Bangor Business School
Working Paper

BBSWP/10/020

MEASURING COMPETITION AND STABILITY: RECENT EVIDENCE FOR EUROPEAN BANKING

By

Hong Liu and Phil Molyneux

Division of Financial Studies, Bangor Business School

and

John O.S. Wilson

School of Management, University of St. Andrews

October, 2010

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

Measuring competition and stability: recent evidence for European banking[1]

Abstract

This paper uses a variety of structural and non-structural measures (including the Lerner index, Rosse-Panzar H-statistic and Profits-Persistence parameters) to gauge competitive conditions in 11 European banking systems over 1997 to 2008.As in Carbo et al (2009) we find that competition measures tend to provide inconsistent results and the measures are statistically unrelated. We also find that our banking sector risk measures (Z-score, loan-loss provisions, variation in ROE and ROA) are unrelated to the various competition measures. This raises doubts about the generality of the findings of previous empirical studies that investigate competition-stability and competition-fragility issues.

Key words: Competition, European Banking, NEIO, Risk, SCP, Stability

[1] The authors are grateful for a number of helpful comments on the paper and for insights provided by Maurizio Sella, Roberto Violi.and Giuseppe Zadra at the European Bank Competition Project Seminar held in Rome on October 4, 2010. The financial support of the Istituto (formerly, Ente) Luigi Einaudi, sponsoring the research project "Competition in European Banking" is gratefully acknowledged. The usual disclaimer applies.

Measuring competition and stability: recent evidence for European banking

1. Introduction

Over the last few years an extensive literature has emerged dealing with the issue of competition and stability in banking[2]. This has been motivated by policy concerns as to what type of market structure leads to the most efficient and stable operating environment for banking firms. Early interest in this area was promulgated by the consolidation wave in the early 2000's and more recently by the impact of the 2007/2008 banking crises.[3] The ECB (2010) reports that the number of banks in the European Union (27 countries) fell from 8,683 to 8,358 between 2005 and 2009. The five-firm assets concentration increased over the same period from 42.6% to 44.3% with the largest increases taking place in Ireland, the UK, and Sweden. From a policy perspective, however, it is difficult to ascertain the influence these structural developments are having (or likely to have) on the stability and competitive stance of banks, especially in the current environment (characterised by large government subsidies resulting from state bailouts during the global financial crisis). This is because, among other things, banking systems are in a state of flux post-crisis and it is difficult to gauge empirically how the current situation will 'play-out'. In addition, there is ongoing debate as to the most appropriate metric to use to gauge competitive behaviour and stability in banking markets. Consequently, the aim of this paper is to provide an insight into issues associated with measuring competition in banking. We utilise a variety of competition metrics (developed in the industrial organization literature), to provide evidence on the evolution of competition in European banking. Furthermore, we explore the extent to which our competition measures are related to measures commonly used in the literature to quantify the extent of financial stability. The results of our analysis suggest that our competition metrics are (in some cases) statistically unrelated. Furthermore, we also find that our banking sector stability measures are unrelated to competition. This casts some doubt as to

[2] Northcott (2004), Berger et al, (2004), Degryse and Ongena (2008) and Dick Hannan (2010) provide reviews of the theoretical and empirical competition literature. Beck et al (2010) and Vives (2010) provide excellent overviews of the theoretical and empirical relationship between competition and financial stability.

[3] Goddard et al, (2009,a,b) and Petrovic and Tutsch (2009) provide a detailed treatment of policy interventions taken by governments in Europe to stabilise the banking system.

the generality of findings produced by studies of competition-stability in banking, and suggests a need for further development of metrics and models used in this research area. The remainder of this paper is structured as follows. Section 2 introduces structural indicators of bank competition, which were developed within the Structure Conduct Performance Paradigm. Section 3 provides an overview of both non-structural and dynamic measures of competition that are rooted within the New Empirical Industrial Organization and Austrian School approaches to competition analysis. Section 4 uses a large sample of banks from 11 European countries to provide a discussion of the evolution of various competition metrics over the period 1997-2008. These measures are also correlated with commonly used risk measures in order to assess the extent to which competition augments or destroys financial stability. Finally, Section 5 provides a summary.

2. Market structure and competition in banking

Structural indicators of competition are typified by measures of industry concentration such as n-firm concentration ratios and the Herfindahl index.[4] These concentration measures aim to reflect the implications of the number and size distribution of firms in the industry for the nature of competition, using a relatively simple numerical indicator. Both the number of firms and their size distribution (in other words, the degree of inequality in the firm sizes) are important. [5]

[4] The n-bank concentration ratio, usually denoted CR_n, measures the share of the industry's n largest banks in some measure of total industry size. The most widely used size measures are based on industry loans, deposits, assets data. The formula for the n-bank concentration ratio is $CR_n = \sum_{i=1}^{n} s_i$ where s_i is the share of i'th largest banks in total loans, deposits or assets. In other words, $s_i = x_i / \sum_{i=1}^{N} x_i$, where x_i is the size of bank i, and N is the number of banks in the industry. There are no set rules for the choice of n, the number of large banks to be included in the calculation of CR_n. However, CR_n for n = 3, 4, 5 or 8 are among the most widely quoted n-firm concentration ratios. The Herfindahl–Hirschman (HH) index is calculated as: $HH = \sum_{i=1}^{N} s_i^2$ where s_i is the market share of bank i, and N is the total number of banks in the industry. For an industry that consists of a single monopoly producer, HH = 1. A monopolist has a market share of $s_1 = 1$. Therefore $s_1^2 = 1$, ensuring HH = 1. For an industry with N banks, the maximum possible value of the Herfindahl–Hirschman index is HH = 1, and the minimum possible value is HH = 1/N.

[5] Other important characteristics of industry structure include: the existence and height of barriers to entry and exit; the degree of product differentiation and the extent of vertical integration and diversification of incumbent firms.

Traditional industrial organization theory encapsulated suggests that increased industry concentration lowers the cost of collusion (smaller numbers of firms make it easier to fix prices) resulting in anti-competitive behaviour and excess profits. This has found an empirical counterpart in the Structure-Conduct-Performance (SCP) paradigm. Over time variations of the SCP hypothesis have emerged. Most noticeably, studies that test to see whether the traditional SCP paradigm (collusion) or competing efficiency hypothesis hold (see Smirlock, 1985 and Evanoff and Fortier, 1988). The latter simply states that if there is a positive relationship between concentration and bank profits/prices this may not necessarily be the result of anti-competitive behaviour, but can be explained by the superior operating efficiency of large banks. Berger (1995), for instance, finds some evidence that (the X-efficiency version) of the efficiency hypothesis holds in U.S. banking and there is also evidence that banks can exert individual market power. However the traditional SCP collusion hypothesis does not hold. Overall, the earlier US literature tends to find evidence that the traditional paradigm holds, although later studies that test the aforementioned competing hypotheses tend to reject the traditional paradigm in favour of the efficiency hypothesis (see Gilbert, 1984, and Berger et al, 2004). Results from various European banking studies tend to find some evidence that the traditional SCP hypothesis holds (see Goddard et al, 2001 for a review). Empirical research based on the SCP paradigm often finds associations in the anticipated direction between structure, conduct and performance variables. However, such relationships are often quite weak in terms of their statistical significance. Much of the early SCP literature examines the relationship between industry structure and performance, taking conduct as given. For example, in industries with only a few large banks, collusion was simply assumed to take place. Overall, however, the question as to whether a positive relationship between industry concentration and performance (however measured, whether by profits or prices) reflects collusion or efficiency has never been resolved empirically (Molyneux and Thornton, 1992; Berger, 1995; Goddard et al, 2007; Dick and Hannan, 2010).

An extensive theoretical literature on oligopoly behaviour has long recognised that major firms in concentrated markets can compete aggressively with one another, and this usually involves firms

having to guess the price and quantity reactions to strategic moves made by each other (so-called conjectural variations). In these games, the competitive environment is determined by the strategic reactions (or conduct) of firms and not by the structure of the market. Drawing on such insights theorists have posited that in contestable markets the competitive behaviour of firms is determined by (actual and potential) entry and exit conditions (proxied by the extent to which prior investments represent sunk costs). The argument goes that markets with low entry and exit conditions are faced with a higher threat of entry by new firms and as such incumbent firms behave competitively to deter entry (Baumol, 1982 and Baumol, Panzar and Willig, 1982). As such, the structural features of the market are irrelevant in determining competitive behaviour; it is entry and exit conditions that matter. A contestable market may have only two firms, but if entry and exit is costless, then the incumbent firms are likely to operate competitively so as to repel/deter potential entrants. Like in the case of competing oligopolists, the competitive features of a contestable market cannot be measured using structural indicators. Consequently, researchers have proposed alternative measures.

3. Non-structural measures of competition in banking

Criticisms of the SCP paradigm have led to a shift away from the presumption that structure is the most important determinant of the level of competition. Instead, some economists argued that the strategies (conduct) of individual firms were equally, if not more, important. Theories that focus primarily on strategy and conduct are subsumed under the general heading of the new industrial organization (NIO). According to this approach, firms are not seen as passive entities, similar in every respect except size. Instead they are active decision makers, capable of implementing a wide range of diverse strategies. Game theory, which deals with decision making in situations of interdependence and uncertainty, is an important tool in the armoury of the NIO theorists. Theories have been developed to explore situations in which firms choose from a plethora of strategies, with the choices repeated over either finite or infinite time horizons (Schmalensee, 1982). Some economists believe game theory has strengthened the theoretical underpinnings of industrial organization, while others are highly critical of the game theoretic approach.

The NIO approach has found an empirical counterpart in the New Empirical Industrial Organization (NEIO). Here in order to measure the conduct of firms, a variety of non-structural measures of competition (mainly) based on the measure of monopoly (or market) power have been developed. In particular, these include measures of competition between oligopolists such as Iwata (1974) and those that test for competitive behaviour in contestable markets, Bresnahan (1982), Lau (1982) and Panzar and Rosse (1987) is referred to as the New Empirical Industrial Organization (NEIO) approach. These indicators have been developed from (static) theory of the firm models under equilibrium conditions and mainly use some form of price mark-up over a competitive benchmark, such as price over marginal cost for the Lerner index and price over marginal revenue for the Bresnahan measure - as indicators of competitive behaviour. The main exception is the Panzar and Rosse (1987) indicator that measures the relationship between changes in factor input prices and revenues earned by firms.

The Iwata (1974) model provides a framework for estimating conjectural variation values for banks that supply homogenous products, and as far as we are aware has only been applied once to banking by Shaffer and Di Salvo (1994) and they find evidence of imperfectly competitive behaviour in a highly concentrated duopoly market[6]. Wider use has been made of the measures suggested by Bresnahan (1982) and Lau (1982) using the empirical approach suggested in Bresnahan (1989). This approach requires a structural model of banking competition where a parameter representing the market power of banks is included. This parameter simply measures the extent to which the average firm's marginal revenue varies from the demand schedule and therefore represents the degree of market power of banks in the sample. As well reported in the literature this approach was first applied to the banking industry by Shaffer (1989, 1993) on the US loan market and the Canadian banking industry, respectively. Applications of this approach to measuring competition in European banking systems include studies on Finnish banking by Suominen (1994), on various European countries by Neven and Röller (1999) and Bikker and Haf (2002), on Italian banking by Coccerese (1998) and Angelini and Cetorelli (2000), on Dutch

[6] The market investigated were a sample of banks operating in south central Pennslyvania.

consumer credit markets by Toolsema (2002) and on Portuguese banking by Canhoto (2004)[7]. Most of this literature finds little evidence of market power in European banking systems, apart from Neven and Röller (1999) who find significant monopoly collusive behaviour where they consider corporate and household loans business across six countries between 1981 and 1989.

In addition to the aforementioned measures there is also an extensive literature that uses the Panzar and Rosse (1987) approach to investigate competitive conditions in European banking and elsewhere. Molyneux et al (1994), Bikker and Groenveld (2000), De Bandt and Davis (2000), Weill (2004), Boutillier et al (2004) and Koutsomanoli-Fillipaki and Staikouras (2004), Casu and Girardone (2006) and Goddard and Wilson (2006) all find that monopolistic competition is prevalent across various European banking systems. (Other cross-country studies such as Claessens and Levine (2004), Goddard and Wilson (2009), Bikker et al (2009) and Schaek et al (2009) suggest the same). Despite changes to the methodological approach to estimating the Rosse-Panzar statistic (as highlighted in Goddard and Wilson (2009) and Bikker et al (2009)) in virtually all studies evidence of monopolistic competition is prevalent (as shown in Table 1) The main finding from the Rosse-Panzar literature is that monopolistic competition is widespread in banking, albeit that there is mixed evidence as to whether competition is generally increasing.

Other studies use the Lerner index to measure competition trends in banking. Carbó, Humphrey and Rodríguez (2003) use the Lerner index to examine competition in regional banking markets in Spain and find evidence of increases in market power over the late 1990's, and finding confirmed by Maudos and Fernández de Guevara's (2004) study of interest margins in European banking. De Guevara and Maudos (2007) use the Lerner index to find evidence of increases in market power in Spanish banking from the mid-1990s to 2002. Other recent single country studies include those of Koetter et al (2008) on US bank holding companies where efficiency adjusted Lerner indexes are used to gauge market power between

[7] Uchida and Tsutsui (2005) study competition in Japanese banking using the Bresnahan approach.

Table 1. *Summary of H-statistic estimates and equilibrium test outcomes*

Authors	Sample period	Country	Results	Equilibrium
Shaffer (1982)	1979	US (New York)	Monopolistic competition	Yes
Nathan and Neave (1989)	1982-1984	Canada	Monopolistic competition	Not estimated
Molyneux et al. (1994)	1986-1989	France, Germany, Italy, Spain and UK	Monopolistic competition, except Italy (monopoly)	No (France: 1987, Italy: 1986, 1987, Spain: 1987, 1989 and UK: 1987, 1989)
Molyneux et al. (1996)	1986 and 1988	Japan	Monopolistic competition in 1988; monopoly in 1986	Yes
Hondroyiannis et al. (1999)	1993-1995	Greek	Monopolistic competition	No (1993, 1994)
De Bandt and Davis (2000)	1992-1996	France, Germany, Italy, and US	Monopolistic competition Monopoly for small banks in France and Germany	No (for large banks in Italy)
Bikker and Haaf (2002)	1988-1998 (varying)	23 industrialized nations	Monopolistic competition	Yes, not reported (p. 2200)
Hempell (2002)	1993-1998	Germany	Monopolistic competition	Not estimated
Claessens and Laeven (2004)	1994-2001	50 countries	Monopolistic competition, competition in more advanced nations tend to be less intense	Yes, most countries (not reported)
Coccorese (2004)	1997-1999	Italy	Monopolistic competition	Yes
Gelos and Roldos (2004)	1994-1999 (varying)	8 emerging countries	Monopolistic competition	No (3 countries)
Shaffer (2004)	March 1984-June 1994	US (4 banks, quarterly)	Monopolistic competition	No (10 cases)
Buchs and Mathisen (2005)	1998-2003	Ghana	Monopolistic competition	Yes
Al-Muharrami et al. (2006)	1993-2002	6 Arab GCC countries	Monopolistic competition	No (for pooled country estimation)
Casu and Girardone (2006)	1997-2003	15 European countries	Monopolistic competition except 2 countries	Yes, most countries, (p. 461)
Goddard and Wilson (2006)	1998-2004	25 countries	Monopolistic competition	N/A dis-equilibrium approach utilised
Laeven (2006)	1994-2004 (varying)	7 East Asian countries	Monopolistic competition	Not estimated
Staikouras and Koutsomanoli-Fillipaki (2006)	1998-2002	25 European countries	Monopolistic competition	No (for small banks)
Matthews et al. (2007)	1980-2004	UK	Monopolistic competition	No (full sample period)
Yeyati and Micco (2007)	1993-2002 (varying)	8 Latin American countries	Monopolistic competition	Not estimated

Yildirim and Philippatos (2007)	1993-2000	13 Latin American countries	Monopolistic competition	No (4 countries)
Goddard and Wilson (2009)	2001-2007	Canada, France, Germany, Italy, Japan, the UK and the US	Monopolistic competition	Dis-equilibrium approach
Schaek, Cihak and Wolfe (2009)	1980-2003	38 countries	Monopolistic competition	Yes, most countries (not reported)
Bikker, Shaffer and Spierdijk (2009)	1986-2004	67 countries	Monopolistic competition	Various – highlights limitations of PR approach

1986 and 2005 – the study finds that competition has declined and the efficiency adjusted measure (used to deal with endogeneity issues) yields different outcomes to the traditional Lerner measure. Koetter and Poghosyan (2009) investigate different technology features of German banks over 1994 to 2004 and find that greater bank market power increases bank profitability but also fosters risk (higher corporate defaults). More recently Fungacova et al (2010) examine market power in Russian banking between 2001 and 2007 and find modest levels of competition improvement over the period Furthermore, their estimates of the Lerner index are similar to those found for more developed banking systems.

Various researchers have also turned their attention to large cross country studies of market power. Such studies have often been linked to efficiency issues. Maudos and De Guevara (2007), for instance, use a funding adjusted Lerner index measure to look at EU15 banking systems 1993 and 2002 where they find a positive link between market power and bank cost efficiency (rejecting the quiet-life hypothesis). Hainz et al (2008) use the Lerner index to examine the link between competition and collateral across 70 countries and find that competition reduces the need for collateral.

While there is a developed literature on the measurement of competition, and its implications for bank performance (efficiency, prices, profitability) and economic welfare, less is known about the links between competition and bank risk-taking, and overall financial stability. Two views are posited in the literature. One school of thought (the so-called competition-fragility view) argues that less competitive banking systems are less fragile because the numerous lending opportunities, high profits, capital ratios and charter values of incumbent banks make them better placed to withstand demand or supply side shocks and provide dis-incentives for excessive risk taking (Carletti, 2008). An alternative view (the so-called competition-stability view) argues that competition leads to less fragility. This is because the market power of banks results in higher interest rates for customers making it more difficult for them to repay loans. This increases the possibility of loan default and increases the risk of bank portfolios, and

subsequently makes the financial system less stable (Boyd and DeNicolo, 2005). Empirical evidence in support of either view in rather mixed. Berger et al (2009) examine market power and risk issues using a sample of over 8,000 banks across 23 developed countries over 1999 and 2005 and, using a standard Lerner index, finds that banks with a greater degree of market power also have less overall risk exposure. Finally, Turk-Ariss (2010) examines market power and financial stability for 60 developing countries over 1999 and 2005. He finds a positive link between market power and stability. This provides some empirical support to the traditional view that competition leads to fragility.

Another recent development has been the use of the Boone (2008) indicator, a new measure of competition based on the efficiency hypothesis proposed by Demsetz (1973), which stresses that industry performance is an endogenous function of the growth of efficient firms. Put simply, the indicator gauges the strength of the relation between efficiency (measured in terms of average cost) and performance (measured in terms of profitability). In general, this indicator is based on the efficient structure hypothesis that associates performance with differences in efficiency. Under this hypothesis, more efficient banks (i.e. banks with lower marginal costs), achieve superior performance in the sense of higher profits at the expense of their less efficient counterparts and also attract greater market shares. This effect is monotonically increasing in the degree of competition when firms interact more aggressively and when entry barriers decline. The Boone indicator theoretically underpins the empirical findings by Stiroh (2000) and Stiroh and Strahan (2003) who state that increased competition allows banking markets to transfer considerable portions of assets from low profit to high profit banks.

As shown theoretically in Boone (2008), the reallocation effect is a general feature of intensifying competition, so that the indicator can be seen as a robust measure of competition. While different forces can cause increases in competition, e.g. increases in the number of suppliers of banking services via lower entry cost, more aggressive interaction between banks, or banks' relative inefficiencies, as long as the reallocation conditions holds, the indicator remains valid. As the industry becomes more competitive, given a certain level of efficiency of each individual bank, the profits of the more efficient banks increase relative to those of less efficient banks

counterparts. Schaeck and Cihák (2010) note that the Boone indicator has a number of appealing qualities compared with other competition indicators. such as the Panzar and Rosse (1987) H-Statistic (which imposes restrictive assumptions about the banking market being in long-run equilibrium), and the Lerner index (which often fails to appropriately capture the degree of product substitutability, see Vives, 2008). The Boone model does not require such restrictive assumptions. What is important for the Boone indicator is how aggressively the more efficient banks exploit their cost advantage to reallocate profits away from the least efficient banks in the market. Various recent studies, Van Leuvensteijn et al (2007), Maslovych (2009) and Schaeck and Cihák (2010) have applied the Boone indicator to banking markets, although there remains some scepticism as to the efficacy of this new competition measure (Schiersch and Schmidt-Ehmcke 2010).

Another strand of empirical research that seeks to evaluate the competitive stance of markets is the persistence of profit (POP) literature that focuses on the dynamics of profitability recognizing the possibility that markets are out of equilibrium at the moment they are observed. The persistence of profit hypothesis developed by Mueller (1977, 1986) is that entry and exit are sufficiently free to eliminate any abnormal profit quickly, and that all firms' profit rates tend to converge towards the same long-run average value. The alternative is that some incumbent firms possess the capability to prevent imitation, or retard or block entry (inhibiting competition). If so, abnormal profit tends to persist from year to year, and differences in firm-level long-run average profit rates may be sustained indefinitely. The degree of first-order serial correlation in firm- or industry-level time-series profit data indicates the speed at which competition causes above- or below-average profit in one year to dissipate subsequently to converge to long-run values. There is a substantial manufacturing POP literature (Geroski and Jacquemin, 1988; Goddard and Wilson, 1999; McGahan and Porter, 1999). However, only a handful of studies investigate POP in banking. Goddard et al. (2004a, b) find that despite intensifying competition there is significant persistence of abnormal bank profits in European banking over 1992 to 1998. Carbo and Fernandez (2007) also find weak evidence of persistence in bank spreads in Europe. In a study of 65 banking systems, Goddard et al (2010a) find that persistence of bank profit appears to be

weaker for banks in developing countries than for those in developed countries suggesting competition is lower in the latter. The study also finds that persistence of profit is stronger when entry barriers are high. (Goddard et al 2010b).

4. Comparing competition measures

One of the major limitations of the extant literature is that there has been only limited work comparing the consistency of the aforementioned competition measures in banking. There are two exceptions. First, Bikker and Bos (2004) examine both structural and non-structural measures of competition in European, Japanese and US banking between 1990 and 2003. They conclude that structural developments as well as data availability issues are likely to 'reduce the reliability of the Bresnahan approach' (p.55) to measuring competition in banking markets. Although not explicitly stated, the tenor of their argument appears to provide support for the consistency of the Panzar and Rosse H-measures. The second study by Carbo et al (2009) focuses on comparing five competition indicators (net interest margin, return-on-assets (ROA), Lerner index, Rosse-Panzar H-statistics and the Herfindahl index) for 14 EU countries between 1995 and 2001. The main finding is that these measures of competition 'often give conflicting predictions of competitive behaviour across countries, within countries, and over time'. The main focus of the remainder of this paper is to follow in the same vein as Bikker and Bos (2004) and Carbo et al (2009) to consider a variety of competition indicators for 11 European banking systems over 1997 to 2008 to see if the apparent lack of consistency still prevails. However, in addition we will also examine various banking sector risk indicators in order to assess if these are related to our competition indicators, and cast some empirical light onto the conflicting theoretical competition-stability predictions proposed in the literature. The competition measures to be compared are as follows:

CR3: the largest three banks' share of assets over the whole banking system. Higher value indicates higher bank concentration.

HHI Herfindahl index, calculated as the sum of each bank's share of total assets of the whole banking system. Higher value indicates more concentrated banking market.(see Table 5)

ROA (return-on-assets) and **ROE** (return-on-equity)

NIM: Net interest margin/total assets.

LERNER: Lerner Index, defined as $(P_{TA} - MC_{TA})/P_{TA}$ where P_{TA} is the price of total assets computed as the ratio "total (interest and non-interest) revenue/total assets"; and MC_{TA} is the marginal cost of total assets computed from a standard translog function with a single output (total assets) and three input prices (deposits, labour and physical capital).

The translog function is as follows:

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

Where Cost represents total bank cost, calculated as total expenses over total assets; Q represents a proxy for bank output or total assets. W_1 and W_2 represent three input prices of funding and fixed capital , respectively, and are calculated as the ratios of interest expenses to total deposits, other operating and administrative expenses to total assets and personnel expenses to total assets, respectively. $Trend$ represent yearly fixed effects to capture technical changes in the cost function over time. As in Turk-Ariss (2010), we scale cost and input prices by the price of labour to correct for heteroscedasticity and scale biases.

The equation is estimated separately for each country. Finally marginal costs (MC) are then computed as:

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

Rosse-Panzar H-statistic: The H-statistic is calculated from a reduced form revenue equation in which factor price inputs and bank outputs are related. Since this approach observes bank's reaction to changes in input prices, the H-statistic equals the sum of the coefficients of input price factors in respect of bank revenue. The numerical value of H within the range 0<H<1 can be interpreted as a measure of the intensity of competition, with the higher the value meaning higher intensity of competition. While under perfect competition, H=1.

Specifically, the H-statistic is estimated using the following reduced-form revenue equation:

$$\ln(P_{it}) = \alpha + \beta_1 \ln(W_{1,it}) + \beta_2 \ln(W_{2,it}) + \beta_3 \ln(W_{3,it}) + \gamma_1 \ln(Y_{1,it}) + \gamma_2 \ln(Y_{2,it}) + \gamma_3 \ln(Y_{3,it}) + \delta D + \varepsilon_{it}$$

where P_{it} is the ratio of gross interest revenue to total assets (proxy for output price of loans), $W_{1,it}$ is the ratio of interest expense to total deposits and money expense to total assets (proxy for input price of deposits), $W_{2,it}$ is the ratio of personal expenses to total assets (proxy for input price of labour), and $W_{3,it}$ is the ratio of overheads to total assets (proxy for input price of equipment/fixed capital). The subscript i denotes bank i, and the subscript t denotes year t. Three control variables are at the individual bank level. Specifically, $\gamma_{1,it}$ is the ratio of equity to total assets, $\gamma_{2,it}$ is the ratio of net loans to total assets, and $\gamma_{3,it}$ is the logarithm of total assets (to control for potential size effects). D is a vector of year dummies

Profits persistence parameter (ROE) – following the same approach as Goddard et al (2010a) we estimate an autoregressive model for bank i's profit rate $\pi_{i,t} = \tilde{\pi}_i + \sum_{k=1}^{\infty} \lambda_{j,k} \pi_{i,t-k} + v_{i,t}$ to arrive at the λ - persistence parameter, using normalised ROE as our profits measure. Using panel data with a short time-dimension it is convenient to estimate a first-order autoregressive (AR(1))

specification for $\pi_{i,t}$, with the higher-order lagged profit rates suppressed. Hence, $\pi_{i,t} = \tilde{\pi}_i + \lambda_j \pi_{i,t-1} + v_{i,t}$. Here, $\tilde{\pi}_i$ denotes bank i's long-run mean normalized profit rate, and λ_j in replaces $\lambda_{j,1}$. The adjustment of normalized bank profit rates (or profit persistence parameter) is interpreted as a consequence of the interaction between profitability and the entry threat, as postulated in the contestable markets literature. Therefore, the higher the entry barriers or the lower the competition condition is, the higher the profit persistence parameter is. Estimation of the persistence of profit coefficients, λ_j is implemented using Arellano and Bover's (1995) system GMM estimator, including both lagged differences and levels of the explanatory variables as instruments.

We also derive country specific bank risk indicators – mean loan-loss provisions and the standard deviation of bank ROA and ROE. In addition we also calculate the Z-index which has been widely used in previous empirical literature as a measure of the safety and soundness of financial institutions (Iannotta et al, 2007; Hesse and Cihak, 2007; and Beck et al, 2009). The Z-index is calculated as:

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

ROA is the bank's return on assets, E/A represents the equity to total assets ratio and $\sigma(ROA)$ is the standard deviation of return on assets. In order to capture the pattern of return volatility we use a three-year rolling time window to calculate $\sigma(ROA)$

The sample composition is drawn from Bankscope and illustrated in Table 2 by country and year.

Table 2 Sample Size – Number of banks

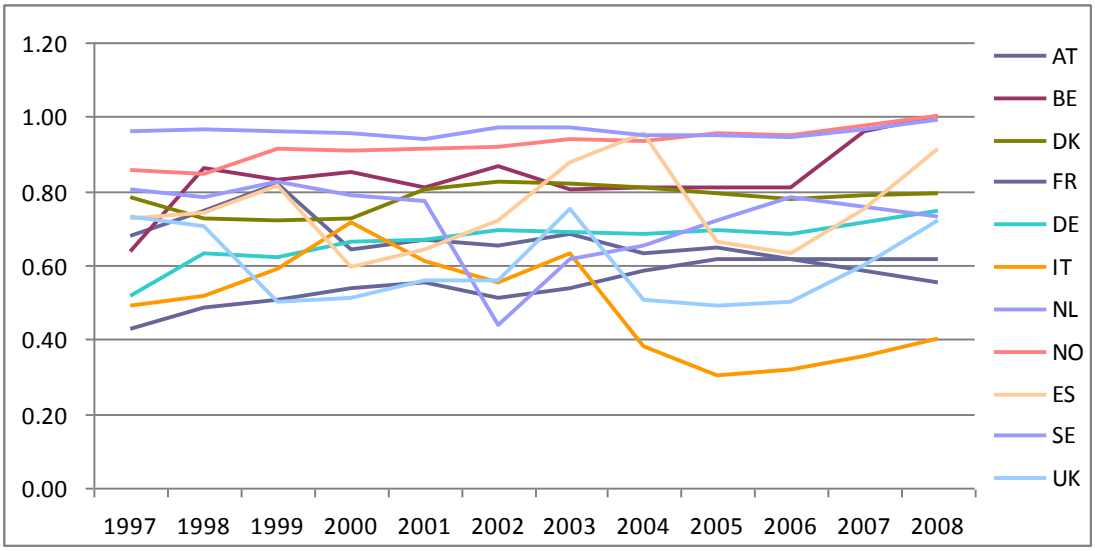
Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AT	31	36	33	155	167	174	210	228	231	233	228	230
BE	30	23	31	51	46	49	51	47	44	43	33	40
DK	14	16	17	52	89	86	84	87	89	93	91	91
FR	123	138	144	301	298	276	267	247	247	228	200	225
DE	648	757	770	1,797	1,682	1,552	1,438	1,418	1,701	1,714	1,668	1694
IT	145	153	155	126	114	77	56	142	646	636	597	626
NL	23	20	18	24	30	27	25	30	31	30	27	29
NO	9	9	12	26	31	36	48	53	98	121	116	111
ES	50	42	31	31	31	28	22	32	184	186	79	149
SE	2	2	3	9	91	91	91	85	89	85	79	84
UK	39	43	47	75	82	84	84	106	118	116	101	111

Source: Bankscope

Figure 1 shows the trends in the CR3 ratio for the range of countries sampled. The diagram illustrates the relatively highly concentrated banking systems in the smaller European economies, and an increase in the majority of systems from 2005 onwards. Italy stands out as having the least concentrated banking systems (and this is also confirmed in ECB, 2010) although the low level of concentration is likely to be overstated given the prevalence of financial groups in the country.[8] While it is argued that structural measures, like concentration ratios and Herfindahl indices, are not good measures of competition (Claessens and Laeven, 2004) they at least provide some indication of the changing nature of the banking system. Antitrust regulators still appear to be concerned about the build-up of dominant market shares and industry concentration, even if the empirical evidence linking structure to direct (non-structural measures of competition – as we will see later) appear to be weak.

[8] Thanks to Maurizio Sella for pointing this out. (The figures also are probably also overstated as they were calculated from the Bankscope database that tends to omit many small institutions.)

Figure 1 CR3 (assets concentration) for 11 European banking systems over the year 1997 to 2008

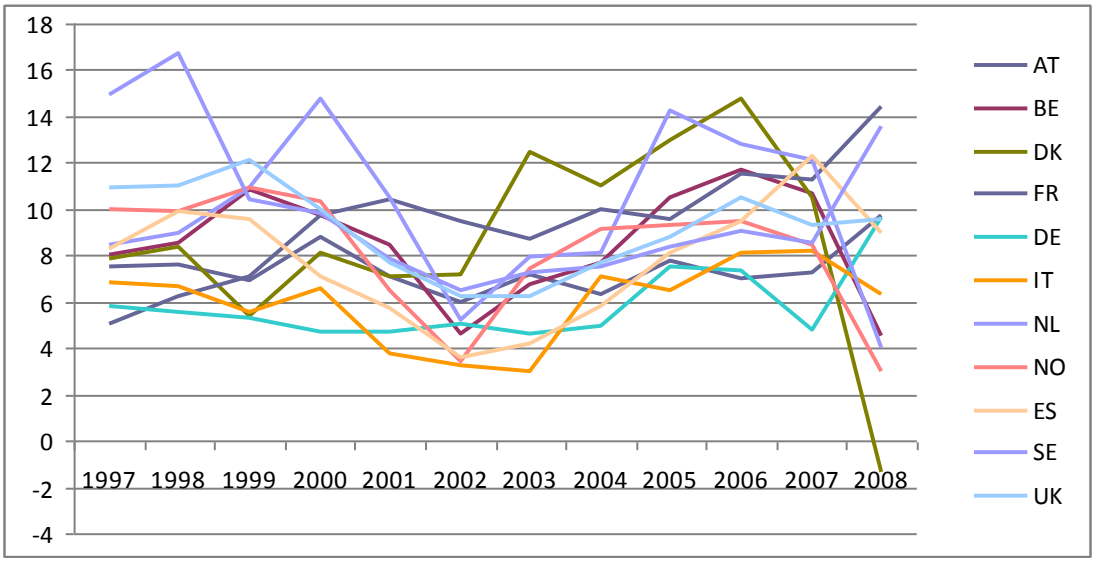


Another basic indicator of the extent of competition in a system relates to profit rates. If an industry can maintain high levels of profits overtime it is suggestive of a lack of rivalry / entry into the market (maybe due to high sunk costs). More formally, if returns minus the cost of capital appear excessive then this is probably a preferred profitability indicator than just straight profits (see Goddard et al 2010b). Table 3 reports ROA figures for the European banking systems under study and Figure 2 the ROE's. It is difficult to identify any discernable trends apart from the general increase in returns from the mid-2000s onwards and the big downturn in most banking systems post-crisis in 2008 (although some systems seemed to improve performance in 2008 – like Austria and France). Overall, it's difficult to identify any competitive inferences from these return figures.

Table 3 ROA for 11 European banking systems over the year 1997 to 2008

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AT	0.41	0.41	0.41	0.63	0.49	0.45	0.56	0.53	0.73	0.59	0.64	3.84
BE	0.39	0.12	2.12	0.97	0.88	0.16	0.34	0.6	0.82	0.84	1.81	0.26
DK	0.79	1.02	0.69	1.12	0.81	0.93	1.74	1.63	1.79	1.98	1.32	-0.48
FR	0.03	0.4	0.56	0.75	0.78	0.7	0.6	0.84	0.72	0.98	0.91	1.62
DE	0.28	0.28	0.28	0.24	0.25	0.27	0.25	0.29	0.47	0.48	0.3	0.29
IT	0.74	0.72	0.43	0.76	0.08	-0.27	0.12	0.64	0.68	0.86	0.9	0.68
NL	0.73	0.78	1.32	2.37	1.03	1.03	0.8	1.76	2.04	0.63	0.59	0.29
NO	0.57	0.95	0.2	0.96	0.33	-0.72	0.69	0.92	0.93	0.89	0.78	0.27
ES	0.67	0.87	0.46	0.59	0.19	-3.98	-0.58	0.27	0.72	0.8	0.86	0.48
SE	0.61	0.84	0.38	0.65	1.03	0.84	0.9	1.03	1.17	1.27	1.21	0.34
UK	0.92	0.68	1.44	1.14	1.22	0.87	0.59	0.43	0.69	1.09	0.89	0.73

Figure 2 ROE for 11 European banking systems over the year 1997 to 2008



A more commonly used metric to gauge competition in banking markets is net interest margin (the difference between interest income and interest cost over total assets) The general trend, illustrated in Table 4 and Figure 3, is downward suggesting reflecting lower spreads (and presumably) more competition in deposit and loan markets since 1997. This indicator is often used by professional bankers to highlight increased competition in their main business areas – although it says nothing about what is happening on the non-interest income side (which could be becoming less competitive). Focusing on margins ignores 30% to 40% of banks income sources in Europe so can only tell a partial competition story.

Table 4 NIMs for 11 European banking systems over the year 1997 to 2008

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AT	2.61	2.8	2.83	2.82	2.67	2.68	2.6	2.46	2.37	2.28	2.33	2.87
BE	1.99	2.2	2.31	2.23	2.26	2.02	1.81	1.63	1.68	1.67	1.58	1.83
DK	4.6	4.51	4.61	4.65	4.59	4.41	4.35	4.16	3.63	3.31	3.16	3.23
FR	2.69	2.58	2.45	2.48	2.44	2.45	2.32	2.33	2.29	2.23	2.2	4.06
DE	2.98	2.83	2.8	2.74	2.69	2.78	2.8	2.76	2.74	2.63	2.46	2.82
IT	3.98	3.79	3.53	3.76	3.61	3.3	2.93	2.67	2.83	3.13	3.34	3.32
NL	2.84	3.37	3.78	4.01	3.88	3.56	3.47	3.21	3.48	3.67	3.61	3.02
NO	2.54	2.86	2.93	2.71	2.82	2.68	2.84	2.67	2.56	2.45	2.43	2.54
ES	3.12	3.03	2.79	2.72	2.69	2.49	2.59	2.54	2.18	2.29	2.08	1.96
SE	3.15	2.72	2.09	2.56	3.98	3.91	3.66	3.47	3.21	2.97	2.94	0.95
UK	2.98	3.09	3.62	3.6	3.13	3.03	2.91	3.23	3.23	3.13	3.03	2.74

Figure 3 NIMs for 11 European banking systems over the year 1997 to 2008

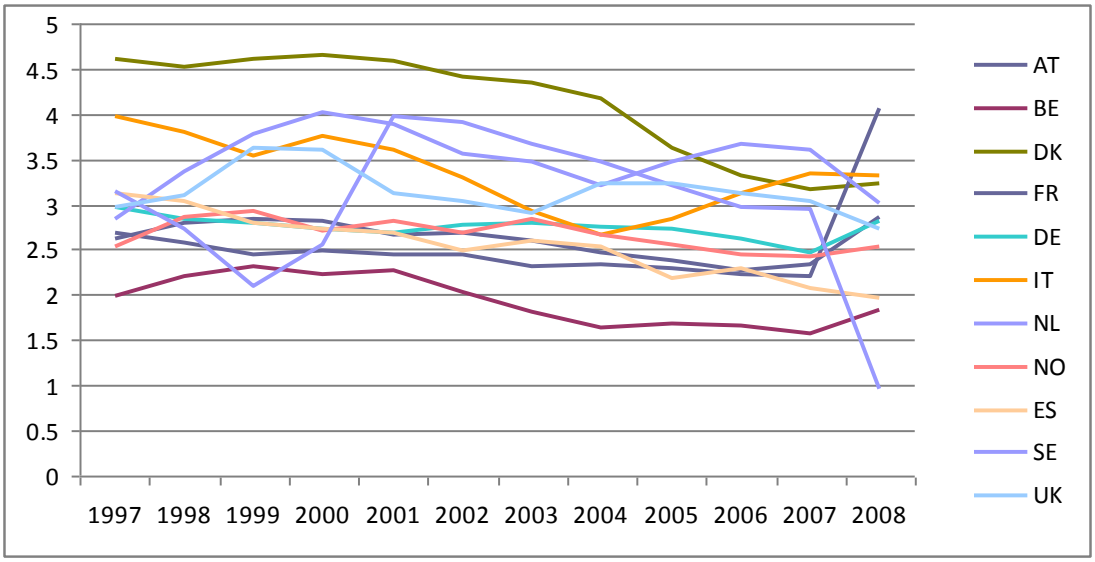


Table 5 presents our estimates over 1997 to 2008 of the other competition and risk indicators. They suggest the following:

- **Lerner index** – Scandinavian banking systems and Spain are the least competitive, Germany is the most competitive. Although not reported, in the majority of countries the Lerner index has increased throughout the 2000's, prices have fallen but marginal costs have decreased at a faster rate – this increases the Lerner measure;
- **HHI (Herfindahl index)** – Netherlands, Austria and Denmark are the most concentrated systems with Germany, Italy and France having the least concentrated structures;
- **H-statistic (Rosse-Panzar statistic)** – Norway appears to be the most competitive banking system whereas Sweden and Denmark seem to be the least competitive. The finding for Norway conflicts with evidence from the Lerner index that suggests the opposite. All estimates range in the monopolistic competition range, similar to the findings of the previous literature as reported in Table 1.
- **Persistence of profits (POP) parameter** - profits persistence (measured in terms of ROE) suggests that this is highest in the UK and Netherlands and lowest in Germany and Sweden. This suggests that competitive conditions are highest in the latter two countries.

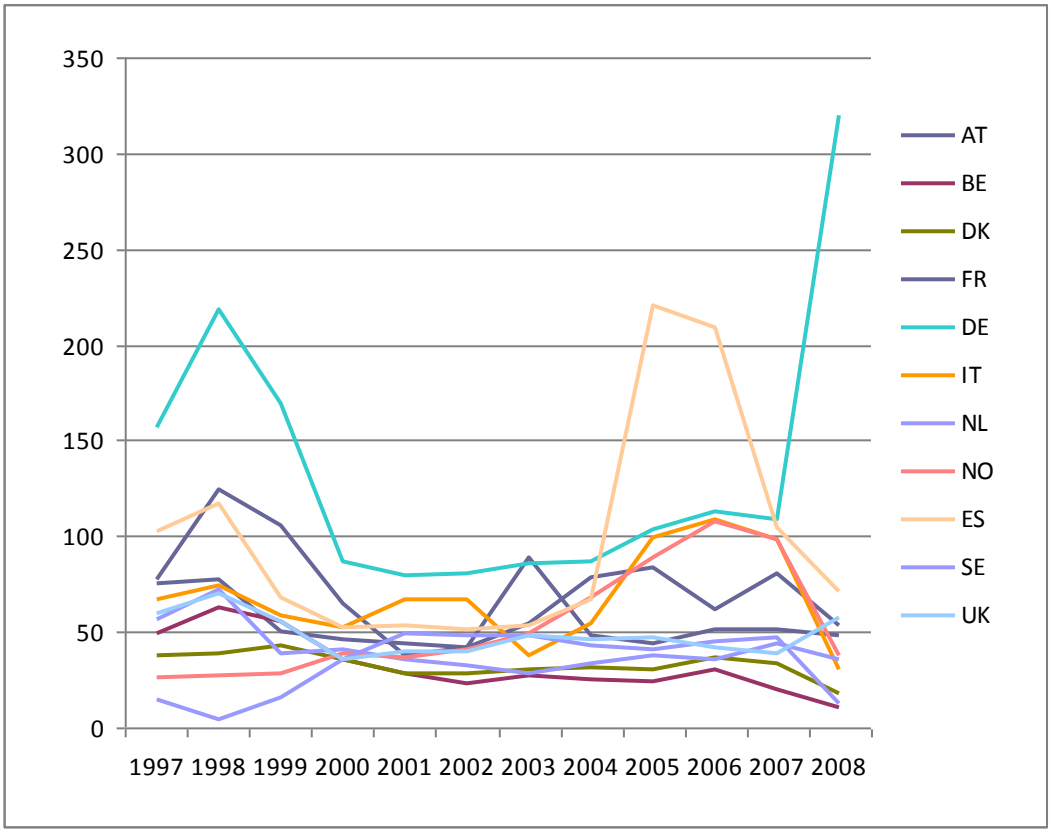
Overall, the different competition measures hardly yield consistent findings. Take Sweden for instance. It has a high Lerner index and low H-statistic – both inferring relatively low levels of competition (as does it relatively high NIM over the study period), yet the POP parameter is the lowest suggesting the most competitive banking system! Some systems appear to be relatively competitive if one uses the majority of the above metrics – for instance Germany has the lowest HHI index, the lowest Lerner index and smallest level of profits persistence.

Table 5 Selected competition and risk measures for 11 European banking systems over the year 1997 to 2008 (mean values)

Country	Lerner Index	HHI	H-statistic	POP (ROE)	LLP	sdroa	sdroe	Z index
AT	11.18	3769.10	0.49	0.48	0.58	0.36	4.11	55.84
BE	13.74	2640.04	0.56	0.54	0.50	0.56	5.97	29.20
DK	20.95	4013.34	0.20	0.49	0.51	0.68	5.20	31.09
FR	14.08	663.43	0.48	0.45	0.40	0.41	4.69	47.90
DE	7.92	799.85	0.58	0.18	0.56	0.24	3.45	89.70
IT	14.87	538.05	0.56	0.46	0.40	0.37	3.41	77.34
NL	12.94	4518.18	0.50	0.72	1.55	0.46	5.12	60.34
NO	22.28	2550.77	0.83	0.38	0.19	0.33	3.40	96.35
ES	17.99	1312.96	0.53	0.53	0.42	0.28	2.73	153.67
SE	21.16	2323.67	0.22	0.12	0.34	0.44	3.38	48.53
UK	16.42	2735.93	0.50	0.68	1.40	0.55	4.93	48.20
Mean	10.78	1084.75	0.49	0.46	0.62	0.42	4.22	67.10

Moving onto the risk indicators, according to the Z-index, Spain, Norway, Italy and Germany appear to be the most stable banking systems with Belgium and Denmark being the most fragile. Our loan loss provisions to total loans (LLP) suggest the UK and Netherlands were the most fragile. The volatility of returns indicators (ROA and ROE) suggest that Belgium, Denmark, the Netherlands and UK banks have been the most risky. There appears to be slightly more consistency in our risk indicators than the competition metrics – although its hardly surprising that volatility in ROA and the Z-index are related as the former comprises part of the Z-index calculation. Figure 4 reports the trends in the Z-index and illustrates the relative strength of the German banking sector over most of the study period.

Figure 4 Z-index for 11 European banking systems over the year 1997 to 2008



Finally, Table 6 provides simple correlation coefficients for the aforementioned competition and risk indicators. The results are not promising. We find no statistical relationship between the Lerner index, H-0statistic, POP parameter and Herfindahl index. The only statistical link we find is between profits persistence and loan-loss provisions - suggesting that less competition is linked to greater risk (competition – stability view). We also find that the volatility risk indicators are both related and these are also linked to the Z-index (as already discussed).

Table 6 Correlation Coefficients of Competition Indicators and Risk

	lerner index	hhi	hstatistic	profitpersistence	llp	sdroa	sdroe	zindex
lernerindex	1							
hhi	0.1781	1						
hstatistic	-0.205	-0.274	1					
profitpersistence	-0.083	0.4443	0.1425	1				

llp	-0.305	0.4996	-0.076	0.6750*	1			
sdroa	0.3383	0.5686	-0.56	0.4121	0.3153	1		
sdroe	-0.158	0.5266	-0.222	0.5483	0.4679	0.8028*	1	
zindex	0.0478	-0.426	0.47	-0.097	-0.23	-0.7678*	-0.7952*	1

*=statistically significantly at 5% interval

5. Conclusion

Following in the footsteps of Bikker and Bos (2004) and Carbo et al (2009) This paper uses a variety of structural and non-structural measures (including the Lerner index, Rosse-Panzar H-statistic and Profits-Persistence parameters) to gauge competitive conditions in 11 European banking systems over 1997 to 2008. As in Carbo et al (2009) we find that competition measures tend to provide inconsistent results and the measures are statistically unrelated. We also find that banking sector risk (Z-score, loan-loss provisions, variation in ROE and ROA) is also unrelated to the various competition measures (apart from the ROE persistence parameter and loan-loss provisions). This raises doubts about the validity of the findings of previous empirical studies that investigate competition-stability and competition-fragility issues.

Further work needs to be undertaken to cross-check the consistency of previous empirical work that investigates competition and stability issues. The Boone indicator, the persistence of profits approach, and the dynamic versions of the Rosse Panzar H statistic deserves greater empirical scrutiny. Given the doubts raised about the efficacy of competition measures caution should be taken in formulating regulatory policies and decisions based on the extant empirical literature.

References

Al-Muharrami, S., Matthews, K., & Khabari, Y. (2006). Market structure and competitive conditions in the Arab GCC banking system. *Journal of Banking and Finance, 30*, 3487-3501.

Angelini, P and Cetorelli, N. (2000). *Bank competition and regulatory reform: The case of the Italian banking industry,. Federal Reserve Bank of Chicago*, Working Paper Series, Research Development, WP. 99-32.

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

Baumol, W.J. (1982). Contestable markets: An uprising in the theory of industry structure. *Americam Economic Review, 72*, 1-15.

Baumol, W.J., Panzar, J.C. and Willig, R.D. (1982). *Contestable Markets and the Theory of Industry Structure*. (Harcourt Brace Jovanovich: San Diego)

Beck, T, Hesse, H, Kick, T and N von Westernhagen (2009). Bank ownership and stability: Evidence from Germany'. *Bundesbank Working Paper Series*, forthcoming

Beck, T., Coyle, D, Dewatripont,M, Freixas, X and P. Seabright (2010) *Bailing Out the Banks: Reconciling Stability and Competition*. (CEPR: London).

Berger, A.N (1995) The profit-structure relationship in banking – tests of market-power and efficient-structure hypotheses. *Journal of Money, Credit, and Banking, 27*, 404-415

Berger, A.N., Demerguc-Kunt, A., Levine, R., Haubrich, J.C., 2004. Bank concentration and competition. Journal of Money, Credit and Banking 36, 433-451

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

Bikker, J.A and J.W.B Bos (2004) Trends in competition and profitability in the banking industry: A basic framework', Paper presented for the *25th SUERF Colloquim*, Madrid, 14th-16th October

Bikker, J.A, and J.M. Groeneveld (2000) Competition and concentration in the EU banking industry, *Kredit and Kapital, 33*, 62-98.

Bikker, J.A. and K.Haaf,(2002) Competition, concentration and their relationship: An empirical analysis of the banking industry, *Journal of Banking and Finance*, 26, 2191-214

Bikker, J.A, Shaffe, S and L. Spierdijk (2009) Assessing competition with the Panzar-Rosse model: The role of scale, costs, and equilibrium, *DNB Working Papers* 225, Netherlands Central Bank, Research Department

Boone, J (2008) A new way to measure competition, *Economic Journal*, 118, 1245-1261

Boutillier, M, Gaudin J and S.Grandperrin (2004) La situation concurrentielle des principaux secteurs bancaires Europeens entre 1993 et 2000: Quels enseignements pour la future structure des marches financiers issue de l'uem, *Fondation Banque de France Working Papers*, 22 February.

Boyd, J., DeNicolo, G., (2005). The theory of bank risk taking revisited. *Journal of Finance* 60, 1329-1343.

Bresnahan, T.F. (1982). The oligopoly solution concept is identified, *Economic Letters, 10*, 87- 92

Bresnahan, T.F. (1989). Empirical studies in industries with market power, *Handbook of Industrial Organisation,* Vol. II Chapter 2 (edited by R. Schmelensee and R. Willig), 1010-1057.(New York: North Holland)

Buchs, T., and J. Mathisen (2005). Competition and efficiency in banking: behavioural evidence from Ghana. IMF *Working Paper WP/05/1.*

Canhoto, A. (2004). Portuguese banking: A structural model of competition in the deposits market. *Review of Financial Economics, 13*, 41-63.

Carbó, S, Humphrey, D, and F. Rodríguez (2003) Deregulation, bank competition and regional growth, *Regional Studies*, 37,:227-237

Carbó, S. Humphrey, D. Maudos, J. and P. Molyneux,(2009) Cross-country comparisons of competition and pricing power in European banking, *Journal of International Money and Finance,* 28 115–134

Carbó, S. and Fernandez, F (2007) The determinants of bank margins in European banking*, Journal of Banking and Finance*, 31, *2043-2063*

Carletti, E., (2008). Competition and regulation in banking. In: Boot, A.W.A., Thakor, A. (Eds.) Handbook of Financial intermediation and banking. Amsterdam: Elsevier.

Casu, B and C.Girardone (2006) Bank competition, concentration and efficiency in the single European market, *The Manchester School, 74*, 441-468

Claessens, S, and L. Laeven (2004) What drives bank competition? Some international evidence, *Journal of Money, Credit, and Banking,* 36, Part 2, 563-584

Coccerese, P (1998*)* Competition among dominant firms in concentrated markets: Evidence from the Italian banking industry. *Centro Studi in Economia e Finanza*, Working Paper 89.

Coccorese, P (2004) Banking competition and macroeconomic conditions: A disaggregate analysis, *Journal of Financial Markets, Institutions and Money, 14*, 203-219

Degryse, H. and Ongena, S. (2008) Competition and regulation in the banking sector: a review of the empirical evidence on the sources of bank rents, in Handbook of Corporate Finance, Financial Intermediation and Banking (Eds) A. Boot and A. Thakor, Elsevier, Amsterdam, pp. 483-554.

De Bandt, O. and P.Davis (2000) Competition, contestability and market structure in European banking sectors on the eve of EMU, *Journal of Banking and Finance,* 24, 1045-1066.

De Guevara, J and J. Maudos (2007) Explanatory factors of market power in the banking system, *The Manchester School*, 75, 275–296

Demsetz, H (1973) Industry structure, market rivalry and public policy, *Journal of Law and Economics*, 16, 1-9

Dick, A.A. and T.H.Hannan (2010) 'Competition and antitrust in banking', in Berger, A.N., Molyneux, P. and Wilson, J.O.S., eds. *Oxford Handbook of Banking.* (Oxford: Oxford University Press), 405-429.

European Central Bank (ECB). (2010). *EU Banking Structure*. September, (Frankfurt: ECB).

Evanoff, D.D and D.L. Fortier (1988) Re-evaluation of the structure-conduct-performance paradigm in banking, *Journal of Financial Services Research*, 1,.277-94

Fungacova, Z, Solanko, L and L.Weill (2010) market power in the Russian banking industry *Bank of Finland (BOFIT) Discussion Paper*, No. 3/2010. (Helsinki: Bank of Finland)

Gelos, R. G and J.Roldos (2004), Consolidation and market structure in emerging banking systems, *Emerging Markets Review, 5*, 39-59.

Geroski, P.A. and Jacquemin, A. (1988) The persistence of profits: a European comparison, *Economic Journal*, 98, 375–89.

Gilbert, R. A (1984) Bank market structure and competition – A survey, *Journal of Money, Credit and Banking*, 16, 617-645

Goddard, J.A, Molyneux, P and J.O. S. Wilson (2001) *European Banking: Efficiency, Technology and Growth,* Chichester: John Wiley and Sons

Goddard, J.A, Molyneux, P and J.O.S Wilson (2004a) The profitability of European banks: A cross-sectional and dynamic panel analysis. *Manchester School*, 72, 363-381.

Goddard, J.A, Molyneux, P, and J.O.S.Wilson (2004b) Dynamics of growth and profitability in banking, *Journal of Money, Credit and Banking* 36, 1069-1090

Goddard, J., Molyneux, P., Wilson, J.O.S. (2009a). The financial crisis in Europe: evolution, policy responses and lessons for the future, *Journal of Financial Regulation and Compliance*, 17, 362-380.

Goddard, J., Molyneux, P., and Wilson, J.O.S. (2009b). The crisis in UK banking: lessons for public policy, *Public Money and Management,* 29, 276-284.

Goddard, J., Molyneux, P., Wilson, J.O.S., Tavakoli, M. (2007). European banking: an overview, Journal of Banking and Finance 31, 1911–35.

Goddard, J. and Wilson, J.O.S. (1999) Persistence of profit: a new empirical interpretation, *International Journal of Industrial Organization*, 17, 663–87.

Goddard, J.A and J.O.S Wilson (2006) Measuring competition in banking: A disequilibrium approach, Working Paper*, University of Wales, Bangor*

Goddard, J.A, and J.O.S Wilson (2009) Competition in banking: a dis-equilibrium approach, *Journal of Banking and Finance*, 2009, 33, 2282-2292

Goddard, J.A, Liu H, Molyneux, P and J.O.S Wilson (2010a).The persistence of bank profit, *Istituto Luigi Einaudi per gli Studi Bancari Finanziari e Assicurativi (IstEin),* Working Paper 2010, Number 2 Research Project: Research Project: European Banking Competition. Available at: www.istein.eu/.

Goddard, J.A, Liu H, Molyneux, P and J.O.S Wilson (2010b) Do bank profits converge?, *European Financial Management*, forthcoming

Hainz, C, Weill, L and C.J.Godlewski (2008) Bank competition and collateral: Theory and evidence, *Bank of Finland Research Discussion Paper*, No. 27/2008, December, (Helsinki: Bank of Finland).

Hempell, H. S. (2002) Testing for competition among German banks. *Deutsche Bundesbank Discussion Paper, No. 04/02*, Economic Research Centre, (Frankfurt:Deutsche Bundesbank)

Hesse, H. and Cihak, M. (2009) Cooperative banks and financial stability, *IMF Working Paper*, WP/07/02 (Washington DC: IMF).

Hondroyiannis, G, Lolos, S and E.Papapetrou (1999) Assessing competitive conditions in the Greek banking system, *Journal of International Financial Markets, Institutions and Money, 9*, 377-391.

Iannotta, G, Nocera G, and A. Sironi (2007) Ownership structure, risk and performance in the European banking industry, *Journal of Banking & Finance*, 31, 2127-2149.

Iwata, G. (1974) Measurement of conjectural variations in oligopoly, *Econometrica, 42*, 947-966.

Koetter, M, Kolari, J, and L.Spierdijk (2008) Efficient competition? Testing the "quiet life" of US banks with adjusted Lerner indices, In proceedings *44th Bank Structure and Competition Conference*, Federal Reserve Bank of Chicago.

Koetter, M. and T. Poghosyan (2009) The identification of technology regimes in banking: Implications for the market power-fragility nexus, *Journal of Banking & Finance*, 33, 1413-1422

Koutsomanoli-Fillipaki, N and C. Staikouras (2004) Competition in the new European banking landscape, Paper presented at the *Money, Macro and Finance 36th Annual Conference*, Cass Business School, London, September 6th-8th

Laeven, L. (2006) Banking sector performance in East Asian countries: the effects of competition, diversification, and ownership. A background paper for 'East Asian Finance: The Road to Robust Markets', *World Bank mimeo*

Lau, L (1982) On identifying the degree of competitiveness from industry price and output data, *Economics Letters*, 10, 93-99

Lerner, A. P. (1934) The concept of monopoly and the measurement of monopoly power, *Review of Economic Studies*, 1, 157—175

Maslovych, M (2009) *The Boone Indicator as a Measure of Competition in the Banking Sector: The case of Ukraine*, MA Thesis. Kiev School of Economics
Matthews, K, Murinde, V and T Zhao (2007) Competitive conditions among the major British banks, *Journal of Banking and Finance, 31*, 2025-2042.

Maudos, J. and J. Fernández de Guevara (2004) Factors explaining the interest margin in the banking sectors of the European Union, *Journal of Banking and Finance*, 28, 2259-2281

Maudos, J and J. Fernández De Guevara (2007) The cost of market power in the European banking sectors: Social welfare cost vs. cost inefficiency, *Journal of Banking and Finance* 31, 2103–2125

McGahan, A.M. and Porter, M.E. (1999) The persistence of shocks to profitability, *Review of Economics and Statistics*, 81, 143–53.

Molyneux, P and J.Thornton (1992) Determinants of European bank profitability: A note, *Journal of Banking and Finance, 16*, 1173-1178

Molyneux, P, Lloyd-Williams, D. M, and J. Thornton (1994) Competitive conditions in European banking, *Journal of Banking and Finance, 18*, 445-459.

Molyneux, P, Thornton, J, and D.M. Lloyd-Williams (1996) Competition and market contestability in Japanese commercial banking system, *Journal of Economics and Business, 48*, 33-45

Mueller, D.C (1977) The persistence of profits above the norm, *Economica,* 44, 369-380.

Mueller, D.C. (1986) *Profits in the Long Run,* (Cambridge: Cambridge University Press)

Nathan, A and E.H.Neave (1989) Competition and contestability in Canada's financial system: empirical results, *Canadian Journal of Economics, 22*, 576-594.

Neven, D and L.H. Roller (1999) An aggregate structural model of competition in the European banking industry, *International Journal of Industrial Organisation, 17*, 1059-1074.

Northcott, C.A (2004), Competition in banking: A review of the literature, *Bank of Canada, Working Paper*, No 2004-24

Panzar, J.C and J.N. Rosse (1987) Testing for 'monopoly' equilibrium, *The Journal of Industrial Economics*, 35, 443-456

Petrovic, A. and Tutsch, R. (2009) National rescue measures in response to the current financial crisis, ECB Legal working paper no.8.

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

Schaeck, K and M. Cihák (2010) Competition, efficiency, and soundness in banking: An industrial organization perspective. *European Banking Center Discussion Paper* No. 2010-20S. July 6 (Tilburg University). Available at SSRN: http://ssrn.com/abstract=1635245

Schmalensee, R.C. (1982) Antitrust and the new industrial economics, *American Economic Review*, Papers and Proceedings, 72, 24–8.

Schiersch, A and J. Schmidt-Ehmcke (2010) Empiricism meets theory: Is the Boone-indicator applicable? DIW Berlin Discussion Paper No. 1030, July, Available at SSRN: http://ssrn.com/abstract=1641034

Shaffer, S (1989) Regulatory distortion of competition, Federal Reserve Bank of Philadelphia Working Papers 89-28

Shaffer, S. (1982) Non-structural test for competition in financial markets. Proceedings of Federal Reserve Bank of Chicago: *Bank Structure and Competition Conference* (pp. 225-233). Chicago.

Shaffer, S (1993) A test of competition in Canadian banking, *Journal of Money, Credit and Banking*, 25, 49-61

Shaffer, S and J. DiSalvo (1994) Conduct in a banking duopoly, *Journal of Banking and Finance*, 18, 1063–1082

Shaffer, S (2004) Patterns of competition in banking, *Journal of Economics and Business, 56*, 287-313

Smirlock, M. (1985) Evidence of the (non) relationship between concentration and profitability in banking, *Journal of Money Credit and Banking*, 17.69-83.

Suominen, M. (1994) Measuring competition in banking: A two-product model, *Scandinavian Journal of Economics, 96*, 95-110

Stiroh, K.J, (2000) Compositional dynamics and the performance of the U.S. banking industry, *Federal Reserve Bank of New York Staff Report*, No. 98.

Stiroh, K.J and P.E. Strahan (2003) Competitive dynamics of deregulation: Evidence from U.S. banking, *Journal of Money, Credit and Banking*, 35, 801-828

Toolsema, L (2002) Competition in the Dutch consumer credit market, *Journal of Banking and Finance, 26*, 2215-2229.

Turk-Ariss, R (2010) On the implications of market power in banking: Evidence from developing countries, *Journal of Banking and Finance*, 34, 765-775

Uchida, H and Y. Tsutsui (2005) Has competition in the Japanese banking sector improved? *Journal of Banking and Finance*, 29, 419-439

Van Leuvensteijn, M, Bikker, J.A, Van Rixtel, A.AR.J.M and C. Kok Sorensen (2007) A new approach to measuring competition in the loan markets of the Euro area, *European Central Bank Working Paper*, No. 768 June (Frankfurt: ECB)

Vives, X (2008) Innovation and competitive pressure, *Journal of Industrial Economics*, 56, 419-469

Vives, X (2010) Competition and stability in banking,. IESE Business School Working Paper No. 852. April, (Barcelona: IESE)

Weill, L (2004) On the relationship between competition and efficiency in the EU banking sectors, *Kredit und. Kapital*, 37, 329–352.

Yeyati, E. L and A.Micco (2007) Concentration and foreign penetration in Latin American banking sectors: Impact on competition and risk. *Journal of Banking and Finance,* 31, 1633-1647.