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On the optimality of bank competition policy

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ON THE OPTIMALITY OF BANK COMPETITION POLICY

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This study examines whether the effect of market structure on financial stability is persistent, subject to current regulation and supervision policies. Extreme Bounds Analysis (EBA) is employed over a sample of 2450 banks operating within the EU-27 during the period 2003-2010. The results show an inverse U-shaped association between market power and soundness and a stabilizing tendency in markets of less concentration, where policies lean towards limited restrictions on non-interest income, official intervention in bank management and book transparency. Regulation significantly contributes as a stability channel through which bank competition policy is optimally designed.

Keywords: Market power; financial stability; regulation; extreme bound analysis
JEL-Classifications: D21; D4; L11; L51

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1. Introduction

Deregulation paves the way for the intensification of competitive conditions, amid which financial institutions could struggle to survive, thus increasing the potential incidence of financial crises. Systemic risk is high, especially for incumbent banks whose market share is large enough to imply negative externalities on national economies in cases where cross-border activity is significant.

The ongoing restructuring towards higher concentration for income diversification and risk management purposes has rendered financial regulation an imperative issue, building upon the failing premises of Basel II. In the light of the present financial crisis, capital regulation has been deficient, falling short of taking account of systemic risks. In addition, ineffective market discipline due to too-big-to-fail policies and deficient risk evaluations of credit ratings agencies are coupled with supervisory authorities with jurisdiction on the non-shadow banking sector. Alongside the ongoing debate on institutional reform in Europe, the present study sheds more light on the dynamics and optimality conditions of banking sector competition, in association with the evergreen topic of financial stability.

This study has a clear focus on the European Union, as the mandate for an integrated competition policy in banking is *sine qua non*, amid an ongoing financial crisis that calls for a framework of precautionary rules and resolution mechanisms in European financial markets. The analysis therefore contributes to the literature by investigating what degree of competition in banking is optimal, in particular, the focus is on the relationship between market power and stability and its persistence, and the effects of concentration and pricing conduct under different regimes of regulation, supervision[1] and corporate governance. To this end, Extreme Bounds Analysis (EBA) is applied for the first time in the related literature, in order to provide evidence for the efficacy of competition policy in the context of preserving European bank solvency. Contrary to many studies, market power is estimated through a bias-free marginal cost that eliminates the monopoly rent that incumbent banks enjoy in the deposits markets when resorting to raise funding.

The remainder of the paper summarises the theories on the relationship between competition and stability (section 2), describes the employed methodology

[1] See appendix for detailed description (Barth et al., 2013).

(section 3), followed by stability determinants (section 4) and sample data (section 5). Section 6 analyses the results (section 6), with some alternative risk measures in section 7, while section 8 concludes.

2. Theory

The analysis stems from the seminal contribution of Keeley (1990), who proposes the 'franchise (charter) value' paradigm. That is, in the event of the emergence of greater competitive pressures, the diminishing market power of banks squeezes profit margins and banks take refuge in riskier projects in order to recoup their lost returns. Bank failures are likely to occur when adverse selection and moral hazard problems indicate that banks are getting more reluctant to monitor borrowers. Thus, loan portfolios tend to comprise marginal applicants, who potentially exacerbate their risk exposure. In contrast, monopolistic markets may promote more prudent behaviour by banks, by reducing their risk-taking appetite amid conditions of more profit-making opportunities and larger capital cushions (Beck, 2008).

At the same time, a considerable source of instability stems from the liability side. As a consequence of the ongoing deregulation of financial markets, interest rates have declined in line with lower entry barriers and activity restrictions. In such conditions, banks strive to improve franchise value and profitability through riskier asset allocation given that, in hard times of insolvency and banks runs, deposit insurance schemes are stand-by to intervene. Hence, it is deemed essential for the authorities to impose restrictions on deposit competition to discourage 'gambling for resurrection' (Cole et al., 1995).

On top of that, Matutes and Vives (1996) consider the self-fulfilling expectations of depositors to endogenously affect the quality – or the failure probability – of a bank. In other words, the bank with high depositors' trust will enjoy higher margins and a greater market share, as perceived to be well diversified and hence safer. In addition, they examine the welfare implications of deposit insurance equilibria: notwithstanding the positive impact of insurance in preventing crises through lower costs and higher market shares, deposit insurance guarantees that all banks are credible. Thus, in the absence of potential diversification gains to exploit, all banks are discounted at the same rate and consequently higher competition implies

high failure probabilities. If decisive regulatory authorities allow for takeovers of the failed institutions, their assets are preserved under a new corporate structure (Perotti and Suarez, 2000). However, the assumption that concentration is conducive to lower competitive pricing seems strong as the net effect on system stability might in some circumstances be positive. That is evident if the preservation of long-term relationships makes banks exploit private and exclusive information about the intertemporal liquidity needs of their customers (Smith, 1984).

In cases when monopolistic conduct is not an inherent feature of large banks, a relative market power may contribute to stability in the presence of well-diversified portfolios and scale economies of few large banks (Diamond, 1984). The size, therefore, does matter in concentrated markets and recent economic history shows that fewer episodes of bank insolvency and runs occurred in Canada, than in U.S[2]. (Allen and Gale, 2000).

The second strand of the literature examining the competition-stability nexus emanates from Stiglitz and Weiss (1981), who show that monopolistic market structures are to be blamed for higher charges on loans and thereby heightened future defaults. Safe borrowers are repelled by high borrowing costs while information asymmetries justify a significant part of nonperforming loans. Boyd and De Nikolo (2005) investigate the loans market channel to conclude that the positive relationship between risk and competition turns out fragile. As monopolistic structures increase loan rates, borrowers with riskier projects dominate the market. Thus, the probability of default is conditional on banks' pricing conduct in the loans markets.

That is not the case, however, for the model of mean-shifting investment technologies by Koskela and Stenbacka (2000), since higher competition diminishes the loan rates without necessarily triggering default risk in equilibrium out of the increased demanded volume of investments. Caminal and Matutes (2002) find that monopolistic markets bearing the costs of monitoring tend to be more susceptible to risky loans and thereby subsequent failures. With insufficient credit rationing, banks place operational solvency in jeopardy with their willingness to lend. By contrast, De

[2] All things held constant, concentration-stability nexus assumes that few large banks operating in a concentrated market like Canada are better diversified and thus, less vulnerable to potential crises. Despite empirical studies that highlight the negative association between size and risk of failure (e.g. Boyd and Runkle, 1993), the paper merely controls for the average size of European banks in the EBA analysis, not the issue itself of financial instability as triggered by low diversification of large institutions.

Nikolo and Luchetta (2009) argue that efficiency, portfolio quality and diversification gains are higher in competitive markets, though non-perfect competition constitutes a second-best alternative.

Allen and Gale (2004) put forward a number of theoretical models of competition and financial stability, trying to shed light on the underlying multifaceted relationship. They include aspects like spatial and Schumpeterian competition, agency costs, financial intermediaries and contagion to explore the trade-off between competition and stability. It is Pareto optimal, though socially undesirable, to have instability in cases of a) perfect competition and complete markets, b) the presence of agency problems due to the incentive to acquire greater market share and the 'last bank standing effect' (Perotti and Suarez, 2002)[3] and c) many banks occupying the same locations and lacking innovation (Schumpeterian competition). Contagion might well be an outcome triggered by the systemic risk of an aggregate shock to liquidity if competitive interbank market forces price takers to liquidate their assets.

From the perspective of supervision and precautionary regulation, interesting arguments have been articulated in the literature. Although it is easier to monitor few and large banks rather than more and smaller banks, operating complexity of large entities has been considerably overlooked. Indeed, universal banks and conglomerates provide the whole spectrum of financial services - e.g. consulting (M&As), instrument and proprietary trading (derivatives included), stock broking, investment management, insurance – which were previously offered by more specialized banks, such as commercial, investment, and merchant banks. Hence, bank monitoring and timely intervention of supervisory authorities when needed constitute a demanding and costly task. In reality, more concentrated markets seem to result in the provision of large subsidies and bail-out schemes. Such contingency plans to correct failure externalities incentivise bank managers to take risks and exacerbate the risk profile of interconnected large banks (Mishkin, 1999).

Without committing to either of the competing hypotheses, it could be the case that there exists a compromise view. Martinez-Miera and Repullo (2010) argue that there exists an inverse U-shaped relationship between competition and the risk of

[3] Supporting the competition-stability literature, it concedes the prudent bank behavior as precipitated by the probability of the other market players be hit by random solvency shock. In the end, duopolies turn out to produce great monopoly rents.

bank failure. In particular, monopolistic markets experience the risk-shifting effect, according to which more competition with low loan rates stabilises banks as they run less risk of default. However, in competitive markets the margin effect implies a decline in total non-defaulting loan revenues that may imperil a bank in the face of potential new market entries.

3. Methodology

3.1. Proxies of market power and bank soundness

The price mark-up over marginal cost (Lerner index) combines the estimation of average prices and marginal costs at the bank level. The average prices are estimated over total assets (TA) along the lines of Shaffer (1993), rather than over other earning assets, in an attempt to expand the total number of observations in the sample which spans the period 2003-2010. First, marginal costs are calculated using a translog cost function, as Turk Ariss (2010) proposes, excluding the price of borrowed funds from the vector of input prices. The reason is that it presumably captures some degree of monopoly power of incumbent banks in the deposits market and thus, the Lerner index would be biased absorbing a 'market effect'.

The model employed takes the following form, which seems to best reflect the whole spectrum of financial intermediation:

$$lnTC_{i,t} = a + \beta_1 lnQ_{i,t} + \frac{1}{2}\beta_2 lnQ_{i,t}^2 +$$
$$\sum_{k=1}^{2}\gamma_k lnW_{i,t} + \sum_{k=1}^{2}\delta_k lnZ_{i,t} + \frac{1}{2}\sum_{k,j=1}^{2}\zeta_{k,j} lnW_{i,t}^2 + \frac{1}{2}\sum_{k,j=1}^{2}\theta_{k,j} lnZ_{i,t}^2 +$$
$$\frac{1}{2}\sum_{k=1}^{2}\lambda_k lnQ_{i,t} lnW_{i,t} + \frac{1}{2}\sum_{k=1}^{2}\mu_k lnQ_{i,t} lnZ_{i,t} + \frac{1}{2}\sum_{k,j=1}^{2}\xi_{k,j} lnW_{i,t} lnZ_{i,t} +$$
$$\rho_1 T + \frac{1}{2}\rho_2 T^2 + \frac{1}{2}\sigma T lnQ_{i,t} + \frac{1}{2}\sum_{k=1}^{2}\varphi_k T lnW_{i,t} + \frac{1}{2}\sum_{k=1}^{2}\psi_k T lnZ_{i,t} + \varepsilon_{i,t} \qquad (1)$$

Where *TC*: total costs (total operating costs, i.e. interest expenses, personnel and other costs), *Q*: total bank output or total assets (output), W_1: price of labour (personnel expenses over total assets), W_2: price of physical capital (other operating expenses over fixed assets), Z_1: fixed assets, Z_2: Off-balance sheet activities, Z_3: total equity

and *T*: time trend. The fixed effects methodology accounts for different bank specificities and the estimation of model (1) separately for each country allows for differentiated production technology in each banking sector. Time dummies also interact with the deterministic kernel in order to capture time-varying and non-neutral technological progress in the banking sector. Homogeneity of degree one in input prices ($\Sigma\gamma_k=1$) and symmetry conditions in all quadratic terms are imposed in model (1) and fixed netputs Z_1 and Z_2 are deflated by total equity (Z_3) to account for heteroscedasticity and scale bias.

When it comes to the estimation of the Lerner index, the approximation of marginal costs comes through the following expression:

$$MC_{i,t} = \frac{TC_{i,t}}{Q_{i,t}}\left[\beta_1 + \beta_2 lnQ_{i,t} + \sum_{k=1}^{2}\lambda_k lnW_{i,t} + \sum_{k=1}^{2}\mu_k lnZ_{i,t} + \sigma T\right] \qquad (2)$$

The Lerner index (*L*) is then estimated for specific bank activities, before examining the determinants of stability, according to the following structural model:

$$L_{i,t} = \frac{AR_{i,t} - MC_{i,t}}{AR_{i,t}} \qquad (3)$$

where *AR* denotes the average revenue of banks estimated by total income over total assets and *MC* the marginal cost derived through model (2). The subscripts signify the importance of the Lerner index as a reliable time-varying proxy of market power at the bank level. Estimation of the natural logarithm of the Z-score follows, as the most widely used proxy of distance from a situation of insolvency. It is computed through the following expression:

$$Z_{i,t} = \frac{ROA_{i,t} + (E/TA)_{i,t}}{\sigma(ROA_{i,t})} \qquad (4)$$

where *ROA*: returns on assets, *EQ/TA*: total equity to total assets, *σ(ROA)*: standard deviation of returns on assets, all expressed for bank *i* at time *t*. It is interpreted as the number of standard deviations by which *ROA* should fall under the mean so as to extinguish bank equity[4]. To avoid time invariance of the denominator, a three-year rolling window is implemented as a second-best solution to allow for profits

[4] Regarding the dependent variable, taking the natural logarithm of the Z-score normalises its extreme values, which are due to high skewness. In the literature, any possible negative values are alleviated by transforming them through truncation at zero point [*ln(1+Z-score)*] or trimming extreme outliers at 1% level and then taking logs. Since the latter produces non-negative values, I opt for it.

volatility; whilst a five-year rolling window would be more appropriate, it is not possible due to data availability.

3.2. Models employed

The underlying literature has proposed different econometric modelling – (e.g) GMM methodology, panel, probit, logit models and duration analysis, among others, – and various determinants of the risk of bank failure. This unwieldy bulk of more than 50 variables has led to mixed results, depending each time on the econometric specification and the independent set of the regression model. This paper studies the key drivers (market power, concentration) of bank risk, conditioned on the variation of carefully pooled variables that one can identify as statistically significant in the literature. In other words, utilising Extreme Bounds Analysis (EBA) as set out by Leamer and Leonard (1983), the partial correlations of dependent and independent variables are examined to explore whether such relationships are fragile or robust at standard confidence levels.

The methodology employed is a sensitivity analysis of linear modelling, regarding multiple regressions of bank risks on groups of observable variables. All variables allowed to exhibit variation at the bank level are lagged one period to avoid reverse causality among them. In other words, the endogeneity of market power may reflect the impact of insolvency on market structure and subsequently on pricing policy. The fact that country-level factors are not lagged provides insight of the potential drivers of heterogeneity[5]. In addition, as some countries (especially Germany) dominate the sample, the analysis employs as a probability weight the inverse of the number of banks operating within each market, as a way to avoid any such bias and guarantee error clustering at the country level. Schematically,

$$lnZ_{i,t} = f\left(L_{i,t-1}, CONC_{i,t}, I_{i,t}, M_{i,t}, B_{i,t-1}\right) + \varepsilon_{i,t} \qquad (5)$$

In this model, the variables of interest are market power and, secondarily, concentration (*CONC*). The Lerner index (*L*) is appropriate for capturing the pricing conduct of banks after computing marginal costs through the standard stochastic

[5] One might expect that regulations have changed because banks have been more fragile after 2007. However, that sort of endogeneity is not evident as the fluctuation of regulation and supervision comes along only three times during the sample period.

modelling of equation (1) and the estimation of the partial derivative of total costs with respect to total assets (equation 2). Concentration is proxied by the Herfindahl-Hirschman ratio (*HHI*) since it is deemed, in the literature, to proxy real market conditions in antitrust policies and represent the root cause of monopolistic pricing and profitability of few banks with high market shares (Structure-Conduct-Profitability paradigm)[6].

The bound analysis starts with the baseline model, which regresses financial stability (*lnZ-score*) of bank *i* at time *t* on the variables of interest (*L*, *CONC*) after controlling for other bank-specific factors (*B*) and macroeconomic conditions (*M*) across the region to deduct the error effects as much as possible and achieve an unbiased depiction in levels and significance of the underlying coefficients. Various bank-specific factors are also employed to encompass different aspects of banks' balance sheet, income structure, corporate governance and general strategic planning. As a next step thereafter, institutional factors that allow for different legal systems, regulatory schemes and market discipline (*I*) are plugged in to construct the bounds of the market structure coefficients.

Thus, the extreme upper and low bounds of the coefficient values come out of all possible combinations of *I*-effects expanding the analysis up to 10 regressions for each model. The degree to which partial correlations between market structure and financial stability are robust or fragile is defined by the persistence of the sign and the statistical significance in-between the range of the bounds. Thus, the variables of interest should be treated with less confidence in so far as their causal effect on risk is contingent on the employed information set. However, the analysis does not aim to come up with a single model that breaks down the competition-(in)stability nexus, but rather to assess their interconnections considering what has been proposed in the empirical literature and always in view of the mandate for constant institutional reform.

Our endeavour is to obtain evidence of a statistically significant relationship between competition and concentration through the employment of a quadratic term of the Lerner index, i.e. to explore whether this is an inverse U-shaped relationship.

[6] Market power and concentration have been applied in the literature interchangeably to explain market conditions; hereinafter, they are both included in the analysis to encompass different aspects of market structure.

This addition comes ad hoc, only in the regression models that construct the extreme bounds, so as to estimate the turning-point level of competition above which the relationship of competition-stability changes; otherwise, the use of it in all model combinations would blur the effective bounds due to endogeneity concerns. In case of no significant coefficient as an extreme bound, a different information set of the same size is used.

Moreover, the impact of country-level variables on risk may be insufficient, when considering it in terms of slopes rather than in levels (model 6). Hence, the model includes interaction terms between country-level factors and the Lerner index, along with lagged bank-specific controls. However, the only drawback in this approach is that interaction terms may bring about multicollinearity problems that are partially counterbalanced by more degrees of freedom in one-step regression analysis of the whole sample. Such problems are depicted in inflated standard errors and, therefore, in higher coefficients revealing little variation (weak data) of a specific independent factor to determine cross-sectional differentials (Levine and Renelt, 1992). The model is schematically the following:

$$lnZ_{i,t} = f\left(L_{i,t-1}, CONC_{i,t} * L_{i,t-1}, I_{i,t} * L_{i,t-1}, M_{i,t} * L_{i,t-1}, B_{i,t-1}\right) + \varepsilon_{i,t} \qquad (6)$$

The Lerner index (L) and concentration ($CONC$) are included in the analysis simultaneously since they tend to reflect different aspects of bank competitiveness. Second, the analysis utilises all possible combinations of two and three *I-variable* sets in order to alleviate multicollinearity problems arising from sets of higher dimension. Indeed, the vector size on the right-hand side of models 1 and 2 appears parsimonious, in line with the procedure followed by Barro (1991). When allowing for interaction terms, model 2 omits the effect of country-wide variables in levels as their inclusion would induce multicollinearity. In addition, the scope of the paper is to investigate the sign persistence of market structure in the resolution of potential financial crises, not its non-linear relationship with institutional variables[7].

[7] Unreported evidence shows that the linear effect of market power and each institutional variable, though significant, does not capture the bearing of the underlying interaction term. Thus, model 2 is not misspecified and, thus, the coefficient associated with the interaction is unbiased.

4. Determinants of financial stability

4.1. Bank-specific variables

Asset size has been used in the literature (e.g. Liu et al., 2012) in an attempt to see whether financial stability comes from managers' attitude to exploit scale economies or by the perception that too-big-to-fail policies will constitute the facility of last resort in the form of governmental subsidies, among others. ***Capital ratio*** is the value of total equity deflated by a bank's total assets, accounting for differentials in risk preference behaviour of bank managers along the lines of Schaeck and Cihak (2008) and Berger et al. (2009). ***Cost efficiency*** turns out to be the most widely employed accounting variable that proxies for operational performance as contemporary efficiency modelling may produce bias due to certain methodological and econometric assumptions. A negative effect on stability is expected since inefficient banks tend to engage in risky behaviour to make up for insufficient performance (Uhde and Heimeshoff, 2009).

Liquidity is controlled for by the ratio of liquid assets over customer deposits and short-term funding. It measures what percentage of deposits and funding can be served in case there is a suddenly bank run. The higher this ratio is the less vulnerable a bank is vis-à-vis a deposit run-off case. Similar proxies appear in the literature, such as liquid assets over liquid liabilities or over total assets (Olivero et al., 2010), with no substantial difference in practice. ***Diversification*** indicates the ability of a bank to expand its operations to off-balance sheet activities, namely to insurance, real estate and securities activities; thus, a standard proxy is the total non-interest operating income over total. A negative association between diversification and risk is expected but it might also be the case that banks with high-income diversification are exposed to greater risks in their attempt to accomplish economies of scope (Stiroh, 2004).

4.2. Macroeconomic variables

Real GDP growth rate has been employed (e.g. Jimenez et al., 2013) in order to control for different stages of the economic cycle. As for the expected effect, higher customer demand after the adoption of Euro may resulted in better managerial efficiency in terms of a relatively superior utilisation of production factors (Conrad et al., 2009). Economic prosperity is thought to reduce the probability of a potential

bank crisis, which usually comes along with loan risk during economic recessions. On the other hand, loan losses can occur during economic booms if high GDP growth rates promote optimistic evaluations of borrowers' creditworthiness leading to less stringent policies, and when competitive structures make managers more willing to risk-taking activities (Jimenez and Saurina, 2006).

Boyd et al. (2004) underscore ***inflation*** as a precursor of imminent bank failures. When the nominal rate of interest and inflation is below a certain threshold, a relatively higher probability of bank failure is present in monopolies where the incentive of loaning out cash reserves dominates that of paying low rates on deposit accounts. In contrast, asset losses are more likely to occur in competitive markets during a crisis, as monopolies tend to make profits from asset liquidation (e.g. deposits), since their size enables them to provide inter-temporally much lower deposit insurance. ***Stock market turnover*** is defined as the total value of traded shares over the average stock market capitalisation. I employ the degree of liquidity in stock markets in order to take account of alternative funding means of firms, which may be related to greater dissemination of credit information and, thus, to greater bank soundness (Beck et al., 2013).

4.3. Regulatory environment[8]

Capital regulatory index (CAP) measures the degree of regulation on bank capital that should be set aside as a buffer for potential market and credit risks. In particular, it is about the initial capital stringency, that is which type of regulatory funds other than cash, governmental securities or borrowed funds, is appropriate and verifiable by the official regulatory authorities - and to what extent. It is also about the overall capital stringency, according to which the regulatory capital is estimated accounting for risks and value losses. Thus, it is quantified by ascribing values of 0 or 1 to every single one of the nine questions included in the appendix, with the observations ranging between 0 (no stringency) and 9 (high stringency). After the advent of euro, the necessity to build upon the inefficient or inadequate regulatory

[8] Barth et al. (2013) provide aggregate data of each country as retrieved from questionnaires filled in by national banks according to the last updated survey of World Bank. Despite the use of collected and classified responses, institutional variables are constructed as prescribed in the appendix.

directives as set out by the Accord of the Basel Committee (Basel I, Basel II and III) has prompted extensive research. Empirical studies are split between those which highlight the invigorating effects of capital requirements by reducing loan losses and those which underline their detrimental implications on risk-taking. Required reserves of capital may constitute sufficient buffers in view of potential liquidity shocks, notwithstanding the case of banks embarking on gambling behaviour in order to make up either for the utility loss of powerful bank owners (Laeven and Levine, 2009), or for the diminishing franchise values (Hellman et al., 2000).

Official supervisory power (OFF) measures the degree of supervisory power exercised by the official authorities and their 'intervention' to the decisions of bank managers. It takes values from 0 to 10, ascribing 0 and 1 to negative and positive responses, respectively. From a theoretical perspective, excessively strong supervision tends to demoralise managers to engage in excessive risk-taking - especially in countries with low accounting requirements (Fernandez and Gonzalez, 2005) - whereas it may be associated with corruption in lending transactions, and obstruction of bank operations (Barth et al., 2004).

Private monitoring index (PRIV) indicates the degree of information released to the public and officials relative to the requirements of auditing authorities and credit rating agencies. It takes values between 0 and 10 after taking into account the 'no' and 'yes' responses of 10 questions, respectively. Hence, higher values highlight greater insight of the public and officials over the economic performance of banks. This factor has been overlooked in the literature while it is only recently that it has been utilised by Schaeck et al. (2009), who argue that the frequent empirical insignificance of concentration may reflect to the common practice of investors, regulatory authorities and credit agencies to inspect large entities closely.

Activity restrictions (ACT) is an interesting variable which measures the extent to which bank activities, like securities, insurance and real estate activities, are under constraint. In particular, it takes the responses of 'prohibited', 'restricted', 'permitted' or 'unrestricted' and assigns them the values of 4, 3, 2 and 1, respectively. Finally, I get the average value of the overall index and draw conclusions regarding the overall degree of activity restriction. In the literature, there are two strands of reasoning in favour of or against their effect on bank soundness. In cases when such restrictions forbid banks to engage in more risky projects, the financial stability

benefit is evident (Uhde and Heimeshoff, 2009). However, if banks are restricted as regards their freedom to diversify their portfolio to non-interest bearing products, the concomitant utility loss induces powerful bank owners to engage in riskier conduct (Laeven and Levine, 2009).

Foreign ownership (FOR) has been employed (e.g. Yeyati and Micco, 2007) and calculated as the total assets of banks, which are owned by foreigners with more than 50% stake, as a percentage to the total assets of the banking system they operate within. The issues related to penetration of foreign banks in a national market are the screening costs of local customers that tend to decline through acquired experience, and the guarantees of the parent bank that constitute a safety net in times of insolvency and liquidity shocks (De Nikolo and Loukoianova, 2007). There is also the option to pick up national banks of monopolistic markets (dodging competition hypothesis), higher operational efficiency (cream skimming hypothesis), or large market shares through branches and subsidiaries (quest for market power hypothesis).

5. Data

The sample includes financial data for 2450 banks headquartering in the enlarged European Union (EU-27). The data are from consolidated accounts of the Bankscope database and, when that is not possible, the use of unconsolidated accounts forms the second-best solution. The data amount to 12118 observations for the period 2003-2010 and are subdivided into the EU-15 and EU-12 subgroups of the European Union.[9] The period under investigation covers the financial crisis after 2007 and the latest update of supervision variables up until 2010[10]. To avoid losing observations-outliers in an already limited sample, trimming each distribution tail of the Lerner index and Z-score at the 1% level is deemed sufficient to ensure robust standard errors. The sample also includes the whole spectrum of productive

[9] EU-15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, Spain, Sweden and UK. EU-12: Cyprus, Czech R., Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Bulgaria and Romania.

[10] In particular, the methodology followed to construct the *I*-variables is explicitly encompassed in the appendix as retrieved from Barth et al. (2013).

specialisation[11] in European banking, after careful elimination of double counting for every single case.

[Insert table 1 here]

Table 1 contains summary statistics of all variables of interest, including those estimated in the main econometric exercise. Each column exhibits the mean values per country as well as the average of the old and new member states.[12] In particular, EU-15 is far more stable throughout the period 2003-2010, as measured by the average Z-score, which is our proxy of distance from a situation of insolvency; Germany and Spain stand out as the best performers in contrast with Finland and Greece, which are well below the average of EU-12. In the latter case, Slovenia, Bulgaria and Poland enjoy greater bank soundness whereas Cyprus, Estonia and Latvia lie far below the lowest score of EU-15 countries. Turning to the Lerner index, harsher monopolistic conditions occur in UK (80.3%), Lithuania (76.4%) and Malta (63.9%). In contrast, Finland, Ireland and Cyprus have negative values of the Lerner index, indicating an irrational behaviour or predatory pricing (hunting more market share) on banking products. The remainder of Table 1 provides a clear snapshot of the special characteristics of each banking market and the conditions of the economy, regulation and supervision.

[Insert table 2 here]

Table 2 contains information on pair wise correlations of the country-specific variables employed in the analysis. Unreported evidence shows a correlation between market power and concentration at the level of -15.5% endorsing thereby the methodology employed to utilise them as distinct drivers of risk-taking. In addition, correlation seems significant at the 5% level between the variables of regulation and supervision. In particular, countries with a developed institutional environment experience, on average, lower transaction activity in the stock market. Moreover, the degree of official intervention in the decisions of bank managers is positively correlated with capital regulation and foreign ownership. In contrast, it appears as a

[11] Bank holding and holding companies, Clearing institutions and custody, Commercial banks, Cooperative banks, Finance companies (Credit card, Factoring and Leasing), Group finance companies, Investment and Trust corporations, Investment banks, Islamic banks, Micro-financing institutions, Other non-banking credit institutions, Private banking and Asset management companies, Real estate and mortgage banks, Saving banks, Securities firms and Specialised governmental credit institutions.

[12] Bulgaria and Romania are included in the EU-12, as they constitute the Southeastern EU group.

substitute mechanism to deter risk-taking motives through a lower degree of public insight; in other words, direct intervention has a role to play when book transparency fails to produce the necessary macroprudential conduct. However, information release in a market of incumbent banks appears as a policy complement to restrictions imposed on potential diversification gains from non-traditional banking activity.

6. Results

Table 3 displays the results of the sensitivity analysis conducted to see whether and to what extent factors of regulation and supervision have an independent impact on bank soundness. The baseline model in the first column excludes all but the macroeconomic and bank-specific controls, while one key variable is added at a time in the following columns. The coefficient of Lerner remains significant throughout, with a negative effect except for the last two columns, where it loses significance; however, the underlying effect turns positive when the model allows for capital regulation. From a policy perspective, capital buffers make banks absorb any risks involved in their operation and constitute a stabilising precondition for higher price mark-up levels; as for the transparency of accounting information, the pricing effect on financial stability is neutralised as information asymmetries are considerably mitigated. In all cases, concentration in the banking market has a negative effect on bank soundness, significant at the 1% level.

There is a high significance of regulatory variables when the specified model assesses them individually, *albeit* official supervision has no explanatory power. Once the whole I-variable set gets in the model, their joint effect turns out to be significant at 1% level according to an F-test estimated. The significant negative sign on activity restrictions[13] implies that when managers are restricted from entering other non-traditional business lines for diversification purposes, their portfolio risk exposure is exacerbated. On the contrary, capital regulation is significant at the 1% level implying that it fosters stability in the banking sector. Hence, higher capitalization makes banks more immune to liquidity shocks although the opportunity cost of such a 'tax burden', in cases of powerful owners, constitutes a considerable motive for risk-taking (Laeven

[13] The stabilizing effect of activity restrictions is found by Berger et al. (2009) and Beck et al. (2013) unlike Laeven and Levine (2009) and Uhde and Heimeshoff (2009) advocating to the contrary.

and Levine, 2009). Similarly, foreign ownership is related to bank stability, when included alone, as the openness to foreign institutions leads to competition and higher profit margins due to the adoption of better practices that enhance operational performance. Bank soundness tend to decline when official supervision included in the policy mix becomes more stringent due to some sort of corruption in lending activities that undermines systemic efficiency (Beck et al., 2006). Last, private monitoring is highly significant with a negative bearing on banking system stability, despite the fact that too-big-to-fail banks have been subject to close monitoring and market inspection. Hence, there is a motive for excessive risk-taking among incumbent banks, without reducing the statistical significance of concentration.

Once the whole set of *I-variables* enters the model, the same pattern holds for regulation variables with the exception of foreign ownership. Considering possible policies, an increase in ACT, CAP, OFF, PRIV by one standard deviation leads to a Z-score change of -2.9%, 11.4%, -15.9% and -11.7%[14], respectively. In fact, there are many possible scenarios of regulatory reform, by combining the above effects towards a more rationalised too-big-to-fail banking system.

Furthermore, conditions of high market demand, as expressed by GDP growth, make banks utilise production factors in a more efficient way, leading to lower average costs through lower average costs (Conrad et al., 2009), while banks are more likely to face insolvency problems during economic downturns. In contrast, the impact of inflation is significantly negative, highlighting possibly the incentive of loaning out cash reserves rather than paying low deposit rates; however, that could highlight a prolonged period of inflation and financial fragility in the non-euro area countries. More liquidity in stock markets has a considerable negative impact on financial fragility, which is not expected. That may reflect the risk-shifting tendency of banks towards non-traditional activities or herding behaviour, among others.

A significantly negative relationship is also evident between asset size and bank soundness coupled with a negative (though not always significant) effect of cost inefficiency. Hence, the exploitation of economies of scale is not achievable insofar as government subsidies and other 'too-big-to-fail' policies operate as last resort mechanisms for managers with excessive risk-taking tendency. That is also in line

[14] The estimation stems from the respective coefficients multiplied by their standard deviation [ACT: 2.069, CAP: 1.462, OFF: 2.314, PRIV: 1.382].

with Schaeck and Cihak (2013), who consider efficiency as a significant channel of stability through competition. Furthermore, wherever significant, the equity ratio has a positive effect at the 1% significance level, indicating a buffer that insulates a bank from low profitability or profit volatility. In contrast, the aim of more portfolio diversification (*TNINTINC/TI*) through economies of scope might bring about excessive risk-taking (Stiroh, 2004). This finding justifies activity restrictions as a necessary policy towards a more piecemeal approach given its negative coefficient. Similarly, the higher a bank's ratio of liquid assets to deposits the smaller its distance from insolvency, as excessive opportunity cost is potentially compensated by risky portfolio allocations.

[Insert Table 3 here]

Turning to Table 4, the EBA approach, through any possible combination of regulatory variables, is used to verify whether there exists a persistent effect of market power and concentration in sign and significance. Hence, the coefficient of the Lerner index takes significant values at the 1% level, ranging between -0.368 and 0.096 when I include [ACT, OFF] and [CAP, PRIV] in the model, respectively. Hence, an increase of one standard deviation in the Lerner index leads to a relative change of the Z-score ranging from -8% to +2.1%. Concentration does not switch impact sign and proves to be stable in its relationship with bank soundness across all possible regressions. It takes values from -0.009 when [OFF, PRIV] come into play, to -0.008 with [ACT, CAP, PRIV] variables.

In the next two rows below the grey ones, the models that construct only the extreme bounds of the Lerner index and concentration comprise the quadratic term of market power to verify whether, and to what extent, it is the case of a non-linear relationship between the Lerner index and the Z-score. The linear effect of market power takes values in the range [0.785, 0.585] and the narrower one [0.608, 0.760] for the extreme bounds of the Lerner index and HHI, respectively. The former bounds indicate fragility in the underlying relationship as opposed to the significance at 1% level in the latter. On the other hand, the respective bounds for the quadratic term are [-1.071, -0.603] and [-0.875, -1.213] while t-values show persistently high explanatory power. It is therefore concluded that an inverse U-shaped relationship between competition and risk does exist and a sign change occurs at the turning points [0.733, 0.970] and [0.695, 0.627], where concentration and market power get close to

their limits. Profits have to fall by 17.4%-12.9% (13.5%-16.9%) more standard deviations if market power increases by one standard deviation, before equity is fully depleted. However, when market power takes values more than 0.733 (0.627), a reduction of market power by one standard deviation means profits must decline by 23.8%-13.4% (19.4%-26.9%) more standard deviations, before equity capital is fully consumed[15].

[Insert Table 4 here]

In table 5, the procedure remains the same following model 2. The linear effect of the Lerner index appears quite stable in its positive sign and persistent significance in the sensitivity analysis. The level of the coefficient of market power is seemingly much higher than that in table 3; the truth is that it is not. If all coefficients of the interaction terms are deducted from the linear effect of the Lerner index, we come up roughly with a persistent negative Lerner coefficient. Market power leads to bank stability in markets of limited concentration where effective systems with fewer restrictions on bank activities, more capital requirements, a smaller share of foreign-owned banks, limited intervention of supervisory authorities on a bank's decisions and less private monitoring are in place. The stand-alone impact of foreign ownership on stability is marginally rejected at the 10% level, while market power and its interaction with concentration appear insignificant. Thus, foreign penetration fails to explain the variation of the Z-score as long as they are seconded by other policy initiatives (last column). The expected effect of a one-standard-deviation increase in ACT, CAP, FOR, OFF and PRIV on the market power-stability correlation is -2.3%, +7.1%, -32.3%, -7.3% and -9.4%[16], respectively. Considering the negative sign as in the results of model 1, regulation policies tend to undermine financial stability, as monopolistic pricing cannot counterbalance the effects of an undiversified portfolio, undisciplined bank management and unreliable accounting information.

[15] One might expect that the majority of banks have a level of market power above the turning point but the descriptive statistics tend to document that it is not. The turning points are estimated at values of Lerner index between 0.73 and 0.97, while the mean value of the averaged Lerner index exceeds 0.73 for only two countries (UK and Lithuania). This inconsistency is justified by the asymmetry of an inverse U-shaped relationship and the shape of the Lerner distribution. Descriptive statistics report the mean values before winsorising by 1%, while the regression analysis allows for mitigated skewness.

[16] The increase of one standard deviation in ACT, CAP, FOR, OFF, PRIV leads to a Lerner coefficient equal to 1.855, 2.033, 1.284, 1.760 and 1.710, respectively. Thus, the relative change is estimated considering the initial level (1.898).

The last part of the table gives an impression on the role of the business cycle and the special characteristics of differently specialised banks. A higher GDP growth rate possibly stabilises profits and concurrently minimises loan losses and profit variation. However, procyclicality exacerbates the leverage profile of the banking sector as higher risks due to securitisation strategies of poor quality should be covered through recapitalisation. On the other hand, the availability of stock market funding tends to have a positive impact on ROA and a negative one on revenue volatility and losses on gross loans.

There is also considerable significance in the interaction terms between lagged competition and macroeconomic variables. GDP growth tends to bolster the stabilizing effect of market power across all cases. In contrast, inflation pressures and stock market liquidity reduce the stabilising effect of market power. As in Table 1, the signs of bank-specific factors remain the same but their statistical significance becomes evident in fewer cases. Looking at the full model, financial fragility is exacerbated by financial institutions with higher asset size, less capital, lower cost efficiency and greater portfolio diversification. Only bank size and non-interest income have a significant effect throughout while, in the model that allows for the single interaction between activity restrictions and market power, cost efficiency and asset liquidity also have explanatory power.

[Insert Table 5 here]

In the grey rows of Table 6, the extreme bounds of competition and concentration, which were estimated from two to three-variable sets, range in-between the values of [0.326, 2.775] and [-0.019, -0.005], respectively. For the former case, the model comprises [CAP, OFF] and [OFF, PRIV] for its lowest bound and highest bound, respectively; as for the interaction term HHI*L, the bounds are constructed by [OFF, PRIV] and [ACT, CAP, OFF] specifications. In addition, the partial correlation at both the 5% and the 1% significance level is fragile in terms of significance, and it takes the replacement of one I-variable to change sign or lose significance, whereas concentration keeps its robust significance across all versions of model 2. Once the squared term comes in, the linear effect across all extreme bounds of the Lerner index and its interaction with HHI lies between the ranges [0.927. 3.394] and [3.394. 2.340], respectively. Similarly, the quadratic variable gets values in-between the bounds [-0.771, -0.809] and [-0.809, -1.316] with a persistent

significance at 1% level across all specifications. Thus, an increase in the Lerner index of one standard deviation leads to higher levels of the Z-score by 7.2% (61.6%), which is further decomposed to a positive 23.8% (19.4%) change up to a point where higher levels of market power lead to a fall by 14.5 (17.8%).

[Insert table 6 here]

7. Alternative measures of risk

Last, the analysis tests alternative measures of market stability and to what degree model 7 can predict their variation. Therefore, the analysis employs as dependent variable Returns on Assets (*ROA*), Equity to Total Assets (*E/TA*), the standard deviation of ROA (*sROA*), the logged nominator of the Z-score [*ln(ROA_E/TA)*], the Z-score with the denominator being averaged over the whole period (*lnZ*) and credit risk as proxied by loan loss charges over average gross loans (*Loan Losses*).

$$Risk_{i,t} = f\left(L_{i,t-1}, CONC_{i,t}, I_{i,t}, M_{i,t}, B_{i,t-1}\right) + \varepsilon_{i,t} \qquad (7)$$

Market power determines, at the 1% significance level, the variation of bank profitability, non-performing loans and the Z-score with the denominator averaged over the whole period (table 7). Market concentration is significantly positive as a regressor of the Z-score and interestingly of loans losses, profit variability and the nominator, out of which no one constituent seems to be correlated with it.

Activity restrictions lead to higher bank profits, possibly because any potential risk diversification gains from non-interest bearing activities is dominated by losses on assets. The fragility of the banking system, as reflected in loan provisioning, increases with capital regulation. The results provide an indication as to which policy has a direct impact on non-performing loans; that is, the more capital reserves are required to be set aside, the more managers may be incentivised to take refuge in higher risk-return profiles, by granting more loans either to marginal applicants or to customers-defaulters at any level of informational asymmetry. Likewise, the share of foreign-owned assets in a banking system does harm to stability to the extent that is associated with lower profitability and higher loan loss provisions. That might

indicate fierce competition, in which incumbent banks strive to survive against 'hit-and-run' practices.

The degree of intervention of official authorities enhances stability through greater quality of earning assets, the preservation of capital levels abiding by the Basel rules, and by contributing towards a healthy loan portfolio devoid of excessive subordinate risks. Hence, the latter is not expected *ex ante* since stricter authorities tend to intervene in bank decisions through suspending dividends, superseding the rights of shareholders thereby demoralizing potential investors. Moreover, the fact that financial institutions are exposed to private sector surveillance appears beneficial for banks to preserve high levels of equity capital and credit rationing. Last, when comparing the results of the last column with the respective one of table 3, the robustness is evident although the allowance of time-variant volatility in the Z-score tends to reduce the effect of market power.

[Insert table 7 here]

8. Conclusions

This study addresses whether the relationship between market structure and financial stability is significant, under different specifications, for the European Union, since the advent of the single currency. In a nutshell, it finds evidence of a positive relationship between concentration and financial fragility, while the inverse U-shaped correlation between the Lerner index and Z-score reconciles previously mutually exclusive theories employing a) linear effects of regulatory and supervisory variables, b) interactions of regulation with bank market power, and c) different dependent variables that encompass various aspects of bank risk.

The results show a linear relationship - albeit not always significant - between the Lerner index and the Z-score at standard significance levels when allowing for various institutional effects. When non-linear effects are investigated, the Lerner index follows the same pattern, taking account of different-sized information sets. The inverse U-shaped relationship is persistent, according to which market power seems to improve bank solvency up to the level of 64.4%, where monopolistic behaviour has negative repercussions. Concentrated markets are highly correlated with financial distress across any specification and robustness check. However, fragility stems from

bank managers' engagement in risk-taking via lending transactions and other non-interest income activities.

In general, the majority of institutional variables could affect bank stability individually. When assessing their significance, more financial stability is traced in markets of more capital regulation and foreign ownership while requirements of information dissemination, restrictions on non-traditional activities as well as supervisory intervention tend to render the financial system more fragile.

Optimal competition policy should promote the mandate of less concentration and precautionary action towards less monopolistic pricing especially in times of high inflation and stock market activity, when banks tend to price 73.3% above their marginal cost. Higher capital buffers in Basel directives vis-à-vis potential losses on the risky portion of OBS allocations, although 'costly' in the wake of the crisis, constitute the stabilising force of too-expensive-to-fail incumbent banks. Official intervention, book transparency and activity restrictions co-exist under a heterogeneous European framework that induces negative externalities on bank soundness, which is due, per se, to the monopolistic pricing of concentrated markets. Policy makers should evaluate the changes in market structure over time and how institutional reforms have affected them, in order to identify the conditions under which bank solvency is best preserved.

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Table 1: Descriptive statistics

	Z-score	Lerner	TA	TC/TI	TNINTI/TI	LIQ/DEPSTF	CONC	GDPGR	Inflation	Stock MT	Activity R.	Capital Reg.	Foreign Own	Official Sup.	Private Mon.
Austria	195.174	0.325	5873.057	0.659	0.203	0.365	0.265	0.023	0.020	0.350	6.333	5.666	0.144	11.666	5.666
Belgium	88.257	0.157	44573.660	0.652	0.295	0.417	0.796	0.020	0.023	0.678	7.333	5.000	0.210	9.666	6.333
Denmark	53.973	0.243	9384.117	0.602	0.211	0.360	0.591	0.014	0.020	0.634	9.666	5.333	0.139	9.666	7.666
Finland	41.317	-0.174	34316.880	0.657	0.386	0.498	0.922	0.031	0.016	1.064	8.000	5.666	0.317	7.333	7.000
France	155.072	0.150	36018.890	0.659	0.306	0.426	0.435	0.015	0.021	0.812	8.000	6.000	0.091	7.333	8.000
Germany	901.771	0.157	5417.424	0.718	0.180	0.230	0.345	0.014	0.019	0.453	7.000	6.666	0.151	10.000	6.666
Greece	47.408	0.152	18160.340	0.657	0.215	0.317	0.674	0.035	0.035	0.587	9.000	5.666	0.108	10.000	7.000
Ireland	67.648	-0.149	40898.670	0.395	0.037	0.871	0.476	0.039	0.031	0.524	7.000	4.000	0.140	9.333	8.333
Italy	253.199	0.156	6903.262	0.669	0.199	0.349	0.387	0.008	0.025	0.425	10.666	5.000	0.056	5.000	9.000
Luxemburg	80.982	0.291	7723.828	0.551	0.283	0.834	0.309	0.040	0.031	1.638	8.333	6.333	0.647	12.000	7.000
Netherlands	57.767	0.057	88215.220	0.664	0.159	0.657	0.838	0.020	0.021	0.922	6.000	6.000	0.067	6.666	7.333
Portugal	70.247	0.411	12145.250	0.746	0.201	0.484	0.720	0.009	0.028	0.396	10.000	6.000	0.185	13.666	7.333
Spain	336.367	0.102	22986.740	0.569	0.171	0.219	0.446	0.030	0.034	0.880	6.666	8.000	0.094	9.666	7.666
Sweden	66.267	0.515	12957.060	0.597	0.210	0.236	0.596	0.027	0.018	1.007	9.000	2.500		7.000	8.000
UK	176.974	0.803	52002.790	0.735	0.351	0.726	0.387	0.023	0.020	1.247	4.666	4.666	0.402	7.666	8.666
EU-15	**172.8**	**0.213**	**26505.1**	**0.635**	**0.227**	**0.466**	**0.546**	**0.023**	**0.024**	**0.774**	**7.844**	**5.500**	**0.197**	**9.111**	**7.444**
Cyprus	25.583	-0.008	5458.085	0.627	0.090	0.468	0.739	0.036	0.028	0.579	11.000	7.000	0.169	10.000	8.333
Czech R.	54.279	0.133	6219.384	0.670	0.303	0.291	0.605	0.047	0.024	0.283	12.000	5.500	0.872	9.500	8.500
Estonia	29.180	0.331	985.089	0.675	0.372	0.782	0.949	0.062	0.048	0.314	7.666	5.666	0.991	12.666	7.000
Hungary	52.143	0.317	2134.387	0.823	0.180	0.648	0.568	0.032	0.054	0.260	9.333	9.666	0.628	14.000	7.666
Latvia	28.784	0.600	1318.662	0.638	0.296	0.485	0.550	0.073	0.071	0.107	7.666	7.000	0.441	11.666	7.000
Lithuania	51.082	0.764	1844.011	0.692	0.254	0.295	0.745	0.075	0.034	0.224	9.333	5.333	0.849	12.000	7.000
Malta	61.043	0.639	1891.901	0.704	0.109	0.597	0.733	0.025	0.025	0.536	10.666	6.666	0.623	13.666	7.333
Poland	70.046	0.219	3406.975	0.674	0.248	0.337	0.594	0.046	0.024	0.286	9.666	4.666	0.529	9.333	7.333
Slovakia	84.259	0.065	4554.698	0.671	0.340	0.364	0.734	0.066	0.046	0.069	11.333	5.333	0.604	13.000	6.666
Slovenia	119.091	0.023	1428.511	0.709	0.201	0.250	0.591	0.045	0.045	0.310	9.666	7.333	0.303	13.333	7.333
Bulgaria	74.998	0.540	908.921	0.735	0.249	0.429	0.464	0.061	0.067	0.202	8.666	7.333	0.500	11.333	7.000
Romania	40.285	0.546	2253.744	0.797	0.258	0.506	0.624	0.064	0.112	0.170	9.333	5.333	0.272	10.000	5.333
EU-12	**57.56**	**0.347**	**2700.36**	**0.701**	**0.242**	**0.454**	**0.658**	**0.053**	**0.048**	**0.278**	**9.694**	**6.402**	**0.565**	**11.708**	**7.208**

Notes: Z-score: the unlogged version of Z-score before winsorizing it; Lerner: the Lerner index before winsorising it, in order to draw remarks on its mean values across the European region; TA: total assets; TC/TI: total cost over total income; TNINTI/TI: total non-interest income over total income; LIQ/DEPSTF: liquid assets over total deposits and short-term funding; CONC: market concentration; GDPGR: the growth rate of GDP; Inflation: inflation rate; Stock MT: stock market turnover; Activity R.: activity restrictions; Capital Reg.: Capital regulation index; Foreign Own.: the share of foreign-owned assets in a banking industry; Official Sup.: official supervisory power; Private Mon.: Private monitoring index. EU-15: the average values of all variables deflated by the number of banks within a banking market; EU-12: the average values of all variables deflated by the number of banks within a banking market including Bulgaria and Romania of the enlarged European Union. Sample: EU-27 during the period 2003-2010. Sources: World Bank, Bankscope and own estimations.

Table 2: Correlation matrix between country-level variables

Variables	CONC	GDPGR	Inflation	Stock MT	Activity res.	Capital Reg.	Foreign own.	Official Sup.	Private Mon.
CONC	1								
GDPGR	0.141	1							
Inflation	0.222	0.356	1						
Stock MT	0.071	0.252	-0.027	1					
Activity Res	0.135	-0.041	0.144	-0.283	1				
Capital Reg.	-0.055	-0.042	-0.061	-0.101	-0.087	1			
Foreign Own	0.181	0.277	0.133	0.328	-0.099	-0.027	1		
Official Sup.	-0.077	-0.011	-0.028	-0.315	0.009	0.334	0.281	1	
Private Mon.	0.030	0.057	0.033	0.333	0.306	-0.095	0.139	-0.459	1

Notes: CONC: market concentration; GDPGR: the growth rate of GDP; Inflation: inflation rate; Stock MT: stock market turnover; Activity R.: activity restrictions; Capital Reg.: Capital regulation index; Foreign Own.: the share of foreign-owned assets in a banking industry; Official Sup.: official supervisory power; Private Mon.: Private monitoring index. Sample: EU-27 during the period 2003-2010. Sources: Bankscope database, World Bank.

Table 3: Regression output of model 5

Variables	**Baseline**	**Sensitivity analysis**					
Lerner	-0.158***	-0.350***	0.089**	-0.129***	-0.145***	-0.055	-0.088
	(0.000)	(0.038)	(0.037)	(0.040)	(0.037)	(0.036)	(0.054)
Concentration	-0.011***	-0.009***	-0.009***	-0.004***	-0.010***	-0.009***	-0.004***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Institutional variables (regulation, supervision, governance)							
Activity restrictions		-0.082***					-0.014*
		(0.005)					(0.008)
Capital regulation			0.111***				0.078***
			(0.006)				(0.009)
Foreign ownership				0.133**			-0.034
				(0.053)			(0.075)
Official supervision					0.004		-0.069***
					(0.004)		(0.007)
Private monitoring						-0.111***	-0.085***
						(0.008)	(0.012)
Country-specific variables							
GDPGR	0.048***	0.026***	0.041***	0.039***	0.043***	0.032***	0.035***
	(0.005)	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)
Inflation	-0.078***	-0.039***	-0.093***	-0.097***	-0.076***	-0.081***	-0.062***
	(0.000)	(0.007)	(0.008)	(0.009)	(0.008)	(0.007)	(0.008)
Stock market turnover	-0.241***	-0.303***	-0.251***	-0.093***	-0.220***	-0.179***	-0.175***
	(0.000)	(0.026)	(0.025)	(0.028)	(0.025)	(0.024)	(0.032)
Bank-specific variables							
Q	-0.006	-0.010*	-0.015***	-0.028***	-0.011**	-0.006	-0.018***
	(0.005)	(0.006)	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)
E/TA	-0.079	0.404***	0.094	0.024	-0.070	0.121	0.516***
	(0.110)	(0.118)	(0.111)	(0.118)	(0.111)	(0.111)	(0.123)
Cost to income	-0.028	-0.155***	0.010	-0.072*	-0.030	-0.017	-0.114***
	(0.040)	(0.034)	(0.044)	(0.043)	(0.040)	(0.041)	(0.040)
Diversification	-0.589***	-0.599***	-0.636***	-0.615***	-0.596***	-0.590***	-0.684***
	(0.050)	(0.053)	(0.052)	(0.054)	(0.051)	(0.051)	(0.055)
Liquidity	-0.011	-0.029**	-0.014	-0.024*	-0.010	-0.023*	-0.027*
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)
Constant	5.462***	6.037***	4.793***	5.255***	5.388***	6.022***	6.239***
	(0.112)	(0.118)	(0.118)	(0.121)	(0.122)	(0.122)	(0.156)
R-squared	0.2188	0.2401	0.2417	0.235	0.2213	0.2329	0.2617
Obs	12118	9529	11956	11136	11956	11956	8709
Banks	2450	2450	2450	2361	2450	2450	2346
Countries	27	27	27	26	27	27	26

Notes: Regression output of model $lnZ_{i,t} = f\left(L_{i,t-1}, CONC_{i,t}, I_{i,t}, M_{i,t}, B_{i,t-1}\right) + \varepsilon_{i,t}$with standard errors clustered at the country level and adjusted by the number of banks operating within each market employing specialization and time dummies to capture various fixed effects. Standard errors are in parentheses while asterisks ***, **, * denote the significance level being at 1%, 5% and 10%, respectively. Sample: EU-27 during the period 2003-2010.

Table 4: Extreme bounds of model 5

Variables	Bounds	Coefficient	Std. error	t-value	I-variables	Significance (1%)	Significance (5%)
Lerner	Low	-0.368	0.039	-9.38	ACT, OFF	Fragile(0)	Fragile(0)
	Base	-0.158	0.036	-4.41	-		
	High	0.096	0.037	2.55	CAP, PRIV		
Lerner	Low	0.785	0.095	8.28	ACT, OFF	Turning points [0.733, 0.644, 0.97]	
	Base	0.565	0.097	5.80	-		
	High	0.585	0.096	6.12	CAP, PRIV		
Lerner^2	Low	-1.071	0.239	-4.49	ACT, OFF		
	Base	-0.877	0.111	-7.86	-		
	High	-0.603	0.113	-5.33	CAP, PRIV		
CONC	Low	-0.009	0.001	-12.71	OFF, PRIV	Robust	Robust
	Base	-0.011	0.001	-15.40	-		
	High	-0.008	0.001	-12.13	ACT, CAP, PRIV		
Lerner	Low	0.608	0.094	6.44	OFF, PRIV	Turning points [0.695, 0.644, 0.627]	
	Base	0.565	0.097	5.80	-		
	High	0.760	0.096	7.94	ACT, CAP, PRIV		
Lerner^2	Low	-0.875	0.111	-7.82	OFF, PRIV		
	Base	-0.877	0.111	-7.86	-		
	High	-1.213	0.124	-9.78	ACT, CAP, PRIV		

Notes: Extreme bounds of model $lnZ_{i,t} = f\left(L_{i,t-1}, CONC_{i,t}, I_{i,t}, M_{i,t}, B_{i,t-1}\right) + \varepsilon_{i,t}$. The table reports the extreme bounds of the Lerner index and concentration with the respective standard errors and t-values. The column '*I-variables*' indicates the specific information set that constructs the underlying bound, and the last two underline the relationship between market structure and financial stability as fragile or robust at 1% and 5% significance level according to whether their sign and significance persistently remains stable over many specifications. The parentheses next to 'fragile' indicate the number of variables needed for the Lerner coefficient to turn significant or with the opposite sign. The rows in grey report the extreme bounds of L and HHI utilizing two and three-variable I-sets while in the two rows below them, the L-squared term comes in ad hoc for every extreme bound case in order to check for non-linearities. Turning points refer to the levels in Lerner distribution where the respective coefficient switches its sign. Sample: EU-27 during the period 2003-2010.

Table 5: Regression output of model 6

Variables	**Baseline**	**Sensitivity analysis**					
Lerner	1.413***	2.071***	0.326**	0.117	1.153***	2.071***	1.898***
	(0.143)	(0.154)	(0.156)	(0.164)	(0.146)	(0.213)	(0.397)
CONC*L	-0.024***	-0.017***	-0.018***	-0.000	-0.022***	-0.020***	0.015***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)
Institutional variables (regulation, supervision, governance)							
Activity restrictions*L		-0.107***					-0.043**
		(0.014)					(0.018)
Capital regulation*L			0.146***				0.135***
			(0.015)				(0.029)
Foreign ownership*L				-0.181			-0.614***
				(0.128)			(0.190)
Official supervision*L					0.014*		-0.138***
					(0.008)		(0.024)
Private monitoring*L						-0.105***	-0.179***
						(0.018)	(0.035)
Country-specific variables							
GDPGR*L	0.037***	0.004	0.016*	0.041***	0.026***	0.022***	0.043***
	(0.007)	(0.008)	(0.008)	(0.010)	(0.008)	(0.008)	(0.010)
Inflation*L	-0.074***	-0.098***	-0.075***	-0.108***	-0.065***	-0.072***	-0.115***
	(0.012)	(0.013)	(0.012)	(0.014)	(0.012)	(0.012)	(0.014)
Stock market turnover*L	-0.528***	-0.892***	-0.360***	0.023	-0.448***	-0.407***	-0.046
	(0.062)	(0.070)	(0.061)	(0.075)	(0.061)	(0.061)	(0.087)
Bank-specific variables							
Q	-0.008	-0.044***	-0.011*	-0.032***	-0.014**	-0.012**	-0.019***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
E/TA	-0.180	0.080	-0.147	-0.087	-0.164	-0.138	0.360***
	(0.114)	(0.122)	(0.112)	(0.117)	(0.114)	(0.114)	(0.119)
Cost to income	-0.014	-0.177***	0.019	-0.060	-0.016	-0.003	-0.119**
	(0.047)	(0.043)	(0.049)	(0.046)	(0.047)	(0.048)	(0.048)
Diversification	-0.590***	-0.991***	-0.613***	-0.604***	-0.597***	-0.606***	-0.691***
	(0.052)	(0.051)	(0.052)	(0.054)	(0.052)	(0.052)	(0.056)
Liquidity	-0.009	-0.053***	-0.011	-0.018	-0.009	-0.010	-0.022
	(0.013)	(0.015)	(0.013)	(0.013)	(0.013)	(0.013)	(0.143)
Constant	4.732***	5.435***	4.712***	4.885***	4.753***	4.706***	4.880***
	(0.109)	(0.107)	(0.111)	(0.115)	(0.110)	(0.110)	(0.121)
R-squared	0.2074	0.1678	0.2177	0.2276	0.2118	0.2135	0.2412
Obs	12118	9529	11956	11136	11956	11956	8709
Banks	2450	2450	2450	2450	2450	2450	2346
Countries	27	27	27	27	27	27	26

Notes: Regression output of model $lnZ_{i,t} = f\left(L_{i,t-1}, CONC_{i,t} * L_{i,t-1}, I_{i,t} * L_{i,t-1}, M_{i,t} * L_{i,t-1}, B_{i,t-1}\right) + \varepsilon_{i,t}$ with standard errors clustered at the country level and adjusted by the number of banks operating within each market employing *specialization* and *time* dummies to capture various fixed effects. Standard errors are in parentheses while asterisks ***, **, * denote the significance level being at 1%, 5% and 10%, respectively. Sample: EU-27 during the period 2003-2010.

Table 6: Extreme bounds of model 6

Variables	Bounds	Coefficient	Std. error	t-value	B-variables	Significance (1%)	Significance (5%)
Lerner	low	0.326	0.156	2.09	CAP, OFF	Fragile(0)	Fragile(0)
	base	1.414	0.143	9.86	-		
	high	2.775	0.323	8.58	OFF, PRIV		
Lerner	low	0.927	0.185	5.01	CAP, OFF	Fragile	
	base	1.986	0.165	12.05	-		
	high	3.394	0.350	9.69	OFF, PRIV		
Lerner^2	low	-0.771	0.125	-6.15	CAP, OFF	Robust	
	base	-0.847	0.118	-7.17	-		
	high	-0.809	0.119	-6.79	OFF, PRIV		
CONC*L	low	-0.019	0.002	8.73	OFF, PRIV	Robust	Robust
	base	-0.024	0.002	-11.48	-		
	high	-0.005	0.002	-2.05	ACT, CAP, OFF		
Lerner	low	3.394	0.350	9.69	OFF, PRIV	Fragile	
	base	1.986	0.165	12.05	-		
	high	2.340	0.225	10.42	ACT, CAP, OFF		
Lerner^2	low	-0.809	0.119	-6.79	OFF, PRIV	Robust	
	base	-0.847	0.118	-7.17	-		
	high	-1.316	0.134	-9.81	ACT, CAP, OFF		

Notes: Extreme bounds of model $lnZ_{i,t} = f\left(L_{i,t-1}, CONC_{i,t} * L_{i,t-1}, I_{i,t} * L_{i,t-1}, M_{i,t} * L_{i,t-1}, B_{i,t-1}\right) + \varepsilon_{i,t}$.The table reports the extreme bounds of the Lerner index and the interaction term CONC*L with the respective standard errors and t-values. The column '*I-variables*' indicates the specific information set that constructs the underlying bound, and the last two underline the relationship between market structure and financial stability as fragile or robust at 1% and 5% significance level according to whether their sign and significance persistently remains stable over many specifications. The parentheses next to 'fragile' indicate the number of variables needed for the Lerner coefficient to turn significant or with the opposite sign. The rows in grey report the extreme bounds of L and CONC*L utilizing two and three-variable I-sets while in the two rows below them, the L-squared term comes in ad hoc for every extreme bound case in order to check for non-linearities. Sample: EU-27 during the period 2003-2010.

Table 7: Regression output of model 7

Variables	ROA	E/TA	sROA	ln(ROA+E/TA)	Loan losses	lnZ
Lerner	0.072***	-0.012	-0.001	0.085	0.058***	-0.337***
	(0.013)	(0.075)	(0.011)	(0.076)	(0.015)	(0.074)
Concentration	0.000	0.002	0.001***	0.002*	0.0004**	-0.006***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Institutional variables (regulation, supervision, governance)						
Activity restrictions	0.008***	0.002	-0.002	0.012	0.003	-0.025***
	(0.001)	(0.001)	(0.001)	(0.011)	(0.002)	(0.009)
Capital regulation	0.001	0.009	-0.002	0.011	0.010***	0.072***
	(0.002)	(0.001)	(0.001)	(0.011)	(0.002)	(0.012)
Foreign ownership	-0.037***	0.136	0.019	0.078	0.031*	-0.214**
	(0.014)	(0.009)	(0.019)	(0.099)	(0.019)	(0.094)
Official supervision	0.004***	0.018**	-0.000	0.022***	-0.013***	-0.083***
	(0.001)	(0.001)	(0.000)	(0.008)	(0.001)	(0.009)
Private monitoring	0.001	0.089***	-0.003	0.092***	-0.021***	-0.064***
	(0.002)	(0.001)	(0.002)	(0.016)	(0.003)	(0.016)
Country-specific variables						
GDPGR	0.001***	-0.001**	-0.001***	-0.000	-0.001***	0.036***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.009)
Inflation	-0.000	-0.001	0.001***	-0.001	0.000	-0.074***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.012)
Stock market turnover	0.002***	-0.004	-0.001*	-0.004	-0.005***	-0.065
	(0.001)	(0.004)	(0.000)	(0.004)	(0.001)	(0.041)
Bank-specific variables						
Q	0.000	-0.017***	-0.000	-0.017***	0.000	-0.033***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.008)
E/TA	0.027***	-	0.035***	-	0.027***	1.076***
	(0.005)		(0.005)		(0.007)	(0.182)
Cost to income	-0.013***	-0.027***	0.002	-0.041***	0.001	-0.490***
	(0.002)	(0.008)	(0.002)	(0.010)	(0.002)	(0.055)
Diversification	0.014***	0.098***	0.012***	0.110***	0.005**	-1.321***
	(0.002)	(0.011)	(0.002)	(0.012)	(0.002)	(0.084)
Liquidity	0.001*	0.050***	0.000	0.053***	-0.001	-0.039
	(0.000)	(0.005)	(0.001)	(0.005)	(0.001)	(0.024)
Constant	-0.006*	0.124***	0.007**	0.106***	0.025***	9.928***
	(0.003)	(0.018)	(0.003)	(0.019)	(0.003)	(0.191)
R-squared	0.2735	0.3991	0.3063	0.4103	0.1064	0.3772
Obs	9568	9571	8785	9568	8984	9568
Banks	2374	2374	2348	2374	2247	2374
Countries	26	26	26	26	26	26

Notes: Regression output of model $Risk = f(L_{i,t-1}, CONC_{i,t}, I_{i,t}, M_{i,t}, B_{i,t-1}) + \varepsilon_{i,t}$, where *Risk* is a vector of alternative measures of stability, namely, Returns on Assets (ROA), Equity to Total Assets (E/TA), the standard deviation of ROA (sROA), the logged nominator of the Z-score [ln(ROA_E/TA)], the Z-score with the denominator being averaged over the whole period (lnZ) and credit risk as proxied by loan loss charges over average gross loans (Loan Losses). Standard errors are clustered at the country level and adjusted by the number of banks operating within each market employing specialization and time dummies to capture various fixed effects. Standard errors are in parentheses while asterisks ***, **, * denote the significance level being at 1%, 5% and 10%, respectively. Sample: EU-27 during the period 2003-2010.

Appendix

Information on Bank Regulatory and Supervision Variables

Variable	Methodology of quantification	Source
Activity restrictions (ACT)	I assign values of 1, 2, 3, 4 if bank participation indicates 'unrestricted', 'permitted', 'restricted' or 'prohibited' responses to the following questions: What is the level of regulatory restrictiveness for a) bank participation in securities activities (the ability of banks to engage in the business of securities underwriting, brokering, dealing, and all aspects of the mutual fund industry), b) bank participation in insurance activities (the ability of banks to engage in insurance underwriting and selling)?, c) bank participation in real estate activities (the ability of banks to engage in real estate investment, development, and management)?, d) bank ownership of nonfinancial firms?	Barth et al. (2004; 2005; 2008; 2012)
(Capital regulation (CAP)	I assign '0' and '1' if the responses are 'no' and 'yes', respectively. The opposite holds for questions 8 and 9 (Yes:0, No:1) and we also assign '1' if 6 < 0.75. The questions are: 1) Is the minimum capital-asset ratio requirement risk weighted in line with the Basel guidelines?, 2) Does the minimum ratio vary as a function of market risk?, 3) Are market value of loan losses not realised in accounting books deducted? 4) Are unrealised losses in securities portfolios deducted, 5) Are unrealised foreign exchange losses deducted?, 6) What fraction of revaluation gains is allowed as part of capital?, 7) Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities?, 8) Can the initial disbursement or subsequent injections of capital be done with assets other than cash or government securities?, 9) Can initial disbursement of capital be done with borrowed funds?	Barth et al. (2004; 2005; 2008; 2012)
Official Supervisory power (OFF)	I assign '0' and '1' if the responses are 'no' and 'yes' (respectively) and add them up. The questions are the following: 1) Does the supervisory agency have the right to meet with external auditors to discuss their report without the approval of the bank?, 2) Are auditors required by law to communicate directly to the supervisory agency any presumed involvement of bank directors or senior managers in elicit activities, fraud, or insider abuse?, 3) Can supervisors take legal action against external auditors for negligence?, 4) Can the supervisory authority force a bank to change its internal organizational structure?, 5) Are off-balance sheet items disclosed to supervisors?, 6) Can the supervisory agency order the bank's directors or management to constitute provisions to cover actual or potential losses?, 7) Can the supervisory agency suspend the directors' decision to distribute Dividends, 8) Bonuses, 9) Management fees?, 10) Can the supervisory agency legally declare-such that this declaration supersedes the rights of bank shareholders-that a bank is insolvent?, 11) Does the Banking Law give authority to the supervisory agency to intervene that is, suspend some or all ownership rights-a problem bank?, 12) Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency supersede shareholder rights?, 13) remove and replace management?, 14) remove and replace directors?.	Barth et al. (2004; 2005; 2008; 2012)
Private monitoring index (PRIV)	I assign '0' and '1' if the responses are 'no' and 'yes', respectively. We construct the index through the formula: {(1*2)+[1 if 3 equals 100%; 0 otherwise]+[1 if 4 and 5 equals zero; 0 otherwise]+[(6-'1')*('-1')+7+8]+9+10+11}. The question are the following: 1) Is an external audit a compulsory obligation for banks? , 2) Are auditors licensed or certified?, 3) What percent of the top ten banks are rated by international credit rating agencies (e.g., Moody's, Standard and Poor)?, 4) Is there an explicit deposit insurance protection system?, 5) Were depositors wholly compensated (to the extent of legal protection) the last time a bank failed?, 6) Does accrued, though unpaid interest/principal enter the income statement while the loan is still non-performing?, 7) Are financial institutions required to produce consolidated accounts covering all bank and any non-bank financial subsidiaries?, 8) Are bank directors legally liable if information disclosed is erroneous or misleading?, 9) Are off-balance sheet items disclosed to the public?, 10) Must banks disclose their risk management procedures to the public?, 11) Is subordinated debt allowable (required) as part of capital?	Barth et al. (2004; 2005; 2008; 2012)
Foreign Ownership (FOR)	What fraction of the banking system's assets is in banks that are 50% or more foreign owned?	Barth et al. (2004; 2005; 2008; 2012)

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