# Bangor Business School
# Working Paper

BBSWP/10/019

## COMPETITION AND STABILITY IN EUROPEAN BANKING:
## A REGIONAL ANANLYSIS

By

Hong Liu and Phil Molyneux

Division of Financial Studies, Bangor Business School

and

John O.S. Wilson

School of Management, University of St. Andrews

October, 2010

Bangor Business School
Hen Goleg
College Road
Bangor
Gwynedd LL57 2DG
United Kingdom
Tel: +44 (0) 1248 38227
E-mail: business@bangor.ac.uk

**Competition and stability in European banking: a regional analysis**[1]


**Abstract**

National measures of competition and macroeconomic activity have been used by researchers in recent years to explain performance and risk differentials across banks. However, such measures may be inappropriate for banks which operate with a regional focus. In this paper we construct measures of competition and economic activity using regional data to examine bank stability in 11 European countries over the period 2000-2008. The results suggest that a U-shaped relationship exists between regional bank competition and stability. This implies that a moderate level of bank competition is required to keep bank risks at a minimum level. Furthermore, regional economic conditions play a significant role in determining the stability of European banks.



**Key words**: Competition, European Banking, Regional Economic Conditions, Risk, Stability



[1] The financial support of the Instituto (formerly, Ente) Luigi Einaudi, sponsoring the research project "Competition in European Banking" is gratefully acknowledged. The usual disclaimer applies.

## Competition and stability in European banking: a regional analysis

### 1. Introduction

The extent to which competition prevails in the banking industry is likely to have far-reaching implications for economic growth, productivity, consumer welfare and financial stability. Theoretical and empirical research that can assess the extent of competition in banking, therefore, has important implications for government agencies responsible for the effective regulation and supervision of the financial system (Boyd and DeNicolo, 2005, Boyd et al, 2006; Berger et al, 2009). In this paper, we examine the impact of competition and regional economic conditions on the stability of banks located in 11 European countries between 2000 and 2008, and find evidence of a U-shaped relationship between regional bank competition and stability. Regional economic conditions are also found to play a significant role in determining the stability of banks.

Recent turmoil in the global financial system has impacted severely on the banking sector with many banks suffering large losses and necessitating the need to raise additional capital privately or through their respective national governments (via various rescue and bailout schemes).[2] The failure of investors, depositors, and supervisors to appropriately discipline banks has led academics and policy-makers to re-consider the links between bank performance, stability and changes in the competitive environment.[3]

Previous research that focuses on the link between competition and bank performance has

---

[2] Brunnermeier (2009) provides an excellent overview of the crisis, while Goddard et al., (2009,a,b) and Petrovic and Tutsch (2009) provide a detailed treatment of policy interventions taken by governments in Europe to stabilise the banking system.

[3] A number of papers and reports have proposed new forms of micro- and macro-prudential regulation to restore and maintain the stability of the financial system. The most comprehensive to date is the Stern School volumes by Acharya and Richardson (2009) and Acharya et al., 2010) and the Centre for Economic Policy Studies (CEPS) Report produced by Carmassi et al, (2010). Stephanou (2010) discusses a number of ways in which the market can be used by supervisors to assess bank risk and discipline the activities of bank managers.

a long empirical tradition. Early work adopted the Structure-Conduct-Performance (SCP) paradigm to assess whether there was any correlation between industry conditions (embodied in structural measures of competition such as concentration ratios) and bank performance. The results of early investigations contend that in order to earn abnormal profits, small numbers of banks may engage in collusive activities, or exercise independent market power, in order to charge higher prices (lower deposit rates / higher loan rates). Later critiques by the Chicago Revisionist School posit that finding evidence of a positive concentration-profitability relationship does not necessarily infer collusive behaviour as it may simply reflect the relationship between size and efficiency (larger banks gain from scale and other efficiency advantages, and consequently more concentrated markets are inherently more profitable). The extent to which banks are able to earn high profits through collusion or the exercise of market power, or as a consequence of superior efficiency, has never been satisfactorily resolved in the empirical literature (Berger, 1995; Goddard et al., 2001, 2007; Degryse and Ongena, 2008; Casu and Girardone, 2006, 2009; Tregenna, 2009; Dick and Hannan, 2010).

More recently, contestable markets theory and its new empirical industrial organization (NEIO) counterpart, emphasize the influence of potential as well as actual competition, and consequently focus on competitive conduct of firms in response to changes in demand and supply conditions. Empirical banking research in this vein has found differences in competitive conditions across banking sectors from the 1980s until the present (Molyneux et al., 1994, Claessens and Laeven, 2004; Goddard and Wilson, 2009). Another strand of the literature examines the dynamics of bank performance in an attempt to assess the extent to which entry, exit and governance mechanisms are efficient enough to drive banks' profit rates to converge towards the same long-run average value. The lower the level of performance (profits) persistence then the more competitive the industry. Evidence suggests that entry barriers and regulatory and information constraints retard the extent to which profit rates converge and therefore inhibit competition (Berger et al., 2000; Goddard et al., 2004a, b; Goddard et al., 2010a, b).

While there is a developed literature on the measurement of competition and its implications for bank performance, less is known about the links between competition and financial stability. Two views are posited in the literature. The first, known as the competition-fragility (charter or franchise value) view, argues that banks earn monopoly rents in less competitive markets resulting in higher profits, capital ratios and charter values. This makes them better placed to withstand demand- or supply-side shocks and discourages excessive risk-taking (Allen and Gale, 2000, 2004; Carletti, 2008). The second, known as the competition-stability view, argues competition leads to less fragility. This is because in concentrated banking systems with low levels of competition, the market power of incumbent banks results in higher interest rates for borrowers making it more difficult for them to repay loans. Such high interest rates increase the incentives for borrowers to take on greater risk in search of higher returns. This increases the possibility of the non-repayment of loans and the default risk of bank portfolios making the financial system less stable (Boyd and DeNicolo, 2005). In addition, large banks are often deemed to be Too-Big, Too-Inter-Connected or Too-Complex-To-Fail and thus they obtain implicit (or explicit) subsidies via government safety nets. This may further increase moral hazard and encourage large banks to take-on excessive risks leading to financial instability (O'Hara and Shaw, 1990; Stern and Feldman, 2004; Brown and Dinc, 2009; Herring and Carmassi, 2010; Beck et al., 2010 and Demirguc-Kunt and Huizinga, 2010).

Empirical evidence in support of the competition-fragility and competition-stability views is rather mixed. For example, Boyd et al. (2006) and DeNicolo and Loukoianova (2006) find that the risk of bank failure rises in lower in competitive markets, while Jiménez et al. (2010) find that risks decrease with an increase in bank market power. Turk-Ariss (2010) assesses how varying degrees of market power influence bank efficiency and stability in developing banking systems and finds that competition leads to instability. Uhde and Heimeshoff (2009), using aggregated data for EU-25 countries, show that national banking market concentration has a negative impact on the stability of European banking systems. Berger et al. (2009) use a variety of risk and competition measures from banks operating in 23 countries. The results provide limited support to both the competition-fragility and competition-stability views in that market power increases credit risk, but banks with greater market power face lower risks. Zhao et al. (2009, 2010) assess the extent to which deregulatory measures aimed at promoting competition lead to increased risk-taking in Indian banking. The results suggest that competition encourages increased risk-taking.

Martinez-Miera and Repullo (2009) suggest a non-linear relationship between bank competition and stability. They argue that the competition-stability view advocated by Boyd and De Nicolo (2005) does not necessarily hold when loan defaults are imperfectly correlated. Heightened competition may reduce borrower's probability of default (risk-shifting effect), but it may also reduce the interest payments from performing loans, which serves as a buffer to cover loan losses (margin effect). They find evidence of a U-shaped relationship between competition (measured by the number of banks) and bank stability. In highly concentrated markets the risk-shifting effect dominates and more competition reduces bank risk, while in very competitive markets the margin effect dominates and the increased competition erodes bank's franchise value and hence increases risks.

All the aforementioned empirical studies that focus on competition and stability issues use national measures of competition and (in some cases) economic activity. Such national measures are likely to be inappropriate for countries where banks have a regional customer focus. Previous evidence has shown significant differences in competition across regional banking markets (Carbó et al., 2007). While banking organizations have grown in size and geographic scope, there is strong evidence that in certain market segments, such as retail deposits and small business loans, banks operate at a regional level (Cohen and Mazzeo, 2003; Elliehausen and Wolken, 1990, 1992; Kwast et al, 1997; Amel and Starr-McCluer, 2002). Furthermore, the contractual relationship between banks and their customers is also more likely to be observed on a regional than on a national basis (Guiso et al, 2004). For example, Laderman et al (1991) find that community banks tend to lend to firms and individuals nearby. Yeager (2004) also states that 75-90% of loan customers are from within the local region. This implies that for many banks (that typically focus on retail and small businesses lending) their performance and stability is more likely to be affected by regional competitive and economic conditions.

Previous research by Daly et al (2004) suggests that there is a positive and significant link between regional economic conditions and bank risk. Regionally focused banks (due to their limited size and geographic scope) are exposed to the risk of a downturn in regional economic conditions (Yeager, 2004). The conditions of these banks are also expected to be connected with the financial conditions of their local customers and, thus, with the economic conditions in the local market. Large national banks are typically regionally diversified, located in financial centers and their performance is more closely linked to the national economy (Daly et al, 2004). According to Conrad et al (2009) demographic and environmental factors are important determinants of the stability of regional banks since decentralized financial institutions cannot easily diversify regional risks.

European banking markets have a long tradition of regional focus with mutual banks (savings and cooperative banks) competing in the same market with their commercial counterparts. As far as we are aware, however, no study has investigated bank competition and stability issues at the regional level. The European case provides a good testing ground to analyze such issues because of the significant differences among regions both in terms of economic development and competitive rivalry in the respective banking markets. In this paper we seek to address this shortfall in the literature by examining the relationship between regional economic conditions and competition and their subsequent impact on bank stability for banks based in 11 European countries over the period 2000-2008. The results suggest that a U-shaped relationship exists between regional bank competition and bank stability. This implies that a moderate level of bank competition is required to ensure the minimum level of bank risks, while too much or too little competition may both damage bank stability. Furthermore, regional economic conditions play a significant role in determining the stability of European banks. The rest of this paper is structured as follows. Section 2 outlines the econometric methods and data and

Section 3 presents the results. Section 4 provides a conclusion.

## 2. Methodology and data

In this section we discuss the empirical model used to investigate the impact of regional bank competition and economic conditions on bank stability. Then we explain our measures of bank stability and regional competition. Discussion of the data and control variables then follows.

### *Estimable model*

The purpose of the estimable model outlined in this section is to capture the effects of region-specific competition and economic conditions on bank stability. We also include a range of bank-specific variables that have been used in previous empirical studies that examine the drivers of bank stability. The model is specified as:

$$\delta_{it} = \alpha_i + \lambda_i \delta_{i,t-1} + \beta_1 LERNER_{jt} + \beta_2 M_{jt} + \beta_3 X_{it} + \beta_4 dSAV + \beta_5 dCOOP + \mu_i + \nu_{it} \quad (1)$$

Where the subscripts $i$ , $j$ , $t$ denotes bank $i$ , region $j$ , and year $t$ . $\delta_{i,t}$ is the risk measure and $\delta_{i,t-1}$ is the one-period lagged risk measure. The risk measure included in our analysis is the Z-index (defined below).[4] $\lambda_i$ represents the rate at which bank risk converges toward a long-run level. $LERNER_{jt}$ is the regional bank competition measure, which is discussed below. $M_{jt}$ is a vector of region-specific variables and $X_{it}$ is a vector of exogenous bank-specific regressors. dSAV and dCOOP are the savings and cooperative banks dummy variables, respectively. $\mu_i$ is a fixed effect, and $\nu_{it}$ is a random disturbance.

---

[4] Accounting based risk measures are utilised because most of the banks in our sample are not publicly listed and therefore market risk based measures are not available.

***Measures of stability*** $(\delta_{it})$ ***and regional bank competition*** $(LERNER_{jt})$

We measure bank stability using the Z-index. This measure combines: a measure of bank performance (return on assets, ROA); a measure of bank risk (standard deviation of ROA); and a measure of safety and soundness (bank equity capital to asset ratio). The resultant Z-index reflects the size of the extent to which the bank has a cushion (of bank capital) to absorb losses. Consequently, higher values are indicative of lower risk and greater stability. The Z-index has been used widely in previous empirical literature concerned with the measurement and determinants of the safety and soundness of financial institutions (Iannotta et al, 2007; Garcia-Marco and Robles-Fernandez, 2008; Hesse and Cihak, 2007; Beck et al, 2009).

The Z-index is calculated as:

$$Z = \frac{ROA + E / A}{\sigma(ROA)}$$

ROA is the bank's return on assets, E/A represents the equity to total assets ratio and $\sigma(ROA)$ is the standard deviation of return on assets. In order to capture the changing pattern of the bank's return volatility, we use a three-year rolling time window to calculate $\sigma(ROA)$.[5] Technically, if $\sigma(ROA)$ measures the standard deviation for the whole sample period the Z-index will be dominated by levels of capital and profitability (Cihak et al, 2009). Since the Z-index is highly skewed, we use the natural logarithm of the Z-index, which is normally distributed (Laeven and Levine, 2009). Also included is a lagged dependent variable $\delta_{i,t-1}$ indicating the persistence of bank risk as found in Jimenez et al (2010) and Garcia-Marco & Robles-Fernandez (2008).

We use the Lerner index as our measure for market competition (Lerner, 1934). The

5 We also use a 4-year rolling time window to calculate the standard deviation of ROA to arrive at our bank risk measure (Z-index) (see Table 5 for robustness test results).

Lerner index measures the mark-up of price over marginal costs and is therefore an indicator of the degree of market power. It is calculated as:

$$Lerner_{it} = (P_{it} - MC_{it}) / P_{it}$$

Where $P_{it}$ is the price of total assets (proxied by the ratio of total revenues to total assets for bank $i$ at time $t$), $MC_{it}$ is the marginal cost of bank $i$ at time $t$. This is derived from a translog cost function as follows:

$$\ln Cost_{it} = \beta_0 + \beta_1 \ln Q + \frac{\beta_2}{2} \ln^2 Q + \sum_{k=1}^{2} \gamma_k \ln W_k + \sum_{k=1}^{2} \phi_k \ln Q \ln W_k + \sum_{k=1}^{2} \sum_{j=1}^{2} \ln W_k \ln W_j + \delta_1 Trend + \delta_2 Trend^2 + \delta_3 Trend \times \ln Q + \sum_{k=1}^{2} \lambda_k Trend \times \ln W_k + \varepsilon \quad (2)$$

Where Cost represents total bank cost, calculated as total expenses over total assets; Q represents a proxy for bank output or total assets. $W_1, W_2$ and $W_3$ represent three input prices of funding, fixed capital and labour, respectively, and are calculated as the ratios of interest expenses to total deposits, other operating and administrative expenses to total assets and personnel expenses to total assets, respectively. $Trend$ represents yearly fixed effects to capture technical changes in the cost function over time.

Following Turk-Ariss (2010), we scale cost and input prices by $W_3$ to correct for heteroscedasticity and scale biases. Equation (2) is estimated separately for each country. Finally marginal costs (MC) are then computed as:

$$MC = \frac{Cost}{Q} [\beta_1 + \beta_2 \ln Q + \sum_{k=1}^{2} \phi_k \ln W_k + \delta_3 Trend] \quad (3)$$

To measure regional bank competition $(LERNER_{jt})$, weighted average regional Lerner indices are calculated. This is done by weighting individual bank Lerner indices by the share of bank deposits over total deposits at the regional level.[6] While the presence of multi-market banks may reduce deposit yet intensify loan market competition (Park and Pennacchi, 2009), the Lerner index (by measuring the mark-up of price over marginal costs) captures the final effects of all sources of impact and hence is an appropriate local competition measure.[7] In contrast to the US where information on the value of deposits, loans and other assets are available at the regional level this is not the case throughout the European Union. Previous research uses the regional distribution of branch offices as weights to calculate their regional competition measures, presuming that a bank's percentage of branches in a market also holds the same share of deposits (or loans, or assets). However, these measures are significantly biased if the assumption is violated. This is the case if multi-market banks compete differently with local banks (Cohen and Mazzeo, 2007). Following the findings of Martinez-Miera and Repullo (2009) we test for possible non-linear effects of competition on stability by including a quadratic term $LERNER_{jt}square$.

***Regional variables*** $(M_{jt})$

Evidence suggests that banks expand their lending by too much during economic upturns and contract by too much during economic downturns (Bikker and Metzemakers, 2005; Bouvatier and Lepetit, 2008). Theoretical explanations for such behaviour are related to a variety of factors including disaster myopia, euphoria, herd behaviour, agency problems

---

6 As suggested by Craig and Dinger (2009), deposit markets are more local than loan markets. Consequently, defining the scope of deposit markets is easier than defining loan markets.

7 A variety of studies have grappled with the problem of measuring bank competition at a regional level. For example, for Italy, Coccorese (2004) calculates the H-statistic for each sub-market as the regional bank competition measure, while Coccorese (2008a) computes the main eight bank (which is considered as 'national') loan concentration ratio for each region as his regional concentration measure. Carbo et al (2003) adopt five indicators of competition; among them are the deposit-related HHI, loan-deposit spread deflated by a cost-of-living index, and the Lerner index. Fernandez de Guevara and Maudos (2009) adopt a weighted average of the Lerner indices of the bank institutions in each province of Spain, weighting with the number of branches of each bank. More recently, Conrad et al (2009) measure regional competition in Germany using the number of competitor branches per savings bank branches in the local area.

and lapses in institutional memory (Berger and Udell, 2004; Dell'Ariccia and Marquez, 2006; Herring, 1999; Panetta et al., 2009; Rajan, 1994; Ruckes, 2004). Despite the varying explanations for the pro-cyclicality of bank lending behaviour there is no clear consensus as to how regional economic development impacts on bank stability.

Intuitively, regional economic variables such as GDP growth are likely to have a positive impact on bank stability. However, there is some evidence to suggest that lending mistakes are more likely during boom periods than in recession (Jimenez and Saurina, 2006). There are two possible reasons to explain this. First, when the economy is growing rapidly, banks become over-optimistic about borrowers' ability to repay and this leads to more liberal credit policies with lower credit standards. This lending behavior tends to ultimately result in a higher level of impaired loans and borrower defaults. Secondly, in boom periods excessive competition that can prevail during an economic upturn may erode margins and encourage managers to seek higher return (and therefore higher risk) business.

Hence, we do not have clear expectations as to the relationship between regional economic conditions and overall bank stability. Consistent with previous (regional) studies, we use two major economic indicators in our analysis – regional real GDP growth (GDPGR) and regional unemployment rate (UNEMPR).

***Bank-specific variables*** $(X_{it})$

We include a variety of bank-specific variables in our model in line with the previous literature. Cost inefficiency (CI), measured as the cost-to-income ratio, is expected to be negatively related to bank stabilities (see Boyd et al, 2006; Agoraki et al, 2009). More inefficient banks are likely to take on greater risk to generate returns to improve performance. Bank lending behavior, captured by the ratio of loans to total assets (LA), is expected to be positively linked to bank risks as credit is one of the riskiest areas of banking business. The greater the bank's loans exposure the higher is the default risk, and hence the lower is the stability.

We also include the natural logarithm of bank total assets (lnTA) to control for bank size effects. This may be positively related to bank stability due to the realization of efficiency benefits via economies of scale. However, managers of larger banks may tend to take-on more risks in expectation of the implicit 'Too-Big-To-Fail' and related government safety net subsidies designed to bail out distressed institutions (O'Hara and Shaw, 1990; Stern and Feldman, 2004; Brown and Dinc, 2009; Herring and Carmassi, 2010 and Demirguc-Kunt and Huizinga, 2010). As such, the relationship between bank size and stability is unclear.

Conventional wisdom suggests that diversification (DIV), measured as non-interest income divided by total revenue, can be positively related to bank stability due to the diversification benefits. However, recent evidence suggests that banks that diversify tend to take-on more overall risk in pursuit of potential economies of scope (Stiroh, 2004; Beck et al, 2009).

***Estimation approach***

Equation (1) takes the form of a linear dynamic panel regression model. Such models include one or more lags of the dependent variable as covariates and contain unobserved individual effects (either fixed or random). By construction, the individual effects are correlated with the lagged dependent variable, rendering the standard fixed effects or random effects estimators inconsistent. Arellano and Bond (1991) use a Generalized Method of Moments (GMM) estimator for such models, known as the difference GMM. The lagged exogenous variables values (levels) constitute legitimate instruments for the first-differenced, lagged dependent variable. However, these lagged variables may provide little information about the first differences (Arellano and Bover, 1995; Blundell and Bond, 1998).

Building on the work of Arellano and Bover (1995), Blundell and Bond (1998) developed a system estimator that exploits additional moment conditions on both first-differences and levels, with lagged first-differences of the series employed as instruments in the levels equation. The system GMM estimator reduces potential bias in finite samples as well as asymptotic imprecision associated with the difference estimator (Blundell and Bond, 1998).

The consistency of the system GMM estimator depends both on the assumptions that the error term is not auto-correlated as well as on the validity of the instruments used. Two specification tests are reported. The first is a Hansen test of over-identifying restrictions, which examines the validity of the instruments by analyzing the sample analogue of the moment conditions used in the estimation procedure. The second test examines the hypothesis of no autocorrelation in the error term. The presence of first-order autocorrelation in the differenced residuals does not imply that the estimates are inconsistent. However, the presence of second-order autocorrelation implies that the estimates are inconsistent.[8]

Equation (1) is estimated, therefore, using the two-step system GMM estimator with Windmeijer-corrected standard errors, including both lagged differences and levels of the explanatory variables as instruments. We measure our exogenous variables, (e.g., competition, regional economy and bank-specific variables) with a one-year lag. This is to mitigate potential endogeneity problems between bank stability, regional economic conditions and other bank-specific features.

### *Data Sources*

Regional economic data from the EU's Eurostat was collected using the NUT[9]

---

[8] The Hansen test and the second-order autocorrelation test results are reported in Table 4 and 5.

[9] The NUTS Regulation lays down the minimum and maximum thresholds for the average size of the NUTS regions, with NUTS1 varying from 3 million to 7 million, NUTS2 from 800,000 to 3 million and NUTS3 from 150,000 to 800,000 (Eurostat, 2008).

(Nomenclature of territorial units for statistics) classification. More specifically, data on real GDP growth and the unemployment rate were collected at the NUTS2 level and covers the period from 2000 to 2007 (where data was available). We further aggregated these measures to arrive at regional economic measures at the NUTS1 level. [10] Unconsolidated bank level income statement and balance sheet financial data over the years from 2000 to 2008 are from the Bankscope database compiled by Bureau Van Dijk. The final sample is an unbalanced panel with 22,413 bank-year observations on 2,397 banks from 47 NUTS1 regions and 11 countries.[11] Each bank is allocated to the region where its headquarters are located.

Table 1 describes the variables and Table 2 reports the summary statistics. As shown in Table 2, the logarithm of the Z-index varies from 0.72 to 8.32, with a mean value of 3.99. This is roughly in-line with that reported in Laeven and Levine (2009) for their international cross-country dataset (with a mean value of 2.88) although they were looking at 48 countries up to 2001 with a small bank sample (270 banks). Regional deposits weighted average Lerner index $(LERNER_{jt})$ varies from 4.81 to 21.81, with a mean value of 10.99, indicative of a competitive banking market across the European area. These figures are broadly in line with other researchers (Fernandez de Guevara et al, 2005; Casu and Girardone, 2009). The average regional GDP growth is 2.16%, while the average unemployment rate is 9.36%. Table 3 further presents the mean values of the variables at the NUTS1 regional level.

[10] Previous studies (Zimmerman, 1996; Meyers and Yeager, 2001; Yeager, 2004) tend to find little correlation between measures of economic conditions and bank performance when regions are defined in a narrower geographic scope such as counties in the US. Others find that state-level economic variables have a significant impact on bank performance (Nealy and Wheelock, 1997; Berger et al, 2000; Meyer and Yeager, 2001; Daly et al, 2008). Calomiris and Mason (2000) find that both state and county economic indicators impacted bank survival rates in the US during the Great Depression. We define our regional variables at the NUTS1 level. The NUTS2 measures, however, are also included in robustness tests.

[11] The countries comprise ten members of the European Union (EU): Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Spain, Sweden and UK; plus Norway.

**Insert TABLES 1, 2 and 3 here**

## 3. Results

In this section we present the results of our empirical analysis. First we discuss the empirical findings with respect to the relationship between competition and stability. We then outline the extent to which regional economic conditions affect bank stability and discuss briefly the impact of other bank-specific characteristics. Finally, we present the results of a number of robustness checks.

We estimate seven regressions to examine the impact of regional bank competition and economic conditions on bank stability. All regional indicators including the competition measure are at the NUTS1 level.[12] The results are summarized in Table 4. All regressions use the regional average Lerner indices weighted by bank deposits ($LERNER_{jt}$) as the competition measure. Regression 1 to 4 uses the natural logarithm of three-year rolling Z-index as the dependent variable. Regression 1 includes only the bank-specific variables; regression 2 adds the regional competition measure (but not the regional economic conditions measure) to regression 1. Regression 3 then uses the regional economic conditions measure, but excludes the regional competition measure. In regression 4, we include all regional competition, economic condition and bank-specific variables into the analysis. Regression 5 to 7 use the three components of the Z-index, namely ROA, KA and SDROA (three-year rolling window standard deviation of ROA) as dependent variables, respectively, to examine whether profitability, volatility of profits or capital strength determine any observed relationship between regional bank competition and stability. Bank-specific covariates are included in all specifications.

We find significant coefficients of lagged Z-index across specifications, indicating that

[12] We also run regressions using bank competition and economic conditions measures at NUTS2 level (see Table 5 for robustness test results).

bank stability appears to persist (to some extent) over time. In column 2 and 4 in Table 4, the coefficient of regional competition is negative for the linear term but positive for the quadratic term $(LERNER_{jt}square)$. Both coefficients are statistically significant. We further calculate the inflection point of the quadratic function and compare it with the distribution of the data. For example, in model 2, the inflection point is 11, which covers approximately 50% of the regional Lerner indices distribution. This implies a significant non-linear relationship between regional market competition and bank stability. According to Martinez-Miera and Repullo (2009), in highly concentrated banking markets where the regional Lerner index is high, the risk-shifting effect dominates. In this environment, when regional bank competition increases (regional Lerner indices decrease), banks are forced to charge lower loan rates and pay higher deposit rates (lower margins), reducing borrower costs and hence increasing bank stability (Z-index increases). In a very competitive market, however, the so-called margin effect dominates where increased regional competition reduces loan interest re-payments and this reduces the size of the buffer covering loan losses thus increasing risk.

When the three components of the Z-index are examined, we find that regional bank competition has a significant negative (positive sign for Lerner indices) impact on ROA and its standard deviation, but not on the equity to assets ratio (KA). However, the non-linear relationship found between the regional Lerner indices and the Z-index does not exist between the components of the Z-index. The coefficients of both quadratic terms of regional market competition are insignificant when ROA and KA are examined. Although the quadratic term is significant when SDROA is examined, the inflection point is 26.5, which is beyond the standard deviation of the ROA's distribution.

We find evidence in Tables 4 that the regional unemployment rate (UNEMPR) has a significant negative impact on bank stability, indicating that those regions with high unemployment tend have less stable banks. Real GDP growth, however, does not enter the regressions significantly.

Large banks (LnTA) are found to have lower and less volatile profitability, although the combined effects cancelled out resulting in no impact on bank stability. In common with evidence presented for the US, diversification (DIV) is found to be negatively associated with the Z-index indicating that diversified banks tend to be more risky (Stiroh, 2004; Stiroh, 2010). Cost inefficiency (CI) tends to lead to lower returns (ROA), but also lowers return volatility (SDROA), resulting in no impact on bank stability. Bank lending behavior (LA) is not found to have a significant impact on bank stability[13]. Both the coefficients of savings (dSAV) and cooperative bank (dCOOP) dummies are positive and significant. This is consistent with previous findings that both savings and cooperative banks (in general) tend to be safer than their commercial counterparts (Beck et al, 2009). These results are mainly driven by mutual banks having lower return volatility, albeit with lower profits. Our results are further consistent with Beck et al (2009) who find that savings banks are safer than cooperative banks (see column 2 in Table 5).[14]

### *Sensitivity analyses of Competition and Stability*

In Table 5, we undertake a number of robustness tests. Hasan et al (2009) contend that allocating banks to regions on the basis of the location of the headquarters ignores the fact that some regions in Europe are financial centers of national or international relevance. Including banks located in these centers may bias our results to some degree. Consequently, in the first specification, we exclude banks located in these financial centers.[15]

---

[13] This perhaps is surprising as one would expect banks with higher loan-to-asset ratios to be more risky. Unfortunately, we do not have access to detailed information on bank-specific loan composition which perhaps could inform us more about the nature of bank loan portfolios and risk.

[14] Beck et al's (2009) and our study does not cover 2010 when many savings banks in Spain and Germany ran into difficulties arising from bad loans in the real estate sector and poorly performing sovereign investments. This was evidenced by the failure of five Spanish and one German savings bank in the stress tests carried out on 91 EU banks by the Committee for European Bank Supervisors conducted in cooperation with the ECB, the EU commission and the national supervisory authorities of 20 Member States in July 2010 (Committee of European Bank Supervisors, 2010).

[15] These regions are Amsterdam, Frankfurt, Madrid, Milan, Paris and London.

Since savings and cooperative banks tend to operate within their regions while their larger commercial counterparts tend to operate across regions in the second specification we exclude the commercial banks from the sample to address this potential bias.

Large regional banks tend to extend their businesses into adjacent regions in order to realize potential economies of scale or benefit from geographical diversification. Their presence in the sample may distort our results so we exclude the 10% and 20% largest banks (by assets size) in each region from the sample in the third and fourth specifications, respectively.

In specification six, we also use a 4-year rolling time window to calculate SDROA to arrive at our bank stability measure (Z-index) to check the sensitivity of our stability measure to time variation. Finally, in specification seven, we run regressions using bank competition and economic conditions measures calculated at the NUTS2 level.

As shown in Table 5, our main results hold. That is, both the linear and quadratic terms of the regional Lerner index are significant in most cases, with a negative and positive sign, respectively. The inflection points range from 25% to 60% of the distribution of regional Lerner index, again confirming the non-linear relationship between bank competition and stability.

## 4. Conclusions

Competitive and economic conditions are likely to play a major role in determining the stability of banks. Previous empirical research has tended to assess any such relationships by using competition and macroeconomic variables computed at the national level. In this study we argue that such metrics are inappropriate for banks where the mode of competition and market served are likely to be organized at a regional level. This paper examines the relationship between regional economic conditions and competition and their subsequent impact on bank stability in European banking. The results suggest a non-linear relationship between regional bank competition and stability. Risk-shifting effects appear to dominate in concentrated markets while margin effects appear prevalent in competitive banking markets (Martinez-Mirea and Repullo, 2009).

Furthermore, regional economic conditions play a significant role in determining the stability of banks. Our results suggest that banking risks heighten in regions with high unemployment. Diversified banks are found to be less stable than their smaller and more focused counterparts. Furthermore, mutual banks appear more stable than their commercial banking counterparts.

Our results are of interest to those government agencies tasked with regulating and supervising competition in banking and regional development within Europe. Given the evidence of a non-linear relationship between bank competition and stability, prudential regulation is essential to ensure that bank sector competition is maintained at a moderate level. Too little or too much competition will both induce higher bank risk and greater financial instability.

## References


Acharya, V., Richardson, M. (Eds.), (2009). Restoring financial stability: how to repair a failed system? New York: John Wiley and Sons.

Acharya, V., Cooley, T.F, Richardson, M. and Walter, I. (2010). Real time solutions for US financial reform. New York: Stern School of Business.

Agoraki, M.E., Delis, M.D. and Pasiouras, F. (2009). 'Regulations, competition and bank risk-taking in transition countries', MPRA Paper 16495.

Allen, F., and Gale, D., (2000). Comparing Financial Systems. Cambridge, MA: MIT Press.

Allen, F., and Gale, D. (2004). 'Competition and financial stability'. Journal of Money, Credit, and Banking 36, 433-80.

Arellano, M., and Bover, O. (1995). 'Another look at the instrumental-variable estimation of error-components models', Journal of Econometrics, vol. 68, pp.29-52.

Amel, D., and Starr-McCluer M. (2002). 'Market definition in banking: recent evidence', Antitrust Bulletin, vol. 47, pp.63–88.

Arellano, M., Bond, S., (1991) 'Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations', Review of Economic Studies, vol. 58, pp.277–297.

Beck, Thorsten, Heiko Hesse, Thomas Kick, and Natalja von Westernhagen (2009). 'Bank Ownership

and Stability: Evidence from Germany'. Bundesbank Working Paper Series, forthcoming.

Beck, T., Coyle, D., Dewatripoint, M., Freixas, X. and Seabright, P., (2010). 'Bailing out the banks: Reconciling stability and competition'. London: Centre for Economic Policy Research.

Berger, A.N., (1995). 'The profit–structure relationship in banking: tests of market power and efficient structure hypotheses', Journal of Money, Credit and Banking, vol.27, pp.404–431.

Berger, A.N., Udell, G., (2004). 'The institutional memory hypothesis and the pro-cyclicality of bank lending', Journal of Financial Intermediation, vol.13, pp.458-495.

Berger, A.N., Bonime, S.D., Covitz, D.M., Hancock, D., (2000). 'Why are bank profits so persistent? The roles of product market competition, information opacity and regional macroeconomic shocks', Journal of Banking & Finance, vol.24, pp.1203–1235.

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

Bikker, J.A., and Metzemakers, P.A.J., (2005). 'Bank provisioning behaviour and procyclicality' Journal of International Financial Markets, Institutions and Money, vol. 15, pp.141-157.

Blundell, R., and Bond, S., (1998). 'Initial conditions and moment restrictions in dynamic panel data models', Journal of Econometrics, vol. 87, pp.115-143.

Bouvatier, V. and Lepetit, L. (2008). 'Banks' procyclical behavior: Does provisioning matter?' Journal of International Financial Markets, Institutions and Money vol. 18, pp. 513-526.

Boyd, J., and DeNicolo, G.. (2005). 'The theory of bank risk taking revisited' Journal of

Finance, vol.60, pp.1329-1343.
Boyd, J., DeNicolo, G., and Jalal, A.M. (2006). 'Bank risk taking and competition revisited: new theory and evidence'. IMF Working paper 06/29.
Brown, C.O. and Dinç, I.S. (2009). 'Too many to fail? Evidence of regulatory forbearance when the banking sector is weak' Review of Financial Studies, forthcoming.
Brunnermeier, M.K., (2009). 'Deciphering the liquidity and credit crunch 2007–08', Journal of Economic Perspectives, vol. 23, pp. 77–100.
Calomiris, C.W., and Mason, J.R., (2000). 'Causes of U.S. bank distress during the Depression', NBER Working Papers 7919, National Bureau of Economic Research.
Carbo, S., Humphrey, D., and Fernandez, F.R. (2003). 'Deregulation, bank competition and regional growth', Regional Studies, vol. 37, pp.227-237.
Carbo .S., Lopez P.R. and Rodriguez F.F. (2007). 'Financial innovations in banking: impact on regional growth', Regional Studies, vol. 41, pp.311–323.
Carletti, E. (2008). Competition and regulation in banking. In: Boot, A.W.A., and Thakor, A. (Eds.) Handbook of Financial Intermediation and Banking. Amsterdam: Elsevier.
Carmassi, J., Luchetti, E. and Micossi, S., (2010). 'Overcoming too-big-to-fail: A regulatory framework to limit moral hazard and free riding in the financial sector'. Brussels: Centre for European policy studies.
Casu, B., and Girardone, C. (2006) 'Bank competition, concentration and efficiency in the single European market', Manchester School vol. 74, pp. 441-468.
Casu B., and Girardone, C. (2009). 'Testing the relationship between competition and efficiency in banking: a panel data analysis', Economics Letters vol. 105, pp.134-137.
Cihak, M., Maechler, A., Schaeck, K. and Stolz, S., (2009). 'Who disciplines bank managers?' IMF working papers, No. 09/272.
Claessens, S., and Laeven, L. (2004). 'What drives bank competition? Some international evidence', Journal of Money, Credit, and Banking vol. 36, pp. 563-583.
Coccorese, P., (2004). 'Banking competition and macroeconomic conditions: a disaggregate analysis' Journal of International Financial Markets, Institutions and Money, vol. 14, pp. 203-219.
Coccorese, P., (2008a). 'Bank competition and regional differences' Economic Letters, vol. 101, pp. 13-16.
Coccorese, P., (2008b). 'An investigation on the causal relationships between banking concentration and economic growth', International Review of Financial Analysis, vol. 17, pp. 557-570.
Cohen A.M., and Mazzeo, M.J., (2007). 'Market structure and competition among retail depository institutions'. Review of Economics and Statistics, vol. 89, pp. 60-74.
Committee for European Bank Supervisors (2010) Aggregate outcome of the 2010 EU wide stress test exercise coordinated by CEBS in cooperation with the ECB. London: Committee for European Bank Supervisors.
Conrad, A., Neuberger, D. and Gamarra, L.T. (2009) 'The impact of regional and demographic factors on the efficiency of German savings banks', University of Rostock working Paper, No. 111
Craig, B., and Dinger, V. (2009). 'Bank mergers and the dynamics of deposit interest rates.' Journal of Financial Services Research vol. 36, pp. 111-133.

Daly, M.C., Krainer, J. and Lopez, J.A. (2004). 'Does regional economic performance affect bank conditions? New analysis of an old question' FRB San Francisco working paper 2004-01..
Daly, M.C., Krainer, J. and Lopez, J.A. (2008) 'Regional economic conditions and aggregate bank performance' Research in Finance, vol. 24, pp. 103-127.
De Guevara, J.F., and Maudos, J., (2009). 'Regional financial development and bank competition: Effects on firms' growth', Regional Studies, vol. 43, pp. 211-228.
Degryse, H., Ongena, S. (2008). 'Competition and regulation in the banking sector: a review of the empirical evidence on the sources of bank rents.' In: Boot, A.W.A., Thakor, A., (Eds.) Handbook of financial intermediation and banking. Amsterdam: Elsevier.
Dell'Ariccia, G., Marquez, R. (2006). 'Lending booms and lending standards', Journal of Finance vol. 61, pp. 2511-2546.
Demirguc-Kunt, A., and Huizinga, H. (2010). 'Are banks too-big-too fail or too big to save? International Evidence from equity prices and CDS spreads.' World Bank Policy Research Paper Number 5360.
DeNicolo, G., Loukoianova, E. (2006). 'Bank ownership, market structure, and risk'. IMF Working Paper, 07/125.
Dick, A.A., Hannan, T.H. (2010). 'Competition and antitrust in banking'. In Berger, A.N., Molyneux, P., Wilson, J.O.S. (Eds.) Oxford Handbook of Banking. Oxford: Oxford University Press.
Elliehausen, G.E., and Wolken, J.D. (1992). 'Banking markets and the use of financial services by households', Federal Reserve Bulletin, vol. 78, pp. 169–181.
Elliehausen, G.E., and Wolken, J.D. (1990). 'Banking markets and the use of financial services by small and medium sized businesses', Federal Reserve Bulletin, vol.76, pp. 801–817.
Eurostat (2008) Regions in the European Union, Eurostat methodologies and working papers, NUTS 2007-EU-27.
Fernandez de Guevara J., Maudos J. and Perez, F. (2005) 'Market power in European banking sector', Journal of Financial Services Research, vol. 27, pp. 109-137.
Fernandez de Guevara, J. and Maudos, J. (2009) 'Regional Financial Development and Bank Competition: Effects on Firms' Growth'. Regional Studies 43, 211-228.
Garcia-Marco, T., Robles-Fernández, M.D. (2008). 'Risk-taking behaviour and ownership in the banking industry: The Spanish evidence', Journal of Economics and Business vol. 60, pp.332-354.
Goddard, J., Molyneux, P., Wilson, J.O.S. (2001). European banking: efficiency, technology and growth. Chichester: John Wiley and Sons.
Goddard, J., Molyneux, P., and Wilson, J.O.S. (2004a). 'Dynamics of growth and profitability in banking', Journal of Money, Credit and Banking, vol. 36, pp. 1069–1090.
Goddard, J., Molyneux, P., and Wilson, J.O.S. (2004b). 'The profitability of European banks: a cross-sectional and dynamic panel analysis', Manchester School vol. 72, pp. 363–381.
Goddard, J., Molyneux, P., Wilson, J.O.S. (2009a). 'The financial crisis in Europe: evolution, policy responses and lessons for the future', Journal of Financial Regulation and Compliance, vol. 17, pp. 362-380.

Goddard, J., Molyneux, P., and Wilson, J.O.S. (2009b). 'The crisis in UK banking: lessons for public policy', Public Money and Management, vol. 29, pp. 276-284.
Goddard, J., and Wilson, J.O.S. (2009) 'Competition in banking: a dis-equilibrium approach', Journal of Banking & Finance vol. 33, pp. 2282-2292.
Goddard, J., Molyneux, P., Liu, H., and Wilson, J.O.S. (2010a). 'Do bank profits converge?', European Financial Management, forthcoming.
Goddard, J., Molyneux, P., Liu, H., and Wilson, J.O.S. (2010b). The persistence of bank profit, St Andrews Management School Working Paper..
Goddard, J., Molyneux, P., Wilson, J.O.S., Tavakoli, M. (2007). 'European banking: an overview', Journal of Banking and Finance vol. 31, pp. 1911–35.
Guiso, L., Sapienza, P. and Zingales, L., (2004). 'Does local financial development matter?', Quarterly Journal of Economics vol. 119, pp. 929–969.
Hasan, I., Koetter, M. and Wedow, M., (2009). 'Regional growth and finance in Europe: Is there a quality effect of bank efficiency?' Journal of Banking & Finance, vol. 33, pp. 1446-1453.
Herring, R.J., (1999). 'Credit risk and financial instability', Oxford Review of Economic Policy, vol. 15, pp. 63-79.
Herring, R.J. and Carmassi, J. (2010). 'The corporate structure of international financial conglomerates: Complexity and its implications for safety and soundness', in A.N. Berger, P. Molyneux and J.O.S. Wilson (eds), Oxford Handbook of Banking, Oxford: Oxford University Press.
Hesse, H. and Cihak, M. (2009) 'Cooperative banks and financial stability', IMF Working Paper WP/07/02.
Iannotta, G., Nocera G., and Sironi, A. (2007) 'Ownership structure, risk and performance in the European banking industry', Journal of Banking & Finance, vol. 31, pp. 2127-2149.
Jiménez, G. and Saurina,J. (2006). 'Credit cycles, credit risk, and prudential regulation', International Journal of Central Banking, vol. 2, pp. 65-98.
Jiménez, G., Lopez, J., Saurina, J. (2010). 'How does competition impact on bank risk taking?', Banco De Espana Working Paper 1005.
Kwast, M.L., Starr-McCluer, M., and Wolken, J.D. (1997) 'Market Definition and the Analysis of Antitrust in Banking', Antitrust Bulletin, vol. 42, pp. 973–995.
Laeven, L., and Levine, R. (2009). 'Bank governance, regulation and risk taking', Journal of Financial Economics, vol. 93, pp. 259-275.
Laderman, E., Schmidt, R., Zimmerman, G.. (1991) 'Location, branching, and bank portfolio diversification: The case of agricultural lending', Federal Reserve Bank of San Francisco Economic Review, pp. 24-38.
Lerner, A.P. (1934). 'The concept of monopoly and the measurement of monopoly power', Review of Economic Studies, vol. 1, pp. 157–75.
Martinez-Miera, D., and Repullo, R. (2009). 'Does competition reduce the risk of bank failure?' Centre for Economic Policy Research Working Paper DP6669.
Meyers, A.P., and Yeager, T.J. (2001). 'Are small rural banks vulnerable to local economic downturns?' Federal Reserve Bank of St. Louis Review, vol. 83, pp. 25-38.
Molyneux, P., Lloyd-Williams D.M., Thornton J., (1994). 'Competitive conditions in European banking'. Journal of Banking & Finance, vol. 18, pp. 445-459.

Neely, M., and Wheelock, D. (1997). 'Why does bank performance vary across states?', Federal Reserve Bank of St. Louis Review, vol. 79, pp. 27-40.
O'Hara, M. and Shaw, W. (1990). 'Deposit insurance and wealth effects: The value of being 'too big to fail', Journal of Finance vol. 45, pp. 1587-1600.
Panetta, F., Angelini, P., Albertazzi, U., Columba, F., Cornacchia, W., Di Cesare, A., Pilati, A., Salleo, C., Santini, G., (2009). 'Financial Sector Pro-cyclicality', Banca D'Italia Occasional Papers, Number 44.
Park, K. and Pennacchi, G. (2009) 'Harming depositors and helping borrowers: The disparate impact of bank consolidation', Review of Financial Studies, vol. 22, pp. 1-40.
Petrovic, A. and Tutsch, R. (2009) 'National rescue measures in response to the current financial crisis', ECB Legal working paper no.8.
Rajan, R.G. (1994) 'Why bank credit policies fluctuate: a theory and some evidence', Quarterly Journal of Economics, vol. 59, pp.399-441.
Ruckes, M. (2004). 'Bank competition and credit standards'. Review of Financial Studies, vol. 17, pp. 1073-1102.
Stephanou, C. (2010) 'Rethinking market discipline in banking: lessons from the financial crisis', World Bank Policy Research Working Paper, 5227.
Stern, G.H. and Feldman, R.J. (2004) Too big to fail: The hazards of bank bailouts. Washington: Brookings Institution Press.
Stiroh, K.J. (2004). 'Do community banks benefit from diversification?' Journal of Financial Services Research, vol. 25, pp. 135-160.
Stiroh, K.J. (2010). 'Diversification in banking.' In Berger, A.N., Molyneux, P., Wilson, J.O.S. (Eds.) Oxford Handbook of Banking. Oxford: Oxford University Press.
Tregenna, F. (2009). 'The fat years: the structure and profitability of the US banking sector in the pre-crisis period', Cambridge Journal of Economics, vol. 33, pp. 609–632.
Turk-Ariss, R. (2010). 'On the implications of market power in banking: evidence from developing countries', Journal of Banking & Finance, vol. 34, pp. 765-775.
Uhde, A., Heimeshoff, U. (2009). 'Consolidation in banking and financial stability in Europe: empirical evidence', Journal of Banking & Finance, vol. 33, pp.1299–1311.
Yeager, T. J. (2004) 'The demise of community banks? Local economic shocks are not to blame', Journal of Banking & Finance, vol. 28, pp. 2135-2153.
Zhao, T., Casu B., and Ferrari, A. (2010). 'The impact of regulatory reforms on cost structure, ownership and competition in Indian banking', Journal of Banking & Finance, vol. 34, pp. 246-254.
Zhao, T., Casu, B., and Ferrari, A. (2009). 'Competition and risk taking incentives in the lending market: an application to Indian banking', Centre for banking research working papers, WP-CBR-02-2009, Cass business school
Zimmerman, G..C. (1996). 'Factors influencing community bank performance in California', Economic Review, Federal Reserve Bank of San Francisco, 26-40.

## Table 1 Description of Variables

| Variable name | Description |
|---|---|
| Z-index (Z) | A measure of how many standard deviations a bank is away from exhausting its capital base. A higher value indicates a higher overall bank stability. It is calculated at the 3-year rolling time window. |
| LERNER | A region-level indicator of bank competition, measured by the average of bank Lerner indices weighted by total bank deposits. Higher values indicate less competition in the local banking sector. |
| LERNERsquare | The square of LERNER |
| real GDP growth (GDPG) | Annual real growth rate of GDP at NUTS1 regional levels. |
| Unemployment rate (UNEMPR) | Annual unemployment rate at NUTS1 regional levels. |
| Bank size – log Total Assets (TA) | The bank's total assets, as reported by Bankscope at original values. |
| Diversification (DIV) | The ratio of non-interest income over total operating income. |
| Loan to assets ratio (LA) | The ratio of total loans over total assets. |
| Cost to income ratio (CI) | The ratio of operating expenses over operating income |
| Equity to assets ratio (KA) | The ratio of bank equity to over total assets |
| Return on assets (ROA) | The ratio of bank net income after tax over total assets. |
| Standard deviation of ROA (SDROA) | the standard deviation of return on assets, calculated at three-year rolling time window. |
| Saving banks dummy (dSAV) | Dummy variable for savings bank |
| Cooperative bank dummy (dCOOP) | Dummy variable for cooperative bank |

## Table 2 Summary Statistics

| Variable | obs | mean | stddev | median | min | max |
|---|---|---|---|---|---|---|
| Z-index (Z) | 20463 | 3.99 | 1.37 | 3.96 | 0.72 | 8.32 |
| LERNER | 376 | 10.99 | 4.63 | 10.52 | 4.81 | 21.81 |
| LERNERsquare | 376 | 141.73 | 115.03 | 110.67 | 23.13 | 475.68 |
| real GDP Growth (GDPG) | 360 | 2.16 | 0.86 | 2.05 | 0.11 | 3.96 |
| Unemployment rate (UNEMPR) | 376 | 9.36 | 4.97 | 7.94 | 3.14 | 25.72 |
| Bank size - log Total assets (lnTA) | 22413 | 6.38 | 1.67 | 6.23 | 1.53 | 14.70 |
| Diversification (DIV) | 22413 | 28.17 | 13.37 | 25.29 | 4.47 | 80.99 |
| Loan to assets ratio (LA) | 22413 | 69.75 | 12.63 | 69.84 | 38.25 | 104.55 |
| Cost to income ratio (CI) | 22413 | 59.47 | 18.05 | 62.28 | 6.68 | 92.60 |
| Equity to assets (KA) | 22413 | 7.45 | 4.48 | 5.94 | 1.88 | 27.43 |
| Return on assets (ROA) | 22413 | 0.48 | 0.45 | 0.33 | -0.12 | 2.14 |
| Standard deviation of ROA (SDROA) | 22413 | 0.27 | 0.32 | 0.11 | 0.00 | 0.86 |

Notes: see Table 1 for detailed definition of each variable.

# Table 3 Summary Statistics at NUTS1 Regional Level

| NUTS1 | No. of banks | No. of obs. | log Z-index | LERNER | Real GDP growth | Unemployment rate |
|---|---|---|---|---|---|---|
| at1 | 69 | 663 | 3.86 | 5.35 | 2.5 | 5.35 |
| at3 | 34 | 325 | 3.92 | 6.82 | 3.1 | 3.19 |
| be1 | 25 | 183 | 3.31 | 9.72 | 2.07 | 15.6 |
| be2 | 15 | 85 | 3.63 | 12.95 | 1.97 | 4.95 |
| de1 | 255 | 3071 | 4.21 | 6 | 2.12 | 5.24 |
| de2 | 263 | 3117 | 4.06 | 6.17 | 2.62 | 5.89 |
| de3 | 13 | 84 | 3.57 | 6.94 | -0.11 | 17.01 |
| de4 | 19 | 184 | 4.1 | 10.66 | 1.61 | 17.02 |
| de5 | 12 | 93 | 4.21 | 5.27 | 2.05 | 12.05 |
| de6 | 18 | 154 | 4.1 | 8.89 | 1.47 | 9.05 |
| de7 | 122 | 1264 | 4.06 | 5.96 | 1.72 | 7.27 |
| de8 | 19 | 165 | 4.3 | 6.06 | 1.23 | 19.09 |
| de9 | 115 | 1314 | 4.18 | 7.49 | 1.56 | 8.33 |
| dea | 193 | 2491 | 4.13 | 7.23 | 1.35 | 8.19 |
| deb | 72 | 805 | 3.94 | 7.69 | 1.58 | 6.74 |
| dec | 21 | 193 | 4.26 | 6.59 | 2.36 | 7.94 |
| ded | 31 | 324 | 4.01 | 4.81 | 2.05 | 17.34 |
| dee | 19 | 173 | 4.51 | 6.18 | 1.52 | 15.7 |
| def | 41 | 437 | 4.09 | 6.88 | 1.29 | 8.28 |
| deg | 28 | 275 | 4.07 | 8.28 | 1.99 | 15.19 |
| dk0 | 22 | 184 | 3.49 | 14.41 | 1.79 | 3.8 |
| es1 | 14 | 53 | 4.1 | 14.03 | 3.74 | 8.58 |
| es2 | 15 | 63 | 4.38 | 19.07 | 3.71 | 6.04 |
| es3 | 39 | 195 | 3.69 | 15.14 | 3.96 | 7.41 |
| es4 | 20 | 80 | 3.83 | 19.51 | 3.7 | 10.8 |
| es5 | 41 | 195 | 3.84 | 17.28 | 3.44 | 7.59 |
| es6 | 16 | 57 | 3.93 | 21.81 | 3.68 | 14.18 |
| fr1 | 90 | 835 | 3.6 | 6.43 | 2.27 | 8.45 |
| fr2 | 19 | 180 | 4.1 | 12.97 | 1.31 | 8.48 |
| fr3 | 10 | 62 | 4.96 | 6.92 | 1.8 | 15.35 |
| fr4 | 14 | 119 | 4.1 | 6.6 | 1.42 | 7.73 |
| fr5 | 19 | 177 | 4.13 | 10.48 | 2.44 | 7.54 |
| fr6 | 18 | 150 | 4.06 | 10.52 | 2.4 | 8.17 |
| fr7 | 21 | 188 | 3.93 | 11.8 | 1.96 | 7.7 |
| fr8 | 15 | 143 | 3.82 | 12 | 2.76 | 12.29 |
| fr9 | 10 | 54 | 3.76 | 15.98 | . | 25.72 |
| itc | 91 | 545 | 3.62 | 12.84 | 1.23 | 4.28 |
| itd | 151 | 974 | 3.84 | 16.57 | 2.05 | 3.35 |

| | | | | | | |
|---|---|---|---|---|---|---|
| ite | 89 | 536 | 3.65 | 8.82 | 1.71 | 5.59 |
| itf | 75 | 453 | 3.74 | 13.66 | 1.14 | 12.05 |
| itg | 30 | 155 | 3.77 | 10.78 | 1.19 | 14.01 |
| nl3 | 17 | 83 | 3.93 | 11.45 | 2.19 | 3.14 |
| no0 | 75 | 514 | 3.85 | 17.53 | . | 3.55 |
| se1 | 16 | 132 | 3.31 | 15.65 | 3.2 | 5.2 |
| se2 | 37 | 377 | 3.95 | 16.8 | 2.67 | 5.5 |
| se3 | 10 | 69 | 4.52 | 11.87 | 2.12 | 6.63 |
| uki | 36 | 299 | 3.85 | 19.55 | 3.11 | 7.27 |
| Mean | 51 | 474 | 3.96 | 10.99 | 2.16 | 9.36 |

Notes: Mean values of listed variables are calculated at NUTS1 regional level. Detailed definition of variables can be found in Table 1.'at' represents Austria, 'be' represents Belgium, 'de' represents Germany, 'dk' represents Denmark, 'es' represents Spain, 'fr' represents France, 'it' represents Italy, 'nl' represents the Netherlands, 'se' represents Sweden, and 'uk' represents the UK. Note that not all NUTS1 regions are included in the sample due to data availability. Further information about the NUTS classification can be found at http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/regional_statistics/nuts_classification

## Table 4 Regional Competition, Economic Conditions and Bank Risks

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | lnZ | lnZ | lnZ | lnZ | ROA | KA | SDROA |
| L.lnZ | 0.264*** | 0.266*** | 0.293*** | 0.295*** | | | |
| | (0.000) | (0.000) | (0.000) | (0.000) | | | |
| L.LERNER | | -0.022** | | -0.022* | 0.018*** | 0.014 | 0.007*** |
| | | (0.010) | | (0.058) | (0.000) | (0.420) | (0.000) |
| L.LERNERsquare | | 0.001*** | | 0.001** | -7.65e-06 | -0.001 | -1.35e-04*** |
| | | (0.001) | | (0.023) | (0.182) | (0.170) | (0.000) |
| L.GDPGR | | | 0.001 | -0.002 | 0.002 | 0.014 | 0.000 |
| | | | (0.953) | (0.878) | (0.457) | (0.279) | (0.927) |
| L.UNEMPR | | | -0.109*** | -0.097** | -0.053*** | 0.048 | 0.005 |
| | | | (0.007) | (0.016) | (0.000) | (0.348) | (0.520) |
| L.lnTA | -0.013 | -0.012 | 0.001 | 0.003 | -0.015*** | 0.028 | -0.015*** |
| | (0.211) | (0.241) | (0.900) | (0.791) | (0.000) | (0.517) | (0.000) |
| L.DIV | -0.004*** | -0.004*** | -0.005*** | -0.004*** | 0.001 | 0.002 | 0.001*** |
| | (0.000) | (0.001) | (0.000) | (0.000) | (0.269) | (0.306) | (0.000) |
| L.CI | 0.001 | 0.001 | 0.002 | 0.002 | -0.004*** | -0.003 | -0.001*** |
| | (0.635) | (0.553) | (0.206) | (0.193) | (0.000) | (0.268) | (0.000) |
| L.LA | 0.001 | 0.001 | 0.000 | 0.001 | 0.001** | -0.002* | 0.000 |
| | (0.141) | (0.203) | (0.825) | (0.548) | (0.035) | (0.087) | (0.696) |
| dSAV | 0.347*** | 0.358*** | 0.361*** | 0.382*** | -0.145*** | 0.078 | -0.060*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.461) | (0.000) |
| dCOOP | 0.196*** | 0.219*** | 0.161*** | 0.180*** | -0.056*** | 0.197* | -0.029*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.002) | (0.073) | (0.006) |
| L.ROA | | | | | 0.265*** | | |
| | | | | | (0.000) | | |
| L.KA | | | | | | 0.964*** | |
| | | | | | | (0.000) | |
| L.SDROA | | | | | | | 0.005 |
| | | | | | | | (0.421) |
| Cons | 2.890*** | 2.942*** | 2.725*** | 2.765*** | 0.336*** | 0.157 | 0.250*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.830) | (0.000) |
| N | 15196 | 15196 | 12773 | 12773 | 13824 | 13824 | 13824 |
| Hansenp | 0.58 | 0.48 | 0.29 | 0.34 | 0.19 | 0.07 | 0.12 |
| AR2 | 0.01 | 0.51 | 0.98 | 0.87 | 0.74 | 0.39 | 0.14 |
| Inflection point | | 11 | | 11 | | | 26.5 |

Notes: System GMM estimator with Windmeijer-corrected standard errors is applied to Eq(1). The detailed information on variables can be found in Table 1. All explanatory variables are lagged with one year period to address the potential endogeneity problem. Regression 1 to 4 use natural logarithm of rolling Z-index at 3-year time window as dependent variable while regression 5 to 7 use three components of Z-index, e.g., ROA, equity to assets ratio (KA) and the standard deviation of ROA (rolling at 3-year time window) as dependent variables, respectively. 'Hansenp' is the p-value of the Hansen test statistic of over-identifying restrictions, while AR(2) is the p-value of the second order autocorrelation test statistic. Inflection point P-values of the estimated coefficients are reported in brackets. Year dummies from 1997 through 2008 are included in the model but not reported in the table. *, **, and *** represent 10, 5 and 1 percent significance level, respectively.

# Table 5 Robustness Tests

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | lnZ | lnZ | lnZ | lnZ | lnZ | lnZ | lnZ |
| L.lnZ | 0.298*** | 0.323*** | 0.033* | 0.027 | 0.824*** | 0.297*** | |
| | (0.000) | (0.000) | (0.094) | (0.181) | (0.000) | (0.000) | |
| L.LERNER | -0.036*** | -0.039** | -0.025** | -0.019* | -0.022*** | -0.025** | -0.024*** |
| | (0.008) | (0.018) | (0.014) | (0.083) | (0.006) | (0.015) | (0.005) |
| L.LERNERsquare | 0.002*** | 0.002*** | 0.001*** | 0.001** | 0.001** | 0.001** | 0.001*** |
| | (0.001) | (0.004) | (0.010) | (0.024) | (0.019) | (0.011) | (0.000) |
| L.RGDPGR | 0.002 | -0.002 | -0.011 | -0.011 | 0.007 | -0.004 | -0.007 |
| | (0.827) | (0.897) | (0.233) | (0.288) | (0.367) | (0.608) | (0.485) |
| L.lnUNEPMR | -0.091** | -0.085* | -0.046 | -0.026 | 0.038* | -0.089** | -0.099*** |
| | (0.025) | (0.060) | (0.273) | (0.564) | (0.072) | (0.015) | (0.008) |
| L.lnTA | 0.002 | 0.020 | 0.029** | 0.019 | 0.002 | 0.004 | -0.005 |
| | (0.865) | (0.168) | (0.048) | (0.285) | (0.769) | (0.667) | (0.640) |
| L.DIV | -0.004*** | -0.002 | -0.006*** | -0.006*** | -0.000 | -0.005*** | -0.008*** |
| | (0.001) | (0.298) | (0.000) | (0.000) | (0.667) | (0.000) | (0.000) |
| L.CI | 0.001 | 0.003* | 0.001 | 0.001 | 0.001 | 0.001 | 0.003** |
| | (0.276) | (0.091) | (0.309) | (0.274) | (0.281) | (0.264) | (0.013) |
| L.LA | 0.001 | 0.001 | 0.001 | 0.000 | -0.000 | 0.001 | 0.000 |
| | (0.436) | (0.350) | (0.535) | (0.825) | (0.693) | (0.460) | (0.773) |
| SAV | 0.367*** | 0.184*** | 0.389*** | 0.379*** | 0.167*** | 0.344*** | 0.468*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| COOP | 0.159*** | | 0.181*** | 0.211*** | 0.044* | 0.149*** | 0.209*** |
| | (0.000) | | (0.000) | (0.000) | (0.052) | (0.000) | (0.000) |
| cons | 2.923*** | 2.687*** | 3.904*** | 3.830*** | 0.538*** | 2.974*** | 4.704*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| N | 12422 | 10443 | 11404 | 9974 | 10637 | 12773 | 13122 |
| Hansenp | 0.30 | 0.30 | 0.30 | 0.74 | 0.75 | 0.70 | |
| AR2 | 0.97 | 0.97 | 0.97 | 0.68 | 0.68 | 0.58 | |
| Inflection point | 9.00 | 9.75 | 12.50 | 9.50 | 11.00 | 12.50 | 12.00 |

Notes: System GMM estimator with Windmeijer-corrected standard errors is applied to Eq(1) through regression 1 to 6. The detailed definition of variables can be found in Table 1. The dependent variable is natureal logarithm of rolling Z-index at 3-year time window except regression 5, where the dependent variable is natureal logarithm of rolling Z-index at 4-year time window . All explanatory variables are lagged with one year period to address the potential endogeneity problem. Regression 1 exclude financial centers from the whole sample. Regression 2 excludes commercial banks from the whole sample. Rregression 3 exclude the largest 10% banks in deposits from each region, while regression 4 excludes the largest 20% banks in deposits from each region. Regression 6 uses regional economic conditions variables (i.e., GDPG and UNEMPR) at NUTS2 region level. Regression 7 employs random effects estimator. 'Hansenp' is the p-value of the Hansen test statistic of over-identifying restrictions, while AR(2) is the p-value of the second order autocorrelation test statistic. P-values of the estimated coefficients are reported in brackets. Year dummies from 1997 through 2008 are included in the model but not reported in the table. *, **, and *** represent 10, 5 and 1 percent significance level, respectively.