$$\Delta p = \frac{S}{M}\Delta M - h\Delta CDS^h - l\Delta CDS^l \tag{4.6}$$

In order to implement the estimation, we add control variables to Equation (4.6) and establish the following specification at the bank level:

$$\Delta p_{it} = \partial_i + \beta_i \Delta M_t + \gamma_i \Delta CDS_t^h + \lambda_i \Delta CDS_t^l + \eta_i \Delta X_t + \varepsilon_{it} \tag{4.7}$$

Where subscript i and t represent the bank and time. The vector X contains three control variables including long-term interests, short-term interests and inflation rates. Note that we only focus on the country-level aggregate CRI in our estimation and thus we employ a pooled version of Equation (4.7) for this purpose. Then the CRI can be expressed as follows.

$$CRI = \frac{\gamma}{\gamma + \lambda} \tag{4.8}$$

4.2 Data

As for the non-performing loan ratio, our input data comes from the Bankscope database. In order to keep consistency with bank competition indicators, we only exclude central bank and clear & custody bank out of our sample when calculating the NPL. The bank-specific NPL is straightforwardly available from the Bankscope database. We further collect the absolute amount of gross loans for each bank to calculate the weight which is used for aggregation.

When it comes to Credit Risk Indicator, we collect monthly data on share prices of all listed bank in each country, two CDS indices and the market return index S&P for each country from the Datastream database. And we get long-term interest rates, short-term interest rates as well as inflation rates from the OECD database. Due to the fact that two CDS indices are only available for the last 7 years, our estimates of CRI are only from 2005 to 2011.

In terms of the high and low risk CDS index, Wagner and Knaup (2009) use “Dow Jones CDX North America Crossover” and “Dow Jones CDX North America Investment Grade”. Likewise, we opt for the European version of these indices—Markit Itraxx Europe and Markit Itraxx Crossover. Markit Itraxx Europe consists of 125 CDS referencing European investment grade credits. These reference entities are the most liquid entities traded in the CDS market and equally-weighted in the calculation. Markit Itraxx Crossover comprises 40 equally-weighted referencing sub-investment grade credits. The Itraxx indices vary considerably with different maturities ranging from one to ten years. Since the reference maturity for CDS contracts is 5 year, we use the 5-year maturity index. Furthermore, both CDS indices are expressed in basis points of spreads. A higher spread suggests a higher default risk.

Finally in order to separate the effect of different influential elements on the share

price change, we apply the orthogonalization method in accordance with Wagner and Knaup (2009) to the S&P index for each country and Markit Itraxx Europe index in the estimation of Equation (4.7).

4.3 Empirical Results

4.3.1 Non-performing loan ratio

Table 4.1 summarizes non-performing loan ratios for each country over 1999-2011. There is an apparent increase in the non-performing loan ratio during our sample period of time for all of the countries. Especially during the sensitive time of economy from 2007 on, the NPL rises significantly. Within the Euro zone, Italy is subject to the highest non-performing loan ratio (4.1% on average). Ireland, Austria and Belgium have high-level impaired loans relative to gross loans as well which on average account for 3.1%, 2.8% and 2.3% respectively. By contrast, other European countries outside the Euro zone remain definitely lower non-performing loan ratios, which is a positive sign for a healthy and stable banking market. Overall, the entire loan market within the Euro area turns out to bear more credit risk than other European countries outside due to the inferior loan quality.

[Insert Table 4.1]

4.3.2 Credit Risk Indicator

The estimated Credit Risk Indicators for each country over 2005-2011 are presented in Table 4.2. We would initially like to point out that the coefficients of CDS indices in Equation (4.7) have correct signs but not very significant. This might be because we use monthly data instead of daily data which would conceal the change of share price. However, interest rates and inflation rates are not available in more detailed frequency than monthly data. Furthermore, even if there is a bias due to the inferior data, we introduce it to all the countries so that the entire trend of credit risk for each country will not change.

As stated by Wagner and Knaup (2009), the CRI measures the relative sensitivities to the high and low risk. Therefore a higher CRI suggests a higher proportion of high risk loans relative to the low risk loans, which would increase the possibility of credit risk. From Table 4.2, we could see that the CRI fluctuates strongly so that there is no apparent time trend. Nevertheless, in the course of the global financial crisis from 2007 to 2008, the CRI is definitely higher than any other year for most of the countries. Compared countries inside and outside of the Euro area, the CRI is quite similar for the two country groups.

[Insert Table 4.2]

4.3.3 Correlation

We calculate the correlation between the CRI and the NPL to see how they are related to each other. As the result shows, the correlation is around 0.14 that is not very strong. According to Wagner and Knaup (2009), the correlation is not an efficient way to observe the association of these two indices as the information in the estimation of the CRI is not fully used in the computation of correlation.[3] As a next step, we rank each country by the CRI and the NPL to see whether both indicators suggesting the same credit risk level. From Table 4.3 we could see that there is no contradicting ranking for any country albeit that the rankings change slightly by different indicators.

[Insert Table 4.3]

5 The Empirical Evidence

In the two previous sections, we calculate multiple indicators to measure bank competition and bank credit risk respectively using various empirical methods. Each and every type of indices is based on different rationales and hence emphasizes on

[3] Wagner and Knaup (2009) develop a method to estimate the relationship between the CRI and the NPL instead of computing the correlation and demonstrate that banks with a higher NPL also have a higher CRI.

different aspects of either bank competition or bank credit risk. In this section, we will empirically investigate the relationship between bank competition and bank credit risk using these measures.

5.1 The Model Specification and Data

As discussed earlier, we establish three hypotheses corresponding to the extant theoretical development. According to the franchise value paradigm supported by many scholars in the 1990s, we put forward the first hypothesis that is bank competition increases bank credit risk. Based on the seminal studies by Boyd et al (2005, 2006 and 2009), we build the second hypothesis, opposite to the first one, that is bank competition decreases bank credit risk. On top of these, we set up the third hypothesis in line with Martinez-Miera and Repullo (2008) that is the relationship between bank competition and bank credit risk is U-shaped.

In order to test the abovementioned hypotheses, we set up the regression specification as follows:

$$R_{it} = \alpha + \beta_1 c_{it} + \beta_2 c_{it}^{\ 2} + \gamma_1 gdpg_{it} + r_2 loansize_{it} + \varepsilon_{it} \quad (5.1)$$

where the subscripts i and t refer to the country and year respectively. The dependent variable is bank credit risk measures such as the NPL and the CRI. Among independent variables, c_{it} denotes competition measures for which we will use Lerner index and Boone indicator as proxies. We include the square of competition measures in our model specification to test the U-shaped link behind the third hypothesis. The rest of explanatory variables are control variables consisting of the real GDP growth and the country-level loan size.

The coefficients β_1 and β_2 are parameters of our interest. If both parameters are significantly positive, bank competition would decrease bank credit risk, which supports Hypothesis 2. On the contrary, negative and significant β_1 and β_2 are the

supportive evidence for Hypothesis 1 that is bank competition would increase bank credit risk. And if β_1 is significantly negative but β_2 is significantly positive, Hypothesis 3 would hold, suggesting a U-shaped relationship between competition and credit risk in the banking sector. Additionally, we expect both of control variables to have negative signs since impaired loans are more likely to increase in bad times or due to excessive amounts of loans.

Regarding the data, we have already estimated bank competition and bank credit risk indices. As a supplement, we additionally collect the real GDP growth rate from the OECD database and calculate the aggregate loan size for each country.

5.2 Empirical Results

Table 5.1 presents the estimated results for countries within the Euro zone. Panel A gives the results using the non-performing loan ratio as the dependent variable while in Panel B Credit Risk Indicator is used as the dependent variable. We use various econometric methods to run the regression including OLS, fixed affects, random effects and level GMM in order. We summarize the coefficients of Lerner index as competition indicator in the first column and the coefficients of Boone indicator as competition measure in the second column for each method that we employ.

[Insert Table 5.1]

Regarding Panel A, we can see that the coefficients of bank competition measures and their squares are significantly negative in almost all the cases except the first OLS estimation in column 1. Lerner index reflects market power---a larger Lerner index implies a larger market power---but competition is lower. As for Boone indicator, it emphasizes on the effect of an increase in marginal cost on the decrease in profits. Since Boone indicator is negative, a larger Boone indicator suggests the change of marginal cost has less influence on profits, which means the market is subject to less

competition. Therefore, both negative signs for competition measures and their squares indicate that bank credit risk declines as bank competition reduces. It is strong supportive evidence for Hypothesis 1.

As for Panel B, the results become complicated. It can be seen that the relationship between Credit Risk Indicator and Lerner index are quite ambiguous. The coefficients are positive but insignificant for most of the cases. By contrast, the links between Credit Risk Indicator and Boone indicator still remain the same as Panel A. However, note that the significance of some coefficients turns out to be weakened (OLS (2) and GMM (2)). In addition, the control variables have unexpected signs and are insignificant as well, which suggests the invalidity of estimation. A possible reason might be the inaccurate calculation of the CRI. As we mentioned before, the CRI might be biased due to the low-frequency data that we applied. Although such biased CRI enables us to make comparisons over time or across countries, it could lead to problems in the model regression. Furthermore, the CRI is only available since 2005, which makes the dataset contract to a small one. This might be another explanation for the vague results in Panel B.

As a complementary proof, we estimate Equation (5.1) using all the original EU member states. Table 5.2 shows the results in the same structure as Table 5.1. On the one hand, it is very clear that the results remain the same as those for countries within the Euro zone in general. And the better part for this enlarged sample set is that the significance of coefficients is obviously improved especially for Panel B where all the coefficients of Boone indicator and its squares become significant. On the other hand, it could be treated as a robustness check of the results which further strengthens our conclusion.

[Insert Table 5.2]

Overall, we conclude with supportive evidence that an increase in bank competition

would lead to an increase in bank credit risk. Furthermore, as our measures both for competition and credit risk mainly focus on the lending market, it should be kept in mind that this conclusion is quite subject to loan markets.

6 Conclusion

The relationship between competition and stability in the banking sector has sparked much debate since the 1990s. Scholars have put considerable amounts of effort in investigating this issue, but unfortunately no consensus has been reached so far. However, the recent global crisis and the disastrous turmoil it brings to the financial system around the world put this issue on the agenda again. A convincing answer to the ambiguous nexus between bank competition and bank credit health would not only resolve the academic debate but also yield rather valuable policy implications shedding light on the chaos of the current banking industry.

Two competing views dominate the theoretical literature concerning the relationship between bank competition and bank stability. One of them supports that less competition in the banking market leaves more franchise value for banks and that in order to preserve this relatively high franchise value, bankers attempt to limit their investment projects, especially reducing the risky ones so that the bank stability could be more guaranteed. The challenging view against the franchise value paradigm emphasizes that market concentration could result in increased lending rates which raise both the default probabilities of repayment and the borrower's incentives for riskier projects. For this reason bank stability will be harmed instead of being improved. In addition, Martinez-Miera and Repullo (2007) develop a compromising theory and argue that the real relationship between competition and bank soundness presents U-shaped.

Accordingly, a large body of empirical literature emerged on the basis of theoretical

development. The conclusions however vary significantly with different research methods and different measures on bank competition, risk or stability that were employed in the studies. This on the one hand can be attributed to the root reason for non-consensus conclusion while on the other hand leaving much room for the future scholars to make improvements especially on the validity of measures.

In an attempt to further empirically explore this issue, we apply more precise indicators to approximate the competition and credit risk degree in the banking sector. We mainly focus on the lending market within the Euro zone as the advent of euro levels the playing ground to the largest extent which provides an ideal sample for our research. In order to check the robustness and make comparisons, we include four European countries out of the Euro area in the dataset that have developed banking industries. Summing up, our study distinguishes from the priori literature in two senses—using multiple more precise measures to capture bank competition and bank credit risk and concentrating on the Euro land—both of them constitute a meaningful complement to the literature.

In terms of our empirical results, we find strong evidence in support of the franchise value paradigm that is increased bank competition raises bank credit risk. To be specific, both Lerner index and Boone indicator as bank competition proxies are significantly negatively linked with the non-performing loan ratio which is a measure for bank credit risk. However, this negative nexus become weak when we approximate bank credit risk with Credit Risk Indicator built by Wagner and Knaup (2009). This might largely be due to the bias that is introduced into the CRI when we substitute daily data with monthly data in the calculation of CRI. But the better part is that the major coefficients of interest are negative despite the lower significance. We therefore conclude from the empirical results that a higher bank competition would result in a higher bank credit risk at least for countries within the Euro area.

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Table 3.1 Variables used in the estimation of translog cost function

Variable			Observable variables
Total costs		TC	interest expenses + non-interest expenses
Outputs	Loans	Y_1	gross loans
	Other earning assets	Y_2	total earning assets - gross loans
	Non-interest income	Y_3	non-interest income
Inputs	Wages	IN_1	personnel expenses
	Deposits	IN_2	interest expenses
	Other expenses	IN_3	other operating expenses
Prices of Inputs	Wage rate	X_1	approximated by personnel expenses/total assets
	Deposit rate	X_2	interest expenses/total funding
	Price of other expenses	X_3	approximated by other operating expenses/fixed assets

Source: author's summary

Table 3.2 Number of banks involved in the estimation

Country	11	10	09	08	07	06	05	04	03	02	01	00	99
Austria	65	264	289	290	308	309	281	268	235	193	182	163	137
Belgium	18	69	76	76	70	85	84	74	78	78	73	75	74
Germany	282	1709	1757	1801	1847	1856	1817	1519	1529	1636	1760	1876	1997
Spain	35	151	211	183	174	209	211	83	21	26	29	28	30
France	76	347	375	385	394	383	388	306	304	317	344	344	331
Ireland	14	39	44	47	54	54	52	34	27	30	31	37	38
Italy	189	646	683	710	722	716	706	59	64	95	133	141	169
Luxembourg	27	82	99	109	107	88	88	86	86	87	89	100	114
Netherlands	33	55	62	64	69	71	68	58	41	47	44	45	42
Portugal	18	40	45	46	45	46	39	15	8	7	9	16	17
UK	258	429	449	446	423	417	402	312	249	245	230	237	241
Denmark	90	118	128	129	108	108	100	85	74	77	76	85	76
Switzerland	312	418	454	470	494	495	510	503	465	442	373	322	315
Sweden	65	98	103	103	114	118	116	106	109	110	105	26	24

Source: author's calculation.

Table 3.3 Marginal cost of loans for each country over 1999-2011

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Austria	0,043	0,041	0,052	0,045	0,032	0,038	0,032	0,039	0,046	0,043	0,042	0,036	0,033	0,040
Belgium	0,068	0,079	0,058	0,036	0,044	0,070	0,022	0,032	0,116	0,085	0,101	0,044	n.a	0,063
Germany	0,041	0,041	0,039	0,039	0,033	0,037	0,034	0,043	0,036	0,022	0,030	0,028	0,037	0,035
Spain	0,058	0,042	0,034	0,030	0,025	0,024	0,027	0,030	0,032	0,037	0,027	0,029	0,036	0,033
France	0,061	0,051	0,076	0,074	0,062	0,045	0,044	0,047	0,041	0,040	0,033	0,035	0,032	0,049
Ireland	n.a	n.a	n.a	n.a	n.a	n.a	0,039	0,025	0,041	n.a.	n.a.	n.a.	n.a.	0,035
Italy	0,053	0,046	0,036	0,059	0,080	0,058	0,023	0,028	0,034	0,043	0,027	0,017	0,021	0,040
Luxembourg	0,081	0,075	0,060	0,051	0,047	0,032	0,036	0,050	0,032	0,034	0,031	0,030	n.a	0,047
Netherland	n.a	n.a	n.a	n.a	n.a	0,037	0,051	0,054	0,053	0,042	0,040	0,067	n.a	0,049
Portugal	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0,040	0,052	0,040	0,069	0,052	0,044	n.a.	0,049
Sweden	n.a.	n.a.	0,064	0,044	0,069	0,050	0,011	0,021	0,027	0,037	0,008	0,006	0,009	0,031
Switzerland	0,042	0,051	0,052	0,047	0,023	0,016	0,033	0,039	0,037	0,019	0,013	0,017	0,013	0,031
Denmark	0,045	0,035	0,040	0,027	0,009	0,017	0,025	0,041	0,034	0,033	0,025	0,021	0,018	0,028
United Kingdom	0,031	0,027	0,018	0,027	0,023	0,033	0,047	0,040	0,036	0,032	0,028	0,028	0,022	0,030
Average	0,052	0,049	0,048	0,043	0,041	0,038	0,033	0,039	0,043	0,041	0,035	0,031	0,024	0,040

Source: author's calculation

Table 3.4 Lerner index for each country over 1999-2011

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Austria	0,383	0,654	0,528	0,489	0,547	0,474	0,584	0,586	0,466	0,565	0,483	0,424	0,396	0,506
Belgium	0,059	0,010	0,036	0,395	0,323	-0,436	0,527	0,401	-0,993	-0,744	-0,927	0,605	n.a.	-0,062
Germany	0,559	0,582	0,623	0,625	0,639	0,606	0,637	0,510	0,640	0,788	0,656	0,639	0,754	0,635
Spain	0,058	0,494	0,390	0,210	0,058	0,384	0,445	0,497	0,568	0,694	0,439	0,389	0,063	0,361
France	0,083	0,294	-0,028	-0,355	0,347	0,467	0,476	0,497	0,536	0,567	0,593	0,480	0,390	0,334
Ireland	n.a.	n.a	n.a	n.a	n.a.	n.a.	0,224	0,874	0,721	n.a.	n.a.	n.a.	n.a.	0,606
Italy	0,233	0,338	0,686	0,410	-0,261	0,064	0,589	0,599	0,507	0,477	0,438	0,576	0,454	0,393
Luxembourg	0,829	0,850	0,893	0,875	0,863	0,859	0,874	0,867	0,946	0,953	0,868	0,796	n.a.	0,873
Netherlands	n.a.	n.a.	n.a.	n.a.	n.a.	0,439	0,239	0,393	0,846	0,397	0,478	-0,537	n.a.	0,323
Portugal	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0,563	0,699	0,635	-0,041	-0,530	0,073	n.a.	0,233
Sweden	n.a.	n.a.	0,057	0,341	-0,271	-0,047	0,755	0,549	0,530	0,399	0,806	0,859	0,834	0,437
Switzerland	0,523	0,547	0,410	0,360	0,453	0,574	0,423	0,397	0,496	0,688	0,630	0,457	0,535	0,499
Denmark	0,229	0,474	0,253	0,536	0,849	0,701	0,552	0,283	0,503	0,572	0,624	0,643	0,703	0,532
United Kingdom	0,536	0,602	0,727	0,479	0,559	0,406	0,465	0,667	0,704	0,705	0,537	0,493	0,632	0,578
Average	0,349	0,485	0,416	0,397	0,373	0,374	0,525	0,558	0,507	0,463	0,392	0,454	0,529	0,448

Source: author's calculation

Table 3.5 Boone indicator for each country over 1999-2011

year	Austria	t-statics	Belgium	t-statics	Germany	t-statics	Spain	t-statics	France	t-statics	Ireland	t-statics	Italy	t-statics
1999	-0,011	-3,350	-0,022	-0,540	0,003	1,960	-0,008	-0,110	0,029	6,180	n.a.		-0,071	-4,360
2000	-0,017	-3,000	-0,047	-4,230	-0,028	-10,980	-0,059	-3,990	-0,077	-8,210	n.a.		-0,046	-4,400
2001	-0,033	-5,770	-0,036	-5,220	-0,076	-22,900	-0,061	-7,570	-0,040	-5,420	n.a.		-0,050	-11,770
2002	-0,122	-26,680	-0,023	-3,930	-0,076	-25,190	-0,224	-5,830	-0,043	-10,830	n.a.		-0,063	-9,690
2003	-0,040	-9,730	-0,029	-6,470	-0,051	-17,290	-0,048	-1,900	-0,031	-1,960	n.a.		-0,053	-2,430
2004	-0,242	-19,550	-0,032	-4,360	-0,002	-0,880	-0,045	-7,930	-0,040	-9,690	n.a.		-0,102	-6,610
2005	-0,016	-2,550	-0,054	-5,340	-0,024	-4,900	-0,019	-6,360	-0,027	-6,000	-0,023	-3,540	-0,042	-16,370
2006	-0,127	-7,770	-0,014	-1,290	-0,021	-8,100	-0,025	-5,840	0,118	6,360	-0,042	-5,240	-0,058	-22,270
2007	-0,050	-13,140	0,142	7,790	-0,018	-5,990	-0,029	-7,650	-0,022	-4,210	-0,092	-1,130	-0,075	-17,750
2008	-0,038	-4,550	-0,133	-2,770	-0,041	-8,110	-0,035	-8,160	-0,025	-3,760	n.a.		-0,065	-4,400
2009	-0,057	-13,790	-0,033	-6,770	-0,024	-10,280	-0,014	-5,560	-0,032	-2,840	n.a.		-0,045	-0,250
2010	-0,038	-13,000	-0,031	-7,690	-0,020	-9,540	-0,029	-6,060	-0,014	-2,630	n.a.		-0,024	-0,400
2011	-0,023	-2,460	n.a.		-0,031	-5,460	-0,038	-2,250	-0,302	-9,630	n.a.		-0,085	-0,920
Average	-0,063		-0,026		-0,031		-0,049		-0,039		-0,052		-0,060	

year	Luxembourg	t-statics	Netherlands	t-statics	Portugal	t-statics	Sweden		Switzerland		Denmark	t-statics	United Kingdom	t-statics
1999	-0,051	-4,890	n.a.		n.a.		-0,038	-2,640	-0,053	-12,510	-0,015	-0,950	-0,033	-9,020
2000	-0,031	-6,570	n.a.		n.a.		0,082	10,630	-0,077	-16,120	-0,015	-1,410	-0,042	-1,810
2001	-0,035	-9,350	n.a.		n.a.		-0,010	-5,670	-0,064	-12,450	-0,083	-7,070	-0,035	-5,410
2002	-0,037	-3,370	n.a.		n.a.		-0,021	-11,830	-0,144	-14,110	-0,036	-3,800	-0,027	-4,000
2003	-0,025	-5,550	n.a.		n.a.		-0,054	-7,950	-0,032	-5,050	-0,020	-3,500	-0,013	-3,220
2004	-0,018	-4,200	-0,018	-3,340	n.a.		-0,020	-4,640	-0,021	-4,980	-0,027	-1,520	-0,039	-4,340
2005	-0,017	-5,510	0,001	0,060	-0,028	-5,640	-0,028	-9,090	-0,046	-6,370	0,000	0,090	-0,034	-5,040
2006	-0,050	-12,440	-0,058	-2,910	-0,035	-6,270	-0,021	-7,040	-0,042	-5,130	-0,011	-2,660	0,000	0,020
2007	-0,042	-15,310	-0,035	-1,850	-0,020	-3,470	-0,040	-11,380	-0,061	-8,290	-0,007	-1,580	-0,067	-4,740
2008	-0,034	-4,150	-0,563	-10,690	-0,062	-7,060	-0,023	-3,310	-0,045	-6,490	-0,032	-2,010	-0,075	-5,370
2009	-0,028	-6,290	-0,027	-2,360	-0,029	-4,330	-0,012	-4,830	-0,015	-1,270	-0,090	-6,770	-0,023	-2,490
2010	-0,023	-8,270	-0,025	-2,360	-0,047	-7,220	-0,018	-3,880	-0,032	-13,350	-0,022	-1,680	-0,040	-5,410
2011	n.a.		n.a.		n.a.		-0,026	-11,750	-0,027	-8,100	-0,043	-4,680	-0,018	-2,710
Average	-0,033		-0,104		-0,037		-0,018		-0,051		-0,031		-0,034	

Source: author's calculation

Table 3.6 Rankings of each country by Lerner index and Boone indicator

Ranking	Country	Lerner	Country	Boone
1	Belgium	-0,062	Netherlands	-0,104
2	Portugal	0,233	Austria	-0,063
3	Netherlands	0,323	Italy	-0,060
4	France	0,334	Ireland	-0,052
5	Spain	0,361	Switzerland	-0,051
6	Italy	0,393	Spain	-0,049
7	Sweden	0,437	France	-0,039
8	Switzerland	0,499	Portugal	-0,037
9	Austria	0,506	United Kingdom	-0,034
10	Denmark	0,532	Luxembourg	-0,033
11	United Kingdom	0,578	Germany	-0,031
12	Ireland	0,606	Denmark	-0,031
13	Germany	0,635	Belgium	-0,026
14	Luxembourg	0,873	Sweden	-0,018
Average		**0,485**		**-0,045**

Source: author's calculation

Table 4.1 Non-performing loan ratio for each country from 1999 to 2011

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Austria	0,018	0,017	0,008	0,017	0,032	0,021	0,015	0,013	0,018	0,023	0,045	0,062	0,077	0,028
Belgium	n.a.	n.a.	n.a.	n.a.	n.a.	0,014	0,018	0,015	0,013	0,017	0,030	0,034	0,042	0,023
Germany	0,009	0,011	0,011	0,013	0,015	0,016	0,019	0,019	0,016	0,018	0,026	0,026	0,032	0,018
Spain	0,011	0,005	0,007	0,007	0,010	0,010	0,008	0,007	0,010	0,031	0,046	0,050	0,062	0,020
France	0,000	0,002	0,004	0,003	0,005	0,004	0,019	0,019	0,021	0,023	0,034	0,036	0,038	0,016
Ireland	n.a.	n.a.	0,001	0,001	0,001	0,003	0,004	0,005	0,005	0,013	0,048	0,100	0,159	0,031
Italy	0,026	0,019	0,017	0,016	0,013	0,022	0,045	0,040	0,044	0,049	0,074	0,082	0,084	0,041
Luxembourg	n.a.	n.a.	n.a.	n.a.	n.a.	0,001	0,006	0,010	0,004	0,013	0,020	0,025	0,014	0,012
Netherlands	n.a.	n.a.	n.a.	n.a.	n.a.	0,011	0,012	0,013	0,008	0,015	0,022	0,020	0,021	0,015
Portugal	0,024	0,007	0,007	0,010	0,012	0,010	0,015	0,014	0,013	0,018	0,029	0,030	0,031	0,017
Sweden	0,021	0,017	0,014	0,010	0,009	0,003	0,006	0,005	0,004	0,006	0,013	0,012	0,010	0,010
Switzerland	0,019	0,014	0,010	0,018	0,027	0,023	0,017	0,013	0,010	0,018	0,015	0,013	0,010	0,016
Denmark	0,001	0,001	0,002	0,001	0,002	0,004	0,003	0,003	0,003	0,009	0,025	0,030	0,033	0,009
UK	0,008	0,006	0,001	0,002	0,002	0,010	0,012	0,012	0,016	0,026	0,047	0,060	0,059	0,020
Average	0,014	0,010	0,007	0,009	0,012	0,011	0,014	0,013	0,013	0,020	0,034	0,042	0,048	0,020

Source: author's calculation

Table 4.2 Credit Risk Indicator for each country over 2005-2011

Country	2005	2006	2007	2008	2009	2010	2011	Average
Austria	0.576	0.581	0.286	0.265	0.325	0.456	0.682	0.453
Belgium	0.708	0.548	0.397	0.972	0.598	0.796	0.856	0.696
Germany	0.483	0.542	0.639	0.510	0.467	0.554	0.155	0.479
France	0.647	0.336	0.293	0.179	0.531	0.198	0.340	0.361
Ireland	0.387	0.588	0.761	0.458	0.570	0.415	0.849	0.575
Italy	0.387	0.481	0.623	0.811	0.281	0.607	0.467	0.522
Luxembourg	0.262	0.536	0.652	0.284	0.267	0.341	0.300	0.377
Netherlands	0.373	0.505	0.381	0.158	0.324	0.450	0.167	0.337
Portugal	0.541	0.361	0.247	0.581	0.552	0.239	0.250	0.396
Spain	0.346	0.670	0.269	0.441	0.232	0.652	0.239	0.407
Switzerland	0.438	0.151	0.527	0.293	0.138	0.244	0.500	0.327
Sweden	0.360	0.271	0.465	0.498	0.269	0.299	0.271	0.348
Denmark	0.619	0.400	0.363	0.470	0.412	0.347	0.494	0.444
UK	0.412	0.102	0.416	0.666	0.555	0.310	0.382	0.406
Average	0.467	0.434	0.451	0.470	0.394	0.422	0.425	0.438

Source: author's calculation

Table 4.3 Rankings of each country by the CRI and the NPL

Ranking	Country	CRI	Country	NPL
1	Switzerland	0.327	Denmark	0.009
2	Netherlands	0.337	Sweden	0.010
3	Sweden	0.348	Luxembourg	0.012
4	France	0.361	Netherlands	0.015
5	Luxembourg	0.377	Switzerland	0.016
6	Portugal	0.396	France	0.016
7	United Kingdom	0.406	Portugal	0.017
8	Spain	0.407	Germany	0.018
9	Denmark	0.444	United Kingdom	0.020
10	Austria	0.453	Spain	0.020
11	Germany	0.479	Belgium	0.023
12	Italy	0.522	Austria	0.028
13	Ireland	0.575	Ireland	0.031
14	Belgium	0.696	Italy	0.041
Average		**0.438**		**0.020**

Source: author's calculation

Table 5.1 Empirical results for countries within the Euro zone

Panel A	**OLS(1)**	**OLS(2)**	**FE(1)**	**FE(2)**	**RE(1)**	**RE(2)**	**GMM(1)**	**GMM(2)**
lerner	0.004		-0.002***		-0.001***		-0.010**	
	(1.64)		(-4.47)		(-4.34)		(-2.39)	
lerner^2	-0.014**		-0.002***		-0.004***		-0.002**	
	(-2.49)		(-3.20)		(-3.45)		(-2.42)	
boone		-0.031***		-0.012**		-0.012**		-0.012**
		(-3.33)		(-2.67)		(-2.69)		(-2.69)
boone^2		-0.016***		-0.060***		-0.005***		-0.124**
		(-4.18)		(-5.13)		(-4.05)		(-2.63)
gdp	-0.261	-0.264	-0.164	-0.161	-0.188	-0.226	-0.149	-0.144
	(-4.72)	(-4.65)	(-3.77)	(-3.81)	(-4.09)	(-4.20)	(-5.69)	(-5.56)
loansize	-0.003	-0.003	-0.005	-0.005	-0.004	-0.003	-0.001	-0.001
	(-4.99)	(-5.12)	(-4.19)	(-4.15)	(-4.06)	(-3.66)	(-1.92)	(-2.00)
L1.npl							0.986	0.997
							(16.62)	(17.35)
_cons	0.032	0.027	0.033	0.031	0.032	0.029	0.009	0.007
	(7.93)	(10.09)	(5.31)	(10.37)	(3.96)	(5.24)	(3.02)	(4.01)
Panel B	**OLS(1)**	**OLS(2)**	**FE(1)**	**FE(2)**	**RE(1)**	**RE(2)**	**GMM(1)**	**GMM(2)**
lerner	-0.098		0.055		-0.096***		0.114	
	(-1.05)		(1.78)		(-2.70)		(1.04)	
lerner^2	0.126		0.004		0.125		-0.035	
	(1.13)		(0.05)		(1.24)		(-0.18)	
boone		-0.676***		-1.209***		-0.963***		-1.665**
		(-3.66)		(-3.04)		(-3.80)		(-2.75)
boone^2		-1.976		-3.580***		-2.791***		-3.534
		(-0.42)		(-3.69)		(-6.53)		(-1.34)
gdp	1.140	1.183	1.030	1.304	1.139	1.214	0.709	1.018
	(1.97)	(2.04)	(1.35)	(1.86)	(2.26)	(2.24)	(0.75)	(1.18)
loansize	0.011	0.008	0.017	0.020	0.011	0.014	0.078	0.131
	(0.64)	(0.44)	(0.40)	(0.48)	(0.61)	(0.50)	(0.94)	(1.78)
L1. cri							-0.146	-0.175
							(-0.76)	(-1.01)
_cons	0.418	0.402	0.384	0.377	0.418	0.390	0.398	0.368
	(6.83)	(13.19)	(6.76)	(16.04)	(6.92)	(10.13)	(2.49)	(3.86)

Panel A and Panel B present the estimated results for Equation (5.1) and are different in dependent variables. In Panel A we use the non-performing loan ratio as the dependent variable while in Panel B Credit Risk Indicator is used. In the parentheses are summarized t-statics and z-values. ******* and ** represent 1% and 5% significance respectively.

Table 5.2 Empirical results for original EU member states

Panel A	**OLS(1)**	**OLS(2)**	**FE(1)**	**FE(2)**	**RE(1)**	**RE(2)**	**GMM(1)**	**GMM(2)**
lerner	0.005		-0.002***		-0.003**		-0.001**	
	(2.00)		(-3.76)		(-2.69)		(-2.59)	
lerner^2	-0.011**		-0.010***		-0.003***		0.003	
	(-2.72)		(-3.25)		(-3.67)		(0.08)	
boone		-0.037**		-0.097***		-0.057***		-0.064***
		(-2.64)		(-3.46)		(-2.89)		(-4.05)
boone^2		-0.074***		-0.017***		-0.018***		-0.011***
		(-3.87)		(-3.64)		(-4.56)		(-5.36)
gdp	-0.251	-0.245	-0.147	-0.143	-0.178	-0.199	-0.141	-0.145
	(-5.15)	(-5.09)	(-4.18)	(-3.95)	(-4.72)	(-4.75)	(-6.88)	(-7.12)
loansize	-0.002	-0.002	-0.004	-0.004	-0.003	-0.003	-0.001	-0.001
	(-5.42)	(-5.71)	(-7.53)	(-7.46)	(-7.24)	(-7.04)	(-2.43)	(-2.49)
L.npl							0.956	0.958
							(17.65)	(17.73)
_cons	0.028	0.025	0.030	0.029	0.028	0.027	0.008	0.008
	(9.68)	(11.56)	(10.73)	(16.63)	(7.37)	(11.03)	(3.94)	(5.03)
Panel B	**OLS(1)**	**OLS(2)**	**FE(1)**	**FE(2)**	**RE(1)**	**RE(2)**	**GMM(1)**	**GMM(2)**
lerner	-0.093		0.036		-0.093		0.100	
	(-1.33)		(0.52)		(-1.33)		(1.10)	
lerner^2	0.098		-0.028		0.098		-0.030	
	(1.02)		(-0.26)		(1.02)		(-0.20)	
boone		-0.771***		-1.212**		-0.994**		-1.649**
		(-3.26)		(-2.77)		(-2.42)		(-2.66)
boone^2		-1.297***		-2.420***		-1.860**		-3.351**
		(-4.79)		(-3.18)		(-2.63)		(-2.65)
gdp	0.490	0.460	0.350	0.496	0.490	0.464	0.346	0.606
	(0.89)	(0.84)	(0.56)	(0.84)	(0.89)	(0.88)	(0.43)	(0.81)
loansize	0.000	-0.001	-0.003	0.002	0.000	0.000	-0.027	0.007
	(0.01)	(-0.10)	(-0.17)	(0.11)	(0.01)	(-0.01)	(-0.57)	(0.17)
L.cri							0.028	0.043
							(0.15)	(0.24)
_cons	0.439	0.409	0.428	0.395	0.439	0.404	0.393	0.355
	(10.36)	(16.90)	(7.79)	(14.91)	(10.36)	(13.99)	(3.36)	(4.10)

Panel A and Panel B present the estimated results for Equation (5.1) and are different in dependent variables. In Panel A we use the non-performing loan ratio as the dependent variable while in Panel B Credit Risk Indicator is used. In the parentheses are summarized t-statics and z-values. ******* and ** represent 1% and 5% significance respectively.

Appendix 1

Constrained linear regression Number of obs = 1613
Root MSE = 0.1165

(1) lnx1 + lnx2 + lnx3 = 1
(2) slnx1 + slnx2 + slnx3 = 0
(3) lny1lnx1 + lny1lnx2 + lny1lnx3 + lny2lnx1 + lny2lnx2 + lny2lnx3 +lny3lnx1 + lny3lnx2 + lny3lnx3 = 0
(4) lny1lny2 - lny2lny1 = 0
(5) lny1lny3 - lny3lny1 = 0
(6) lny2lny3 - lny3lny2 = 0
(7) lnx1lnx2 - lnx2lnx1 = 0
(8) lnx1lnx3 - lnx3lnx1 = 0
(9) lnx1lnx3 - lnx3lnx2 = 0

lntc	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
lny1	.5169239	.0189918	27.22	0.000	.4796722	.5541755
lny2	.4612946	.0331498	13.92	0.000	.3962726	.5263167
lny3	.1309832	.0255593	5.12	0.000	.0808498	.1811167
lnx1	.5035666	.0346313	14.54	0.000	.4356388	.5714944
lnx2	.2797117	.033071	8.46	0.000	.2148443	.344579
lnx3	.2167217	.0292448	7.41	0.000	.1593592	.2740842
slny1	.0756617	.0028418	26.62	0.000	.0700877	.0812357
slny2	.1581764	.0049959	31.66	0.000	.1483772	.1679757
slny3	.0749705	.0051454	14.57	0.000	.064878	.085063
slnx1	-.0965071	.0091878	-10.50	0.000	-.1145285	-.0784856
slnx2	.0950354	.0091832	10.35	0.000	.077023	.1130479
slnx3	.0014716	.0039496	0.37	0.709	-.0062754	.0092186
lny1lny2	-.1041397	.0042729	-24.37	0.000	-.1125208	-.0957586
lny1lny3	.0082522	.0044192	1.87	0.062	-.0004158	.0169203
lny2lny1	-.1041397	.0042729	-24.37	0.000	-.1125208	-.0957586
lny2lny3	-.0607451	.0030655	-19.82	0.000	-.066758	-.0547323
lny3lny1	.0082522	.0044192	1.87	0.062	-.0004158	.0169203
lny3lny2	-.0607451	.0030655	-19.82	0.000	-.066758	-.0547323
lnx1lnx2	.0442338	.004735	9.34	0.000	.0349463	.0535212
lnx1lnx3	-.0009694	.0065347	-0.15	0.882	-.013787	.0118482
lnx2lnx1	.0442338	.004735	9.34	0.000	.0349463	.0535212
lnx2lnx3	.057706	.0124336	4.64	0.000	.0333179	.0820941
lnx3lnx1	-.0009694	.0065347	-0.15	0.882	-.013787	.0118482
lnx3lnx2	-.0009694	.0065347	-0.15	0.882	-.013787	.0118482
lny1lnx1	-.0858993	.0057	-15.07	0.000	-.0970797	-.074719
lny1lnx2	.0728676	.0039159	18.61	0.000	.0651867	.0805484
lny1lnx3	-.0089093	.0024261	-3.67	0.000	-.013668	-.0041506

lny2lnx1	-.0130386	.0065123	-2.00	0.045	-.0258123	-.0002649
lny2lnx2	.0825441	.0071996	11.47	0.000	.0684223	.0966658
lny2lnx3	-.0093094	.00273	-3.41	0.001	-.0146641	-.0039548
lny3lnx1	.0616839	.006795	9.08	0.000	.0483557	.075012
lny3lnx2	-.1149338	.0063728	-18.04	0.000	-.1274338	-.1024338
lny3lnx3	.014995	.0027235	5.51	0.000	.009653	.020337
_cons	.8637727	.0977625	8.84	0.000	.6720155	1.05553

We present the estimated results of the translog cost function for Germany in 2010. TC is the dependent variable representing the total cost. Y1, Y2 and Y3 denoting output variables consist of loans, other earning assets and other services respectively. X1, X2 and X3 are variables of input prices incorporating the ratio of personnel expenses to total assets, the ratio of interest expenses to total funding, and the ratio of other operating expenses to fixed assets respectively. Sln denotes the square of the logarithm of corresponding variables.