Another look at Bank Consolidation and Financial Stability

Santiago Carbó-Valverde
Bangor Business School and FUNCAS
(s.carbo-valverde@bangor.ac.uk)

Luis Enrique Pedauga
University of Granada
(pedauga@ugr.es)

Francisco Rodríguez-Fernández
University of Granada and FUNCAS
(franrod@ugr.es)

Abstract

In this paper we show that a non-monotonic relationship links certain structural characteristics of the banking market to financial stability, including the number of banks in the market, the branching decisions and branch productivity. Using a non-dynamic panel threshold regression we explain how financial stability is affected by baking market power when market power is subject to one or more regime-switches that characterize a possible non-linear or a threshold effect. The results show that economies with a small number of financial institutions over branched but with a low number of employees per office achieve fewer risk of bank failure. However, such gains are absent in the case of economies with a large number of institutions, where decreases in competition produce a higher risk of financial instability.

Key words: Financial stability • Market power • Bank branches • Panel threshold regression

JEL classification: G21 • G33 • G34

1. Introduction

The international financial sector has been subject to substantial structural changes since the U.S. subprime credit crisis in mid-2007. The crisis has resulted in numerous bank failures, the nationalisation of many financial institutions, bailout and interventions by regulatory and supervision authorities and a considerable deterioration of economic output and employment at both sides of the Atlantic. In order to deal with this situation, many banking sectors have suffered important restructuring processes through mergers and acquisitions, implementing a set of related efficiency measures including the reduction of employees and branches at many banks.

Even if restructuring processes are common features following banking crises, there is no consensus as to whether the effects of these processes are positive or negative in terms of financial stability. One set of studies can be considered within the so-called *concentration-stability* approach. For example, in Allen and Gale (2004) or Boyd and Nicoló (2005), BDN henceforth, it is suggested that higher concentration of banking systems can generate greater economic value and reduce financial fragility. Opposite different view is provided by authors like Beck et al. (2006) and Uhde and Heimeshoff (2009) supporting the *concentration-fragility* approach, which holds that highly concentrated financial systems generate more systemic risk and financial instability.[1]

In this paper we hypothesize that the different findings under both approaches can be at least partially related to non-monotonic relationships between bank market power and financial stability. The aim of our paper is related to the theoretical findings of Martínez-Miera and Repullo (2010), MMR henceforth, who suggest that the link between bank competition and financial stability could turn negative if more competition reduces loan rates, which in turn leads to lower probabilities of default, and more financial stability. This response is referred to as the *risk-shifting effect* and was first identified by BDN under the assumption that loan defaults are perfectly correlated with the bank's probability of failure. However, in the case of imperfect correlation of loan defaults, more competition leads to lower loan rates, and consequently lower revenues from performing loans, and, less financial stability. This effect is known as the *margin effect*. Depending on which of the two effects (the "risk-shifting" or the

[1] For a detailed literature review of the different theoretical models, see for example Berger et al. (2008)

"margin") dominates, the final effect of market competition on financial stability may have a different sign and significance.

Most of the existing literature dealing with banks' soundness have employed monotonic linear models. These studies have offered mixed or ambiguous results. For example, the findings reported by Boyd et al. (2006), De Nicoló and Loukoianoca (2006) Schaeck et. al. (2006) or Turk-Ariss (2010) show that higher bank competition is related to a lower risk of bank failure, in line with the *concentration-stability* approach. However, the findings of De Nicoló et al. (2004) and Uhde Heimeshoff (2009) Jiménez (2010), among others, support the *concentration-fragility* approach, since they suggest that bank risk decreases with bank market power. We hypothesize that both approaches may be reconciled to some extent by addressing the potential non-linearity of the relationship between bank competition and financial stability.

Some previous studies – including Liu et al. (2010) and Maudos and Fernández (2010) – tangentially deal with non-linearity by including a quadratic term in their bank market power explanatory variable, they find that the *risk-shifting effect* appears to dominate in more concentrated markets while the *margin effect* emerges dominant in more competitive banking markets. Although this solution results useful for testing the presence of non-linearity, it has the disadvantage of a priori imposing a U-shaped relationship which is not feasible to determine what the channel is or threshold that explains the non-monotonic connections between financial stability and bank competition. These relationships could change as a result of a stimulus which is triggered by exceeding a certain critical value, e.g. the number of banks as it has been proposed theoretically by MMR.

This study employs a non-dynamic panel threshold regression technique set out by Hansen (1999)[2], which allows us to test if the relationship between financial stability and market power, is conditional on one or more regime-switches or thresholds that characterize a possible non-linear effect. This approach has several advantages. First, the threshold value is estimated rather than being imposed a priori, and second, the changes in the number of banks, for example, can be assessed more easily since the variable is directly considered as an explanatory variable in the empirical model.

2 Hansen (1999) is who has further developed the statistical theory of threshold models.

We apply this methodology on a panel of banks belonging to 23 OECD countries over 1996-2010. In addition we also consider using other transition variables besides the number of banks. In particular, we use bank branching decisions and the number of employees per branch, as a proxy of managerial office performance, providing a deeper understanding on what of the two effects – the *risk-shifting* or the *margin effect* – dominates.[3]

Since we find a U-shaped relationship our main contribution to current knowledge is that we reconcile diverse opinions as to whether processes of financial consolidation are positive or negative in terms of financial stability and show evidence of the channels through which the nonlinearity works. Thus, our results show that economies with a small number of financial institutions, over branched but with high level of managerial office performance achieve greater stability, measured by the Z-score indicator. However, such gains are absent in the case of economies with a large number of institutions, where increases in market power achieved by greater financial consolidation may actually produce financial instability.

The structure of the article is as follows. The next section briefly describes the main theories and empirical results in earlier contributions. The third section presents the model specification and the estimation methods. The fourth section describes the data and discusses the reasons for having selected the threshold variables in which we observe asymmetry in the relation between competition and stability. The fifth section presents the empirical results, and in the last section, some conclusions are drawn.

2. Literature review: a brief overview

2.1 *Concentration-stability* approach

The studies supporting the concentration-stability approach rely on four main type of findings related to bank concentration: *i*) enhanced ability to increase capital reserves; *ii*) constituted value; *iii*) enhanced ability to ration credit; and *iv)* enhanced monitoring and control.

According to the first hypothesis, large banks are more able to withstand liquidity

3 Managerial office performance is the systematic process by which a firm involves its employees, as individuals and members of a group, in improving organizational effectiveness in the accomplishment of firms mission and goals, e.g. revenue-maximizing firm's strategy.

shocks and macroeconomic instability; because they can increase their profits more easily by taking advantage of the benefits of greater concentration. Hence, financial fragility is reduced by the strengthening of *"capital reserves"*.

The theoretical work of Allen and Gale (2004) and BDN, considering different models of general equilibrium, show that financial crises are less likely in more concentrated banking systems. Their main argument is related to long-term dynamics, as it is theoretically proved that in the absence of competitions, banks have a greater capacity to absorb the deterioration of their assets, by appropriate management of their reserves in response in adverse situations. These findings have been also supported by empirical studies such as Paroush (1995) and Benston et al. (1995), which suggest that the increased market power obtained from the benefits of diversification following bank mergers leads to more bank stability. Furthermore, a detailed investigation of bank mergers in the U.S. has shown that the variance in pre-merger profits of the target bank and the corresponding covariance of the merging bank are negative with respect to the purchase price. Similar results were reported by Craig and Santos (1997), who analyse post-merger profitability and risk, and conclude that consolidation acts as a stabilisation mechanism. Finally, Schaeck et al. (2006) use cross section data for 38 countries and derive the Panzar-Rosse H-statistic providing empirical evidence that competition increases the probability of a banking crisis and that its duration is greater in more competitive environments. An important feature in many of these papers is that concepts of "concentration" and "competition" are sometimes unambiguously used.

The hypothesis of "*constituted value*" refers to the intangible value associated with the enhanced reputation obtained when a large bank is created. It is assumed that the increase in constituted value, arising from increased market power, discourages the bank's management from taking excessive risks that might threaten their own privileges. This is so because the higher is the value of an institution, the greater the opportunity cost of bankruptcy, which encourages banks to accept high-risk investments. This jeopardises their future profits but, at the same time, creates incentives to generate assets of higher quality.

As noted by Beck (2008), the question of constituted value in banking has been studied by Chan et al (1986), Keeley (1990) and Park and Peristiani (2007), under the theoretical assumption that banks choose the risk of their asset portfolio in terms of how to transfer it to depositors, so that in a world of limited liability, and where ever more competitive pressures to maximise profits are exerted, banks have greater incentives to take excessive risks – and thus the system becomes more fragile.

Another hypothesis in favour of the concentration-stability approach involves the economies of scale achieved when big banks diversify their investment portfolios. Authors such as Diamond and Dybvig (1983), Boyd and Prescott (1986) and Boot and Thakor (2000) have observed that large institutions tend to adjust better to the process of *"credit rationing"*; firstly, because the loans managed by these institutions are lower in volume but higher in quality, they are able to significantly increase their return on investment; secondly, these banks possess larger technological platforms and so, in general, they enjoy a comparative advantage in the provision of lending monitoring services. Additionally, because such banks usually have access to cross-border activities, they can geographically diversify the risk of their investments and thus improve their situation and financial strength (Méon and Weill, 2005).

The final hypothesis supporting the concentration-stability view is that a concentrated financial system, with just a few very large banks, is easier to control than one that is less concentrated but with many small banks. This means that, from a regulatory perspective, the supervision of this kind of financial institutions is more effective and the risk of contagion is better controlled (Allen and Gale, 2004).

2.2 *Concentration–fragility* approach

The concentration fragility approach also relies mainly on four different hypotheses: *i*) the aggravated problem of moral hazard; *ii*) increased interest rates; *iii*) the inefficiencies of risk diversification; *iv*) the complexity of processes and organisation.

The first hypothesis suggests that institutions in these markets suffer from the "too big to fail" effect (Mishkin, 1998), according to which regulators tend to grant big banks larger guarantees and subsidies, via a government-sponsored safety net, which encourages investment managers to take greater risks, thus aggravating the *"moral hazard problem"*.

Secondly, it is argued that the *"increased interest rates"* on loans from banks -a characteristic of more concentrated markets, in which financial institutions tend to act as monopolists- induce firms to take on greater investment risks in order to offset the loan repayments required. The theoretical models by Boyd and Nicoló (2005; 2006) predict that the higher the interest rates are, the greater is the likelihood that loans will become non-income-generating. Therefore, the risk of loan defaults in this context increases the likelihood of bank failures. In the same vein, Caminal and Matutes (2002) show that a lower degree of competition in the banking sector may lead to less credit rationing, larger loans and a higher probability of bank failure if these loans are subject to greater multiplicative uncertainty.

The third hypothesis states that more concentrated markets suffer from a greater degree of *"inefficiencies in the diversification of risk"*, since the increased size of banks, following mergers and acquisitions, generally leads to reduced administrative efficiency, less effective internal control and increased operational risks arising from failures of supervision, as shown by Cetorelli et al. (2007).

Finally, the argument of *"organisational complexity"* (Beck et al., 2006) is also in favour of the concentration-fragility approach. In particular, the size of a bank is positively correlated with a lower degree of transparency, as greater size allows the bank to expand operations across multiple geographic markets and lines of business, using sophisticated financial instruments. A complex corporate organisation makes the resulting structure much harder to monitor than in the case of a small bank.

3. The non-dynamic panel threshold regression method

3.1 The model specification

The systemic banking soundness has been usually studied through monotonic linear models that relate a financial stability dependent variable to a market competition measure (proxy by concentration indexes), as follows:

$$Z_{it} = \mu_i + \beta_1^{'} c_{it} + \sum_j \psi_j^{'} x_{j,it} + \sum_k \phi_k^{'} y_{k,it} + e_{it} \quad (1)$$

where Z_{it} represents the Z-score ratio as a measure of financial soundness, c_{it} as a measure of banking market competition, e_{it} as an error term, and μ_i and β_1 are the parameters to be estimated under the hypothesis that there exists only one regime (that is, there is no threshold). However, a more general model specification could be considered to test the hypothesis that financial stability could be affected by market power, as such power is subject to one or more regime-switches that characterize a possible non-linear effect. In this sense, the use of a non-dynamic panel threshold regression method provides useful according to the following specification (Hansen, 1999):

$$Z_{it} = \mu_i + \overbrace{\beta_1' c_{it} I(q_{it} < \gamma) + \beta_2' c_{it} I(q_{it} \geq \gamma)}^{\textit{Regime-dependent regressor}} + \underbrace{\textstyle\sum_j \psi_j' x_{j,it}}_{\substack{\textit{Financial soundness} \\ \textit{indicators}}} + \underbrace{\textstyle\sum_k \phi_k' y_{k,it}}_{\substack{\textit{Macro prudential} \\ \textit{indicators}}} + e_{it} \quad (2)$$

where $I(.)$ is an indicator function. Where the observations are divided into two 'regimes' depending on whether the threshold variable q_{it} is smaller or larger than the threshold γ. Each regime is distinguished by the two regression coefficients β_1 and β_2, that capture possible asymmetric effects of market power on financial stability (positive or negative). In order to distinguish these coefficients, the elements of q_{it} must be non-time-invariant and the error term $e_{it} \sim N(0, \sigma^2)$. An alternative way of writing (2) is:

$$Z_{it} = \begin{cases} \mu_i + \beta_1' c_{it} + e_{it}, & q_{it} < \gamma \quad \textit{(low regime)} \\ \mu_i + \beta_2' c_{it} + e_{it}, & q_{it} \geq \gamma \quad \textit{(high regime)} \end{cases} \quad i=1,...,N; \quad t=1,...,T \quad (3)$$

These equations include two set of control variables: *i*) bank-level *Financial soundness indicators* ($x_{j,it}$), and *ii*) country-level *Macro prudential indicators* ($y_{k,it}$), that are included to reduce the possibility of spurious correlations due to omitted variable bias. The expression (3) can be viewed as a special case of (1) by constraining the slope coefficients on this group of variables to be the same in the two regimes, which has no effect on the distribution. The reason why model (2) has a slope coefficient is that it switches between regimes (denoted by c_{it}). This isolates the so-called regime-dependent regressor.

3.2 Estimation and inference of threshold effects

Even though equation (2) is non-linear in the parameters, for any given threshold γ, the slope coefficients β_1 and β_2 can be estimated by using conditional least squares after a fixed-effects transformation, where the estimate of γ is the value that minimizes the residual variance obtained by a least square procedure:

$$\hat{\gamma} = \underset{\gamma \in \Gamma_n}{argmin}\, S_1(\gamma) \quad (4)$$

where $S_1(\gamma)$ is the sum of squared residuals from estimating (2) for a given threshold γ such that $\Gamma_n = \Gamma \cap \{q_1, \ldots, q_n\}$. If n is very large, the minimization problem of (4) can be solved by a grid search by taking a certain percentage (η%) of observations out to ensure a minimum number of them in each regime. For some $N < n$, let $q_{(j)}$ denotes the (j/N) percentile of the sample $\{q_1, \ldots, q_n\}$, and let $\Gamma_N = \Gamma \cap \{q_{(1)}, \ldots, q_{(N)}\}$. Then the value of $\hat{\gamma}_N$ that minimizes $S_N(\gamma)$ could be considered as a good approximation of $\hat{\gamma}$, just requiring N function evaluations (Hansen, 2000). The main advantage of the threshold estimation technique is that the value of the threshold variable at which a significant change in coefficients occurs is endogenously determined in the estimation procedure.

An important question to be considered when a panel threshold regression model is specified is whether it is statistically significant to move from no threshold effect as in equation (1) to the non-linear expression in (2). Then, to test the hypothesis of a threshold effect we should impose the following linear constraint:

$$Ho: \beta_1 = \beta_2 \tag{5}$$

This expression shows that the relevant null hypothesis is that there is not an asymmetric pass-through from increases on banking market power to the stability of the financial sector. However, from an econometric standpoint the constraint in (5) results in a non-standard testing problem since under the null there are some parameters that are not identified[4]. Hansen (1999) shows that the likelihood ratio tests of Ho, with near-optimal power against the null alternatives, is a standard F-statistic based on:

$$F_1 = (S_0 - S_1(\hat{\gamma}))/\hat{\sigma}^2 \tag{6}$$

where S_0 is the sum of squared error assuming a non threshold specification (1). Because the fixed-effects in (2) falls in the class of models considered by Hansen (1999), a bootstrapping procedure to simulate the first-order asymptotic distribution of the likelihood ratio test should be considered to obtain an asymptotically valid p-value [5.]

[4] The so-called 'Davies' Problem (see Davies, 1977, 1987). For more details see Andrews and Ploberger (1994) and Hansen (1999).
[5] For further details on the implementation of the bootstrap see Hansen (1999)

4. Data and variables

4.1 Sources and sample selection

Our empirical analysis is based on a sample of 23 OECD countries during 1996-2010. The set of Financial Soundness Indicators (FSIs) were obtained from the World Bank-FSB database of bank profitability, the balance sheets of firms reported in the Fitch-IBCA Bank Scope database, and the time series taken from the macroeconomic summaries of the International Financial Statistics database provided by DataStream. These indicators are based on an exhaustive measurement of the current conditions of financial health and soundness of a representative pool of banks in a given country.

Table 1

Definitions of variables to analyze Financial Stability

Variable	Definition	Source
Financial Stability		
1. Z-score	Ratio of the sum of return on assets (RoA) and the equity capital (K) to the total assets, divided by the standard deviation of the return on assets, considering a four year rolling window.	Fitch-IBCA BankScope
Competition measures		
2. C5	Concentration index	Fitch-IBCA / Own calculation
3. HHI	Herfindahl-Hirschman Index	
4. Lerner index	Banks' market price (P_{TA}) less marginal cost (C_{TA}) relative to their price	
5. Nimta index	Interest rate mark-up after controlling for different sized banks by deflating by total asset value.	
Threshold measures		
6. Number of MFI's	Number of Monetary financial institutions	OECD Banking Statistics
7. Ratio employees to branch	Number of employees per banks' branches	
8. Ratio branches to banks	Number of branch per banks	
Financial soundness indicators:		
9. Impaired Loans Ratio	Measure the impaired loans as a percentage of book value of total assets	Fitch-IBCA / Own calculation
10. Financial Leverage Ratio	One minus Shareholders' Equity relative to Total Liabilities	
11. Interest Margin Ratio	Net interest income relative to their Gross interest and dividen income	
12. Operating risk Ratio	Non interest expenses relative to their Net interest margin	
13. Commissions	Fees and commissions as a percentage of book value of total assets	
14. Spread Income	Difference between the assets it invests in loans and the cost of its funds (Short term and Long Term Funding).	
Macroprudential indicators		
15. Economic growth	Gross Domestic Product (GDP) growth rate	International Financial Statistics (IMF)
16. Inflation	Annual percentage change in the Consumer price index (CPI)	
17. Level of real interest rate	Lending interest rate adjusted by the GDP deflator	
18. Goverment debt to GDP	Debt owed by a central government as a percentage of the GDP	
19. Political Constrain	Captures how likely a change in preferences of any political actor translates into a change in the status-quo public policy	Heniz (2010)

4.2 Variable construction

4.2.1 Financial stability index (*dependent variable*):

As Boyd et al. (1993) we define instability as a state where $(RoA_t - K_t) \leq 0$, with RoA its return on assets and K is the bank's capital-asset ratio. Then, in line with the existing literature we construct the Z-score index by collecting information directly from the balance sheets of firms reported in the Fitch-IBCA Bank Scope database[6]. The index was computed for each bank by country and year by adding the average RoA to the average capital-to-asset ratio, and dividing this sum by the standard deviation of the return on assets ($\sigma_{roa,t}$) assuming normality in the distribution:

$$Z_t \equiv (RoA_t + K_t)/\sigma_{RoA,t} \quad with \quad \sigma^2_{RoA,t} \overset{i.i.d.}{\sim} (0, \sigma^2) \tag{7}$$

Accordingly, this indicator would rise with increases in bank profitability and fall with the proportion of capital to assets or with higher *RoA* volatility. Therefore, from an economic point of view, the Z-score reflects the probability of a bank becoming insolvent when its asset value is less than the value of its debt, and so a higher (lower) value implies a lower (higher) risk of default (see appendix for the probabilistic implications). Throughout the entire the sample, most observations of the Z-score are found within the range of 4 and 70; however, there are some extreme observations, resulting in the sample range being from -5 to 2,840 with an average of 28, which leads to the question of whether it is appropriate or not eliminate outliers from the distribution of the Z-score. On the one hand, we are interested in the events of financial instability, which makes it interesting to include extreme observations, but on the other hand, these outliers may be due to exceptional events or, simply errors in the data. In order to mitigate the effects of outliers and misreported data, the highest and the lowest 1% observations were winsorized. As for the distribution by country, Switzerland and Italy exhibit the highest average values (48.5% and 28.4%, respectively) while Estonia (7.5%) and the Finland (10.5) report the lowest. The overall probability of a bank becoming insolvent for the OECD sample is 20.3%.

[6] For some recent papers using this methodology, see e.g. Nicoló et al. (2004), Laeven and Levine (2007), Hesse and Čihák (2007), Uhde and Heimeshoff (2009) and Carbó et al. (2011).

Table 2
Financial Stability and Competition Measures
(Mean values and ranks over 1996–2010)

Countrys	**Financial Stability**		**Competition measures** (*regime-dependent regressor*)									
	Z-score		Lerner		Nimta		C5		HHI		H-statistic	
	Index	Rank	(%)	Rank	(10 x %)	Rank	(%)	Rank	Index	Rank	Index	Rank
Austria	22.7	15	0.340	8	0.022	15	0.45	7	116.6	7	0.515	17
Belgium	16.5	9	0.341	9	0.017	8	0.69	17	215.0	16	1.274	23
Czech Republic	15.2	7	0.514	21	0.020	11	0.66	14	147.2	8	0.205	7
Denmark	18.6	10	0.508	20	0.035	23	0.67	15	178.8	13	0.307	9
Estonia	7.5	1	0.418	14	0.030	21	0.93	23	390.2	23	1.236	22
Finland	10.5	2	0.457	17	0.016	4	0.83	21	317.8	21	0.664	21
France	24.4	18	0.288	4	0.021	12	0.42	6	52.1	3	0.317	10
Germany	25.2	20	0.460	18	0.025	18	0.21	1	33.8	1	0.477	16
Ireland	23.0	17	0.690	23	0.006	1	0.53	8	97.6	6	-0.005	2
Israel	20.3	11	0.321	6	0.022	14	0.76	20	174.2	12	0.546	19
Italy	28.4	22	0.393	12	0.028	20	0.30	2	149.6	9	0.458	15
Japan	16.5	8	0.450	16	0.017	7	0.34	3	40.8	2	0.535	18
Korea Rep. of	11.1	3	0.283	2	0.016	6	0.41	4	70.1	5	0.189	5
Netherlands	26.4	21	0.307	5	0.014	3	0.66	13	195.5	15	0.284	8
Norway	23.0	16	0.253	1	0.019	10	0.85	22	289.7	20	0.201	6
Poland	14.2	6	0.382	11	0.032	22	0.57	10	321.7	22	0.441	14
Portugal	22.0	13	0.422	15	0.017	9	0.68	16	189.9	14	-0.053	1
Slovakia	11.2	4	0.597	22	0.022	16	0.74	18	165.9	11	0.381	12
Slovenia	14.1	5	0.372	10	0.023	17	0.61	12	216.8	17	0.647	20
Spain	24.8	19	0.487	19	0.021	13	0.41	5	264.7	19	0.322	11
Sweden	22.0	14	0.334	7	0.025	19	0.58	11	164.1	10	0.127	4
Switzerland	48.5	23	0.288	3	0.016	5	0.75	19	227.7	18	0.404	13
United Kingdom	20.5	12	0.394	13	0.014	2	0.54	9	64.9	4	0.110	3
Max	48.5		0.690		0.035		0.93		390.2		1.274	
Median	20.3		0.404		0.021		0.59		177.6		0.416	
Min	7.5		0.253		0.006		0.21		33.8		-0.053	

Source: author calculation

4.2.2 Competition measures (*regime-dependent regressor*):

Rather than using only concentration indices - as the N-firm ratio (C_N) or the Herfindahl-Hirschman Index (HHI) - to capture the effects of changes in competition on financial stability (measured at country-level), we propose to use of bank-level data to infer the competitive behaviour in the banking industry. We therefore use measures such as the Net interest margins ratio ($NIMTA$) and the Lerner index ($LERNER$), estimated in the same way as Schaeck et al. (2006) or Carbó et al. (2007).

The $NIMTA$ ratio, has been widely used to capture the pricing ability of banks to raise spread between the interest revenues from bank assets (price loan, P_L) and the interest expense on bank liabilities (price deposit, P_D), since the seminal work of Ho and Saunders (1981). This measure, computed through the net interest margin (difference between interest income and interest expense) over total bank assets is also known as the bank's loan-deposit rate spread $(P_L - P_D)$[7].

However, as it has been pointed out by Carbó et al. (2009) the Ho-Saunders model is based solely on pure intermediation activities. For this reason, we also consider the Lerner index, which allows us to complement our analysis by considering a multi-product framework thereby reflecting a more diversified bank output.

The latter is computed as $(P_{TA} - MC_{TA}/P_{TA})$, where P_{TA} is the price of total assets, which the ratio of total (interest and non-interest) income over total assets and MC_{TA} is the marginal cost of total assets. As in Carbó et al. (2009) we consider a standard trans-log function with a single output (total assets) and three input prices (deposits, labour and physical capital). The cost function is estimated as a panel data with fixed effects covering a sample of 23 countries over 1996–2010[8].

4.2.3 Threshold variables (*risk-shifting and margin effect*):

To account for potential nonlinear effects, three threshold variables were considered: *i*) the number of financial institutions, *ii*) bank branching expansion, and *iii*) the number of employees per branch. All these variables were computed using the Bank Profitability-FSB database published by the World Bank.

Given that our main goal is try to solve the empirical puzzle on whether highly concentrated financial systems generate more systemic risk or not, we are going to use the intuition behind the U-shaped relationship proposed by BDN and extended by MMR, to analyze the effect of competition on the risk of bank failure (financial instability) as result of a potential combination of a negative risk-shifting effect and a positive margin effect.

The negative risk-shifting effect, identified by BDN, establishes that more

[7] For an extended literature review about uses of this index and for extended studies for the European banking sector see for example Maudos and Fernández (2004) and Carbó and Rodríguez (2007).
[8] See appendix for estimation details.

market power leads to higher loan rates, which in turn lead to higher probabilities of default. As for the (positive) margin effect, it suggests that more market power leads to higher loan rates, and consequently to increases in revenues from performing loans, providing a buffer for loan losses (see figure 1).

The intuition to use the number of financial institutions (N_{it}) as threshold variables is based on the theoretical results presented by MMR, where it is shown that when the number of banks is sufficiently large, the margin effect dominates the risk-shifting effect, so any additional entry would increase financial instability. These results suggest that the risk-shifting effect tends to dominate in monopolistic markets, whereas the margin effect dominates in more competitive markets, which suggests that a U-shaped relationship between competition and financial instability is observed depending on the number of bank observed in a specific market.

Figure 1
Channels relating competition and financial stability

Concentration-Stability (*Margin effect*):

	Channels				Final effect
↑ *Lerner index* ↓ *Competition*	↑ *Loan rates*	↑ *Revenues*	↑ *Buffer*	↑ *Z-score*	**(+) *if dominate***

Concentration-Fragility (*Risk shifting effect*):

	Channels				Final effect
↑ *Lerner index* ↓ *Competition*	↑ *Loan rates*		↑ *Default*	↓ *Z-score*	**(-) *if dominate***

Channels ***Final effect***

The theoretical results suggest that the benefits of a margin effect will eventually be outweighed by the bankruptcy's costs (probabilities of default), once the number of banks in a specific market (N_{it}) pass some critical threshold (γ). Thus, under the MMR theoretical framework, under a dominant risk-shifting behaviour, the nexus between financial stability and market power could be non-monotonic in the following way:

$$Z_{it} = \begin{cases} \beta_1' > 0, & N_{it} < \gamma_1 \\ \beta_2' \leq 0, & N_{it} \geq \gamma_1 \end{cases} \quad (8)$$

This hypothesis suggests that when a financial market is confronted with increased competition, if a banks' franchise value diminishing effect is observed, banks rationally choose more risky portfolios. However, as BDN point out, there exists a fundamental mechanism that reverses the risk-shifting effect when the choices on bank are size-dependent, causing that banks become more risky as their markets become less competitive, given that banks charge lower rates, and their borrowers have an incentive to choose safer investments, hence more safer institutions. However, this argument does not take into account the fact that lower rates also reduce the banks' revenues from performing loans, and this could be affected by other dimensions of the banking business, not considered in the theoretical framework established by BDN and MMR, such as the bank branching strategies and the number of employees per branch, dimensions that could directly affect revenues, and therefore the dominance mechanism between the margin effect and the risk-shifting effect.

Table 3
Number of Banks, Branches and Offices
(Average values over 1996–2010) [/a]

Countrys	Number of Banks		Number of Branches	Number of employees	Threshold measures			
					Employees / branch		Branch / banks	
	Population	*Sample*	*Population*	*Population* 10^3	*Number*	*Rank*	*Number*	*Rank*
Austria	854	200	4463	69	15	7	5	2
Belgium	115	74	12172	72	8	2	160	23
Czech Republic	41	27	2147	45	21	15	52	18
Denmark	102	92	2065	44	21	14	20	8
Estonia	12	7	272	5	19	12	27	11
Finland	357	13	1255	27	21	16	4	1
France	987	336	29565	405	14	5	53	19
Germany	2480	1696	39500	689	18	9	17	6
Ireland	46	38	989	37	37	22	21	9
Israel	37	14	1132	43	38	23	36	15
Italy	841	322	29299	342	12	4	36	14
Japan	133	73	13967	370	26	17	100	20
Korea Rep. of	472	45	6969	99	15	6	117	21
Netherlands	111	54	4804	125	28	18	44	16
Norway	151	74	1342	23	18	10	9	4
Poland	868	31	4097	164	35	19	6	3
Portugal	214	25	5647	57	10	3	23	10
Slovakia	26	17	1138	21	19	11	46	17
Slovenia	34	18	726	12	16	8	35	13
Spain	283	88	40284	248	8	1	142	22
Sweden	123	77	2183	43	20	13	18	7
Switzerland	319	316	3259	116	36	20	10	5
United Kingdom	405	313	13380	488	37	21	32	12

Source: OECD (2010) "Structure of the financial system" OECD Banking Statistics (database), and authors' calculation.
[a]/ Entries have been rounded and simplified to make the contrasts easier to see.

The idea to use the bank branching strategy as a threshold variable is motivated by Berger (1997) and Carlson and Mitchener (2006), who find that branching expansion stabilizes banking systems given that a branching strategy enables banks to diversify geographically their risk and also access to a wider customer base. However, under certain circumstances, this could also lead to inefficiencies in the diversification of risk, because the increased size of banks may result in a less effective internal control and in increased operational risks arising from failures of supervision (Cetorelli et al., 2007). To explain this mixed result, authors like Carlson and Mitchener (2006) focus on the 'over branching' effects as an additional channel to affect banking stability, explaining that additional branches could attract extra customers, raising total bank output above the average cost-minimizing level. That is, banks could prefer to open extra branches and operate on the upward-sloping part of their average cost curve, if they experience scale economies. Then there might be some critical threshold on branching expansion (B_{it}) where competition increases financial stability:

$$Z_{it} = \begin{cases} \beta_1' < 0, & B_{it} < \gamma_2 \\ \beta_2' > 0, & B_{it} \geq \gamma_2 \end{cases} \tag{9}$$

Hence, over a certain number of branches per bank, the risk-shifting effect is dominated by the margin effect, given that the prevailing effect is the efficiency in the diversification of risk, as over-branch banking strategies increases financial stability in less competitive markets.

Finally, the third threshold variable considered is the ratio of employees per branch, which can be considered also as a proxy of the management capacity of firms to increase revenues and it also may diminish the negative risk-shifting effect that offset the positive margin effect. This idea is based on the efficient resource allocation perspective suggested by Hartman et al. (2001), where they show that small branches, though limited in human resources, tend to be the most efficient. Therefore, we also test if there is a critical level of employees per branch which determines an efficiency threshold (E_{it}) that changes the regime of the relationship between competition and financial stability in the following way:

$$Z_{it} = \begin{cases} \beta_1' > 0, & E_{it} < \gamma_3 \\ \beta_2' < 0, & E_{it} \geq \gamma_3 \end{cases} \tag{10}$$

The latter states that the gain of greater financial stability, promoted by higher market power, may depend also on the capacity of more productive branches to choose the right mix of human resources. As before, the effect on the risk of bank failure would result from the combination of a negative risk-shifting effect and a positive margin effect, with the margin effect dominating for a sufficiently small number of employees per branch (more productive).

4.2.4 Financial soundness and Macro-prudential indicators (*Control variables*):

To mitigate the omitted-variable bias, we also consider measures that control for the financial health and soundness of a country's financial sector as a whole, as well as by other bank specific factors, which allows us to control some other effects of market competition, financial stability or both (Schaeck et al., 2006). As pointed out by Uhde and Heimeshoff (2009), the growth rate of real GDP should be considered as a control variable because the investment opportunities of banks may be correlated with economic cycles, and therefore the sign of this coefficient is expected to be positive. Additionally, we include inflation and interest rates, as their potential effects depend on whether or not they are anticipated by financial institutions during an economic downturn[9].

It is also important to identify the adjustment capacity of the institutional supervisory structure and the adaptation of the regulatory framework associated with consolidation processes, as these are key factors in determining stability. To reflect these institutional effects, we use the Political Constraints Index (Henisz, 2002), which measures how changes in the preferences of political actors lead to changes in public policies and in the status quo. In particular, it takes into account political constraints on executive discretion. The index ranges between 0 and 1, where higher values indicate greater limits on the discretional behaviour and higher acceptance of changes proposed by the government (greater political consensus), and lower values indicate greater executive discretion to implement its policies (associated with higher political risk). Studies like Henisz (2002), Jensen (2007) and Busse and Hefeker (2007) have found that lower political risk is correlated with higher investment flows. Therefore, the sign of this variable is expected to be positive, in the understanding that increased *stimuli* to

[9] The use of macroprudential indicators has been frequently used in the efficiency literature, see for example Salas and Saurina (2003), Yildirim and Philippatos, 2007 and Uhde and Heimeshoff (2009).

economic growth produce positive returns on investment, and that this effect is directly related to greater financial stability.

5. Competition threshold and Financial Stability: empirical results

5.1 Competition-Stability nexus at the country level

The first step is to test for the existence of a threshold (γ) using the likelihood ratio test, F_1, as discussed above. This involves estimating equation (2) by least squares, allowing for zero and single threshold (sequentially) and computing the residual sum of squares (S_1) for threshold levels, where the transition variable used is the number of financial institutions ($q_{it} \equiv N_{it}$) at the country level. Model *i*) and *ii*) consider the concentration ratio C_5, and the HHI as they have been generally used in previous studies as linear specifications, while in model *iii*) and *iv*) we propose consider other competition variables such as the $LERNER$ and the $NIMTA$ ratio. In all these models, the measure of financial stability is the *Z-score* computed for each country and year (see table 4).

The results show that bank C_5 concentration ratio and the Lerner index are statistically significant regardless of the regime examined. In the low regime, when the country has less than about 229 financial institutions, $I\ (N_{it} < \gamma)$, the estimated coefficient β_1 is positive, while in the high regime, with more than 229 institutions, $I\ (N_{it} \geq \gamma)$, the β_2 coefficient is negative, thus confirming the asymmetry of the sign in the relationship between market power and financial stability in the 23 countries included in the sample. A significant effect is also found for the HHI index. In this case higher market power is found to promote financial stability only when the country has less than 124 financial institutions, $I\ (N_{it} < \gamma)$, whereas above this threshold, $I\ (N_{it} \geq \gamma)$, an increase in competition leads to an increase in the risk of bank failure (see table 5)

To provide some robustness to the threshold model results, we test for single threshold and their asymptotic 95% confidence intervals are reported in Table A.3. The point estimates are the value of γ at which the likelihood ratio hits the zero axis, which is in near to the percentile 57 when the concentration ratio C_5 is considered, and 60% when the Lerner index is used as regressor. In these three cases, the 95% confidence intervals for the threshold parameters can be found beneath the dotted line, except for the use of the NIMTA index where the non-linearity at country level was rejected.

For the control variables, regardless of the model examined, the spread results significant and negative, indicating that increases in the difference between the assets invested by the banks in loans and the cost of funding (Short term and Long Term Funding) increase financial instability. The aggregated leverage ratio is found to be positive but only significant in the second model, indicating that increases in shareholders' equity relative to liabilities, promote financial stability. The coefficient representing fees and commissions is found negative, but only significant in the first model, showing with low evidence that an increase in fee revenues could be related to a higher risk of bank failure. Among the macro-prudential variables, domestic real interest rate is found to be negative and significant in most models, confirming that higher loan interest rates established by banks may induce borrowers to take on risky investments to compensate higher loan repayments. Finally as expected, the economic growth and government debt to GDP ratio were also significant, confirming the expected positive impact of these variables on financial soundness.

A relevant feature of these results is that they reconcile the diverse positions found in the literature. Thus, the results reported by De Nicoló et al. (2004) and Uhde and Heimeshoff (2009), who find evidence on the *concentration-fragility* approach, are similar to our estimates when consolidation processes take place in countries with a high number of institutions.

Table 4
Tests for single threshold effects *(at country level)*

Regimen-dependent regressors:	*Model*	*Threshold variable:*	*Threshold estimates*		*Ho: No threshold*	
			γ	95 % Conf. Interval	F-stat	p-value
C5	**- *i* -**	Number of Banks	229	[209 , 237]	5.78	0.045
HHI	**- *ii* -**		124	[107 , 126]	0.00	0.011
Lerner	**- *iii* -**		229	[223 , 281]	0.05	0.093
Nimta	**- *iv* -**		278	[52 , 609]	74352.64	0.535

Notes: Similarly to Hansen (1999), each regime has to contain at least 5% of all observations, where 1000 bootstrap replications were used to obtain the *p-values* to test for single thresholds in each model.

Table 5
Financial Stability - Market Power (*at country level*)
Model: Panel threshold regression
Dependent variable: Z-score

Models:

Coeficient estimates: $$Z_{it} = \mu_i + \beta'_1 x_{it} I(q_{it} < \gamma) + \beta'_2 x_{it} I(q_{it} \geq \gamma) + \sum_j \psi'_j f_{j,it} + \sum_k \phi'_k m_t + e_{it}$$

		- i -	- ii -	- iii -	- iv -
Regimen-dependent regressors:		***Competition measures:***			
		C5	***HHI***	***Lerner***	***Nimta***
Low regime	β_1	**0.5853** **	**0.060** **	**0.2591** *	**-1.063**
		(0.22681)	(0.02423)	(0.15380)	(1.70956)
High regime	β_2	**-0.5061** **	**-0.066** ***	**-0.4367** **	**3.288**
		(0.25136)	(0.01869)	(0.21748)	(2.31319)
Threshold variable:					
Number of Banks	γ	**229**	**124**	**229**	**278**
Regimen-independent regressors:					
Financial soundness indicators					
Interest margin	ψ_1	**-0.1538**	**-0.2161**	**-0.0074**	**-0.1734**
		(0.16731)	(0.16718)	(0.19744)	(0.18492)
Non interest expenses	ψ_2	**0.0797**	**0.1479**	**-0.0486**	**0.1118**
		(0.15545)	(0.15523)	(0.18296)	(0.17270)
Commissions	ψ_3	**-26.0665** **	**-7.9317**	**-15.6734**	**-10.8359**
		(11.93317)	(12.29444)	(15.87000)	(14.73657)
Leverage	ψ_4	**1.4311**	**3.3001** **	**2.3438**	**2.2211**
		(1.35446)	(1.47033)	(1.54547)	(1.46430)
Spread	ψ_5	**-2.9848** ***	**-1.4894** *	**-2.9277** ***	**-2.8821** ***
		(1.04970)	(0.93697)	(0.93832)	(0.92064)
Macroprudential indicators					
Economic growth	ϕ_1	**0.0075**	**0.0096** *	**0.0079**	**0.0090**
		(0.00583)	(0.00623)	(0.00621)	(0.00596)
Inflation	ϕ_2	**0.0050**	**0.0111**	**0.0089**	**0.0126**
		(0.00817)	(0.00973)	(0.00932)	(0.00920)
Domestic real interest rate	ϕ_3	**-0.0086**	**-0.0143** **	**-0.0117** *	**-0.0163** **
		(0.00573)	(0.00704)	(0.00696)	(0.00691)
Goverment debt to GDP	ϕ_4	**0.0069** ***	**0.0054** ***	**0.0061** ***	**0.0073** ***
		(0.00132)	(0.00100)	(0.00178)	(0.00140)
Political Constraints	ϕ_5	**0.2123**	**-0.0397**	**0.1203**	**0.0988**
		(0.18236)	(0.14780)	(0.27760)	(0.27934)
Number of obs		271	305	260	271
Number of groups		21	21	21	21
First Stage F-test		6.74	7.12	3.79	5.33
Prob > F		0.00	0.00	0.00	0.00
χ2 test of heteroskedasticity		4.24E+04	1.76E+04	6.92E+04	5.11E+04
P-value		0.00	0.00	0.00	0.00

Note: */**/*** Statistically significant at the 10/5/1% level. White SE are given in parentheses. Similarly to Hansen (1999), each regime has to contain at least 5% of all observations. Bootstrap replications (1000) were used to obtain p-values. Constant term included but not reported.

Table 6

Countries according to number of institutions (γ = 229)

	Low regime (+ *effects*)				High regime (- *effects*)				
$I(q_{it}<\gamma)$	Estonia	12	Denmark	102					$(q_{it}\geq\gamma)$
	Slovakia	26	Netherlands	111	Spain	283	Italy	841	
	Slovenia	34	Belgium	115	Switzerland	319	Austria	854	
	Israel	37	Sweden	123	Finland	357	Poland	868	
	Czech Republic	41	Japan	133	United	405	France	987	
	Ireland	46	Norway	151	Korea Rep. of	472	Germany	2480	
			Portugal	214					

Note: Refers to the average number of financial instutions reported on OECD Banking Statistics.

As for the theoretical arguments of Beck et al. (2006) and the empirical findings of Schaeck et. al. (2006), supporting the *concentration-stability* approach, they correspond to our results on financial consolidation in economies with a lower number of financial institutions. In this sense, policies oriented toward processes of financial consolidation should pay particular attention not only to the degree of concentration, but also to the number of financial institutions operating in those banking sectors.

Thus, countries such as Norway, Portugal or Spain, which are close to the threshold that we estimate, may also be close to the point at which the gains from a higher concentration of banking institutions could represent a reduction of financial stability (see table 6). Moreover, our results are in line with the theoretical general equilibrium prediction proposed by BDN, where the number of banks (N_{it}) in a market could affect the monotonic relationship between baking stability and competition in financial markets.

5.2 Competition-Stability nexus at *bank level*

In order to check for the presence of thresholds effects at the bank-level, specifications (1) and (2) were estimated by least squares, allowing for zero and single threshold (sequentially). The test statistic F_1, along with the bootstrap p-values and 95% confidence intervals for each threshold variable considered are shown in Table 7. We find that the test for a single threshold is highly significant. Therefore, we find evidence at a bank-level that a nonlinear relationship between financial instability and market competition depends on banks' efficiency levels.

Table 7
Tests for single threshold effects (*at banking level*)

Regimen-dependent regressors:	*Model*	*Threshold variable:*	*Threshold estimates*		*Ho: No threshold*	
			γ	95 % confidence interval	F-stat	p-value
Lerner	**- *i* -**	Ratio employees to offices	17.21	[17.184 , 17.661]	323.69	0.016
Nimta	**- *ii* -**			[17.184 , 17.661]	237.35	0.003
Lerner	**- *iii* -**	Ratio branches to banks	16.58	[16.196 , 20.265]	240.49	0.001
Nimta	**- *iv* -**			[15.721 , 20.265]	284.16	0.001

Notes: Similarly to Hansen (1999), each regime has to contain al least 5% of all observastions. 1000 bootstrap replications were used to obtain the p-values to test for single thresholds in each model.

Table 8 show the results of the non-dynamic panel threshold regression, where two different efficiency ratios where considered as a transition variable: the ratio of employees to branches and the ratio of branches to banks, so that the threshold estimate γ indicates a shifting relationship between market power and financial stability (measured at bank level). No matter the competition variable considered (Lerner index or NIMTA) the results are significant at both regimes, regardless of the model examined. In the low market power regime, when the country has less than about 16 branches per bank, $I\ (q_{it} < \gamma)$, the estimated coefficient β_1 is negative, while in the high number of branches regime, with more than 17 branches, $I\ (N_{it} \geq \gamma)$, the β_2 coefficient is positive, thus confirming that over-branch banking strategies increase financial stability in less competitive markets. These results confirm the asymmetry in the sign of the relationship between competitive behaviour and financial stability in the banking institutions considered for the 23 countries included in the sample.

Our finding is consistent with the hypotheses of Goodhart et al. (2006) and by Hesse and Čihák (2007), who conclude that in countries like the USA, Germany, Italy and Spain -where there is a strong presence of savings and cooperative banks- an increase in the bank competition is found to significantly reduce financial instability, as measured by the Z-score. As an additional robustness check for our threshold results, we also estimate a single threshold and their asymptotic 95% confidence intervals are reported in Table A.4. In the case when the ratio of employees per bank ratio is considered the estimation is around 17, which split the values in the empirical distribution in small (or large) number of employees’ threshold variable.

Table 8

Financial Stability - Market Power (*at banking level*)

Model: Panel threshold regression

Dependent variable: Z-score

Models:

Coeficient estimates: $Z_{it} = \mu_i + \beta'_1 x_{it} I(q_{it} < \gamma) + \beta'_2 x_{it} I(q_{it} \geq \gamma) + \sum_j \psi'_j f_{j,it} + \sum_k \phi'_k m_t + e_{it}$

		- i -	**- ii-**	**- iii -**	**- iv -**
		Competition measures:			
Regimen-dependent regressors:		***Lerner***	***Nimta***	***Lerner***	***Nimta***
Low regime	β_1	**-0.0748** ***	**-1.222** ***	**0.0650** ***	**0.657** ***
		(0.02144)	(0.24927)	(0.02080)	(0.22045)
High regime	β_2	**0.0673** ***	**0.745** ***	**-0.0501** **	**-1.006** ***
		(0.02080)	(0.21988)	(0.02086)	(0.23806)
Threshold variable:					
Ratio branches to banks	γ	**17.44**	**15.72**		
Ratio employees to offices				**17.211**	**17.211**
Regimen-independent regressors:					
Financial soundness indicators					
Impaired loans	ψ_1	**-0.0334**	**-0.0858**	**-0.0671**	**-0.0505**
		(0.06343)	(0.05351)	(0.06367)	(0.05333)
Interest margin	ψ_2	**1.1802** **	**0.1080**	**1.0739** *	**0.7597** *
		(0.57338)	(0.40744)	(0.57113)	(0.42553)
Non interest expenses	ψ_3	**-0.0082** *	**-0.0181** ***	**-0.0118** **	**-0.0203** ***
		(0.00479)	(0.00374)	(0.00486)	(0.00374)
Commissions	ψ_4	**1.3608**	**0.6687**	**1.7372** *	**0.8003**
		(0.99160)	(0.70990)	(1.00216)	(0.71865)
Leverage	ψ_5	**-0.9580** ***	**-0.9061** ***	**-0.9655** ***	**-0.8827** ***
		(0.08688)	(0.06645)	(0.08688)	(0.06527)
Spread	ψ_6	**-0.0924**	**-0.0962**	**-0.1698**	**-0.1163**
		(0.13765)	(0.12096)	(0.13571)	(0.12063)
Macroprudential indicators					
Economic growth	ϕ_1	**0.0008**	**0.0108** ***	**0.0007**	**0.0013**
		(0.00105)	(0.00097)	(0.00106)	(0.00097)
Inflation	ϕ_2	**0.0178** ***	**0.0276** ***	**0.0190** ***	**0.0238** ***
		(0.00245)	(0.00204)	(0.00246)	(0.00206)
Domestic real interest rate	ϕ_3	**-0.0737** ***	**-0.1206** ***	**-0.0850** ***	**-0.1091** ***
		(0.00905)	(0.00718)	(0.00847)	(0.00726)
Goverment debt to GDP	ϕ_4	**0.0631** ***	**0.0370** ***	**0.1660** ***	**0.1491** ***
		(0.01190)	(0.01027)	(0.01233)	(0.01012)
Political Constraints	ϕ_5	**-0.0094**	**0.0632** ***	**-0.0011**	**0.0476** ***
		(0.01369)	(0.01151)	(0.01354)	(0.01150)
Number of obs		24105	18663	24105	18663
Number of groups		4685	3958	4685	3958
First Stage F-test		83.74	86.61	106.44	82.61
Prob > F		0.00	0.00	0.00	0.00
χ2 test of heteroskedasticity		4.50E+37	6.20E+35	6.10E+37	6.20E+35
P-value		0.00	0.00	0.00	0.00

Note: */**/*** Statistically significant at the 10/5/1% level. White SE are given in parentheses. Similarly to Hansen (1999), each regime has to contain at least 5% of all observations. Bootstrap replications (1000) were used to obtain p-values. Constant term included but not reported.

Table 9
Countries according to bank level results

		Ratio employees to offices			
		Low regime (+ *effects*) $I(q_{1,it}<\gamma)$		High regime (- *effects*) $I(q_{1,it}\geq\gamma=17.21)$	
Ratio branches to banks	Low regime (-) $I(q_{2,it}<\gamma)$	Austria		Finland Norway	Poland Switzerland
	High regime (+) $I(q_{2,it}\geq\gamma=16.58)$	Belgium France Italy Korea Rep. of Portugal	Slovenia Spain	Czech Republic Denmark Estonia Germany Ireland Israel	Japan Netherlands Slovakia Sweden United Kingdom

Note: Refers to the average number of ratios.

6. Concluding Remarks

The issue on whether a greater concentration of banking institutions improves or worsens financial stability has produced mixed results in previous empirical studies. We readdressed the question and try to reconcile the apparently conflicting results by considering the multifaceted nature of the relationship between the two key variables under study. To do so, we took a non-linear empirical approach, in the form of a non-dynamic panel threshold regression method, following Hansen (1999), for a sample of 23 OECD countries in the period from 1996 to 2010.

Our results offer robust evidence of asymmetries in the relationship between financial stability and bank competition, depending on the number of banks, the level of bank efficiency and the number of employees per branch. Our main contribution to current knowledge in this area is that we reconcile diverse opinions as to whether processes of financial consolidation are positive or negative in terms of financial stability. Our results show that those economies with a small number of financial institutions (less than about 229), over-branched (more than 15 branches per bank) and with a low number or employees per branch (less than 17) achieve greater stability, measured by the Z-score indicator. However, such gains are absent in the case of economies with a large number of institutions, where decreases in competition achieved by greater financial consolidation may actually produce financial instability.

Appendix A1
Lerner index of market power

We compute the Lerner index considering a multi-product framework (total assets) reflecting a diversified bank output as follows:

$$Lerner = (P_Q - MC_Q)/P_Q \tag{A1.1}$$

where P_Q is the price of total assets ($Q = TA$) computed as the ratio of total (interest and non-interest) income as a proportion of total assets and MC_Q is the marginal cost of total assets. The index ranges from a high of 1 to a low of 0, with higher numbers implying greater market power. For a perfectly competitive (where $P_Q = MC_Q$), $Lerner = 0$; such a firm has no market power.

Similar like Carbó et al. (2009) we considered a standard translog function with a single output (total assets) and three input prices: labor (P_L), physical capital (P_K) and deposits (P_D). In this sense, we assume that production is characterized by constant returns to scale and that any technical change affecting factor prices are Hicks-neutral. For our three-input LKD model, we specify this cost function with symmetry and constant return to scale imposed as: λ

$$\begin{aligned} lnC_{it} &= \alpha_0 + \alpha_1 lnQ_{it} + \frac{\alpha_2}{2} lnQ_{it}{}^2 + \sum_j \beta_j \, lnP_{j,it} + \frac{1}{2}\sum_j \gamma_j \, lnP_{j,it}{}^2 + \sum_j \lambda_j \, lnQ_{it} lnP_{j,it} + \\ &+ \sum_j \sum_h \varphi_{jh} \, lnP_{j,it} \, lnP_{h,it} + t + t^2 + t \, lnQ_{it} + \sum_j t \, lnP_{j,it} + \varepsilon_{it} \, , \; j,h = L,K,D \end{aligned} \tag{A1.2}$$

The specification includes a quadratic time trend (t) as an approximation of technical progress. Since linear homogeneity in prices is imposed we established the following restrictions on (A1.1) assuming perfect competition in the input market, so that the input prices have been treated as fixed:

$$\beta_L + \beta_K + \beta_D = 1$$

$$\varphi_{KK} + \varphi_{KL} + \varphi_{KD} = 0$$

$$\varphi_{KL} + \varphi_{LL} + \varphi_{LD} = 0 \qquad \text{(A1.3)}$$

$$\varphi_{KD} + \varphi_{DL} + \varphi_{DD} = 0$$

Then given the level of output (Q), the cost minimizing input demand functions are derived thought the logarithmically differentiation of (A1.2), which using Shepard's Lemma, allow us to obtain the LKD input share of demand equations as follows:

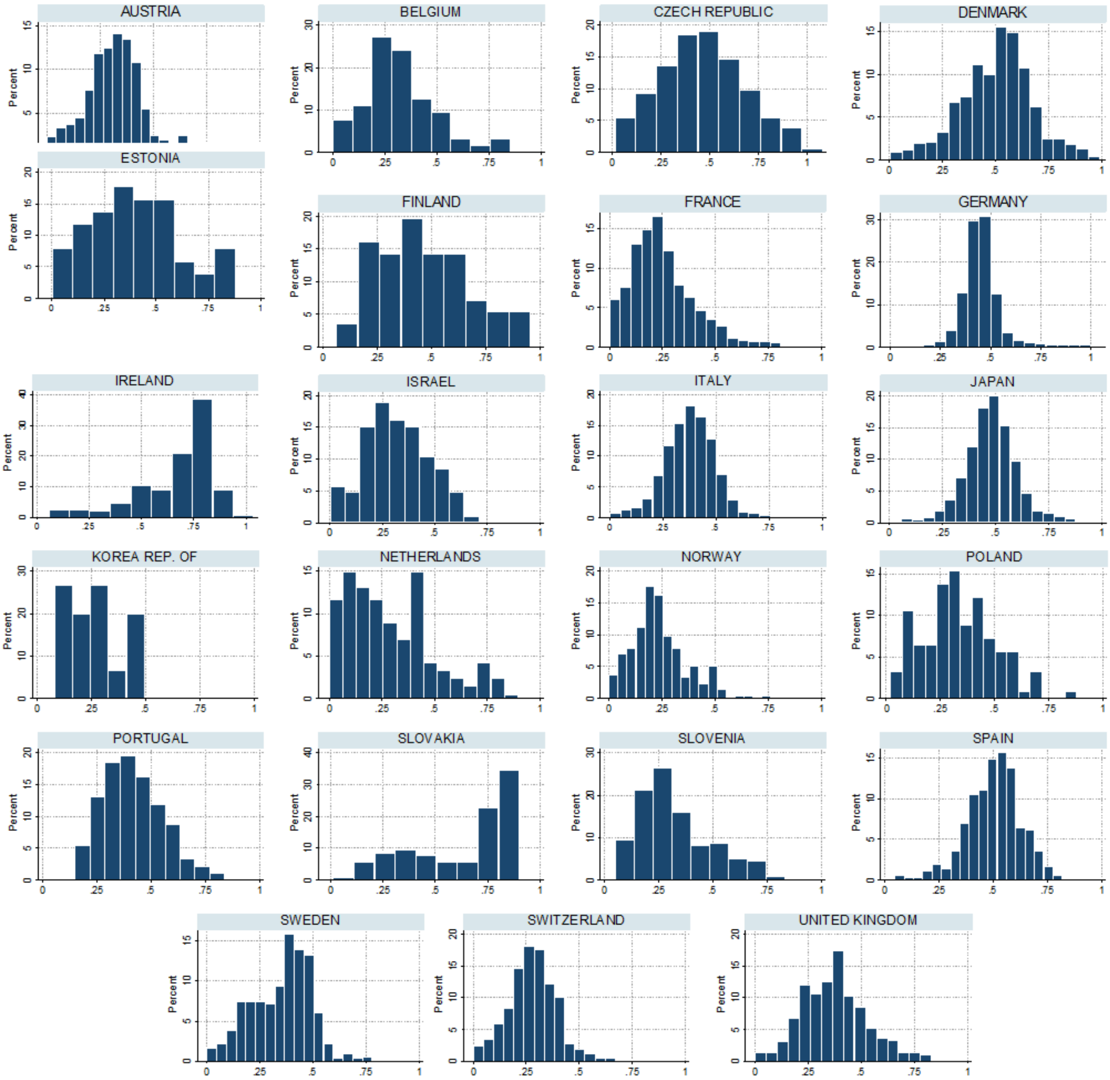
$$\frac{\partial lnC}{\partial lnP_i} = \frac{\partial C}{\partial P_i}\frac{P_i}{C} = \beta_j + \sum_j \gamma_j \, lnP_{j,it} \,, \qquad j = L, K, D \qquad \text{(A1.4)}$$

Finally, we then estimate simultaneously expressions (A1.2) and (A1.4), rewriting the former as:

$$P_Q = \frac{C}{Q}\left(\alpha_1 + \alpha_2 lnQ + \sum_j \lambda_j \, lnP_{j,it}\right) + t \,, \qquad j = L, K, D \qquad \text{(A1.5)}$$

where the first term of the right-hand side is the marginal cost, derived from equation (A1.2) establishing the corresponding first order condition. Finally, the Lerner index in (A1.1) is averaged over time for each bank and country.

Figure A1
Lerner index of market power
(Sample over 1996-2010)



Source: author calculation

Appendix A2
Z-score index of financial stability

As Boyd et al. (1993) we build the Z-score financial stability as aan indicator of the bank's probability of insolvency. Given the widespread measure of accounting profitability return on assets, RoA, and assuming this as a random variable with finite mean μ_{RoA} and variance σ^2_{RoA}, the Bienaymé-Chebyshev inequality allows us to state the probability of insolvency as:

$$p(\pi < -K) = p(RoA < K) = \int_{-\infty}^{K} f(RoA)dRoA \tag{A2.6}$$

where p(.) is a probability and f(Roa) is the p.d.f. of return of assets. If RoA is normally distributed, we can rewrite (A2.6) as

$$p(RoA < K) = \int_{-\infty}^{Z} N(0,1)dZ$$

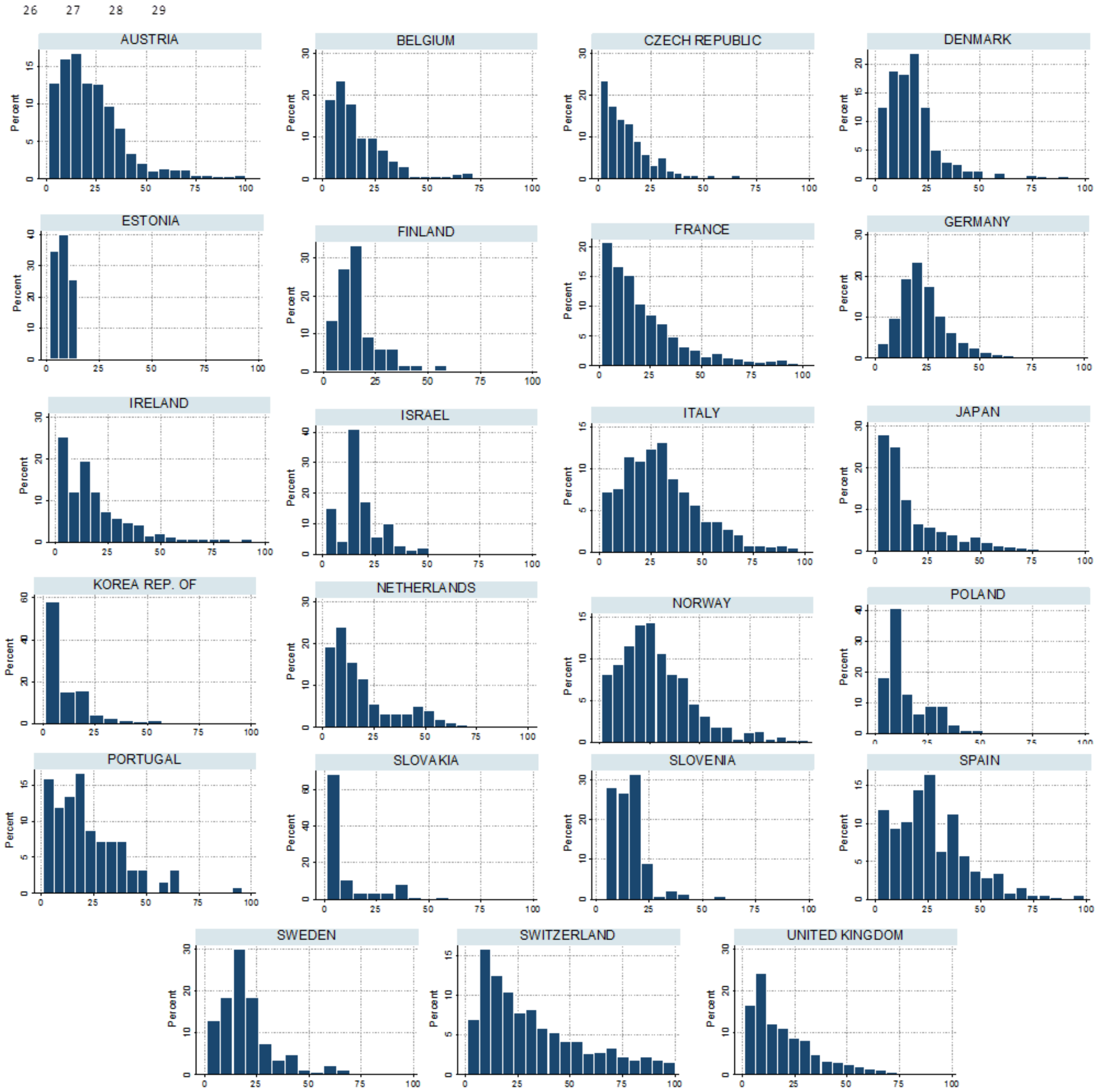
$$Z_t \equiv (RoA_t - K_t)/\sigma_{RoA,t} \quad \text{with} \quad \sigma^2_{RoA,t} \overset{\text{i.i.d.}}{\sim} (0, \sigma^2) \tag{A2.7}$$

where the K_t is the true mean and σ_{RoA} the true standard deviation of the return of assets distribution. As a consequence, the Z_t could be interpreted as the number of standard deviations below the mean, by which profits must fall in order to reduce equity, $(RoA_t - K_t) \leq 0$.

Figure A2

Z-score index of financial stability

(Sample over 1996-2010)

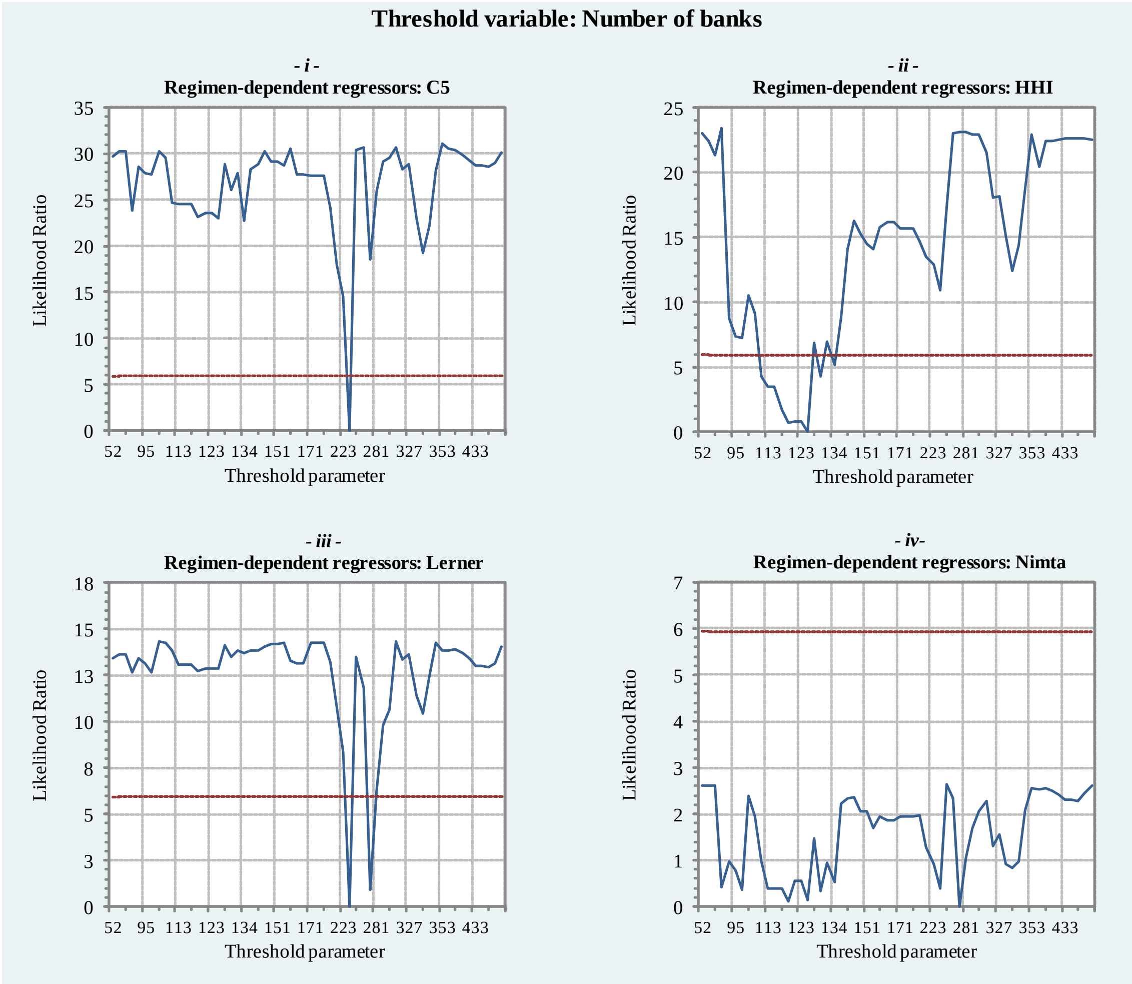


Source: author calculation

Figure A3

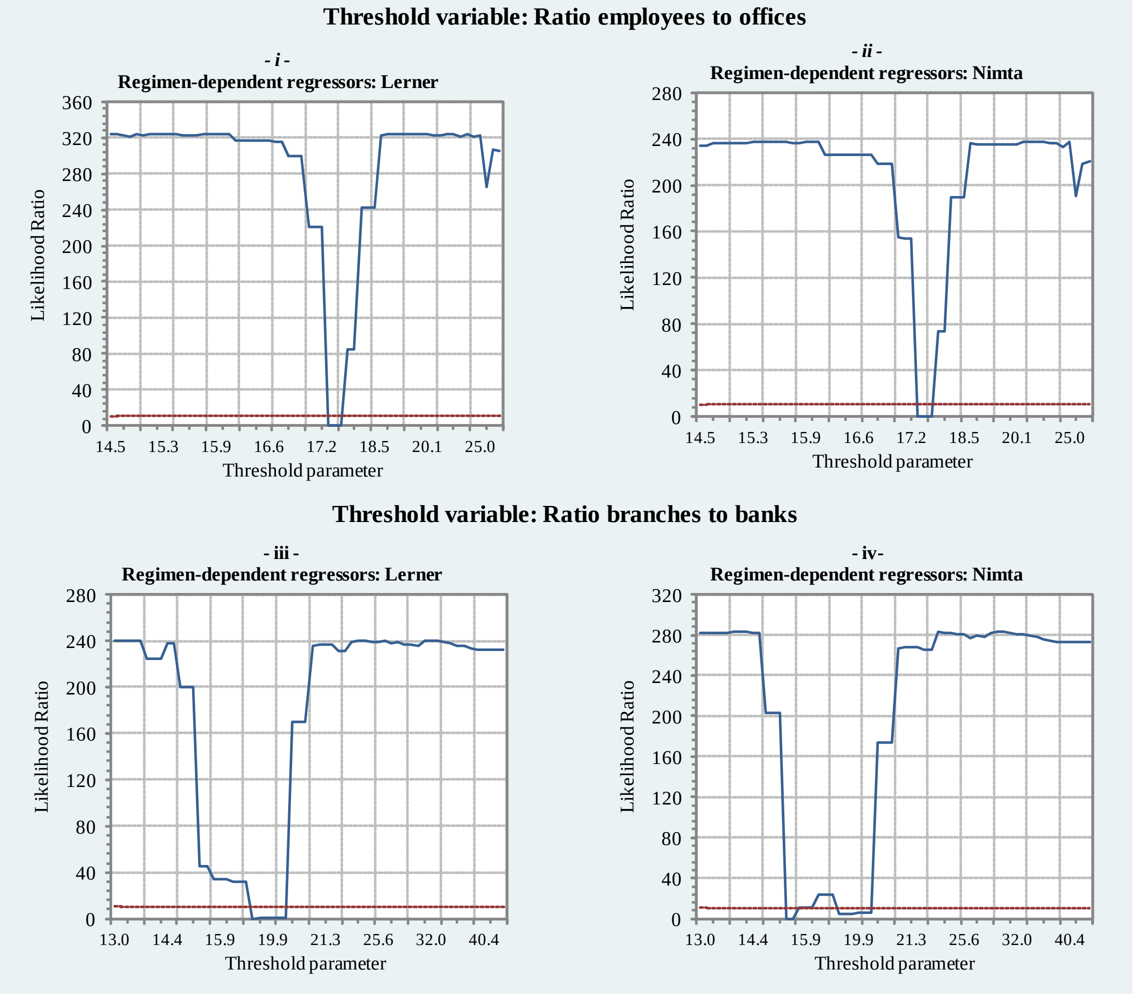
Confidence interval construction in single threshold models

(at country level)



Source: author calculation

Figure A4
Confidence interval construction in single threshold models
(at bank level)



Source: author calculation

References

Allen, F., and Gale, D. (2004). ‘Competition and Financial Stability’. Journal of Money, Credit, and Banking, Vol. 36 No. 3, pp. 453–480.

Beck, T. (2008). ‘Bank Competition and Financial Stability : Friends or Foes ?’, Policy Research Working Paper, No. 4656 (June).

Beck, T., Demirgüç-Kunt, A., and Levine, R. (2006). ‘Bank concentration, competition, and crises: First results’, Journal of Banking and Finance, Vol. 30 No. 5, pp. 1581–1603.

Benston, G. J., Hunter, W. C., and Wall, L. D. (1995). ‘Motivations for Bank Mergers and Acquisitions : Enhancing the Deposit Insurance Put Option versus Earnings Diversification’, Money, Credit and Banking, Vol. 27 No. 3, pp. 777–788.

Berger, A. N., Leusner, J. H., and Mingo, J. J. (1997). ‘The efficiency of bank branches’, Journal of Monetary Economics, Vol. 40, pp. 141–162.

Boot, A. W. A., and Thakor, A. V. (2000). ‘Can Relationship Banking Survive Competition?’, The Journal of Finance, Vol. LV No. 2, pp. 679–713.

Boyd, J. H., Graham, S. L., and Hewitt, R. S. (1993). ‘Bank holding company mergers nonbank financial firms : Effects on the risk of failure’, Journal of Banking and Finance, Vol. 17, pp. 43–63.

Boyd, J. H., and Nicoló, G. D. (2005). ‘The Theory of Bank Risk Taking and Competition Revisited’, The Journal of Finance, Vol. LX No. 3, pp. 1329–1343.

Boyd, J. H., and Prescott, E. C. (1986). ‘Financial Intermediary-Coalitions’, Journal of Economic Theory, Vol. 38, pp. 211–232.

Boyd, J., Nicolò, G. D., and Jalal, A. A. (2006). ‘Bank risk taking and competition revisited: New theory and new evidence’, IMF Working Paper, Vol. 06 No. 297.

Busse, M., and Hefeker, C. (2007). ‘Political risk, institutions and foreign direct investment’, European Journal of Political Economy, Vol. 23, pp. 397–415.

Caminal, R., and Matutes, C. (2002). ‘Market power and banking failures’, International Journal of Industrial Organization, Vol. 20, pp. 1341–1361.

Carbo-Valverde, S., Hannan, T. H., and Rodriguez-Fernandez, F. (2011). ‘Exploiting old customers and attracting new ones: The case of bank deposit pricing’, European Economic Review, Vol. 55 No. 7, pp. 903–915.

Carbó V., S., Humphrey, D. B., and López del Paso, R. (2007). ‘Do cross-country differences in bank efficiency support a policy of “national champions”?’, Journal of Banking and Finance, Vol. 31 No. 7, pp. 2173–2188.

Carlson, M., and Mitchener, K. J. (2006). ‘Branch Banking , Bank Competition , and Financial Stability’, Journal of Money, Credit and Banking, Vol. 38 No. 5, pp. 1293–1328.

Cetorelli, N., Hirtle, B., Morgan, D., Peristiani, S., and Santos, J. (2007). ‘Trends in Financial Market Concentration and Their Implications for Market Stability’, Economic Policy Review, March, pp. 33–51.

Chan, Y.-S., Greenbaum, S. I., and Thakor, Anjan, V. (1986). ‘Information reusability, competition and bank assset quality’, Jounral of Bankin and Finance, Vol. 10, pp. 243–253.

Craig, B., and Santos, J. C. (1997). ‘The Risk Effects of Bank Acquisitions’, Economic Review, No. Q2, pp. 25–35.

De Nicoló, G., Bartholomew, P., Zaman, J., and Zephirin, M. (2004). ‘Bank consolidation, internationalization, and conglomeration: trends and implications for financial risk’, Financial markets, institutions and instruments, Vol. 13 No. 4, pp. 173–217.

Diamond, D. W., and Dybvig, P. H. (1983). ‘Bank Runs, Deposit Insurance, and Liquidity’, Journal of Political Economy, Vol. 91 No. 3, pp. 401–419.

Goodhart, C. a. E., Sunirand, P., and Tsomocos, D. P. (2006). ‘A model to analyse financial fragility’, Economic Theory, Vol. 27 No. 1, pp. 107–142.

Hansen, B. E. (1999). ‘Threshold effects in non-dynamic panels : Estimation , testing , and inference’, Journal of Econometrics, Vol. 93, pp. 345–368.

Hansen, B. E. (2000). ‘Sample splitting and threshold estimation’, Econometrica, Vol. 68 No. 3, pp. 575–603.

Hartman, T. E., Storbeck, J. E., and Byrnes, P. (2001). ‘Allocative efficiency in branch banking’, European Journal of Operational Research, Vol. 134, pp. 232–242.

Henisz, W. J. (2002). ‘The institutional environment for infrastructure investment’, Industrial and Corporate Change, Vol. 11 No. 2, pp. 355–389.

Hesse, H., and Čihák, M. (2007). ‘Cooperative Banks and Financial Stability’, IMF Working Paper, No. 07/2.

Ho, T. S. . Y., and Saunders, A. (1981). ‘The Determinants of Bank Interest Margins : Theory and Empirical Evidence’, The Journal of Financial Quantitative Analysis, Vol. 16 No. 4, pp. 581–600.

Jensen, N. M. (2007). ‘Firm-Level Responses to Politics: Political Institutions and the Operations of U.S. Multinationals’, Working paper Washington University in St. Louis, pp. 1–33.

Keeley, M. C. (1990). ‘Deposit Insurance, Risk, and Market Power in Banking’, The American Economic Review, Vol. 80 No. 5, pp. 1183–1200.

Laeven, L., and Levine, R. (2007). ‘Is there a diversification discount in financial conglomerates?’, Journal of Financial Economics, Vol. 85 No. 2, pp. 331–367.

Mishkin, F. S. (1998). ‘Financial Consolidation: dangers and opportunities’, NBER Working Paper, No. 6655.

Méon, P.-G., and Weill, L. (2005). ‘Can mergers in Europe help banks hedge against macroeconomic risk?’, Applied Financial Economics, Vol. 15 No. 5, pp. 315–326.

Park, S., and Peristiani, S. (2007). ‘Are bank shareholders enemies of regulators or a potential source of market discipline?’, Journal of Banking and Finance, Vol. 31 No. 8, pp. 2493–2515.

Paroush, J. (1995). ‘The Effect of Merger and Acquisition Activity on the Safety and Soundness of a Banking System, Review of Industrial Organization, Vol. 10, pp. 53–67.

Schaeck, K., Cihák, M., and Wolfe, S. (2006). ‘Are more competitive banking systems more stable?’, Journal of Money, Credit and Banking, Vol. 41 No. 4, pp. 711–734.

Uhde, A., and Heimeshoff, U. (2009). ‘Consolidation in banking and financial stability in Europe: Empirical evidence’, Journal of Banking and Finance, Vol. 33 No. 7, pp. 1299–1311.