UNIVERSITA' DEGLI STUDI DI PADOVA

DIPARTIMENTO DI SCIENZE ECONOMICHE ED AZIENDALI "M.FANNO"

CORSO DI LAUREA MAGISTRALE / SPECIALISTICA IN BUSINESS ADMINISTRATION

TESI DI LAUREA

"COMPETITION AND STABILITY IN THE BANKING SECTOR: THEORY AND EMPIRICAL EVIDENCE"

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ANNO ACCADEMICO 2015 – 2016

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ABSTRACT

Since the outbreak of the financial crises in the 1980s, the relationship between competition and stability in the banking sector has been of primary interest for both academics and policymakers. Building on the seminal paper by Beck, De Jonghe and Schepens (2013), we study how competition and stability are related using a sample of around 20,000 banks from 113 countries during the period from 1996 to 2014. We reach two major findings. Firstly, country-specific features play a crucial role in explaining the large cross-country variations in the competition-stability relationship. Secondly, the way in which competition and stability interact is non-linear and this non-linearity is highly influenced by country-specific factors.

Keywords: Bank competition; Financial stability; Cross-country heterogeneity; Interaction effects; Non-linearity.

ACKNOWLEDGEMENTS

First of all, I would like to thank my family, to whom this work is dedicated, for the support and the encouragement during these years.

I would like to thank my supervisor, Giovanni Caggiano, for helping me with the writing of this thesis.

I would like to thank Nicole, for having shared with me the course of the academic studies.

I would like to thank all my friends, with whom I spent fantastic moments.

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INTRODUCTION

The relationship between competition and stability in the banking sector remains a widely debated issue and unambiguous conclusions have not been reached yet. Traditionally-accepted belief is that competition plays a fundamental role in granting efficient marketplaces, where goods and services are sold at the cheapest possible price, the innovation processes guarantee technologically-advanced products and the social welfare is maximised. In the 1960s, this way of thinking led firstly the US but later on several other governments, to initiate a process of liberalization and deregulation of the banking sector: financial depth, growth and efficiency were the main objectives. However, the banking sector has specific features that make it unique and not comparable to the other "productive" sectors: it must be efficient but also stable. The liberalization process of the second-half part of the 20th century was followed by a sharp increase in the number of individual defaults and systemic crises as well. The ever-increasing rivalry among existing credit institutions and new entrants seems to be the principal culprit but actually there is no consensus on whether more competition has a positive or negative impact on the stability of a banking system. The recent financial crisis has reignited new interest in the fields, both among academics and policymakers alike.

The academic literature relative to the topic is vast but two are the main branches to which all the theories refer. On the one hand, there is the traditional "competition-fragility" view, which posits that more competitive and less concentrated banking systems are more prone to incur in financial troubles. Advocates of the competition-fragility hypothesis argue that more competition shrinks bank's margins and charter values, thus providing incentives to take on more risks (Keeley, 1990; Suarez, 1994; Edwards and Mishkin, 1995), and reduces the informational rents banks can extract from long-lasting relationships with their clients (Besanko and Thakor, 1993; Boot and Greenbaum, 1993). Moreover, large banks are usually better diversified and more concentrated banking systems may be easier to monitor because of the limited number of banks (Allen and Gale, 2004). On the other hand, the alternative "competition-stability" view states that more competition and less concentration improve the soundness of the banks. The argumentation is based on the risk-shifting paradigm and the "too-big-to-fail" issue. The former has been developed by Boyd and De Nicolò (2005) who argue that lower lending rates reduce the probability that borrowers bankrupt or take on risky projects (moral hazard problem). The latter arises as consequence of rescue policies, which prevent systematically important banks failing but generate implicit incentives to gamble

(Mishkin, 1999). Both branches of literature have been supported by several empirical studies. Those focusing on single countries provide evidence that strongly differs with respect to the methodology and the sample analysed (Keeley, 1990; Demsetz, Saidenberg, and Strahan, 1996; De Nicolò, 2000) whereas most of cross-country studies highlight a positive relationship between competition and stability but also between concentration and stability (Beck, Demirgüç-Kunt, and Levine, 2003; Beck et al., 2003; Schaeck, Cihák, and Wolfe, 2009). This uncertainty triggers an inconclusive debate on the effects of different regulatory policies, too. Capital requirements and activity restrictions may reduce the riskiness of the banks' balance sheets (Hellmann, Murdock and Stiglitz, 2000) but also imply more herding and less diversification. Similarly, deposit insurances may prevent bank runs but also magnify moral hazard and adverse selection problems (Matutes and Vives, 2000; Cordella and Yeyati, 2002). One potential explanation to this contrasting evidence may be that the relation between competition and stability is non-monotonic (Martinez-Miera and Repullo, 2010; De Nicolò and Lucchetta, 2011) or strongly determined by country-specific features (Beck, De Jonghe and Schepens, 2013).

Our research work empirically investigates the link between competition and stability using bank level data from 20,031 credit institutions and 113 countries over a time lapse of 19 years (from 1996 to 2014). This empirical analysis is built on the paper by Beck, De Jonghe and Schepens (2013), which has been implemented through the exploitation of new time series data[1] and by studying the role of a potential non-linearity in the competition-stability relationship. In our econometric model, we focus on two main indicators: the Lerner index, which proxies for market power and competition, and the Z-score, which proxies for bank stability. In addition to the dependent and the explanatory variables, we include several bank-specific variables to control for the impact of alternative business models. Furthermore, we add some interaction terms between the Lerner index and country-specific variables to study how different institutions affect the average competition-stability relation. The results we reached provide a threefold contribution to the empirical literature. First, we find that on average the link between market power and bank soundness is positive, that is less competition improves the stability of the banking sector. Second, this average relationship hides substantial cross-country (and also cross-time) heterogeneity: when running by-country (and by-year) regressions, the competition-stability correlation coefficients range from negative, over non-significant to strongly positive. In particular, we find that in countries

[1] Data in Beck, De Jonghe and Schepens ended in 2009, thus they do not give much information with respect to the evolution of the financial crisis of the dawn of the 21st century. By contrast, our update allows further insight to understand how the banking system has reacted.

where the deposit insurance system offers low protections, there are multiple supervisors and the limitations on bank activities are not many, it is more likely to find a relation between market power and bank soundness that is negative or not statistically different from zero. Third, there is strong evidence that the relation between market power and bank soundness is not linear: at low level of market power, an increase in market power is beneficial for the stability of the banking sector but once a given threshold is crossed, a further increase turns out to have a negative impact. This parabolic relation is shaped differently according to the characteristics of each country. For the banks operating in most of the countries in our sample, the inflection point is located at a level of market power that is above the 99th percentile of the Lerner index distribution. Therefore, any increase in market power has a positive impact on the bank soundness. However, we find that in countries with low deposit insurance coverage, multiple supervisory authorities and few activity limitations, the inflection point occurs much before, roughly around the 47th percentile of the Lerner index distribution. For countries with such features, an increase in market power is beneficial only when the competitiveness is strong. To the best of our knowledge, this is the first time that the non-linearity is studied considering the impact of different country-specific features. We test the sensitivity of our findings using alternative definitions of competition and stability, as well as alternative formulations of the econometric model. The original results are confirmed under most of the alternative setups. Nevertheless, it is likewise important to recognise the principal limitations of our analysis: firstly, we strongly rely on a measure of competition, i.e. the Lerner index, which has been derived without considering where each bank actually competes; secondly, the relation between Lerner index and Z-score may be partially driven by the fact that both indicators have been calculated including the level of profitability; thirdly, our panel data is unbalanced and we lack data relative to certain indicators; finally, we do not enter the political debate suggesting in which direction future regulatory and supervisory policies should go.

The thesis is structured as follows: chapter 1 provides a general overview of the banking sector over the last century; chapter 2 presents the most relevant contribution of the academic and empiric literature; chapter 3 shows our empirical analysis.

CHAPTER 1
OVERVIEW OF THE BANKING SECTOR

1.1 HISTORICAL BACKGROUND

The recent history of the banking sector can be split into two periods: the first one, from the end of World War II up to the 1970s, strictly regulated and stable, and the second one, lasting four decades since then, much more liberalized and characterized by widespread banking turbulences.

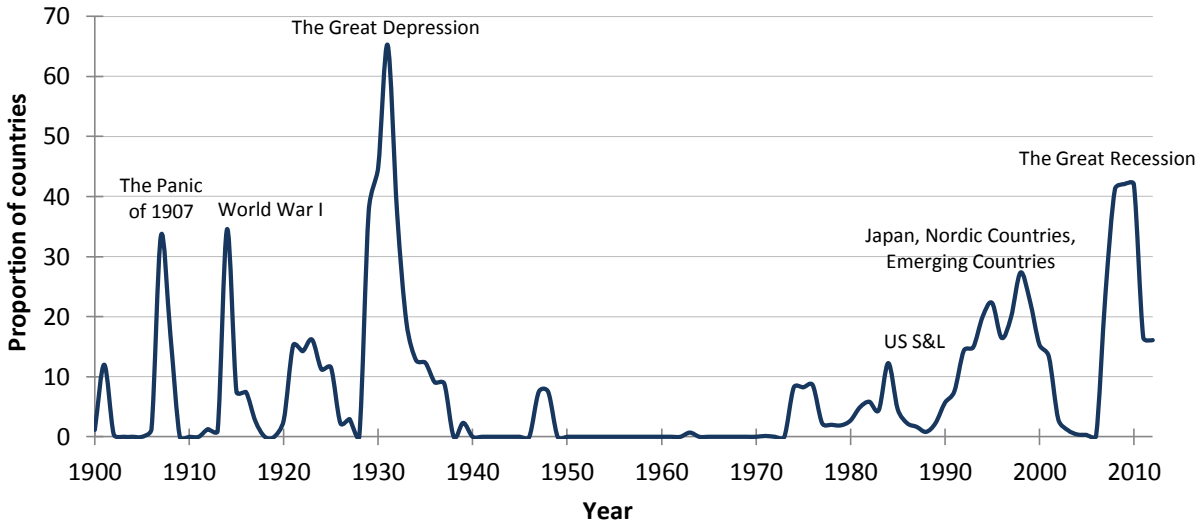


Figure 1: Proportion of countries with systemic banking crises (weighted by their share of world income). Data source: Reinhart and Rogoff database; Vives (2010).

In the former of these periods, the predominant view was that competition put pressure on the banking system, narrowing the margins and thus giving incentive to take excessive risk in order to recover the gap. The perception of competition as a destabilising factor led the public authorities to adopt restrictive policies, among which rate ceiling, activity limitations, branching restrictions and separation of commercial banks from investment banks[2]. The willingness to maintain the banking system as much stable as possible paved the way for the introduction of the first deposit insurance mechanisms and lender of last resort facilities (Vives, 2010). This stable period ended sharply at the dawn of the 1970s, when many developed and developing countries started being hit by financial troubles. The instability persisted until the beginning of the 1990s and resulted in huge costs sustained by the

[2] The Glass-Steagall Act enacted in 1933 in the United Stated prevented an institution from performing commercial, investment and insurance activities under one single entity. The objective was to limit the effects of negative financial shocks on the real economy.

governments to bailout the insolvent credit institutions. In the US the troubles of the Savings & Loans costed around 3.2% of GDP, in the Nordic Countries the recovery costs were around 6% of GDP whereas in Japan they were about 100 billion dollars (Carletti, 2000). In those years the banking system had been strongly liberalized in order to stimulate its development and growth. The changes in the regulatory framework included less restrictive rules relative to the setting of the interest rates, the activity restrictions and the geographical segregation[3] (Vives, 2001). The liberalization process triggered an increase in the level of competition not only from within the banking sector but also from outside, with the rapid development of non-bank financial intermediaries, processes of disintermediation[4] and new financial products (Vives, 2010), as shown in Figure 2.

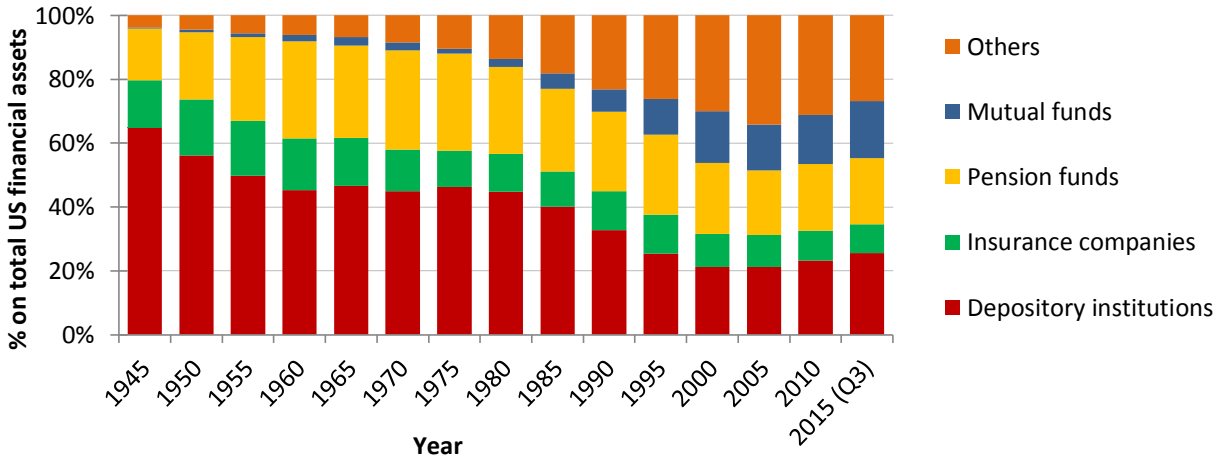


Figure 2: Distribution of US domestic financial assets by type of financial intermediary[5]*. Source: Financial Accounts of the United States, Board of Governors of the Federal Reserve System.*

The *ratio* was that, as in other non-financial markets, competition would have guaranteed a more efficient banking system, fostered innovation and lowered the cost of products and services. However, several international studies identified the liberalization process itself as a determinant to explain the banking sector problems, together with a weak macroeconomic environment, ineffective legal systems, forbearance policies and other structural factors (Demirgüç-Kunt and Detragiache, 1998). The process of liberalization and increasing

[3] The Riegle-Neal Act of 1994 allowed banks to acquire or to open new branches anywhere in the United States.
[4] Disintermediation: process of reduction of the financial flows managed directly by the banking system. In the 1980s it has been triggered by the development of new saving products alternative to the traditional bank deposits. Source: www.bankpedia.org.
[5] Detail of what each financial intermediary category includes:

- Depository institutions: commercial banks, savings institutions and credit unions
- Insurance companies: property-casualty insurance companies and life insurance companies
- Pension funds: private pension funds, public pension funds and retirement funds
- Mutual funds: mutual funds and money market mutual funds
- Others: closed-end and exchange-traded funds, government-sponsored enterprises, issuers of asset-backed securities, finance companies, real estate investment trusts, security brokers and dealers, holding companies and funding corporations

competition came up beside other relevant changes to which we commonly refer with the word "globalization", i.e. technological progress, advances in computational capacity, in managerial attitudes and risk coverage techniques (Vives, 2001). This overhaul process generated a shift from the traditional business of taking deposits and making loans to the offer of services historically provided by investment banks, such as asset management, M&A and proprietary trading. One can easily understand that size became important. The transformation took place in the form of consolidation, both in Europe and in the United States, mainly driven by domestic merger (BNP-Paribas in France, IMI-San Paolo in Italy, Citicorp and Travelers Group – to form Citygroup – in the US).

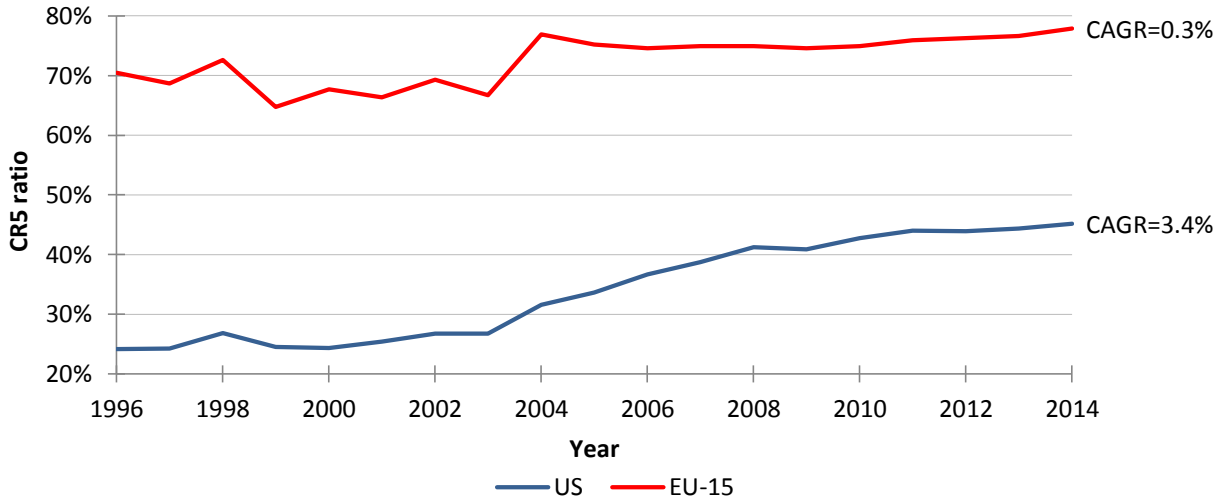


Figure 3: Share of total assets held by the five largest banks[6]. The level of concentration in Europe has been calculated as average of the concentration ratios of all the 15 member states. Source: Bankscope, own calculations.

Even if both United States and Europe are moving towards more consolidated banking system, the phenomenon is much larger in the former than in the latter. If we take a deeper look at what happens within the European Union, we clearly notice that the countries are not implementing the same policy. Most countries (10 out of 15) experienced an increase in the consolidation of the banking sector from 1996 to 2014 but there is a minor group of countries that are going in the opposite direction.

[6] Data relative to commercial, savings and cooperative banks only.

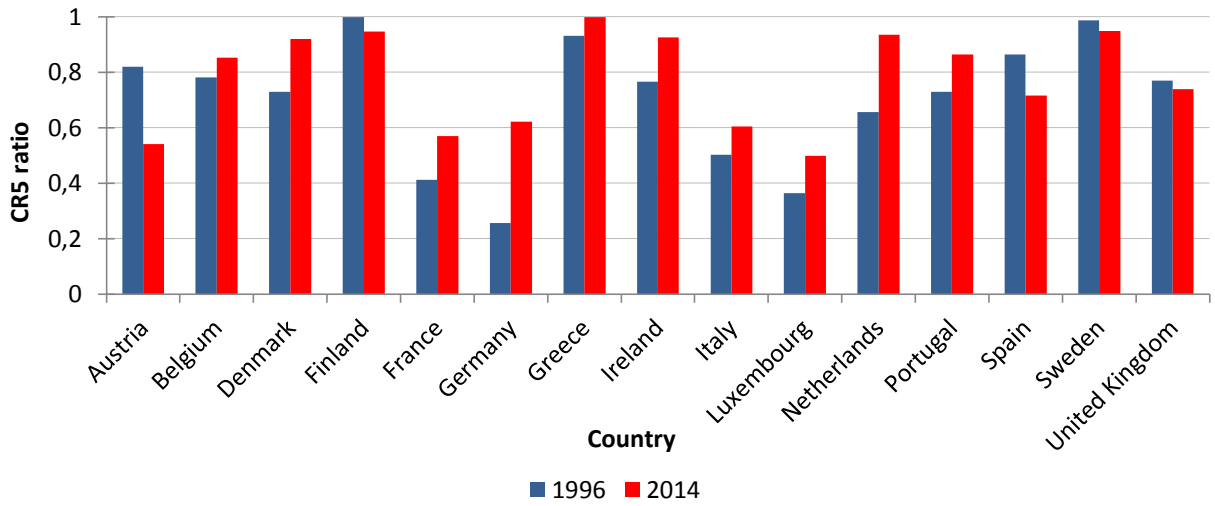


Figure 4: Comparison between the total assets concentration ratio of the five largest banks in EU-15 in 1996 and 2014[7]*. Source: Bankscope, own calculations.*

Since competition has been introduced into the banking sector in the 1970s, capital requirements together with proper supervision and disclosure requirements have always been seen as the channel through which it is possible to make the banking system sound (Basel I, II and III frameworks in Europe). While the beginning of the 21st century was a period of relative financial stability, the burst of the subprime crisis in the US generated new concerns for policymakers, even for those not in the middle of the storm. The relationship between competition, market structure and stability was to be again of primary importance.

1.2 COMPETITION, EFFICIENCY AND STABILITY IN THE BANKING INDUSTRY

Competition has been defined as "the process of rivalry between firms seeking to win customers' business over time" (Whish and Bailey, 2012). Traditional benefits of competition are lower prices, higher quality products and, in a nutshell, more efficiency. According to the classic economic literature, the social welfare[8] is maximised in a perfectly competitive environment, where many players, each one with a small market share, compete each other selling homogeneous products and services. Under perfectly competitive markets it is not possible to improve the wealth of someone without reducing the wealth of someone else, in other words a state of Pareto-efficiency is achieved. The efficiency of a market consists in three aspects (Motta, 2004; Whish and Bailey, 2012):

[7] As before, data are relative to commercial, savings and cooperative banks only.
[8] Defined as consumers' welfare together with producers' welfare.

1. Allocative efficiency: all the economic resources are allocated in the best way among the consumers;
2. Productive efficiency: all goods are produced and services delivered at the minimum possible cost;
3. Dynamic efficiency: producers are more prone to innovate and stimulate the research and development of new products and services.

By contrast, in imperfectly competitive environments the social welfare cannot be maximized and a Pareto-efficient condition cannot be achieved. Usually in these markets the regulators enact provisions called competition or antitrust policies with the aim to maintain adequate levels of competition, thus ensuring sufficient social welfare and efficiency.

From this point of view, the banking sector does not differ from the other industries. Perfectly competitive banking markets would imply huge amounts of financing granted at low rates and efficiently allocated, continuous development of innovative business practices, ever-increasing quality in the services offered and so on (Claessens and Laeven, 2004). However, the banking industry has some specific features that make it different from all the other economic sectors. The essence of the banks is their double role of intermediaries between savers and borrowers and of liquidity providers. Banks collect a huge amount of wealth from a vast number of small individuals by offering saving products with a short maturity (such as current accounts and term deposits) and redistribute this wealth to other individuals through loan agreements and other forms of financing with a longer maturity. By pooling together assets and liabilities with different maturities, banks are said to be engaged in asset transformation (Heffernan, 2005). This specialness of the financial sector is the core of the fragility problem. On the liability side, the maturity misalignment between assets and liabilities exposes banks to liquidity risk. When there is a bank run, a lot of depositors try to withdraw cash from their accounts, forcing the bank to find liquidity in the interbank market or by selling its assets. However, the interbank market may lack of depth or the bank may be able to liquefy the assets only with a huge discount in the price, making the effect of a liquidity shortage even more dramatic. On the asset side, the major issue arises from the information asymmetries that make hard assessing the viability of the projects that are going to be financed. Hence, the value of the assets held by a bank may drop as borrowers become unable to service their debt positions. Even if the amount of non-performing loans remains stable, the wealth of the bank may deteriorate if the return of the investments made falls below the cost sustained to raise funds, for example as consequence of changes in the interest rate or exchange rates. The opaqueness of the assets and the fact that liabilities are not affected at all by the asset risk (due to deposit insurances or other forms of guarantee) may

lead the bank to find incentives in taking great risks (Carletti, 2010) in order to counterbalance the higher rate on funding. Moreover, the banking sector is much more interlinked and exposed to the macroeconomic environment than others. As a result, there is the danger that troubles of one institution negatively affect the performances of all the others or that an adverse shock of the economy (i.e. low GDP growth, high interest rates, high inflation, unexpected devaluations) worsens the viability of a lot of projects at the same time (Carletti and Hartmann, 2002). The contagion may trigger a domino effect that ultimately may results in a systemic crisis, with tremendous consequences for both the financial sector and the real economy.

The willingness to ensure the stability of the banking sector, prevent the occurrence of systemic crisis and minimize the social cost of failure is the root cause of many financial regulations and safety net arrangements such as deposit insurances, lender of last resort facilities, "too-big-to-fail" policies and "too-many-to-fail" policies. Because of their central role in the competition-stability relationship, each one will be briefly described:

- Deposit insurances: agreements that guarantee the depositors up to a certain maximum if the bank fails. They may be explicit, if the bank buys an insurance on behalf of its account holders[9], or implicit, if the depositors think that the public authorities will never let the bank fail.
- Lender of last resort: instrument through which the central bank provides emergency liquidity to illiquid but solvent institutions in order to avoid that the difficulties of one single bank propagate to the other institutions.
- Too-big-to-fail policies: provisions that apply to bail out large banks whose default would have a systemic impact. They include an array of instruments that range from lending money (like the lender of last resort) to the protection of uninsured depositors.
- Too-many-to-fail policies: provisions relative to the simultaneous rescue of a multitude of credit institutions which apply when their recapitalization has a lower cost than their bankruptcy (Carletti, 2000).

It is important to notice that any form of public protection or bailout is not without side effects, even if properly designed. Any insurance scheme generates an implicit moral hazard problem. The anticipation of a future aid exacerbates the excessive risk-taking problem, in particular for those banks that are considered systematically important, thus generating strong disparities between large and small institutions in favour of the first category. The effects of

[9] In this case, banks normally pay a risk premium to a deposit insurance fund, which is usually administered by bank supervisors (Heffernan, 2005)

moral hazard can be restrained through an adequate capital regulation and an effective supervision by the government or the central bank. The current regulation is going in this direction.

In conclusion, it is clear that the stability of the banking sector is as important as its efficiency. Efficiency can be achieved only if a certain level of competition is maintained; however, the level of competition might be one of the several factors that affect the bank stability. The idea that competition is unambiguously beneficial in the banking system is weaker than in other sectors. At this point, it is worth determining whether there exists any link between stability and competition and, in the event, what its sign is. If it is true that competition has a deleterious impact on banking, as many policymakers have always thought, competition should be limited, otherwise it should be promoted. In the next chapter, the main academic and empirical studies will be presented.

CHAPTER 2
SURVEY OF THE LITERATURE

This section of the thesis provides a review of the academic literature's findings with regard to the influence that competition and concentration have on the stability of the banking sector. These studies are not an end in themselves but have a great influence on the choices that policymakers and international institution make. It is worth noticing from the beginning that the academic literature has formulated divergent predictions regarding the link between competition and stability and up to now no clear conclusions have been reached on whether this link is either positive or negative.

2.1 COMPETITION AND STABILITY IN THE ACADEMIC LITERATURE

The academic literature can be divided into two strands. Earlier studies promote the "competition-fragility" view, according to which intense competition threatens the stability of the entire banking sector by inducing banks to take on excessive risks. By contrast, more recent studies support the "competition-stability" view, which argues that competition is not only necessary to promote and sustain an efficient market but also reduces the risk of banking distresses and maintains the system sound. All these theoretical predictions differ in the nature of the model used and in the more or less strict interactions that competition is assumed to have with market structures (such as the level of concentration[10]), regulatory frameworks (such as the presence of a deposit insurance) and macroeconomic variables.

Despite some earlier publications[11], academic interest in the field has been triggered by Michael Keeley (1990) with his article published in the American Economic Review, where he tested and confirmed the hypothesis that the deregulation measures enacted in the US in the second-half part of the 1900s caused bank failures and deposit insurance payouts to reach record highs.

[10] According to the SCP paradigm, many studies assume a strict relationship between competition and concentration. Less competition is usually considered the same thing as more concentration.
[11] See Marcus (1984), Dermine (1986) and Chan, Greenbaum and Thakor (1986).

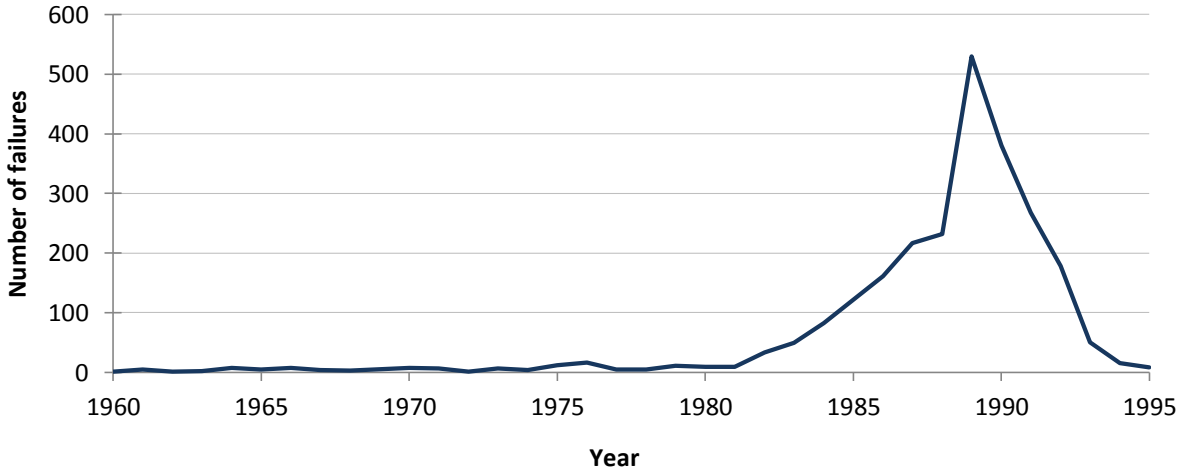


Figure 5: Number of bank failures in the United States during the period 1960-1995. Source: Federal Deposit Insurance Corporation.

Until the mid-1960s, banks were partially protected from competition thanks to a variety of regulatory barriers (limitation on branching, on geographic expansion, on deposit rate, etc.). The great liberalization of these anticompetitive laws seems to have caused banks' market power to decline and restrained the incentives to act prudently. The empirical results provided by Keeley's model confirmed this hypothesis and proved that banks with more market power hold more capital and have lower default risk. This conclusion was reached in two steps. Firstly, market power was estimated by employing James Tobin's *q*, where $q=\frac{\text{Firm total market value}}{\text{Firm total asset value}}$. Secondly, variations in *q* were related to two measures of risk: the capital-to-asset ratio at market values and the risk premium paid on large, uninsured certificates of deposit (CDs). Since it resulted that a decline in market power lowers the capital-to-asset ratio and boosts the risk premium to be paid, Keeley concluded that the increase in competition proved to be detrimental to the stability of the US banking industry, bringing about a tragic surge of failure in the 1980s.

From now on, many researchers have been supporting or rejecting Keeley's findings. Over time, the literature on the field has become vast and this review is far from being exhaustive but wants to point out the basic features of the different strands. In the following sections, a selection of the existing theoretical literature will be presented, classifying the contributions under two sub-sections, depending on whether they sustain the competition-fragility or the competition-stability view.

2.1.1 COMPETITION-FRAGILITY HYPOTHESIS

Traditionally-accepted belief in the banking literature is that competition hampers the stability of the banking sector, incrementing the probability of bankruptcy. Therefore, competition

must be restrained. The hypothesis of the existence of such a trade-off has caught on in the academic environment as well as in the government circles since the beginning of the 1990s. From then on, several studies have provided support to the "competition-fragility" theory and many regulatory and supervisory measures have gone straight in the direction of limiting competition. In the previous chapter we pointed out that bank instability can arise both on the asset side, as consequence of excessive risk taking behaviours, and on the liability side, as consequence of bank runs. In the next pages, the main contributions will be summarized, starting from those that focus on the effects of competition on the asset side and then moving to those that look at the effects on the liability side.

2.1.1.1 COMPETITION AND FRAGILITY FROM THE ASSET SIDE

EFFECTS ON CHARTER VALUE

This section of the academic literature takes inspiration directly from the article written by Keeley (1990). The presence of a trade-off between level of competition and bank risk-taking, that is to say between competition and financial stability, has been modelled on the convincing reasoning called "charter value hypothesis". Its strong appeal makes the charter value theory the cornerstone of the competition-fragility literature. In a nutshell, it states that competition undermines the stability of the banking system by reducing the banks' charter value. From a mere accounting point of view, the charter value (sometimes defined also franchise value) is an intangible asset. It is the present value of the expected future streams of profits from holding a banking license. Put differently, it represents the opportunity cost of going bankrupt (Northcott, 2004). This means that the franchise value can be captured only if the bank stays in the business. Profits generated thanks to a strong market power provide a buffer against negative externalities, making the bank less vulnerable and more attractive for investors. This makes the share price to increase well above its book value, which in turn reinforce the charter value. Together with profits, which are the principal driver of the charter value, efficiency, reputation and good customer relationships matter too. What the literature and actually many bank supervisors sustain is that the charter value prevents banks from excessive risk taking. Given that the charter value can be captured only if the bank remains in the business, bank's owners attempt to avoid bankruptcy. As a consequence, they will be very reluctant to make risky investments, become more conservative and the entire banking system stabilizes. By contrast, an increase in competition causes profits to drop, reduces the charter value, eases the reward for prudent behaviours and eventually threatens the stability of the financial sector. Concretely, when the cost of debt goes up because of an increase of the competitive conducts, bank's owners react choosing riskier asset portfolios. In a world of limited liabilities and unobservable risk choices, if the investment results profitable, the

shareholders will fully enjoy the up-side part of risk taking; if instead the outcome is unfavourable, their losses will be limited since the risk has been partially shifted to the depositors. "With sufficient competition banks will find desirable to gamble", (Hellmann, Murdock, and Stiglitz, 2000). To sum up, as higher funding costs due to fiercer competition erode profits and lower profits imply a lower charter value, banks have ever-increasing incentives to prefer riskier strategies, which exacerbate the probability of non-performing loans, with negative repercussions for the entire banking sector. On the other hand, under less competitive system, banks have greater profit opportunities, capital cushions and therefore fewer incentives to take excessive risk, thus improving the stability of the financial sector (Beck, 2008).

Four years after the Keeley's research, Suarez (1994) proposes a dynamic model through which he explains that the charter value is a relevant constituent of the bankruptcy cost and, therefore, represents an incentive to remain in the business and carry out prudent behaviours. Low market power and inconsistent prudential regulations undermine the charter value and the stability of the banking sector as a consequence.

Edward and Mishkin (1995) reach a conclusion similar to that of Keeley. Relative to the US financial crisis, they argue that fiercer competition eroded the banks' cost advantage in acquiring funds and weakened their position in the loan market. As long as the traditional business became no longer profitable, banks began to invest into new, riskier activities, thus destabilizing the banking sector.

Bolt and Tieman (2004) investigate the effect of competition on the quality of the loans. They explain that in more competitive environments banks loosen their acceptance criteria. In the short run, this policy allows banks to attract more demand and make larger profits but the quality of the loans granted progressively deteriorates, leading to higher probability of failure in the long run. Thus, competition makes boosting short-term market share more attractive than continuing the operations in the long run. It is clear that the stability of the banking system is affected.

EFFECTS ON INFORMATIONAL RENTS AND FINANCIAL INNOVATION

Besanko and Thakor (1993) focus on the concept of relationship banking[12] as source of value for banks' charter. In the course of the relation with their clients, banks obtain borrower-specific information. This process is costly but generates informational rents. Given that these benefits are shared between banks and borrowers, they are both willing to make this relation

[12] Relationship banking means that lender and borrower are involved in repeated bilateral credit transactions.

lasting. Hence, banks see a value in monitoring accurately their borrowers so to limit risky exposures in their portfolios. However, when the industry becomes more competitive, relationship banking falls in value. Banks are not able to capture informational rents anymore, reducing their incentives to make efforts in scouting and screening their counterparties. In addition, the need to achieve higher profits makes the pursuit of risky investments more attractive. All this makes financial troubles more likely.

Boot and Greenbaum (1993) reach similar conclusions in a dynamic model through which they show that monopoly rents promote an optimal level of monitoring.

More recently, Marquez (2002) shows that in more competitive banking systems, the information relative to individual borrowers become more scattered, as each bank is able to gather information about a smaller pool of borrowers. In turn, this hinders the banking screening criteria, thus granting loans to low credit quality applicants.

In addition, competition can alter the mechanism by means of which new financial products impact the stability of the financial system. Analysing the credit derivatives innovation, Instefjord (2005) finds that derivatives have two contrasting effects: on the one hand, they enhance the financial stability by improving the sharing of risks (as any hedging instrument should do); on the other hand, they make further acquisitions of risk more attractive. This latter effect prevails if the degree of competition in the credit market is high, with a consequent dangerous distortion of the lending incentives.

EFFECTS ON PORTFOLIO DIVERSIFICATION AND SUPERVISION

Advocates of the competition-fragility hypothesis propose also a rather different argument. In more concentrated industries, banks are less in number, larger in size and better diversified. The greater size allows banks achieving economies of scale in intermediation[13], whereas a greater diversification of activities restrains profit volatility, stabilizes the performances and makes banks less likely to fail. Another argument in support of the competition-fragility hypothesis refers to the fact that the limited number of institutions in concentrated banking system simplifies the supervisory activities. As regulation and supervision are more effective in concentrated banking systems, crises are less pronounced in those countries. According to Allen and Gale (2004) this argument is supported by some historical facts: characterized by a large number of banks, the US has shown a much greater financial instability if compared with the UK or Canada, characterized instead by less diffuse banking systems. Although these

[13] See Diamond (1984) and Ramakrishnan and Thakor (1984) for a more detailed disclosure.

considerations do not rely directly on competition but rather on concentration, they are still important features of the market structure.

IMPACT OF REGULATION

Another group of authors focus on the regulatory policies that may correct the perverse effects of competition on the investment strategies, reinforcing the bank's franchise value or limiting the incentives to take excessive risks. Traditionally, deposit insurance systems have been the most commonly used mechanism to preserve the stability of the banking sector, although they are not without side effects. As a matter of fact, deposit insurances can rule out bank runs without affecting the banks' power to transform assets (Diamond and Dybvig, 1983) but introduce moral hazard and risk-shifting problems. Banks may "feel free" to take excessive risk since depositors and market participants do not care about the failure of the bank anymore.

Matutes and Vives (2000) study the link between competition for deposits, banks' risk taking and different deposit insurance schemes using a model characterized by three relevant features: competition is imperfect, banks are subject to limited liability and there exist large perceived social costs in the event of failure. They conclude that competition jeopardizes bank stability but the magnitude depends on the deposit insurance scheme that is in force. Three cases are analysed:

1. Uninsured market: without deposit insurance, when competition is deep, deposit rates (and therefore bank asset risk) are excessive and failure costs are high. When risk is unobservable (that is, there is a moral hazard problem), deposit regulation is not enough to maximize welfare but must be combined with investment restrictions.
2. Flat-rate deposit insurance: in this case, competition leads to excessive deposit rate and asset risk even if there are no social costs of failure. Vives (2010) says that this kind of deposit insurance kills the disciplining effect of the market. Both deposit regulation and investment restrictions are needed.
3. Risk-adjusted deposit insurance premiums: deposit rate and asset risk are lower than in the other cases, for each level of competition. Welfare may be further improved by introducing deposit regulations that lower deposit rate and asset risk.

Cordella and Yeyati (2002) address the same topic through a model interpreted by many as an extension of the previous one. They develop two alternative scenarios: the benchmark, characterized by a fixed-rate deposit insurance, and the alternative one, characterized by risk-adjusted deposit insurance premiums. In the former case, more competition increases the

interest rate paid on deposits and the riskiness of the assets, thus shrinking the margins of the bank. On the contrary, in the latter case, since financial information is publicly disclosed, banks can credibly commit to improve the quality of their portfolios, thus reducing the cost of funding (depositors are willing to accept a lower interest rate if the bank is more solid) despite the level of competition.

In addition to an insurance on deposits, there are other regulatory approaches to improve the stability of the banking sector. Among these, Hellmann, Murdock and Stiglitz (2000) deal with the discipline on minimum capital as instrument to discipline or even discourage imprudent behaviours. They present a dynamic model where banks can decide on the riskiness of their assets and compete in the deposit market. Conforming to the charter value literature, competition erodes margin and encourages excessive risk taking. In order to induce prudent behaviours and boost the charter value, capital requirements should be introduced. With sufficiently high capital requirements, banks internalize the negative consequences of gambling and therefore become more prone to invest in less risky activities. Notwithstanding, the authors point out that capital requirements alone are insufficient (in other words, lead to a Pareto-inefficient outcome) for as long as banks can freely determine the deposit rate. Their way of reasoning is the following: banks have to choose between gambling and investing in prudent assets. When banks lie on the Pareto frontier, the two strategies provide the same payoffs. However, in competitive markets, each bank has an incentive to deviate from the equilibrium by offering a slightly higher deposit rate, so to attract more depositors and earn a higher margin from gambling (market-stealing effect). Only the introduction of interest rate ceiling precludes banks to move toward inefficiently high deposit rate and guarantees the achievement of Pareto-efficient outcomes, making capital requirements an effective tool to limit excessive risk-taking.

Building on Hellmann, Murdock and Stiglitz (2000), Repullo (2004) presents a dynamic model of imperfect competition to explain that without a proper regulation, more competition is dangerous for the soundness of the banking system. However, in contrast with the previous research, risk-based capital requirements are considered effective to prevent the risk-shifting incentives. The reason is that under this setup, the costs of an increase in capital are fully charged to the depositors; consequently, neither margins nor the charter value are affected and the only effect is an increase of the amount of losses that would be faced by the shareholders in case of default.

Summarizing:

	Risk-taking incentives		
Banking regimes	Liability	Asset	Regulation
Free banking (observable risk/high disclosure)	Medium-low	Absent	Capital requirements
Free banking (unobservable risk/low disclosure)	Medium-high	Maximal	Capital requirements + Asset restrictions
Risk-insensitive insurance	High	Maximal	Capital requirements + Asset restrictions
Risk-based insurance	Low	Absent	Capital requirements

Figure 6: Possible banking regimes, the incentives to take risk and the regulatory instruments. More developed economies are moving towards the top and the bottom rows. Risk-based deposit insurance, disclosure requirements and supervision are considered the best way to limit excessive risk taking behaviours. Basel I, II and III are the frameworks that have been accompanying this movement since 1988. Source: (Vives, 2010).

An alternative regulatory instrument to monitor risk taking in competitive market consists in the merging policies, as analysed by Perrotti and Suarez (2002). They study the competition-stability trade-off in a dynamic framework where charter values are conditioned by the level of competition that will prevail in the future. As usual, banks compete for deposits and can choose to make either prudent or speculative investments. The previous literature has never considered the fact that failures modify the market structure of the banking sector, increasing concentration at least temporarily. Thus, surviving banks may gain from the failure of the competitors, introducing the "last bank standing" effect. An active merging policy that allows survivors to take over failed businesses stimulates prudent behaviours, as the last bank standing will reinforce its charter value (Beck, 2008). At the same time, an active entry policy must be enacted in order to prevent the destabilizing effect of an increase in the level of concentration. Only a combination of the two policies allows ensuring a stable banking system.

2.1.1.2 COMPETITION AND FRAGILITY FROM THE LIABILITY SIDE

The link between competition and liability risk has been largely disregarded by the academic literature. Most of the studies postulate that banks operate either in perfect competition or in monopoly and do not pay too much attention on the effects of different market structures and on how banks interact among each other (Carletti and Hartmann, 2002).

EFFECTS ON DEPOSIT MARKET

Rather than focusing on the link between concentration and investing decisions, Smith (1984) holds portfolio decisions as given and analyses the liquidity side of the balance sheet. He develops a model where banks compete in the deposit market to attract depositors who will withdraw their deposits at different points in time. Given that depositors themselves are the only ones who know their own liquidity needs, from the banks' side the probability

distribution of their withdrawals is unknown. If such an adverse selection problem is present, the banking sector is unable to reach any form of equilibrium. As a matter of fact, once an equilibrium is reached, it will be immediately destroyed by the chance of a bank to offer better contracts to certain categories of depositors. It results that lower levels of competition make the environment less fragile, allowing bank relationships to survive for a longer period of time. According to the authors' point of view, the introduction of deposit rate ceilings may counterbalance the destabilizing effect of competition on deposits, allowing the banking system to reach a Nash equilibrium.

Matutes and Vives (1996) shows that ascribing bank fragility to the competitive conditions only is not correct. Illiquidity problems can emerge in any market structure, even in case of a monopoly bank. Panic runs result from the co-ordination failure among depositors or as consequence of the arrival of pessimistic forecasts about the future solvency of the bank. They depend endogenously on depositors' expectation, which are self-fulfilling. It follows that a bank considered solid is able to gain a larger market share, benefit from a better diversification and become actually safer. The self-fulfilling nature of depositors' expectation allows multiple equilibria, under which it may be that several banks, only one bank or none bank are active. The introduction of a deposit insurance improves the welfare by minimizing co-ordination failures (all banks are perceived safe) and extending the market (depositors are willing to deposit more if they are confident they will receive the money back). On the other hand, by maintaining all banks in the business, deposit insurance may preclude the realization of desirable concentration of deposit, inducing fiercer competition in the deposit market, which intensifies the likelihood of failure. This trade-off makes the final outcome uncertain and ascertainable only looking also at the market structure.

In a more recent research, Vives (2010) argues that panic runs can occur independently of the level of competition but an increase in rivalry deteriorates the coordination problem, thus increasing the instability of the system, the probability of a crisis and the impact of bad news on fundamentals.

EFFECTS ON INTERBANK MARKET

Competition may also affect the stability of the banking system through the functioning of the interbank market. In the event of a liquidity shortage, banks with liquidity surplus have to cope with picks which have opposite effects. Either they provide liquidity to the troubled peer and avoid the contagion to other institutions or they refuse to come to the aid, forcing the closure or an inefficient liquidation of the assets.

Allen and Gale (2004) sustain that in a world of perfect competition an even small liquidity shortage may force the bank's bankruptcy. Since in perfect competition all banks are small, they act as price takers and their decisions do not affect the collective equilibrium. If a bank is in trouble, the other institutions have no incentives to provide liquidity. This in turn affects the bank that has lent money to the distressed one and the vicious circle goes on until all banks are forced to sell their assets at loss, with adverse consequences for the entire sector (Allen and Gale, 2000). Contagion is hence an important source of banking instability, much more likely when the level of competition is high. Therefore, an imperfectly competitive market may be more stable since each bank realizes that its behaviour affects the overall equilibrium. By providing funds to needy institutions, the banking system avoids the danger of contagion and preserves its stability.

Besides, Saez and Shi (2004) show that if the market structure is characterized by a limited number of banks, banks have an incentive to cooperate and aid the distressed institutions to overcome the temporary illiquidity. This will stop any form of contagion and make the banks providing liquidity in this way better off. This strategic interaction works better if built around the concept of liquidity pool, defined as "a claim structure where banks are indirectly connected by holding bank deposits". This mechanism works in a similar way to a central bank.

This theory is sustained also by Acharya, Gromb and Yorulmazer (2012), who show that a central bank able to credibly commit to play the role of lender of last resort can favour an efficient allocation of liquidity in the interbank market.

Carletti, Hartmann and Spagnolo (2002) address the topic from a slightly different perspective. They analyse the effect that mergers have on competition, measured by the level of post-merger loan rates, and on stability, measured by the interbank market liquidity risk. The conclusions they reach are not univocal. A "large" merger has three effects. Firstly, more concentration increases the market power of the merged entities. This puts upward pressures on loan rates. Secondly, more concentration implies cost reductions. This puts downward pressures on loan rates. Consequently, the overall impact on the level of competition varies depending on which effect prevails. Finally, more concentration alters the timing and the average size of liquidity shortages, with a result that depends on the nature of the liquidity shocks, the cost of refinancing and the competition effect produced by the merger (higher or lower loan rates). Therefore, mergers can give origin either to more or less stability depending on which effect prevails. Surprisingly, mergers that improve the level of competition, and hence make the banking system more efficient, have a detrimental impact on the interbank

market conditions because they drain a large amount of liquidity. This ambiguity makes it harder for market regulators to enact effective policies since having knowledge of the potential efficiency gain may be extremely complex.

2.1.2 COMPETITION-STABILITY HYPOTHESIS

While the charter value literature argues that less concentrated and more competitive banking structures are more fragile, an alternative strand of literature shows that competition may improve the stability of the banking sector. It is important to recognize that this literature is relatively recent and the contributions are not so many. As in the competition-fragility literature, these studies deal with the interaction between competition and stability from different perspectives. In particular, two main ways of transmission are identified: the risk-shifting paradigm and the too-big-to-fail view.

RISK-SHIFTING PARADIGM

Studies supporting this paradigm focus on the effects of competition on moral hazard and adverse selection problems. In contrast with the works belonging to the competition-fragility trend, this research allows for competition both in the deposit and loan market. Before surveying the evidence provided, it is necessary to define what moral hazard and adverse selection are. Moral hazard arises whenever the incentives of the parties entered in a contract changes. In particular, if a party is insulated from risk, this party will behave differently since it does not bear the results and the responsibilities of its actions. Hence, the incentives to act carefully fail. In banking, moral hazard triggers the assumption of excessive risks through two similar mechanisms. First, when depositors are fully insured, they have no incentives to monitor what their banks are doing. Hence, banks may have an incentive in taking more risks. Second, if there is a lender of last resort which will provide liquidity to avoid the default of a credit institute, banks have again an incentive in making risky investments. By contrast, the adverse selection results from the existence of asymmetric information between buyers and sellers. In banking, it may be the case that borrowers undertake dangerous projects of which the bank is not aware.

The risk-shifting paradigm and, more generally, the entire competition-stability view have become popular after the publication of Boyd and De Nicolò (2005). They argue that according to the theoretical models published so far, banks are assumed to choose the riskiness of their investments by solving a *portfolio problem*, where asset prices and return distributions are fixed. Banks simply decide how to allocate the available resources discriminating among a set of possible investment opportunities (loans, securities, bonds,

etc.). When the deposit market becomes less competitive, banks improve their profitability, act in a more conservative way and become reluctant to look for deeply speculative investments. The alternative theorization made by Boyd and De Nicolò assumes that banks solve an *optimal contracting problem* where it is the borrower, and not the bank, who decides on the risk of the investment made with the loan provided by the bank. Under this definition, borrowers' behaviour is unobservable or observable at cost. Hence, the bank acts as agent with respect to its depositors and as principal with respect to its borrowers. This latter relationship had never been accounted for by the academic literature. In this framework, competition plays a new role because now banks compete both in deposit and loan market. Further, the way in which competition influences the incentives of the entrepreneurs who receive the loan and of the bank that lends them (Carletti, 2010) is new too. Less competition results in lower deposit rates (as before) but also in higher loan rates: both effects lead to more rents earned by the bank. However, these higher loan rates are charged to the borrowers, thus contracting their profits and increasing their probability of default. Moreover, the riskiness through the loan market channel is further strengthened by a moral hazard problem. As a matter of fact, higher loan rates lead firms and entrepreneurs to adjust their investment choices moving towards riskier ones, thus increasing the probability that the loan will not be settled. By contrast, lower rates imply higher net values, which encourage the entrepreneurs who are borrowing the money to spend more effort in making the investment successful. The Boyd and De Nicolò's (2005) model evidences that competition and fragility are positively correlated if there is moral hazard. Nevertheless, the authors themselves claim that this is not the rule. The effects of an increase in the competition level are complex and the final outcome resulting from the deposit and the loan market channels may be ambiguous. What is relevant is that the loan market channel exists too, and it must be taken into as much consideration as the deposit market channel[14].

Though considered the cornerstone of the competition-stability hypothesis, Boyd and De Nicolò were not the first to raise doubts about the appealing charter value hypothesis. Stiglitz and Weiss (1981) show that the interest rate charged by banks affects the riskiness of the loans, sorting the potential customers. On the one hand, the higher cost of funding discourages safer borrowers; on the other hand, it attracts risky borrowers who undertake investments with high payoffs but low probability of success. Eventually, the amount of non-performing loans increases and the stability of the banking sector is undermined.

[14] This model has been criticized by Wagner (2009). He argues that Boyd and De Nicolò assume that the bank's entire risk is determined by the borrowers, whereas, according to the author's view, it is the bank that can ultimately decide the riskiness of its assets by setting lending standards, scouting procedures and covenants.

Koskela and Stenbacka (2000) find a positive correlation between competition and stability analysing how the market structures affect the project choice in credit markets. They show that the introduction of competition in the loan market cuts the lending rates and stimulates more investments, without increasing the risk of default of the bank. This is the first study which comes to the conclusion that there is no reason for the competition-stability compromise to exist.

Caminal and Matutes (2002) present a model where banks can choose between two countervailing channels to reduce the scope of moral hazard and adverse selection problems induced by the borrowers and, hence, ensure proper investment choices. On the one hand, by credit rationing, banks refuse to accommodate a loan or limit the supply of additional funds to a risky counterparty even if willing to pay a higher interest rate. In this way, borrowers have lower incentives to cheat and invest into too uncertain projects. On the other hand, by costly monitoring, banks limit the agency problem by making an ongoing control on the project undertaken by the firm during the interim of the relation. The idea is that a monopoly bank relies more on monitoring than on credit rationing, thus granting larger loans to the applicants. Therefore, since larger loans are more subject to multiplicative uncertainty, the exposure to aggregate risk may turn out to be greater in a monopoly rather than in a pure competition setting. Consequently, it is not necessary the case that more competition is detrimental to the stability of the financial sector.

TOO-BIG-TO-FAIL POLICIES

Another group of proponents of the competition-stability hypothesis focuses on the effect that concentration has on stability. If compared to diffuse banking systems, concentrated banking systems are usually characterized by a small number of large institutions. Since their failure has wide implications for both the financial and economic sector, governments are more concerned about the health of these financial institutions and reluctant to let them fail in the event of insolvency problems. This is the reason why more consolidated banking systems are more likely to receive subsidies through explicit or implicit "to-big-to-fail" or "too-important-to-fail" policies (Mishkin, 1999), which protect large banks by assuring ample insurance subsidies. The expectation of future financial aids emphasizes risk taking incentives, since banks recognize that they are systematically important and thus under the umbrella of the government safety net. From this point of view, more concentration may undermine the stability of the banking system instead of reinforcing it. Moreover, few large banks are more interdependent and consequently more prone to contagion, reinforcing again the idea of the existence of a negative link between concentration and stability.

EFFECTS ON SUPERVISION

In addition to this, advocates of the competition-stability theory disagree with the idea that a concentrated banking system is easier to monitor. As a matter of fact, bank size usually goes at the same pace with complexity, especially after the consolidation trend of the 1990s which has led many banks to offer a full array of products and services previously performed by independent boutiques. As result, large institutions may turn out to be harder to monitor than small ones.

Summing up the discussion about the theoretical literature, the interrelation between competition and stability is complex as it is driven by a broad set of factors. On the one hand, the competition-fragility hypothesis, theorized through the charter value proposition, states that in more competitive systems banks choose a riskier portfolio and have less incentives to properly screen the borrowers. Conversely, if competition is limited, banks are more profitable, hold larger capital cushions and have less pressure to take excessive risks. On the other hand, the more recent competition-stability hypothesis shows that more competitive banking systems imply lower landing rate, reducing the cost of borrowing, thus diminishing the entrepreneurs' incentive to make risky investments. Moreover, government policy (deposit insurance, capital requirement, forbearance policy, etc.) may enter the game, mitigating or emphasizing certain aspects of the interaction between competition and stability. All in all, it seems reasonable to think that the relationship between competition and stability is non-linear. Broadly speaking, once a certain limit is reached, a further intensification in the level of competition may deteriorate the quality of the banks' portfolios and raise the probability of financial troubles (Carletti and Vives, 2009). In conclusion, if it is true that competition has an ambiguous effect on the stability of the banking sector, the role of many regulatory and supervisory policies should be rethought. At this point it is necessary to go a step forward and look at what data tell us. In the next paragraph the empirical literature will be taken into account.

2.2 MEASURES OF COMPETITION AND STABILITY

In order to evaluate empirically the relation between stability and competition, appropriate measures must be defined. The empirical studies use a wide set of approaches to approximate the levels of competition and stability of the banking sector. Here follows a brief explanation of the most commonly used measures.

2.2.1 MEASURING BANKING SYSTEM STABILITY

In most cases bank stability is measured in a negative way, i.e. by taking into account systemic or individual financial crises.

SYSTEMIC DISTRESS

In a nutshell, a systemic distress is a period during which the banking system is unable to perform its intermediation functions (liquidity provisions, payment services, deposit taking) in an effective way. Even if there is more than one single definition of systemic distress, the one given by Demirgüç-Kunt and Detragiache (1998) has been commonly accepted in literature. An episode of distress is classified as systemic under one of the following conditions:

- Non-performing assets exceed 10% of total assets in the banking system;
- The rescue operation has a fiscal cost of at least 2% of the GDP;
- The result of the financial troubles is a diffuse bank nationalization;
- There are protracted bank runs;
- The government reacts to the crisis with emergency measures such as deposit freezes, long-lasting bank holidays or blanket deposit guarantees.

In the empirical works, a condition of systemic crisis is usually captured by a dummy variable, which takes the value 1 when a systemic crisis is observed and 0 when it is not.

INDIVIDUAL BANK DISTRESS

Although systemic banking distresses are regulators' and governors' worst nightmare, in addition to these there are situations of individual banking crises that undermine the soundness of the financial system and raise concerns as they may result in a systemic crisis. Furthermore, the failure of a large bank may impact all the cross-border financial activities, as is clearly shown by the recent experience of the US subprime market, which affected the balance sheet of many European banks (Beck, 2008). There are two measures of individual bank fragility commonly used by researchers: the Z-score[15] and the non-performing loan (NPL) ratio.

Z-Score: it is a proxy of how close to bankruptcy the bank is. It is calculated using accounting data as follows:

$$Z_{i,t} = \frac{ROA_{i,t} + \frac{E_{i,t}}{TA_{i,t}}}{\sigma_{ROA_{i,t}}}$$

[15] Be careful not to confound this methodology with the Altman Z-index used in corporate finance.

where: ROA is the rate of return on assets, E/TA is the ratio between equity and total assets and σ_{ROA} is the standard deviation of the return on assets (Boyd, De Nicolò, and Jalal, 2006). In the formula *i* denotes an individual bank and *t* a point in time. The Z-index combines in a single number the profitability given by the ROA, the leverage given by E/TA and the volatility of the returns given by σ_{ROA}. The result indicates the number of standard deviations by which the profits would have to fall prior to deplete all the equity capital. As it measures the distance from insolvency, higher values imply a lower probability of insolvency and, hence, a higher bank stability (Beck, De Jonghe, and Schepens, 2013).

Non-performing loan ratio: in some empirical publications, researchers use the non-performing loan ratio as proxy for the bank risk profile. It is calculated as ratio between the volume of non-performing loans and total loans. Differently from the Z-score, the NPL ratio covers credit portfolio risk only and cannot be linked directly to the probability of default of the bank.

2.2.2 MEASURING BANKING SYSTEM COMPETITION

Measuring bank competition is even more arduous than measuring stability. Competition is a clear concept in economic theory and the Merriam-Webster dictionary[16] defines competition as "the effort of two or more parties acting independently to secure the business of a third party by offering the most favourable terms". Though precise, this definition does not give any clue on how competition can be measured. The literature proposes a variety of approaches, which can be classified into three classes: market structure measures, measures of market contestability and direct measures of competition.

MARKET STRUCTURE MEASURES

This approach is based on the Structure-Conduct-Performance (SCP) paradigm, which dominates the industrial organization theories between the 1950s and the 1970s, linking market structures and performances. Structure mainly refers to the degree of concentration in the market. Conduct refers to the way in which firms behave in various dimensions such as pricing strategies, investments in R&D and advertising levels. Performance refers to how the firms' economic behaviour impact on the social efficiency. The SCP paradigm predicts that higher concentration encourages collusion and affects the sector performances in an unfavourable way from a social point of view (Berger et al., 2004). The reasoning is as follows: structure affects conduct (higher concentration leads to less competitive behaviours), conduct affects performance (less competitive behaviours lead to higher market power and

[16] http://www.merriam-webster.com/

lower social efficiency) (Claessens, 2009). Since there exists a causal link from market structure to firms' behaviour (higher concentration leads to less competition and higher market power), competition can be approximated using market structure measures. Familiar measures of market structure that authors commonly use as proxies for market competition are the Herfindahl-Hirschman index (HHI) and the *k*-bank concentration ratio (CR*k*).

Herfindahl-Hirschman index (HHI): commonly used in literature, it is also called full-information index. Mathematically, it is the calculated as sum of the market shares of all the banks in the market:

$$\sum_{i=1}^{n} s_i^2$$

where s_i^2 is the square of the market share of the *i*-th bank and *n* is the number of banks in the market. For example, if there are one bank with 50% market share and two banks with 25% market share each, the HHI will be: $0.5^2+0.25^2+0.25^2=0.375$. Hence, the HHI gives greater weight to larger banks than to smaller ones. Its values ranges from 1/*n* to 1, with the lowest value reached when the market is characterized by *n* banks of equal size and 1 in case of monopoly (Bikker and Haaf, 2002). According to some other arrangements, the HHI is calculated as $\sum_{i=1}^{n}(s_i * 100)^2$, where s_i is the market share of the *i*-th bank. Slightly differently from the previous calculation (but it is only due to mathematics), the HHI takes values from 1/n to 10,000. In accordance to the US Merger Guidelines (2010), a value below 1,500 indicates an unconcentrated market structure, a value between 1,500 and 2,500 a quite concentrated market structure whereas a value above 2,500 a highly concentrated market structure.

***k*-bank concentration ratio (CR*k*)**: mainly used if the available data are limited, it is simply the sum of the market shares of the *k* largest banks:

$$\sum_{i=1}^{k} s_i$$

where s_i is the market share of the *i*-th bank and *k* the number of banks considered. There are no specific rules about the best value of *k* so the choice is somewhat arbitrary. Notwithstanding this, *k* is usually chosen between 3 and 5. Differently from the HHI, the concentration ratios give the same weight to each bank, without accounting for the effect of many small banks. The values range from 0 to 1, with the lowest value approached if considering an infinite number of banks with the same size and 1 if the banks considered make the entire banking industry (Bikker and Haaf, 2002).

The SCP paradigm is not without weaknesses (Claessens and Laeven, 2004; Claessens, 2009). First of all, structure is not necessarily exogenous, rather it might be the consequence of firms' behaviour. Secondly, the level of competition of an industry may be influenced by factors other than concentration, among which the ownership structure, the existence of entry and exit barriers or activity restrictions. Moreover, the commonly used performance variables (for example, net interest margins and profitability) may be affected not only by competition but also by other factors both systemic such as the country's macroeconomic context, the taxation regime or the legal system, and idiosyncratic, such as the single bank's leverage or risk preferences. Furthermore, many studies measure competition and margins at institutional level without making any distinction between different product lines (deposit, lending and payment services). An additional challenge consists in the definition of the relevant market. Many analyses focus on the entire economy, but this could not be a correct assumption at all because banks (especially small institutions) may compete at local level only (Beck, 2008; Carletti, 2010).

MEASURES OF MARKET CONTESTABILITY

This approach is based on the evaluation of regulatory framework indicators to assess the competitive conditions. Usually, the variables considered are entry requirements, activity limitations, information asymmetries, the presence of foreign ownership, changes in financial instruments and innovations. All these factors may contribute to affect the degree of competition. Therefore, on the one hand competitive conducts can emerge in concentrated environment; on the other hand, collusive behaviours can take place although many firms compete in the market.

DIRECT MEASURES OF COMPETITION

In order to overcome the deficiencies related to the structural models, new measures of competition have been introduced. These new approaches do not evaluate the degree of competition assessing the market structure but measure banks' conduct directly, in terms of marginal revenues and costs. Below the most common measures:

H-statistic: this measure has been developed by Panzar and Rosse in 1987. This method assesses the level of competition by examining to which extent a variation in the cost of the input factors affects the equilibrium revenues earned by a bank. In a perfectly competitive environment, when input prices boost, both marginal cost and marginal revenues raise by the same amount (under perfect competition, MC=MR and there are no profits). By contrast, in a monopolistic environment, the same increase in input prices will not affect revenues or will even decrease them (Schaeck and Cihák, 2007). The Panzar and Rosse (PR) model provides a

measure, called H-statistic, of the extent to which outputs react to factor prices. Its calculation starts from the estimation of the reduced-form equation of revenues:

$$\ln(TR_{it}) = \alpha + \sum_{k=1}^{n} \beta_k \ln(W_{k,it}) + \sum_{j=1}^{n} \gamma_j \ln(CF_{j,it}) + \epsilon_{i,t}$$

where TR_{it} denotes total revenue, $W_{k,it}$ the *k*-th input factor and $CF_{j,it}$ other firm-specific control variables (Bikker, Shaffer, and Spierdijk, 2012). The subscripts *i* and *t* denote the bank and the time, respectively. The H-statistic is equal to:

$$\sum_{k=1}^{n} \beta_k$$

that is the sum of the estimated elasticities of revenue with respect to input prices.
The magnitude of the H-statistic explains the level of competition in the market:

- H-statistic ≤ 0 indicates monopoly;
- 0 < H-statistic < 1 indicates monopolistic competition;
- H-statistic = 1 indicates perfect competition.

Despite the advantages, the H-statistic presents some drawbacks since the model is based on some assumptions that may not necessarily hold. Firstly, it assumes that the banking market is in equilibrium; otherwise, the profit-maximizing condition would not be valid. Actually, it is very rare. Furthermore, it supposes that the demand function has constant elasticity and that the cost structure is homogeneous.

Lerner index: similarly, the index evaluates the pricing power of a bank by capturing its ability to charge a price above its marginal cost. It is calculated as:

$$Lerner_{it} = \frac{P_{it} - MC_{it}}{P_{it}}$$

where P_{it} denotes the price and MC_{it} the marginal cost. The subscripts *i* and *t* denote the bank and the time, respectively. The values taken by the Lerner index range from 0 to 1, with higher values implying less competition and, hence, greater market power. Koetter, Kolari and Spierdijk (2012) proposed an adjustment to the Lerner index to account for cost and profit inefficiencies as firms do not exploit all their opportunities. The **adjusted-Lerner index** is calculated as:

$$Adjusted\ Lerner_{it} = \frac{\pi_{it} + TC_{it} - q_{it}MC_{it}}{\pi_{it} + TC_{it}}$$

where π_{it} denotes the profit of the bank, TC_{it} the total cost, q_{it} the total output (loans and securities) and MC_{it} the marginal cost. The interpretation is the same as the standard Lerner index. The Lerner index is powerful as it allows analysing the level of competition among different product lines. However, it has the weak point that the information required for the calculation is sensitive and, consequently, may be difficult to collect.

Boone indicator: it expresses the effect of competition by comparing the performances of efficient banks with those of inefficient ones. The intuition is that more efficient banks (i.e. with lower marginal costs) perform better and these higher performances come at the expenses of the less efficient counterparties. This effect becomes stronger when the degree of competition increases (Schaeck and Cihák, 2014). The new measure of competition introduced by Boone (2000) is the Relative Profit (RP). Considering two firms, *i* and *j*, with *i* more efficient than *j*, the ratio between their profits, π_i/π_j, raises after an increase in the level of competition. This happens because the profit of the more efficient bank grows more or falls by a lower amount than the profit of the less efficient bank. This process has been defined "profit reallocation effect of competition": when competition becomes fiercer, profits shift from inefficient to more efficient banks (Boone, 2008)[17]. Instead of calculating the ratio between the profits of the *i*-th bank and a reference bank, π_i/π_1, one way to implement the RP measure is by estimating the following regression:

$$\ln(\pi_i) = \alpha + \beta \ln(MC_i)$$

where π_i denotes the profits, MC_i the marginal cost and the subscript i the bank. The RP measure is captured by the parameter β which indicates how much less efficient firms are punished with lower relative profits (Boone, Griffith, and Harrison, 2005). Readjusting:

$$\beta = \frac{\partial \ln(\pi_i)}{\partial \ln(MC_i)}$$

Hence, the Boone indicator can be interpreted as a profit-elasticity index: it estimates the percentage decrease (increase) in profit that results from an increase (decrease) in marginal costs by 1%. Since profit and marginal cost are linked by a negative relationship, the sign of the coefficient is negative. For example, a β equal to -3 means that the profits of a bank whose marginal costs are 1% higher than another (more efficient) are 3% lower than the other bank. In conclusion, large values of β in absolute term indicates more competitive banking system and vice versa (Diallo, 2015).

[17] This effect can be better understood thinking at the concept of market transparency: when competition increases, markets become more transparent, customers recognize the firms that offer high value at low price and will buy their products, at the detriment of the less efficient firms.

2.3 EMPIRICAL EVIDENCE

The early empirical studies emerged in the 1990s and since that time they have evolved continuously. Most of the earlier works assert a negative relation between competition and stability, whereas more recent works suggest that increases in competition are beneficial for the stability of the financial sector. In the 1990s the empirical literature mainly tested the SCP paradigm in the banking industry and, accordingly, competition has been quantified by means of measures of concentration such as CR_n or HHI. Due to the lack of many available data, these budding empirical studies were based on bank-level data of single countries, in particular of the local US banking market. As years go by, this quite simple approach has been overcome and researchers have begun to test alternative paradigms in addition to SCP. Competition started to be analysed on the basis of a broader and more dynamic perspective, accounting for market structures, regulatory restrictions on entry and exit, legal impediments, ownership structures and national institutional environments (Berger et al., 2004). The ever-increasing availability of large panel data has progressively enabled cross-country comparisons, which allow a better assessment of how competition and concentration are relevant for stability. As for the theoretical literature, the empirical studies have reached ambiguous predictions regarding the nexus between competition, concentration and stability, mainly determined by the sample chosen, the period under study and the methodology employed. Below, a review of the main empirical works has been carried out, starting from bank-level studies on single countries and then moving to cross-country studies.

2.3.1 BANK-LEVEL STUDIES BASED ON ONE COUNTRY

Overall, one can classify bank-level studies on single countries into four classes in relation to the topic on which they focus.

MARKET POWER

Most of the studies relative to individual countries evaluate the impact that competition has on charter values and risk-taking incentives. As briefly outlined in the previous chapter, Keeley (1990) assesses if the increase in competition following the relaxation of the financial industry restrictions in the US in the 1980s has given birth to a sharp decline in franchise values and a higher default risk through a reduction of capital cushions and an increase of asset risk. He measures the banks' market power applying the Tobin's q ($\frac{\text{Market value of assets}}{\text{Book value of assets}}$) and the banks' risk using two variables, the capital-to-asset ratio ($\frac{\text{Market value of equity}}{\text{Market value of asses}}$) and the interest rate on large certificates of deposits. He takes two pooled estimations. Firstly, looking at 85 large US

bank holding companies[18] (LBHCs) in the period 1971-1986, Keeley finds that a higher Tobin's *q* is positively and significantly related to a higher capital-to-asset ratio, indicating that a less competitive banking market is associated with larger capital cushions. Secondly, looking at 77 large bank holding companies in the period 1984-1986, Keeley finds that the Tobin's *q* is negatively and significantly related to the interest rate paid on large CDs, indicating that a less competitive banking market is associated with lower risk premiums. On aggregate, these results are consistent with the franchise value paradigm, providing evidence that increased competition erodes the charter values, reduces the capital cushions and eventually gives incentive to take excessive risks.

Several later studies confirm the negative relationship found by Keeley. Demsetz, Saidenberg and Strahan (1996) study the relation between charter value and asset risk looking at a pool of 100 US banks holding companies between 1986 and 1994. They find that there is an inverse relationship between franchise value and stock-return volatility[19], where the franchise value is defined as the difference between the bank's market value and its replacement cost (after some adjustments it approximates the Tobin's *q*) whereas the stock-return volatility is measured by the weekly standard deviation of stock returns. The paper shows that banks with large charter value are better capitalized and hold more diversified loan portfolios. For a sample of publicly traded US S&Ls, Brewer and Saidenberg (1996) find that franchise values (measured by the market-to-book asset ratio) are negatively related to risk (measured by the standard deviation of equity returns), thus supporting the charter value theory. Galloway, Lee and Roden (1997) examine the banks' risk-taking behaviour before and after the deregulation of the early 1980s. They find that banks with a high charter value behaved prudently over the entire sample period (1977-1994), whereas banks with a low charter value have undertaken more risks since 1983, proving that the increase in competition after the deregulation had a negative impact on the stability of the banking industry. Hannan and Prager (1998) show that the removal of the restrictions on branching and multibank holding company operations made the deposit market more competitive, which in turn caused a decline of the banks' profitability. Even more recently, Dick (2006) examines the effect of the Riegle-Neal act on bank performances on the basis of a sample for the period 1993-1999: he founds that the removal of restrictions led to an increase in charge-off losses and loan loss provisions.

[18] According to the Bank Holding Company Act of 1956, a bank holding company is defined as bank that has control over another bank.

[19] The volatility of stock returns is an "all-inclusive" measure of risk since it incorporates the asset risk, the off-balance sheet positions and the leverage.

These results contrast sharply with those obtained by Jayaratne and Strahan (1998), who argue that severe restrictions limit the expansion and growth of efficient banks. In contrast with the charter value literature, they argue that the increase in competition after the branching deregulation in the US lowered operating costs and loan losses. This occurred because more efficient banks started to grow at the expenses of their less efficient rivals, implementing the overall efficiency of the banking system. In turn, more efficiency generated benefits for the borrowers in terms of lower loan rates. The reduction in loan losses also suggests that banks monitored their counterparties in a better way. Similarly, starting from a sample referred to the US banking industry from 1976 to 1994, Stiroh and Strahan (2003) demonstrate that when the banking market became less restrained after the deregulation, banks' performances and market shares improved significantly. The authors attribute this dynamics to the competitive reallocation effect, which transfers market share and control toward the better-run banks over time.

Apart from this branch of research, there is another group of studies which do not deal with the US banking system. For example, Capie (1995) examines the stability and efficiency of the UK banking system over the period 1890-1940. Those years were very stable and no major banking panic or financial crises surfaced. Looking at the structure of the market, there was an ongoing trend towards a more consolidated and less competitive industry, leading progressively from a system with many players to an oligopoly. This experience seems to be consistent with the idea that a less competitive environment contributes to maintain the banking system sound. Salas and Saurina (2003) replicate closely Keeley's work on a sample of 21 Spanish commercial banks for the period between 1968 and 1998. They observe that banks with high charter values (measured by the Tobin's *q*) tend to have higher solvency ratios (measured by the capital-to-asset ratio) and lower credit risks (measured by the non-performing loan ratio). Thus, this work supports the franchise value theory. For another sample of Spanish banks for the period 1988-2003, Jimenez, Lopez and Saurina (2007) assess the relation between bank competition and risk taking. Competition has been measured by both concentration parameters and the Lerner index, while risk has been approximated using the non-performing loan ratio. After controlling for macroeconomic variables and banks' specific features, they find that when measuring competition with the Lerner index for commercial loan products, banks with higher market power present lower NPL ratios[20]. This result supports the competition-fragility view and therefore the charter value paradigm.

[20] This approach was criticized because the loan losses ratio is used both as measure of non-performing loans and as variable in the Lerner index function (Vives, 2010). Consequently, any relationship might be mechanical rather than economically meaningful.

However, when applying concentration measures (such as the number of banks, the CR5 and the HHI indexes) or the Lerner index for the deposit market, data do not show any significant correlation between market power and portfolio risk. A similar result is obtained also in a study of the Russian banking system including 20,000 quarter observations for the period 2001-2007, where competition is measured by the Lerner index and stability by a dummy variable which takes value one if at least one bank has lost its licence over a quarter and zero otherwise (Fungácová and Weill, 2009). The key finding is a negative coefficient for the Lerner index, which means that more market power implies fewer failures. As for Italy, with reference to a sample of 7,275 observations on 729 individual banks, Bofondi and Gobbi (2003) prove that there is a positive correlation between number of banks in the market and loan losses. Yaldiz and Bazzana (2010) analyse the role of market power on risk-taking behaviours on a sample of Turkish banks from 2001 to 2009. Referring to the dependent variables, the non-performing loan ratio (NPL) and the Z-index are used as measure of credit risk and overall bank risk, respectively, whereas relative to the explanatory variable, market power is proxied by the standard Lerner index and by the ratio $\frac{\text{Total revenues - Total costs}}{\text{Total revenues}}$ [21]. In this case, the empirical results support the competition-stability view: as market power increase, banks' risk increases too. These findings are in line with those reached by the previous study of Tunay (2009), where it equally appeared that there is a negative relationship between competition and fragility in the Turkish banking system[22].

BANK SIZE

An extensive section of the literature focuses on the connection between bank size and probability of default, chiefly for American institutions. In their analysis of the annual data from 122 US bank holding companies between 1971 and 1990, Boyd and Runkle (1993) assess the relationship between bank size and risk. They find that there is a negative and significant relationship between size and volatility of asset returns, but data do not provide strong evidence that large banks have a lower likelihood of failure. According to the interpretation given to these results, large banks are able to diversify better their portfolios (the volatility of the returns is lower), but these benefits do not reflect into a lower probability of default. The reason may lie on the highly leveraged structure of these large banks.

[21] With respect to the Lerner index, this calculation does not require any specification relative to the cost function or restrictions on inputs and outputs.

[22] In this work, competition was proxied by the share of assets held by the three largest banks and fragility by both the NPL ratio and a 0/1 dummy variable. Since the research is in Turkish, check İskenderoğlu and Tomak (2013) for a more detailed disclosure.

Boyd and Graham (1991; 1996) go a step further and investigate whether large, well-diversified banks fail less often than small banks in the US between 1971 and 1994. If considering the entire period, small banks have performed better than large ones, with a cumulative failure rate of 12% versus 17%. However, when breaking the sample into sub-periods, results change: small banks are less likely to fail in the earlier periods (1971-1986) but more likely to fail afterwards (1986-1994). They explain that, albeit better diversified, large institutions do not always experience lower failure rates because the implicit too-big-to-fail protection leads them to take more risks.

Demsetz and Strahan (1995; 1997) restate the traditional idea that large banks present lower stock return volatility than small banks thanks to better diversified assets. Nevertheless, large banks are not able to translate the diversification advantage into an effective risk reduction as it is counterbalanced by the fact that they usually operate with greater leverage and undertake riskier projects.

De Nicolò (2000) investigates how bank size is related to measures of charter value and insolvency risk, analysing a sample of publicly traded banks in the US, Japan and several European countries between 1988 and 1998[23]. For the majority of banks considered, he finds that greater size is associated with lower charter values and higher insolvency risk. Moreover, data do not prove that large banks benefit from a better diversification; if present, diversification benefits and economies of scale in intermediation are more than offset by the increase in risk taking.

MERGERS AND ACQUISITIONS

Another strand of the empirical literature strictly connected with the previous one assesses the effects of mergers and acquisitions in terms of concentration, competition and stability. The key point is that if mergers allow diversifying risk, then any increase in concentration will lead to lower risk and higher bank stability (Carletti and Hartmann, 2002). Paroush (1995) breaks up the total effect of a merger into six components:

- Direct effects on the merged firm:
    1. Diversification effect: thanks to diversification benefits, the risk exposure of the combined entity is lower than the average of the stand-alone companies. In order to bear this hypothesis, Paroush provides the example of the mega-merger between Manufactures Hanover Trust Co. and Chemical Banks. After

[23] Although this is a cross-country study, I prefer to present here the major evidence brought because of the strict connection with the works presented previously.

the merger, the loan concentration across the four segments (customer, business, real estate and international) shrinks.

2. Capital effect: the capital structure becomes stronger.

- Direct effects on the entire banking system:
  3. Size effect: the overall risk in the system is reduced because there are less but larger players.
  4. Averaging effect: the overall risk is reduced by mixing the risks of the two banks.
- Indirect effects on social welfare:
  5. Consumers' surplus effect: it is reduced because of the drop in degree of rivalry.
  6. Producers' surplus: it may be reduced by diseconomies of scale or arising inefficiencies.

The author argues that the first four effects more than counterbalance the last two ones and eventually the M&A final effect is an increase in banking stability.

Benston, Hunter and Wall (1995) analyse the prices bid to acquire target banks in a sample of 302 US bank mergers over the period 1981-1986. This research aims at understanding whether the bid prices reflect synergies from risk diversification or rather more attractive deposit insurance put options[24]. The earning diversification hypothesis states that buyers are willing to pay more for targets that guarantee cash flow enhancement thanks to a more diversified portfolio. By contrast, the put-option hypothesis states that acquirers prefer companies offering the opportunity to bet on risky projects or to become too-big-to-fail. Data show that the pre-merger variance of seller's earnings as well as the pre-merger covariance between buyer's and seller's earnings is negatively related to bid prices. These findings agree with the former hypothesis (if consistent with the latter, the covariance would have opposite sign) and consequently the authors assert that mergers are strategic choices that make the environment more stable.

Craig and Santos (1997) compare the pre and post-merger features of 256 US bank acquisitions from 1984 to 1993. They find that the merged entity shows an improved profitability (with a growing trend over time), minor variability of ROE and ROA and a lower probability of failure (measured by the Z-score).

[24] Shareholders may find attractive incentives to "put" their assets to the insurance company (or the government) in the event that they undertake risky projects that deplete all the capital.

Another group of researchers are more cautious. Chong (1991) confirms that it is true that mergers help to improve profitability; however, the increase in profitability is followed by an increase in systemic risk (exposure to market risk), in particular for large banks. Furthermore, banks might intensify their leverage in order to acquire or merge with other banks, thus making the financial structure less strong. Hughes and Mester (1998) argue that the cost advantages coming from diversification-related economies of scale are neutralized by the willingness to take on more risks. Hughes et al. (1996; 1999) confirm that the diversification of the market risk is determinant to ensure a higher level of stability. They maintain that the economic benefits of consolidation (higher profitability, better efficiency and lower default risk) are the greater the more the bank engages in interstate expansion: a geographic consolidation helps to reduce the potential deterioration of the risk profile by increasing the diversification of macroeconomic risk. Without geographic consolidation, the final effects are more uncertain.

BANK INTERDEPENDENCIES

De Nicolò and Kwast (2002) ask themselves whether the consolidation of the financial sector increases at least partly the degree of systemic risk. They argue that banks' interdependencies are a good proxy of systemic risk. Direct and indirect bank interdependencies arising from on and off-balance sheet exposures are quantified by tracking the correlations of stock returns from a sample of 22 large and complex banking organizations between 1988 and 1999. They find that these correlations show an upward trend over the sample period, especially for the (relatively) less complex banking organizations. Statistical tests suggest that the increase of the LCBOs' market share in the 1990s is positively and significantly correlated to the increase in the abovementioned interdependencies. This is consistent with the idea that consolidation dynamics put upward pressure on the level of systemic risk.

2.3.2 BANK-LEVEL STUDIES BASED ON THE COMPARISON OF TWO COUNTRIES

This group of historical studies compare market structure, efficiency and stability of banking systems across pairs of countries. Bordo, Redish and Rockoff (1996) make a comparison between the Canadian and the US banking systems' performances from 1920 to 1980. They note that Canadian banks are more stable (in terms of lower failure rates) than US ones and argue that this might be due to the oligopolistic structure of the Canadian banking market. However, despite the higher profitability of the Canadian banks, data do not prove conclusively that the Canadian banking industry is less competitive: the level of nominal and

real rates on deposits and loans is not consistent with the existence of monopoly rents. All in all, these findings suggest that the Canadian banking system is more stable, more efficient and not less competitive than the US one.

Comparing the UK and German banking system during the period 1971-1997, Hoggarth, Milne and Wood (1998) observe that in UK the banks' profitability is regularly higher but also more variable and thus less stable. The higher UK profits can be explained by the greater extent of non-interest incomes and the lower costs of personnel, while the increased stability of German banks can be explained by the lower and less variable inflation rates together with less competitive conditions, in particular with reference to foreign competitors. Therefore, this study describes two situations: Germany, less competitive and more stable, and UK, more competitive and less stable. In line with many theoretical predictions, this historical evidence seems to confirm the existence of a trade-off between competition and stability.

Similarly, Staikouras and Wood (2000) study the Greek and the Spanish banking system during the 1900s, finding strong evidence that the latter is both more competitive and more stable. Like the historical comparison between Canada and US, this research supports the theory that there is no trade-off between competition and stability.

The main conclusion from the review of this first section of the empirical literature is that it appears impossible to infer a univocal relationship between competition and stability. "The potential effects of financial consolidation on the risk of individual institutions are mixed, the net result is impossible to generalise, and thus a case by case assessment is required" (Group of Ten, 2001). In sum, specific features and circumstances seem to drive the final outcome.

2.3.3 CROSS-COUNTRY EVIDENCE

The recent availability of many cross-country time-series data has given birth to a new branch of empirical literature, whose main aim is to assess the validity of the theoretical predictions made in the past collecting data from several countries. In general, these studies can be classified into two classes. Those belonging to the first one address the topic of the link between competition, concentration and systemic risk: the results within this class mainly point out to a negative relation between competition and systemic fragility, whereas the effect of concentration is less clear. Those belonging to the second group focus instead on the relation between competition, concentration and individual bank stability: the results found by this class are less homogeneous as they vary depending on the sample considered and on the

way in which competition and stability are measured. Hence, the results reached by these two groups of empirical research do not go in the same direction. One possible explanation of this misalignment is that systemic distress and probability of individual fragility are too different concepts and one cannot take for granted that the latter results in the former.

COMPETITION, CONCENTRATION AND SYSTEMIC RISK

Using data on 70 countries between 1980 and 1997, Beck, Demirgüç-Kunt and Levine (2003) assess the impact of bank concentration and competition on the probability of country to be affected by a systemic crisis. Crisis is represented by a dummy variable, which takes value one if the country is suffering a systemic banking crisis and zero otherwise. Episodes of crisis are treated as systemic following the definition provided by Demirgüç-Kunt and Detragiache (1998). Concentration is measured by CR3 based on total assets. In order to find accurate evidence, the authors include in the regression many explanatory variables to control for a set of factors that may affect both concentration and stability, among which regulatory policies, national institutions, ownership structures, macroeconomic and financial conditions. The major findings are three. First, the correlation between concentration ratio and the probability of systemic crises is negative and significant, meaning that concentration has a stabilizing effect. Consistently with the concentration-stability argument, banking systems characterized by few, large banks are less likely to suffer systemic banking crises. Even if the stabilizing effect of concentration weakens with the increase in the degree of concentration, the overall relation between concentration and stability remains negative. Secondly, data show that the fewer the regulatory restrictions are on entry and on bank activities, the lower the bank fragility. Thus, the paper is consistent with the idea that competition fosters the soundness of the banking system. Finally, countries with better developed institutions (property rights, low corruption, etc.) which promote openness and competition tend to face a lower probability of suffering a systemic crisis. Overall, these findings show clearly that measures of concentration and competition cannot be treated as suitable inverse but describe different features of the economic environment. In other words, concentrated banking systems are not more stable because less competitive but rather because banks are usually better diversified or easier to monitor.

Three years later, Beck, Demirgüç-Kunt and Levine (2006a; 2006b) revisit the topic in a study on 69 countries from 1980 to 1997. Using a standard panel logit model, they evaluate if the probability for a country to be hit by a systemic crisis depends on the level of concentration of the banking system (measured by the share of assets held by the three largest banks). Controlling for macroeconomic, financial, regulatory, cultural and other specific

features that literature has shown to be related to the likelihood of a crisis, they reach two main results. First, the correlation between bank concentration and financial crisis is negative and robust. That means that systemic crises are less likely in more concentrated systems. Second, competitive banking systems where most of the entry applications are accepted and where banks are allowed to engage in a wide range of activities show a lower probability of experiencing a systemic crisis. Thus, greater competition is associated with improved stability. As already found in the previous study, bank concentration cannot be used as indicator of lack of competition. When analysing the mechanisms underlying the concentration-stability link, they find that the stabilizing effect of concentration comes from the better possibilities for large banks to diversify risks. By contrast, they do not find evidence that more concentrated banking system are easier to monitor by the supervisory authorities or that the greater stability originates from the market power and consequent franchise value that large banks enjoy in more concentrated systems. To sum up, the message coming from these studies could be: "More competitive banking systems are less fragile, when controlling for concentration" (Vives, 2010).

Evrensel (2008) reaches the same conclusions on a sample of 79 countries and 50 crisis episodes between 1980 and 1997. Although there are some differences between G10 and non-G10 countries[25], overall high concentration of the banking sector together with high economic and banking freedom increases the survival time and makes systemic crises less likely.

The results achieved by Beck, Demirgüç-Kunt and Levine (2006a; 2006b) are confirmed in another cross-country study realized by Schaeck, Cihák and Wolfe (2009), partially based on their work of three years earlier (Schaeck, Cihák, and Wolfe, 2006). They analyse the effects of competition combined with concentration on the banking system stability for a sample of 45 countries during the period 1980-2005. The crisis variable is captured by a 0/1 dummy and a distress is classified as systemic on the basis of the widely employed Demirgüç-Kunt and Detragiache (1998) scheme. The H-statistic is employed to measure directly the level of competition whereas concentration is measured on the basis of the share of total assets held by the three largest banks in a country. Moreover, to test if competition and concentration capture different features of the banking system, both indicators are included simultaneously in the regression model. As usual, other control variables are included in the model. They find that both competition and concentration reduce the probability of a crisis and prolong the time

[25] Non-G10 countries and in wider terms all developing countries have a higher incidence of banks' failure, irrespective of the level of concentration. A plausible explanation is that in those countries high concentration and strict regulation are not the result of competitive market forces but arise as consequence of the lack in democracy and property rights.

to crisis. Given that both competition and concentration enter significantly into the model and affect bank stability through different channels, they conclude that the view according to which more concentration can be interpreted as less competition does not hold. As already stated, a possible reason is that concentration makes a banking system more stable by allowing a better asset diversification or by enlarging the average bank size rather than by restraining competition. Another interesting explanation is related to a measurement issue: at least for some products and services, competition is a local feature of banking market that national-level measures of concentration are not able to capture. This hypothesis would explain why the earlier studies based on the analysis of local markets reached similar conclusions employing competition or concentration indicators.

On the other hand, De Nicolò et al. (2004) find a different result about the relationship between concentration and systemic risk on a sample of banks from 90 countries during the period 1993-2000. Compared to the previous studies, they take a different approach to represent the systemic fragility of a banking sector. Instead of dating when banking crises has started and ended, systemic risk potential is evaluated on the basis of the Z-index of the consolidated accounts of the five largest banks in each country. Calculated in such a way, the Z-index embeds the degree of interdependencies and measures the joint probability of a failure of these banks. Concentration is proxied by the CR5. In the regression model, the authors control for different macroeconomic conditions, institutional environments and degree of government intervention (bank recapitalizations, financial restructurings and bailouts). It results that high concentration implies high levels of systemic risk potentials over the entire sample period and this relation becomes even stronger during the last three years. This finding is germane to the hypothesis that consolidation and conglomeration have the potential of increasing the banks' risk profile with a magnitude that offsets any diversification benefit that could arise.

Levy Yeyati and Micco (2007) reach another conclusion for a smaller data set of eight Latin American countries in the 1900s: according to them, concentration has no effects on bank competition and on insolvency risk whereas more competitive banking systems are more fragile. This result provides support to the franchise value paradigm, but it might turn out to be distorted by the increase in foreign bank penetration that characterized those countries.

It is now worth taking into account the argument introduced by Boyd, De Nicolò and Loukoianova (2009): they sustain that many empirical studies employ indicators of banking crisis that actually are indicators of the governments' response to the banking distress rather than measures of the mere crisis occurrence. In order to understand the root cause of the

fragilities of the banking sector, it becomes necessary to distinguish systemic banking crises from government interventions. Starting from this innovative insight, the authors build a model providing evidence that more concentration makes systemic shocks more likely but does not increase the probability of public intervention (for example, as result of forbearance policies), and that more competitive system are less likely to suffer systemic crisis. In light of this, the results in Beck, Demirgüç-Kunt and Levine (2006a; 2006b) need to be revised. What they actually predict would be that more concentration is related to less intervention by the public authorities and not to a lower probability of systemic distresses, which is expected to augment instead.

In more recent years, Fernández, Gonzáles and Suárez (2013) explain how the competition in the banking sector (measured by the Lerner index) influences the effect of a systemic crisis on the real economy, using a sample of 36 systemic banking crises in 30 countries from 1980 to 2000. On average, market power turns out not to be an effective barrier against the propagation of the negative real effect of a financial crisis. The reason lies on the fact that high market power actually boosts growth during normal periods but engenders huge losses during financial downturns. However, the real effects of a more or less pronounced market power depend also on the country-specific features: market power is found to promote economic development during both crisis and non-crisis periods in countries where capital requirements are stricter or creditors' rights are not protected. Under these circumstances, market power favours the birth of lending relationships, which mitigate the credit reduction during adverse times.

Based on a sample of 145 countries between 1997 and 2010, Diallo (2015) studies the relation between competition and stability using three different measures of competition (Boone indicator, Lerner index and adjusted-Lerner index) and two econometric methods (a logistic probability analysis and a duration analysis). He shows that bank competition is negatively related to financial stability and this result remains robust for an array of controls including all the alternative methodologies. Hence, this paper strongly supports the competition-fragility view.

All the studies mentioned above provide relevant indications concerning the intervention of the regulatory and supervisory authorities. Political measures aiming at limiting bank activities and setting entry barriers are negatively associated with banking stability in Beck, Demirgüç-Kunt and Levine (2006a; 2006b) and Schaeck, Cihák and Wolfe (2009). Barth, Caprio and Levine (2004) address this topic more directly analysing a database of regulatory and supervisory policies in 107 countries. They find that policies that impose detailed

disclosure requirements entrust corporate control of banks to the private sector and incentivize private agents to exert control, represent the best solution to stimulate development, growth and stability of the banking sector. Quite surprisingly, the impact of capital requirements on bank stability is found not to be significant. According to another cross-country study on developed and developing countries between 1973 and 2002, the liberalization of the financial market reduces the likelihood of systemic crises, provided that the banking supervision is adequate and efficient (Shehzad and De Haan, 2009). However, the authors highlight that there is some evidence that the likelihood of individual banking crises increases after liberalization. Cubillas and González (2014) assess the way in which financial liberalization impact the banks' investment choices using an international sample of 433 banks in 83 countries between 1991 and 2007. Interestingly, less strict regulations always increase the riskiness of the banks' balance sheets but through different channels depending on the level of the institutional and economic development of the country. In more industrialized countries, financial liberalization is harmful for the stability of the banking system because it allows banks to undertake riskier activities; conversely, in less industrialized countries, liberalization is detrimental because it triggers an increase in the level of competition. The authors find that capital requirements are useful to mitigate the negative impact of the liberalization in both developed and developing countries. However, as long as the channels through which liberalization and stability interact are different, thorough policy measures should be tailored according to the specific features of the economic and institutional environment.

In summary, findings are clearly not unanimous and a well-defined path to follow is impossible to draw. Nevertheless, it is likewise clear that limiting contestability at all is no longer the unique strategy that government are suggested to pursue.

COMPETITION, CONCENTRATION AND INDIVIDUAL BANK STABILITY

In addition to the consideration relative to the systemic risk potential, De Nicolò et al. (2004) explore also how consolidation and conglomeration affect the risk of individual financial firms. The sample consists on the largest 500 financial institutions all around the world during the period from 1995 to 2000. Both consolidation, defined as an increase in size, and conglomeration, defined as an expansion in the scope of the activities, provide contrasting incentives in the decision-making processes. Looking at the consolidation effects, on the one hand the larger size allows exploiting economies of scale and benefiting from less volatile profits thanks to a better diversification; on the other hand, a larger structure is also more complex and may become too costly to be managed. Moreover, too-big-to-fail and moral hazard concerns may arise. Looking at the conglomeration effects, they may result in products and services diversification, but the supervision may become complex with the great risk to

extend bailout provisions to non-bank firms. All in all, the final outcome depends on whether the former or the latter effects prevail. The empirical evidence suggests that large banks and conglomerates are not less risky than smaller and more specialized institutions in 1995, whereas the level of risk is significantly higher in 2000. In particular, larger firms turn out not to be able to achieve a higher level of profitability or less volatile returns. In light of this, the authors conclude that the incentives to take more risks prevail on the benefits achievable thanks to the exploitation of economies of scale or scope.

Demirgüç-Kunt, Laeven and Levine (2004) analyse the impact of market structure, bank regulations and national institutions on banks' costs of financial intermediation using bank-level data from a sample of more than 1,400 institutions in 72 nations. Two measures of cost are employed. The net interest margin ($\frac{\text{Interest income - Interest expense}}{\text{Interest bearing assets}}$) focuses on the traditional banking activities of borrowing and lending, whereas the overhead expenditure ratio ($\frac{\text{Overhead costs}}{\text{Total assets}}$) reflects cost inefficiencies and market power. The authors measure the level of concentration employing the CR3 on assets and control for bank-specific features such as asset liquidity and volatility, capitalization and leverage, as well as for country-specific features such as restrictions on entry and activities, property rights and economic freedom. They find that the large part of the variation in the financial intermediary costs is determined by the bank's specific characteristics, but also by regulations together with national institutions. What is relevant for our issue is that there is not strong evidence regarding the link between concentration and net interest margins and between concentration and overhead expenditures. More specifically, the relationship is positive and robust when controlling for bank-specific features but becomes weaker when controlling for regulatory limitations and, more generally, for the institutional environment.

Martinez Peria and Mody (2004) study the effects of bank concentration on spreads and costs in a sample of developing Latin American countries during the late 1990s. The bank spread is the difference between the interest rate paid by borrowers and that due to depositors; it measures how much the financial intermediation is costly. Too large a spread may hamper the development of savings and loan markets since the cost of using the financial system may become unsustainable. In turn, the stability and the efficiency of the financial system decline. Undoubtedly, the magnitude of this process is much higher for developing countries. The authors find that concentration raises spreads significantly and is related to higher administrative costs. Thus, the stability of the banking sector is undermined when the level of concentration increases.

Beck, Demirgüç-Kunt and Maksimovic (2004) assess how the banking market structure impacts the way in which firms get access to finance. Using a sample based on 74 countries, they find that high concentration level and bank regulations that limit competition (like entry barriers and activity limitations) raise obstacles for financing, especially for small and medium-sized enterprises. However, a high level of institutional development together with a large share of foreign banks helps mitigating these obstacles and improves the firms' access to the credit market. These results are consistent with another empirical study of 29 OECD countries, where it is shown that in pro-competitive EU countries firms have an easier access to the credit market (Cetorelli, 2004).

Micco and Panizza (2005) focus on the relationship between bank concentration and credit volatility analysing a sample of 93 developed and developing countries from 1990 to 2002. What they find is a strong and negative relationship between market concentration and credit sensitivity to external shocks. Since more concentration leads to higher profits, banks with some monopoly power are able to put aside buffers that help them to maintain lending standards during periods of economic downturns, thus reducing the risk of contagion between financial institutions and maintaining the stability of the banking sector.

Schaeck and Cihák (2007) evaluate the impact of bank competition and concentration on bank stability for a pool of more than 2,600 banks in ten European countries between 1999 and 2004. Competition and concentration are measured by the H-statistic and the CR3 respectively, whereas bank soundness is captured by the ratio of equity to total assets. After controlling for bank-level and country-level variables that may affect the relationship between competition, concentration and stability, they find that the H-statistic enters all the regression with a positive and significant coefficient. This means that the banks operating in more competitive environments have higher capital ratios. The positive relation suggests that banks behave more prudently (by holding more capital) when the level of competition becomes harder. Although the stabilizing effect of competition relaxes when the banking industry is more concentrated and the degree of economic development is higher, data always show that bank capitalization is a channel through which competition fosters stability. In contrast with the theoretical literature, the regression does not point out any significant relationship between concentration and capital ratios.

Two particularly influential studies are those of Boyd, De Nicolò and Jalal (2006; 2009). As in Beck, Demirgüç-Kunt and Levine (2006a; 2006b), they analyse the relationship between competition, concentration and risk-taking. However, focusing on individual-bank fragility

rather than on systemic bank distress, they reach a diametrically opposite conclusion. Data belong to two different samples, a cross-country data set of about 2,600 banks in 134 non-industrialized countries from 1993 to 2004 and a cross-sectional sample of 2,500 banks in US in 2003. In this study competition is measured by the Herfindahl-Hirschman index and stability by bank-level measure such as the Z-score and the ratio between equity and assets (Carletti, 2010). In both samples they find that countries with a higher HHI are more likely to fail. This means that the probability of failure is lower in less concentrated countries, a result that is in line with the competition-stability hypothesis and rejects the competition-fragility theory. Moreover, they conclude that more competition seems to improve the willingness to land and eventually leads to a lower probability of bank's default.

The concentration-fragility view finds further support in the findings of Uhde and Heimeshoff (2009). Using balance sheet data of more than 2,600 European banks between 1997 and 2005, they provide evidence that concentration, measured by the CR5 on assets, is negatively related to individual bank stability, measured by the Z-score. What is of particular interest is the analysis of how each Z-score component reacts to an increase in concentration. They find that the relation between concentration and ROA, capital ratio and volatility of ROA is always positive. These results indicate that the overall negative relation between concentration and stability is determined by the higher return volatility of larger-size banks in concentrated markets.

Revisiting the debate on the competition-stability view, Amidu and Wolfe (2009) examine the relationship between competition, diversification and stability on a panel dataset of 978 banks from 2000 to 2007. Bank competition is measured by the H-statistic and the Lerner index; revenue diversification is measured by the Herfindahl-Hirschman index for each bank; bank stability is measured by the Z-score, capital ratio and NPL ratio. The calculation and the interpretation of this HHI differ from the standard one. Instead of a markets share measure, here the HHI is an indicator of revenue diversification.

$$HHI_{(REV)} = \left(\frac{\text{Non interest income}}{\text{Net operating income}}\right)^2 + \left(\frac{\text{Net interest income}}{\text{Net operating income}}\right)^2$$

where: Net operating income = Non interest income + Net interest income.

High values of $HHI_{(REV)}$ are interpreted as high revenue concentration and less diversification. The same process is repeated for diversification within non-interest activities.

$$HHI_{(NII)} = \left(\frac{\text{Commission income}}{\text{Non interest income}}\right)^2 + \left(\frac{\text{Trading income}}{\text{Non interest income}}\right)^2 + \left(\frac{\text{Other operating income}}{\text{Non interest income}}\right)^2$$

where: Non interest income = Commission income + Trading income + Other operating income.

The interpretation is the same as before. High values of $HHI_{(NII)}$ indicate more concentration.

Going back to the paper, the authors show that the relation between competition and stability is positive and significant, even if alternative measures are employed. The core finding is that as the environment becomes more competitive, banks react by diversifying their portfolio across and within interest and non-interest bearing activities, and this process contributes to make banks sound. Such a result remains robust to a set of control variables among which the regulatory environment and the funding structure.

Like the theoretical and the single-country empirical studies, cross-country findings highlight once again that the relationship between competition, concentration and stability is multifaceted. Just to sum up, cross-country studies mostly point to the following:

- Liberalization leads to an increasing fragility of the banking sector if not matched with a solid institutional environment and adequate regulations;
- Some measures of competition indicate a positive correlation between competition and stability;
- The connection between concentration and stability is ambiguous;
- Larger banks tend to be better diversified but the related benefits might be counterbalanced by excessive risk-taking.

2.4 MIXED CONCLUSIONS

Too much ado about nothing? Undoubtedly someone thinks so. Neither the academic nor the empirical literature has reached unambiguous conclusions and the connection between competition, concentration and stability is still uncertain. Zigraiova and Havranek (2015) collect 598 estimates of the relation between competition and stability from 31 recent studies (from 2006 to 2014) applying meta-analysis methods[26]. Given that the measures used to proxy for competition and stability have a broad scope, all the individual estimates are standardized to a common metric, called Partial Correlation Coefficient (PCCs)[27]. In this way, the results reported in different studies can be easily compared.

[26] In any area of study, meta-analysis consists in a second-level research whose aim is to summarize the results reached in the primary research.

[27] $PCC = \frac{t}{\sqrt{t^2+df}}$, where t is the t-statistic of the reported coefficient and df indicates the degrees of freedom of the estimation.

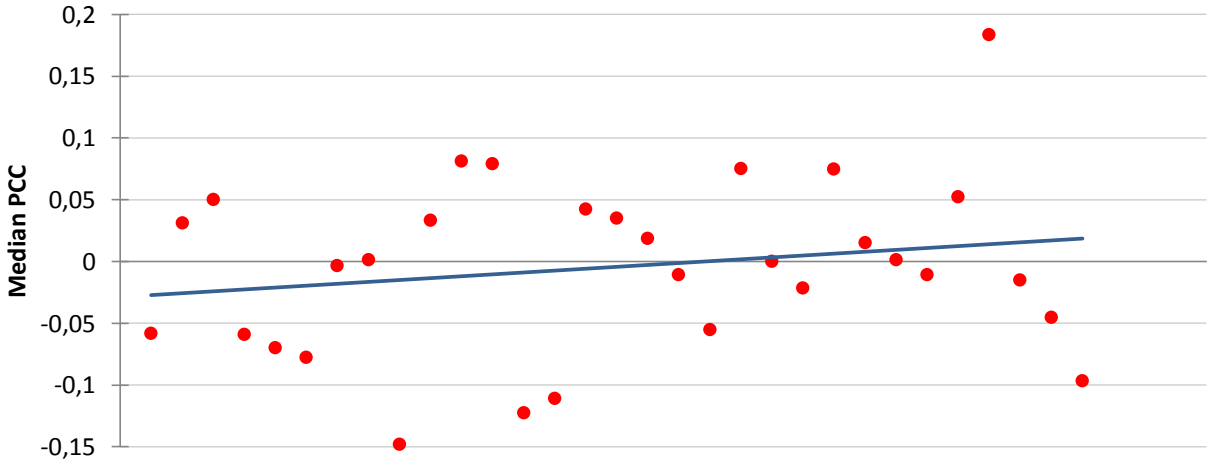


Figure 7: PCCs computed on the basis of the correlation between competition and financial stability as reported in each study. In the event of more than one correlation coefficient per study, the median value is taken. Source: graph based on data reported in the appendix to the paper available at http://meta-analysis.cz/competition/.

As clearly visible from figure 6, if taken together, the estimates provided by the empirical literature suggest no interconnection between competition and stability. The estimated coefficient are scattered and the line showing the linear fit, though upward sloping, is not statistically significant. According to the authors' in-depth analysis, the great variability in the coefficients is due to the fact that the way in which the calculations are made influences the results systematically. Not only the definition of competition and stability but also the dataset used, the methodology employed and the variables included as control affect the estimations.

At this point one could definitively think that a satisfactory conclusion cannot be reached. Luckily, this is not correct at all. In addition to the papers that fit well under either the competition-stability or competition-fragility label, there is another group of works that try to put together the two contrasting strands of literature, arguing that the predictions made can be combined into a unique model that better describes what actually happens in the real world.

Martinez-Miera and Repullo (2010) develop a model that finds its basic features in that outlined by Boyd and De Nicolò (2005). However, they criticize the assumption that the loan defaults are perfectly correlated and therefore also the idea that the loans' probability of default determines the bank's probability of default. It is arguably much more realistic to assume that loans are not perfectly correlated. Martinez-Miera and Repullo extend the Boyd and De Nicolò (BDN) model by assuming an imperfect correlation in the loans' probability of default and also by considering that more competition shrinks the interest incomes coming from performing loans. According to this new setting, more competition triggers two effects that go in opposite directions. On the one hand, more competition lowers the loan rates, which in turn reduce the borrowers' probability of default and their incentives to invest in risky

projects. This channel is defined *risk-shifting effect* and works as identified by BDN. On the other hand, by allowing for imperfect competition of loan defaults, lower landing rates induced by increased competition reduce the payments from non-defaulting borrowers, who would be able to fulfil the lending agreement even at a higher interest rate, thus providing a buffer against loan losses. This channel is defined *margin effect*. The final effect of an increase in competition is theoretically ambiguous, depending on which of the two effects prevails. Numerical solutions show that, when the number of banks is relatively small, i.e. in very concentrated markets, the risk-shifting effect prevails; therefore, any further entry improves the banks' stability. By contrast, when the number of banks is sufficiently large, i.e. in more competitive markets, the margin effect dominates and additional entries make the banking system more fragile. Under this innovative framework, the relationship between competition and risk of failure is no longer monotonic but U-shaped. This means that as the number of banks in the market keeps growing, the banks' probability of failure first declines and then increases.

An alternative explanation of the potential non-linearity in the competition-stability relationship is that presented by De Nicolò and Lucchetta (2011) in their general equilibrium model with moral hazard, partially based on their work of two years before (De Nicolò and Lucchetta, 2009). They take two versions into account. In the first one, called *basic*, the bank is a coalition of entrepreneurs that raises funds from the depositors; there are only two players and competition is at deposit level only. In the second one, called *extended*, the firm is a coalition of entrepreneurs financed by the bank, which is a coalition of bankers financed by depositors; there are three players and competition is both at deposit and loan level. In both versions, there are two specifications in relation to the bank's screening technology (called *intermediation technology*). According to the first one, the technology function presents constant returns to scale, i.e. the cost of screening and monitoring is proportional to the size of the investment made by the borrower; according to the second one, the technology function presents increasing returns to scale, i.e. the cost of screening and monitoring is independent of the size of the borrower's investment. Below a summary of the results:

- Basic model:
    - The technology shows constant returns to scale: competition increases the overall bank risk and shrinks capital cushions. The maximum welfare can be reached at an intermediate level of competition in the deposit market.
    - The technology shows increasing returns to scale: results fully overturn. The increase in the cost of funding prompted by the competition is more than

counterbalanced by the reduction of the intermediation technology costs. Eventually, an increase in the level of competition enlarges the expected profits and reinforces the stability of the banking sector. It is not necessary to introduce the competition in the loan market, as in Boyd and De Nicolò (2005), to find a positive relationship between competition and stability.

- Extended model (more realistic): if the intermediation technology is inefficient, i.e. high monitoring costs and low set-up costs, an intermediate level of competition is optimal; if the intermediation technology is efficient, i.e. low monitoring costs and high set-up costs, perfect competition is optimal. The returns of the intermediation technology are not relevant in this framework.

Not only theoretic but also empiric models try to find a linkage between the competition-fragility and the competition-stability paradigms. Berger, Klapper and Turk-Ariss (2009) study the effect of competition on individual bank risk using a sample of 8,235 banks operating in 23 different developed countries. They use the NPL ratio, the Z-index and the capitalization ratio (Equity over Total Assets) as proxies for bank stability and the Lerner index and the HHI both on deposits and loans as proxies for market power. In building the regression model, they control also for other bank-specific features (asset composition, bank size, foreign ownership) and country-specific features (activity restrictions, banking freedom, legal rights). Furthermore, following Martinez-Miera and Repullo (2010), they allow for a non-linear relation between bank stability and degree of competition. Since the relationship between market power measures and NPL ratio is positive, data suggest that banks with higher market power have riskier portfolio, which is consistent with the competition-stability view. However, the relation between market power measures and the Z-index is positive too[28], providing evidence that banks with higher market power present a lower overall risk exposure. This latter result is consistent with the competition-fragility hypothesis. The reason for this ostensible contradiction is that banks with more market power seem to offset the higher loan risks by holding more equity capital, by maintaining a smaller portfolio or by employing other risk-mitigating techniques. The relation between competition and capital ratios is found to be significant only when employing the HHI on total loans as explanatory variable.

Beck, De Jonghe and Schepens (2013) combine the two stands of literature and argue that the relationship between competition and stability shows a great variability across regulatory

[28] Keep in mind that the Z-index is an inverse measure of fragility. High values indicate a greater distance from insolvency.

frameworks, market structures and degrees of institutional and economic development. On the basis of a sample of more than 17,000 banks from 79 industrialized and non-industrialized countries over the period 1994-2009, they find that on average the relation between market power (captured by the Lerner index) and stability (measured the Z-score) is positive, even if the cross-country variation is large, with estimates ranging from strongly negative, over insignificant to significantly positive. In particular, they argue that the specific characteristics of a country may alter the strength with which market power affects stability via three possible channels.

Institutional and financial characteristic: more effective systems of credit information sharing and better developed (more liquid) stock markets enhance the positive effect of market power on financial stability.

Regulation and supervision: a certain type of regulation may set some limits on the possibility that a bank in financial troubles engages in risky activities, in order to limit the deterioration of the soundness of the entire financial system. A more generous deposit insurance makes the relationship between market power and stability stronger, whereas a more stringent capital regulation, the presence of multiple supervisors and the introduction of an external governance are found not to be significant to shape the competition-fragility nexus.

Herding[29] and market structure: they may affect the moral hazard and adverse selection problems when the financial system is under pressure. In particular, stricter activity restrictions, a more similar revenue structure among banks and large aggregate capital buffer to cover industry wide losses strengthen the market power-stability relationship.

To sum up, the findings obtained by Beck, De Jonghe and Schepens are useful to reconcile seemingly conflicting empirical studies. Market, regulatory and institutional frameworks can be determinant to favour the validity of either the competition-stability/risk-shifting or competition-fragility/charter-value view.

Ben Ali, Intissar and Zeitun (2015) analyse the relationship between concentration and financial stability for a sample of 173 industrialized and not-industrialized countries between 1980 and 2011, finding evidence that supports both the concentration-stability and the concentration-fragility paradigm. The methodology followed differs from the other studies. The authors ask whether also an indirect channel exists besides the conventional direct one, through which concentration may influence the occurrence of financial troubles. In order to

[29] Herding refers to the covariation of banks' behaviour, that is how much banks move together. It is an important feature of the market, especially from a supervisory perspective. The decision on whether or not to intervene is determined also by the number of banks that are at risk simultaneously.

answer the question, they test two possible transmission channels: the return on assets and the net interest margin effects. Systemic crisis is captured by a dummy variable (0, 1), concentration is measured by the CR3 on assets, the return on assets (ROA) is defined as net income over total assets and the net interest margin as net interest income over total earning assets. With reference to the direct channel, the results of the regression model indicate that the correlation between concentration and systemic crisis is negative but not statistically significant. As a consequence, they conclude that changes in the concentration level do not have a direct impact on the stability of the financial system. Conversely, the indirect effects are robust. The profitability channel captured by the ROA is consistent with the theory that in more concentrated banking systems banks have a higher market power and hence larger revenues, which in turn increase their capital buffers and enhance the capacity of the banks to deal with negative externalities successfully. Thus, this first indirect effect is stabilizing: more concentration leads to more stability. On the other hand, the interest rate channel supports the theory according to which more concentrated institutions charge higher interest rates on loans. Therefore, since the least risky customers are likely not to borrow at these rates, the quality of the banks' balance sheet is expected to deteriorate, thus increasing the risk of incurring in financial troubles. The second indirect effect is therefore destabilizing: more concentration enhances the probability of default. When considering cross-country heterogeneity, the results show that the stabilizing effect of concentration prevails for the developing countries only; for the subsample including the developed countries, the empirical evidence is consistent with both the stabilising and the destabilising effect.

In conclusion, this survey of the empirical literature proves that the nexus between competition, market structures and stability, is multifaceted and it is very hard to draw any strong conclusion. This widespread uncertainty makes it necessary to run a case-by-case analysis, which may be something that would explain the diversity of political approaches adopted by the different governments until now. In order to try to give a useful contribution to the study of the relationship between competition and stability, in the following chapter we present a thorough empirical analysis.

CHAPTER 3
EMPIRICAL ANALYSIS

In this chapter we investigate the relationship between competition and stability in the banking sector for the time-period between 1996 and 2014. In carrying out this analysis we follow the methodology used by Beck, De Jonghe and Schepens (2013) to choose the sample data and explain the cross-country heterogeneity. However, this is not a simple revisit. We incorporate the most recent cross-country time-series data and provide innovative evidence with regard to the non-linearity in the relationship between competition and stability. The chapter is structured as follows: the first part is about the methodology and the empirical models employed, the second part concerns the variables on which we rely, the third part includes the presentation and interpretation of the results.

3.1 METHODOLOGY

As we have seen in the previous chapter, the empirical literature has traditionally shown two different approaches to stress if and how competition can affect the stability of the banking sector: a single-country or a cross-country setup. Since the studies based on the first approach have outlined a great fluctuation in the results reached, we apply a cross-country model in line with the most recent research and with the aim of gaining better insight into the competition-stability relationship. In order to determine the relationship between competition and stability, the first step is to regress a measure of bank stability on a measure of competition. In addition to this, as long as the stability of the banking system is driven not only by the level of competition but also by bank-specific and country-specific features, both are included as explanatory variables. The first econometric model we use takes the following form:

Eq (1): $$Stability_{i,j,t} = \alpha + \beta * Competition_{i,j,t-1} + \gamma * \boldsymbol{X}_{i,j,t-1} + \delta * \theta_i + \boldsymbol{\nu}_{j,t} + \varepsilon_{i,j,t}$$

In this setup, *i, j* and *t* denote the bank, the country and the time, respectively. Stability is the dependent variable; competition is the explanatory variable; $\mathbf{X}_{i,j,t-1}$ is a vector of bank-specific variables that capture the bank's business model; θ_i stands for a dummy variable that refers to the bank's specialization (commercial, savings or cooperative bank); finally, $\mathbf{v}_{j,t}$ is a vector of country-year dummy variables (that is to say, a dummy variable for each country-year pair), which captures the influence of unspecified global factors that vary over time. The independent variables capturing the level of competition and the bank-specific characteristics

are introduced in the model with one-period lag to mitigate problems of reverse causality. The coefficient $\beta_{j,t}$ is our top-interest parameter given that it documents the relation between competition and stability. As it will be detailed later on, the β coefficient is positive on average but it shows a large degree of variation across countries and over time as well (albeit to a lower extent). In order to have a better knowledge of what drives this heterogeneity, we modify the previous model incorporating country-specific variables:

Eq (2): $Stability_{i,j,t} = \alpha + (\beta_0 + \beta_1 \boldsymbol{Z}_{j,t}) * Competition_{i,j,t-1} + \gamma * \boldsymbol{X}_{i,j,t-1} + \delta * \theta_i + \boldsymbol{\nu}_{j,t} + \varepsilon_{i,j,t}$

where $\mathbf{Z}_{j,t}$ is a vector of country-specific variables (or just one of these variables depending on the specification) that capture the impact of regulation, supervision, market structure, financial and institutional environment. All the other variables have the same meaning as the original regression model[30]. By means of this second setup, we avoid running into a spurious relationship between competition and stability that might have been determined by country-specific features affecting the level of both competition and stability. We continue to include country-year fixed effects and lagged independent variables for the same reasons as before.

Finally, following Martinez-Miera and Repullo (2010), we developed a third model to verify the existence of a non-linear relationship between banking stability and competition:

Eq (3):

$Stability_{i,j,t} = \alpha + (\beta_0 + \beta_1 \boldsymbol{Z}_{j,t} + \beta_2 \boldsymbol{X}_{i,j,t-1}) * Competition_{i,j,t-1} + \beta_3 * Competition^2_{i,j,t-1} + \gamma * \boldsymbol{X}_{i,j,t-1} + \delta * \theta_i + \boldsymbol{\nu}_{j,t} + \varepsilon_{i,j,t}$

where all the variables and their meaning are the same as in the previous models.

Summary statistics of the variables employed are reported in Appendix 1.

3.2 DATA

3.2.1 DATA SOURCES

In order to make our econometric model operational, we collect data from different sources. Bank-specific variables have been retrieved from Bankscope, a database provided by Fitch/Bureau van Dijk, which contains data on balance sheets and income statements of banks all around the world on the basis of publicly available information. By contrast, variables referring to country-specific features have been obtained from more than one source. Subsequently, they have been matched with bank-level ones depending on the country where the bank is located (based on the information provided by Bankscope). Overall, data have

[30] As a matter of fact, the first model, Eq (1), can be interpreted as a specific case of Eq (2) where β_1=0.

been collected for the period between 1996 and 2014. Although most of the data are available for the entire time-span, some indicators have a more limited coverage[31]. Once data have been collected, we apply some selection criteria relying on the approach followed by Beck, De Jonghe and Schepens (2013). First of all, we restrict our analysis to commercial, savings and cooperative banks only, which cover 72%, 13% and 15% of our sample, respectively. Moreover, when both consolidated and non-consolidated statements are available, we consider consolidated statements only to avoid double counting. This yields a sample of 23,419 banks operating in 200 countries. After this preliminary selection, some additional filtering criteria have been applied to delete non-representative data. Firstly, we eliminate those banks that lack the data we need to calculate the measures of stability and competition over the whole period taken into account. Secondly, in line with many empirical works, we remove banks with missing data on income statement and balance sheet basic variables. Following Berger, Klapper and Turk-Ariss (2009), we carefully drop banks and not just bank-year observations in order to maintain the explanatory power of the panel data. Thirdly, we eliminate banks belonging to countries for which data on many country-specific features are not collected and reported or with less than 50 bank-year observations over the whole sample period. After employing these selection procedures, the sample consists of 20,031 banks from 113 countries, both developed and developing[32]. As long as the overwhelming majority of the banks in the sample operate in the US (roughly 50%), we decide to limit this overrepresentation. Specifically, for each time-period we include the largest 150 US banks and 1,800 randomly chosen US banks. After that, we winsorize all variables to lessen the influence of outliers. In particular, we drop all values lying at the top and bottom 0.5% of the distribution of each variable[33]. An additional consideration we made is relative to the currency in which bank-specific variables are expressed. Although most of the indicators are ratios, with regard to those in level, they are expressed in 2014 US dollars in order to avoid the effect of the inflation[34].

3.2.2 DESCRIPTION OF THE VARIABLES

This section is devoted to the descriptions of the most important variables in the model, starting from those used to gauge the level of financial stability and market power and then moving to the other bank-specific and country-specific variables. It is worth noting from the

[31] See appendix 2 for a more detailed description of source and coverage of each variable.
[32] See appendix 3 for an in-depth survey of the countries included in the sample.
[33] However, we run a regression with no-winsorized data as supplemental control. See the section relative to the robustness analysis for any detail.
[34] Actually, bank size (measured by total assets) is the only variable in level entering the regression model directly. Other variables in level are employed indirectly, for example to calculate the Lerner index.

beginning that we need bank-level measures of stability and competition to exploit cross-country and cross-time variations in their relationship, since country level indicators would not permit to understand the heterogeneity in the competition-stability relationship across different countries. Therefore, we employ two well-known bank-level indicators: the Z-score to measure the soundness of the banking system and the Lerner index to capture the level of competition in the market.

MEASURE OF STABILITY: Z-SCORE

The measure of stability employed is the Z-score, a bank-level indicator that proxies the single bank's distance from insolvency; hence, higher values indicate less risk. As already stated in the previous chapter, the Z-score is an indicator that combines profitability, leverage and return volatility into a single number. It is calculated as $\frac{ROA+\frac{E}{TA}}{\sigma_{ROA}}$, where ROA is the period-average return on assets, E/TA the period-average ratio between equity and total assets and σ_{ROA} the standard deviation of ROA calculated over three years[35]. Following Beck, De Jonghe and Schepens (2013), we prefer to compute the standard deviation of ROA over a window of three rolling years rather than the entire sample period because of two reasons. Firstly, we avoid within bank variations to be determined exclusively by variation of the numerator, i.e. profitability and capital structure. Secondly, as long as the panel is unbalanced, we avoid the standard deviation to be calculated over periods of different length for different banks. Starting from raw data, we determine one value per bank each year, even if more than one year of data is employed to calculate the denominator of the Z-score (Berger et al., 2009). The Z-score takes higher values when profitability and capital levels are higher and when returns are less volatile. In line with many other empirical works, the Z-score enters the regression after a natural logarithm transformation to smooth extreme values. The ln(Z-score) ranges from 0.073 to 8.613 with an average of 4.291 and a standard deviation of 1.407. As we can see in Appendix 1, the Z-score varies more among banks (standard deviation is 1.093) than within banks (standard deviation is 0.926). If we take a look at the averages by country[36], the more stable one is Switzerland with a value of 5.308 whereas the less stable is Uruguay with a value of 2.605.

MEASURE OF COMPETITION: LERNER INDEX

The level of competition in the market is captured by the Lerner index. It is a measure of market power computed at bank-level that captures the mark-up of prices over marginal costs. In other words, market power is proxied by the percentage by which prices exceed marginal

[35] If the available data did not cover three consecutive years, we did not compute the Z-score.
[36] See Appendix 3.

costs. Mathematically, the Lerner index is constructed as $\frac{P_{i,t}-MC_{i,t}}{P_{i,t}}$, where $P_{i,t}$ denotes the price and $MC_{i,t}$ the marginal costs. As usual, *i* and *t* indicate the bank and the time, respectively. Higher values denote more market power and, hence, less competition. The price of bank activities is proxied by the ratio between total operating income and average total assets. As long as banks are allowed to engage in both interest and non-interest based activities, we include both interest revenues (interest income on loans and dividends) and non-interest revenues (net gains on trading activities, securities and assets evaluated at fair value through profit and loss statement, net fees and commissions). On the other hand, marginal costs are derived from a translog cost function, which puts in relation the total operating costs with three input prices: price of bank activities, price of labour and price of borrowed funds[37]. Modelled in such a way, the Lerner index captures the effects of the bank's pricing power on both the investment and funding side of the banking industry, thus resulting in a measure for current and future profits that embraces the original concept of franchise value (Beck, De Jonghe and Schepens, 2013). As reported in Appendix 1, the Lerner index ranges from -0.926 to 0.656, with an average of 0.211. As in the case of the Z-score, the variation is mainly between banks rather than over time. If we look at the average Lerner index by country[38], competition reaches its minimum level in Qatar with an average Lerner index of 0.497 and its maximum level in Ireland with an average Lerner index of -0.265.

Although in the most recent research works the Lerner index has become the most commonly used measure of market power, many other cross-country studies rely on other indicators, mainly at country-level but also at bank-level. As already explained in the introduction to the paragraph, country-level indicators cannot be successfully employed under this setup. Despite this, we are interested in studying if the Lerner index is related in some way with the other measures of competition and market structure that have been used in other empirical works. The correlation table in Appendix 5 reports the pairwise correlations between the Lerner index and other measures of market power and concentration. Among the measures of market power there are the H-statistic and the Boone indicator, whereas among the measures of concentration there are the number of banks, the Herfindahl-Hirschman index (calculated on three different bases: total assets, gross loans and total customer deposits) and the CR3 and CR5 based on total assets. Moreover, we also include the average market share, calculated for a given country and year on both total assets and total loans. Since all these indicators are at country-year level, we calculate the country-year averages of the Lerner index and the market

[37] See Appendix 4 for a detailed description of how marginal costs have been derived.
[38] See Appendix 3.

share in order to make data comparable. As results from the correlation table, the Lerner index is meaningfully and statistically related to all the other indicators but three (H-statistic, Boone indicator and number of banks). These findings suggest that the Lerner index is a powerful measure of competition, which incorporates many features of the economic environment. In conclusion, the Lerner index remains preferable over the other measures at least because of two reasons: the first one is that it varies across banks, thus letting emerge any cross-country heterogeneity; the second one is that it incorporates the concept of franchise value into one number, thus creating a link between theoretical models and empirical evidence. In any case, it is heartening to know that the Lerner index is strongly correlated to other measures of competition.

Because of its central role played in this analysis, we take strong care of the accuracy of the relationship between Z-score and Lerner index. Since both indicators have profitability as component of the numerator, we must be sure that any relationship arising between the two does not turn out to be simply mechanical. We approach the problem as suggested by Beck, De Jonghe and Schepens (2013), i.e. by considering first of all how the two indicators fluctuate over time. Appendix 6 provides information on the time series evolution of the Lerner index and the Z-score (upper figure) as well as of the Lerner index and the denominator of the Z-score, profit volatility (lower figure). The former graph, which plots the Lerner index and the Z-score, highlights that the two indicators follow the same path over time, thus providing evidence of a positive correlation between stability and market power. The latter graph, which regards the Lerner index and the profit volatility, shows that market power and profit volatility are negatively correlated, that is to say that less competition is related to lower profit volatility. That both graphs bring the same results is a first signal that Lerner index and Z-score are not mechanically related by having profitability as first order driver. Later on, further evidence about this thorny problem will be provided.

BANK-SPECIFIC VARIABLES

This set of variables is included in our econometric model to control for the bank's business model. All the indicators are computed at bank level using data from Bankscope database. Appendix 1 reports summary statistics, whereas Appendix 2 reports data sources and the years covered.

Share of wholesale funding: calculated as share of wholesale funding in total funding, it is a liquidity measure that describes the bank's debt structure. Wholesale funding is calculated as money market funding plus other borrowings (i.e. public funds, foreign deposits, brokered deposits), whereas total funding is calculated as wholesale funding plus total customer

deposits. It ranges from 0% (i.e. a bank financed entirely by customer deposits) to 99.9% (i.e. a bank financed almost entirely by sources other than customer deposits). The average is 18% and most of the variation occurs between banks rather than within banks over time.

Loans to total assets: calculated as ratio between net loans and total assets, it proxies for the composition of the asset side of the balance sheet. It is a liquidity ratio that indicates the proportion of assets tied up in loans. The higher this ratio, the lower the liquidity available for the bank and the higher the exposure to credit risk. It ranges from 0.5% to 95%, with an average of 58%. Variations are mainly among banks.

Non-interest revenue share: calculated as percentage of non-interest income in total income, it proxies for the composition of the bank's source of revenues. Non-interest income includes net income from fees, asset trading and sale and insurance activities; total income includes both interest and non-interest bearing proceeds. It ranges from 0% to 100%[39], with a mean of 27%. Variability is again determined by between-banks variations rather than within-banks variation.

ln(total assets): calculated as the natural logarithm of total assets, it proxies for the size of the bank. Since data are highly skewed, this variable is taken in logs to smooth out the largest values. It ranges from 1.3 to 12.8, with an average value of 6.2. The standard deviation is quite high (1.88) and mostly determined by variation among banks.

Loan loss provisions to interest income: calculated as loan loss provisions divided by total interest income, it proxies for the bank's credit risk. This ratio should be as low as possible and high values indicate that risk is not properly counterbalanced by higher margins. It ranges from -77% to +226%[40] and averages out at 15%. In contrast with the previous indicators, variations take place both among banks and within banks over time with a similar magnitude.

Annual growth in total assets: calculated as year-to-year growth of total assets, it controls for the bank's strategy and asset development. Data are quite skewed, ranging from -46% to 200%. On average, banks experience an 11% annual growth rate with quite high variations, which can be observed both between banks and over time.

Specialization dummies: three specialisation dummies which lead to the classification of banks into the three types in our sample: commercial banks (70%), savings bank (14%) and cooperative banks (16%).

[39] In Appendix 1 the lowest value reached is -38%. This is due to the fact that some losses (on trading and derivatives, securities and assets at fair value) are included in the computation of the indicator and, hence, the final ratio may turn negative. Neglecting the accounting procedures, from an economic point of view, the share of revenues coming from non-interest bearing activities can be at least equal to 0%.

[40] The ratio is negative when loan impairment charges are negative.

COUNTRY-SPECIFIC VARIABLES

As anticipated in the previous sections, the relationship between competition and stability presents substantial variations when controlling for bank-specific features only. Therefore, we introduce different country-specific factors to see if and how they contribute to generate such cross-country heterogeneity. Unlike the abovementioned bank-specific variables, these ones exhibit much larger variations both across countries and within countries across time. The description of the variables employed follows these steps: firstly, we explain the economic meaning and the way in which the variable has been computed; secondly, we present some summary statistics to give an insight into the order of magnitude of the variables involved; lastly, we report the correlation with the other country-specific variables. Appendix 1 contains summary statistics, Appendix 2 data sources and the years covered, Appendix 7 correlations among all the country-specific variables.

Depth of information sharing: it captures the strength, scope, accessibility and quality of credit information content available through private or public credit bureaus in different countries. The index ranges from 0 to 6, with higher values denoting that there is more information at disposal to facilitate the lending decisions. More in detail, a score of 0 indicates that the registry is not operational or that it covers less than 0.1% of the adult population. Then, a score of 1 is given for each of the following features that the country credit registry has: 1- data on both individuals and firms are available; 2- the data available are both positive (i.e. original loan amount, on-time payments) and negative (i.e. late payments, number of defaults); 3- in addition to those from financial institutions, information comes also from retailers or utility companies; 4- historical data cover at least two years; 5- data on loan amounts below 1% of income per capita are distributed; 6- by regulation, borrowers have the right to access their data in the largest registry of the economy (Getting Credit Methodology, Doing Business Database). Looking at the trend over time, the quality of the information content of credit registries has increased over the years. In only ten years the average score moved from 3.15 in 2005 to 4.46 in 2014. What we expect to obtain from the data is that in countries with a more developed credit information system, an increase in market power enhances the stability of the banking system by more. The economic reasoning is the following: knowing that if they fail to repay a loan, it will be more difficult for them to obtain another one, borrowers choose less risky projects. Equally, a reduction in market power is more detrimental to the financial stability because banks may loosen their screening criteria if there are less information asymmetries.

Stock market turnover: it is gauged as total value of stocks traded divided by average market capitalization for the period. The ratio between stocks traded and stocks listed is usually interpreted as an indicator of how much the financial market is developed. Where stock markets are more developed, firms do not have to rely strongly on bank-based funding but can easily switch to alternative sources of funding. On the other hand, more information disclosure is required and reputation losses may easily spread to other markets. All these rationales can impact on the way in which competition affects the investment choices of the banks. Taking a look at our sample, the index ranges from 0 to more than 4 with an average of 1. Stock market turnover and depth of information sharing are positively and significantly correlated among each other, i.e. countries with better credit information systems are more likely to have more developed stock markets.

Capital stringency: this indicator provides information on the strength of capital regulation in terms of components and minimum amount of capital that banks must have. It ranges from 0 to 10, with higher values denoting greater stringency. It consists of two parts: an overall capital stringency indicator, which addresses how minimum capital adequacy is determined and gives 0 to 7 scores, and an initial capital stringency indicator, which deals with the sources of fund that can be used to capitalize a bank at the initial stage and gives 0 to 3 scores. In our sample, the index ranges from 1 to 10 with an average of 6.6. It is noteworthy that capital regulation has become more stringent over time, moving from 5.79 in 2000 to 7.32 in 2013. Following many theoretical predictions and in light of the enactments of the governments in recent years, we hypothesize to find that capital regulation restrains the negative effects of the competition on bank soundness. The stringency of capital requirements tends to be lower in countries with more developed credit information sharing (the correlation between the two indicators is negative).

Deposit insurance coverage: calculated as ratio between deposit insurance coverage and GDP per capita, it tells us how much generous the insurance scheme is. On the one hand, generous deposit insurances limit the risk of bank runs; on the other hand, these may give birth to moral hazard problems. When deposit insurances are inappropriate, banks may find profitable to invest in high-risk lines of business. In our sample, deposit insurances range from 33% of GDP per capita to more than 16 times GDP per capita, with an average of 2.5 times[41]. In the regression model, this variable is used in logs. Deposit insurances are more generous where restrictions on bank activities are stronger and bank revenues are homogeneous.

[41] There are several countries without deposit insurance mechanisms, among which China, Israel, Egypt, Saudi Arabia and United Arab Emirates. When we winsorized the dataset, these countries have been excluded.

Multiple supervisors: this indicator takes just two values, 0 or 1, according to whether there is a single or multiple official supervisory authority. Having multiple supervisors improves the effectiveness of the supervision, thus reducing the banks' incentives to make too risky investments. On the other hand, the presence of more than one supervisor may lead to a detrimental overlapping of roles and areas of influence, thus generating regulatory uncertainty. This ambiguity is reflected in our data: currently, only two countries out of five prefer to rely on multiple supervisory authorities. The indicator is positively correlated with credit information sharing and stock market turnover.

External governance index: this indicator ranges from 0 to 19 and results from the sum of the scores obtained by the country with reference to four different parameters: effectiveness of external audit (0-7 scores), financial statement transparency (0-6 scores), accounting practices (0-1 scores), accuracy of the evaluations performed by external rating agencies and incentives for creditors to monitor the performances of the banks (0-5 scores). Higher values indicate better external audit, more transparency, better accounting practices and better credit monitoring. In our sample, the evaluation of the performances of the external governance ranges from 7 to 18, with an average of 13.6. It is interesting to notice that on average private monitoring mechanisms have become more powerful over time. In 2000, the average score is less than 12, whereas in 2010 it is approximately 15. The correlation table in Appendix 7 shows that external governance is more effective when capital stringency is higher.

Activity restrictions: this indicator measures if banks are allowed to invest in activities other than the traditional ones. The index ranges from 4 to 16 and combines four indicators which give 1 to 4 scores each. These indicators measure the extent to which banks may engage in securities activities (underwriting, brokering and dealing), insurance activities (underwriting and selling), real estate activities (investment, development and management) and non-financial activities other than those strictly related to the banking business (for example, owing voting shares in non-financial firms). Higher values indicate more restrictive rules and hence more difficulties for banks to diversify away from the traditional interest-based activities. A stricter regulation should prevent banks engaging in speculative activities but might make the overall banking system more vulnerable to external shocks[42]. Our sample shows data that go from 4 to 16, with an average of 9.1. Variations are limited and mainly across countries. Activity restriction is positively correlated with deposit insurance coverage and negatively related to credit information sharing and heterogeneity in revenues.

[42] If banks' balance sheets are similar, an economic shock will have similar effects on all banks, thus increasing the systemic risk.

Heterogeneous bank revenues: this indicator looks at the banks' revenue structure. Mathematically, it is built as the within-year, within-country standard deviation of non-interest income share. Being a measure of dispersion, it can be interpreted as an indicator of how much banks behave similarly. High values denote very heterogeneous banking systems where the financial institutions present substantial revenue differences. The converse holds for low values. In our sample, the index ranges from 0.05 to 0.33 with an average of 0.16. Neither between countries nor over time variations are relevant. Heterogeneous bank revenues is positively correlated with depth of information sharing whereas it is negatively correlated with activity restrictions and systemic stability. This is very interesting and perfectly rational at the same time: banks with similar revenue structures are more likely in countries with more restrictions on bank activities (if banks cannot diversify, their sources of revenue will be similar) and riskier banking systems (if the financial market is uncertain, banks will seek refuge into the same assets).

Systemic stability: it is proxied by the aggregate Z-score, which is the Z-score calculated at country-level for each year. Analytically:

$$Z - score_{j,t} = \frac{\frac{\sum_{i=1}^{n} Net\ income_{i,j,t}}{\sum_{i=1}^{n} Average\ total\ assets_{i,j,t}} + \frac{\sum_{i=1}^{n} Equity_{i,j,t}}{\sum_{i=1}^{n} Total\ assets_{i,j,t}}}{\sigma(ROA)_j}$$

where *i*, *j*, *t* denote the bank, the country and the time, respectively. The standard deviation of the return on assets is calculated over the entire period. The country-level Z-score measures how large the capital buffer provided by the overall banking industry to face wide losses is. In the regression model this variable is used in logs. The ln(country Z-score) ranges from -0.66 to 3.73, with an average of 2.59. The only statistically significant correlation is that with revenue heterogeneity, as described just before.

3.3 EMPIRICAL RESULTS

In this section, we show the empirical results we reached. In the first part, we present the findings when assuming a homogeneous relationship between competition and stability. In the second part, we investigate how this average relationship varies over time (cross-time heterogeneity) and between countries (cross-country heterogeneity). In the third part, we integrate the existing model by adding country-specific variables to analyse the influence of different macroeconomic environments. In the fourth part, we explore the non-linear nature of the relationship between market power and stability. All these results are reported in Appendices 8 to 12.

3.3.1 COMPETITION AND STABILITY: HOMOGENEOUS RELATIONSHIP

In this setup, we regress the natural logarithm of the Z-score on the Lerner index and a set of bank-specific control variables, while controlling also for country-year fixed effects, as specified in Equation 1. The outcomes are shown in Appendix 8.

The results in **column 1** provide evidence of a positive and statistically significant relationship between market power and bank soundness. This means that a reduction in market power, or otherwise an intensification of the competitive conduct, reduces the stability of the banking system. Thus, the results support the competition-fragility view while they reject the competition-stability view. It is worth noticing that the results are relevant not only from a statistical point of view, but also from an economic perspective. Since the Z-score in used in logs, the coefficient of the Lerner index can be interpreted as a semi-elasticity[43]. If the Lerner index falls by one standard deviation (0.1533[44]), the Z-score falls by 21.5%. Having in mind the economic meaning of the Z-score, this percentage tells us that a one standard deviation decrease in market power cuts by 21.5% the number of standard deviations by which profits have to fall before depleting all the capital.

Columns 2 and 3 prove that the relationship between market power and stability is not simply driven by the fact that both variables are linked to bank profitability. In column 2 the Lerner index is related to profit volatility, the denominator of the Z-score[45]. More market power is associated with more stable profits, thus confirming the conclusions reached looking at the lower panel in Appendix 6[46]. The results in column 3 give further support to our theory. A reduction in the level of competition is related to an improvement of the capital to assets ratio, which is another component of the Z-score. The coefficient of the Lerner index is larger than in the previous two specifications but we have to remember that in this case it cannot be interpreted as a semi-elasticity because the dependent variable is not in logs. We do not calculate the results for the other component of the Z-score, the return on assets, since any outcome would be simply mechanical and without a relevant economic meaning.

[43] The semi-elasticity gives the percentage change in Y resulting from a numerical change in X. It differs from the elasticity, which gives the percentage change in Y resulting from a percentage change in X.
[44] See Appendix 1.
[45] We use the negative of profit volatility (-ln(sd(ROA))) instead of profit volatility as is in order to work with a measure of stability like the Z-score and obtain results that can be easily compared. Profit volatility is calculated over three rolling years.
[46] Differently from Appendix 6 where we study a time dimension only, here we rely on within country, within year heterogeneity.

In **columns 4 and 5**, two alternative measures of stability are employed[47]. In column 4, we calculate the Z-score in a slightly different way. Instead of computing the volatility of profit on a time-span of three years, now it is calculated over the entire sample period. We know that there are some drawbacks in computing the sd(ROA) in such an alternative way: one of them is that we do not account for the differences in the sample period among banks. However, there are also convincing reasons to include those banks reporting data for less than three consecutive years. For example, this could be due to defaults, M&A activities, creation of new entities after a financial restructuring and so on. All these possible explanations represent the outcome of the conduct of the economic operators and are therefore perfectly rational reactions to changes in the competitive conditions, market structures and industry riskiness. Under this alternative setup, the relationship between market power and stability remains positive. Interestingly, the coefficient of the Lerner index is much lower than in column 1. According to our opinion, this is due to mathematical reasons and do not have relevant economic implications: the increase in the number of observations (0.5% more than the original setup) is not enough to justify such a relevant change in the Lerner index coefficient. In column 5, we employ the non-performing loan ratio as measure of financial stability. This frequently used indicator is calculated as ratio between non-performing loans and total loans, where non-performing loans are those defined as such by Bankscope. Unlike the Z-score, the NPL ratio does not account for the entire banking risk but only for loan portfolio risk. In contrast with the findings reached by Berger, Klapper and Turk-Ariss (2009), we find a negative relationship between market power and credit risk. Therefore, we reject the hypothesis that more market power leads banks to invest in riskier loan portfolios. Conversely, this result confirms the idea that competition is detrimental for bank soundness.

In **column 6**, we apply a 2SLS regression model, with the Lerner index instrumented by three variables: loan growth, cost-income ratio and an interaction term between the HHI index and the bank's market share[48] (Beck, De Jonghe and Schepens, 2013). Furthermore, we add bank fixed effects. Under the original setup, we employ independent variables lagged by one period to mitigate problems of endogeneity due to reverse causality. Differently, introducing

[47] Summary statistics:

Variable	Observations	Min	Max	Mean	Standard deviation	Between variation	Within variation
ln(Z-score-EP)	129,172	-0.512	6.245	3.223	1.086	1.069	0.268
NPL ratio	81,363	0	0.50	0.044	0.062	0.049	0.037

Source: Bankscope, own calculations.

[48] Loan growth is the annual growth rate of gross loans; cost-income ratio is determined as overheads (the large part of which is personnel expenses) over net operating income (sum of interest and non-interest income before impairment charges); both HHI index and market share are calculated on total assets.

instrumental variables and fixed effects we mitigate problems of endogeneity due to omitted variables (like bank ownership structure, presence of foreign shareholding, managerial organization). The relationship between market power and soundness remains positive and statistically significant and the coefficient of the Lerner index is only a little bit smaller than that in column 1 (1.402 vs 1.405). This means that a model without fixed effects and instrumental variables does not lead to biased estimates.

In **columns 7 to 9** we employ alternative bank-level measures of competition. In column 7 we include the two subcomponents of the Lerner index, price of bank activities and marginal costs, as separate regressors[49]. The former proxies for competition in the loan market and, more generally, in all the markets where banks compete to increase revenues, whereas the latter proxies for competition in the funding market as well as other markets where banks compete to reduce costs. Results show that prices are positively and significantly associated with bank soundness whereas marginal costs are negatively and significantly associated with bank soundness. Therefore, competition is detrimental to the stability of the banking sector irrespective of where competition originates (prices, costs or both). In column 8 and 9 we substitute the Lerner index with an alternative bank-level measure of competition: the bank's market share, calculated on total assets (column 8) and on total loans (column 9). With regard to the Lerner index, an indicator of market power calculated on the bank's share of assets or loans accounts more directly for rents originate from being too-big-to-fail. Since we are investigating country-year variations, there is a high correlation (almost perfect) between bank size and market share, especially if market share is calculated on total assets. Because of this reason and following Beck, De Jonghe and Schepens (2013), we prefer to drop the variable describing bank size directly, i.e. ln(total assets)[50]. As we expected, we find a positive and statistically significant relation between bank stability and market share (both when calculated on total assets and total loans). Hence, data seem not to provide evidence that large banks gamble more than the smaller ones because they consider themselves too-big-to-fail. However, this result is not univocal: it is very likely that for most of the banks in the sample an indicator of competition based on market share may pick up the same features gauged directly by the Lerner index, such as the pricing power. If this is the case, the relationship between Z-score and market share is positive for the same reasons just as it is positive between Z-score and Lerner index.

[49] Price of bank activities is the ratio between total operating income and total assets, whereas marginal costs are derived from a translog cost function (see Appendix 4).

[50] In the section about the robustness analysis we run the same regression including bank size as a separate regressor. This alternative setup has no major changes.

In order to understand better if the Lerner index and the market share describe two different features of the economy, we introduce both indicators simultaneously: the Lerner index together with total assets market share in **column 10** and the Lerner index together with loan market share in **column 11**. As is shown in column 10, market share is still positively related to the Z-score, although it is no longer statistically significant. This means that pricing power and market share are two closely related concepts, not only when averaged at country level - the correlation table in Appendix 5 shows a positive and significant correlation between the two - but also within country in a given year. By contrast, when measuring market power on total loans (column 11), both indicators remain positively and significantly associated with banking stability, thus suggesting that they actually describe two different things. This result might seem conflicting with the previous one but actually there is an economic rationale behind these. The Lerner index is an indicator that looks at the level competition the bank is facing from an overall perspective, like the market share computed on total assets does. Therefore, their behaviour is expected to be similar. This is exactly what data tell us: when using both regressors independently, one turns out not to be significant. By contrast, when we focus on a specific market, like the loan market, it is more likely that the Lerner index does not capture accurately all the dynamics of that market. This is why the market share computed on total loans remains significant.

Up to now, we have proved that market power and financial stability are positively correlated. However, this average relationship hides large variations both over time and across country that are worth to be considered and analysed.

3.3.2 COMPETITION AND STABILITY OVER TIME

We analyse how the relationship between competition and stability changes over time by focusing on the sign and magnitude of the β coefficient, which is the estimated correlation coefficient of the market power-stability relationship when running by-year regressions. We employ the same model used just before (the one detailed in Equation 1); however, it is run separately for each year and include country fixed effects instead of country-year fixed effects. As a matter of fact, we are now interested in how the relationship varies over time and not within a given year. In order to provide unbiased conclusions, we use two different indicators of bank soundness: the Z-score and the negative of profit volatility. Both are taken in logs and built with a standard deviation of return on assets computed over a window of three years. In the upper panel of Appendix 9, we present the time series pattern of the β coefficient when employing the Z-score as measure of stability. The coefficient is always positive and averages at 1.46 but shows great variations (the overall standard deviation is

equal to 0.39), with estimates ranging from 0.64 in 1998 to 1.99 in 2012. Given that these coefficients are semi-elasticities, an increase in the Lerner index of one standard deviation (0.1533[51]) reduces the Z-score by 10% in 1998 and by 31% in 2012. These strong variations over time, however, are much larger from 1997 to 2009 than from 2010 onwards. In the first sub-period the standard deviation is 0.41, whereas in the second sub-period the standard deviation is just 0.17.

These fluctuations are confirmed when using the negative of the volatility of ROA as measure of bank soundness (lower panel in Appendix 9). The correlation coefficient is 0.53 on average but ranges from -0.32 in 1998 to 1.14 in 2009. The standard deviation is higher than in the previous case, being 0.49. However, we have to notice that in this latter specification many coefficients are not statistically significant[52]. Nevertheless, the fact remains that there is substantial variation over time even when focusing on the denominator of the Z-score only.

3.3.3 COMPETITION AND STABILITY ACROSS COUNTRIES

In this section, we analyse how the competition-stability relationship varies across countries. The methodology applied is the same as before. We provide evidence of cross-country heterogeneity looking at the values of the Lerner index coefficient that results from running country-by-country regressions. Instead of country-year dummies, we include time fixed effects only to control for heterogeneity over time. The other variables employed remain the same. As before, we apply one measure of competition, i.e. the Lerner index, and two measures of stability, i.e. the Z-score and the negative of profit volatility, both in logs. The results are presented in Appendix 10. The height of the bars indicates the order of magnitude of the market power-stability relationship, whereas the colour indicates the significance (in red the results which are statistically significant, in blue those which are not significantly different from zero). In the upper panel we run a regression using the ln(Z-score) as dependent variables. Even if on average the franchise value theory seems to prevail (the average correlation coefficient is 1.26), the table shows large variations, much larger than those over time. The coefficients are even negative for a group of countries[53], suggesting that for those countries more competition is beneficial for the stability of the banking sector. For the average country, i.e. a country for which the correlation coefficient is 1.26, a one standard deviation drop in the Lerner index (0.1533) generates a 19% drop in the Z-score. Considering that the standard deviation of the Lerner index coefficient across the 113 pooled countries is

[51] See Appendix 1.
[52] Coefficients are not statistically significant in 1998, 1999, 2006, 2007 and 2008.
[53] However, those statistically significant are just two: Algeria and El Salvador.

1.27, the same change in the Lerner index may lead to a change in the Z-score that varies from almost 0% [0.1533*(1.26-1.27)] to 39% [0.1533*(1.26+1.27)].

Substantially, the conclusions do not change when employing the negative of the ROA volatility as measure of stability. On average, the relationship is still positive (0.44); however, the number of countries for which the correlation coefficient is negative or not statistically different from zero is much larger if compared to the previous specification. This greater heterogeneity is confirmed by the standard deviation of the estimated coefficients, which is equal to 1.33. Applying the same reasoning as before, we find that a one standard deviation drop in the Lerner index increases the volatility of profits by 7% on average. The same change may have an impact on profit volatility that ranges from -14% to +27%.

If we look at the country labels[54], we notice that the sign and magnitude of the correlation coefficients seem not to be related to the geographic location or the income level of the countries. As we can see from the last two panels in Appendix 10, if we classify the 113 countries by region or income level, each group shows the same trend. There are always a few countries experiencing a negative relationship between market power and bank soundness, whereas the large majority presents a positive relationship. This is a first piece of evidence that the drivers of heterogeneity cannot be investigated at an aggregate level. Rather, it is more likely that what influences the link between competition and stability are the specific features of a given country. In the next paragraph, we will try to understand the reason behind this large cross-country heterogeneity by studying how different country-specific features may impact on the relationship between market power and bank soundness.

3.3.4 COMPETITION AND STABILITY: CROSS-COUNTRY HETEROGENEITY

In order to provide an insight into the cross-country heterogeneity, we first analyse if and how the variables chosen to describe the country-specific features are correlated with the market power-bank soundness coefficient. These pairwise correlations are reported in the last set of rows of Appendix 7. Unfortunately, many correlations present very high p-values and therefore, they are not significantly different from zero. The only statistically meaningful conclusion we can draw is that competition is more detrimental to the stability of the banking sector if deposit insurances are more generous (pairwise correlation is 0.228) and if bank revenues are more homogeneous (pairwise correlation with revenue heterogeneity is -0.202).

[54] See Appendix 3 for further information about country codes and names.

Since this analysis does not allow us to have a clear picture of how the competition-stability relationship varies on varying the country-specific characteristics, we rely on the regression model outlined in Equation 2. With respect to Equation 1, now we introduce an interaction term between the Lerner index and the country-specific variables to see how the average competition-stability relationship evolves when considering different country-specific features. All the other variables used as control are maintained as well as the specialisation dummies and the country-year fixed effects. The results reached with this regression model are reported in Appendix 11. In order to facilitate the interpretation of the results, all country-specific variables have been normalised before interacting them with the Lerner index. In this way, the magnitude of the coefficient reflects the actual economic meaning and is not biased by the unit of measure or the scale of the variables employed.

In **columns 1 to 9** we study one interaction term at a time. We have to notice that on average the relationship between market power and bank soundness is always positive. More in detail, this relationship is stronger in countries where credit information are more shared, there is larger liquidity in the stock markets, deposit insurances are more generous, the external governance is more effective, there are more restrictions on the range of activities banks can engage in, the banks' revenue structure is more homogeneous and the financial stability is greater. By contrast, capital requirements and multiple supervisors seem not to have a relevant impact on the competition-stability relationship.

In **column 10** we introduce all the interaction term at the same time. We find that the relationship between market power and bank soundness is stronger in countries with more generous deposit insurance schemes, one supervisory authority and stricter activity restrictions. It is particularly interesting to look at the value of the coefficients of the significant interaction terms. The magnitude of the significant coefficients ranges from -0.194 (interaction with multiple supervisors) to 0.314 (interaction with deposit insurance coverage). Considering that the coefficient of the Lerner index without interactions is 1.442, a one standard deviation change of just one of these two variables leads to a change in the competition-stability relationship that varies from -13% to +22%[55]. The combination of changes in more than one country-specific variable may generate even larger fluctuations.

[55] The country specific variables have been standardized and therefore, they have zero mean and unit variance. On average, the β coefficient is 1.442 (that is the coefficient of the Lerner index without interactions, given that all the country-specific variables are zero). A one standard deviation change means that the country-specific variables move from 0 to 1. After this change, the β coefficient is no longer 1.442 but 1.442 plus the interaction coefficients. Considering the coefficient of the interaction with multiple supervisors (-0.194) and with deposit insurance coverage (0.314), the β coefficient becomes 1.248 and 1.756, respectively. This corresponds to a -13/+22% change in the magnitude of the market power-stability relationship.

In **column 11** we run the same regression as in column 10 but instead of the Z-score we use the negative of profit volatility as measure of bank stability. The results do not differ from the previous case except for the first interaction term (depth of information sharing * Lerner index) that becomes significant at the 5% level. Interestingly, the coefficient of the other interaction terms are very similar to those in column 10, thus proving that having profitability in both the dependent and the explanatory variable does not bias the results.

In order to have a better insight into the way in which country-specific features affect the market power-bank soundness relationship, we estimate the β coefficients at the 5th and 95th percentile of the standardised distribution of the significant country-specific variables. The results are reported in the table below:

	(1) p5	(2) p95	(3) ln (Z-score)	(4) ln (Z-score)	(5) **Δ%**	(6) -ln (sd(ROA))	(7) -ln (sd(ROA))	(8) **Δ%**
Depth of information sharing	-2.203	0.753				0.359	0.956	**166%**
Deposit insurance coverage	-1.688	1.323	0.912	1.857	**104%**	0.230	1.254	**445%**
Multiple supervisors	-0.741	1.349	1.586	1.180	**-26%**	0.933	0.569	**-39%**
Activity restrictions	-1.524	1.415	1.084	1.774	**64%**	0.624	0.971	**56%**

Figure 8: In columns 1 and 2, we report the standardised value of the country-specific variables at the 5th and 95th percentile. In columns 3 and 4, the estimated β coefficient at the 5th and 95th percentile of the abovementioned variables when using the Z-score as measure of bank soundness. In column 5, the difference in percentage between the resulting β coefficients. Columns 6 and 7 are derived as columns 3 and 4 but using the negative of profit volatility as measure of bank stability. Column 8 shows the differences in percentage as in column 5.

Once again, it appears clear that the magnitude of the relationship between market power and bank soundness varies significantly according to the value of the country specific variables. For example, the β coefficient more than doubles when the value of the deposit insurance coverage moves from the 95th to the 5th percentile and it is even more than four times if using profit volatility as measure of stability. Credit information sharing and restrictions on bank activities have a likewise strong economic impact. If we compare two countries with opposite features, that is, country "A" with low deposit insurance, more than one supervisor and few activity restrictions vs country "B" with generous deposit insurances, just one supervisor and strict activity restrictions, we find that the correlation between market power and bank soundness is 0.29 for country A and 2.33 for country B[56]. Hence, a one standard deviation decrease of the Lerner index lowers the Z-score by 4% in country A and by 36% in country B.

[56] Country A: 1.442+(-1.688)*0.314+1.349*(-0.194)+(-1.524)*0.235=0.29
Country B: 1.442+1.323*0.314+(-0.741)*(-0.194)+1.415*0.235=2.33
We put the other country-specific variables equal to their average, i.e. zero; as a consequence, all the other interaction terms are equal to zero.

If we redo the same analysis using the coefficients in Column 11, we find an even larger gap between the two countries. The reduction in market power being equal, country A experiences an increase in the Z-score by 10%, whereas country B experiences a decrease in the Z-score by 26%.

At this point one could argue that the findings in column 10 of Appendix 11 are in conflict with those in Appendix 10, given that the estimated coefficient of the competition-stability relationship does not flip sign. Actually, what is more important and what we want to focus on is the magnitude of the cross-country variation rather than the sign. The conclusion we can draw from this analysis is that the way in which market power and bank soundness are related together depends strictly on the characteristics of the country under observation. The impact of the country-specific features is large and therefore, it is not possible to generalise one piece of evidence and simply store any result under the label "competition-stability" or "competition-fragility". Our findings may be useful to reconcile seemingly conflicting empirical studies which provide evidence in favour of one theory rather than another one. We have to recognize that the majority of the empirical works find support to the franchise value theory; however, if we were to collect a sample of countries with limited credit information sharing, illiquid stock markets, no deposit insurances, ineffective governance, few activity restrictions, more heterogeneous revenue structure and high systemic risk, it would be more likely to find a non-significant or even negative relationship between market power and bank soundness.

3.3.5 COMPETITION AND STABILITY: A NON-LINEAR RELATIONSHIP

In addition to the differences in the sample of countries, the time span and the applied methodology, another potential explanation of the contrasting empirical evidence among different studies may be the existence of a non-monotonic relationship between market power and financial stability. In the most recent years, the hypothesis of a non-linearity has been matter of study by many researchers, among which Martinez-Miera and Repullo (2010) represents the cornerstone of the academic theories. Among the empirical studies, most of them employ country-level indicators of concentration to gauge the level of competition in the market. With respect to these studies, we adopt a different approach at least because of three reasons: firstly, we do not rely on structural measures of concentration; secondly, we use bank-level indicators of stability and market power (Z-score and Lerner index); thirdly, we study the influence of different institutional and regulatory frameworks. To find evidence of a non-linear relationship, we introduce the square of the Lerner index as outlined in Equation 3. Once a non-linear relationship is ascertained, we first investigate if this non-linearity can be

explained by an interaction term between the Lerner index and a bank-specific or country-specific variable[57]. After that, we describe the characteristics of this non-linear relationship by comparing the inflection point of the parabola with the distribution of the data. As for the other econometric model used up to now, we continue to include bank-specific control variables, among which the specialisation dummies, and country-year fixed effects. Bank-specific and country-specific variables have been standardized before interacting them with the Lerner index to make the coefficients of the estimates easily comparable. The results of this research are reported in Appendix 12, which for clarity's sake is divided into two sections: table A, from column 1 to 9, and table B, from column 10 to 19.

In **column 1** we simply introduce the square of the Lerner index to determine if data provide evidence of non-linearity. The coefficient of the Lerner index is positive and significant whereas the coefficient of the Lerner index squared is negative and significant. Taken together, these two coefficients indicate that there is an inverse U-shaped relationship between market power and bank stability. For small values, the variable in level dominates the squared variable but once a certain threshold is reached, the converse holds. Hence, the overall sign of the relationship is positive for small values of the Lerner index and negative for large values. From an economic point of view, this means that more market power is beneficial for the soundness of the banking sector only up to a certain level. Once this level is crossed, the competition-fragility theory does not hold anymore and is replaced by the competition-stability theory.

In **columns 2 to 8** we introduce one interaction term each time. These interactions are made of Lerner index times a bank-specific variable. Doing so, we are able to determine if the driver of non-linearity lies in the funding structure, the asset structure, the revenue structure, the bank size, the credit risk, the bank's growth or the market share. Since the square of the Lerner index remains statistically significant under all the specifications, none interaction correctly explains the non-linearity in the market power-bank soundness relationship.

The same conclusions hold for **column 9**, where we add all the interactions simultaneously. Again, the coefficient of the Lerner index squared remains significant.

With the regressions in table B, we go a step forward. Instead of focusing on bank-specific features, we now investigate if there are some country-specific characteristics that help explain the non-linearity. The methodology is the same as before. From **columns 10 to 18** we

[57] From a mathematical perspective, we want to understand if X^2 is actually X*Z instead of X*X, where X is the Lerner index and Z one of the bank-specific or country-specific variables.

introduce one interaction terms each time, whereas in **column 19** we introduce all the interactions simultaneously. The results show that the coefficient of the Lerner index squared remains negative and statistically different from zero under all specifications. Hence, neither the interactions with country-specific variables are useful to describe the non-monotonic nature of the market power-bank soundness relationship. We can conclude this first part of the analysis sustaining that the non-linearity is an intrinsic factor of the relationship between market power and bank soundness and exactly for this reason it is not explainable by interacting the Lerner index with other variables describing either the banks' business model or the financial, economic and institutional development of the countries where the banks operate.

So far we have verified that the non-linearity exists under several alternative definitions of the model and that it takes the form of a downward-oriented parabola, given that the coefficient of the Lerner index in level is positive, whereas the coefficient of the Lerner index squared is negative. Now, it is interesting to determine the inflection point, that is to say the point at which the market power-bank soundness relationship flips sign and turns from positive to negative. The inflection point lies at 0.85 in the general model (column 1) but ranges from 0.71 to 0.87 when considering alternative specifications (columns 2 to 19)[58]. Therefore, the relationship between market power and bank soundness turns negative when the Lerner index exceeds a value approximatively between 0.71 and 0.87, depending on which specification we want to rely on. If compared with the distribution of the data, we notice that all these values lie above the largest value of the distribution of the Lerner index[59]. Hence, a non-linear relationship between market power and stability exists because the coefficient of the Lerner index squared is negative and significant but this relationship never flips sign. Beyond this average relationship, however, data reveal a large cross-country heterogeneity. As a matter of fact, until now we have based our conclusions on the average country only, which is a country whose features are derived from the average features of all the countries in the sample. By contrast, if we consider countries with poor credit information sharing, illiquid stock market, low deposit insurances, ineffective external governance, no activity restrictions, strong heterogeneity in bank revenues and widespread financial risk, it will be more likely that the inflection point occurs at a much lower level with respect to the average case. We test this hypothesis using a model setup like that in column 19. We determine the predicted inflection

[58] We consider the average value of the bank-specific and country-specific variables so that the interaction terms are equal to zero, being the variables normalized.
[59] We consider the distribution of the winsorized Lerner index. If we considered the non-winsorized distribution, the inflection point would lie above the 99th percentile.

points when deposit insurance coverage, multiple supervisors and activity restrictions present a value corresponding to the 5th and 95th percentile of their distribution.

	(1) p5	(2) Inflection point	(3) Percentile Lerner index	(4) p95	(5) Inflection point	(6) Percentile Lerner index
Deposit insurance coverage	-1.688	0.540	99th	1.323	0.886	> max
Multiple supervisors	-0.741	0.803	> max	1.349	0.607	99th
Activity restrictions	-1.524	0.529	98th	1.415	0.924	> max

Figure 9: In columns 1 and 2, we report the standardised value of the country-specific variables at the 5th and 95th percentile. In columns 2 and 5 the inflection points calculated at the 5th and 95th percentile of the abovementioned variables. In columns 3 and 6 the percentiles of the Lerner index distribution at which the inflection points correspond.

As we can see from the table, when accounting for one country-specific feature at a time, no major changes arise. With respect to the average case, this time the relationship between competition and stability turns negative but only under specific conditions (very low deposit insurance coverages and activity restrictions and in case of multiple supervisors) and for a very limited, negligible, number of banks (less than 2%). However, if considering the combined effect of all these country-specific features, the economic relevance is much larger. We build a fictitious scenario given by a country with low deposit insurances, multiple supervisors and few restrictions on bank activities. Under these assumptions, the estimated inflection point is 0.209, which corresponds to the 47th percentile of the distribution of the Lerner index. For countries with such features, competition becomes a stabilizing factor for a much larger number of banks than the other countries. Put differently, an increase in market power does not improve the soundness of the banking system for each level of market power but only up to a given (relatively low) threshold. This is a very interesting result that first needs to be interpreted in light of the findings obtained with the linear model. It is true that the result we reached is a limit case, artificially built considering variations in the country-specific features whose effects go in the same direction. However, despite the way it has been derived, what is actually relevant is that this finding provides further evidence about the great variability induced by country-specific features on the competition-stability relationship. According to Martinez-Miera and Repullo (2010), introducing competition in a monopolistic market has a stabilising effect at the beginning because more competition leads to a decrease in the lending rates that in turn makes borrowers safer. They called this channel risk-shifting effect. However, from the bank's perspective, a lowering of the interest rate implies less interest income from performing loans and hence less profits. This second channel is called margin effect. Once a certain level of competition is reached, the margin effect prevails over the risk-shifting effect and an additional increase in the level of competition has a

destabilizing effect on the stability of banking system. We recognize that the model by Martinez-Miera and Repullo has been structured looking at the loan market only: however, it may still be interesting to interpret our "comprehensive" result in light of this model. According to our findings, the margin effect seems to prevail for most of the countries and the larger its magnitude the greater the level of competition is (given the slope of the quadratic function). By contrast, the risk-shifting effect seems to have a negligible economic relevance. As a consequence, competition turns out to be a destabilizing factor almost always and the competition-fragility theory prevails. When accounting for different country-specific features, the scenario changes sharply. In countries with low deposit insurance protections, multiple supervisory authorities and limited restrictions on the set of activities bank can engage in, the risk-shifting effect becomes stronger whilst the margin effects becomes weaker. Therefore, it is sufficient to exceed a lower level of market power so that a further increase in market power deteriorates the soundness of the banking system. According to our calculation, for those countries the turning point occurs at an intermediate level of competition, roughly around the 47^{th} percentile of the distribution of the Lerner index. The economic rationale behind this phenomenon is complex. Probably, a large direct influence is played by the level of restrictions on bank activities. In countries with few limitations, banks can easily switch from source of revenues to another. If the traditional lending market becomes less profitable because the interest rates that can be charged fall, banks can recover the gap investing more on other businesses (for example stock trading, asset management, bond market, etc.). In those countries the margin effects is much less strong and higher level of competition may be not only sustainable but also desirable. Despite this preliminary economic explanation, there is much room for further research to shed light on the economic mechanisms underlying the non-linearity of the competition-stability relationship.

3.4 ROBUSTNESS ANALYSIS

In this section we discuss several robustness checks to confirm the accuracy of the achieved estimates under different definitions of the variables employed. First of all, we make some additional tests to check the robustness of the results reported in Appendix 8, i.e. when we assumed a homogeneous relationship between market power and stability. These robustness checks are reported in Appendix 13, **Table A**.

In **columns 1 and 2** we include in the regression model the Lerner index, the market share on assets and the bank size as separate regressors. In column 10 and 11 of Appendix 8 we excluded the bank size because of its strict (within year, within country) correlations with the market share. Introducing bank size as a separate regressor does not alter the results.

In **column 3** we exclude from the regression model two variables: loan loss provisions to interest income and annual growth in total assets. These variables gauge the credit risk and the asset expansion, which are usually the most relevant source of risk for a bank. Under this alternative setup, the coefficient of the Lerner index is smaller whereas that of the control variables is larger. Probably, the effect of the two dropped variables is partially absorbed by the remaining control variables.

In **column 4** we drop the loans to assets ratio. The results are unaffected.

In **columns 5 to 8** we restrict the sample to banks having particular characteristics. In column 5 we consider commercial banks only. The coefficient of the Lerner index is slightly smaller whereas the other control variables behave as in the general model, except for bank size (the correlation coefficient turns out negative and statistically significant whereas in the standard model it is not statistically different from zero). In column 6 we include only banks operating in countries and years where a systemic banking crisis is underway[60]. The Lerner index coefficient is a little bit smaller (-7% if compared with the standard model) and the coefficient of share of wholesale funding becomes positive and significant. Probably, during period of financial distress, a bank able to collect funds other than customer deposits is more stable because less exposed to withdrawals or bank runs. The other coefficients do not show substantial variations. In columns 7 and 8 we focus on developed and developing countries, respectively. Countries are classified as developed if belonging to one of the following income groups: High income (OECD), High income (non OECD) or Upper middle income. By difference, developing countries are those belonging to one of the other groups: Lower middle income or Low income. The Lerner index coefficient remains positive and statistically significant in both cases. However, for developing countries the regression coefficient is larger, meaning that competition has a greater impact on the stability of the banking system.

[60] We introduce a dummy variable which takes value 1 if a country is experiencing a systemic banking crisis in a given year. Afterwards, we run the regression restricting the sample to banks associated to a value of 1 of the dummy variable. Data are available for the period 1997-2011. Source: Global Financial Development Database.

In **columns 9 and 10** we use two different indicators of market power: the Boone indicator in column 9 and the H-statistic in column 10[61]. Given that these indicators are available at country-year level, we cannot include country-year fixed effects anymore but year fixed effects only. The Boone indicator gauges the level of competition by measuring the elasticity of profits to marginal costs. Since costs have a negative impact on profits, the elasticity is negative. Specifically, the higher the level of competition, the more negative the Boone indicator is because the reallocation effect is larger. However, if the bank does not realize a profit but a loss, the elasticity turns positive. To deal with this issue, in the regression model we use the absolute value of the Boone indicator, so that large values always indicate more competition (Diallo, 2015). The coefficient of the Boone indicator is negative and significantly different from zero, thus confirming that competition and bank soundness are negatively related. In column 10 we rely on the H-statistic, a measure of competition based on the elasticity of revenues with respect to input prices. Under perfect competition marginal costs and marginal revenues are equal, hence the elasticity is equal to one. By contrast, under a monopoly the elasticity is equal or less than zero. In addition, the Global Financial Development Database (from which data have been retrieved) explains that the value of the H-statistic may be greater than one in some oligopolistic market. Therefore, like the Boone indicator, large values are associated with fiercer competitive conducts. The results in column 10 show that the coefficient of the H-statistic is negative and statistically significant. This is a further evidence that the relationship between competition and stability remains negative even if employing alternative measures of competition.

Now, we will discuss some robustness tests to confirm the evidence in Appendix 11 (linear model with country-specific variables) and Appendix 12 (non-linear model). The results are reported in Appendix 13, **Table B**.

In **column 1** we run the same regression as in column 10 of Appendix 11 but calculating the denominator of the Z-score over the entire sample period instead of three years. The Lerner index coefficient remains positive and statistically different from zero, suggesting that market power and competition are still positively related. However, the magnitude of the correlation

[61] Summary statistics:

Variable	Observations	Min	Max	Mean	Standard deviation	Between variation	Within variation
Boone indicator	17,3711	-0.266	0.249	-0.049	0.049	0.032	0.031
H-statistic	43,677	0	1.489	0.676	0.188	0.170	0.082

Source: Global Financial Development Database.

coefficient is much lower[62] than the original setup (with standard deviation computed over 3 rolling years) and the interactions present substantial differences in terms of significance and magnitude of the coefficients. Probably, it is due to mathematical reasons and does not have implications in economic terms.

In **column 2** we add an interaction term between the Lerner index and the market share (calculated on total assets) to the regression in column 10 of Appendix 11. We want to evaluate if large banks consider themselves too-big-to-fail and hence have an incentive to behave more aggressively and undertake riskier investments when the level of competition increase. The coefficient of the new interaction term is positive and significant at 5% level, thus suggesting that the presence of large banks emphasizes the negative effects that competition has on the stability of the banking sector. The magnitude, however, is not very large. The coefficients of all the other significant interaction terms and of the Lerner index as well remain very close to the original results. Therefore, we continue to find that in countries with more generous deposit insurance schemes, one supervisor and several activity restrictions, bank react stronger to changes in the level of competition, despite the presence of large banks.

In **column 3** we include the nine country-specific variables as independent regressors in addition to their interactions with the Lerner index. Furthermore, we include country and time fixed effects separately instead of their interaction. No major changes arise under this setup. The only noticeable thing is that the first interaction term becomes significant at the 5% level.

In **columns 4 and 5** we confirm the non-linearity in the competition-stability relationship using two new specifications of the model outlined in Equation 3. In column 4 we introduce all the interaction terms used up to now, i.e. the interactions between Lerner index and bank-specific variables (these coefficients are not reported to save space) as well as those between Lerner index and country-specific variables. As we can see, the magnitude of the coefficients does not change. In column 5, in addition to all the interactions, we add the country-specific features as independent regressors as well as country and time fixed effects separately instead of their interactions. Again, the results do not show any specificity, rather the magnitude of the coefficients of both the Lerner index and the interaction terms are similar to that of the previous column.

[62] This change is magnitude has been already stressed when studying a homogeneous relationship between competition and stability (Appendix 8, column 4).

In **columns 6 to 8** we study the non-linearity using the negative of profit volatility as measure of bank soundness instead of the Z-score. The non-linearity is confirmed even under these setups: the coefficients of the Lerner index in level are positive and significant, whereas the coefficients of the Lerner index squared are negative and significant. The larger variability observed when employing the negative of profit volatility instead of the Z-score finds a further confirmation: the inflection point occurs at a lower level, being between the 78th and the 80th percentile of the distribution of the Lerner index, if compared to the model with the Z-score as measure of competition.

In addition to these, we realise another battery of tests to check the sensitivity of our results with respect to the influence of extreme values. We run again the most important regressions made until now using data from the same database as before but not winsorized. In this way, we will be able to determine if the outliers drive the results in some way. The outcomes are reported in Appendix 13, **Table C**.

In **columns 1 to 4** we assume a homogeneous relationship between competition and stability. Competition is proxied by the Lerner index, whereas stability is proxied by the Z-score in column 1, by the negative of profit volatility in column 2, by the capitalization ratio in column 3 and by the non-performing loan ratio in column 4. The relationship between market power and stability is positive but not statistically significant under all the specifications.

In **columns 5 and 6** we introduce all the interactions between Lerner index and country-specific variables. We employ two different measures of stability: the Z-score in column 5 and the negative of profit volatility in column 6. The coefficients of the Lerner index are positive and statistically significant, even if their magnitude is lower if compared to the same regressions but using a winsorized dataset.

In **columns 7 to 9** we study the sensitivity of the non-linear relationship. In column 7 we assume a homogeneous relationship between competition and stability, in column 8 we introduce the interactions between the Lerner index and the bank-specific variables, whereas in column 9 we introduce the interactions between the Lerner index and the country-specific variables. The coefficients of the Lerner index in level remain positive and statistically significant, even if their magnitude is lower similarly to the previous case. Conversely, the coefficients of the Lerner index squared turn positive and statistically significant, thus suggesting that the U-shaped relationship described before is vanished. Though positive and statistically significant, their magnitude is actually very close to zero.

In conclusion, the use of a non-winsorized database alters some results. The lower magnitude of the coefficients may be explained by the presence of outliers that make the estimates less precise or even no longer significant as in the first columns. More scattered data may also be the cause of the lack of non-linearity. Further research would be necessary to determine if these results are determined by merely statistical issues or if there is an economic interpretation behind them.

3.5 LIMITATIONS

The first potential limitation of the results of this analysis is that we were not able to account for the increasing globalisation of the banking sector. When banks operate all around the world, they also compete all around the world and our measure of competition should be able to capture this dynamic. It is true that the Lerner index is built at bank level; in this way, we avoid the big problems of the original measures of concentration which were built at country level and required the definition of a geographical market. However, we estimate the marginal costs through a translog cost function that is run separately for each country and the banks are associated to their country according to the classification provided by Bankscope, which do not consider where banks actually compete. Beyond these considerations, we must notice that some empirical studies have found that the use of average costs, which do not require the definition of any geographical link, leads to results that do not differ in a systemic way from that obtained using marginal costs (Beck, De Jonghe and Schepens, 2013). In addition to this, there are other two issues that must be recognized. Firstly, the use of consolidated data creates a discrepancy between local banks which operate and thus compete within a single country and large conglomerates operating in wider markets. Secondly, banks that operate abroad may be subject to regulations different from that in the country of establishment. All these aspects are not accurately considered in our model since bank-level data about the domestic or foreign nature of assets and liabilities are not available.

The second potential limitation is relative to the decomposition of the Z-score into its subcomponents to mitigate the hard-wired effects of profitability. Actually, the problem is mitigated but the results may be still driven by this mechanism, at least partially.

The third limitation is that our panel data lack many annual observations, especially relative to country-level indicators. When running regressions including only one country-specific indicator at a time, the number of observations is enough to obtain reliable estimates. The problem magnifies only when considering several country-specific features together. As a

matter of fact, the already limited number of data is further reduced because only those entries for which all data are available are kept in the regression model. Consequently, the number of observations really at disposal collapse and the estimates loose consistency[63]. We partially mitigate the problem by making the reasonable assumption that the features of a country remain the same for a certain number of years. For example, data from Bank Regulation and Supervision Database are released for just four years (2000, 2003, 2007, and 2010) but we assume that the values remain constant between two series of data. We adopt the same approach for depth of information sharing (since we lack data before 2005, the values reported in 2005 are assumed constant since 1996), stock market turnover (data are assumed unvaried from 2012 onwards) and deposit insurance coverage (data are assumed constant from 2003 to 2009, from 2010 to 2012 and from 2013 to 2014). This manipulation of the data does not alter the results, neither in statistical nor in economical term, but allows only exploiting a larger pool of sample observations[64]. Despite the effort, when running regressions including a multitude of country-specific variables, the number of observations at disposal is still somewhat scarce.

[63] At the beginning, the number of observation to compute the regression in column 10 of Appendix 11 was just over 4,000 and no variables were statistically significant.

[64] We compared the results obtained before and after the interpolation of the data when running regressions with one country-specific variable at a time: the magnitude and the significance of the coefficients did not show remarkable changes. Neither the summary statistics showed relevant modifications.

CONCLUSIONS

Under the traditional view, competition is considered a destabilizing factor of the banking system as it shrinks margins, erodes the franchise values and encourages the assumption of great risks. By contrast, under the alternative "competition-stability" view, competition is considered a stabilizing factor as it triggers a reduction in the interest rates charged on borrowers, thus limiting their probability of default and moral hazard. Both theories have been sustained by many empirical works, which differ for the characteristics of the pooled sample, the years covered and the measures of competition and stability chosen. In this paper, we investigate the link between market power and stability building on the seminal work by Beck, De Jonghe and Schepens (2013), which we implement by employing the most recent available panel data and by allowing for a non-monotonic relation between competition and stability. First of all, we study a simple, homogeneous relationship between market power and bank soundness, on the basis of which the competition-fragility theory seems to prevail over the competition-stability theory. However, when running by-country or even by-year regressions, it appears clear that the average relationship actually hides substantial heterogeneity. As a matter of fact, the true market-power-bank-soundness correlation coefficients range from negative (few countries), over non-statistically different from zero (several countries) to strongly positive (most of the countries). In order to have a better insight into the drivers of heterogeneity, we analyse how different country-specific features come into play affecting the average competition-stability relationship. We find that in countries with less generous deposit insurance schemes, more than one supervisory authority and mild activity restrictions, it is more likely that an increase in market power has a negative or non-significant impact on the financial stability. In addition to this, we find strong evidence in favour of a non-monotonic relationship between market power and stability. Our results show that for "low" levels of market power an increase in market power makes the system more stable but once a certain threshold is reached, market power is no longer a stabilising factor. Comparing this reverse U-shaped trend with the distribution of the data, we find that on average all the observations lie on one tail of the parabola (the inflection point lies above the largest value of the Lerner index). Hence, the relationship between competition and stability never flips sign and more market power always implies greater stability. However, if we account for different country-specific features, we find that for countries with low deposit insurance protections, multiple supervisors and low activity restrictions, the inflection point occurs at a much lower level (roughly around the 47^{th} percentile of the distribution of the

Lerner index). For those countries, the margin effects dominates over the risk-shifting effects from high to medium level of competition, whereas the opposite holds from medium to low level of competition. This empirical evidence has large economic implications, especially for policymakers. They suggest that it is not possible to consider the relationship between competition and stability as stand-alone but must be observed in a wider context, where both country-specific and bank-specific characteristics are accounted for. It follows that the same regulatory policies may have different effects in countries with different characteristics. This should suggest that supranational regulations must be thoroughly designed to avoid that the beneficial effects for a country have negative consequences in countries with different market structures or level of institutional, financial and economic development.

APPENDIX 1

Variable	Observations	Min	Max	Mean	Standard deviation	Between variation	Within variation
1) Bank soundness and market power							
ln(Z-score)	111,323	0.0734	8.6130	4.2905	1.4072	1.0930	0.9259
Lerner index	115,343	-0.9264	0.6563	0.2108	0.1533	0.1294	0.1062
2) Translog cost function							
Total operating cost	122,997	0.3415	12.576	166.10	693.73	705.02	226.74
Price of fixed assets	118,778	0.0009	0.5464	0.0222	0.0456	0.0380	0.0265
Price of labour	116,510	0.0006	0.1026	0.0166	0.0121	0.0112	0.0049
Price of funding	126,009	0.0000	0.4616	0.0361	0.0406	0.0332	0.0232
Average price of bank activities	118,806	0.0123	0.7436	0.0827	0.0746	0.0651	0.0366
Marginal cost	115,369	0.0096	0.6680	0.0652	0.0639	0.0550	0.0342
3) Bank-specific variables							
Share of wholesale funding	125,792	0	0.9985	0.1813	0.2306	0.2093	0.0892
Loans to total assets	126,023	0.0055	0.9450	0.5800	0.1872	0.1714	0.0785
Non-interest revenue share	125,667	-0.3843	1.0000	0.2723	0.2060	0.1804	0.0938
ln(total assets)	126,288	1.2784	12.8366	6.1582	1.8782	1.7834	0.4822
Loan loss provisions to interest income	119,045	-0.7736	2.2632	0.1557	0.2401	0.1660	0.1951
Annual growth in total assets	117,278	-0.4667	2.0020	0.1083	0.2262	0.1617	0.1840
Commercial bank dummy	20,031	0	1	0.7065	0.4554	0.4554	0
Savings bank dummy	20,031	0	1	0.1361	0.3429	0.3429	0
Cooperative bank dummy	20,031	0	1	0.1574	0.3641	0.3641	0
4) Country-specific variables							
Depth of information sharing	212,148	0	6	4.4716	2.0301	1.5714	0.9953
Stock market turnover	203,454	0.0031	4.0407	1.0172	0.6874	0.7337	0.4092
Capital stringency	200,128	1	10	6.5466	1.5357	0.9646	1.1966
Deposit insurance coverage	182,050	-1.0945	2.7901	0.6648	0.7685	0.5955	0.4506
Multiple supervisors	205,323	0	1	0.3547	0.4784	0.4603	0.2176
External governance index	171,138	7	18	13.583	2.3521	1.6501	1.6852
Activity restrictions	182,613	4	16	9.1487	2.7224	2.4717	1.1289
Heterogeneous bank revenues	208,458	0.0534	0.3255	0.1576	0.0587	0.0403	0.0301
Systemic stability	208,072	-0.6589	3.7282	2.5911	1.0026	0.8920	0.2216

This table provides summary statistics for the most important variables included in the model. The table can be divided into four sections:

1. The first panel is relative to the variables of largest interest: stability, proxied by the natural logarithm of the Z-score, and competition, proxied by the Lerner index. The Z-score is computed as the sum of return on assets and equity-to-assets divided by the standard deviation of the return on assets (computed over a three years rolling window); larger values indicate more stability. The Lerner index measures the level of competition through the mark-up of prices over marginal costs. Larger values indicate higher market power and, hence, less competitive business conditions.
2. The second panel includes the variables used to compute the Lerner index: the average price of bank activities is captured by the ratio between total operating income and average total assets whereas marginal costs are estimated through a translog cost function, which relates total operating costs to three inputs. These three inputs are: price of fixed assets (other operating and administrative expenses over average total assets), price of labour (personnel expenses over average total assets) and price of funding (interest expenses over total deposits and money market funding).
3. The third panel contains information relative to the control variables employed in the model to take out the impact of different business models. The business model is assumed to be based on seven features: funding structure (share of wholesale funding), asset mix (loans-to-assets ratio), revenue structure (non-interest revenue share), bank size (total assets, in logs), credit risk (loan loss provisions to interest income), bank's growth (annual growth in total assets) and bank's specialisation (commercial, savings, cooperative dummy). All but ln(total assets) indicate a proportion: these variables are reported in decimals and not in percentage (0.1 means 10%).
4. The fourth panel summarizes the variables used in the regression model to account for country-specific features: depth of creditors' information available at credit bureaus, development of stock markets, strength of capital requirements, existence of insurances on deposits, the number of supervisors, the presence of external supervisory authorities, the level of restrictions imposed on bank activities, the heterogeneity of the source of revenues (at country level) and the systemic risk.

For all variables, we show the number of observations, the smallest value, the largest value, the mean and the standard deviation. This latter one is further explained analysing the variation between banks (or between countries, if the variable is measured at country level) and over time. Not all variables are available for each bank in each time period. This is the reason why the number of observations fluctuates and is not fixed (see Appendix 2 for further information about variable source and coverage.

APPENDIX 2

Variable	Source	Coverage	Description
Bank-level variables			
Z-score	Bankscope, own calculations	1996-2014	(ROA+E/TA)/σROA
Lerner index	Bankscope, own calculations	1996-2014	(P-MC)/P
Share of wholesale funding	Bankscope, own calculations	1996-2014	Share of money market funding to total deposits and money market funding
Loans to total assets	Bankscope	1996-2014	Share of loans in the asset composition
Non-interest revenue share	Bankscope	1996-2014	Non-interest revenues to total revenues
ln(total assets)	Bankscope	1996-2014	Bank size based on the amount of total assets
Loan loss provision to interest income	Bankscope	1996-2014	Ratio between provisions for loan losses and interest income
Asset growth	Bankscope	1996-2014	Annual growth in total assets
Specialization dummy	Bankscope		A variable denoting the bank's specialization: Commercial, Savings or Cooperative
Country-level variables			
Depth of information sharing	Doing Business Database	2005-2014	Strength of information content in credit registries (from 0 to 6)
Stock market turnover	The World Bank data-indicators	1996-2012	Stock traded to stock listed
Capital stringency	Bank Regulation and Supervision Database Global Banking Regulation Dataset	3 waves: 2000, 2003, 2007, 2010	Strength of capital regulation in a country (from 0 to 10)
Deposit insurance coverage	Deposit Insurance Around The World Database Deposit Insurance Dataset (2013)	1996-2003, 2010, 2013	Deposit insurance over GDP per capita
Multiple supervisors	Bank Regulation and Supervision Database Global Banking Regulation Dataset	3 waves: 2000, 2003, 2007, 2010	Dummy variable equal to one if there are multiple supervisors
External governance index	Bank Regulation and Supervision Database Global Banking Regulation Dataset	3 waves: 2000, 2003, 2007, 2010	Strength of external auditors, accounting transparency and existence of external ratings (from 0 to 19)
Activity restrictions	Bank Regulation and Supervision Database Global Banking Regulation Dataset	3 waves: 2000, 2003, 2007, 2010	Stringency in the set of non-interest activities banks can engage in (from 4 to 16)
Heterogeneous bank revenues	Bankscope, own calculations	1996-2014	Within-year, within-country standard deviations of non-interest income share
Systemic stability	Bankscope, own calculations	1996-2014	Z-score at country level

This table reports information relative to the sources from which the variables have been retrieved, the years for which data are available and a brief description of how the variable is calculated.

APPENDIX 3

Country name	Country code	Number of banks	Avg. Lerner index	ln (Z-score)	Cond. correlation
Algeria	DZ	17	0.324	3.939	-2.057
Angola	AO	15	0.322	3.180	1.273
Argentina	AR	89	0.199	3.010	0.717
Armenia	AM	16	0.287	3.326	2.139
Australia	AU	35	0.201	4.106	1.820
Austria	AT	306	0.189	4.069	1.839
Azerbaijan	AZ	26	0.313	3.010	1.305
Bahrain	BH	13	0.270	4.259	4.863
Bangladesh	BD	28	0.147	3.401	0.603
Belarus	BY	22	0.287	2.825	0.086
Belgium	BE	72	0.178	3.935	1.936
Benin	BJ	8	0.310	3.223	2.441
Bolivia	BO	15	0.191	3.404	0.678
Bosnia And Herzegovina	BA	25	0.223	4.134	2.725
Botswana	BW	10	0.308	3.312	2.302
Brazil	BR	174	0.188	3.034	0.857
Bulgaria	BG	25	0.260	3.492	-0.726
Burkina Faso	BF	9	0.255	3.253	6.028
Cambodia	KH	20	0.158	3.800	0.974
Cameroon	CM	7	0.366	3.550	2.657
Canada	CA	96	0.203	4.153	0.941
Cayman Islands	KY	7	0.056	3.524	1.909
Chile	CL	38	0.230	3.909	-0.207
China	CN	126	0.391	4.355	1.066
Colombia	CO	49	0.234	3.420	2.669
Costa Rica	CR	54	0.250	4.028	1.969
Cote D'Ivoire	CI	9	0.252	3.063	2.457
Croatia	HR	50	0.158	3.709	1.575
Cyprus	CY	18	0.269	2.998	-0.015
Czech Republic	CZ	33	0.253	3.629	2.660
Denmark	DK	124	0.261	3.634	1.224
Dominican Republic	DO	72	0.172	3.442	0.457
Ecuador	EC	25	0.232	3.644	-0.566
Egypt	EG	21	0.252	3.785	0.327
El Salvador	SV	17	0.194	3.796	-1.817

Country name	Country code	Number of banks	Avg. Lerner index	ln (Z-score)	Cond. correlation
Lebanon	LB	54	0.143	4.173	0.738
Lithuania	LT	12	0.241	3.015	2.062
Luxembourg	LU	131	0.126	3.868	-0.494
Macao	MO	10	0.289	4.357	2.942
Macedonia (Fyrom)	MK	18	0.150	3.386	1.032
Malawi	MW	7	0.367	2.878	0.576
Malaysia	MY	48	0.275	3.864	-0.067
Mali	ML	9	0.173	3.410	2.023
Malta	MT	12	0.246	4.235	2.755
Mauritius	MU	17	0.344	3.627	2.816
Mexico	MX	20	0.075	2.760	0.614
Morocco	MA	12	0.320	4.420	1.331
Mozambique	MZ	14	0.258	2.902	0.729
Nepal	NP	30	0.395	3.748	3.011
Netherlands	NL	43	0.188	4.043	0.511
New Zealand	NZ	20	0.158	3.868	0.453
Nigeria	NG	63	0.353	2.950	2.813
Norway	NO	144	0.266	4.090	1.568
Oman	OM	11	0.277	3.947	2.188
Pakistan	PK	27	0.080	3.448	2.177
Panama	PA	64	0.287	3.811	-0.569
Paraguay	PY	23	0.113	3.145	0.693
Peru	PE	31	0.283	3.750	0.454
Philippines	PH	42	0.269	4.013	1.659
Poland	PL	60	0.232	3.668	0.956
Portugal	PT	119	0.136	3.670	2.353
Qatar	QA	6	0.497	4.239	0.617
Republic Of Korea	KR	22	0.282	3.540	0.214
Republic Of Moldova	MD	16	0.263	3.379	0.933
Romania	RO	29	0.236	2.992	0.999
Russian Federation	RU	944	0.199	3.653	-0.180
Saudi Arabia	SA	9	0.354	4.219	1.241
Senegal	SN	8	0.327	3.661	1.687
Serbia	RS	32	0.224	3.077	1.114
Sierra Leone	SL	7	0.399	2.952	1.499

Estonia	EE	11	0.351	3.021	1.298	Singapore	SG	19	0.315	4.145	0.799
Ethiopia	ET	9	0.478	3.602	-2.087	Slovakia	SK	19	0.206	3.630	2.607
Finland	FI	24	0.114	3.882	-1.521	Slovenia	SI	22	0.271	3.500	2.582
France	FR	354	0.177	4.259	1.865	South Africa	ZA	22	0.239	3.855	1.394
Germany	DE	2,415	0.173	5.250	0.326	Spain	ES	220	0.239	4.261	2.348
Ghana	GH	21	0.361	3.014	0.190	Sri Lanka	LK	19	0.264	3.406	-0.235
Greece	GR	22	0.177	2.819	3.680	Sweden	SE	104	0.318	3.936	0.295
Honduras	HN	22	0.176	4.034	0.944	Switzerland	CH	474	0.216	5.308	1.184
Hong Kong	HK	38	0.291	4.149	0.243	Thailand	TH	27	0.242	3.660	2.599
Hungary	HU	29	0.208	3.161	0.852	Trinidad And Tobago	TT	10	0.403	4.016	-0.316
Iceland	IS	21	0.246	2.929	0.296	Tunisia	TN	17	0.324	3.916	0.096
India	IN	91	0.271	3.839	3.302	Turkey	TR	44	0.258	3.507	1.218
Indonesia	ID	99	0.262	3.655	1.539	Uganda	UG	17	0.298	3.296	2.623
Ireland	IE	19	-0.265	3.483	1.731	Ukraine	UA	29	0.287	2.924	0.254
Israel	IL	16	0.182	4.045	0.988	United Arab Emirates	AE	20	0.442	4.192	2.217
Italy	IT	809	0.240	4.102	2.021	United Kingdom	GB	130	0.200	3.807	0.793
Jamaica	JM	7	0.120	3.920	1.917	United Republic Of Tanzania	TZ	28	0.234	3.340	1.514
Japan	JP	595	0.244	4.028	2.317	United States Of America	US	10,178	0.245	4.211	2.057
Jordan	JO	11	0.298	4.252	3.051	Uruguay	UY	36	0.108	2.605	1.145
Kazakhstan	KZ	32	0.314	3.114	1.510	Venezuela	VE	54	0.349	2.847	-0.082
Kenya	KE	41	0.306	3.761	1.910	Vietnam	VN	44	0.235	3.902	-0.193
Latvia	LV	27	0.337	2.906	0.431						

This table shows: the list of countries in the sample, the country code (ISO 3166-1 alpha-2 Codes), the number of banks in each country, the country-average Lerner index and Z-score (this one in logs) and the conditional competition-stability correlation coefficient for each country. The sample is made of 113 countries, both industrialised and not-industrialised. The conditional correlation is the coefficient of the Lerner index when running by-country regressions of the Z-score on the Lerner index and a set of bank-specific control variables while controlling for time fixed effects. As it is shown in the table, the Lerner index is quite scattered as it ranges from -0.265 in Ireland to 0.497 in Qatar. The same holds for the Z-score, which ranges from a minimum of 2.605 in Uruguay to a maximum of 5.308 in Switzerland.

APPENDIX 4

Marginal costs estimate through a translog cost function:

As many authors (Beck, De Jonghe and Schepens (2013) and Berger, Klapper and Turk-Ariss (2009) among others), we estimate marginal costs using a translog cost function. We develop a regression model where total operating costs are built as a function of an aggregate bank output proxy and three input prices. The model takes the following form:

$$\ln(C_{i,t}) = \alpha_0 + \alpha_1 \ln(Q_{i,t}) + \alpha_2 \left(\ln(Q_{i,t})\right)^2 + \sum_{j=1}^{3} \beta_j \ln(w_{i,t}^j) + \sum_{j=1}^{3}\sum_{k=1}^{3} \beta_{j,k} \ln(w_{i,t}^j) \ln(w_{i,t}^k) +$$

$$+ \sum_{j=1}^{3} \gamma_j \ln(w_{i,t}^j) * \ln(Q_{i,t}) + \nu_t + \theta_i + \varepsilon_{i,t}$$

where: $C_{i,t}$ indicates the total operating costs (computed as the sum of other operating and administrative expenses, personnel expenses and interest expenses), $Q_{i,t}$ indicates the bank's total assets, $w^j_{i,t}$ with $j \in \{1,2,3\}$ indicates the three input prices (w^1 represents the price of fixed assets, w^2 the price of labour and w^3 the price of funding). The first one is built as ratio of other operating and administrative expenses to total assets, the second one as ratio of personnel expenses to total assets and the third one as ratio of interest expenses to total deposits and money market funding[65]. The equation is estimated separately for each country to take into account potential differences in the technological development. In addition, we include time dummies to account for changes in business cycle conditions (ν_t) and a bank specialisation dummy (θ_i). Furthermore, we impose some restrictions on the cost structure: $\sum_{j=1}^{3} \beta_j = 1$, $\sum_{j=1}^{3} \gamma_j = 0$ and $\forall k \in \{1,2,3\}$: $\sum_{j=1}^{3} \beta_{j,k} = 0$.

Now, we can compute marginal costs as:

$$MC_{i,t} = \frac{\partial C_{i,t}}{\partial Q_{i,t}} = \frac{C_{i,t}}{Q_{i,t}} (\widehat{\alpha_1} + 2\widehat{\alpha_2} \ln Q_{i,t} + \sum_{j=1}^{2} \widehat{\gamma_j} \ln \frac{w_{i,t}^j}{w_{i,t}^3})$$

[65] Other operating and administrative expenses include depreciations, amortizations, administrative expenses, occupancy costs, software costs, operating lease rentals, audit and professional fees and other operating expenses of an administrative nature.
Personnel expenses include wages, salaries, social security costs, pension costs and other staff costs, including staff stock options.
Price of funding includes interest expenses on customer deposits, other interest expenses and preferred dividends paid and declared.
Source: Bankscope User Guide.

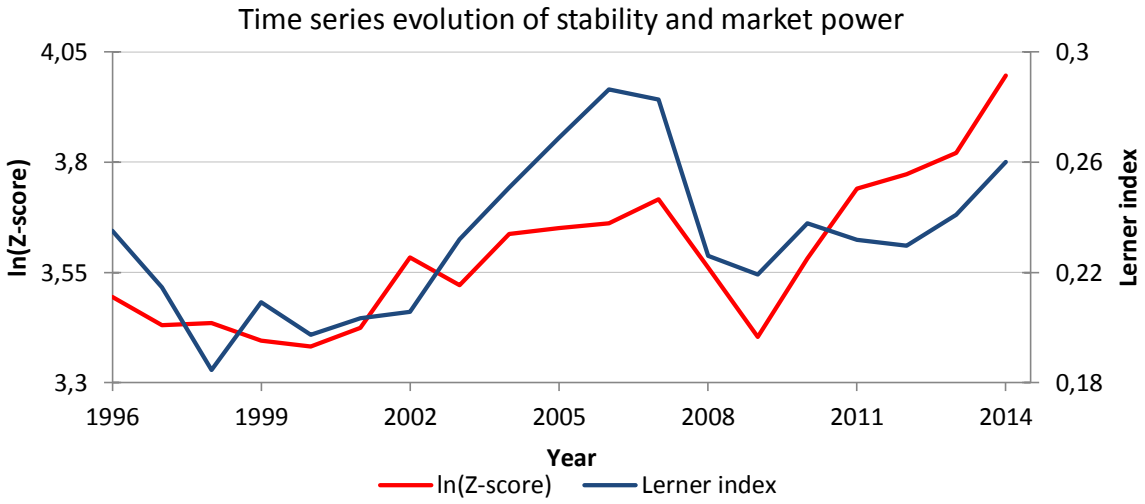
APPENDIX 5

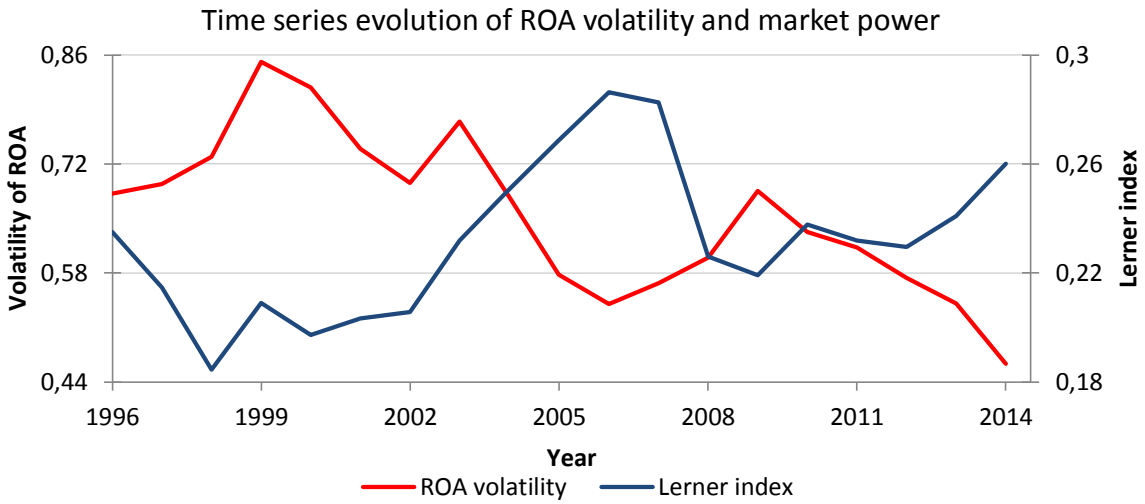
	Lerner index	Market share (assets)	Market share (loans)	Number of banks	HHI (assets)	HHI (loans)	HHI (deposits)	CR3	CR5	Boone indicator	H-statistic
Lerner index	1										
	2,033										
Market share (assets)	0.063	1									
	(0.005)										
	1,990	2,057									
Market share (loans)	0.044	0.913	1								
	(0.051)	(0.000)									
	1,990	2,052	2,058								
Number of banks	-0.030	-0.175	-0.172	1							
	(0.179)	(0.000)	(0.000)								
	2,022	2,046	2,047	2,110							
HHI (assets)	0.074	0.210	0.245	-0.135	1						
	(0.001)	(0.000)	(0.000)	(0.000)							
	1,989	2,041	2,042	2,061	2,061						
HHI (loans)	0.065	0.260	0.243	-0.146	0.946	1					
	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)						
	1,989	2,040	2,041	2,060	2,059	2,060					
HHI (deposits)	0.061	0.260	0.278	-0.145	0.946	0.921	1				
	(0.006)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)					
	1,989	2,039	2,041	2,059	2,056	2,055	2,059				
CR3	0.047	0.445	0.438	-0.198	0.859	0.834	0.832	1			
	(0.042)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)				
	1,918	1,974	1,972	1,976	1,976	1,976	1,974	1,976			
CR5	0.069	0.564	0.555	-0.261	0.744	0.734	0.734	0.942	1		
	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
	1,822	1,876	1,875	1,877	1,877	1,877	1,875	1,875	1,877		
Boone indicator	0.011	0.045	0.063	-0.006	0.164	0.157	0.152	0.165	0.120	1	
	(0.673)	(0.080)	(0.013)	(0.801)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
	1,528	1,541	1,541	1,560	1,533	1,533	1,530	1,497	1,438	1,582	
H-statistic	-0.082	-0.297	-0.293	0.055	-0.058	-0.087	-0.043	-0.023	-0.034	0.038	1
	(0.150)	(0.000)	(0.000)	(0.334)	(0.305)	(0.126)	(0.450)	(0.682)	(0.556)	(0.507)	
	311	312	311	312	312	312	312	311	307	301	312

This table shows the pairwise correlations, the p-values and the number of observations relative to various indicators of competition, market power and market structure. Correlations are calculated on the basis of country-year level data. Variables that vary at bank level (i.e. Lerner index and market share) are firstly averaged at country level and then correlated with the other measures. The Lerner index is a bank-specific measure of competition calculated as the mark-up over marginal costs that banks can charge. Together with the Lerner index, market share is another indicator varying at bank level. It is the market share that a bank has in a country in a specific year, calculated on both total assets and total loans. The number of banks indicates how many banks are active in a specific country and year. The HHI measures the concentration of the banking market by summing the squares of the market shares of each bank in a given country and year. Larger values indicate more concentration. It is computed on three bases: total assets, total loans and total customer deposits. CR3 and CR5 are two alternative concentration measures, constructed as the market share hold by the three or five largest banks in a given country and year. Again, larger values mean higher concentration. The Boone indicator is a direct measure of competition calculated as elasticity of profits to marginal costs. The more negative the Boone indicator, the higher the level of competition is. The H-statistic proxies the level of competition measuring the elasticity of bank revenues to input prices. The lower the H-statistic, the lower the level of competition is. In the table below, the annual coverage and the source from which data have been retrieved are presented:

Variable	Coverage	Source
Lerner index	1996-2014	Bankscope, own calculations
Market share (assets, loans)	1996-2014	Bankscope, own calculations
Number of banks	1996-2014	Bankscope, own calculations
HHI (assets, loans, deposits)	1996-2014	Bankscope, own calculations
CR (3-banks, 5-banks)	1996-2014	Bankscope, own calculations
Boone indicator	1999-2013	Global Financial Development Database
H-statistic	2010-2013	Global Financial Development Database

APPENDIX 6





The table shows the time series evolution of the cross-country averages of the Lerner index, the Z-score and the volatility of profits. These indicators are firstly computed at bank-year level starting from raw data retrieved from Bankscope. After that, they are averaged at country-year level and subsequently by year. In such a way, the same weight is assigned to each country, irrespective of the number of banks in each country.

The upper graph shows the time path of market power, proxied by the Lerner index, and banking system stability, proxied by the natural logarithm of the Z-score. The Lerner index is calculated as the mark-up of prices over marginal costs, whereas the Z-score is calculated as ratio of the sum of return on assets and equity-to-assets over standard deviation of ROA (calculated on three years). The evolution of the Z-score is plotted on the left-hand axis, the evolution of the Lerner index on the right-hand axis, the years on the horizontal axis.

The lower graph shows the time path of market power, proxied again by the Lerner index, and profit volatility, proxied by the three years rolling standard deviation of the return on assets. The profit volatility index lies on the left-hand axis, the Lerner index on the right-hand axis, the years on the horizontal axis.

APPENDIX 7

	Depth of information sharing	Stock market turnover	Capital stringency	Deposit insurance coverage	Multiple supervisors	External governance index	Activity restrictions	Heterogeneous bank revenues	Systemic stability	β coefficient
Depth of information sharing	1									
	111									
Stock market turnover	0.345	1								
	(0.001)									
	95	96								
Capital stringency	-0.222	-0.046	1							
	(0.020)	(0.659)								
	110	96	112							
Deposit insurance coverage	0.042	-0.018	-0.096	1						
	(0.714)	(0.884)	(0.402)							
	78	72	78	78						
Multiple supervisors	0.230	0.359	-0.099	-0.003	1					
	(0.015)	(0.000)	(0.301)	(0.980)						
	111	96	112	78	113					
External governance index	0.075	0.141	0.227	0.134	-0.039	1				
	(0.483)	(0.204)	(0.031)	(0.274)	(0.713)					
	89	83	91	68	91	91				
Activity restrictions	-0.323	-0.134	0.156	0.317	0.012	0.130	1			
	(0.001)	(0.192)	(0.102)	(0.005)	(0.898)	(0.218)				
	111	96	112	78	113	91	113			
Heterogeneous bank revenues	0.368	0.018	-0.079	-0.197	-0.097	0.020	-0.439	1		
	(0.000)	(0.866)	(0.409)	(0.083)	(0.306)	(0.853)	(0.000)			
	111	96	112	78	113	91	113	113		
Systemic stability	-0.006	-0.074	-0.129	0.122	-0.047	-0.045	0.105	-0.218	1	
	(0.954)	(0.476)	(0.177)	(0.287)	(0.624)	(0.670)	(0.270)	(0.021)		
	110	95	111	77	112	91	112	112	112	
β coefficient	-0.139	0.029	0.110	0.228	-0.025	0.102	0.066	-0.202	0.067	1
	(0.147)	(0.778)	(0.248)	(0.044)	(0.796)	(0.336)	(0.488)	(0.032)	(0.486)	
	111	96	112	78	113	91	113	113	112	113

This table shows the correlations between the country-specific variables employed in the econometric model. Before calculating the correlations, variables are firstly averaged at country level. For each pair of variables, the pairwise correlation coefficient, the p-value and the number of observations are reported. The last set of rows illustrates the correlation between the country-specific features and the competition-stability relationship. The β coefficient is the coefficient of the Lerner index in a country-by-country regression model where the ln(Z-score) is regressed against the Lerner index and a set of bank-specific variables, while controlling also for banks' specialization and time fixed effects (the same values are reported in Appendix 3 under the label "Conditional correlation").

APPENDIX 8

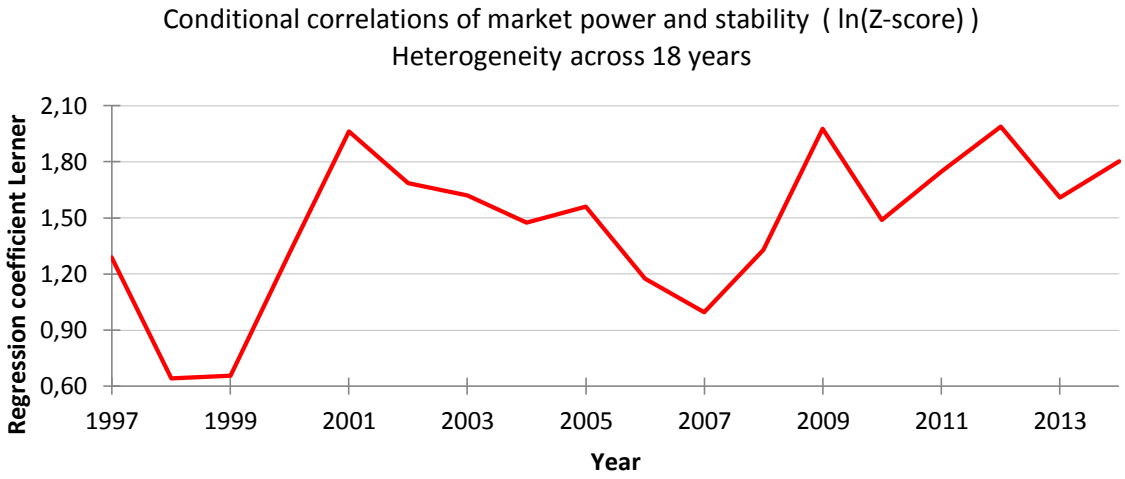
	(1) ln(Z-score)	(2) -ln(sd(ROA))	(3) Eq/TA	(4) ln(Z-score_EP)	(5) NPL	(6) ln(Z-score)	(7) ln(Z-score)	(8) ln(Z-score)	(9) ln(Z-score)	(10) ln(Z-score)	(11) ln(Z-score)
Lerner index	1.405***	0.813***	2.350***	0.409***	-2.537***	1.402***				1.401***	1.407***
	(0.052)	(0.052)	(0.359)	(0.023)	(0.296)	(0.073)				(0.052)	(0.051)
Share of wholesale funding	-0.077*	-0.179***	0.467	-0.111***	-0.438	-0.073	-0.092**	-0.065	-0.067	-0.084**	-0.082**
	(0.042)	(0.045)	(0.360)	(0.023)	(0.303)	(0.070)	(0.042)	(0.041)	(0.041)	(0.041)	(0.041)
Loans to total assets	0.083*	0.264***	-2.334***	0.027	-0.728**	0.070	0.204***	0.200***	0.187***	0.100**	0.095**
	(0.048)	(0.052)	(0.397)	(0.030)	(0.297)	(0.092)	(0.050)	(0.048)	(0.048)	(0.048)	(0.048)
Non-interest revenue share	-0.521***	-0.710***	0.0929	-0.086***	-0.920***	0.087	-0.350***	-0.440***	-0.437***	-0.509***	-0.511***
	(0.048)	(0.053)	(0.344)	(0.023)	(0.278)	(0.067)	(0.051)	(0.047)	(0.047)	(0.048)	(0.048)
ln(total assets)	0.002	0.088***	-1.563***	-0.129***	-0.074***	0.062**	0.013**				
	(0.005)	(0.005)	(0.061)	(0.008)	(0.026)	(0.027)	(0.005)				
Loan loss provisions to interest income	-0.825***	-0.679***	-0.595***	-0.123***	5.055***	-0.623***	-0.809***	-0.781***	-0.782***	-0.822***	-0.825***
	(0.025)	(0.024)	(0.109)	(0.008)	(0.178)	(0.028)	(0.026)	(0.025)	(0.025)	(0.025)	(0.025)
Annual growth in total assets	-0.632***	-0.379***	-1.956***	-0.167***	-1.324***	-0.288***	-0.467***	-0.313***	-0.312***	-0.624***	-0.624***
	(0.023)	(0.023)	(0.149)	(0.010)	(0.138)	(0.024)	(0.023)	(0.021)	(0.021)	(0.023)	(0.023)
Price of bank activities							3.039***				
							(0.362)				
Marginal costs							-5.917***				
							(0.405)				
Market share (total assets)								0.921***		0.211	
								(0.199)		(0.194)	
Market share (loans)									1.038***		0.329*
									(0.192)		(0.187)
Constant	4.789***	1.697***	20.59***	4.233***	7.310***	3.776***	5.045***	4.963***	4.961***	4.781***	4.774***
	(0.269)	(0.384)	(1.476)	(0.273)	(1.977)	(0.195)	(0.277)	(0.281)	(0.280)	(0.267)	(0.265)
Observations	79,683	80,215	80,875	80,148	45,427	78,179	79,356	82,208	82,236	79,763	79,808
R^2	0.3630	0.4898	0.3659	0.3622	0.5242	0.0383	0.3556	0.3492	0.3487	0.3622	0.3620
Specialisation dummies	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Country-year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No	Yes	No	No	No	No	No

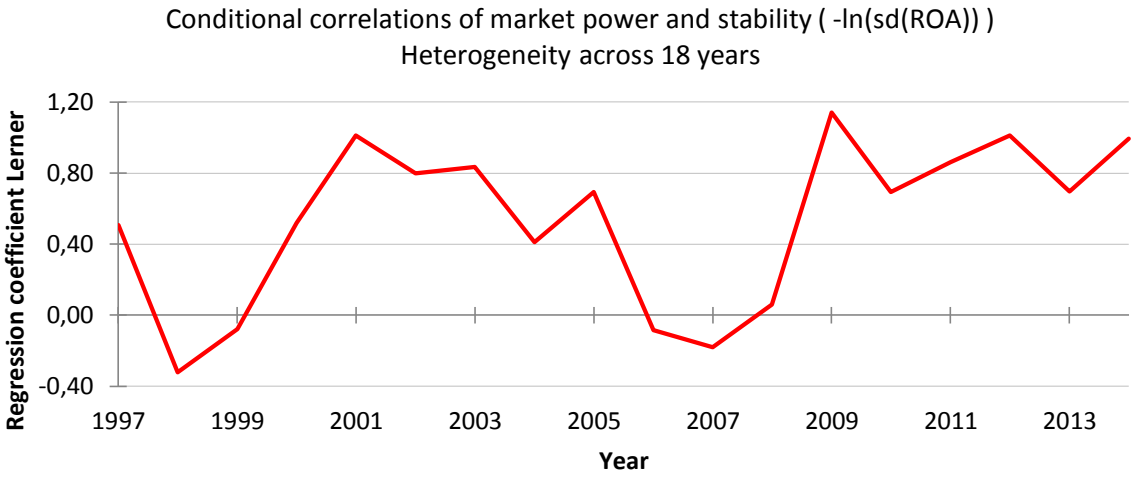
Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table shows the results of several regressions modelled as outlined in Equation 1. The total sample consists of 113 countries and covers 18 years (1996-2014). The dependent variable is bank soundness and is proxied by several indicators as specified in the header row. The explanatory variable is market power, proxied by the Lerner index or by the market share. In addition, we add a group of control variables relative to the bank business model, among which there are three bank specialisation dummies. Furthermore, we control for unobserved heterogeneity at country-year level by means of country-year dummies. In order to mitigate possible concerns due to reverse causality, we use lagged independent variables. Finally, we calculate robust standard errors to cope with heteroscedasticity issues. The robust standard errors are shown in brackets. In the first column we present the standard model, with ln(Z-score) as proxy for bank stability and the Lerner index as proxy for market power. In the following four columns, we use alternative measures of risk, that are the volatility of profits, the capitalization ratio, the ln(Z-score) where the standard deviation of the return on assets is calculated over the entire sample period instead of three years and the non-performing loan ratio. In column 6 we apply a 2SLS method, where the Lerner index is instrumented by loan growth, cost-income ratio and an interaction term between HHI and market share. Moreover, we add bank fixed effects. In the next three columns we use alternative measures of market power, that are the subcomponents of the Lerner index (price of bank activities and marginal costs), the market share computed on total assets and the market share computed on loans. Columns 10 and 11 report regressions where the Lerner index as well as the market share are employed simultaneously as independent variables.

APPENDIX 9

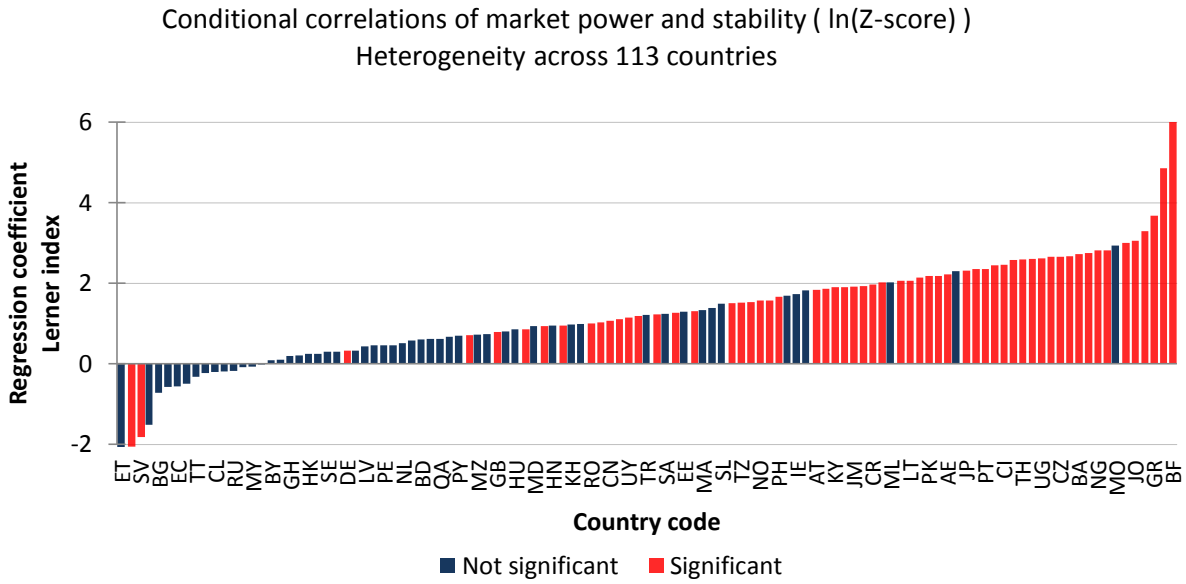


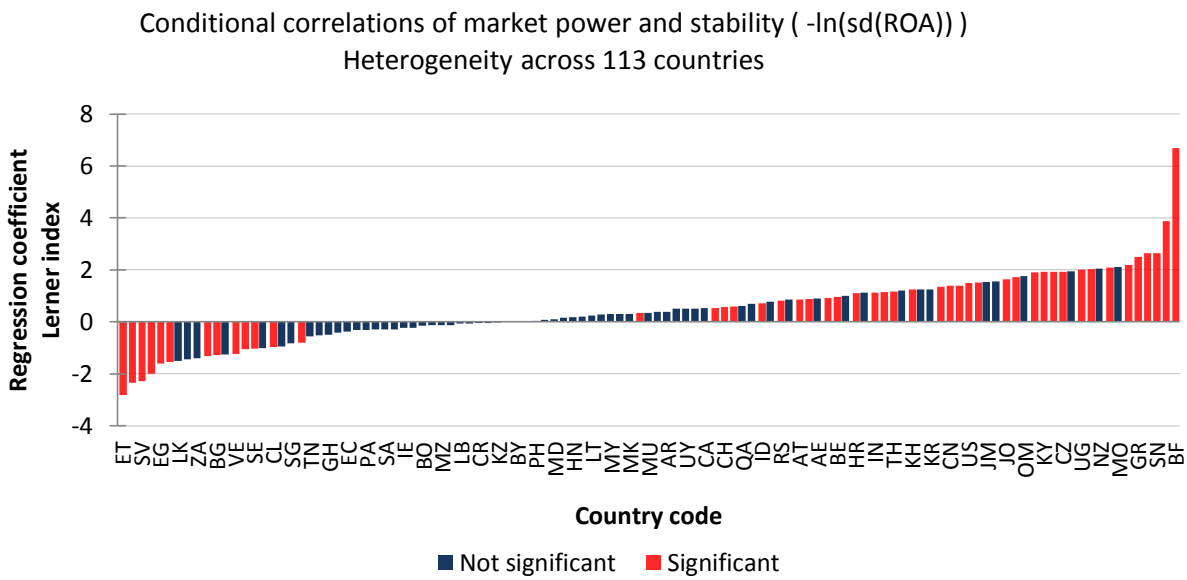


This table shows the time series evolution of the conditional correlation coefficients of market power and stability between 1997 and 2014. Market power is proxied by the Lerner index whereas bank stability is proxied by the Z-score in the upper panel and by the volatility of returns in the lower panel. The coefficients are derived from the regression outlined in Equation 1, which is run separately for each time period. Instead of country-year fixed effects, now we include country fixed effects only. In the upper graph, all the coefficients are significantly different from zero; by contrast, in the lower graph there are five estimates which are not statistically significant: 1998, 1999, 2006, 2007 and 2008. Below, a table reporting summary statistics of the correlation coefficients under both specifications:

Dependent variable	Min	Max	Mean	Standard deviation
ln(Z-score)	0.64	1.99	1.46	0.39
-ln(sd(ROA))	-0.32	1.14	0.53	0.49

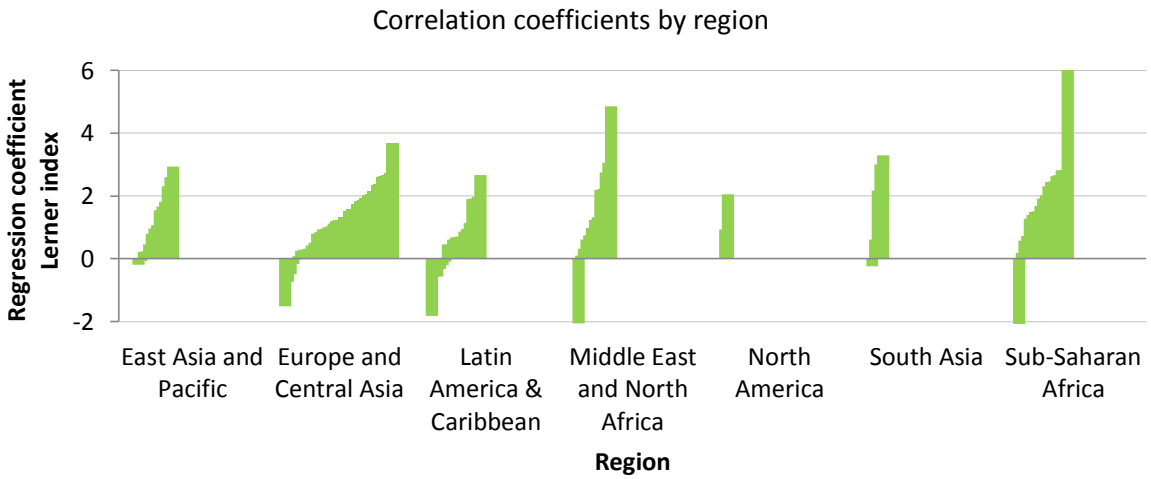
APPENDIX 10

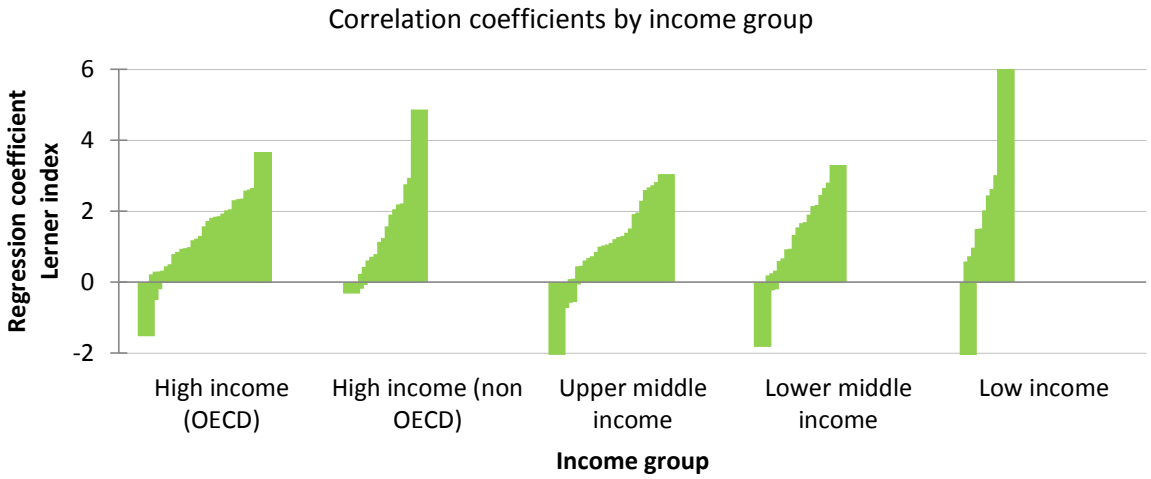




This table shows the correlation coefficient of the market power-stability relationship for all 113 countries in our sample. Market power is proxied by the Lerner index whereas bank stability is proxied by the Z-score in the upper panel and by the volatility of returns in the lower panel. The coefficients are derived from Equation 1, run separately for each country. Control variables are the same as the standard model; since we want to exploit cross-country heterogeneity, we include time dummies only instead of country-year dummies. The height of the bars indicates the magnitude of the relationship whereas the colour indicates whether the relationship is significant (red) or not (blue). On the horizontal axis, the country label is reported. Further details on country names and values of the correlation coefficients are reported in Appendix 3. Summary statistics of the correlation coefficients are provided below:

Dependent variable	Min	Max	Mean	Standard deviation
ln(Z-score)	0.64	1.99	1.46	0.39
-ln(sd(ROA))	-0.32	1.14	0.53	0.49





In these tables the correlation coefficients of the first panel are grouped with respect to the geographic location and the income level of the respective countries. Geographic region and income group are assigned to each country on the basis of the classification provided by Bankscope. The table below provides summary statistics about the correlation coefficients relative to each group:

Group	Observations	Min	Max	Mean	Standard deviation
1) By region					
East Asia and Pacific	14	-0.193	2.942	1.169	0.969
Europe and Central Asia	41	-1.521	3.680	1.204	1.047
Latin America & Caribbean	19	-1.817	2.669	0.603	1.043
Middle East and North Africa	13	-2.057	4.863	1.412	1.615
North America	2	0.941	2.057	1.499	0.558
South Asia	5	-0.235	3.302	1.772	1.374
Sub-Saharan Africa	19	-2.087	6.028	1.834	1.512
2) By income					
High income (OECD)	32	-1.521	3.680	1.297	1.068
High income (non OECD)	19	-0.316	4.863	1.322	1.289
Upper middle income	30	-2.057	3.051	1.032	1.167
Lower middle income	21	-1.817	3.302	1.208	1.199
Low income	11	-2.087	6.028	1.758	1.884

APPENDIX 11

	(1) ln(Z-score)	(2) ln(Z-score)	(3) ln(Z-score)	(4) ln(Z-score)	(5) ln(Z-score)	(6) ln(Z-score)	(7) ln(Z-score)	(8) ln(Z-score)	(9) ln(Z-score)	(10) ln(Z-score)	(11) -ln(sd(ROA))
Lerner index	1.403***	1.423***	1.389***	1.310***	1.393***	1.407***	1.429***	1.424***	1.431***	1.442***	0.804***
	(0.052)	(0.054)	(0.054)	(0.060)	(0.053)	(0.061)	(0.054)	(0.052)	(0.052)	(0.067)	(0.071)
Depth of information sharing * Lerner index	0.114**									0.132	0.202**
	(0.046)									(0.088)	(0.096)
Stock market turnover * Lerner index		0.135***								0.002	0.081
		(0.041)								(0.066)	(0.064)
Capital stringency * Lerner index			0.022							-0.013	-0.0047
			(0.041)							(0.062)	(0.062)
Deposit insurance coverage * Lerner index				0.327***						0.314***	0.340***
				(0.052)						(0.069)	(0.070)
Multiple supervisors * Lerner index					0.028					-0.194**	-0.174**
					(0.050)					(0.086)	(0.083)
External governance index * Lerner index						0.221***				-0.037	-0.025
						(0.054)				(0.073)	(0.073)
Activity restrictions * Lerner index							0.303***			0.235***	0.118*
							(0.046)			(0.072)	(0.070)
Heterogeneous bank revenues * Lerner index								-0.133***		-0.017	0.025
								(0.045)		(0.064)	(0.070)
Systemic stability * Lerner index									0.102**	0.137	0.046
									(0.041)	(0.086)	(0.086)
Constant	4.771***	4.831***	4.820***	4.571***	4.822***	4.779***	4.841***	4.754***	4.812***	3.284***	0.497***
	(0.268)	(0.271)	(0.271)	(0.198)	(0.271)	(0.265)	(0.271)	(0.266)	(0.270)	(0.153)	(0.191)
Observations	79,564	76,440	74,585	69,988	75,497	65,707	64,300	79,165	78,960	47,773	47,931
R^2	0.3629	0.3534	0.3635	0.3479	0.3672	0.3499	0.3325	0.3614	0.3606	0.3040	0.4478
Bank-specific control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Specialisation dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table provides information about the drivers of the heterogeneity that characterises the competition-stability relationship. Results are obtained by running regressions as outlined in Equation 2. As in Equation 1, a measure of bank stability (Z-score) is regressed on a measure of market power (Lerner index) and a group of control variables, among which there are the bank specialisation dummies. With respect to Equation 1, now we add a vector with the interaction terms between the Lerner index and the country-specific variables to determine if and how country-specific features may affect the way in which the level of competition and financial stability are related. Since we are interest in exploiting within country, within year variations, we include country-year fixed effects to control for unobserved heterogeneity at country-year level. Moreover, to mitigate for reverse causality, we lag the independent variables by one period, as indicated by subscripts in Equation 2. Furthermore, the standard errors are robust to exclude problems of heteroscedasticity. The robust standard errors are reported in brackets. In order to facilitate the comprehension of the economic impact that country-specific features have, all country-specific variables have been normalised before interacting them with the Lerner index. That way, we avoid possible misunderstandings related to the unit of measure or the scale of the variables. Not all variables have data available for all countries and years. This explains why the number of observations differs among the alternative specifications of the model. When combining all variables together, the number of observations shrinks sharply because we consider banks that have available data relative to all regressors at least for one year. In columns 1 to 9, we introduce one interaction term each time. In column 10, we introduce all the interactions simultaneously. In column 11, we introduce again all the interactions but now we use the negative of profit volatility as measure of stability instead of the Z-score.

APPENDIX 12

Table A

	(1) ln(Z-score)	(2) ln(Z-score)	(3) ln(Z-score)	(4) ln(Z-score)	(5) ln(Z-score)	(6) ln(Z-score)	(7) ln(Z-score)	(8) ln(Z-score)	(9) ln(Z-score)
Lerner index	1.625***	1.650***	1.755***	1.668***	1.681***	1.616***	1.642***	1.622***	1.838***
	(0.064)	(0.064)	(0.065)	(0.064)	(0.063)	(0.064)	(0.070)	(0.064)	(0.072)
Lerner index^2	-0.955***	-0.947***	-1.109***	-0.981***	-1.110***	-0.948***	-0.998***	-0.977***	-1.299***
	(0.132)	(0.133)	(0.132)	(0.132)	(0.130)	(0.132)	(0.153)	(0.134)	(0.153)
Share of wholesale funding * Lerner index		-0.200***							-0.165***
		(0.036)							(0.036)
Loans to total assets * Lerner index			0.218***						0.149***
			(0.036)						(0.039)
Non-interest revenue share * Lerner index				-0.203***					-0.149***
				(0.033)					(0.035)
ln(tot. assets) * Lerner index					0.216***				0.205***
					(0.040)				(0.042)
Loan loss provisions to interest income * Lerner index						0.025			0.011
						(0.027)			(0.027)
Annual growth in total assets * Lerner index							0.030		0.047
							(0.032)		(0.031)
Market share assets * Lerner index								0.094***	0.074***
								(0.021)	(0.022)
Constant	4.801***	4.767***	4.941***	4.753***	4.943***	4.806***	4.804***	4.789***	4.966***
	(0.271)	(0.271)	(0.270)	(0.273)	(0.272)	(0.271)	(0.271)	(0.267)	(0.272)
Observations	79,351	79,351	79,351	79,351	79,351	79,351	79,351	78,788	78,788
R^2	0.3645	0.3651	0.3647	0.3653	0.3647	0.3645	0.3645	0.3640	0.3655
Bank-specific control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Specialisation dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table provides evidence of non-linearity in the competition-stability relationship. We apply the model outlined in Equation 3. The Z-score is regressed on the Lerner index both in level and squared. In the model there are also the usual bank-specific control variables, among which the specialisation dummies, as well as country-year fixed effects to control for heterogeneity at bank level. To mitigate the reverse causality, we lag the independent variables by one period. Moreover, we use robust standard errors (reported in brackets) to deal with the heteroscedasticity. In addition, we introduce interaction terms between the Lerner index in level and the country-specific variables, in order to determine if the non-linearity is explainable by an interaction term. Before interacting with the Lerner index, the variables have been normalised, so to facilitate the comparison of different estimates. In column 1 we run a regression without any interaction term. In columns 2 to 8 we introduce a different interaction term each time. In column 9 we include all the interactions together.

Table B

	(10) ln(Z-score)	(11) ln(Z-score)	(12) ln(Z-score)	(13) ln(Z-score)	(14) ln(Z-score)	(15) ln(Z-score)	(16) ln(Z-score)	(17) ln(Z-score)	(18) ln(Z-score)	(19) ln(Z-score)
Lerner index	1.622***	1.655***	1.619***	1.552***	1.619***	1.688***	1.636***	1.669***	1.659***	1.739***
	(0.064)	(0.066)	(0.065)	(0.074)	(0.064)	(0.070)	(0.066)	(0.066)	(0.065)	(0.085)
Lerner index^2	-0.952***	-0.994***	-1.009***	-1.062***	-0.998***	-1.192***	-0.944***	-1.033***	-0.986***	-1.185***
	(0.133)	(0.137)	(0.133)	(0.152)	(0.131)	(0.139)	(0.137)	(0.137)	(0.135)	(0.168)
Depth of information sharing * Lerner index	0.093*									0.090
	(0.048)									(0.086)
Stock market turnover * Lerner index		0.155***								0.027
		(0.042)								(0.067)
Capital stringency * Lerner index			0.037							-0.032
			(0.043)							(0.063)
Deposit insurance coverage * Lerner index				0.313***						0.272***
				(0.052)						(0.069)
Multiple supervisors * Lerner index					0.034					-0.222**
					(0.049)					(0.088)
External governance index * Lerner index						0.185***				-0.069
						(0.055)				(0.075)
Activity restrictions * Lerner index							0.343***			0.318***
							(0.046)			(0.073)
Heterogeneous bank revenues * Lerner index								-0.184***		-0.074
								(0.0458)		(0.065)
Systemic stability * Lerner index									0.100**	0.101
									(0.041)	(0.089)
Constant	4.787***	4.846***	4.837***	4.508***	4.837***	4.801***	4.858***	4.751***	4.823***	3.298***
	(0.270)	(0.273)	(0.274)	(0.201)	(0.273)	(0.268)	(0.273)	(0.267)	(0.272)	(0.150)
Observations	79,234	76,143	74,282	69,711	75,183	65,456	64,020	78,836	78,631	47,582
R^2	0.3644	0.3551	0.3653	0.3497	0.3689	0.3522	0.3345	0.3631	0.3621	0.3065
Bank-specific control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Specialization dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table is a continuation of Table A but instead of focusing on bank-specific features, now we analyse the effects that country-specific characteristics have on the non-linearity. The methodology adopted and the control variables used are the same as in Table A. The interaction terms are made of Lerner index times normalised country-specific variables. In columns 10 to 18 we introduce one interaction term each time whereas in column 19 all the interactions are added simultaneously.

APPENDIX 13

Table A

	(1) ln(Z-score)	(2) ln(Z-score)	(3) ln(Z-score)	(4) ln(Z-score)	(5) ln(Z-score)	(6) ln(Z-score)	(7) ln(Z-score)	(8) ln(Z-score)	(9) ln(Z-score)	(10) ln(Z-score)
Lerner index	1.398***	1.406***	0.740***	1.402***	1.310***	1.309***	1.397***	1.523***		
	(0.052)	(0.0520)	(0.045)	(0.051)	(0.059)	(0.094)	(0.054)	(0.174)		
Market share (total assets)	0.277									
	(0.211)									
Market share (loans)		0.429**								
		(0.205)								
Boone indicator									-1.506***	
									(0.188)	
H-statistic										-0.357***
										(0.056)
Share of wholesale funding	-0.074*	-0.070*	-0.126***	-0.075*	-0.039	0.137*	-0.055	-0.500***	0.053	-0.151**
	(0.042)	(0.042)	(0.041)	(0.041)	(0.047)	(0.074)	(0.043)	(0.163)	(0.036)	(0.06)
Loans to total assets	0.087*	0.081*	0.059		0.067	-0.079	0.082*	0.080	0.266***	0.044
	(0.048)	(0.049)	(0.047)		(0.058)	(0.083)	(0.049)	(0.202)	(0.048)	(0.075)
Non-interest revenue share	-0.514***	-0.513***	-0.612***	-0.536***	-0.522***	-0.545***	-0.539***	-0.295	-0.143***	-0.386***
	(0.048)	(0.048)	(0.047)	(0.047)	(0.056)	(0.084)	(0.050)	(0.191)	(0.043)	(0.074)
ln(total assets)	0.000	-0.002	-0.009*	0.002	-0.019***	-0.039***	0.003	-0.014	0.003	0.062***
	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)	(0.008)	(0.005)	(0.025)	(0.004)	(0.008)
Loan loss provisions to interest income	-0.824***	-0.827***		-0.820***	-0.701***	-0.738***	-0.831***	-0.770***	-0.999***	-0.931***
	(0.026)	(0.026)		(0.025)	(0.031)	(0.042)	(0.033)	(0.087)	(0.026)	(0.035)
Annual growth in total assets	-0.631***	-0.630***		-0.633***	-0.500***	-0.579***	-0.648***	-0.490***	-0.337***	-0.429***
	(0.023)	(0.023)		(0.023)	(0.026)	(0.048)	(0.024)	(0.072)	(0.023)	(0.047)
Constant	4.783***	4.787***	4.895***	4.854***	4.623***	2.756***	4.802***	5.038***	5.135***	5.266***
	(0.268)	(0.267)	(0.283)	(0.267)	(0.282)	(0.088)	(0.270)	(0.287)	(0.051)	(0.080)
Observations	79,120	79,149	85,517	80,127	34,919	17,721	74,796	4,887	70,854	20,455
R^2	0.3627	0.3625	0.3330	0.3620	0.3091	0.3740	0.3513	0.3199	0.1885	0.2513
Specialisation dummies	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Country-year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Year dummies	No	No	No	No	No	No	No	No	Yes	Yes

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table shows some robustness tests to confirm the findings in Appendix 8. The basic model is that outlined in Equation 1, with the Z-score as dependent variable, the Lerner index as explanatory variable and a set of control variables, among which bank specialisation dummies and country-year fixed effects. In columns 1 and 2 we add the market share calculated on total assets (column 1) and gross loans (column 2). In column 3 we remove two control variables, i.e. loan loss provisions to interest income and annual growth in total assets, whereas in column 4 we remove loans to total assets from the set of control variables. In the following four columns we restrict our sample to commercial banks only (column 5), banks operating in countries and years characterised by systemic financial crises (column 6), banks belonging to countries classified as developed (column 7) and not developed (column 8). In columns 9 and 10 we replace the Lerner index with two alternative indicators of market power: the Boone indicator (column 9) and the H-statistic (column 10). Since these indicators are available at country level only (they have been retrieved from Global Financial Development Database), we include time dummies only instead of country-year dummies.

Table B

	(1) ln (Z-score-EP)	(2) ln(Z-score)	(3) ln(Z-score)	(4) ln(Z-score)	(5) ln(Z-score)	(6) -ln(sd(ROA))	(7) -ln(sd(ROA))	(8) -ln(sd(ROA))
Lerner index	0.380***	1.450***	1.420***	1.902***	1.921***	1.255***	1.377***	1.334***
	(0.030)	(0.069)	(0.067)	(0.097)	(0.094)	(0.061)	(0.069)	(0.085)
Lerner index^2				-1.380***	-1.527***	-1.984***	-2.176***	-2,174***
				(0.196)	(0.190)	(0.129)	(0.145)	(0.171)
Depth of information sharing * Lerner index	-0.012	0.134	0.205**	0.056	0.131			0.128
	(0.042)	(0.088)	(0.083)	(0.086)	(0.082)			(0.093)
Stock market turnover * Lerner index	0.003	0.025	-0.066	0.017	-0.057			0.133**
	(0.027)	(0.068)	(0.064)	(0.069)	(0.067)			(0.065)
Capital stringency * Lerner index	0.049	-0.009	0.003	-0.039	-0.030			-0.050
	(0.030)	(0.063)	(0.059)	(0.064)	(0.060)			(0.067)
Deposit insurance coverage * Lerner index	0.075***	0.310***	0.234***	0.242***	0.170***			0.237***
	(0.027)	(0.069)	(0.065)	(0.070)	(0.065)			(0.068)
Multiple supervisors * Lerner index	-0.049	-0.198**	-0.182**	-0.260***	-0.250***			-0.198**
	(0.033)	(0.086)	(0.081)	(0.089)	(0.083)			(0.085)
External governance index * Lerner index	-0.028	-0.042	0.052	-0.124*	-0.027			-0.055
	(0.033)	(0.074)	(0.071)	(0.075)	(0.072)			(0.072)
Activity restrictions * Lerner index	-0.031	0.231***	0.284***	0.286***	0.333***			0.300***
	(0.032)	(0.072)	(0.069)	(0.073)	(0.070)			(0.071)
Heterogeneous bank revenues * Lerner index	0.004	-0.020	-0.085	0.009	-0.050			-0.067
	(0.024)	(0.065)	(0.062)	(0.067)	(0.063)			(0.068)
Systemic stability * Lerner index	0.091**	0.145*	0.041	0.081	-0.013			-0.059
	(0.042)	(0.086)	(0.081)	(0.091)	(0.086)			(0.090)
Market share (total assets) * Lerner index		0.079**		0.071*	0.040		0.142***	
		(0.040)		(0.040)	(0.040)		(0.022)	
Constant	2.875***	3.288***	3.393***	3.343***	3.392***	1.730***	1.798***	0.415**
	(0.171)	(0.153)	(0.254)	(0.157)	(0.259)	(0.374)	(0.374)	(0.194)
Observations	47,981	47,581	47,773	47,390	47,390	79,880	79,317	47,740
R^2	0.3306	0.3040	0.2903	0.3075	0.2940	0.4966	0.4975	0.4560
Bank-specific control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Specialisation dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-specific control variables	No	No	Yes	No	Yes	No	No	No
Interactions: bank-specific variables * Lerner index	No	No	No	Yes	Yes	No	Yes	No
Country-year dummies	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Country dummies	No	No	Yes	No	Yes	No	No	No
Year dummies	No	No	Yes	No	Yes	No	No	No

Robust standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table shows some additional checks to confirm the robustness of the evidence provided in Appendices 11 and 12. In the first three columns we stress the validity of the results reached in column 10 of Appendix 11. In column 1 we calculate the volatility of profits (the denominator of the Z-score) over the entire sample period instead of three rolling years. In column 2 we add an interaction term (Lerner index * Market share (total assets)). In column 3 we add the nine bank-specific variables as stand-alone regressors while maintaining their interactions and controlling for country-fixed effects and time-fixed effects separately (instead of relying on their interactions). In the remaining five columns we check for the non-linearity. In column 4 we introduce the interactions of the Lerner index with bank-specific features and country-specific features as well. In column 5 we add the country-specific variables as separate regressors as well as country and time fixed effects separately. In columns 6 to 8 we redo the regressions in columns 1, 10 and 19 of Appendix 12 using the negative of profit volatility as measure of stability instead of the Z-score. Profit volatility has been calculated over a window of three years.

Table C

	(1) ln(Z-score)	(2) -ln(sd(ROA))	(3) Eq/TA	(4) NPL	(5) ln(Z-score)	(6) -ln(sd(ROA))	(7) ln(Z-score)	(8) ln(Z-score)	(9) ln(Z-score)
Lerner index	0.027	0.022	-0.0003	-0.003	0.208***	0.150***	0.127***	0.635***	0.414***
	(0.022)	(0.019)	(0.0005)	(0.002)	(0.052)	(0.040)	(0.049)	(0.087)	(0.085)
Lerner index^2							0.0006***	0.002***	0.004***
							(0.0002)	(0.0006)	(0.0008)
Share of wholesale funding	-0.141***	-0.276***	0.018***	0.009*	-0.141***	-0.245***	-0.140***	-0.089*	-0.156***
	(0.043)	(0.044)	(0.004)	(0.005)	(0.052)	(0.054)	(0.043)	(0.050)	(0.052)
Loans to total assets	0.251***	0.472***	-0.046***	-0.016***	0.238***	0.564***	0.232***	0.078	0.220***
	(0.051)	(0.054)	(0.005)	(0.006)	(0.061)	(0.066)	(0.051)	(0.071)	(0.060)
Non-interest revenue share	-0.109***	-0.145***	0.0005	-0.005*	-0.190***	-0.241***	-0.125***	-0.223***	-0.217***
	(0.028)	(0.027)	(0.002)	(0.002)	(0.045)	(0.044)	(0.031)	(0.031)	(0.046)
ln(total assets)	0.009*	0.095***	-0.018***	-0.002***	0.002	0.081***	0.007	-0.002	-0.001
	(0.005)	(0.006)	(0.0007)	(0.0004)	(0.006)	(0.0065)	(0.005)	(0.007)	(0.006)
Loan loss provisions to interest income	-0.391***	-0.313***	-0.003***	0.026***	-0.393***	-0.342***	-0.391***	-0.396***	-0.388***
	(0.021)	(0.018)	(0.001)	(0.003)	(0.027)	(0.023)	(0.021)	(0.022)	(0.027)
Annual growth in total assets	-0.245***	-0.177***	-0.009***	-0.010***	-0.243***	-0.169***	-0.257***	-0.330***	-0.254***
	(0.015)	(0.014)	(0.001)	(0.001)	(0.020)	(0.019)	(0.016)	(0.036)	(0.020)
Depth of information sharing * Lerner index					0.240***	0.186***			0.058
					(0.071)	(0.058)			(0.063)
Stock market turnover * Lerner index					-0.212***	-0.141***			0.113
					(0.052)	(0.040)			(0.069)
Capital stringency * Lerner index					0.142***	0.097**			0.070
					(0.048)	(0.041)			(0.054)
Deposit insurance coverage * Lerner index					0.086*	0.062			0.114**
					(0.047)	(0.042)			(0.057)
Multiple supervisors * Lerner index					-0.031	-0.017			-0.182**
					(0.060)	(0.046)			(0.088)
External governance index * Lerner index					-0.106*	-0.090*			0.047
					(0.061)	(0.049)			(0.065)
Activity restrictions * Lerner index					0.042	0.052			0.012
					(0.057)	(0.046)			(0.070)
Heterogeneous bank revenues * Lerner index					-0.024	-0.007			-0.125**
					(0.040)	(0.029)			(0.063)
Systemic stability * Lerner index					0.229***	0.170***			0.093*
					(0.055)	(0.047)			(0.051)
Share of wholesale funding * Lerner index								-0.076**	
								(0.033)	
Loans to total assets * Lerner index								0.082**	
								(0.041)	
Non-interest revenue share * Lerner index								-0.029***	
								(0.004)	
ln(total assets) * Lerner index								0.018	
								(0.047)	

Loan loss provisions to interest income * Lerner index								-0.051***	
								(0.017)	
Annual growth in total assets * Lerner index								0.027	
								(0.028)	
Market share (total assets) * Lerner index								-0.007	
								(0.027)	
Constant	4.814***	1.520***	0.225***	0.0840***	3.463***	0.354*	4.817***	4.871***	3.635***
	(0.287)	(0.402)	(0.017)	(0.022)	(0.200)	(0.194)	(0.286)	(0.281)	(0.216)
Observations	84,155	84,633	85,140	47,838	51,322	51,515	84,155	84,155	51,322
R^2	0.3330	0.4665	0.3183	0.4067	0.2673	0.4148	0.3347	0.3427	0.2711
Specialisation dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table shows the results of a battery of robustness test based on a non-winsorized database. The methodology and the variables employed are the same as when using a winsorized database. In columns 1 to 4 we run homogeneous regressions using different dependent variables: the Z-score (column 1), the negative of profit volatility (column 2), the capitalization ratio (column 3) and the non-performing loan ratio (column 4). In columns 5 and 6 we introduce the interactions of the Lerner index with the normalised country-specific variables; again, we employ different indicators of bank soundness: the Z-score and the negative of profit volatility. In column 7 we introduce the square of Lerner index, in column 8 we add the interactions with the normalised bank-specific variables and in column 9 we add the interactions with the normalised country-specific variables.

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