JEL Classification: G01, G21
Keywords: financial crisis; performance; risk; banks

Financial Crises, Concentration and Efficiency: Effects on Performance and Risk of Banks*

Sergio SANFILIPPO AZOFRA
María CANTERO SAIZ
Begoña TORRE OLMO
Carlos LÓPEZ GUTIÉRREZ—*corresponding author* (carlos.lopez@unican.es)
all authors: University of Cantabria, Business Administration Faculty, Spain

Abstract
This paper analyzes the changes that financial crises cause in the relationship between bank market share, efficiency and profitability, as well as in the relationship between market concentration and risk. The empirical analysis was performed on a sample of 15,399 banks from major OECD countries over the period 2002–2009. The results show that market power was replaced by efficiency as the main determinant of bank profitability during the crisis. Prior to the crisis, market concentration and risk had a quadratic relationship, while thereafter the increase in market concentration produced no increase in risk.

1. Introduction

The analysis of the structural determinants of profitability has been a recurrent topic in the banking literature. Many studies have focused their attention on the relationship between profitability, market concentration and efficiency because of its implications for competition, regulations and bank management. This relationship can be explained mainly by two hypotheses (Demsetz, 1973; Berger, 1995). On the one hand, the market power hypothesis considers that greater market concentration, or market power, facilitates the setting of higher prices for customers, which increases windfall profits for banks. On the other hand, the efficiency hypothesis assumes a positive relationship between efficiency and bank profits.

Traditional studies that analyze the relationship between profitability, market concentration and efficiency indicate that market share and market concentration generate noncompetitive rents (Hannan, 1991; Berger and Hannan, 1997; Berger et al., 1999). In the last decade, deregulation, technological changes and the globalization of financial markets have increased competition in the banking sector. This could have given rise to a reduction in the effect that market concentration has on profitability. However, recent studies show that market concentration still remains relevant in determining the profitability of banks, especially in certain products. With regard to this, Carbó et al. (2007) note that market power is higher in non-traditional activities. De Jonghe and Vander Vennet (2008) show that banks with a large market share in concentrated markets still generate non-competitive rents. They also find that the best-managed banks have a competitive advantage. Additionally, several

* The authors would like to thank the University of Cantabria Foundation for Education and Research in the Financial Sector (UCEIF Foundation) for financial support.

authors show that the relevance of the efficiency and market power hypotheses varies between countries (Gonzalez, 2008; Hsieh and Lee; 2010; Goddard et al., 2011).

An important limitation of these studies is that they were conducted in a period of economic growth and expansion in which banks experienced high profitability. Financial crises can generate a number of important changes in the relationship between profitability, market power and efficiency in the banking industry. They reduce the profitability of banks. On the other hand, they increase the concentration of the banking industry due to mergers and acquisitions. According to Mitchell and Mulherin (1996), industry shocks lead to takeover waves. In spite of the fact that higher market concentration could increase bank performance, obtaining rents from market power is more difficult during crises because of a decrease in lending, higher cost of financing and a rise in loan losses (Demirgüç-Kunt et al., 2006; De Jonghe and Vander Vennet, 2008; Bolt et al., 2012). Moreover, in a crisis the difference in profitability between more and less efficient banks is more obvious because the former are able to reduce costs, avoid excessive delinquency and get better financing conditions (Dietrich and Wanzenried, 2011; Bolt, et al., 2012). A few studies have analyzed the effects of business cycles on bank profitability (Vander Vennet et al., 2005; De Jonghe and Vander Vennet, 2008; Dietrich and Wanzenried, 2011; Bolt, et al., 2012), but none of them has examined the effects of crises on the relationship between profitability, market power and efficiency.

The first contribution of this paper is to analyze the changes that financial crises cause in the relationship between bank market share, efficiency and profitability, which have not been studied previously. We propose that crises strengthen the efficiency hypothesis and weaken the market power hypothesis. The 2008 financial crisis provides an excellent opportunity to analyze the effects of crises and compare the situation before and after a crisis. Although the intensity of the crisis varies depending on the country, we are witnessing the rapid disappearance and restructuring of banks, a massive wave of mergers and acquisitions,[1] an increase in delinquency and a decline in banking activity.[2]

Not only can crises affect the relationship between profitability, efficiency and market power, but they can also alter the relationship between market concentration and bank risk. So, the second contribution of this paper is to analyze the changes that crises cause in this relationship. Market power can increase or decrease bank risk according to two contradictory hypotheses: concentration-stability and concentration-fragility (Uhde and Heimeshoff, 2009). Empirical evidence about this relationship is controversial, so further research is necessary. We propose that crises reinforce the concentration-fragility hypothesis because in the context of crisis there is a tendency to perceive greater risk in more concentrated markets because of systemic risk.

To test the changes in the relationship between profitability, concentration and efficiency, as well as between market concentration and risk, we performed an empirical analysis on a sample of 15,399 credit institutions from major OECD countries over the period 2002–2009. The analysis was performed using the system-

[1] Wheelock (2011) shows that the number of US banks fell by 12% between December 31, 2006, and December 31, 2010.

[2] Ivashina and Scharfstein (2010) show that, in the United States, new loans to large borrowers fell by 79% during the peak period of the financial crisis relative to the peak of the credit boom before the crisis.

GMM methodology for panel data, which allows controlling for endogeneity between efficiency, market concentration and market share and thus helps in overcoming one of the traditional limitations of many previous works.

The results show that, during the period of expansion and economic growth, banks in more concentrated markets had higher profitability, as proposed by the market power hypothesis. However, with the onset of the financial crisis, many banks experienced serious liquidity, delinquency and solvency problems. This is reflected in our results, which show that efficiency has replaced concentration as the deciding factor in the profitability of banks, as proposed by the efficiency hypothesis. With regard to risk analysis, before the crisis, market concentration and risk had a quadratic relationship. That is, market concentration had a negative effect on risk, but as concentration increased, its negative effects on risk decreased. However, after the beginning of the crisis, there is not enough evidence to support a relationship between concentration and risk.

The remainder of the article is structured as follows: Section 2 reviews previous literature, Section 3 focuses on the empirical analysis and the discussion of the results, and Section 4 presents the conclusions, followed by the bibliography and appendices on the procedures followed in calculating the efficiency and scale economies.

2. Theoretical Review

2.1 Market Concentration, Market Share, Efficiency and Profitability

Numerous previous studies have proposed a relationship between market concentration, efficiency and profitability of banks based primarily on two theories: the market power hypothesis and the efficiency hypothesis.

The market power hypothesis considers that greater market concentration or market share would facilitate the setting of prices less favorable to consumers, leading to an increase in extraordinary profits (Stigler, 1964; Berger, 1995). This hypothesis has two versions. The first version, called the structure-conduct-performance (SCP) hypothesis, indicates that the greatest profits come from high concentration in the market, due to both competition concerns and the existence of entrance barriers (Demsetz, 1982). The second version, called the relative market power (RMP) hypothesis, assumes that only banks with significant market share and differentiated products can exercise effective market power (Shepherd, 1982).

The efficiency hypothesis proposes a positive relationship between the efficiency of a bank and its profits (Demsetz, 1973; Peltzman, 1977; Berger, 1995). In addition, more efficient banks gain market share because lower unit costs enable them to attract more customers.[3] Thus, the profits of these banks would be high because of their lower costs, although some of the efficiency gains would be transferred to consumers. The origin of this greater efficiency has been explained as being due to superior management skills and production technology (*X*-efficiency hypothesis) or scale economies (scale-efficiency hypothesis).

There is another theory, called the quiet life hypothesis (QLH) that provides an explanation for the relationship between competition, concentration, market power

[3] This greater attraction of customers would be achieved by setting lower interest rates for loans and higher interest rates for deposits.

and efficiency. According to this hypothesis, managers of firms in less competitive markets put less effort into pursuing efficiency because they can enjoy a share of market power rents through discretional expenses or a reduction of their effort (Hicks, 1935). So, this hypothesis proposes a negative relationship between market power and efficiency as a consequence of managers' quiet life. With regard to this, Berger and Hannan (1998) find that US banks that operate in more concentrated markets are less cost efficient.

Previous works show that during the eighties, banks operating in more concentrated markets set higher interest rates on loans and lower rates on deposits (Hannan, 1991; Berger and Hannan, 1997; Berger et al., 1999). The most recent works show that financial deregulation and the introduction of new technologies have increased competition. Still, market concentration remains a relevant factor in determining the profitability of banks. De Jonghe and Vander Vennet (2008) found that although the best-managed banks will have a competitive advantage in the long term, a high market share in concentrated markets generates noncompetitive rents.

Moreover, Corvoisier and Gropp (2002) found that market concentration has different effects depending on the type of product. In this sense, Carbo and Rodríguez (2007) noted that market power increases when banks perform nontraditional activities. Gonzalez (2008) found that the validity of the efficiency hypothesis varies from country to country depending on the variables, such as deposit insurance funds or entrance barriers. Hsieh and Lee (2010) noted that the relationship between competition and profits in the banking sector may be affected by numerous factors, such as restrictions on banking or nonbank financial activities, entry barriers for foreign banks, the efficiency of the judicial system or the stability of the financial system. Goddard et al. (2011) examine the intensity of competition in 65 national banking industries. They find that persistence is negatively related to the rate of growth in GDP per capita and is positively related to the size of entry barriers. In an analysis of non-investment banks in the United States, De Haan and Poghosyan (2012) find that bank size reduces return volatility. However, this negative impact decreases with market concentration.

Obviously, financial crises reduce the profitability of banks because they give rise to a significant decline in their activity and an increase in delinquency. A few studies have analyzed the effects of business cycles on bank profitability. Bikker and Hu (2002) find that bank profits are correlated with the business cycle. Vander Vennet et al. (2005) study European banks in the economic downturn of 2000–2003. They show that bank performance varies over the business cycle. De Jonghe and Vander Vennet (2008) also find that GDP growth increases bank profitability in an analysis of 183 banks from 15 European countries between 1997 and 2004. In an analysis of Greek banks from 1985 to 2001, Athanasoglou et al. (2008) report that the business cycle has a positive effect on bank profitability, but only in the upper phase of the cycle. In a study of OECD banks over the period 1979 to 2007, Bolt et al. (2012) find evidence that bank profits behave pro-cyclically, especially during severe recessions.

Crises can also lead to higher market concentration. Mitchell and Mulherin (1996) show that industry shocks lead to takeover waves, and as a result they increase market concentration. According to the market power hypothesis, market

power facilitates the setting of higher prices for customers, which increases windfall profits for banks. However, obtaining rents from market power is more difficult during crises because lending decreases substantially, the cost of lending is higher and delinquency rises. Demirgüç-Kunt et al., (2006) maintain that the growth of credit slows down substantially in banking crises and banks reallocate their asset portfolio away from loans. De Jonghe and Vander Vennet (2008) explain that higher interest rates are more likely during economic booms because of higher inflation expectations. Bolt et al. (2012) show that loan losses are the main driver of the reduction in bank profitability during crises.

In crises the difference in profitability between more and less efficient banks is more obvious because the former are able to reduce costs, get better financing conditions, avoid excessive delinquency and reduce their risk. Regarding cost and funding conditions, Bonfim and Santos (2004) conclude that efficiency levels reduce funding costs in bond markets for European banks. Pasiouras and Kosmidou (2007) show that efficiency in expenses management is one of the main determinants of bank profitability because it reduces the cost of funding and the need for external funding. As far as delinquency is concerned, Berger and DeYoung (1997) maintain that cost inefficiency is an important indicator of future problem loans, which might well lead to a decrease in profitability. Finally, several authors find that inefficiency increases the risk of failure (Berger and Humphrey, 1992; Wheelock and Wilson, 2000). This gives rise to a drop in profitability because investors demand higher premiums on uninsured deposits in banks with high risk, which increases funding costs (Liang, 1989; Demirgüç-Kunt et al., 2006).

In this regard, we propose the following hypothesis:

H1: In the context of financial crisis, the efficiency hypothesis becomes more relevant than the market power hypothesis in explaining bank profitability.

2.2 Market Concentration and Risk

Throughout the literature linking market power and risk, one can find two alternative hypotheses: the concentration-stability hypothesis and the concentration-fragility hypothesis. The concentration-stability hypothesis proposes a negative relationship between market concentration and risk. According to this hypothesis, banks in concentrated markets can increase profits and reduce financial instability through the provision of greater capital reserves, which protect them against economic and liquidity shocks (Boyd, et al., 2004). On the other hand, in markets with high concentration, banks have a higher franchise value, which deters them from taking excessive risks (Keeley, 1990). Besides, large banks have a comparative advantage in monitoring loans and are able to achieve greater diversification of both the loan portfolio and the geographical distribution (Méon and Weill, 2005). Lastly, it is much easier to supervise a few banks than several. Consequently, supervision is more effective in concentrated systems with fewer banks, and such greater effectiveness reduces systemic risk (Allen and Gale, 2000).

However, the opposite approach, namely the concentration-fragility hypothesis, asserts that the higher the concentration, the higher the risk. A higher concentration can lead to an increase in interest rates on loans, so borrowers will have to undertake riskier projects to repay their loans (Boyd and De Nicolò, 2005). More-

over, banks in more concentrated markets tend to be larger, so they are usually more protected by governments, given their importance in the overall economy. Nevertheless, this additional protection may lead them to take greater risks, which may reduce financial stability (Mishkin, 1999). Moreover, a larger size and greater diversification (more common among big banks) can lead to reduced efficiency in management, less effective internal control and increased organizational complexity, which can lead to higher operational risk (Cetorelli et al., 2007).

Regarding empirical evidence, some studies show that financial stability is higher in more competitive banking markets and systemic risk is thus lower (Schaeck et al., 2009; Uhde and Heimeshoff, 2009). In fact, De Haan and Poghosyan (2012) find that larger banks located in concentrated markets have experienced higher earnings volatility during the recent financial crisis. However, other studies show evidence in favor of the opposite approach, arguing that greater market power leads to greater financial stability. In this regard, Maudos and Fernández de Guevara (2011) argued that a high level of competition between banks could lead to greater financial instability and systemic risk; thus, a certain level of market power may be beneficial.

During crises, there is a tendency to perceive greater risk in more concentrated markets and large banks because of systemic risk and the possibility of contagion. As the IMF (2010) reported, the financial crisis has highlighted the complexity of systemic linkages. In this regard, Huang et al. (2012) show an increase in the perceived systemic risk in Asia after the onset of the crisis, mainly driven by heightened risk aversion and squeezed liquidity, and Haq and Heaney (2012) carries out an analysis of financial institutions across 15 European countries over the period 1996–2010. They find that both idiosyncratic and total risk sensitivity to bank capital have become more positive following the crisis, so bank capital fails to reduce bank risk.

In this regard, we propose the following hypothesis:

H2: In the context of financial crisis, the concentration-fragility hypothesis becomes more relevant than the concentration-stability hypothesis.

3. Empirical Analysis

3.1 Selection of the Sample and Models

3.1.1 Selection of the Sample

For the empirical analysis, a sample of credit institutions from major OECD countries was used. *Table 1* shows the number of institutions and observations included in the analysis from each country.[4] For each country, there was a panel of credit institutions[5] with data available for a minimum of four consecutive years between 2002 and 2009. Such data are essential for the second-order serial correlation test, which is performed to ensure the robustness of the estimates made by system-GMM (Arellano and Bond, 1991).[6] The sample period provides an excellent

[4] We left out OECD countries with very few credit institutions with data available.

[5] Following Maudos and Fernández de Guevara (2007), the sample used includes banks, savings banks, cooperative banks and other types of banking firms so as to provide a broad representation of banking sectors in each country.

[6] This test is fundamental to guaranteeing the robustness of the estimations made via the system-GMM methodology.

Table 1 Sample Description

Panel A: Country Distribution of the Sample							
	Number of banks per country				Sample representativeness		
	Observations	Number of commercial banks	Number of other banks	Number of total banks	Commercial banks[a] (%)	Others banks[a] (%)	Total banks[a] (%)
Australia	196	30	17	47	93.06	25.81	81.14
Austria	1,497	38	186	224	55.01	42.57	46.64
Belgium	307	31	21	52	60.57	21.63	37.03
Canada	241	15	20	35	93.33	22.22	80.60
Chile	190	29	2	31	93.55	34.38	83.42
Czech Rep.	138	18	4	22	86.31	15.56	64.80
Denmark	598	51	34	85	54.66	10.56	38.96
Finland	76	8	6	14	59.55	34.57	50.96
France	1,724	97	177	274	45.04	38.50	41.37
Germany	11,678	100	1,557	1,657	94.35	63.24	72.48
Greece	66	9	3	12	21.36	20.00	21.13
Hungary	70	9	2	11	46.51	1.86	33.88
Ireland	50	7	4	11	69.51	5.10	31.43
Italy	4,703	89	966	1,055	34.46	37.10	35.54
Japan	3,654	116	400	516	58.42	20.40	36.03
Korea	79	12	4	16	61.14	24.81	40.69
Luxembourg	493	61	11	72	50.56	44.49	48.92
Netherland	172	19	14	33	30.23	22.74	26.76
Norway	639	9	109	118	80.12	31.55	47.71
Poland	143	24	3	27	44.86	56.72	48.33
Portugal	103	10	12	22	61.73	76.86	70.09
Slovakia	84	12	2	14	79.81	8.74	51.26
Spain	421	18	68	86	74.84	50.85	62.05
Sweden	625	15	79	94	66.97	38.60	50.19
Switzerland	3,042	119	308	427	72.86	28.82	48.71
Turkey	236	31	13	44	68.76	11.11	52.04
United Kingdom	640	63	52	115	60.25	47.48	53.35
United States	72,711	7,730	2,555	10,285	85.89	34.72	46.49
Total	**104,576**	**8,770**	**6,629**	**15,399**			

Panel B: Temporary Distribution of the Sample									
	2002	2003	2004	2005	2006	2007	2008	2009	Total (observations)
Number of banks	12,913	13,353	13,795	15,001	13,448	12,851	12,053	11,162	**104,576**

Notes: [a] Assets of banks in the sample by category, as a percentage of total assets of banks in each category in the BankScope database. Other banks includes savings banks, cooperative banks and other types of banking firms.

opportunity to analyze the changes that the 2008 financial crisis has generated in the relationship between profitability, market power and efficiency, as well as in the relationship between risk and market power. The financial information on each institution came from the BankScope database, and the macroeconomic information from the World Development Indicators database of the World Bank, OECD statistics, the European Central Bank and the Federal Deposit Insurance Corporation (FDIC) of the United States.

3.1.2 Models

To perform the profitability analysis, we followed Berger (1995), which proposes the estimation of the market power and the efficiency hypotheses through a single equation. To evaluate these hypotheses before and after the crisis and to test the differences between the two periods we propose the following model:

$$\begin{aligned} R_{it} = {} & \beta_1 + \left(\beta_2 + \beta_3\ PRECRISIS_t\right) CONC_{mt} + \left(\beta_4 + \beta_5\ PRECRISIS_t\right) MS_{it} + \\ & + \left(\beta_6 + \beta_7\ PRECRISIS_t\right) XEF_{it} + \left(\beta_8 + \beta_9\ PRECRISIS_t\right) SEF_{it} + \beta_{10}\ EQUITY_{it} + \\ & + \beta_{11} LOANS_{it} + \beta_{12} SIZE_{it} + \beta_{13} MERGER_{it} + \sum_{t=1}^{t=7} \tau_t YEAR_t + \sum_{m=1}^{m=27} \tau_m\ COUNTRY_m + e_{it} \end{aligned} \quad (1)$$

To analyze the relationship between risk and market concentration, we proposed the following model:

$$\begin{aligned} Z_{it} = {} & \beta_1 + \left(\beta_2 + \beta_3\ PRECRISIS_t\right) CONC_{mt} + \left(\beta_4 + \beta_5\ PRECRISIS_t\right) CONC_{mt}^2 + \\ & + \beta_6 XEF_{it} + \beta_7\ SEF_{it} + \beta_8\ MS_{it} + \beta_9\ LOANS_{it} + \beta_{10}\ SIZE_{it} + \beta_{11}\ LOANDEP_{it} + \\ & + \beta_{12}\ MERGER_{it} + \sum_{t=1}^{t=7} \tau_t YEAR_t + \sum_{m=1}^{m=27} \gamma_{\mathrm{m}}\ COUNTRY_m + e_{it} \end{aligned} \quad (2)$$

In the profitability analysis model (1), the dependent variable (R_{it}) is a measure of the profitability of banks. ROA and ROE were used as the measures of profitability, being the most widely used in the literature (Berger, 1995; Goldberg and Rai, 1996; Tregenna, 2009; Hsieh and Lee, 2010).[7]

In the risk analysis model (2), the dependent variable (Z_{it}) is the *Z*-score, measured as follows:

$$Z_{it} = \frac{ROA + K/A}{\sigma_{ROA}}$$

where *ROA* is the return on assets, *K* is the equity capital, *A* is the total assets, and σ_{ROA} is the standard deviation of *ROA*. The *Z*-score is widely used to measure the risk of a bank (Boyd et al., 1993; Laeven and Levine, 2009); the higher the *Z*-score, the lower the probability of bankruptcy of a bank.[8]

$CONC_{mt}$ is the market concentration. We used the Herfindahl index (HHI), which is the sum of the squared market share, measured in terms of assets, of all

[7] We use pretax ROA and pretax ROE to avoid the bias of different tax systems in each country (Díaz et al., 2004).

[8] *Table 7* (*Appendix 1*) shows average levels of the *Z*-score by country.

credit institutions operating in a market. For European Union members, the data were obtained directly from the European Central Bank. In the US, the index was approached for each state using data from the Federal Deposit Insurance Corporation (FDIC). In the US we calculated the concentration at the state level because the index for the whole country does not adequately collect the level of competition, concentration, and market power of banks (Dick, 2006; Edelstein and Morgan, 2006). For other countries, this index was estimated using all banks listed in the BankScope database. Model (2) includes the variable $CONC^2_{mt}$ because the relationship between concentration and risk might be quadratic rather than linear (Maudos and Fernández de Guevara, 2011).

MS_{it} is the market share, measured in terms of assets, of bank i at time t. In the case of the US, we calculated this at the state, rather than the national, level.

XEF_{it} is the cost X-efficiency of bank i at time t. We estimated the Fourier flexible cost function by applying the stochastic frontier approach (SFA) to measure this variable.[9]

SEF_{it} is the scale efficiency of bank i at time t. We derived the Fourier flexible cost function, with respect to the inputs, to measure this variable.[10]

$PRECRISIS_t$ is a dummy variable that takes the value of 1 for the years 2002 to 2007 and of 0 otherwise. It therefore represents the years before the outbreak of the financial crisis. In model (1), this variable was used to distinguish the effects of market concentration on efficiency before and during the crisis. In this way, this variable interacts with the variables $CONC_{mt,}$ $CM_{it,}$ XEF_{it} and SEF_{it}. The effect that these variables had on profitability during the crisis was measured by the coefficients β_2, β_4, β_6 and β_8, respectively. The effect that $CONC_{mt}$ had on the pre-crisis profitability is reflected by the sum of the coefficients $(\beta_2 + \beta_3)$. In the case of $CM_{it,}$ XEF_{it} and SEF_{it}, this effect is reflected by the coefficients $(\beta_4 + \beta_5)$, $(\beta_6 + \beta_7)$ and $(\beta_8 + \beta_9)$, respectively. To test the significance of the coefficients $(\beta_2 + \beta_3)$, $(\beta_4 + \beta_5)$, $(\beta_6 + \beta_7)$ and $(\beta_8 + \beta_9)$, we must perform the linear restriction test under the null hypotheses H0: $\beta_2 + \beta_3 = 0$, H0: $\beta_4 + \beta_5 = 0$, H0: $\beta_6 + \beta_7 = 0$ and H0: $\beta_8 + \beta_9 = 0$, respectively. In model (2), this variable was used in interaction with the variables $CONC_{mt}$ and $CONC^2_{mt}$ to distinguish the effects of concentration on risk before and during the crisis. The effect of the variable $CONC_{mt}$ on risk during the crisis was measured by the coefficient β_2 and that on the pre-crisis risk by the sum of the coefficients $(\beta_2 + \beta_3)$. To test the significance of the coefficients $(\beta_2 + \beta_3)$, we performed a linear restriction test under the null hypothesis (H0): $\beta_2 + \beta_3 = 0$. Similarly, the effect of the variable $CONC^2_{mt}$ after the onset of the crisis would be reflected in the coefficient β_4, whereas for the pre-crisis effect, we performed a linear restriction test on the coefficients $(\beta_4 + \beta_5)$ under the null hypothesis (H0): $\beta_4 + \beta_5 = 0$.

$EQUITY_{it}$ is the ratio of equity over assets to capture the risk of insolvency. Low $EQUITY_{it}$ indicates higher leverage, which means higher borrowing costs, resulting in lower net interest margins and profits (Tregenna, 2009). Another approach holds that a bank with higher $EQUITY_{it}$ can take advantage of business opportunities more effectively and thus receive a higher return (Athanasoglou et al., 2008).

[9] See *Appendix 1* for a description of the procedure for calculating X-efficiency. *Table 7* (*Appendix 1*) shows average levels of X-efficiency by country.

[10] See *Appendix 2* for a description of the procedure for calculating scale economies.

Table 2 Expected Signs

	During the crisis				Before the crisis			
	β_2	β_4	β_6	β_8	$\beta_2 + \beta_3$	$\beta_4 + \beta_5$	$\beta_6 + \beta_7$	$\beta_8 + \beta_9$
SCP	+	NS	NS	NS	+	NS	NS	NS
RMP	NS	+	NS	NS	NS	+	NS	NS
X-efficiency	NS	NS	+	NS	NS	NS	+	NS
Scale effic	NS	NS	NS	+	NS	NS	NS	+

Notes: SCP: structure-conduct-performance hypothesis. RMP: relative market power hypothesis. X-efficiency: *X*-efficiency hypothesis. Scale effic: scale efficiency hypothesis. NS: not significant.

$LOANS_{it}$ is the ratio of loans to total assets and is a measure of the risk of the bank, as well as its activity (Bourke, 1989; Eichengreen and Gibson, 2001; Saunders and Wilson, 2001; Wheelock and Wilson, 2004).

$SIZE_{it}$, calculated as the natural logarithm of total assets (deflated), serves to control for the size of the bank (Goldberg and Rai, 1996; Behr et al., 2010).

The $MERGER_{it}$, dummy variable takes the value of 1 in year t if the total assets of a bank change more than 75% in that year. Olivero et al. (2011) use this measurement to distinguish banks that have probably been involved in mergers or acquisitions.

$LOANDEP_{it}$ represents the ratio of loans to deposits, controlling for differences in the intermediation ratio (Fries and Taci, 2005).

Additionally, dummy variables for country and time were included.

Table 2 shows the expected signs in our model (1) according to the structure-conduct-performance (SCP) hypothesis, the relative market power (RMP) hypothesis, the *X*-efficiency hypothesis and the scale-efficiency hypothesis.[11] Under the structure-conduct-performance hypothesis, during the crisis coefficient β_2 would be positive and significant, while β_4, β_6 and β_8 would not be significant. Meanwhile, under the relative market power hypothesis, coefficient β_4 would be positive and significant, but β_2, β_6 and β_8 would not be significant. On the other hand, under the *X*-efficiency hypothesis, β_6 would be significant, but β_2, β_4 and β_8 would not be. Lastly, according to the scale efficiency hypothesis, β_6 would be positive and significant, but β_2, β_4 and β_8 would not be significant. *Table 2* also shows the expected signs according to these hypotheses before the crisis. In this case, we had to perform a linear test of the coefficients.

In model (2), the coefficients β_2 and $(\beta_2 + \beta_3)$ would be positive and significant under the concentration-stability hypothesis but negative and significant under the concentration-fragility hypothesis. However, both hypotheses might affect the relationship between market concentration and risk. In this case, there would be a quadratic relationship; thus, β_2 and $(\beta_2 + \beta_3)$ would be significant and negative, while β_4 and $(\beta_4 + \beta_5)$ would be positive and significant.

Table 3 presents the descriptive statistics of the variables used in the analysis and *Table 4* the correlations between variables.

[11] See Berger (1995) for a thorough explanation of the expected signs according to these hypotheses.

Table 3 Sample Statistics

Variable	Mean	Standard deviation	Minimum	Maximum
ROA	0.0097	0.0123	-0.1991	0.3176
ROE	0.1030	0.1124	-0.7994	0.7926
CONC	0.1029	0.1138	0.0075	0.8184
MS	0.0035	0.0212	3.86E-07	0.9690
XEF	0.8910	0.0662	0.0898	0.9982
SEF	1.2971	0.1306	0.3789	1.9881
EQUITY	0.1002	0.0556	0.0016	0.9725
LOANS	0.6314	0.1696	0.00004	0.9936
SIZE	12.7227	1.7559	8.3196	22.1172
Z	39.6814	50.4657	0.2343	3856.9870
LOANDEP	0.8077	1.5567	0.0001	200.5656

Table 4 Correlations

	CONC	MS	XEF	SEF	EQUITY	LOANS	SIZE	LOANDEP
CONC	1							
MS	0.1078***	1						
XEF	0.0011	-0.0376***	1					
SEF	-0.0269***	-0.0569***	0.0561***	1				
EQUITY	0.2216***	0.0047	0.0716***	-0.0024	1			
LOANS	0.1721***	0.1192***	0.0300***	0.1015***	-0.0648***	1		
SIZE	-0.0841***	0.4090***	-0.0530***	0.1268***	-0.3982***	0.0398***	1	
LOANDEP	0.1630***	0.1355***	0.0560***	0.0957***	0.0617***	0.9071***	0.0785***	1

Notes: Spearman's rank correlation coefficients. *** indicates a level of significance of 0.01, ** indicates a level of significance of 0.05, * indicates a level of significance of 0.1.

3.2 Results

The models in equation (1) and (2) are estimated using two-step system-GMM (Generalized Method of Moments) with robust errors, which is consistent in the presence of any pattern of heteroskedasticity and autocorrelation. This method allows for controlling the problems of endogeneity by using lagged independent variables as instruments (Arellano and Bond, 1991) and is very suitable for estimating the proposed model because the relationships between efficiency, market concentration, market share and profitability are endogenous. Thus, efficiency affects not only profitability but also market concentration and market share, which in turn can influence efficiency through the "quiet life" effect (Berger and Hannan, 1997). In addition, market share itself can influence market concentration. Therefore, we introduce the variables CONC, MS, XEF and SEF lagged as instruments.

3.2.1 Profitability Analysis

The results of the profitability analysis are shown in *Table 5*. We estimated six models, three for ROE and three for ROA. In models (a) and (d), we introduced only those variables related to the market concentration and the efficiency hypo-

Table 5 Results (Profitability Analysis)

	ROE			ROA		
	(a)	(b)	(c)	(d)	(e)	(f)
CONC	0.1092	0.0701	0.0692	0.0108	-0.0033	-0.0013
	(0.6)	(0.62)	(0.91)	(0.54)	(-0.36)	(-0.12)
CONC * PRECRISIS	0.0161	0.0170	0.0263	0.0019	0.0104	0.0072
	(0.11)	(0.14)	(0.36)	(0.12)	(1.19)	(0.69)
MS	1.2917	1.1242	1.7222	-0.0476	0.2562	0.1284
	(0.24)	(0.23)	(0.63)	(-0.09)	(1.15)	(0.52)
MS * PRECRISIS	-0.5251	-0.1964	-0.6974	0.1178	-0.2108	-0.1097
	(-0.12)	(-0.05)	(-0.34)	(0.26)	(-0.98)	(-0.41)
XEF	1.3431 ***	0.9262 *	0.9621 **	0.1056 **	0.1090 ***	0.1105 ***
	(3.36)	(1.67)	(2.28)	(2.52)	(3.34)	(3.31)
XEF * PRECRISIS	-1.1837 *	-0.8329	-0.8786 **	-0.1122	-0.1321 ***	-0.1254 ***
	(-1.85)	(-1.27)	(-2.1)	(-1.63)	(-2.99)	(-3.59)
SEF	-0.4702	0.8097	0.5686	-0.06728	0.0401	0.0200
	(-0.14)	(0.31)	(0.27)	(-0.16)	(0.33)	(0.14)
SEF * PRECRISIS	0.4442	-0.0368	-0.1305	0.08848	-0.0773	-0.0373
	(0.16)	(-0.02)	(-0.1)	(0.29)	(-0.65)	(-0.27)
EQUITY		0.1392	0.1804		0.0153	0.0275
		(0.13)	(0.36)		(0.28)	(0.67)
LOANS		0.4095	0.4510 **		0.0145	0.0159
		(1.27)	(2.11)		(0.95)	(0.99)
SIZE		-0.0093	-0.0080		-0.0024	-0.0013
		(-0.16)	(-0.27)		(-0.64)	(-0.32)
MERGER			-0.0824			-0.0034
			(-0.92)			(-0.9)
CONS	-0.0457	-1.2093	-1.1942	-0.0124	0.1025	0.0433
	(-0.03)	(-0.37)	(-0.43)	(-0.07)	(0.75)	(0.3)
$(\beta_2 + \beta_3)$	0.1253 **	0.0871 *	0.0955 ***	0.0128 *	0.0071 ***	0.0059 **
	(2.01)	(1.84)	(2.87)	(1.88)	(2.74)	(2.49)
$(\beta_4 + \beta_5)$	0.7665	0.9278	1.0247	0.0701	0.0453	0.0186
	(0.49)	(0.50)	(0.85)	(0.47)	(0.62)	(0.27)
$(\beta_6 + \beta_7)$	0.1594	0.0933	0.0835	-0.0066	-0.0230	-0.0149
	(0.43)	(0.24)	(0.44)	(-0.16)	(-0.58)	(-0.42)
$(\beta_8 + \beta_9)$	-0.0260	0.7729	0.4380	0.0212	-0.0372	-0.0172
	(-0.02)	(0.42)	(0.38)	(0.15)	(-0.61)	(-0.25)
Country dummies	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes	yes	yes
m^2	1.41	1.29	1.62	1.17	1.45	1.20
Hansen	0.67	4.58	8.86	0.35	18.41	18.67

Notes: Coefficients associated with each variable. In brackets, *T*-student; *** indicates a level of significance of 0.01, ** indicates a level of significance of 0.05, * indicates a level of significance of 0.1; m^2 is the 2nd order serial correlation statistic. Hansen is the over-identifying restriction test. $(\beta_2 + \beta_3)$ is the tests of joint significance associated with the variable CONC. $(\beta_4 + \beta_5)$ is the tests of joint significance associated with the variable MS. $(\beta_6 + \beta_7)$ is the tests of joint significance associated with the variable XEF. $(\beta_8 + \beta_9)$ is the tests of joint significance associated with the variable SEF.

theses, plus the country and time dummies. In models (b) and (e), we added other variables that control for certain characteristics of banks. Finally, in models (c) and (f) we added the variable $MERGER_{it}$.

To evaluate the effects before the crisis, we must focus on the test of joint significance ($\beta_2 + \beta_3$), ($\beta_4 + \beta_5$), ($\beta_6 + \beta_7$) and ($\beta_8 + \beta_9$). The results show that before the crisis, the structure-conduct-performance (SCP) hypothesis was the most relevant in explaining the profitability of banks because only the ($\beta_2 + \beta_3$) coefficient is significant. This coefficient is positive, indicating that companies operating in more concentrated markets had higher profits. These results, which agree with those of previous works, show that in more concentrated markets, banks charge higher loan rates and offer lower deposit rates (Hannan, 1991; Berger and Hannan, 1997; Berger et al., 1999).

To measure the effects of the crisis, we must focus on the variables without interaction. Note that the variable *CONC* has an associated coefficient that is not significant. So there is not enough evidence to conclude that market concentration improved bank profitability after the onset of the crisis. Conversely, the variable *XEF*, which measures the efficiency of banks, becomes significant and positive (before the crisis, this variable was not significant[12]). Therefore, the efficiency hypothesis primarily explains the profitability of banks during the financial crisis.

The results show a significant change in the determinants of profitability before and after the onset of the crisis, which supports our first hypothesis (H1). Before the crisis, most developed countries experienced a sharp increase in the banking business. In this process, the securitization of loans and bond issues played an important role. Our results show that in more concentrated markets, banks would have taken greater advantage of this process. A higher concentration would facilitate the setting of prices less favorable to consumers, as proposed by the structure-conduct-performance hypothesis. Thus, in a situation of high growth in borrowing by households and firms, banks in more concentrated markets managed to obtain higher margins and increased profitability.

With the onset of the financial crisis, the previous expansion in banking suddenly slowed and delinquency rose. Moreover, the disappearance of liquidity in financial markets triggered solvency and liquidity problems in many banks. Consequently, the funding provided by credit institutions decreased significantly, resulting in a significant change in business strategies.[13] Our results show that in a situation of financial and economic crisis, the best-managed banks will be able to reduce costs, avoid excessive increases in nonperforming loans and get better financing terms, as proposed in the *X*-efficiency hypothesis. Therefore, efficiency would be the key factor in determining the profitability of banks during a financial crisis, which is consistent with our first hypothesis (H1).

3.2.2 Risk Analysis

The results of the risk analysis are reported in *Table 6*. We estimated four models: (a), (b), (c) and (d). In model (a) we present the results of the basic model,

[12] See coefficients ($\beta_6 + \beta_7$) in *Table 5*.

[13] Ivashina and Scharfstein (2010) show a significant drop in loans in the US just after the onset of the financial crisis.

Table 6 Results (Analysis of Risk)

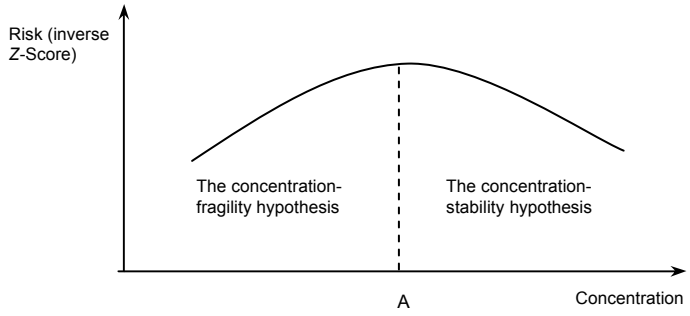
	(a)		(b)		(c)		(d)	
CONC	-30.6808	*	-31.8151	*	-40.2332	*	-11.9725	
	(-1.73)		(-1.8)		(-1.66)		(-0.97)	
CONC * PRECRISIS	-15.1226		-15.9467		-13.1651		-14.2454	*
	(-1.05)		(-1.12)		(-0.81)		(-1.65)	
$CONC^2$	61.0156		60.7062		66.7862		14.1623	
	(1.23)		(1.39)		(1.28)		(0.58)	
$CONC^2$ * PRECRISIS	28.3913		31.5753		29.5670		30.5188	
	(0.77)		(0.86)		(0.78)		(1.48)	
XEF	187.1374	**	197.3824	**	190.5076	**	49.2609	
	(2.22)		(2.33)		(2.16)		(0.65)	
SEF			-72.1909		-112.4667		-127.3901	
			(-0.47)		(-1.15)		(-1.45)	
MS					-137.1177		-173.6775	
					(-0.72)		(-1.21)	
LOANS	40.3807		49.5908		30.7319		52.0088	
	(0.78)		(1.03)		(0.61)		(1.09)	
SIZE	7.4218		6.1120	*	6.6243		2.13946	
	(1.37)		(1.67)		(1.45)		(0.79)	
LOANDEP	-0.9783		-0.8976		-0.3714		1.36940	
	(-0.35)		(-0.36)		(-0.13)		(0.49)	
MERGER							-42.5480	**
							(-2.01)	
CONS	-210.5898		-112.4614		-59.6591		150.553	
	(-1.3)		(-0.54)		(-0.37)		(0.89)	
$(\beta_2 + \beta_3)$	-45.8034	***	-47.7618	**	-53.3983	**	-26.218	*
	(-2.57)		(-2.51)		(-2.43)		(-1.92)	
$(\beta_4 + \beta_5)$	89.4069	**	92.2815	**	96.3531	**	44.6811	*
	(2.33)		(2.45)		(2.01)		(1.7)	
Country dummies	yes		yes		yes		yes	
Year dummies	yes		yes		yes		yes	
m^2	1.08		1.34		1.48		1.44	
Hansen	9.83		9.60		6.97		12.52	

Notes: Coefficients and *T*-student associated with each variable; *** indicates a level of significance of 0.01, ** indicates a level of significance of 0.05, * indicates a level of significance of 0.1; m^2 is the 2nd order serial correlation statistic. Hansen is the over-identifying restriction test. $(\beta_2 + \beta_3)$ is the tests of joint significance associated with the variable *CONC*. $(\beta_4 + \beta_5)$ is the tests of joint significance associated with the variable $CONC^2$.

whereas in model (b) we introduce the variable SEF_{it}, in model (c) we include the variable MS_{it} and in model (d) we control for mergers and acquisitions.

$(\beta_2 + \beta_3)$ and $(\beta_4 + \beta_5)$ show the linear and quadratic effects of market concentration on risk before the crisis. While both are significant in all models, $(\beta_2 + \beta_3)$

Figure 1 The Effect of Market Concentration on Risk (Inverse *Z*-Score)



is positive and ($\beta_4 + \beta_5$) is negative. Therefore, before the financial crisis, the effect of market concentration on risk was not linear but quadratic, as shown in *Figure 1*. Thus, when the concentration is low, any increase in concentration would increase the risk; thus, the concentration-fragility hypothesis prevails. One possible explanation for this is that an increase in concentration might result in higher interest rates for borrowers, who then tend to undertake riskier projects to repay their debts (Boyd and De Nicolò, 2005). In addition, it is also possible that an increase in concentration gives rise to a reduction in the effectiveness of internal control according to the "quiet life" hypothesis (Berger and Hannan, 1998).

However, as the market concentration increases, the negative effects on risk are increasingly offset by the positive effects. From point (A) onward, the benefits of market concentration on risk outweigh the negative effects, so the concentration-stability hypothesis becomes more important; therefore, an increase in concentration would reduce risk. This change in the relationship between market concentration and risk could be due to the fact that banks in highly concentrated markets have higher capital reserves due to windfall profits and therefore are more resilient to shocks (Boyd, et al., 2004). Additionally, supervision is more effective in concentrated systems with few banks, thus reducing systemic risk (Allen and Gale, 2000).

To test the effects of concentration on risk after the onset of the financial crisis, we must focus directly on the variables *CONC* and $CONC^2$. The coefficient associated with the variable *CONC* is negative and significant in models (a), (b) and (c), but not significant in model (d) when we control for mergers and acquisitions. The coefficient associated with variable $CONC^2$ is not significant. Therefore, there is not enough evidence to conclude that after the onset of the financial crisis an increase in concentration resulted in an increase in risk. This lack of evidence might be due to the fact that the financial crisis has increased funding and liquidity problems and raised delinquency globally. Additionally, a lot of banks with problems have undertaken mergers and acquisitions in an attempt to recapitalize (either on their own initiative or forced to do so by regulatory changes) which might be affecting their risk.

Regarding the control variables, *XEF* and *SIZE* show significant positive coefficients in several models but not in all. The variable *MERGER* is negative and significant, so banks that have undertaken mergers or acquisitions are riskier.

4. Conclusions

Crises alter the structure of the banking industry, which might affect the relationship between market concentration, efficiency and profitability, as well as the relationship between market concentration and risk. To analyze the changes we performed an empirical analysis on a sample of credit institutions from major OECD countries over the period 2002–2009. The results of the empirical analysis show a very significant change in the determinants of profitability after the onset of the financial crisis. Before the crisis, most banks in developed countries experienced a sharp increase in business spurred by increased demand for housing, low interest rates and good economic prospects. Strong demand for loans and credit from families and businesses encouraged financial institutions to seek funding through bond markets, securitization and asset packaging in the context of ample liquidity. Our results show that banks in more concentrated markets would have benefited most from this process, as proposed by the structure-conduct-performance (SCP) hypothesis.

With the onset of the crisis, many banks suffered significant losses from rising delinquencies. In addition, the sudden disappearance of liquidity in financial markets limited the possibilities of financing, endangering banks, many of which had to be rescued or to seek state intervention. Consequently, the funding provided by banks decreased significantly, resulting in a significant change in business strategies. Our results show that efficiency has become the deciding factor in the profitability of banks, as proposed by the *X*-efficiency hypothesis. Therefore, in a recession the more efficient banks would obtain greater profitability through better cost control and the implementation of better management and risk control techniques.

Regarding risk analysis, our results show that in a period of growth and expansion, the relationship between concentration and risk was quadratic. When the concentration is low, increases in market concentration produced increases in risk; thus, the concentration-fragility hypothesis had greater importance. However, as the market concentration increased, its relationship to risk changed, with the concentration-stability hypothesis becoming more relevant. From a certain point, increased market concentration would reduce the risk. However, during a crisis, there is not enough evidence to support a relationship between concentration and risk which might be due to funding and liquidity problems and a rise in mergers and acquisitions.

APPENDIX 1

To estimate cost efficiency, we used the Fourier flexible functional form under the alternative specification. We estimated the efficiency frontier using the stochastic frontier approach (SFA). In addition, we followed the intermediation approach that considers three outputs, three input prices, financial capital (equity) as a correction factor, and eight environmental variables.[14] We also incorporated the time trend as a measure to control for technological progress (Altunbas et al., 2001). Our specification of the cost function is as follows:

$$\begin{aligned}\ln(C) = {} & \alpha + \sum_{i=1}^{3}\beta_i \ln(w_i) + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3}\beta_{ij}\ln(w_i)\ln(w_j) + \sum_{k=1}^{3}\gamma_k \ln(y_k) + \\ & + \frac{1}{2}\sum_{k=1}^{3}\sum_{n=1}^{3}\gamma_{kn}\ln(y_k)\ln(y_n) + \omega\ln(E) + \frac{1}{2}\psi\ln(E_i)^2 + \tau_1 T + \frac{1}{2}\tau_2 T^2 + \\ & + \sum_{i=1}^{3}\sum_{k=1}^{3}\rho_{ik}\ln(w_i)\ln(y_k)\sum_{i=1}^{3}\eta_{iE}\ln(w_i)\ln(E) + \sum_{i=1}^{3}\varsigma_i T\ln(w_i) + \\ & + \sum_{k=1}^{3}\rho_{kE}\ln(y_k)\ln(E) + \sum_{m=1}^{3}\sum_{k=1}^{3}\vartheta_k T\ln(y_k) + \sum_{s=1}^{8}\mu_k\ln(v_s) + \\ & + \sum_{q=1}^{4}\left[\varphi_q\cos(x_q) + w_q\sin(x_q)\right] + \sum_{q=1}^{4}\sum_{r=1}^{4}\left[\varphi_{qr}\cos(x_q + x_r) + w_{qr}\sin(x_q + x_r)\right] + \\ & + \sum_{q=1}^{4}\left[\varphi_{qqq}\cos(x_q + x_q + x_q) + w_{qqq}\sin(x_q + x_q + x_q)\right] + \ln u + \ln\varepsilon\end{aligned}$$

The dependent variable is total cost (operating and financial cost).

Outputs:

1. y_1 = loans
2. y_2 = other earning assets
3. y_3 = off-balance sheet items

Input prices:

1. w_1 = cost of lendable funds: financial costs over liabilities (deposits, money market funding and other funding)
2. w_2 = cost of physical capital: defined as the ratio of expenditure on plant and equipment and the book value of physical capital
3. w_3 = cost of labor: personnel costs to total assets (Maudos et al., 2002)

Fixed netput:

1. E = financial capital (equity)

[14] See Altunbas and Molyneux (1996), Peristiani (1997), Berger and Humphrey (1997), Dietsch and Lorenzo-Vivas (2000), Maudos et al. (2002), Berger and Mester (2003) and Carbó et al. (2007).

Environmental variables of the country:

1. v_1 = domestic loans to GDP
2. v_2 = population density
3. v_3 = per capita GDP
4. v_4 = bank capital to total assets
5. v_5 = Herfindahl concentration index to assets
6. v_6 = number of branches per square kilometer
7. v_7 = deposits per square kilometer
8. v_8 = loans to deposits

Time trend:

1. T = time trend

The variables x_q, $q = 1, 2, 3, 4$ are rescaled values of the variables ($\ln y_k$), $k = 1, 2, 3$ and $\ln(E)$ such that x_q is in the $[0.2\pi]$ interval, where π is the number of radians and not the profits. Moreover, we cut 10% off each end of the $[0.2\pi]$ interval such that the x_q span is $[0.1\times2\pi, 0.9\times2\pi]$. This eliminates problems of approximation to the extremes. The formula for x_q is the $0.2\pi - \mu \times a + \mu \times$ variable, where $\mu \equiv (0.9\times2\pi - - 0.1\times2\pi) / (b-a)$, and $[a, b]$ is the range of the variable.

Since the duality theorem requires that the cost function is linearly homogeneous in input prices and continuity requires that the second-order parameters are symmetric, the following restrictions apply to the parameters:

$$\sum_{i=1}^{3} \beta_i = 1;\ \sum_{i=1}^{3} \beta_{ij} = 0;\ \sum_{i=1}^{3} \rho_{ik} = 0;\ \sum_{i=1}^{3} \eta_{im} = 0$$

The inefficiency term is assumed to be distributed as half-normal.

$$\beta_{ij} = \beta_{ji};\ \gamma_{ik} = \gamma_{ki}$$

APPENDIX 2

We estimated scale economies by deriving the cost function with respect to the inputs:

$$SCALE = \sum_{n=1}^{3} \frac{\partial \ln C}{\partial \ln y_i}$$

This measure was calculated with the mean of the input and output values in various size classes (Vander Vennet, 2002; Sanfilippo et al., 2008) and for each of the years analyzed.[15]

A bank operates under increasing, constant or decreasing returns to scale when this measure is greater than, equal to or less than 1, respectively.

[15] We considered six intervals: 1) less than \$500m; 2) between \$500m and \$1bn; 3) between \$1bn and \$3bn; 4) between \$3bn and \$5bn; 5) between \$5bn and \$10bn; 6) more than \$10bn.

Table 7 Country *X*-Efficiency and *Z*-Score

	X-Efficiency	*Z*-score
Australia	0.8548	44.0205
Austria	0.8977	33.5869
Belgium	0.8639	44.7946
Canada	0.8953	38.7209
Chile	0.8396	37.4506
Czech Republic	0.7982	30.2663
Denmark	0.8986	17.4281
Finland	0.8599	28.8283
France	0.8836	42.8714
Germany	0.8989	47.8613
Greece	0.8672	22.8610
Hungary	0.7704	22.3766
Ireland	0.9013	17.4348
Italy	0.8886	63.2430
Japan	0.8754	34.3213
Korea	0.8952	26.0978
Luxembourg	0.8065	24.2774
Netherlands	0.8590	36.4672
Norway	0.8498	43.3718
Poland	0.8713	27.0623
Portugal	0.8388	30.6462
Slovakia	0.7387	33.8510
Spain	0.8675	48.1499
Sweden	0.9003	26.3981
Switzerland	0.8783	75.7755
Turkey	0.8717	21.3495
United Kingdom	0.8559	32.4474
USA	0.8936	36.2176

Note: Average levels of *X*-efficiency and *Z*-score.

REFERENCES

Allen F, Gale D (2000): Financial contagion. *Journal of Political Economy*, 108:1–33.

Altunbas Y, Gardener EPM, Molyneux P, Moore B (2001): Efficiency in European Banking. *European Economic Review*, 45:1931–1955.

Altunbas Y, Molyneux P (1996): Economies of scale and scope in European banking. *Applied Financial Economics*, 6:367–375.

Arellano M, Bond S, (1991): Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. The *Review of Economic Studies*, 58:277–297.

Athanasoglou P, Brissimis S, Delis M (2008): Bank-specific, industry-specific and macroeconomic determinants of bank profitability. *Journal of International Financial Markets, Institutions and Money*, 18:121–136.

Behr P, Schmidt RH, Xie R (2010): Market structure, capital regulation and bank risk taking. *Journal of Financial Services Research*, 37:131–158.

Berger AN (1995): The profit-structure relationship in banking-tests of market-power and efficient-structure hypotheses. *Journal of Money, Credit and Banking*, 27:404–431.

Berger AN, Demsetz RS, Strahan PE (1999): The consolidation of the financial services industry: Causes, consequences, and implications for the future. *Journal of Banking & Finance*, 23:135–194.

Berger AN, Hannan TH (1997): Using efficiency measures to distinguish among alternative explanations of the structure-performance relationship in banking. *Managerial*, 23:6–31.

Berger AN, Hannan TH (1998): The efficiency cost of market power in the banking industry: a test of the `quiet life´ and related hypotheses. The *Review of Economics and Statistics*, 80:454–465.

Berger AN, Humphrey DB (1992): Measurement and Efficiency Issues in Commercial Banking. In: Zvi Griliches (ed): *Output Measurement in the Service Sectors*. University of Chicago Press, Inc., Chicago.

Berger AN, Humphrey DB (1997): Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research*, 98:175–212.

Berger AN, Mester LJ (2003): Explaining the dramatic changes in performance of US banks: technological change, deregulation, and dynamic changes in competition. *Journal of Financial Intermediation*, 12:57–95.

Berger AN, Young R de(1997): Problem loans and cost efficiency in commercial banks. *Journal of Banking & Finance*, 21:849–870.

Bikker JA, Hu H (2002): Cyclical patterns in profits, provisioning and lending of banks and pro-cyclicality of the new Basel capital requirements. *Banca Nazionale del Lavaro Quarterly Review*, 55:143–175.

Bolt W, Haan L de, Hoeberichts M, Oordt MRC van, Swank J (2012): Bank profitability during recessions. *Journal of Banking & Finance*, 36:2552–2564.

Bonfim D, Santos C (2004): Determinants of banks' financing costs in the bond market. *Banco de Portugal-Financial Stability Report-2004*:119–130.

Bourke P (1989): Concentration and other determinants of bank profitability in Europe, North America and Australia. *Journal of Banking & Finance*, 13:65–79.

Boyd JH, Graham SL, Hewitt RS (1993): Bank holding company mergers with nonbank financial firms: Effects on the risk of failure. *Journal of Banking & Finance*, 17:43–63.

Boyd JH, Nicoló G de (2005): The theory of bank risk taking and competition revisited. The *Journal of Finance*, 60:1329–1343.

Boyd JH, Nicoló G de, Smith BD (2004): Crises in competitive versus monopolistic banking systems. *Journal of Money Credit and Banking*, 36:487–506.

Carbó Valverde S, Humphrey DB, López del Paso R (2007): Do cross-country differences in bank efficiency support a policy of "national champions"? *Journal of Banking & Finance*, 31:2173–2188.

Cetorelli N, Hirtle B, Morgan D, Peristiani S, Santos J (2007): Trends in financial market concentration and their implications for market stability. *Economic Policy Review*, 13:33–51.

Corvoisier S, Gropp R (2002): Bank concentration and retail interest rates. *Journal of Banking & Finance*, 26:2155–2189.

Demirgüç-Kunt A, Detragiache E, Gupta P (2006): Inside the crisis: An empirical analysis of banking systems in distress. *Journal of International Money and Finance*, 25:702–718.

Demsetz H (1973): Industry Structure, Market Rivalry, and Public Policy. *Journal of Law and Economics*, 16:1–9.

Demsetz H (1982): Barriers to Entry. The *American Economic Review*, 72:47–57.

Díaz, B, García M, Sanfilippo S (2004): Bank acquisitions and performance: evidence from a panel of European credit entities. *Journal of Economic and Business*, 56:377–404.

Dick AA (2006): Nationwide branching and its impact on market structure, quality, and bank performance. *Journal of Business*, 79:567–592.

Dietrich A, Wanzenried G (2011): Determinants of bank profitability before and during the crisis: Evidence from Switzerland. *Journal of International Financial Markets, Institutions & Money*, 21:307–3027.

Dietsch M, Lozano-Vivas A (2000): How the environment determines banking efficiency: A comparison between French and Spanish industries. *Journal of Banking & Finance*, 24:985–1004.

Edelstein P, Morgan DP (2006): Local or state? Evidence on bank market size using branch prices. *Economic Policy Review*, 12:15–25.

Eichengreen BJ, Gibson HD (2001): *Greek banking at the dawn of the new millennium*. Centre for Economic Policy Research.

Fries S, Taci A (2005): Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries. *Journal of Banking & Finance*, 29:55–81.

Goddard J, Liu H, Molyneux P, Wilson JOS (2011): The persistence of bank profit. *Journal of Banking & Finance*, 35:2881–2890.

Goldberg LG, Rai A (1996): The structure-performance relationship for European banking. *Journal of Banking & Finance*, 20:745–771.

González F (2008): The relationship between charter value and bank market concentration: the influence of regulations and institutions. *Applied Financial Economics*, 18:153–172.

Haan J de, Poghosyan T (2012): Bank size, market concentration, and bank earnings volatility in the US. *Journal of International Financial Markets, Institutions and Money*, 22:35–54.

Hannan TH (1991): Foundations of the structure-conduct-performance paradigm in banking. *Journal of Money Credit and Banking*, 23:68–84.

Haq M, Heaney R (2012): Factors determining European bank risk. *Journal of International Financial Markets, Institutions and Money*, 22:696–718.

Hicks, JR (1935): Annual survey of economic theory: the theory of monopoly. *Econometrica*, 3: 1–20.

Hsieh MF, Lee CC (2010): The Puzzle between banking competition and profitability can be solved: International evidence from bank-level data. *Journal of Financial Services Research*, 38:135–157.

Huang X, Zhou H, Zhu H (2012): Assessing the systemic risk of a heterogeneous portfolio of banks during the recent financial crisis. *Journal of Financial Stability*, 8:193–205.

IMF (2010): *Sovereigns, Funding, and Systemic Liquidity*. IMF World economic and financial surveys, 0258-7440. Washington, D.C.

Ivashina V, Scharfstein D (2010): Bank lending during the financial crisis of 2008. *Journal of Financial Economics*, 97:319–338.

Jonghe O de, Vander Vennet R (2008): Competition versus efficiency: What drives franchise values in European banking? *Journal of Banking & Finance*, 32:1820–1835.

Keeley MC (1990): Deposit insurance, risk, and market power in banking. The *American Economic Review*, 80:1183–1200.

Laeven L, Levine R (2009): Bank governance, regulation and risk taking. *Journal of Financial Economics*, 93:259–275.

Liang N (1989): Bank profits, risk, and local market concentration. *Journal of Economics and Business*, 41:297–305.

Maudos J, Fernandez de Guevara J (2007): The cost of market power in banking: Social welfare loss vs. cost inefficiency. *Journal of Banking & Finance*, 31:2103–2103.

Maudos J, Fernández de Guevara JF (2011): Bank size, market power and financial stability. In: Molyneux P (Ed.): *Bank performance, risk and firm financing*. Ed. Palgrave Macmillan, Hampshire.

Maudos J, Pastor JM, Pérez F, Quesada J (2002): Cost and profit efficiency in European banks. *Journal of International Financial Markets, Institutions and Money*, 12:33–58.

Méon PG, Weill L (2005): Can mergers in Europe help banks hedge against macroeconomic risk? *Applied Financial Economics*, 15:315–326.

Mishkin S (1999): Financial consolidation: Dangers and opportunities. *Journal of Banking & Finance*, 23:675–691.

Mitchell ML, Mulherin H (1996): The impact of industry shocks on takeover and restructuring activity. *Journal of Financial Economics*, 41:193–229.

Olivero MP, Li Y, Jeon BN (2011): Consolidation in banking and the lending channel: Evidence from bank-level data in Asia and Latin America. *Journal of International Money and Finance*, 30: 1034–1054.

Pasiouras F, Kosmidou K (2007): Factors influencing the profitability of domestic and foreign commercial banks in the European Union. *Research in International Business and Finance*, 21: 222–237.

Peltzman S (1977): The gains and losses from industrial concentration. *Journal of Law and Economics*, 20:229–263.

Peristiani S (1997): Do mergers improve the X-efficiency and scale efficiency of US banks? Evidence from the 1980s. *Journal of Money, Credit, and Banking,* 29:326–337.

Sanfilippo S, García M, Torre B (2008): Size, Target Performance and European Bank Mergers and Acquisitions. *American Journal of Business*, 23:53–64.

Saunders A, Wilson B (2001): An analysis of bank charter value and its risk-constraining incentives. *Journal of Financial Services Research*, 19:185–195.

Schaeck K, Cihak M, Wolfe S (2009): Are competitive banking systems more stable? *Journal of Money Credit and Banking*, 41:711–734.

Shepherd WG (1982): Economies of scale and monopoly profits. In: Craven JV (ed): *Industrial Organization, Antitrust, and Public Policy*. Kluwer Nijhoff, Boston.

Stigler GJ (1964): A theory of oligopoly. The *Journal of Political Economy*, 72:44–61.

Tregenna F (2009): The fat years: the structure and profitability of the US banking sector in the pre-crisis period. *Cambridge Journal of Economics*, 33:609–632.

Uhde A, Heimeshoff U (2009): Consolidation in banking and financial stability in Europe: Empirical evidence. *Journal of Banking & Finance*, 33:1299–1311.

Vander Vennet R (2002): Cost and profit efficiency of financial conglomerates and universal banks in Europe. *Journal of Money, Credit, and Banking*, 34:254–282.

Vander Vennet R, Jonghe O de, Baele L (2005): Bank risks and the business cycle. In: Balling, Morten, Lierman, Frank, Mullineaux, Andrew (Eds): *Competition and profitability in European financial services*. Routledge, pp. 257–284.

Wheelock DC (2011): Banking industry consolidation and market structure: impact of the financial crisis and recession. *Federal Reserve Bank of St. Louis Review*, 93:419–438.

Wheelock DC, Wilson PW (2000): Why do banks disappear? The determinants of U.S. bank failures and acquisitions. The *Review of Economics and Statistics*, 82:127–138.

Wheelock DC, Wilson PW (2004): Consolidation in US banking: Which banks engage in mergers? *Review of Financial Economics*, 13:7–39.