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Bank Competition, Monetary Policy Transmission, and Financial Stability in the U.S.

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Bank Competition, Monetary Policy Transmission, and Financial Stability in the U.S.

By

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Declaration

I hereby declare that this thesis is the results of my own investigations, except where otherwise stated. All other sources are acknowledged by bibliographic references. This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree unless, as agreed by the University, for approved dual awards.

Yr wyf drwy hyn yn datgan mai canlyniad fy ymchwil fy hun yw'r thesis hwn, ac eithrio lle nodir yn wahanol. Caiff ffynonellau eraill eu cydnabod gan droednodiadau yn rhoi cyfeiriadau eglur. Nid yw sylwedd y gwaith hwn wedi cael ei dderbyn o'r blaen ar gyfer unrhyw radd, ac nid yw'n cael ei gyflwyno ar yr un pryd mewn ymgeisiaeth am unrhyw radd oni bai ei fod, fel y cytunwyd gan y Brifysgol, am gymwysterau deuol cymeradwy.

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SYMBOL	DESCRIPTION
CPI	Consumer Price Index
CV	Conjectural Variation
ES	Efficiency Structure
FE	Fixed Effect estimator
Fed	Federal Reserve
FFR	Federal funds rate
GDP	Gross Domestic Product
GMM	Generalised Moment's Method
HHI	Hirschman–Herfindahl Index
IO	Industrial Organisation
LI	Lerner Index
LLP	loan loss provision
MP	Market power
NEIO	New Empirical Industrial Organisation
POP	The Persistence of Profit
P-R H-statistic	Panzar-Rosse H statistic
ROA	Return On Assets
ROE	Return On Equity
SCP	Structure-Conduct-Performance
SLOOS	Senior Loan Officer Opinion Survey on Bank Lending Practices
TA	Total assets
U.S.	United States

CHAPTER ONE

General Introduction

1.1 Background

Over the past three decades the commercial banking system in the United States (U.S.) has undergone a period of consolidation and restructuring. Moreover, the recent financial crisis of 2007-2009 raised questions about the future of the economy that may affect many individuals and institutions now and for years to come. In particular, the crisis raised concerns about how and why banks interact with each other and the economy, and consideration of the implications, not only for business cycles, but also the long-term health and stability of the economy.

From a theoretical point of view, increased competition has "direct" effects as the driving force behind the acceleration in consolidation. This has raised concerns regarding the increased concentration in the banking sector and, according to the industrial organization (IO) literature, an increase in bank market power (MP).[1]In turn, MP in banking is the

[1]For the banking industry, performance benefits from an increase in competition are of key interest because: 1) it should force banks to increase the interest rate on deposits, update the quality of financial services, create new delivery channels and therefore positively influence saving rate; 2) it is hypothesised to reduce managerial inefficiency in deploying financial resources and therefore decrease intermediation costs (that is, it would entail improvements in productive efficiency); 3) it would stimulate a vigorous pace of technological innovation in the industry (that is, it would improve dynamic efficiency); 4) it would push prices closer to marginal costs and increase the quantity of credit supplied (that is, it would result in an improvement of allocative efficiency); 5) it would restore the signalling function of prices with respect to

channel through which consolidation could have "indirect" effects on other economic phenomena. Indeed, there is a counter-argument in the literature that proposes that increases in competition and financial innovation in markets, such as subprime lending, have contributed to the recent financial turmoil. Another concern is that the crisis and government support for the largest banks increased bank concentration, reducing credit availability for small firms and economic growth, and potentially contributing to future instability as a result of moral hazard problems, associated with too-big-to-fail institutions. Larger banks, especially those with greater MP are more likely to engage in risky activities and may, therefore, be more exposed to instability. These banks know that because of their systemically important size, they will be protected by the government safety net, under the so-called the concept 'too-big-to-fail', developed by Mishkin (1999).

The consideration of why competition matters goes further, as Beck (2011, cited in World Bank Report, 2013: 82), argues:

Competition in banking is not dangerous by itself; it is the regulatory framework in which banks operate and which sets their risk-taking incentives that drives stability or fragility of banking. Competition can be a powerful source of useful innovation and efficiency and foster stability through improved lending technologies; competition, however, can also endanger stability if mixed with the wrong kind of regulation.

With regard to bank regulation, the experience from the last crisis has led to a prudential approach and attempts to correct the excessive risk taking incentives for banks in an

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risk, liquidity, maturity, and demand and supply conditions of loanable funds, thus facilitating the selection of investment projects and the allocation of risks.

increasingly competitive market. Therefore, it is not market structure or competition by itself that drives fragility, but a regulatory framework that sets the wrong incentives. Prudential re-regulation, however, in contrast to economic regulation, is regarded as market friendly: it targets risk taking in the presence of intense competition, rather than limiting competition (World Bank Report, 2013).

1.2 Financial intermediation in the U.S. banking industry

The U.S. commercial banking industry has changed substantially during the four decades since 1976. A wave of state-wide deregulation, beginning in 1976 and ending with national deregulation in 1994, made banking markets more competitive. However, the number of commercial banks in the U.S. declined considerably as a result of structural deregulation which allowed banks to merge and consolidate into larger megabanks. At the same time, technological innovations were permanently changing the way financial markets channelled capital from saving to investment opportunities in the U.S. economy. In particular, asset securitization became an increasingly important means of funding loans that had traditionally been funded by banks.[2]

1.2.1 Restrictive government regulations

Prior to 1970, U.S. commercial banking was a heavily regulated and protected industry. Most states had laws prohibiting branching or allowing limited branching, while all states

[2]As noted above, the origins of asset securitization can be traced to the pooling and funding of mortgages by the government-sponsored agencies involved in the secondary mortgage market. However, by the late 1980s, securitizations of loans by private asset-backed-securities (ABS) issuers had become a viable means of funding other types of loans, such as consumer loans.

banned interstate branching. Government regulations safeguarded banks from geographic competition, from product competition, and, to a great extent, from price competition. The regulatory limitations on interstate banking and intrastate branching insulated small commercial banks from large bank competition and gave them a competitive advantage in lending and deposit-taking at the local level. These advantages also extended to the payments system, which in the U.S. at that time was based largely on paper checks. A paper-based payments system requires not just that payers and payees have deposit accounts upon which to write and deposit checks, but also that depository institutions have safe and convenient physical locations for processing checks (DeYoung, 2009).

1.2.2 Deregulation

From the beginning of the 1970s, most states adopted new laws that fundamentally deregulated the banking industry in the US. Table: 1.1 demonstrates the history of the geographic deregulation of restrictions on intrastate branching and interstate banking since 1970. Several states removed restrictions on intrastate bank branching and permitted banks to expand across state lines. During 1970 and 1980, only fourteen states allowed intrastate branching freely while twelve states prohibited this completely. The remaining states imposed restrictions of varying degree. However, between 1970 and 1994, thirty-eight states removed their restrictions on branching (see Table: 1.1).

The programme of state-level geographic deregulation did not lead to the immediate appearance of unrestricted interstate branching. However, the Riegle-Neal Interstate Banking and Branching Efficiency Act (IBBEA) of 1994 mandated unrestricted interstate banking and branching from June 1997. These deregulatory acts helped accelerate the adoption of new financial processes and information technologies by U.S. banks.

The history of deregulation during the 1980s and 1990s presents an appropriate context for the study of how state level geographic deregulation affected the commercial banking industry. Both theoretical and empirical evidence confirms the costs and benefits of deregulation are mixed. Earlier studies suggest that only small and inefficient local banks are major beneficiaries of regulations limiting geographic expansion, thereby protecting them from competition from larger and more efficient firms (Jayarathe and Strahan, 1998; Kroszner and Strahan, 1999). However, Nippani and Washer (2005) find that the return on assets (ROA) of small banks fell significantly below that of larger banks in the post-IBBEA period. They conclude that the enactment of IBBEA placed small banks at a competitive disadvantage, which could eventually lead to their demise in the form of failure and/or acquisition.

Other studies that also report negative impacts of bank deregulation suggest that geographic restrictions allowed banks to increase their MP (Evanoff and Fortier, 1988; Amel and Liang, 1992). Calem (1994) finds that small banks lose market share after the removal of intrastate branching restrictions. Tirtiroglu, Daniels and Tirtiroglu (2005) suggest that geographic restrictions on intrastate branching and interstate expansion have a negative impact on growth and productivity in the U.S. commercial banking sector.However, critics have argued that deregulation brings major benefits. According to this view, regulations restricting the geographical scope of commercial banking operations have a negative impact, contributing to increased costs, reduced profitability (Schranz, 1993) and lower efficiency (Jayaratne and Strahan, 1998). Merrick and Saunders (1985) pointed out three major benefits of deregulation: increased competition, improved quality of services, and more efficient use of society's resources in producing bank products. The removal of barriers to entry, such as restrictions on interstate and

interstate branching, is necessary to ensure efficient provision of banking services. Berger, Demsetz and Strahan (1999) and Berger and Mester (2003) argue that rising profitability during the 1990s, primarily reflected in higher revenue can be attributed to merger activity. In addition, they report that a continual process of innovation sustained increased profitability during this period. They dismiss the MP explanation for rising profitability, since concentration at the Metropolitan Statistical Area (MSA) level and non-MSA level remained unchanged during the 1990s.

Stiroh and Strahan (2003) find that the lifting of geographic restrictions shifted assets away from low-profit to high-profit banks, increasing the average profitability of the banking industry. In other words, the competitive dynamics of the industry redirected resources towards more profitable banks, and led to substantial and beneficial real effects on the U.S. economy (Yildirim and Mohanty, 2010). Zou, Miller and Malamud (2011) combine the performance measures of Jayaratne and Strahan (1998) and Nippani and Green (2002) to examine the effects of geographical deregulation on U.S. commercial bank performance across states. They find that deregulation on an intrastate basis generally improves bank profitability and performance, with higher returns and reduced risk especially among small banks.

Dick (2006) and Rice and Strahan (2010) report that loan prices and spreads decrease as a result of banking deregulation. Their evidence suggests that credit risk increases with greater geographic diversification, while competition in credit markets increases. They also find evidence of efficiency gains resulting from the unbundling of bank products and services, and replacement of explicit interest rates and fees with implicit ones.

Chen (2007) studies the effect of deregulation, characterized by removing entry restrictions, on bank credit risk. His theoretical model shows that, when entry restrictions are removed, an incumbent bank screens borrowers more intensively, resulting in lower credit risk. Enhanced screening is accompanied by lower lending rates, implying that the commonly assumed relationship between credit risk and the price of banking services does not necessarily exist.

1.2.3 Financial Innovation

Financial Innovation played and still plays a significant role on the Banking industry. Banking is one of the most Information technology intensive industries in the U.S., which influences both the front-office and the back-office of banks (Berger 2003). Regulations enacted in the 1990s, such as the Riegle-Neal Interstate Banking and Branching Efficiency Act (IBBEA) of 1994, helped accelerate the adoption of new financial processes and information technologies by U.S. banks even further. Berger, Demsetz and Strahan (1999) and Berger and Mester (2003) reported that the rise in profitability during the 1990s was also sustained by the continual process of innovation. Financial innovation included modern information processing, telecommunications, and financial technologies that ranged from the introduction of the internet and emails, utilising economic and statistical models in decision making, providing better deposit and payment services, and financial engineering used to devise new financial instruments and manage risks (Berger and DeYoung, 2006; Berger, 2003).

Financial Innovation was an important catalyst to widen the typical reach of banks in their relevant markets. The average geographical distance between lenders and borrowers in the U.S. has increased over time (Petersen and Rajan, 2002). In the period from 1985 to

1998 in the U.S., multibank holding companies expanded geographically (Berger and DeYoung, 2006). Petersen and Rajan, (2002) showed that firms are choosing more distant lenders and also communicating with them in more impersonal ways. Financial institutions seemed to be able to provide more remote lending without the risks of making poorer decisions by benefiting from advances in loan-screening technology and communication tools which have made hard information more available and on time. (Petersen and Rajan, 2002). Berger and DeYoung (2006) showed that the geographical expansion by multibank holding companies in the period from 1985 to 1998 was facilitated both by increasing their parental control over their affiliates, and by decreasing their agency costs of distance. The authors attributed their success to achieve this expansion to, among other factors such as deregulation, the advances in technologies such as information processing, telecommunications, and financial technologies. Research conducted by Brevoort and Hannan (2006) supported the identification of innovations, such as credit scoring which increased the banks' ability to assess the creditworthiness of distant small business borrowers, as a reason to explain the trend of increased geographical lending. Small banks do not seem to share the same enthusiasm of distant lending, and are found to be less likely to provide loans as the distant between them and the borrowers increases.

In the 1980s and early 1990s, financial innovation was the tool that large U.S. commercial banks used when they were facing stagnant deposit bases and fierce competition, which pushed the costs of extensive branch networks higher (Radecki, Wenninger, and Orlow, 1997; Akhavein, Frame and White, 2005). These large commercial banks resorted to reducing their retail operations costs by adopting technologies that provided greater economies or less diseconomies of scale, at the margin, compared to traditional banking

functions, including technologies such as ATMs, internet banking, and call centres. During the same period, research found that the U.S. banks increased profit productivity and decreased cost productivity by diversifying their risks using M&Ss, with tools made available by new technologies, which contributed to more consolidation in the banking industry (Berger 2003).

Financial innovation is also influenced by the organisation structure of the adopting bank. Akhavein, Frame and White (2005) found that the more centralised the bank is, or the less profitable it is, the more likely they are to adopt small business credit scoring technology earlier than their peers. This finding suggests that financial innovation and the organisation structure of U.S. banks influence each other and are affected by each other. It can also be said that regulations that made it easier for banks with centralised organization structure to branch out geographically, such as the Riegle-Neal Interstate Banking and Branching Efficiency Act (IBBEA) of 1994, have also influenced the early adoption of financial technologies.

1.2.4 Delegated Monitoring

According to the modern theory of financial intermediation, banks perform two central roles in the economy, the first role is liquidity creation (e.g. Diamond and Dybvig (1983) and Kashyap, Rajan, and Stein (2002)), and the second is risk transformation (e.g Diamond 1984). Empirical research has focused mainly on banks' role as risk transformers. Liquidity transformation is the process by which financial intermediaries use money from bank users' savings funds to invest into firms' projects (Diamond, 1984). Intermediaries are useful for this, as they can deal with issues of asymmetric information

sharing between parties and can engage in liquidity transformation; the process of investing in illiquid projects and liquid assets simultaneously.

Diamond (1984) develop a model of delegated monitoring. Intermediaries have a diversified portfolio of projects for which they provide finance. They pre-commit to monitor borrowers by promising lenders a fixed return. If the intermediary does not monitor, then it will be unable to pay the promised return to lenders. Diamond's model thus illustrates how banks have an incentive to act as a delegated monitor and produce the information necessary for an efficient allocation of resources. Holmstrom and Tirole (1997) explain that higher bank capital generates stronger incentives for banks to monitor their borrowers, and this can not only improve borrowers' access to non-bank funding sources like the capital market.

A related strand of the recent literature focuses on the role of securitisation and how it reduced the fundamental role traditionally performed by banks in liquidity transformation (Diamond and Dybvig, 1983). Altunbas et al.(2007) argue dramatic increase in securitisation activity has modified the functioning of credit markets by reducing the fundamental role of liquidity transformation performed by financial intermediaries. The authors claim that the changing role of banks from "originate and hold" to "originate, repackage and sell" has also modified banks' abilities to grant credit and the effectiveness of the bank lending channel of monetary policy. They supported them argument by using large sample of European banks, and found that the use of securitisation appears to shelter banks' loan supply from the effects of monetary policy. They point out that securitisation activity has also strengthened the capacity of banks to supply new loans but this capacity depends upon business cycle conditions and, notably, upon banks' risk positions.

The change in banks' business models from "originate and hold" to "originate, repackage and sell" had significant implications for financial stability and the transmission mechanism of monetary policy. The implications of securitisation for the incentives banks have to grant credit and their ability to react to monetary policy changes can be analysed from different angles (Gambacorta and Marques-Ibanez, 2011). Altunbas et al. (2009) used European banks data to demonstrate that securitising banks are less responsive to monetary policy.

Bord and Santos, (2012) find U.S. banks have increasingly used the originate-to-distribute model in their term-loan business since the early 1990s and bank have continued to rely on the traditional originate-to-hold model in their credit-line business. Bord and Santos, (2012) also find that as banks retained smaller and smaller portions of the term loans they originated in their balance sheet, they were fuelling the growth of nonbank institutions in particular, collateralized loan obligations and investment management companies.

1.3 Industry structure

The banking industry appears to have responded to changes in the regulatory framework in a significant way. The number of commercial banks has been declining since 1984, including the two decades between 1994 and 2013. Moreover, the distribution of bank

size has changed, with the emergence of a few dozen larger megabanks.[3]The decline in the number of banks in the U.S. has been well documented.[4]At year-end 1980, there were 14,483 commercial banks with 42,390 nationwide branches. By year-end 2012, the number had fallen to 6,085: a decline of almost 58 percent. However, the number of commercial bank branches has nearly doubled, to 83,078: an increase of more than 49 percent (see Figure 1.1). Analyzed by bank size, over 91 percent of commercial banks were community banks (i.e. organizations with less than $1 billion in assets in 2013 dollars). Nearly all the decline occurred in this sector, especially among the smallest banks (with less than $500 million in assets in 2013 dollars), from 5,408 banks in 1998 to 1,814 at year-end 2013. The majority of banks that failed and those that were acquired were in this sized group, while some small banks grew and exited this group by acquiring other small banks. Meanwhile, the proportion of mega banks increased dramatically between 1998 and 2013, to almost 64 percent (see Figure 1.2).

As shown in Figure 1.3, the level of total assets (TA) for medium sized banks has remained relatively stable since 1998, as has the level for small banks, with a slight fall from 2008 until 2013, due to the global financial crises. On the other hand the size of TA for large banks has substantially increased since 1998. DeYoung and Rice (2004a) found that increases in the size of U.S. commercial banks up to about $500 million unambiguously improved the risk- return trade off: expected returns increased, while the variability of these returns declined. Increases in bank size beyond $500 million were

[3]Megabanks are defined as having assets over $100 billion. Despite the large number of banks in the U.S., the ten largest banks hold almost a third of national deposits.
[4] See, for example, the papers by Berger et al. (1995); Group of Ten (2001); DeYoung, Hunter and Udell (2004); Critchfield et al. (2005).

associated with the choice of less traditional business strategies that yielded increased returns but also increased risk.

A wave of bank failures contributed to the decline in the number of U.S. commercial banks. From 1985 through to the early 1990s, the largest number of bank failures since the Great Depression occurred in the U.S., with over 1,400 failures (see Figure 1.4). There were two main causes of failure: first, an unexpected increase in interest rates that destroyed the profitability of banks that had financed long-term fixed rate loans with short-term deposits; second, sustained regional declines in real estate values.

Various regulatory changes were implemented during the 1990s and mid 2000s in an attempt to reduce the probability of the occurrence of a large number of failures. There were only 74 commercial bank failures in the U.S. between 1994 and 2008, a figure that reflects greatly improved economic conditions and stronger safety-and-soundness regulation (see Figure 1.4). However, between 2009 and 2013, an additional 386 institutions failed. While the 1980s-1990s wave of failures was caused by exposure to interest rate risk and geographic loan concentration, more recent examples reflect substantial investments in geographically diversified mortgage-backed securities, coupled with a nationwide downturn in housing markets.[5]

After the 1980s, many U.S. commercial banks grew rapidly, essentially by acquiring or merging with other banks. On average, approximately350 commercial banks were

[5]Policy actions taken by the U.S. Treasury (providing temporary capital injections) and Federal Reserve (making short-term liquidity available) are likely to have reduced the number of banks that would otherwise have failed during 2008 and going forward.

acquired each year during the 1980s, about 500 during the 1990s, and about 270 during the 2000s. Between1980 and 2013, 12,094 bank charters were merged out of existence (see Figure 1.4). Acquisitions have substantially altered the structure of the U.S. banking industry, with the number of commercial bank charters dropping by more than half, from 14,421in 1990 to 5,869 at year-end 2013.The increase in new charter banks in the U.S. has been well documented.[6]

During the period 1980-2013, the number of de novo bank entrants averaged 163 per year. This large volume was made possible by competition between the federal banking authority (the OCC) and the 50 separate state banking authorities, all of which can grant banking charters. The number of start-up institutions peaked in 1982, then declined each year until 1994. Subsequently, as economic conditions improved, de novo entry into the banking industry resumed and continued until 2007, before dropping close to zero at year-end 2013(see Figure 1.4).

In the U.S., commercial banks were the main supplier of loans to U.S. businesses during the 1970s, providing finance for commercial and industrial projects. However, the development of capital markets, and the ease with which finance can be raised through capital market operations, has made it easier for large corporations to raise capital at modest cost, resulting in the decline of traditional commercial and industrial (C&I) lending activities. Figure 1.5 demonstrates the widening gap between total bank assets and the volume of C&I lending. This trend was most obvious in the early 1980s during

[6] See, for example, Berger, Bonime , Goldberg and White (2004); DeYoung (2009).

the Savings and Loan(S&L) crises, and later in the 1990s and 2000s, when various regulatory reforms were implemented. Several factors underlie this gap between TA and C&I lending. Deregulation of asset powers by several key states led many S&L enterprises to change their operating strategies. These changes substantially intensified the competitive environment of commercial banks and depressed profitability.[7]

Bank asset size began to increase over the 1990s and 2000s due to market extension megamergers (DeYoung, Hunter and Udell, 2004). Petersen and Rajan (2002) note that the average geographical distance between lenders and borrowers in the U.S. has increased overtime. The authors demonstrate that firms are choosing more distant lenders and also communicating with them in more impersonal ways. The evidence suggests the trend correlates well with the increases in the productivity of lenders. One explanation for why financial institutions are doing more distant lending without making poorer decisions is that advances in loan-screening technology and communications have increased the availability and timeliness of hard information, thus allowing for more impersonal and remote lending. The findings of Brevoort and Hannan (2006) support this trend of increased geographic lending distance between borrowers and lender. They identify innovations, such as credit scoring, which have increased a bank's ability to assess the

[7]'The S&L industry crisis between 1980 and 1982, caused by historically high interest rates, is followed by a review of the federal regulatory structure and supervisory environment for S&Ls. The government's response to the early S&L crisis was then examined in greater detail, as were the dramatic developments that succeeded this response. The period from year-end 1982 to year-end 1985 was characterized by extremely rapid growth, as the industry responded to the new regulatory and legislative climate, involving deregulation of asset powers and interest rates.' (Federal_Deposit_Insurance, 1997: 178).

creditworthiness of small business borrowers. However, they find that small banks are less likely to provide loans if the distance between the lender and borrower increases.

Derivative contracts represent an important area of growth for the U.S. banking industry. Figure 1.6 depicts the increase in the nominal value of derivative contracts held by U.S. banks relative to their TA for the period 1992-2012. The growth rate of these contracts is much faster than that of TA.

In Figure 1.7, income from traditional sources is compared with income from non-traditional sources. Income from non-traditional sources doubled as a percentage of total commercial bank income between 1980 and 2000, when merger activity peaked. The gap between the two has declined quite steadily for a number of reasons. First, deregulation allowed commercial banking to expand into non-traditional activities, such as securities underwriting, securities brokerage and insurance sales, which generate non-interest income. Second, while in the past banks would earn interest income by providing credit to their business customers, today banks have shifted from portfolio lending to securitized lending, transforming consumer lending from an interest generating to a fee generating line of business for many banks.

DeYoung and Roland (2001) compare the fee income that a bank receives from securitizing a mortgage loan to the interest income earned by making a small business loan and holding it in its loan portfolio. The authors argue that the increase in non-interest income causes higher earnings volatility, which fundamentally alters the bank's risk-return profile. Several empirical studies have investigated the riskiness of non-interest income. DeYoung and Rice (2004) observe that this type of income increases more quickly for large commercial banks, and find that marginal increases in non-interest

income are associated with a worsening of risk-return trade-offs. Stiroh (2004a, 2004b) finds no evidence of diversification gains at banks that combine interest and non-interest income. Dick et al. (2007) emphasize how the increasingly retail-focused strategies of large U.S. banks expose them to economic and business cycle volatility. The sub-prime mortgage crisis, which started in 2007 and lasted for several years, illustrates the income volatility associated with fee-driven transactions. While the headlines in the financial press dwelled almost exclusively on the large capital losses suffered by banks and other investors in sub-prime mortgage-backed securities, banks that originated, serviced, and/or securitized mortgages experienced material, and in some cases crippling, reductions in fee income, as investor demand for new mortgage backed securities (MBSs) dried up and household demand for both new and existing houses declined. Total industry non-interest income fell from 43% of operating income in 2006 to 38% during the first three quarters of 2008 (shown in Figure 1.7), the largest two-year decline since the mid-1970s. Many of the largest financial institutions with non-diversified, mono-line mortgage banking strategies failed (e.g. American Home Mortgage, New Century Financial, Countrywide Financial, and Washington Mutual) due to the combined impact of plummeting fee income and large losses in their portfolios of subprime mortgages and mortgage-backed securities.

1.4 Research questions and methodology

There have been major structural changes within the U.S. banking system over the past four decades, including state-wide deregulation, international financial integration,

privatization and technological innovations. The examination of the evolution of competition during these changes is critical for understanding the impact of structural reforms in banking industry concentration, and the intensity of competition, and the manner in which banks conduct their business. A significant body of the empirical literature argue that an increase in competition has been considered the driving force behind the acceleration in consolidation, raising concerns about increased concentration in the banking sector. The main problem with most of U.S. studies is that they are driven largely from applying standard industrial organization (IO) theory to the banking industry without accounting for the deficiencies and challenge to this theory. Finally, the 2007-09 financial crisis raised awareness of the relationship between overall competitions, bank lending, financial stability and risk-taking incentives within the context of the various measures of competition. This research aims to fill those gaps.

Motivated by the processes of deregulation, consolidation and the 2007-09 financial crisis in the U.S, this thesis focuses on answering the following three main research questions:1) What kind of competitive conditions characterise the U.S commercial banking industry? 2) What are the impacts on the intensity of competition in the lending market? 3) What are the effects of bank competition on financial stability and risk-taking behaviours?

Chapter 2 empirically investigates the literature on the functioning of different banking competition measures. We aim at answering the following questions.

Main question:

What type of measures could be used to test banking competition?

Related questions:

Do levels of competition matter in the transmission of monetary policy?

What the impact of competition on the banking system, in perspective of five main areas: efficiency, access to finance, stability, risk-taking and regulation?

Through our analysis of the literature, we hypothesise that competition appears to enhance the effectiveness of monetary policy transmission through the bank lending channel. Our investigation reveals that many studies find that competition among banks is good for efficiency and for the wider economy because it lowers prices and improves quality. In addition, competition encourages innovative behaviour, which forces banks to increase their efficiency, improving the access of households and firms to financial services and external finance. The link between competition and financial stability has been widely recognized in theoretical and empirical research, as well as in the conduct of prudential regulation with respect to banks (Schaeck, Cihak and Wolfe, 2009; Berger et al., 2009; Amidu and Wolfe, 2013).

Chapter 3 extends the thesis with cross-state comparisons of competition and pricing power in U.S. banking and investigates whether different competition and MP metrics produce similar results. We aim at answering the following empirical question:

Main question:

What kind of competitive conditions characterise the U.S. commercial banking industry?

Related questions:

Which states banking system are more competitive?

We examines how competition has evolved due to structural reforms changes by investigating changes in competition in the banking industry in 41 U.S. states between 1987 and 2010 to 2012 in some cases. We used a variety of non-structural measures of competition, including the LI and R-P H statistic. The results suggest that U.S. commercial banks generate revenues under a monopolistically competitive environment. Furthermore, a decline in the LI between 2005 and 2008 and slight increase in the R-P H statistic for the same period, suggest low bank MP and a high degree of competition in the banking system during the recent global financial crisis. Finally, consistent with Carbo et al. (2009), we find that competition measures tend to provide inconsistent results and are statistically unrelated.

Chapter 4 builds from the realisation of the literature identified in chapter 2 and investigates the effect of competition on the relationship between monetary policy changes and the bank lending channel, using U.S. state regional data.

Main question:

What are the impacts on the intensity of competition in the lending market?

Related questions:

What effect does competition have on the transmission of monetary policy through the bank lending channel?

How do banks respond to the monetary policy of the Federal Reserve according to their characteristics and their MP?

We explore how U.S. banks respond to the monetary policy of the Federal Reserve (Fed) according to their characteristics and MP, using banking micro-data over the period from 1992 to 2014. We estimate the degree of competition using the Lerner Index (LI) of MP (Berger, Klapper and Turk-Ariss, 2009). Secondly, we examine how banking competition impacts on the transmission of interest rate policy through the bank lending channel. The final step involves examining how this relationship varies according to bank characteristics (size, liquidity and capitalisation). The analysis finds that a tightening of monetary policy through an increase in the federal funds rate leads to a decrease in the growth rate of bank loans. Results from GMM modelling suggest that banks with MP, estimated by the LI, have a credit supply that is sensitive to monetary policy shock. Increased competition appears to enhance the effectiveness of monetary policy transmission through the bank lending channel. In addition, we find that over the period from 2008 to 2011 the lending channel has been strengthened; nevertheless, the negative effect of MP on lending has remained.

Chapter 5 Understanding the extent to which the degree of competition in banking may affect the stability of the whole system continues to be an important issue in the literature, and has intensified in the wake of the 2007-09 crisis.

Main question:

What are the effects of bank competition on financial stability and risk-taking behaviours?

Related questions:

How size and the recent financial crisis individually and interactively affect the relationship between competition and stability?

Do levels of competition matter in the overall system stability and soundness?

How the recent banking crisis affected the relationship between MP and risk-taking?

This paper investigates the the impact of the financial crisis on the relationship between competition and stability/ risk-taking, and whether size is a significant factor in this relationship in the context of U.S. banking between 1987 and 2013. Our empirical approach involves two steps. First, we estimate the LI of MP, which is used as an indicator of competition. MC are derived from a translog function specified according to the stochastic frontier approach. We then regress this measure and other independent variables on a number of stability indicators, including insolvency risk (Z-score based on ROE and ROA); income variability (standard deviation of ROE and ROA); equity ratio and loan loss reserves to total loans. This paper concludes that the relationship between competition and risk-taking behaviour is positive, supporting the competition-stability view in the literature. In addition, bank size is an important dimension in the relationship between competition and stability. Larger banks appear to be more solid and maintain higher levels of capitalisation in a more collusive structure. It appears that capitalisation enhances the stability of these banks operating under lower levels of competition. Additionally, we find that inflation is more important for stability than economic growth. Finally, our results have important implications for bank capital regulations in the light of the 2007-09 financial turmoil.

1.5 Contribution to the literature

The thesis makes several contributions to the literature, and further understanding of the impact of financial reform on bank behaviour with respect to competition, bank lending,

monetary policy, financial stability and risk-taking, based on the evidence for U.S. banking between 1987 and 2013. These contributions can be summarised as follows.

- Previous studies on the impact of competition on bank efficiency, bank lending, monetary policy, financial stability and risk-taking behaviour are largely treating these as separate issues. Moreover, the recent financial crisis of 2007-2009 raised questions about the future of the economy that may affect many individuals and institutions. In particular, the crisis raised concerns about how and why banks interact with each other and the economy. This research systematically examines these aspects of the impact of competition with reference to U.S. commercial banking, using a consistent theoretical framework. Furthermore, taking advantage of the unique reform experience of U.S. banking, this research examines the impact of the shift of policy focus between 1987 and 2013.

- Previous studies on the measurement of competition in banking mainly relied on a static approach derived from NEIO literature. This literature contends that indicators of the mark-up of price (average revenue) over marginal costs (giving a Lerner Index) and the degree to which input price changes are reflected in average revenues (the H-statistic) provide ‘‘realized’’ measures of the degree of competition. In this paper, we examine whether different metrics of competition and MP produce similar results. We compare results from non-structural indicators of competition using U.S. state banking data over the period 1990-2010 to 2013 in some cases. To the best of our knowledge, this is the first time this approach is used in state level data.

- Previous studies on the changes in competition are expected to affect the transmission of monetary policy through the bank lending channel. The literature supporting the existence of the bank lending channel as a locomotive of monetary policy changes finds the effectiveness of such transmission is influenced by the cross-sectional heterogeneity of bank characteristics. This research is the first attempt, to extend such literature to examine the role of competition in the relationship between monetary policy changes and the bank lending channel using US state regional data. We argue that due to the exclusive economic and structural characteristics of each state in the US, the transmission of monetary policy through the bank lending channel differs across states. We apply a fundamental approach by using bank-level indicator of competition rather than market level such as concentration ratio in order to explore the reaction of banks to changes in monetary policy under the prevailing competitive conditions.

- Previous studies on the relationship between competition and stability/ risk-taking mainly focused on whether there exists a relationship between the three without distinguishing the extent to how size and the recent financial crisis individually and interactively affect the relationship between competition and stability, using data from U.S. banking. The literature is not conclusive about this effect. This research is the first attempt, as far as we are aware, to extend such literature to analyse whether this view is valid by interacting the competition measure with a SIZE variable. The crisis has intensified the interest of regulators in large banks as they show the ‘‘too big to fail’’ (TBTF) effect, because of their systemic importance.

- Previous studies of the competitive conditions in the U.S. commercial banking case mostly used form data or whole country data ignoring states level. Our research enhanced the literature by examining 41 U.S. states commercial banking using a uniform database over a long time period, from 1987to 2013, or 1987 to 2010, in some cases.

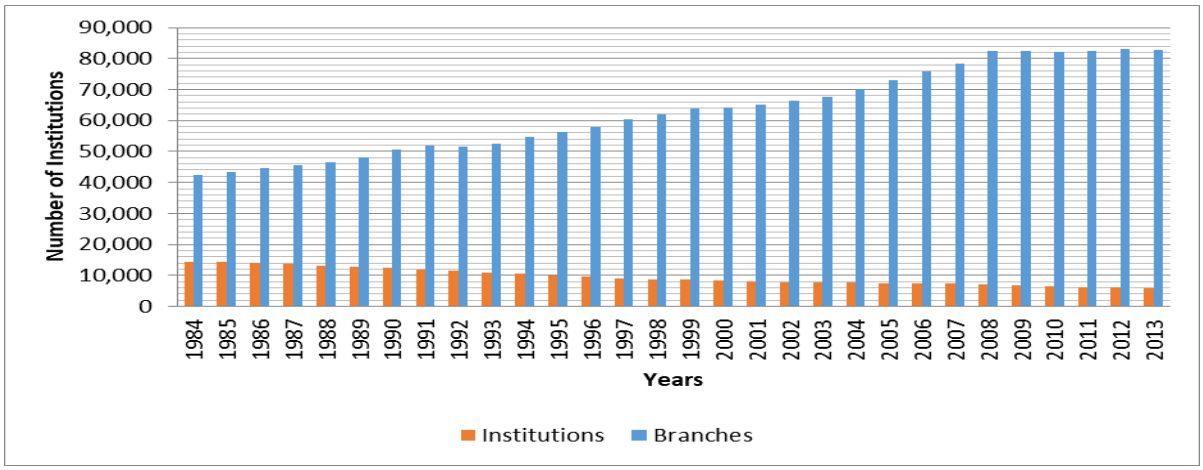
1.6 Structure of the thesis

Beside this general introduction, the thesis is consists of five chapters. Chapter 2 provides a comprehensive review of theoretical concepts and stylized facts concerning the impact of competition on bank efficiency, bank lending, monetary policy, financial stability and risk-taking behaviour. It provides insights into topics such as bank capital regulation in light of the recent 2007-09 global financial crisis, and the use of regulation to discipline banks and its effect on financial markets. It also reviews the existing literature on banking competition measures, which serve to establish the motivation for our empirical study. Chapter 3 introduces the concept of bank competition and the main approaches to studying bank competition. It outlines the empirical findings for the U.S. commercial banking industry using a variety of non-structural measures of competition, including the LI and R-P H statistic. Chapter 4 examines the effect of competition on the transmission of monetary policy through the bank lending channel. We show how U.S. banks respond to the monetary policy of the Federal Reserve (Fed) according to their characteristics and MP, using banking micro-data over the period from 1992 to 2014. However, we find that a tightening of monetary policy through an increase in the federal funds rate leads to a decrease in the growth rate of bank loans. Results from GMM modelling suggest that banks with MP, estimated by the LI, have a credit supply that is sensitive to monetary

policy shock. Chapter 5 investigates the effects of bank competition on financial stability and risk-taking behaviour, and investigates whether the relationship between competition and financial stability has been affected by the global financial crisis. It also examines whether size is a significant factor in this relationship. Chapter 6 summaries the main findings from the three research papers and draws some general conclusions and policy implications. It also highlights the limitations of this research, and provides suggestions for future research,

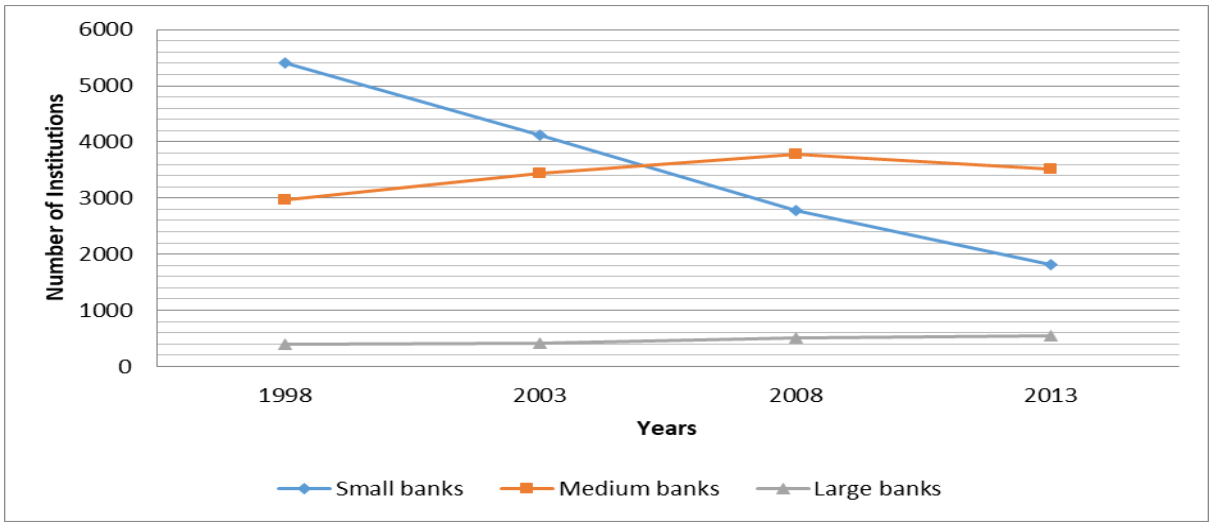
1.7: Tables and Figures

Figure 1.1: Number of commercial banks versus number of branches over time: 1984–2013.



Source: Federal Deposit Insurance Corporation (FDIC): Historical statistics on banking.

Figure 1.2: Change in commercial banks' types between 1998 and 2013.



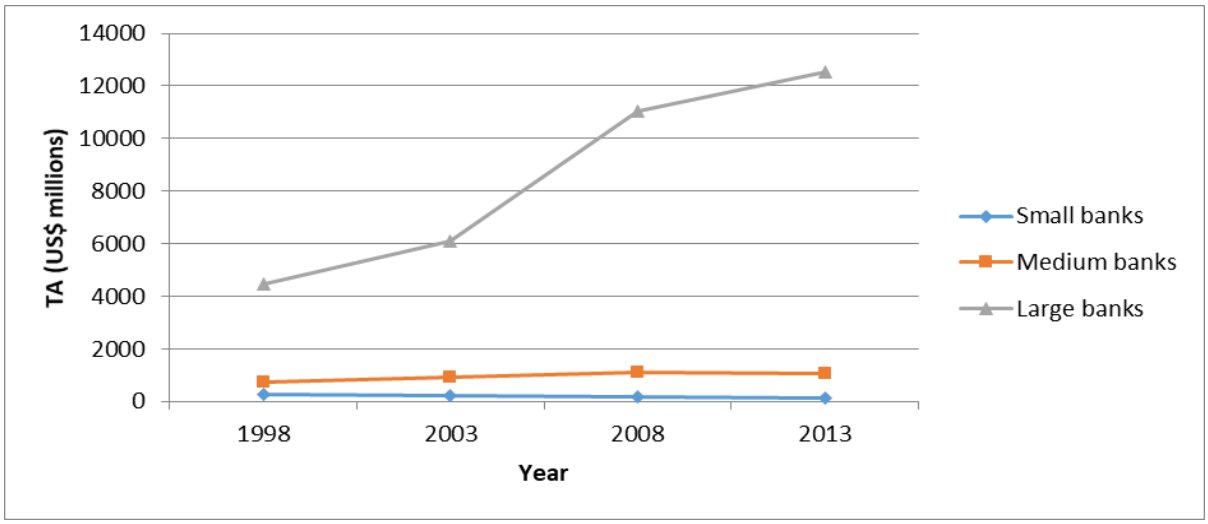
All Commercial Banks - Assets less than $100M

All Commercial Banks - Assets $100M to $1B

All Commercial Banks - Assets more than $1B

Source: Federal Deposit Insurance Corporation (FDIC): Historical statistics on banking.

Figure 1.3: Change in commercial banks' TA size between 1998 and 2013.



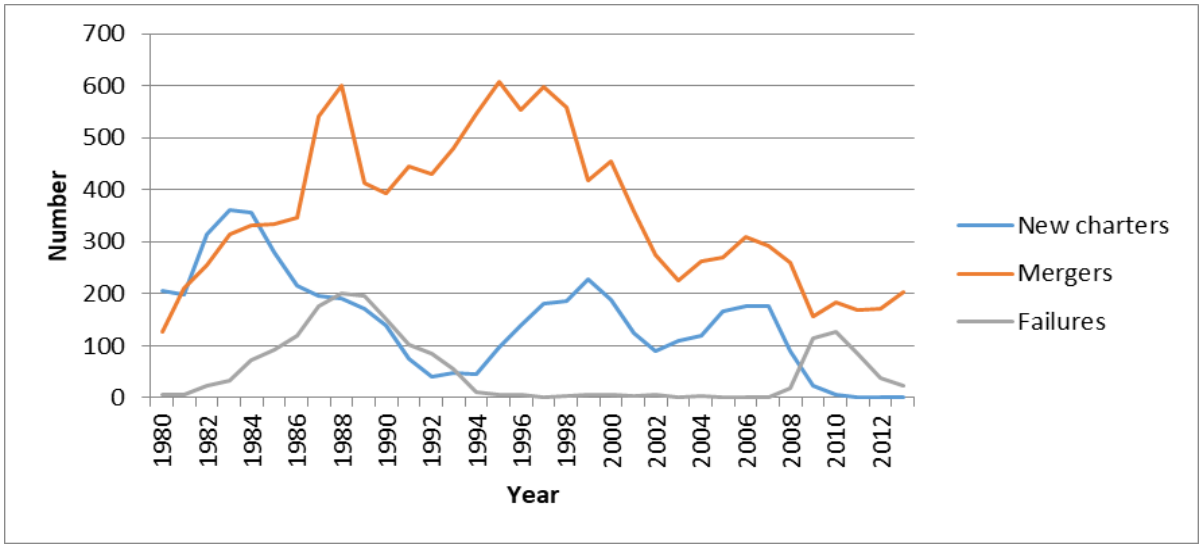
All Commercial Banks - Assets less than $100M

All Commercial Banks - Assets $100M to $1B -

All Commercial Banks - Assets more than $1B

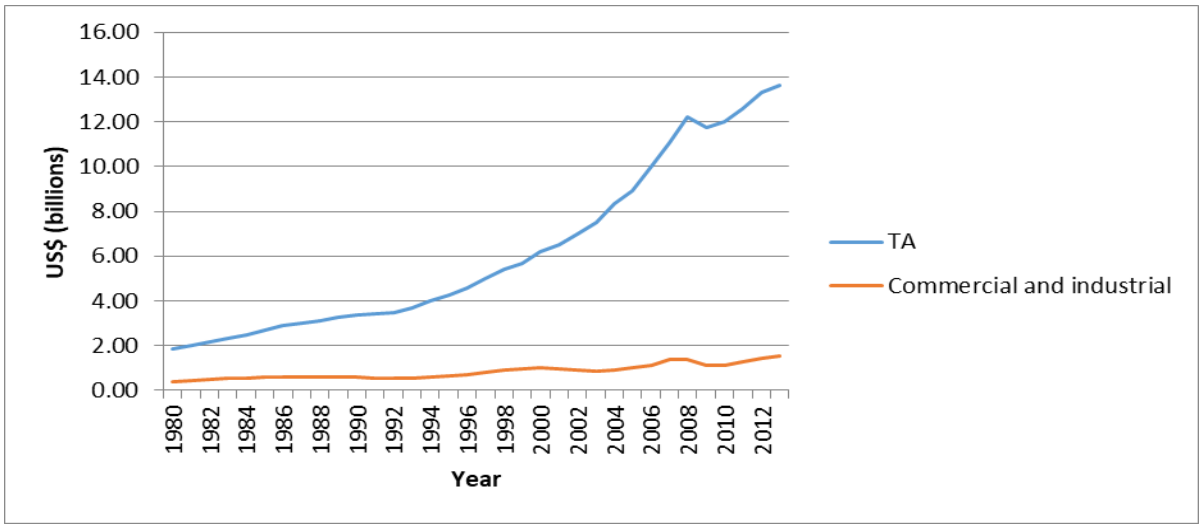
Source: Federal Deposit Insurance Corporation (FDIC): Historical statistics on banking.

Figure 1.4: Commercial bank mergers, failures, and new entries for the period 1980–2013.



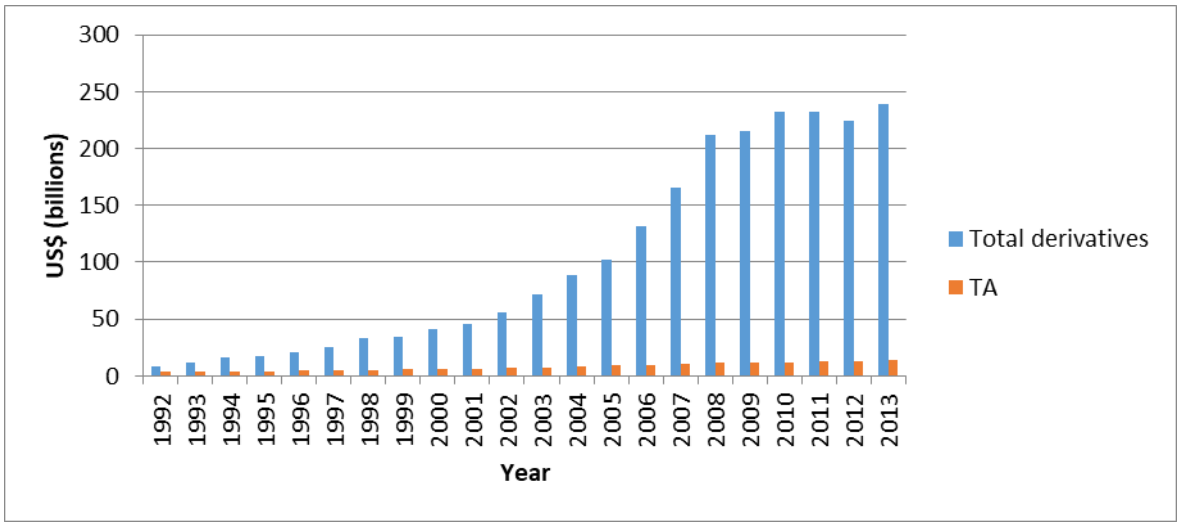
Source: Federal Deposit Insurance Corporation (FDIC): Historical statistics on banking.

Figure 1.5: U.S. bank TA and commercial and industrial loans 1980–2013.



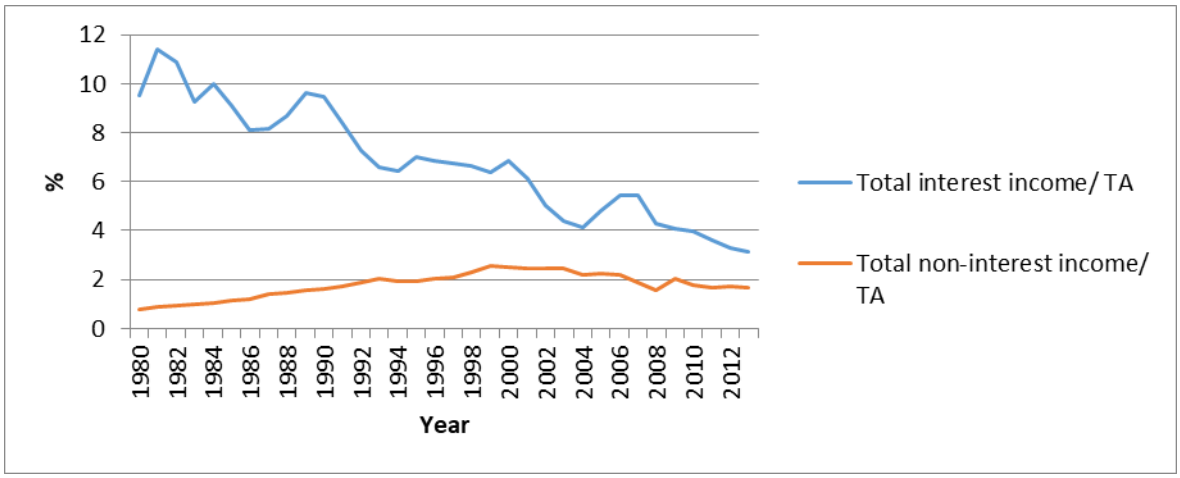
Source: Federal Deposit Insurance Corporation (FDIC): Historical statistics on banking.

Figure 0.6: Bank TA and nominal value of derivatives 1992–2013.



Source: Federal Deposit Insurance Corporation (FDIC): Historical statistics on banking.

Figure 1.7: Ratios of U.S. banks' interest income and non-interest income to TA 1980–2013.



Source: Federal Deposit Insurance Corporation (FDIC): Historical statistics on banking.

Table 1.1: Deregulation of Restriction on Geographical Expansion (Year of State-Level).

State	Intrastate branching via M&A	Unrestricted intrastate branching permitted	Interstate banking permitted
Alabama	1981	1990	1987
Alaska	<1970	<1970	1982
Arizona	<1970	<1970	1986
Arkansas	1994	**	1989
California	<1970	<1970	1987
Colorado	1991	**	1988
Connecticut	1980	1988	1983
Delaware	<1970	<1970	1988
DC	<1970	<1970	1985
Florida	1988	1988	1985
Georgia	1983	**	1985
Hawaii	1986	1986	**
Idaho	<1970	<1970	1985
Illinois	1988	1993	1986
Indiana	1989	1991	1986
Iowa	**	**	1991
Kansas	1987	1990	1992
Kentucky	1990	**	1984
Louisiana	1988	1988	1987
Maine	1975	1975	1978
Maryland	<1970	<1970	1985
Massachusetts	1984	1984	1983
Michigan	1987	1988	1986
Minnesota	1993	**	1986
Mississippi	1986	1989	1988
Missouri	1990	1990	1986
Montana	1990	**	1993
Nebraska	1985	**	1990
Nevada	<1970	<1970	1985
NewHampshire	1987	1987	1987
NewJersey	1977	**	1986
NewMexico	1991	1991	1989
NewYork	1976	1976	1982
NorthCarolina	<1970	<1970	1985
NorthDakota	1987	**	1991
Ohio	1979	1989	1985
Oklahoma	1988	**	1987
Oregon	1985	1985	1986
Pennsylvania	1982	1990	1986
RhodeIsland	<1970	<1970	1984
SouthCarolina	<1970	<1970	1986
SouthDakota	<1970	<1970	1988
Tennessee	1985	1990	1985
Texas	1988	1988	1987
Utah	1981	1981	1984
Vermont	1970	1970	1988
Virginia	1978	1987	1985
Washington	1985	1985	1987
WestVirginia	1987	1987	1988
Wisconsin	1990	1990	1987
Wyoming	1988	**	1987

Sources: Kroszner and Strahan (1999) and Yildirim, H.S. and S.K. Mohanty, (2010)

CHAPTER TWO

THEORETICAL CONCEPTS AND STYLIZED FACTS: THE IMPACT OF COMETITION ON THE BANKING SYSTEM

2.1 Introduction

The importance of banks in channelling funds from lenders to borrowers is widely recognised. A major factor that affects the way in which financial markets operate is the degree of competition. An increase in competition has been considered the driving force behind the acceleration in consolidation, raising concerns about increased concentration in the banking sector. Furthermore, the global financial crisis of 2007-2009 brought to the fore the debate about the relative importance of bank size, competition, bank regulation and the bank lending channel for monetary policy transmission. The crisis also raised concerns about loose monetary policy and discussion of whether it was responsible for the credit boom. It can be argued that, in the run up to the crisis, low interest rates and abundant liquidity led financial intermediaries to take excessive risks, fuelling asset prices and increasing leverage.

Studying how banks interact with each other and the economy is essential. There have been major structural changes within the U.S. banking system over the past three decades, including domestic consolidation and regulatory reforms, with many restrictions on entry and operation lifted. Further developments have involved improvements in information technology and financial innovation, with the advent of new financial products. These

changes have affected banking industry concentration, and the intensity of competition, and have transformed the manner in which banks conduct their business.

Shaffer (1994) argues that competition and concentration contrast with each other, and we should accept the theoretical proposition that 'a more concentrated market implies a lower degree of competition due to undesirable exercise of market power by banks'. However, Baumol et al. (1982) state that, under particular conditions, competition and concentration can coexist.

Many studies find that competition among banks is good for efficiency and for the wider economy because it lowers prices and improves quality. In addition, competition encourages innovative behaviour, which forces banks to increase their efficiency, improving the access of households and firms to financial services and external finance. The link between competition and financial stability has been widely recognized in theoretical and empirical research, as well as in the conduct of prudential regulation with respect to banks (Schaeck, Cihak and Wolfe, 2009; Berger et al., 2009; Amidu and Wolfe, 2013). Finally, competition improves the monetary transmission of policy rates to bank market rates (Bikker et al., 2007).

Carlson and Mitchener (2006) show that competition also positively affects stability. They find that the expansion of bank branching in the U.S. increased competition in the 1920s. This eliminated inefficient banks, which effectively made the banking system more stable (see also Berger and Hannan, 1998).

Degryse and Ongena (2007) provide empirical evidence that competition not only lowers interest rates for borrowers but also improves access to credit for informational opaque

borrowers. They show that bank branches strengthen their relationships with borrowers when they face stronger competition (see also Boot and Thakor, 2000).

Section 2.2 of this chapter examines the relationship between competition and the transmission of monetary policy changes via the bank lending channel. It also describes the way in which monetary shocks are transmitted to the real economy. Background information and stylised facts on banking competition measures are provided in Section 2.3. Section 2.4 examines the impact of competition on the banking system, focussing on five main areas: efficiency, access to finance, stability, risk-taking and regulation.

2.2 Competition, the bank lending channel and monetary policy

The financial system can be viewed as the intermediary through which monetary policy may be used to influence output, investment, prices and employment within the economy. Monetary policy can affect key macroeconomic variables through different channels, namely the interest rate channel, bank lending channel and broad credit channel. The influence of monetary policy on these channels is known as the monetary transmission mechanism. The standard view of the transmission mechanism focuses on the effect of monetary policy on federal funds rate (interest rates), and through interest rates on lending and credit.

This rate is the interest rate at which depository institutions in the U.S. actively trade balances held at the Fed, called federal funds, with each other, usually overnight, and on an uncollateralized basis. This rate is determined by the FOMC, whose members normally

meet eight times a year, about seven weeks apart. The committee may also hold additional meetings and implement target rate changes outside of its normal schedule.

Peek and Rosengren (2013) provide an overview of several factors that may explain the renewed interest in the role played by bank lending in the transmission mechanism of monetary policy. First, financial innovation has resulted in a shift in the focus of monetary policy from money aggregates to interest rates, as the Federal Reserve relied on the federal funds rate as its policy instrument, until hitting the Zero Lower Bound (ZLB) after the global financial crisis. Second, episodes of liquidity shortage in the U.S., such as those associated with the failure of Penn Central, the 1987 stock crash, the Long-Term Capital Management crisis, the events of 9/11, and the Lehman failure, have highlighted the important role of bank lending during liquidity and financial crises. Third, concerns about the bank capital crunch of the early 1990s have once again returned as numerous banks and non-bank lending institutions became capital constrained as a result of the credit problems that arose in August 2007. Finally, as traditional interest rate policies became limited by a ZLB, countries increasingly looked to alternative monetary policy tools. In the U.S., the commercial paper and asset-backed commercial paper markets have been used in an effort to stimulate lending by financial institutions (Peek and Rosengren, 2013).

In theory, monetary shocks are transmitted to the real economy primarily via the interest rate channel (Mishkin, 1996). A fall in the demand for loans following an interest rate rise reduces the demand for investment, and this discourages economic activity. A reduction in lending is therefore due to a lower demand for loans, and not to a reduced loan supply. However, the theory of the bank lending channel contradictsthis proposition and assumes that banks face liquidity constraints that force them to reduce loan supply in

response to a restrictive monetary policy shock (Kashyap and Stein, 2000; Köhler, Hommel and Grote, 2006; Amidu and Wolfe, 2013). Bernanke and Blinder (1988) provide a simple IS-LM theoretical model of the bank lending channel, where banks rely solely on deposits for funding. Romer and Romer (1990) fail to find evidence for the importance of the bank lending channel; they argue that banks can shield themselves from Federal Reserve induced changes in reserves by holding negotiable certificates of deposit with little or no reserve requirements. Disyatat (2011) argues that the importance placed on policy-induced changes in deposits is misplaced, and that the lending channel works through the effect of monetary policy on bank balance sheet strengths and risk perception (Amidu and Wolfe,2013). However, Stein (1998) offers an alternative perspective, showingthat the bank lending channel is still operative when banks have several sources of funding.

Empirical analyses of the bank lending channel, however, suggest that its strength is determined by the capitalization, size and liquidity of banks. Bernanke and Blinder (1992) find a relationship between the federal funds rate and bank lending over and above the liquidity effects caused by changing interest rates, which constitutes evidence that the bank-lending channel exists. The credit channel of the monetary policy transmission mechanism is investigated by Kashyap, Stein, and Wilcox (1993), who use a financing mix variable to study the bank lending channel in relation to the corporate sector. They find that changes in monetary policy lead to a shift in the mix of firms' external financing. They observe that tighter monetary policy leads to an increase in commercial paper issuance and a reduction in bank lending, and argue that the spread between commercial paper and treasury bills is a proxy for the stance of monetary policy.

Kashyap and Stein (1995) argue that bank size affects the reaction of banks to restrictive monetary shocks. Small banks have limited access to asymmetric information on the capital markets and may therefore find it difficult to raise uninsured funds in response to monetary policy shocks. Their empirical findings suggest that small banks are more responsive (that is, they shrink their loan portfolios by more) than large banks to a monetary policy tightening. Likewise, Kishan and Opiela (2000) use the capital-to-asset ratio as a proxy for a bank's ability to raise uninsured deposits, and find that the loan portfolios of well-capitalized banks are less sensitive to monetary policy shocks than those of poorly capitalized banks of the same size. Gambacorta (2005) finds heterogeneity in monetary policy transmission across banks with different capitalisation and liquidity levels but reports no size effect. However, Olivero, Li and Jeon (2011b) find that in Latin America, bank size, liquidity and capitalisation influence the transmission of monetary policy through the lending channel.

Kashyap and Stein (2000) study the impact of monetary policy on bank lending behaviour for the Federal Reserve System's commercial banks and bank holding companies. Their research reports that smaller and less liquid banks reduce their loan supply in response to contractional monetary policy, as their ability to raise deposit forms of financing is compromised. Another reason for small banks to restrict lending is that they cannot sell non-reservable liabilities, due to a failure of the Modigliani–Miller proposition. These changes in bank lending behaviour, particularly affecting bank-dependent borrowers, have important implications for firms' financing behaviour, as their impact compounds the effects of changes in interest rates.

Another reason for the existence of a bank lending channel for monetary policy transmission arises from the market structure of the banking sector. According to Kashyap and Stein (1997, 2000), Kishan and Opiela (2000) and Gambacorta (2005), the largest banks would be expected to be able to raise uninsured finance more easily, which would make their lending less vulnerable to monetary policy shocks, irrespective of other bank characteristics. This suggests that certain banks have MP to raise finance from alternative sources, and this may or may not derive from their size. In principle, banks with MP may restrict the quantity of loans in order to increase their price, and firms reliant on bank loans for financing may find it more difficult to raise funds for investment projects. If interest rates on loans are marked up above the marginal product of capital when MP is present, banks may react differently to monetary policy changes than those that compete in openly competitive markets. The degree of competition in the banking industry may, therefore, affect the way in which banks adjust their lending when there are changes in short-term interest rates, and this effect may carry implications for the funding of investment projects (Severe, 2011).

Variations in the monetary policy transmission mechanism due to banking concentration or competition have implications for loan-dependent borrowers and for a monetary authority's ability to stabilize the real economy. Kahn, Pennacchi and Sopranzetti (2001) examine cross-sectional differences in the behaviour of rates for personal and automobile loans, and obtain different results for the two types of loan. Interest rates for personal loans are stickier in more concentrated banking markets, while auto loan rates adjust more quickly in such markets. They attribute the difference to efficiency gains from scale economies in auto loan markets that are absent in markets for personal loans. Amore recent study by Adams and Amel (2005) uses aggregate data for the U.S. from 1996 to

2002 and finds that the effect of monetary policy on the bank lending channel is weaker in more concentrated rural banking markets than in less concentrated urban markets. Adams and Amel (2011) also examine the effect of local bank market concentration, measured by the HHI, on the transmission of the federal funds rate to business loan origination. They find a significant impact, with a stronger effect in less concentrated markets.

Olivero, Li and Jeon (2011b) examine the role of competition on the transmission of monetary policy changes through the bank lending channel, using commercial bank-level data for twenty Asian and Latin American banks between 1996 and 2006. The degree of competition is measured by the static and dynamic H-statistic, proposed by Panzar and Rosse (1987). Olivero, Li and Jeon (2011b) claim that increased competition weakens the transmission of monetary policy changes through the bank lending channel if it is associated with a reduction in the informational asymmetries between banks regarding their borrowers' creditworthiness. These informational frictions, and the fact that incumbent banks accumulate proprietary information about their customers, make it costly for borrowers to switch from the incumbent bank (from which they have been borrowing for a period of time) to a new rival bank. These switching costs create a customer ''lock-in" or ''hold-up" effect.

2.3 Bank competition: measurement and stylized facts

Competition in banking is important because it carries important implications for productive efficiency, financial stability and for the effective regulation and supervision of the banking sector. Berger and Humphrey (1997) argue that an increase in competition

is the mechanism through which financial reforms exert a positive impact on banks' productive performance. Reducing competition may lead to increased inefficiencies in the banking system and place a burden on the rest of the economy. The arguments for the potential benefits of competition derive largely from applying standard industrial organization (IO) economics to the banking industry (e.g. Freixas and Rochet, 1997). The Harvard School is the name used to identify traditional IO, involving the elements of structure, conduct and performance. The structure-conduct-performance (SCP) paradigm, originally developed by Mason (1939) and Bain (1951), attempts to infer the degree of competition in an industry from its structural features, by establishing a direct link from industry structure to firm conduct, and from firm conduct to industry performance. According to the SCP paradigm, a firm's MP increases with industry concentration, due to a direct link between industry structure and competitive conduct. The SCP hypothesis argues that higher concentration in the banking industry causes less competition and, accordingly, higher margins and the enhanced profitability (Vesala, 1995).

Many earlier studies on competition in banking, and more general IO literature based on the SCP paradigm, find a positive relationship between profitability and measures of market structure, using either the k-bank concentration ratio (CRk) or HHI to measure concentration. The SCP hypothesis asserts that banks are able to extract monopolistic rents in concentrated markets through their ability to offer lower deposit rates and charge higher loan rates. The setting of prices is less favourable to consumers in more concentrated markets, as a result of collusion or other forms of non-competitive behaviour. The more concentrated the market structure, involving a smaller number of firms, the less competition, and greater probability that firms will achieve a joint price-

output configuration that approaches a monopolistic solution(Smirlock, 1985; Berger, 1995; Berger et al., 2004).

Until the late 1990s, the SCP paradigm was widely used in the banking literature, although, overall, empirical results were mixed. Many researchers found a positive statistical relationship between profitability and concentration, interpreted as an indication of non-competitive behaviour in concentrated markets (Smirlock, 1985; Berger, 1995; Berger et al., 2004; Northcott, 2004). Such a relationship could be explained by the MP theory or, more recently, the efficient structure hypothesis (ESH).

MP theory includes two hypotheses: the traditional SCP paradigm and the relative-MP (RMP) hypothesis. As mentioned previously, under the SCP hypothesis, higher concentration leads to increased interest rate spreads as a result of collusion and other market imperfections. On the other hand, according to the RMP hypothesis, banks with large market shares and well-differentiated products are able to exercise MP in pricing these products and earn supernormal profits (Berger, 1995; Skorpen, 2011). Empirically, the RMP hypothesis is supported when concentration in equations explaining performance turns out to be insignificant, while market share is positively related to prices and/or profitability. The difference between the two hypotheses revolves around whether MP proves to be generic to a market or is specific to individual banks within a market.

Newer economic theory has, however, challenged the realism of this framework and shown that the direct link between market structure and performance can disappear under alternative assumptions. Baumol and et al. (1982) show that competitive pricing (that is, a price that just covers the costs of production plus a normal rate of return on capital) can prevail, regardless of the number of firms in the market, if an outside firm can attract

customers by low pricing and recover any cost of entry, while abandoning the market if older firms retaliate by under-pricing.

Friedman et al. (1971), on the other hand, have shown that a large number of firms may even tacitly collude to set high prices if they think ahead, since the temporary profits one firm could gain by under-pricing its rivals today could be offset by subsequent losses if its rivals retaliate by cutting their prices. Other scholars identify patterns of conduct and pricing that are intermediate between being perfectly competitive and monopolistic, depending on such factors as interest rates, the cost of adjusting size or capacity, or unanticipated demand shocks (Rotemberg and Saloner, 1986; Worthington, 1990).

Another challenge to the SCP is the ESH, devised by Demsetz (1973) and Peltzman (1977), which suggests that a positive relationship between profitability and market concentration is not the result of MP, but the greater efficiency of firms with larger market share. The ESH includes two hypotheses: the X-efficiency and scale-efficiency hypotheses. The X-efficiency hypothesis suggests that banks with superior management are able to more fully utilize their assets, and thus incur lower costs and increase profits. Efficient firms tend to grow due to their strong profitability and management, which may result in increased market share and concentration. On the other hand, the scale-efficiency hypothesis argues that some firms achieve a more efficient scale of operation, which can lead to lower costs, higher profits and faster growth. In other words, the superior performance of the market leaders endogenously determines the market structure, implying that higher efficiency produces both higher concentration and greater profitability.

Berger (1995) finds some evidence that the ESH is valid for U.S. banking. However, in several European banking studies, reviewed by Goddard et al. (2001), structural factors appear to be more important, and the SCP hypothesis may have more relevance for European banking.

A third challenge to the traditional SCP approach arises from the recognition that accounting data on profits may not provide a true measure of economic profit. Furthermore, in order to measure a structural variable such as concentration, one must define the relevant product and geographical markets. Besides technology and freedom of entry and exit of firms from markets determine market structure and, hence, optimal conduct and performance. These can be difficult, especially for the banking sector, which has many differentiated and substitutable products, a number of which are supplied by non-bank firms (Paul, 1999).

Further criticism levelled against both the SCP and the efficiency hypotheses relates to the embedded assumption of one-way causality from market structure to performance. In other words, most SCP studies do not take into account the conduct of the banks in the market and the impact of performance on market structure. These deficiencies of the structural approach have motivated the search for alternative non-structural methodologies to investigate firms' competitive behaviour. In this context, non-structural models of competitive behaviour known as the new empirical industrial organization (NEIO) have developed testable hypotheses relating to competitive conduct in markets.

2.4 New Empirical Industrial Organization (NEIO)

NEIO has been developed to analyse the competitive conduct of market participants directly, without taking into account market structure. One of its distinguishing features is the use of models of the price and quantity setting behaviour of market participants. As a consequence, the NEIO approach is based on profit-maximizing equilibrium conditions. There are two main methods within this approach that are used in the empirical analysis of banking: the Conjectural Variations (CV) model (Iwata, 1974; Bresnahan, 1982; Lau, 1982) and the Panzar and Rosse method, from which the H-statistic is derived (Panzar and Rosse, 1987).

2.4.1 Conjectural Variations (CV) model

The CV model was introduced by Bresnahan (1982) and Lau (1982) to measure the MP of the average, profit-maximising, oligopolistic bank in the short term. It also indirectly measures price-cost margins. Empirically, the conduct parameter is obtained by estimating simultaneously a demand function and supply function, including a parameter representing the degree of MP of firms. It is based on the idea that a bank, when choosing its output takes into account the reaction of competitor banks. Bresnahan (1982) and Lau's (1982) model shows profit-maximizing firms set marginal costs that are equal to their perceived marginal revenue to determine product pricing and the quantity they will supply.

In a perfectly competitive market, the perceived marginal revenue equals the average revenue, and firms adopt marginal cost pricing. Under perfect collusion (monopoly), however, the perceived marginal revenue does not equal average revenue or the market demand function. The model statistic λ calculates firms' deviations from marginal cost (competitive) pricing. If $\lambda = 0$, firms behave in a perfectly competitive manner. In

contrast, Shaffer (1993) shows that if $\lambda = 1$, firms price according to the industry's marginal revenue curve, which is consistent with perfect collusion. Values of λ between 1 and 0 reflect varying degrees of imperfect competition. A distinguishing feature of this approach is that the model does not require firm-specific data, but utilises aggregate industry data (Shaffer 1993).

Two of the earliest empirical investigations based on this approach and applied to the banking industry using aggregate data were conducted by Shaffer (1989, 1993), who focused on U.S. loan markets and the Canadian banking industry. In both cases, the degree of competition was found to be between perfect competition and the Cournot equilibrium, with values of λ that were not significantly different from zero. Zardkoohi and Fraser (1998) used the model to test whether geographical deregulation in the U.S. affected market structure in individual states. Perfect competition was found in most states, but imperfect competition in others. Chang et al. (2008) investigate MP in the U.S. commercial banking sector during the 1990s, using static and dynamic variants of the Bresnahan-Lau CV model. Using panel unit root tests, the authors find that the sector is highly competitive in the short term, but enjoys a certain level of MP in the long term. The findings suggest that deregulation effectively encourages orderly but benign competition among banks.

Several empirical studies have applied this approach to European banking, including Suominen (1994) to the Finish banking deposit and loan markets, and Swank (1995) to the Dutch mortgage and savings deposit markets. A study of several European countries by Neven and Roller (1999) reports evidence of monopolistic or collusive behaviour in the corporate and household loan market across six countries between 1981 and 1989.

Bikker (2003) applies the Bresnahan model to loan markets and deposit markets in nine European countries. The estimated values of λ are significantly different from zero for both the UK loan market and the German deposit market, suggesting the markets are in Cournot equilibrium. In many submarkets, including loan markets in Italy, Netherlands, Belgium and France, and deposit markets in the UK, Portugal and Sweden, the values of λ are zero, indicating perfect competition. The degree of competition is between perfect and the Cournot equilibrium in the German, Portuguese, Spanish and Swedish loan markets and the Spanish deposit market. Móré and Nagy (2004) investigated the degree of competition in the Hungarian loan and deposit markets. These were found to be much less competitive than in other EU member nations during the period 1996 –2003.

2.4.2 The Panzar-Rosse (P-R) Revenue Test

Panzar and Rosse (1987) devised a testable estimationof profit maximization under monopoly which they extended to other market equilibria. They present a reduced form approach using industry or bank-level data to discriminate between perfect competition, monopolistic competition, and monopoly. The Panzar-Rosse (P-R) test, also known as the *Revenue Test,* is based on the revenue function of a firm and determines the market structure in which it operates. The test investigates the way in which changes in factor input prices are reflected in equilibrium industry or bank-specific revenues. Whether a bank operates in a competitive market or exercises some monopoly power can be inferred from observation of that bank's total revenue as it responds to changing input prices.

Panzar and Rosse (1987) define a measure of competition (H statistic) as the sum of the elasticities of the reduced-form revenues with respect to factor prices. They show that this

statistic can reflect the structure and conduct of the market to which the firm belongs, since H represents the percentage variation of the equilibrium revenue derived from a unit percent of increase in the price of all factors used by the firm. The test takes account of the fact that the response to input price changes will vary according to the degree and nature of competition.

Negative values for H correspond to monopoly or perfectly collusive oligopoly, as an increase in input prices will increase marginal costs, reduce equilibrium output and subsequently reduce total revenues. As monopolists produce on the elastic portion of the inverse demand schedule, a reduction in output has a negative effect on revenue.

An H-statistic equal to one (unity) corresponds to perfect competition. In perfect competition, some firms exit the market, so that the competitive firm faces higher demand, which produces an increase in revenue by the same proportion as the increase in costs (i.e. demand is perfectly elastic).

In monopolistic competition the H-statistic is between zero and one. Under monopolistic competition, where potential entry leads to contestable market equilibrium, revenues will increase less than proportionally in relation to the input prices, as the demand function facing the individual firms is not perfectly elastic. In this case, the individual firm will produce more output, leading to an increase in revenue. However the proportionate change in revenue is less than the proportionate change in cost, leading to an H-statistic between zero and one. It is worth stressing that the interpretation of competition based on the H-statistic requires that the industry is in a state of long-term equilibrium (Nathan and Neave, 1989).

Molyneux et al. (1994) point out that there is a second interpretation of the H-statistic, which allows testing for equilibrium. In this case, the elasticities of returns need to be substituted for elasticities of revenues. Since the P-R approach is based on comparative static models, inferences from the H-statistic are invalid if markets are not in long-term equilibrium. Hence, testing for equilibrium should precede testing for MP (Glode, 2005).

The empirical test for equilibrium is suggested by the fact that competitive capital markets will equalize risk-adjusted rates of return across banks, such that rates of return would not be correlated with input prices. To test for equilibrium, the E-statistic can be calculated, using the return on assets as the dependent variable in place of the total revenue (or interest income) in the regression equation. Values of the E-statistic equal to zero indicate equilibrium, and values less than zero disequilibrium. However, if the sample is not in long-term equilibrium, a finding of $H<0$ no longer necessarily implies monopolistic competition, but it remains true that $H>0$ disproves monopoly (Shaffer, 1985, 2004).

2.5 Impact of competition on the banking system

2.5.1 Competition and banking efficiency

Competition in the banking market and the efficiency of banks are major factors that have an impact both on the performance and financial health of banks and on the wealth of consumers and businesses. From a theoretical perspective, there is relatively little literature on the link between competition and efficiency. Nonetheless, three different views on the direction of causality can be identified from the literature.

First, the “quiet life” hypothesis focuses mainly on the effect of MP on efficiency. According to this hypothesis, suggested by Hicks (1935), MP allows banks to relax their efforts and increases their costs, suggesting a positive link between competition and efficiency (Färe et al., 2012). The higher the MP, the less effort managers make to maximize efficiency. Therefore, there is a negative correlation between MP and managerial efficiency.

The anticipated relationship between higher levels of MP and lower efficiency is typically based on the following four arguments (Berger and Hannan, 1998). First, if firms can charge prices in excess of competitive levels, managers do not have incentives to work as hard to keep costs under control, and can instead enjoy a “quiet life”. Second, MP may allow managers to pursue objectives other than revenue/profit maximization. Third, in a non-competitive environment, managers devote resources to obtaining and maintaining MP, which raises costs and reduces efficiency. Finally, MP allows inefficient managerial behavior to persist, without any motivation to pursue maximization of firm value (Färe et al., 2012).This idea has been challenged on the grounds that the owners of monopolistic firms could nonetheless exert some control on managerial effort.

Leibenstein (1966) argued that inefficiencies inside firms (X-inefficiencies) could be reduced by increased competition as managers respond to competition pressure. X-inefficiencies emerge from imperfections in the internal organization of firms, creating information asymmetries between owners and managers, or incompleteness of managers' contracts. Competition helps reduce these inefficiencies through two channels. First, it provides incentives for managers to exert more effort to avoid the personal costs of bankruptcy. Second, a greater degree of competition allows owners to make a better

assessment of firm (and managerial) performance relative to other companies (Weill et al., 2013).

The second view of the direction of causality in the theoretical literatures based on the ES hypothesis. This predicts a negative relationship between competition and efficiency, where causality runs from efficiency to competition (Demsetz, 1973). According to this hypothesis, the best-managed firms have the lowest costs and thus gain the largest market shares, which leads to an increase in the level of market concentration. As concentration can be considered an inverse measure of competition, a negative link between competition and efficiency is expected.

The third view of the relationship between competition and efficiency derives from the alternative "banking specificities" hypothesis, which suggests that competition has a detrimental impact on cost efficiency (Weill et al., 2013). This approach is derived from the theoretical literature which argues that banking markets have a number of specific characteristics in comparison to other markets. In theory, banking markets have a structure of imperfect competition, which may arise from the problems of adverse selection, moral hazard, and information asymmetries between the lender and the borrower in credit markets. Banks have to implement mechanisms to address the resulting market failure problems, such as building up long-term relationships with customers (Pruteanu-Podpiera, Weill and Schobert, 2008; Casu and Girardone, 2007; Weill et al., 2013).

Petersen and Rajan (1995) argue that banks with MP have lower costs of monitoring and transactions with borrowers. Under such circumstances, a positive relationship between MP and cost efficiency would emerge. Banks with MP may also have other cost

advantages, as the supply of credit available to young firms is higher and the cost of such funds is lower in more concentrated markets than in a competitive environment. Moreover, banks with more MP will have greater flexibility in terms of profitability, capitalization, and screening capacity. In addition, it is less likely that borrowers will switch to a competitor, so the bank can benefit by lending to the same borrowers again in the future. As a consequence, Petersen and Rajan (1995) argue that young and lower quality firms may especially be negatively affected by banking competition.

Only a small number of studies have analyzed the relationship between MP and efficiency in banking. The first wave of studies investigated the link between cost efficiency and market structure indicators (market share or concentration indices). Berger (1995) examines U.S. banks, while Goldberg and Rai (1996) examine European banks. These studies show a positive relationship between cost efficiency and market share or concentration. As higher concentration and greater market share are both associated with lower competition, this research supports the hypotheses which predict a negative relationship between competition and cost efficiency.

Fu and Heffernan (2009) investigate the relationship between market structure and performance in China's banking system from 1985 to 2002. They test the SCP and RMP hypotheses, together with the X-efficiency and scale efficiency versions of the ES hypothesis. The authors find no evidence to support the quiet-life hypothesis, probably because strict interest rate controls prevent the state banks from earning monopoly profits. No relationship between market structure indicators and cost efficiency is found in any of the estimated regressions.

The second wave of empirical studies considers non-structural measures of competition. Maudos and De Guevara (2007) examine the relationship between MP and cost efficiency in the banking sectors of 15 European Union countries over the period 1993-2002. They find a positive relationship between MP and cost efficiency, rejecting the quiet life hypothesis. Using L is (mark-up of price over marginal cost; Lerner, 1934), to estimate MP, the study shows that, while MP increases in the loans market, it decreases in the deposits market.

For the U.S. banking industry, Koetter et al. (2008, 2011) consider various aspects of bank MP and efficiency. In the first paper, they report that competition declines among U.S. bank holding companies over the period 1986-2006, and increasing MP is positively related to cost efficiency, according to regressions of both adjusted and unadjusted LIs on efficiency scores using several estimation methods. In addition, there is a negative relationship between competition and efficiency, according to instrumental variable regressions, which accounts for the possible simultaneity of a positive relationship between MP and efficiency. However, Turk-Ariss (2010) finds a significant negative association between bank MP (as measured by the LI) and cost efficiency.

In their second paper, Koetter et al. (2011) report substantial increases in MP in the U.S. banking industry after the relaxation of limits on interstate banking. The study finds a positive relationship between MP and cost efficiency. By contrast, there is a significant negative relationship between profit efficiency and cost efficiency.

The third wave of empirical studies includes attempts to measure competition by employing non-structural measures and performing Granger-causality tests to check the sign and direction of causality between competition and efficiency. Pruteanu-Podpiera,

Schobert and Weill (2007) analyze the relationship between competition (measured by the LI) and efficiency for a sample of Czech banks. Granger-causality tests are performed to examine the sign and type of causal relationship between competition and efficiency. Competition is found to negatively Granger-cause efficiency, but efficiency does not Granger-cause competition. Similar investigations are performed by Casu and Girardone (2009) for banks from the five largest EU countries, and by Weill et al. (2013) for a sample of Chinese banks. Casu and Girardone (2009) find limited evidence of a negative impact running from competition to efficiency, and find no evidence of reverse causality. Both studies corroborate the results of earlier studies that find a negative relationship between competition and efficiency. It is suggested that a causal effect from competition to efficiency is better explained by the banking specificities hypothesis than the efficient-structure hypothesis. In the case of Chinese banks, Weill et al. (2013) find no increase in bank competition even as cost efficiency improves. In contrast to the empirical literature showing that competition negatively Granger-causes cost efficiency for Western banks, they find no significant relationship between competition and efficiency. This suggests that measures to increase bank competition in China are not detrimental to efficiency.

Schaeck et al. (2010) investigate the relationship between efficiency, competition and soundness for the U.S. and several European countries. Granger causality tests are used to examine the relationship between competition (measured by the LI) and various measures of efficiency. Their tests provide evidence that increases in competition lead to increases in bank profit efficiency in Europe and in the U.S. For the U.S., cost efficiency is also improved by increased competition, but for Europe greater cost efficiency is associated with greater MP.

Overall, the theoretical literature provides conflicting evidence with respect to the sign and direction of causality between competition and efficiency. Rahim (2016), using the Malaysian commercial banking sector, found the same relationship as Schaek and Cihak (2008) who used banks in Europe and the United States. Rahim found a positive effect of competition on technical efficiency while Schaeck and Cihak found competition to be positively related to both profit and cost efficiency. Schaek and Cihak also found that increased competition increases bank soundness via the efficiency channel.

Andries et al. (2014) reported that the impact of competition is sufficient in the case of profit efficiency, which means an increase of competition determines sufficient increase of profit efficiency rather than an increase of cost efficiency. This evidence could be determined by the increasing of banking competition that causes banks to diversify the portfolios of products and services and to enter into new markets with higher but riskier returns (especially on CEEC).

Moyo (2018) investigate the relationship between competition, efficiency and soundness in the South African banking sector. Results show that the impact of competition on efficiency depended on the measure of competition used. When using the Lerner index there was a negative effect of competition on efficiency while the opposite was true when using the theoretically robust Boone indicator. However, the empirical literature predominantly indicates a negative relationship (Pruteanu-Podpiera, Schobert, and Weill, 2007; Casu and Girardone, 2009; Schaeck et al., 2010; Weill et al., 2012).

2.5.2 Competition and access to finance

Both theoretical and empirical research show mixed results for how competition between banks may positively or negatively impact on firms' access to financing. The traditional MP hypothesis argues that that competition in the banking market reduces the cost of finance and increases the availability of credit. In contrast, the "information" hypothesis (Petersen and Rajan, 1995) suggests that, in the presence of information asymmetries and agency costs, competition can reduce access to credit by making it more difficult for banks to forgo any interest rate premiums they might otherwise have to charge when lending to small and risky distressed firms.[8] In response, banks establish a lending relationship that will allow them to extract informational rents for access to debt finance by potential borrowers over time (Ryan et al., 2014).

There is a large literature examining the links between competition and access to finance for various proxy measures of competition in banking markets. Employing bank concentration measures[9] as a proxy for bank MP, Petersen and Rajan (1995) find that increased concentration is associated with greater access to finance for a cross-section of U.S. firms that access local banking markets. In contrast, Beck, et al. (2004) use data for 74 developed and developing countries and find that high bank concentration in the banking market increases obstacles to accessing finance, but only in countries with low levels of economic and institutional development. This finding is supported by Ongena

[8] Banks operating in a competitive market must break even in each period and thus must hold risk-adjusted returns constant by charging higher interest rates on lending where the borrower's returns exhibit greater uncertainty (Ryan, O'Toole and McCann, 2014).

[9] Concentration measures such as the five-firm concentration ratio CR (5) or the HHI.

et al. (2012), who find a positive association between concentration and credit constraints, using a survey on the financing of Chinese SMEs combined with detailed bank branch information.

A second body of research which focuses on direct measures of competition and contestability shows that firms' access to finance is easier in more competitive banking markets. Using data on growth in value added for the period 1980–90 for 16 countries, and measuring competition at the country level (using the P-R H-statistic), Claessens and Laeven (2005) find that competition is positively associated with industrial growth.[10]They suggest that competitive banking sectors are better at providing finance to financially dependent firms. With direct measures of competition, including the LI, Carbó-Valverde et al. (2009) find evidence that competition promotes access to finance for a sample of Spanish SMEs, supporting the MP hypothesis. However, the results for the LI are not consistent with results using concentration measures as proxies for competition. Carbó-Valverde et al. (2009) conclude that concentration is not a good measure of competition.

Love and Peria (2012) find that a low level of competition in the banking market, indicated by high values of the LI, diminishes access to finance, for a cross-section of firms in 53 developing countries. However, this finding is dependent on the wider economic and financial environment in which the firms operate. In particular, higher levels of financial development and greater availability of credit information reduce the

[10]Higher values of the H-statistic are associated with more competitive banking systems.

adverse effect, while high levels of government ownership of bank assets are associated with a stronger negative impact of bank MP on access to finance. Ryan et al. (2014) investigate the impact of MP on the investment financing constraints experienced by small- and medium-sized enterprises (SMEs), using a large sample of 118,000 SMEs for 20 European countries for the period 2005-2008. This study finds that increased MP results in increased financing constraints for SMEs. Additionally, the effect of bank MP on constraints is stronger in financial systems that are more bank dependent. This suggests that further developing alternative liquid financing sources for SMEs in Europe would help develop a more stable financing environment.

Fungáčová et al. (2017) analyzed the impact of bank competition on the cost of credit using a cross-country sample of firms from 20 European countries over the period 2001–2011. They concluded that competition increases the cost of credit and the effect is stronger for smaller firms. Recently, Pereira et al. (2018) use panel data from 83 countries over a 10-year period and find that greater banking industry concentration is associated with more access to deposit accounts and loans, provided that the market power of banks is limited.

2.5.3 Competition and stability in the banking system

The question of whether competition increases or decreases the stability of banks has long been of interest to both policymakers and academics. There are three main views arising from theoretical studies to explain the relationship between competition and stability. The first is the competition-fragility /concentration-stability view, which states that

competitive banking systems are less stable and more fragile because competition reduces profits and erodes the franchise value of banks, consequently increasing incentives for excessive risk taking (Chan, Greenbaum and Thakor, 1986; Keeley, 1990).[11]The second perspective is the competition-stability/concentration-fragility view, which argues that, as the banking system becomes more competitive, it is less prone to risk of bank failures, which in turn enhances stability. The third view highlights the fact that the relationship between market structure and stability is complex and involves important interactions with the macroeconomic, regulatory and institutional frameworks of countries.

2.5.3.1 Competition-fragility or concentration-stability view

The competition-fragility or concentration-stability view suggests that collusive behaviour in less competitive systems may consolidate returns and enhance financial stability by encouraging banks to hold higher levels of capital as a buffer against adverse economic and liquidity shocks. If a bank earns high profits as a result of its greater MP, its potential losses will escalate if the bank engages in risk-taking behaviour (Chan, Greenbaum and Thakor, 1986; Keeley, 1990). This view is developed by Keeley (1990) and Hellman et al. (2000) under the franchise value hypothesis. This argues that managers and shareholders alike will not take on risky investments in order to protect their franchise value, in case bankruptcy occurs. Additionally, banks with greater MP can adequately screen loan applications and give higher quality loans, which may improve the efficiency

[11]In accounting terms, franchise value is defined as an intangible asset. It is the market value of a bank's equity exceeding its book value and reflected in the market price of shares (Carletti et al., 2007).

of the process of capital allocation, and, therefore, contribute to economic growth. Thus, effective credit screening would enhance the stability of banks (Boot and Thakor, 2000) and improve the quality of their loan portfolios in a system characterised by increased concentration and reduced information asymmetry.

A somewhat different argument in support of the competition-fragility view is that more concentrated banking systems tend to have larger banks, which are able to diversify their portfolios more effectively. A final argument refers to the number of banks to be supervised. Given that a more concentrated banking system typically involves a smaller number of banks, this might reduce the supervisory burden and enhance the overall stability of the system. Competition can also destabilize the banking sector through its impact on the interbank market and payments system.

By contrast, higher levels of competition may have a harmful impact on stability. It erodes MP and profit margins, causing bank franchise values to drop, therefore leading to more aggressive risk taking in an effort to earn higher profits. For example, if banks choose to follow more risky policies by taking on more credit risk or lowering capital levels, this increases the probability of higher non-performing loan ratios and more bank bankruptcies, resulting in greater fragility and financial instability. Therefore, less concentrated banking systems are considered more prone to experience crises (Keeley 1990; Carletti and Hartmann, 2002; Jimenez et al., 2007; Beck 2008; Berger et al., 2009).

Earlier empirical literature investigating the relationship between market structures and banking system performance mostly focuses on the U.S. banking market. Marcus (1984, in Beck 2008) reveals that, as MP and franchise values decline, banks engage in riskier policies. Chan, Greenbaum and Thakor (1986, in Beck, 2008) reveals that increased

competition reduces the profits that banks earn by identifying high quality borrowers. They argue that a decline in franchise value reduces the incentive for banks to screen borrowers. Therefore, credit quality declines and bank risk increases.

Keeley (1990) provides a theoretical framework and empirical evidence for the franchise value view for the U.S. banking system in the1980s. He argues that deregulation of the banking sector following relaxation of state branching restrictions in the 1970s and 1980s increased competition and led to a reduction in MP and hence franchise values. Both Benston et al. (1995) and Paroush (1995) examine bank mergers in the U.S. and argue that increases in MP arising from the diversification benefits of mergers contribute to financial stability (Schaeck, Cihak and Wolfe, 2009).

Beck, Demirguc-Kunt and Levine (2006) suggest that crises are less likely to occur in more concentrated banking systems and that bank fragility increases with more competition. Chang et al. (2008) examine the relationship between financial stability and bank concentration. Their results suggest that more concentrated banking systems may improve stability. There is evidence to suggest that competition can destabilize the banking sector through its impact on the interbank market and the payments system. Allen and Gale (2000) examine contagion in the context of a banking system that has regional banks connected by interbank deposits. Perfect competition can prevent banks from providing liquidity to a bank affected by a temporary liquidity shortage (Allen and Gale, 2000; Beck, 2008). By contrast, Saez and Shi (2004) argue that if banks are limited in number, they may have an incentive to act strategically and cooperate to provide liquidity to any bank with a temporary liquidity shortage. Micco and Panizza (2005) find that banks

with a larger market share can internalize the positive counter-cyclical effects of expanding credit during recessions and have incentives to reduce financial contagion.

Allen and Gale (2004) further analyze the relationship between contagion, financial fragility and competition. They define contagion as an important source of financial instability, which occurs when a small shock to an individual bank spreads throughout the rest of the financial system, causing a systemic problem affecting the entire economy. They extend this model of contagion to allow for imperfect competition in the banking sector, showing that an imperfectly competitive market may be more stable than a perfectly competitive one. There is, therefore, a trade-off between competition and financial stability, because each oligopolistic bank realizes that its actions affect the price of liquidity. By providing sufficient liquidity to the market, such banks can ensure that contagion and their own potential bankruptcies are avoided.

2.5.3.2 Competition-stability or concentration-fragility view

The early empirical literature on the link between competition and stability is mixed. Some of these studies failed to find that larger banks are less likely to fail, as predicted by the competition-fragility view (Boyd and Graham, 1991, 1996; Boyd and Runkle, 1993; De Nicoló, 2000).On the other hand, studies using cross-country, time-series datasets offer evidence supporting the competition-stability view. Beck, Demirgüç-Kunt and Levine (2006, 2007a) find that more competitive banking systems (defined as those with fewer regulatory restrictions on bank entry and activities) are less likely to suffer systemic banking distress. This finding is confirmed by Schaeck, Čihák and Wolfe

(2009), who find a negative relationship between bank competition and systemic bank fragility, using the H-statistic to measure competition. Schaeck and Čihák (2010b) identify bank capitalization as one of the channels through which competition fosters stability. Using data for more than 2,600 European banks, they show that banks have higher capital ratios in more competitive environments.

Building on previous work, Amidu and Wolfe (2013) investigate the competition-stability relationship by examining the complex interaction between three key variables: degree of MP, diversification and stability. The results show that competition improves stability via the income diversification channel. The empirical results of Soedarmonoa, Machrouh and Tarazi (2013) support these findings, indicating that a higher degree of bank MP is positively associated with capital ratios, income volatility and insolvency risk.

Advocates of the competition-stability view argue that larger banks, especially those with greater MP, are more likely to engage in risky activities and are thus less stable. These banks know that, because of their systemically important size, they will be protected by the government safety net, under the concept of 'too-big-to-fail', developed by Mishkin (1999). According to this concept, when banks become too large, the moral hazard problem for those with more risky loan portfolios accelerates with the knowledge that they will be protected by public finance. Additionally, monopolistic banks tend to charge higher loan rates to increase their returns, which may attract borrowers with more risky projects to cover the higher loan repayments (Tabak, Fazio and Cajueiro, 2012). In this case, the probability of defaults rises and bank stability deteriorates, potentially leading to failure (Boyd and De Nicolo, 2005). Moreover, large banks can expand across multiple

geographical markets and develop complex business lines and financial instruments, which can be detrimental to their stability (Amidu and Wolfe, 2013).

De Nicolo et al. (2004) and De Nicolo and Loukoianova (2006) suggest that concentration may induce higher levels of systemic risk. Boyd et al. (2009) find a positive and significant relationship between the probability of failure and concentration. Uhde and Heimeshoff (2009) use aggregate data for 25 EU countries to show that bank concentration is negatively associated with financial soundness. Schaeck and Cihak (2014) showed that a higher level of competition leads to more stability. Isa et al. (2018) find that competition promotes financial stability, and reduces credit risk in the banking system.

2.6 Competition and bank risk taking

The literature indicates that the lower short-term interest rates are, the higher the risks undertaken by banks, because low short-term interest rates influence the asset side of the bank's balance sheet, inducing the bank to seek more aggressive risk-taking strategies to make up for the forgone revenues from safe assets, reduced yield from its portfolios, and lowered leverage. These influences are further escalated due to financial frictions such as limited liability and asymmetric information, and due to bank capitalization levels (Seeberg, 2015).

The opposite is also true. As short-term interest rates increase, they affect the asset side of the banks' balance sheet by increasing the expected return of its portfolio, thus inducing the bank to reduce its demand for risky assets or to increase its portfolio monitoring or

both (Seeberg, 2015). There is also evidence in the literature to show that banks also react to high monetary policy reducing their risk-taking through reducing their leverage accordingly to reduce its depositors demanded rates, thus maximizing their profitability (Dell'Ariccia, Leaven and Marquz, 2010).

Seeberg (2015) showed empirically that bank risk-taking increases when monetary policy (or key policy rates) is accommodating (or low). The author also suggested that monetary policy through the risk-taking channel could impose risks to financial stability if it was not the intended effect of such policy.

The literature shows that market structure affects bank risk-taking as well (Dell'Ariccia, Leaven and Marquz, 2010; and Seeberg, 2015). On the one hand, in a perfectly competitive market, a higher monetary policy will decrease bank risk-taking, regardless of their leverage level. On the other hand, in a monopoly, a higher monetary policy will increase bank risk-taking levels because the monetary policy increase only affected the risk-shifting effect, thus inducing the monopolistic bank to increase its risk-taking to compensate its forgone margin.

The ownership structure of the banks is also found to impact the risk-taking channel. In the period from 1999-2011, European banks reacted to monetary policy differently by have different risk-taking attitudes and appetites depending on their form of ownership structure. Bank risk-taking reactions to monetary policy seem to be more vivid with shareholder banks compare to stakeholder ones, according to findings by Caselli (2016). The author showed evidence that the risk-taking channel of the monetary policy was dampened in the aggregate economy due to the existence of stakeholder banks. This biodiversity of bank ownership structure, the author concludes, promotes the stability of

the financial and economic system, by dampening the impact of lower interest rates on the systemic risk.

Tabak, Gomes, and Junior, (2012) examine the Brazil banking industry and suggests that the bank with more market power willing to take more risk. The authors find that when a bank has both high market power and capitalisation, they tend to reduce their risk-taking policies, as they try to avoid risking losing their grown charter values. Banks with low market power and high capitalisation tend to have more appetite for risk to grow their charter values (Tabak, Gomes, and Junior, 2012).

During the period 1997-2011, U.S. banks' risk-taking activities represented by loans given to higher risk borrowers increased with the decrease of the short-term interest rates from the monetary policy (Dell'Ariccia, Laeven and Suarez, 2013). This finding did seem to be weaker for poorly capitalized banks; however, the finding is stronger the longer the low short-term interest rates remained, albeit the risks themselves were not excessive. This empirical study and others did evident the bank risk-taking channel of monetary policy, since the 1990s (Dell'Ariccia, Laeven and Suarez, 2013; Delis, Hasan, and Mylonidis, 2012; and Seeberg, 2015).

The bank risk-taking channel should be accounted for when formulating macro-economic monetary policies designed to counter increasing inflation rates. Abbate and Thaler (2015) recognised that since banks are protected by limited liabilities since they have an array of investment choices with varying risks from which they can choose without the input of depositors, which causes an agency problem and induces banks to undertake more risks than they should, thus lowering the growth of capital, output and consumption. Research has already found that the lower the monetary rates are the higher risks that

banks will pursue (Dell'Ariccia, Leaven and Marquz, 2010; and Seeberg, 2015). Abbate and Thaler (2015) found that a central bank monetary policy designed with the bank risk-taking channel in mind, would tolerate higher inflation volatility in order to reduce risk taking damaging fluctuations to the household's conditional lifetime utility.

Delis, Hasan, and Mylonidis (2012) confirmed the existence of the negative relationship between an expansionary monetary policy and the banks' risk-taking channel in the U.S. since the 1990s, which they attributed to financial deregulation and technological advances. The authors also found that U.S. banks' overall loan portfolios risks decreased when the low monetary policy was introduced, but increases the longer the monetary policy remained low. As a result of the impact of long term low monetary policy on the bank risk-taking channel and their impact on the macro economy, the literature suggests that the Federal Reserve Bank should have a macro-prudential supervision on this matter by integrating the supervision of bank risk-taking channel in an expansionary monetary policy environment into its macroeconomic policy framework to achieve price and financial stability. The literature also suggests that bank supervisors and regulators should also be more effective on regulating policies to keep an eye on monetary policy and limit its effects on their risk-taking policies.

A variety of theoretical and empirical studies have focused on the effects of competition on bank risk-taking behaviour. One chain of causation, using models such as those of Keeley (1990), Matutes and Vives (2000), Hellmann, Murdock and Stiglitz (2000) and Repullo (2004), and Allen and Gale (2004), predicts that fiercer competition among banks will result in greater risk taking. The intuition behind this proposition is that a higher

degree of MP at bank level is associated with high monopoly rents, which managers want to protect by investing in safe assets.

Researchers and bank regulators worldwide view the franchise value as a key factor in limiting the riskiness of individual banks and hence of banking systems more broadly. In general, higher franchise values reduce incentives for banks to take excessive risks. The banks can limit or reduce risk-taking by holding more equity capital or less risky portfolios and may become relatively conservative in order to protect their franchise values. This, in turn, enhances the stability of the whole banking system (Keeley, 1990; Schaeck et al., 2009; Jimenez et al., 2007; Yeyati and Micco, 2007; Beck, 2008).

Keeley (1990) shows that competition increases in the U.S. banking industry in the aftermath of financial deregulation and leads to a reduction in MP, and hence franchise values. He demonstrates that the decline in MP leads to a higher risk premium that banks have to pay on certificates of deposits and results in lower capital-to-asset ratios. The reduced profits and franchise values resulting from competition also increase the value that bank owners and managers put on deposit insurance funds and magnify the agency problem between bank owners and the government.

An alternative approach considers the risk taking behaviour of banks as endogenous, and identifies a link between competition and risk taking with regard to the private benefits that banks can earn from informational specialization. In other words, changes in informational rents in an increasingly competitive environment may drive excessive risk taking. Besanko and Thakor (1993) state that increased competition is associated with a decrease in informational rents obtained from relationship lending, which, in turn,

increases risk taking.[12]In the context of asymmetric information, Marquez (2002) shows that an increase in the number of banks in a market disperses borrower-specific information and results in both higher funding costs and greater access to credit for low-quality borrowers.

Taking the behaviour of banks as exogenous, the first strand of theoretical literature concentrates on the adverse selection problem that banks face with borrowers. An increase in the number of banks increases the imperfection of information-gathering and processing techniques. As a consequence, increased competition may have an adverse impact on bank solvency. Suarez (1994), using a dynamic optimization model with an infinite horizon, shows a trade-off between MP and solvency. If the MP and franchise value decrease, the incentive to engage in riskier policies increases significantly. Since the franchise value is a component of bankruptcy costs, it encourages banks to carry out prudent policies that increase stability and solvency.[13]

Using a dynamic model of moral hazard, Hellmann et al. (2000) show that competition can undermine prudent behaviour in the presence of moral hazard and lead to inefficient or excessive risk taking. They argue that financial liberalization (that is, removal of interest ceilings) results in increased competition for deposits, which, in turn, lowers

[12] In the course of the relationship with their borrowers, banks need some private information about them. Acquiring this information is a costly process; however, it provides informational rents to banks. As long as banks appropriate at least part of these rents, they have an incentive to monitor borrowers so as to enjoy the value of the relationship which in turn limits their risk exposure. In more competitive environments, relationship banking decreases in value; banks earn fewer informational rents from their relationship with borrowers, reducing their incentives to properly screen them. So in a framework of relationship banking, increased competition induces banks to choose riskier portfolio strategies (Besanko and Thakor,1993).
[13] Chan et al. (1986, in Jimenez et al., 2012) also consider the franchise value a component of the private cost of bankruptcy.

profitability and franchise value. This encourages moral hazard behaviour, inducing banks to take excessive risks.

Matutes and Vives (2000) examine the link between imperfect competition in the deposit market, risk taking incentives and deposit insurance. They conclude that MP lowers bank default probability under three conditions. First, when there is no deposit insurance but intense competition exists, the failure costs are high, deposit rates are excessive, so bank asset risk is high. Second, when deposits are insured through a flat rate scheme, competition leads to excessive deposit rates, even without failure costs, and banks take the maximum asset risk. Finally, when deposit insurance premiums are risk adjusted, deposit rates and bank asset risk are lower than in an economy without deposit insurance.

Using a dynamic model of imperfect competition in banking, Repullo (2004) shows that the absence of regulation in the banking sector, which means more competition and lower bank margins, leads to more risk and decreases bank soundness. The author argues that risk-based capital requirements are found to effectively control the risk-shifting incentives. Moreover, Allen and Gale (2004) argue that reduction in the franchise value of banks also decreases effort on monitoring, additionally increasing riskiness. However, these models take investment risk as exogenous and only focus on the effect of competition relating to the bank liability side of the balance sheet (Schliephake, 2013).

Boyd and De Nicolo (2005) criticize the traditional franchise value paradigm in several respects. They point out that the studies that support this paradigm ignore the fact that banks invest in loans besides other assets, focus only on the deposit market, and do not take into account the loan market. They also assume that banks choose the riskiness of their assets and may increase or decrease risk depending on the degree of competition.

The authors argue that, as deposit markets become more concentrated, banks become less eager to seek low probability, high return outcomes, in turn decreasing their risk profile.

Increased concentration or decreased competition among banks in loan markets could result in higher interest rates on business loans, which may raise the credit risk of borrowers as a result of moral hazard issues, as suggested by Stiglitz and Weiss (1981).[14]Boyd and De Nicolo's "risk-shifting" paradigm (BDN model, 2005) proposes that increased competition across both the loan and deposit markets could lower loan rates and decrease borrower credit risk by making it easier for borrowers to repay loans, which then reduces moral hazard incentives to shift into riskier projects. Therefore, greater competition reduces the default risk of borrowers and hence bank losses. Correspondingly, the risk of failure declines and financial stability is enhanced.

A third model developed by Martinez-Miera and Repullo (MMR model, 2010) shows that the results of the BDN model do not necessarily hold in the case of imperfectly correlated loan defaults. As an alternative, they extend the BDN model by introducing imperfect correlation across borrowing firms. Under this assumption, two possible characterisations of the effects of bank competition are introduced. The "margin effect" is based on the hypothesis that more competition leads to lower loan rates, and consequently lower revenues from non-defaulting borrowers, which in turn decreases profits, increases bank

[14] The higher interest rates charged to loan customers make it harder to repay loans and create moral hazard incentives for borrowers to shift into riskier projects to compensate for the high loan rates. This practice results in an increase in firm default risk and so in a higher probability that loans become non-performing and result in a higher bankruptcy risk and greater bank instability. Also the higher rates may also result in a riskier set of borrowers due to adverse selection problems. This is because a bank that sets higher prices for all its customers runs the risk of being adversely selected by least profitable customers (Boyd and De Nicolo, 2005).

risk taking and failure. However, the margin effect operates in the opposite direction to that predicted by the BDN model, since the risk-shifting effect captures the higher risk of firm failure that may occur as loan interest rates increase, but this has to be balanced against the effect of the higher margins that generate more revenue from non-defaulting borrowers who pay the higher interest rates. Martinez-Miera and Repullo (2010) show that there is a U-shaped relationship between competition and the risk of bank failure. As the number of banks increases, the probability of bank default first declines but then increases beyond a certain point. Depending on the degree of default correlation across firms and the intensity of the risk-shifting effect, it is possible to find an initial decline in risk, as the number of banks, and thus competition, increases, but an eventual increase in risk, as the number of banks operating in a market continues to grow. The risk shifting effect is shown to dominate in very concentrated markets, so that entry reduces the probability of bank failure, whereas in very competitive markets the margin effect dominates, and further entry increases the probability of failure.

In addition to the theoretical literature, there exists a large empirical literature examining the effect of bank competition on stability and bank risk. One strand of empirical research uses large aggregated one-country datasets. Demsetz, Saidenberg and Strahan (1996), building on Keeley's (1990)work on U.S. banks, also find that higher charter values are associated with higher capital holdings and lower levels of risk. Salas and Saurina (2003) apply a similar methodology to data on the Spanish banking system and find that higher charter values are associated with lower levels of credit risk.

Research by Jayaratne and Strahan (1998) produce findings that contrast with Keeley’s results. They show that branching restrictions in U.S. banking serve as entry barriers that

prevent efficient banks from expanding, and therefore reduce the efficiency and performance of the banking system. They find evidence that once these restrictions are lifted and interstate banking is allowed, competition among banks increases and this sharply reduces risk for U.S. banks between 1975 and 1992. The authors conclude that an increase in competition has the opposite effect to that predicted by the franchise value paradigm in that it improves bank performance and stability. However, Dick (2006) shows that, for the period 1993–99, the removal of restrictions leads to an increase in bank service quality, accompanied by a rise in operating costs and service fees. Due to these increasing costs and higher risk, spreads fall. The author also provides evidence of increased charge-off losses and loan loss provision (LLP). As a result, she concludes that deregulation decreases bank stability.

De Nicolo and Loukoianova (2007) examine the joint effects of bank ownership and market structure on banks' risk profiles and financial stability for 133 developing countries for the period 1993-2004. Their results indicate a positive and significant relationship between bank concentration and risk of failure, and this relationship is stronger when state-owned banks have sizeable market shares. The authors conclude that the risk of bank failure rises in less competitive markets.

Schaeck and Cihak (2012) find a positive relationship between competition and bank capital ratios. Inasmuch as better capitalized banks can be considered less risky, these results confirm the competition-stability hypothesis. Soedarmonoa, Machrouh and Tarazi (2013) study the impact of bank competition on financial stability for a broad set of commercial banks in Asia over the 1994–2009 period. They indicate that a higher degree of MP in the banking market is positively associated with capital ratios, income volatility

and insolvency risk. Fiordelisi and Mare (2014) studied the relationship between competition and risk using data on European cooperative banks and found that competition increases stability.

More research is required in this area using different measures of competition and risk, in order to resolve the on-going theoretical argument. Berger et al. (2009) use a variety of risk and competition measures, such as non-performing loans and book value failure probabilities (i.e. z-scores), which are affected by MP, as measured by the bank level LI. The authors also include squared competition measures in their empirical work to account for the possible nonlinearities suggested by the MMR model. Their results are rather mixed and provide some support for the MMR results, in that they found evidence for both the competition-fragility and competition-stability hypotheses, which predict that MP increases credit risk. However, they found that banks with more MP typically have lower overall risk measures, which supports the competition-fragility hypothesis. Zhao et al. (2010) assess the extent to which deregulatory measures aimed at promoting competition lead to increased risk taking across Indian banks. The results suggest an increase in risk taking incentives accompanying an increase in competition.

Leroy and Lucotte (2017) use the Z-score and systemic dimensions of risk and the Lerner index as in Ahamed and Mallick (2017) to analyse the relationship between competition and bank risk across a large sample of European listed banks over the period 2004–2013. Results suggest that competition encourages bank risk-taking and then increases individual bank fragility. The authors find that competition enhances financial stability by decreasing systemic risk. This result can be explained by the fact that weak competition tends to increase the correlation in the risk-taking behaviour of banks

2.7 Competition and regulation

The effect that bank competition can have on the risk taking behaviour of banks has for a long time given rise to much debate among regulators, policy makers and researchers regarding whether banks should be regulated, and, if so, how best to design regulation. One of the most important justifications for regulating the financial system is to promote banking stability and discourage excessive risk taking associated with agency problems, (moral hazard, adverse selection) leading to bank failures that might harm depositors and disturb the payment system (Vives, 2011).Banking crises have revealed the importance of bank regulation to hedge against the high risks resulting from imbalances in bank balance sheets.

In recent years, minimum capital regulations have been the main tool for regulating banks.[15]Since equity provides a buffer against unexpected shocks and reduces moral hazard, it is believed that a bank with large amounts of equity is less reliant on deposit funding, thereby reducing its risk of failure and helping to stabilise the banking system. Nonetheless, higher equity funding may have adverse effects as it increases the cost of

[15] Capital adequacy regulation has been formulated under the auspices of the Bank for International Settlements (BIS). Basel I (in 1988), and the more recent updated Basel II (in 2006), establish minimum capital adequacy guidelines for internationally active banks. Virtually all developed countries' banking systems, and most others, currently adhere to Basel capital standards. BIS has been instrumental in helping to establish minimum international standards in the regulation of banks (particularly in emerging and less-developed countries) via its guidance and oversight on the 'Core Principles for Effective Banking Supervision' (1997, 2006).

intermediation and decreases the profitability of the banking industry, reducing bank charter values and providing incentives for higher risk taking. Simultaneously, as banks become more constrained, their ability to create liquidity and contribute to economic growth (e.g.by lending) will be hampered during normal times, resulting in increased loan interest rates. The theoretical research on whether increased loan interest rates stabilize or destabilize banks actually goes further. On the one hand, it is argued that the margin effect stabilizes banks because that the higher loan interest rates create higher earnings on non-defaulting loans, which can offset losses from defaulting loans. On the other hand, Boyd and De Nicolo's (2005) risk shifting effect (based on their BDN model) means that higher loan interest rates destabilize banks by reducing the net earnings of borrowers, which induces a shift towards riskier project investments (also discussed by Schliephake, 2013).

In reality, the relationships between capital requirements, competition and financial stability are more ambiguous, in part due to the complexities and unique position that banks play in the economy (Allen and Gale, 2004; Moyo et al., 2014). The empirical evidence for those relationships has produced mixed results. As previously mentioned (see 2.4.4), Keeley (1990) reports that increased competition after deregulation in the US banking system in the 1980s causes a decline in franchise values and increased default and asset risks. He provides evidence that the solvency ratio has a positive relationship with MP, indicating that more competitive banking systems are associated with reduced capital cushions and higher bank fragility. He also shows that interest rates on certificates of deposit have a negative relationship with MP, which means that reduced MP is associated with higher interest rates on certificates of deposits and higher risk premiums. Hellmann, Murdock and Stiglitz (2000) find that higher capital requirements reduce the

incentives for banks to increase asset risk. They state that a value-maximising bank prefers to meet higher required capital ratios by raising additional capital, rather than by selling assets and retiring deposits.

In line with Hellmann et al. (2000), Matutes and Vives (2000) suggest that deposit regulation (deposit limits or rate ceilings) and investment restrictions are needed to limit risk-taking when competition is intense. Repullo (2004) uses a dynamic model of imperfect competition in banking and shows that in the absence of regulation, more competition and lower bank margins lead to more risk and decreases in soundness. They conclude that capital requirements may not be enough and additional regulations, such as deposit rate controls, deposit premiums or asset restrictions, could be useful in reducing risk within a competitive environment (Delis et al., 2011).

Using a structural model, Delis et al. (2011) estimate competitiveness indicators for a large cross-section of countries. Claessens and Laeven (2004) relate the competitiveness indicator to a number of country characteristics, and find that greater foreign bank presence and fewer activity restrictions in the banking sector can make for more competitive banking systems. They also find some evidence that entry restrictions on commercial banks can reduce competition. This suggests that being open to new entrants is very important competitive pressure. On the other hand, an absence of restrictions could allow the creation of large financial conglomerates, thus reducing competition. Beck et al. (2004) document a similarly positive association between concentration and reduced restrictions on bank industry activities.

Furthermore, evidence from studies that look at the diversification opportunities of banks across various market segments suggest that restrictions on bank activities will influence

competition and bank behaviour in other segments of the market. A recent paper by Molyneux et al. (2014) investigates the influence of bank competition, concentration, regulation and national institutions on individual bank fragility, as measured by the probability of bankruptcy and bank Z-scores, and using information on 14 Asia Pacific economies from 2003 to 2010. Their empirical results show that tougher entry restrictions may benefit bank stability, whereas stronger deposit insurance schemes are associated with greater bank fragility.

Schaeck and Cihak (2011) find a positive relationship between higher levels of competition and bank capital ratios, which may have an impact on the stability of the banking sector. However, there is little empirical evidence that more stringent capital regulation actually improves the stability of a particular banking sector, as pointed out by Barth et al. (2008).

These wide-ranging empirical results offer conflicting evidence on the relationship between bank competition and stability. Beck et al. (2011) developed a unified framework to assess how regulation, supervision and other institutional factors may make it more likely that the data favour one theory over the other (charter value paradigm versus risk-shifting paradigm). Based on cross-country data they find that the relationship between MP and bank soundness is positive. An increase in competition will have a larger impact on bank risk taking incentives in countries with stricter restrictions on activity and un-concentrated banking markets. The authors suggest that restrictions and herding trends can intensify the negative impact of competition on bank stability, and regulatory reforms should take this into account. They conclude that capital regulation seems to have little influence on the relationship between competition and stability.

Another strand of literature has focused on the impact that competition and capital regulation have on bank stability. Martinez-Miera (2009) analyzes the impact of capital requirement regulation on bank failure under different market structures when loan defaults are imperfectly correlated. He argues that if the asset risk of a bank's loan portfolio is not perfectly correlated, capital requirements have ambiguous effects on stability. Hakenes and Schnabel (2011) show that the ambiguous effect of competition on risk taking translates into ambiguous effects of capital requirements on the stability of the banking sector. They argue that stricter capital requirements attenuate competition for loans, implying higher loan rates, and hence higher risk-taking by borrowers. Therefore, the risk in single loans increases. Overall, these effects may translate into an increase in the probability of banks defaulting.

Delis et al. (2011) use a sample from the Central and Eastern European banking sectors over the period 1998–2005 to investigate whether regulation has an independent effect on risk-taking, or whether the effect is mediated via the MP of banks. Their empirical results suggest that capital requirements and supervisory power have a direct impact on credit risk by reducing non-performing loans. However, the stabilizing effects of capital regulation diminishes when the banks have sufficient MP to increase their credit risk, and are maximised for banks that possess moderate to high MP. These results clearly suggest that regulation alone may not be sufficient to control credit risk. The findings also indicate that regulators may be able to contain bank risk-taking through restrictions on activities which appear to reduce the lending of banks with relatively high MP, and have a direct negative effect on the solvency risk.

Recently, Schliephake (2013) examined the impact of capital requirements on the competitive behaviour of banks and the resulting implications for the stability of the banking sector. The results suggest that changes in the loan interest rate can result in higher risk taking by borrowers, which destabilizes the sector. The author finds evidence that the enhanced price setting power can reverse the effect capital requirements have on stability in perfect competition. By changing the competitive environment in the banking sector, capital regulation can increase the riskiness of the sector, even if regulation would enhance stability under perfect competition.

2.8 Macro-prudential policies and risks

The eventful history of banking crises has shown, a run on a single bank can lead to a loss of depositors' confidence in the banking system as a whole, causing a generalized liquidity crisis and threatening to undermine the stability of the financial system as a whole. These crises have always been a major concern for authorities since they disrupt the banking system's ability to perform its functions, such as financial intermediation, the provision of payment systems, and acting as a conduit for monetary and interest rate policy. This led to a shift in focus of macro-prudential regulation. The first is mainly concerned with the solvency risk of single institutions, resulting from their individual exposure to underlying market risk, that is, systemic risk, whereas the contribution of institutions to systemic risk is the central concern for macro-prudential regulation.

Clearly, measures to address systemic risk are strongly needed. Systemic risk is defined by Caruana (2012) as "a risk of disruption to financial services that is caused by

impairment of all or parts of the financial system and has the potential to have serious negative consequences for the real economy". Viewing the banking system as a collection of interconnected balance sheets, systemic risk consists of three key elements. The first is an idiosyncratic shock that may affect the health of only a single financial institution. The second is the propagation or transmission mechanism through which a shock spreads from one financial institution to another. The third is the spill-over to the real economy, which provides the justification for policy intervention to prevent the financial system from collapsing. There are aspects of systemic risk, considered briefly in turn below, which may require policy intervention include panics, contagion, pro-cyclicality, and currency mismatch.

Panics

In the Diamond and Dybvig (1983) model, panics are self-fulfilling events, when all agents find it rational to withdraw their deposits. Banking crises in the US at the end of the nineteenth and beginning of the twentieth centuries appear to have been triggered primarily by panics, against a background of no evidence of downturns in macroeconomic fundamentals. This view influenced policy makers during the 2007-09 global financial crisis. In the case of Ireland in 2008, for example, the authorities tried to eliminate panics by issuing guarantees of banks' debt. Due to the huge cost of these guarantees, however, an International Monetary Fund and European Union bail-out was eventually required.

Contagion

Contagion describes the situation when financial distress experienced by one institution is transmitted to others through a loss of confidence. Interconnectedness and common

asset exposures increase the likelihood of contagion. For example, if a bank is unable to meet its liabilities to bondholders because its loans portfolio has been written down due to borrower defaults, other interconnected financial institutions holding the bank's debt as investments might also need to write down the value of their assets. As an example of interconnectedness, the failure of Lehman Brothers in September 2008 undermined confidence in the ability of the insurer AIG to meet its commitments to make payments under credit default swap agreements it had entered into, effectively insuring counterparties against default on the part of Lehman and others. This in turn raised concerns over the financial stability of the counterparties to these agreements. Common asset exposure arises when all financial institutions attempt to diversify their assets portfolios in a similar manner. Although diversification is privately beneficial, systemic risk increases if the portfolios become too similar.

Pro-cyclicality

Pro-cyclicality refers to the evolution and build-up of risk over time, as the dynamics of the financial system and the real economy reinforce each other. When the real economy is booming, credit expansion contributes to the inflation of asset price bubbles, and financial innovation leads to the creation of new financial instruments and the accumulation of risks that may be poorly understood, and consequently under-priced, by institutional and private investors alike. Encouraged by an abundance of credit, leverage increases throughout the financial system; while complacency over risk leads to the erosion of safety margins such as underwriting standards for lending, or haircuts in securities financing. Hidden and unforeseen risks emerge as strains develop during the run-up to the turning point of the cycle. During the downward phase of the cycle, the

value of bank assets may be reduced to the point where banks are unable to meet their liabilities. In such situations depositors may anticipate the financial difficulties of banks, and rush to withdraw their deposits. The bursting of an asset price bubble, which may have developed through excessive availability of credit, entails a reduction in the value of assets, such as mortgages, used to back securities held by financial institutions.

Currency mismatch

As we saw in Unit 7, one of the key features of the 1997 Asian Crisis was that banks and firms in South Korea, Thailand and several other Asian countries had taken out loans from international lenders that were denominated in foreign currencies, to finance assets that were denominated in local currency. A sharp devaluation of the local currency undermined the banks' solvency by reducing the value of the banks' assets relative to their liabilities. The central banks held insufficient foreign currency reserves to be able to intervene in the foreign exchange market to prevent the currency from falling.

In the case of a market-wide or systemic shock, central bank intervention might be required to meet the demands of the banking system as a whole for liquid reserves. In this case, an auction mechanism is commonly used to provide reserves on a multilateral basis; and the central bank's emergency response is essentially an extension of regular open market operations (Dobler et al., 2016). Government agencies other than the central bank could provide this systemic response: for example, the Troubled Assets Relief Program (TARP) introduced in October 2008 involved the purchase or guarantee by the US Treasury of $700 billion of troubled assets held by financial institutions.

Goodhart (1995) argues that the distinction between illiquid and insolvent borrowers is difficult to define in practice, especially since the decision to fund an illiquid bank is

usually taken within a short time-scale, making it difficult for the central bank to determine with certainty whether the bank is solvent or not. In a crisis, the mark-to-market value of tradeable assets may be highly volatile, making an accurate assessment of solvency difficult. The central bank may lack the information or expertise to evaluate non-tradeable assets such as loans, or collateral pledged in support of loans. A regulator may be reluctant to declare an institution insolvent for fear of damaging its own reputation. The threat of contagion may induce the central bank to err on the side of caution, by rescuing any bank regardless of its solvency.

Many economists have noted that by acting as the Lender of last resort (LOLR), the central bank can eliminate the 'bad' equilibrium in the Diamond and Dybvig (1983) model, preventing panics and the associated contagion. In fact, historical and empirical evidence suggests clearly that the LOLR has helped avoid bank runs in many cases. For instance, Miron (1986) finds that in the period 1915-1928, no financial panic occurred in the US. This is in contrast to the period prior to the formation of the Federal Reserve System, when the probability of a panic within any year was estimated to be 31.5%. According the Meltzer (1986), the US banking crises that followed the Wall Street stock market crash of 1929 arose because the Federal Reserve "did not follow Bagehotian principles".

There are, however, risks associated with the LOLR function. By supplying liquidity and reserves during a banking crisis, the central bank can be seen as protecting or preventing the elimination of weak banks. Moral hazard issues arise if banks believe they can undertake risky actions without fear of the consequences. There is no easy answer to this problem, which was clearly understood in the earliest debates on central banking and can be found in Bagehot's writings. The central bank tries to minimize moral hazard through

its continuous daily oversight of the activities of the banking system in normal times. It employs a considerable amount of moral suasion to direct banks away from risky actions. Some have suggested constructive ambiguity as a remedy for moral hazard. In contrast to the classical view that the LOLR function should be defined explicitly, advocates of constructive ambiguity propose that borrowing from the central bank should be viewed as a privilege, and not a right. It should be left up to the central bank to decide whether to act as LOLR, dependent on the circumstances. Constructive ambiguity may assist in imposing discipline in the market, because institutions are uncertain whether central bank assistance will be forthcoming if they mismanage their own risk.

Adherents to the classical view of LOLR argue that if the rules are not stated clearly, the value of the LOLR function is undermined, since depositors cannot feel confident that their deposits are safe. It has been suggested that LOLR support should be provided for financial stability purposes only, and therefore restricted to systemically important institutions. However, this approach would encourage large banks to take excessive risks, creating a wealth transfer effect from small to large banks deemed 'too-big-to-fail'. In any event, it may be difficult to determine which banks pose a systemic risk: during a period of financial duress, even the failure of a small bank may pose dangers for financial stability through contagion effects.

The global financial crisis prompted a re-evaluation of the LOLR function. As pointed out by Domansky and Sushko (2014) the effectiveness of LOLR activity was challenged during the acute stage of the crisis, as central banks improvised new ways to address liquidity outside the banking sector. The stigma associated with central bank lending hindered discount window borrowing, reducing the effectiveness of central banks in providing emergency liquidity.

Another critical issue was the duration of the emergency liquidity support during the crisis. Experience during the crisis was consistent with the view of Goodhart (1995) that it is difficult to distinguish between illiquid and insolvent institutions. Illiquidity tends to progress into insolvency the longer a crisis lasts; and it can be difficult to determine what is meant by 'temporary'. Different central banks address liquidity needs over various timescales, ranging from one week to a few months. However, the global financial crisis showed that liquidity problems in otherwise solvent banks can persist for months or years; and a prescribed time limit for support may tie the central bank's hands in an unhelpful manner. After the global financial crisis, quantitative easing policies in several jurisdictions pumped liquid funds into the financial system, reducing the need for banks to seek LOLR support.

Pricing of LOLR support also varies between central banks. Some apply a fixed spread over the central bank's overnight lending facility; others make the rate dependent on conditions. A balance needs to be struck between setting a rate that is sufficiently high to discourage use and minimise moral hazard, and setting a rate that is so high as to exacerbate the problems LOLR is seeking to address. Closer supervision after LOLR support is received may take the form of an agreed funding plan, comprising projections of the bank's assets and liabilities going forward, which provides a basis for regular review.

Central bank lending is normally with recourse, so that the liability remains with the borrower regardless of the performance of the collateral. An asset fire sale takes place when a bank is forced to sell its assets at reduced prices, in order to raise cash. In a crisis the principle of lending against good collateral may be difficult to apply: the distressed bank may have already liquidated its highest-quality assets, and those remaining may be

difficult to value against a background of market turbulence. Non-recourse lending limits the borrower's liability to the value of the asset pledged as collateral. In this case the lender assumes the credit risk. Non-recourse lending by the central bank may be helpful in relieving fire sale risk. Determining the appropriate haircut (difference between the market value of the collateral and the size of the loan) is crucial: if the haircut is too small, moral hazard is increased and the central bank bears an excessive cost; but if the haircut is too large, the central bank's intervention fails to alleviate the pressure on the bank (Dobler et al., 2016).

Provision by the regulatory authorities of deposit insurance forms an important part of the safety net structure. More broadly defined, deposit insurance may also refer to a wide range of interventions by the regulatory authorities to provide deposit guarantees, bail-outs or other forms of support for banks in financial distress. Such interventions are generally at the discretion of the regulatory authorities or the government, and not guaranteed in advance.

In several countries, including Australia, Austria, Denmark, Germany and Ireland, there is no limit on the sum insured. In other cases, only deposits up to a specified amount are covered. In the US, the FDIC insures checking (current) account deposits, savings account deposits, money market deposits and certificates of deposit. The standard sum insured is $250,000 per depositor per authorised institution, for each account ownership type. In the UK, the Financial Services Compensation Scheme, administered by the Prudential Regulatory Authority at the Bank of England, insures current and savings account deposits (including cash ISAs), and savings bonds, held in banks, building societies and credit unions. The standard sum insured is £85,000 per depositor per authorised institution.

In Diamond and Dybvig's (1983) theoretical model, deposit insurance eliminates the incentive for depositors to participate in a bank run, ruling out the occurrence of the 'bad' equilibrium, because they are aware their deposits are guaranteed. Furthermore, if a bank run never occurs, then the deposit insurance scheme never has to pay out. Therefore the provision of deposit insurance is cost-less. However, there are several reasons why this optimistic interpretation of the costs and effectiveness of deposit insurance might not materialize in reality: First, in the Diamond and Dybvig model the bank's assets are risk-free. This means the provision of deposit insurance does not affect the bank's incentives to accept risk. When risky investments are introduced, the banks' incentives and behaviour are subject to a moral hazard problem, influenced by the presence, and the terms and conditions, of the deposit insurance scheme. Second, in the Diamond and Dybvig model deposit insurance is effective in preventing bank runs caused by what is known as a coordination problem. Each depositor withdraws her deposits early because she is worried that other depositors may panic and withdraw their deposits early, in response to some random event which, in reality, does not impinge on the bank's solvency. By removing the incentive for any depositor to withdraw early, deposit insurance eliminates this coordination problem. However, if bank runs are linked to non-random events, such as a deterioration in economic conditions which does impact upon the solvency of banks, then the existence of deposit insurance may fail to eliminate the threat of bank runs. Finally, the Diamond and Dybvig model refers to a narrowly-defined deposit insurance scheme, which provides an explicit commitment to reimbursement of depositors. For broadly-defined deposit insurance involving intervention at the discretion of the regulatory authorities to support or bail out distressed banks, the moral hazard

issues become more complex, and the effectiveness of discretionary intervention in preventing runs on banks is uncertain.

The protracted US savings and loan (S&L) crisis of the 1980s and 1990s is often cited as a case study in moral hazard issues in banking created by deposit insurance. Constituted similarly to UK building societies, S&Ls typically held large portfolios of mortgage loans. When interest rates increased sharply in the late-1970s and early-1980s, and the S&Ls were forced to increase their deposit rates accordingly, they were exposed to heavy losses, because many of their mortgages had been granted on fixed-interest terms. It has been argued that the extension of deposit insurance coverage, administered at the time by the Federal Savings and Loan Insurance Corporation (FSLIC), was a significant cause of the adoption by many S&Ls of a highly risky balance sheet structure, characterized by maturity mismatch. Many S&Ls became technically insolvent, but rather than enforce immediate closure FSLIC often allowed them to continue to operate, in the hope that they could recover. In 1989 responsibility for deposit insurance was transferred from the FSLIC, which had become insolvent, to the FDIC. Between 1986 and 1995 more than 1,000 S&Ls, around one-third of the total, were closed or subject to other forms of resolution.

The global financial crisis of 2007-09 also contains lessons concerning the effectiveness (or lack of effectiveness) of deposit insurance in preventing banking or financial crises. In a crisis arising not from a coordination failure in the sense of Diamond and Dybvig, but from a fundamental deterioration in economic conditions, governments may be need to do much more than promised under narrowly-defined deposit insurance to restore financial stability. The bursting of the US real estate bubble in 2006, the subsequent spike in subprime and other mortgage delinquencies, and the catastrophic effect on the

valuation of asset-backed and other structured securities held in institutional investors' portfolios, are widely viewed as root causes of the 2007-09 crisis.

Allen et al. (2011) argue that this extension of support beyond the explicit commitments of the deposit insurance schemes in existence before the crisis runs the risk of exacerbating the moral hazard problem, if it is anticipated by financial institutions that additional support will always be forthcoming. In order to avoid the temptation to extend the scope of coverage after a crisis has broken, supervision should be strengthened, and a commitment that banks that become insolvent will be permitted to fail should be issued. The willingness of the regulatory authorities to permit failure can be signalled by the development of procedures for the orderly resolution of failing institutions. Deposit insurance coverage should be limited, to ensure that the bank's depositors bear some of the risk emanating from the assets side of the bank's balance sheet. In this respect, a balance must be struck between providing sufficient coverage to maintain depositor confidence, and ensuring that coverage is not so high that depositors lose interest in overseeing the prudent management of the bank.

An essential aspect of the bank's role as a financial intermediary is that its assets are risky. If the bank incurs losses on its assets (as happened, for example, when subprime mortgage delinquencies caused the value of mortgage-backed securities to plunge during the 2007-09 global financial crisis), these losses must be absorbed by the bank's owners. If the equity capital is insufficient to absorb the losses, the bank becomes insolvent, and collapses. Capital adequacy requirements are designed to ensure that the amount of equity capital is sufficient to absorb any losses that might realistically be expected to occur, and protect against bankruptcy.

During the 1980s, bank supervisors around the world adopted risk-adjusted capital adequacy requirements for banks. At the same time, on the assets side of the balance sheet, regulatory reserve requirements in the form of cash or other liquid assets, were either reduced or abolished in many cases. Risk-adjusted capital adequacy requirements stipulate minimum levels of capital a bank must maintain at all times, to ensure that is has sufficient capability to withstand losses on its lending or its investments. Risk-adjusted capital requirements make the required level of capital dependent on the riskiness of the bank's assets portfolio. If a bank holds a large proportion of its assets in low-risk forms, its risk-adjusted capital adequacy requirement is low; but if it holds a large proportion in high-risk assets, its risk-adjusted capital adequacy requirement is high.

In June 1988, officials from the industrialized nations reached an agreement, known as the 'Basel (or Capital) Accord', to standardize bank capital adequacy requirements across countries. The main objective of the Basel Accord was to promote global financial stability by co-ordinating supervisory definitions of capital and risk assessments. Co-ordination at the international level has become increasingly important in a world of highly integrated financial markets where a loss of confidence in the banking system in one country may easily spread to others.

Under Basel I, banks must satisfy two types capital requirement based on two definitions of equity capital. Tier 1 capital comprises common equity Tier 1 capital (CET1) and additional Tier 1 capital (AT1). CET1 comprises ordinary shares, retained earnings, and a few other items. AT1 comprises securities with equity-like characteristics that have been issued by the bank, such as convertible bonds, which convert into equity if CET1 falls below a critical threshold. Tier 2 capital comprises loan loss reserves, and subordinated debt that is paid off only after depositors and creditors have been paid. Under Basel 1, the

bank must hold CET1 capital of at least 4% of risk-adjusted assets, and total capital (Tier 1 capital plus Tier 2 capital) of at least 8% of risk-adjusted assets. For a bank to be classified as well capitalized, it must meet the more stringent thresholds of 6% of risk-weighted assets for CET1 capital, and 10% of risk-weighted assets for Tier 1 and Tier 2 capital combined.

Subsequently, in view of the importance of off-balance-sheet business, and the high level of risk associated with these activities, off-balance-sheet commitments such as interest rate swaps and trading positions in futures and options were incorporated into the calculations of risk-weighted assets. Similar principles apply: different risk-weights are assigned to different categories of off-balance-sheet activity.

While considered an important step towards improving transparency, the Basel Accord was criticized on a number of counts (Tirole, 1994). Basel I does not adequately capture portfolio risk, which depends on the correlations between the returns on the assets comprising the bank's portfolio. The calculation of equity capital is based on historical cost and not market value accounting. Reliance on balance sheet measures that are updated annually in most countries renders the computation of capital slow to adjust to new information. Finally, Basel I focuses on solvency, and ignores liquidity. Insolvency, typically, creates liquidity problems; but a shortage of liquidity does not necessarily imply insolvency.

The Basel Committee subsequently produced a revised framework for capital requirements, commonly referred to as Basel II, which came into effect on 1 January 2007 in G10 countries and in all EU member states. Basel II is multifaceted, and based on three main pillars. Pillar 1 sets minimum capital requirements to cover credit risk, market risk

on the bank's trading book, and operational risk. Under Pillar 1, banks may choose between three approaches to dealing with credit risk, depending on the bank's level of sophistication. The simplest level, the standardized approach, is an extension of Basel I risk-weightings, with a larger number of risk categories. Credit risk assessments by external rating agencies may be used to inform risk weightings. The next level is the 'Internal Rating-Based (IRB) Approach'. With the permission of regulatory authorities, banks with the capability for more sophisticated risk modelling can apply their own internal estimates. The IRB approach is based on four key parameters:

- The probability of default over a one-year horizon.
- The loss given default as a percentage of exposure to default.
- Exposure at default (absolute amount).
- Maturity.

The third level is the securitization framework, in which banks should hold regulatory capital to cover their positions in securitized assets. The risk-weightings may be based on either the standardized approach or the IRB approach.

Pillar 2 of Basel II enables supervisors to adjust the capital buffer to reflect additional risks not taken into account by Pillar 1, as well as factors that are external to a bank, such as business cycle fluctuations. Pillar 3 requires banks to disclose information regarding risk exposures, capital adequacy and other material details, in a timely fashion. Greater transparency should strengthen market discipline and act as a constraint on risk-taking behaviour. Forward-looking market information embodied in banks' share and bond prices and ratings should be taken into account by supervisors, and provide advance warnings of the need for intervention.

Criticism of Basel II focused on the macroeconomic side-effects, and issues of competition, fairness and regulatory capture (Lind, 2005). The issue of pro-cyclicality was widely debated, reflecting the concern that Basel II may have tended to amplify the business cycle. In boom conditions, risk is widely believed to be low, and bank lending increases. Some of the additional lending turns out to be of poor quality, and insufficient capital is accumulated. During a recession, conversely, loan delinquencies deplete capital, while a mood of pessimism suggests that the accumulation of capital should be prioritized over new lending, leading to credit rationing.

Concerns were raised that heavy capital requirements in Basel II may make banks reluctant to lend to small and medium-sized enterprises (SMEs). The Basel Committee acknowledged that the risk from lending to SMEs may be lower in practice than is indicated by share capital and tangible assets. Owner-managers, for example, may be prepared to commit additional personal funds to stave off bankruptcy if required. Lending to many SMEs may help a bank to maintain a more diversified loans portfolio. These and other considerations encouraged the Basel Committee to reduce the risk weightings and capital requirements on loans to SMEs under certain conditions.

Basel II may have favoured large banks, which have discretion to use their own risk modelling tools and risk management systems to influence their own capital requirements. The fixed costs involved in setting up advanced risk management systems are high, while the operational costs are limited. Once a bank had invested in a sophisticated system, it could make substantial savings in the costs of holding capital. However, the global financial crisis of 2007-09 fatally undermined confidence in the banks' internal models for risk measurement and in the credit-rating agencies' ratings,

and raised doubts about the effectiveness of market discipline as a constraint on risk-taking.

There was concern that once a supervisory authority has endorsed a specific risk management system, the authority will be less inclined to express criticism of the system, since this would imply retraction of its earlier approval. In other words, Basel II was subject to a risk of regulatory capture. It was also suggested that too much supervisory harmonization in the implementation of Basel II, or voluntary harmonization by the banks themselves, might lead to excessively similar risk management systems. Herding behaviour by banks might reinforce cyclical swings and increase the risk of systemic disturbances, especially if excessively standardized risk management systems provide what turn out to be inaccurate assessments of risk (Lind, 2005).

Arrangements for the capital regulation of banks after the global financial crisis, known as Basel III, modify and extend the three-pillar approach to capital regulation. Greater emphasis is placed on common equity (CET1) capital as the main loss-absorber; and substantial efforts have been made to strengthen the capitalization of banks across the board, in recognition of the shortcomings that were starkly exposed by the global financial crisis. New capital and liquidity standards phased in between 2013 and 2019 required banks to achieve a minimum ratio of CET1 capital to risk-weighted assets of 4.5% by 2015. An additional capital conservation buffer of 2.5% of risk-weighted assets, intended to strengthen loss-absorbing capacity, bringing the overall CET1 capital ratio to 7% of risk-weighted assets by 2019. National regulators are permitted to impose a discretionary countercyclical capital buffer of up to 2.5% of risk-weighted assets. Banks identified as Global Systemically Important Banks (G-SIB) must hold additional capital in the range 1% to 2.5%. G-SIBs are large, interconnected and complex banks whose failure would

pose systemic risk. At the time of writing in 2018, 30 banks were identified as G-SIBs. Basel III also introduced a new Leverage Ratio, requiring banks to maintain a minimum 3% ratio of Tier 1 Capital to total assets (not risk-weighted assets).

In recognition of the impact of liquidity shortages in fuelling the global financial crisis, and the protracted duration of liquidity difficulties for some institutions, banks must be able to demonstrate that they hold sufficient liquid assets to survive a 30-day stress test. The Liquidity Coverage Ratio (LCR), which is the ratio of High-Quality Liquid Assets to Total Net Liquidity Outflows over 30 days, should achieve 100% by 2019. Banks must also be able to demonstrate that they are not excessively reliant on short-term wholesale funding, with reference to a Net Stable Funding Ratio (NSFR).

Basel capital adequacy regulation constitutes a relatively intrusive regulatory regime for banks, in comparison with firms in most other industries. Critics of this regime have argued that capital regulation is only necessary because of the moral hazard problems created by the 'safety net', especially the availability of central bank LOLR support for stressed banks, and deposit insurance. As we argued above, deposit insurance may encourage excessive risk-taking by banks; and similar arguments can be applied to LOLR. According to this critique, capital regulation is only needed to mitigate excessive risk-taking tendencies on the part of banks that are caused by these other features of the regulatory regime. By contrast, the safety net encourages banks to increase leverage and lower capitalization in pursuit of higher shareholder returns, secure in the knowledge that the deposit insurance fund or central bank will provide a bail-out in the event that the downside risks materialize.

2.8 Conclusion

A major factor that affects the way in which financial markets operate is the degree of competition. An increase in competition has been considered the driving force behind the acceleration in consolidation, raising concerns about increased concentration in the banking sector. Furthermore, the global financial crisis of 2007-2009 brought to the fore the debate about the relative importance of bank size, competition, bank regulation and the bank lending channel for monetary policy transmission. In this chapter, we carefully review the theoretical arguments and the empirical evidence of six interrelated aspects of the impact of competition on the banking system, namely the relationship between competition and the transmission of monetary policy changes via the bank lending channel, the impact of competition on efficiency, access to finance, stability, risk-taking and regulation. Overall, the theoretical aspects of the existing approaches to the measurement of competition have been studied extensively. Despite a growing number of researches, the literature is still rather limited and inconclusive on many aspects.

According to the existing literature on the measurement and stylized facts of bank competition, structural approaches seem not consistent due several deficiencies arising from the structural approach, developments in industrial organization, as well as the recognition of the need to endogenise the market structure. Consequently the recent literature has concentrating on the New Empirical Industrial Organization (NEIO) models, mainly the conjectural variations approach and the P-R approach. Initially, P-R model built up a testable implication of monopolistic profit maximizations which then extended to other market equilibrium. They present a reduced form approach using industry or bank-level data to discriminate between perfect competition, monopolistic

competition, and monopoly. The empirical outcome is more or less similar in all studies indicating a relatively high degree of competition in the banking industry.

In addition, the existing literature on the relationship between competition and the transmission of monetary policy changes via the bank lending channel are largely related. For instance, it is found that increased competition weakens the transmission of monetary policy changes through the bank lending channel if it is associated with a reduction in the informational asymmetries between banks regarding their borrowers' creditworthiness. These informational frictions, and the fact that incumbent banks accumulate proprietary information about their customers, make it costly for borrowers to switch from the incumbent bank (from which they have been borrowing for a period of time) to a new rival bank. These switching costs create a customer ''lock-in" or ''hold-up" effect (Olivero, Li and Jeon, 2011b). The empirical literature, however, found variations in the monetary policy transmission mechanism due to banking concentration or competition have implications for loan-dependent borrowers and for a monetary authority's ability to stabilize the real economy.

The theoretical literature provides conflicting evidence with respect to the sign and direction of causality between competition and efficiency. However, the empirical literature predominantly indicates a negative relationship (Pruteanu-Podpiera, Schobert, and Weill, 2007; Casu and Girardone, 2009; Schaeck et al., 2010; Weill et al., 2012).

Both theoretical and empirical research show mixed results for how competition between banks may positively or negatively impact on firms' access to financing. The traditional MP hypothesis argues that that competition in the banking market reduces the cost of finance and increases the availability of credit. Taking into account the borrower-lending

relationship and banks' information production, Petersen and Rajan, (1995) suggests that, in the presence of information asymmetries and agency costs, competition can reduce access to credit by making it more difficult for banks to forgo any interest rate premiums they might otherwise have to charge when lending to small and risky distressed firms.

The issue of competition and its effect on financial stability are inextricably intertwined; three main views on the causal relation between competition and stability in banking. The first is the competition-fragility /concentration-stability view, which states that competitive banking systems are less stable and more fragile because competition reduces profits and erodes the franchise value of banks, consequently increasing incentives for excessive risk taking (Chan, Greenbaum and Thakor, 1986; Keeley, 1990). The second perspective is the competition-stability/concentration-fragility view, which argues that, as the banking system becomes more competitive, it is less prone to risk of bank failures, which in turn enhances stability. The third view highlights the fact that the relationship between market structure and stability is complex and involves important interactions with the macroeconomic, regulatory and institutional frameworks of countries.

Furthermore, whether the increase of competition would incentivise banks' risk taking depends on the change in banks' informational rents in an increasingly competitive environment. In other words, changes in informational rents in an increasingly competitive environment may drive excessive risk taking. Besanko and Thakor (1993) state that increased competition is associated with a decrease in informational rents obtained from relationship lending, which, in turn, increases risk taking. In the context of asymmetric information, Marquez (2002) shows that an increase in the number of banks in a market disperses borrower-specific information and results in both higher funding

costs and greater access to credit for low-quality borrowers. Although theoretical literature concentrates on the adverse selection and moral hazard problem that banks face with borrowers. An increase in the number of banks increases the imperfection of information-gathering and processing techniques. As a consequence, increased competition may have an adverse impact on bank solvency as well as inducing banks to take excessive risks.

Finally, the role of market regulations is considered as a determinant in shaping competition due to the complexities and unique position that banks play in the economy (Allen and Gale, 2004; Moyo et al., 2014). According to Keeley (1990) reports that increased competition after deregulation in the US banking system in the 1980s causes a decline in franchise values and increased default and asset risks. He provides evidence that the solvency ratio has a positive relationship with MP, indicating that more competitive banking systems are associated with reduced capital cushions and higher bank fragility. Hellmann, Murdock and Stiglitz (2000) find that higher capital requirements reduce the incentives for banks to increase asset risk.

CHAPTER THREE

CROSS-STATE COMPARISONS OF COMPETITION AND PRICING POWER IN U.S. BANKING

3.1 Introduction

An increasing number of studies of competition in banking have measured competitive behaviour within one country (Nathan and Neave, 1989; Vesala, 1995; Molyneux et al., 1996; Rime, 1999; Maudos and Pérez, 2003; Belaisch, 2003; Coccorese, 2004 and 2009; Matthews et al., 2007; Lopez and Di Colli, 2010; Fungacova et al., 2011; Koetter, et al., 2012). Research has also been conducted across a number of countries (Molyneux et al., 1994; De Bandt and Davis, 2000; Bikker and Groeneveld, 2000; Koutsomanoli-Fillipaki et al., 2006; Bikker et al., 2010), Studies have used either one indicator (Yildirim and Mohanty, 2010; Coccorese, 2009)or a number of metrics (Bikker and Haaf, 2002; Claessens and Laeven, 2004; Casu and Girardone, 2006; Schaeck et al., 2009; Goddard and Wilson, 2009; Carbó et al., 2009; Liu et al., 2013).

The issue related to measuring bank competitive behaviour is relevant for policy making since U.S. banking industry has become more concentrated in recent years. The number of commercial banks in the U.S. declined from 14,417 in 1985 to 6,529 in 2010, a 55% reduction. The market share of the largest 10 banks in the U.S. has increased to more than40% in recent years.

As the banking industry has become more concentrated – and since the relationship between concentration and MP remains unsettled – it is important that policy makers apply the relevant metrics to be able to determine accurately the overall state of U.S. banking competition and the effects of deregulation (branching). They also need to be able to evaluate the impact of events that affect market structure, such as mergers, acquisitions and failures, as well as shocks, such as financial crises.

The literature on competition in banking may be categorised according to two major perspectives: structural and non-structural approaches. The structural approach to the measurement of competition is based on the SCP paradigm (see 2.3) and the ES hypothesis (see 2.5.1), as well as a number of formal approaches which originate from IO theory (Bikker and Haaf, 2002b; see 2.3). The SCP paradigm and ES hypothesis investigate, respectively, whether a highly concentrated market causes collusive behaviour among the larger banks resulting in superior market performance or, conversely, whether it is the efficiency of larger banks that enhances their performance. However, because of the theoretical and empirical deficiencies of the structural models (Bikker and Haaf, 2002b), non-structural models for the measurement of competition and MP were developed. With roots in NEIO theories, this stream of approaches includes the Bresnahan (1982: see 2.4.1) model and the P-R model (Panzar and Rosse, 1987; see 2.4.2). They test competitive conduct and the use of MP, and stress the analysis of banks' competitive conduct in the absence of structural measures.

As discussed above (see 2.3), early studies of market structure in banking were based on the SCP paradigm. Typically, these studies assumed market structure to be exogenous and regressed profitability on the concentration ratio and a number of control variables. Results, which showed a positive relationship between profitability and the concentration

ratio, were interpreted as evidence that banks in concentrated markets exercise MP. In contrast to the SCP paradigm, the ESH suggests that large banks tend to outperform small banks in terms of profitability because they are often more efficient. However, the available evidence does not resolve the debate, because neither SCP nor ESH variables are of great importance in explaining bank profitability (Berger, 1995; Berger and Humphrey, 1997). Moreover, both approaches focus on profitability, rather than the deviation of output price from marginal cost, which is a more reliable theoretical basis for analysing competitive conditions (Paul, 1999).

As discussed above (see 2.3), the shortcomings of the SCP and ESH approaches are addressed by the NEIO approaches, which assess the strength of MP by examining deviations between observed and marginal cost pricing, without explicitly using any market structure indicator. The R-P (1977) reduced-form Revenue model and the Bresnahan (1982) and Lau (1982) mark-up model are the two most popular approaches in this strand of literature. Both are derived from profit-maximizing equilibrium assumptions. The R-P approach works well with firm-specific data on revenues and factor prices, and does not require information about equilibrium output prices and quantities for the firm and/or industry. In addition, the approach is robust for small samples.

In this paper, we examine whether different metrics of competition and MP produce similar results. We first compare results from non-structural indicators of competition using U.S. state banking data over the period 1990-2010. The analysis is particularly concerned with applying the metrics from the literature, which contends that indicators of the mark-up of price (average revenue) over marginal costs (giving an LI) and the degree to which input price changes are reflected in average revenues (the H-statistic) provide ‘‘realized’’ measures of the degree of competition. These indicators are estimated

at the bank level in U.S. banking and are compared with a standard market structure measure of concentration (HHI) and other bank performance indicators (net interest margin and return on assets) that are often used to gauge the competitive features of the industry.

Second, we attempt to identify a number of bank-specific and state-specific factors that explain non-structural measures of U.S. interstate banking competition. An empirical approach is adopted similar to that of Demirguç-Kunt et al. (2004),Claessens and Laeven (2004), and Carbo et al. (2009) to examine the effects these characteristics have on competition measures for U.S. banking.

3.2 Literature review

The theoretical literature on the measurement of competition demonstrates that its level is not directly observable due to the specific costs of banking products and the possible reactions of banks to competitors' actions. There are, therefore, many different approaches to estimating levels of competition. Since the early 2000s, researchers have recognized the non-structural approaches proposed by Panzar and Rosse (1977, 1987). As outlined above (Ch. 2.4.2), P-R methodology uses firm/bank-level data and investigates the extent to which changes in factor input prices are reflected in equilibrium industry or bank-specific revenues.

The P-R (1987) method has been used to examine competitive conditions or exercises of monopoly power in the banking industry around the world. For instance, competitive conditions in individual countries have been studied by Vesala (1995) for Finland; Coccorese (2005), Hon-droyiannis and Papapetrou (1999), and Delis et al. (2008) for Greece; Rime (1999) for Switzerland; Hempell (2002) for Germany; Coccorese

(2004,2009), Gutiérrez (2008), and Lopez and Di Colli (2010) for Italy; Maudos and Pérez (2003), Carbó et al. (2003) and Delis et al. (2008) for Spain; and Matthews et al. (2007) for Britain. All find evidence that European countries' banking industries are characterised by monopolistic competition. However, all of these papers produce mixed evidence as to how the degree of competition varies over time.

Using the P-R approach, a cross-country analysis for various European banking markets was conducted by Molyneux et al. (1994) between 1986 and 1989. On average, their results suggest monopolistic competition in Germany, France, Spain and the UK, and monopoly in Italy, similar to the findings reported by Staikouras et al. (2006). With the same approach, Bikker and Groeneveld (2000) and Staikouras et al. (2006) obtain results consistent with monopolistic competition for the European banking market as a whole. In spite of the deregulation and liberalisation of the EU banking industry over the observation period (1989-1996), Bikker and Groeneveld (2000) find hardly any evidence of increasing competition over the years.

DeBandt and Davis (2000) assess the effect of European Monetary Union (EMU) on market conditions for banks based in countries which adopted the Single Currency over the period 1992-96, and compare the behaviour of large and small EMU banks with a U.S. sample. They find that the behaviour of large EMU banks is not fully competitive compared to the U.S., while the level of competition appears to be even lower for small institutions, especially in France and Germany. However, due to the short sample period, as well as substantial year-to-year variations in the results, it is not possible to draw clear conclusions regarding competition trends. A recent paper by Bikker and Spierdijk (2008) provides a cross-country analysis of changes in banking competition during the period 1986-2004. They show that there was a significant decline in competition towards the end

of the period in several Western countries (in particular, in Euro-zone countries in 2001-2002). They also find that the banking industry in emerging markets became more competitive during the last decade of the period.

At the state level in the U.S. banking system, Yildirim and Mohanty (2010) report that commercial banks in general operated under monopolistic competition during the period 1976-2005, but this finding does not hold for every state when different time periods are investigated. The authors also analyse the sample according to bank size and find that market competition for large banks in Delaware, Oregon, and Rhode Island can be characterized as monopolistic, while small banks in Arizona and Massachusetts seem to operate under conditions of perfect competition. Their results also suggest that the U.S. banking industry might have experienced less competitive behaviour in recent years due to the increased MP of larger banks. They find a certain level of decline in the competition index following interstate branching deregulation. This fall in competition seems to have been caused by changes in the competitive conduct of large banks only, as the test statistic remains almost the same for small banks during both periods.

Following a similar approach, Claessens and Laeven (2004) estimate the extent to which changes in input prices are reflected in revenues earned by banks in 50 countries' banking industries. The H-statistic generally varies between 0.60 and0.80, suggesting that monopolistic competition is the best description of the degree of competition. The authors then relate this competitiveness measure to indicators of country-level industry structure and regulatory regimes. Industries with more foreign bank entry, and fewer entry and activity restrictions are more competitive. There is no evidence that the intensity of competition is inversely related to industry concentration, measured by concentration ratios and the HHI. The results suggest that contestability determines effective

competition, especially through foreign bank entry and reduction in restrictions on bank activities

Carbò et al. (2009) demonstrates that for a cross-section of 15 European countries, over the period 1995-2001, comparison of five well-known indicators of banking market competition often given conflicting assessments of the level of competition, both across countries and over time. These five measures, namely: net interest margin, LI, ROA, H-statistic, and HHI, are all positively related across the 15 countries for a panel of 5,261 observations (around 750 banks).When the sample size was reduced from 5261 to 2,584 (around 370 banks), due to data limitations associated with implementing further statistical analysis, negative relationships among these measures were evident. In particular, when the mark-up of price over marginal cost was relatively high, according to the LI, indicating weak competition, the other indicators were generally lower, indicating more intense competition. Accordingly, Carbò et al. (2005) suggest that these indicators may be unreliable when making cross-country comparisons of competition in Europe.

Most of the studies reviewed above have used different measures of bank revenue and different control variables in the estimation of the P-R statistic. Studies from the early 1990s generally proxy bank revenue as interest received. More recent studies use a price function instead of a revenue equation, in which the dependent variable is total revenue divided by TA. Total revenue is used due to the increasing importance of commission, trading, and fee income. Vesala (1995) and Gischer and Stiele (2009) assert that the revenue and price equations will give different estimates of the H-statistic.

Challenges to the methodological approaches used to estimate the P-R H statistic are presented by Goddard and Wilson (2009) and Bikker et al (2010). Goddard and Wilson

(2009) investigate the implications for the estimation of the H-statistic of a form of misspecification bias in the revenue equation. They demonstrate in a Monte Carlo simulation exercise that a fixed effect estimation, using a static revenue equation, produces an H-statistic which is biased towards zero. This bias has serious implications for the researcher's ability to distinguish accurately between monopoly, monopolistic competition and perfect competition. Goddard and Wilson (2009) use the dynamic panel regression technique of Arellano and Bond with multiple instruments. In fact, a crucial assumption of the P-R approach is that accurate estimation of the H-statistic is based on the assumption that markets are in long-term equilibrium at each point in time. Their empirical results for the FE and generalised moment's method (GMM) estimators of the H-statistic for 25 countries' banking industries are consistent with the main conclusions of the preceding simulation exercise, namely that the FE estimator of the H-statistic is substantially biased towards zero. The empirical evidence supporting the partial adjustment model is stronger for a group of developed countries than for a group of developing countries and transition economies.

A number of recent studies have used estimation of the LI to try to determine the trends in competitive behaviour over time. Some of the most important studies in this area are Shaffer (1993) for Canadian banks and Angelini and Cetorelli (2003) for Italian banks. Angelini and Cetorelli (2003) show that financial deregulation fosters a reduction in price-cost margins. A more recent paper by Fungacova et al. (2011) analyses competition in the Russian banking industry using the LI and finds a high degree of MP.

Fernández de Guevara et al. (2005) estimate LIs for the five most important banking industries of the European Union (Germany, France, Italy, U.K., and Spain) during the

period 1993-1999. Despite the process of deregulation and the increasing integration of European markets, no reduction in the MP of the banks is observed.

Two key assumptions underlie the emphasis that competition can increase in traditional markets for banking services. First, the LI may fall for deposits and/or loans, while, at the same time, a more aggregate indicator of overall competition, ROA, may rise as income from off-balance-sheet activities expands (Carbò et al., 2009). Second, banks may achieve increased efficiency due to cost savings arising from the shift to electronic payments and substitution of ATMs for expensive branch offices (Carbó, Humphrey and Lopez del Paso, 2004; Humphrey et al., 2004; Carbò et al., 2009). Koetter and Poghosyan (2009) investigate different technology features of German banks over the period 1994-2004 and find that greater MP increases bank profitability but also fosters risk (higher corporate defaults).

Fernandez de Guevara and Maudos (2007) examine MP in Spanish banks using LI estimations and find an increase in MP from the mid-1990s to 2002. They conclude that, as marginal costs are driven down faster than prices, the LI measure of MP increases, largely due to efficiency and specialisation. However, bank concentration was found to be insignificant, supporting the findings reported by Berger et al., 2004; Claessen and Laeven, 2004; Fernández de Guevera et al., 2005[a].

Koetter et al. (2012) develop an adjusted version of the Lerner index, which corrects for biases that affect the original Lerner index when either profit inefficiencies or cost inefficiencies, or both, are present. In this case the measurement of price and/or marginal cost for the purposes of calculating the Lerner index is distorted. The (unadjusted) Lerner index may incorrectly attribute part of the divergence between measured price and

measured marginal cost to market power, rather than to profit or cost inefficiency. Koetter et al.'s adjusted Lerner index is as follows:

$$\text{LERNER-ADJUST} = \frac{\pi + TC - MC \times Q}{\pi + TC}$$

where π = predicted profit, TC = predicted total operating cost, MC = marginal cost, Q = output (loans + securities). Predicted profit, predicted total operating cost, and marginal cost, are obtained from the estimated profit and cost functions.

Both the SCP and the NEIO approaches to measuring competition in the banking industry are based on static models of competitive equilibrium. In contrast, empirical research concerning the dynamics of profitability recognises the possibility that the markets are out of equilibrium at the time when data are observed. The persistence of profit (POP) hypothesis developed by Mueller(1977,1986) states that entry and exit are sufficiently free to eliminate any abnormal profits quickly, and that all firms' profit rates tend to converge towards the same long-term average value. The alternative view is that some incumbent firms possess the capacity to prevent imitation or block entry. If so, abnormal profit trends may persist from year to year, and differences in the firm-level long-term average profits rate may be sustained indefinitely (Liu et al., 2013). Berger et al. (2000a) and Goddard et al. (2004) find evidence that there is significant year-to-year persistence in the profitability of U.S. and European banks, respectively. Carbo and Fernandez (2007) also find weak evidence of persistence in bank spreads in Europe.

Goddard et al (2011) find evidence that POP is weaker for banks in developing countries than for those in developed countries, suggesting that competition is less intense in the latter. POP is also negatively related to the rate of growth in GDP per capita, and positively related to the size of entry barriers, which means that it is stronger when entry

barriers are high (Goddard et al., 2010[b]). Liu et al. (2013) find statistical links between profit persistence and LLP, suggesting that less competition is linked to greater risk, supporting the competition- stability view. Persistence or autocorrelation in the profitability and revenue data appears to be an overlooked empirical regularity in the specification of empirical models widely used in the NEIO competition literature.

3.3 Data and Methodology

3.3.1 Data

The dataset used in this paper is obtained from the Reports of Income and Condition (Call Reports), covering the period from 1987 to 2010. All commercial banking institutions regulated by the Federal Deposit Insurance Corporation, the Federal Reserve, or the Office of the Comptroller of the Currency must file these reports on a regular basis. They include complete balance sheet and income statement data, as well as data on off-balance sheet activities for each bank. We collect annual data on insured commercial banks in the 50 states of the U.S. and the District of Columbia over the same period, 1987-2010; that is, we use the fourth quarter reports and exclude observations that have missing data. We examine all banks to include the impact of entry and exit on market structure, and also focus on the performance of a core of healthy, surviving institutions during the sample period.

There were 10,617 banks in the U.S. banking industry in 1987, but this number declined to 5,146in 2010 due to industry consolidation. After deleting observations whose input prices are negative or zero, we obtained a balanced panel of 189,552 observations for the whole period, as shown in Table 3.1.Banks in the states of Alaska, Delaware, Hawaii, Idaho, Maine, Nevada, New Hampshire, Vermont and Rhode Island, and District of

Columbia, are excluded from our analysis due to the unavailability of data. A summary of the selected sample is specified in Table 3.1.

Table 3.2 shows the descriptive statistics for the output and input price variables employed in Equation (3.1and 3.4).

3.3.2 Methodological approach

This paper follows the methodologies used by Bikker and Bos (2004), Carbo et al. (2009), and Liu, Molyneux and Wilson (2013). We first estimate the degree of competition in the U.S. banking industry using three indicators that have been widely used to infer the competitive behaviour of commercial banks: the P-R H-statistic and LI.

3.3.2.1 (P-R) H-statistic

Following Bikker and Haaf (2002a), Bikker et al. (2009), and Goddard and Wilson (2009), we adopt the P-R approach to measure the degree of competition in U.S. regional banking markets. With this methodology, the H-statistic (see Ch. 2.4.2) is calculated by applying a regression estimation of Equation 3.1,using bank-level panel data for each state.

$$\ln(RE_{it}) = \alpha + \beta_1 \ln(W_{1,it}) + \beta_2 \ln(W_{2,it}) + \beta_3 \ln(W_{3,it}) + \beta_4 \ln(Y_{1,it}) + \beta_5 (Y_{2,it}) + \beta_6 (Y_{3,it}) + \varepsilon_{it} \quad [3.1]$$

In this equation, (RE_{it}) is financial income as a measure of the revenue for bank i in year t; $W_{1,it}$ is the input price of labour defined as salaries and benefits /TA; $W_{2,it}$ is the cost

of capital defined as non-interest expenses minus salaries and benefits /premises and fixed assets; $W_{3,it}$ is the cost of physical capital defined as non-interest expenses/salaries and benefits. A number of control variables are also included at the individual bank level to take account of bank-specific features (size, risk, and deposit mix differences), similar to those used in Claessens and Laeven (2004) and other previous studies. These factors are: $Y_{1,it}$ is the equity/TA; $Y_{2,it}$ is the net loans/TA and $Y_{3,it}$ is the logarithm of TA (to control for potential size effects). For these factors, i denotes bank i:t denotes year *t.*

In the above equation, the P-RH-statistic is given by the sum of the elasticities of revenue with respect to input prices: $H=\beta_1+\beta_2+\beta_3$. Under monopoly, P-RH< 0; under perfect competition, P-RH = 1; and under monopolistic competition, 0 < P-RH < 1. As in Vesala (1995) and Bikker and Haaf (2002a), we interpret estimates of the H-statistic as providing a continuous measure of the level of competition, with larger positive values indicating stronger competition.

The nature of estimation of the P-R H-statistic means that we are specifically interested in understanding how total revenues respond to variations in cost figures. In this study, we use the log of interest revenues (operating income) as dependent variables in which the dependent variable is only the interest part of total revenue. This is consistent with the view that financial intermediation constitutes the core business of most banks, and is in line with other studies, such as Shaffer (1982), Nathan and Neave (1989), Vesala (1995), Coccorese (1998), and De Band and Davis (2000).

The estimation of the P-R H-statistic using a static revenue equation such as Equation 3.1, has been criticized in the recent literature. First, this type of equation assumes that market participants are price-takers in the input market. It also assumes that reduced-form revenues are not affected by shifts in the market demand curve in conditions of long-term

competitive equilibrium. Goddard and Wilson (2009) suggest applying a dynamic panel estimator to a dynamic model of the revenue equation. This would allow for a partial adjustment towards the long-term equilibrium, with this adjustment being captured by the inclusion of a lagged dependent variable in the revenue equation. Following their suggestion, we apply Arellano and Bond's (1991) GMM to our panel data to estimate equation 3.1. The difference GMM estimator applies a first-difference transformation to eliminate the bank-level fixed effects, and uses lagged differences or levels of the dependent variable and explanatory variables as instruments to eliminate non-zero covariance between the lagged dependent variable and the disturbance term, and between any endogenous explanatory variables and the disturbance term.

$$\Delta \ln(RE_{it}) = \beta_0 + \delta_1 \Delta \ln(RE_{i,t-1}) + \beta_1 \Delta \ln(W_{1,it}) + \beta_2 \Delta \ln(W_{2,it}) + \beta_3 \Delta \ln(W_{3,it}) + \beta_4 \Delta \ln(Y_{1,it}) + \beta_5 \Delta(Y_{2,it}) + \beta_6 \Delta(Y_{3,it}) + \Delta\varepsilon_{it} \qquad [3.2]$$

We obtain a dynamic P-RH-statistic by calculating $(\beta_1+\beta_2+\beta_3)/(1-\delta_1)$. In this case, the persistent coefficient δ_1 is particularly useful in the interpretation of the dynamic H-statistic. If δ_1 is close to zero, the dynamic H-statistic is virtually unbiased, but if $\delta_1 > 0$ the dynamic H-statistic is somewhat downward biased.

3.3.2.2 Lerner Index (LI) of MP

The examination of the state of competition in a banking system can be approached by calculation of the LI of MP (Lerner, 1934). The index reflects the ability to set prices above marginal costs. LI values range between zero and one (unity), representing perfect

competition and monopoly, respectively. The higher the mark-up, the greater the realized MP and the lower the level of competition (Carbo, et al. 2009).

Equation 3.3 shows how the LI is computed:

$$\mathrm{LI} = \frac{\mathrm{P} - \mathrm{MC}}{\mathrm{P}} \qquad [3.3]$$

where P is the price of TA, computed as the ratio of total operating income (interest and non-interest income) to TA; MC is the marginal cost of TA calculated from a standard translog function with one output (TA) and three input prices (price of borrowed funds, labour, and physical capital). Because marginal costs (MC) cannot be observed directly, their estimates in Lerner calculations are derived from a translog function using Coelli and Battese's (1995) specification.

We, therefore, estimate a translog frontier cost function to derive the marginal costs. The cost function is derived according to the definition of the intermediation approach, which states that banks incur costs from the use of a number of inputs to produce a number of outputs. Therefore, three input variables (borrowed funds and deposits, labour and physical capital) and total assets account for the aggregate ouput of the bank. Under the assumption that the heterogeneous flow of services produced by a bank is proportional to its total assets. Our translog frontier cost function is estimated using Equation 3.4:

$$\begin{aligned}\ln \mathrm{TC}_{\mathrm{it}} \;=\; & \alpha + \beta \ln \mathrm{Y}_{\mathrm{it}} + \sum_{\mathrm{h}=1}^{3} \gamma_{\mathrm{h}} \ln \mathrm{W}_{\mathrm{hit}} + \frac{1}{2}\eta \,[\ln \mathrm{Y}_{\mathrm{it}}]^2 + \\ & \sum_{\mathrm{h}=1}^{3} \sum_{\mathrm{k}=1}^{3} \frac{1}{2} \delta_{\mathrm{hk}} \ln \mathrm{W}_{\mathrm{hit}} \mathrm{W}_{\mathrm{kit}} + \sum_{\mathrm{h}=1}^{3} \varpi_{\mathrm{h}} \ln \mathrm{Y}_{\mathrm{it}} \ln \mathrm{W}_{\mathrm{hit}} + \\ & \sum_{\mathrm{j}=1}^{3} \kappa_{\mathrm{j}} \ln \mathrm{E}_{\mathrm{jit}} + \psi \ln(\mathrm{Trend}) + \frac{1}{2}\pi [\ln \mathrm{Trend}]^2 +\end{aligned}$$

$$\theta \ln\text{Trend} \ln Y_{it} + \sum_{h=1}^{3} \varrho_h \ln \text{Trend} \ln W_{hit} + \sum_{j=1}^{3} \tau_j \ln E_{jit} \ln Y_{it} + \sum_{h=1}^{3}\sum_{j=1}^{3} \varphi_{hj} \ln E_{jit} \ln W_{hit} + \sum_{j=1}^{3} \phi_j \ln\text{Trend} \ln E_{jit} + \varepsilon_{it} \quad [3.4]$$

In this equation, the subscript i denotes the cross-sectional dimension; t denotes the time dimension; h denotes the number of inputs; ln is the natural logarithm expression. TC is total costs, including financial and operating costs. Output (Y) is represented by a simple variable total assets. Three input prices are selected: the price of borrowed funds (W_1), the price of labour (W_2); and the price of capital (W_3). E is a vector of bank specific variables: log of fixed assets (FA), log of equity (EQ), and log of LLP. The time variable, Trend, is included to control for the effect of technological change. We impose symmetry and linear homogeneity in input prices. Cost and input prices are scaled by the price of fixed assets, while the variable of total equity is used to correct for heteroskedasticity and scale bias. The MC function is derived from the translog function and specified as in Equation 3.5:

$$MC_{it} = \frac{\partial \ln TC_{it}}{\partial \ln Y_{it}} \frac{Y_{it}}{TC_{it}} = \left\{\beta + \eta_n \ln Y_{it} + \sum_{h=1}^{3} \varpi_h \ln W_{hit} + \theta \ln\text{Trend} + \sum_{j=1}^{3} \tau_j \ln \varepsilon_{jit}\right\} \frac{Y_{it}}{TC_{it}} \quad [3.5]$$

Estimation needs to impose symmetry and homogeneity conditions

$$\sum_{h=1}^{3} \gamma_h = 1 \qquad \sum_{h=1}^{3}\sum_{k=1}^{3} \delta_{hk} = 0 \qquad \sum_{h=1}^{3} \varpi_h = 0$$

$$\sum_{h=1}^{3} \varrho_h = 0 \qquad \sum_{h=1}^{3}\sum_{j=1}^{3} \varphi_{hj} = 0 \qquad \delta_{hk} = \delta_{kh}$$

Estimated model is

$$
\begin{aligned}
&\ln\left(\frac{TC_{it}}{W_{3it}}\right) = \alpha + \beta\, Y_{it} + \sum_{h=1}^{2} \gamma_h \ln\left(\frac{W_{hit}}{W_{3it}}\right) + \\
&\frac{1}{2}\eta\,[\ln Y_{it}]^2 + \sum_{h=k}^{2}\sum_{k=1}^{2} \delta_{hk} \ln\left(\frac{W_{hit}}{W_{3it}}\right) \ln\left(\frac{W_{kit}}{W_{3it}}\right) + \\
&\sum_{h=1}^{2} \varpi_h \ln Y_{it} \ln\left(\frac{W_{hit}}{W_{3it}}\right) + \sum_{j=1}^{3} \kappa_j \ln E_{jit} + \psi \ln Trend + \\
&\frac{1}{2}\pi[\ln Trend]^2 + \theta \ln Trend \ln Y_{it} + \\
&\sum_{h=1}^{2}\sum_{j=1}^{3} \varphi_{hj} \ln E_{jit} \ln\left(\frac{W_{hit}}{W_{3it}}\right) + \\
&\sum_{j=1}^{3} \phi_j \ln Trend \ln E_{jit} + \varepsilon_{it}
\end{aligned}
\qquad [3.6]
$$

3.3.2.3 Estimation of the P-RH statistic

In this paper, we adopt the intermediation approach suggested by Sealey and Lindley (1977) in the specification of variables included in our models. The intermediation approach has been extensively used in the literature, due partially to the availability of financial data. This approach views a bank as an intermediary that employs a combination of labour, capital, and various funds to produce services. We, therefore, adopt the intermediation approach to define bank inputs and outputs.

In the literature, the definition of inputs and outputs varies across studies and mainly depends on researchers' assumptions about the production process of banks. Previous studies of market structure have utilised different specifications in order to apply P-R methodology to the banking industry. For instance, Molyneux et al.(1994),Bikker and Groeneveld (1998),Claessens and Laeven (2004), and Liu, Molyneux and Wilson (2013) have used the log ratio of interest revenues to TA as the dependent variable, while Shaffer

(1982),Nathan and Neave (1989), Vesala (1995), Coccorese (1998), and De Band and Davis (2000) have used the logarithm of interest revenues for the same purpose.

In this study, we accept the assumption that the main inputs of commercial banks are the labour, cost of physical capital and funds, which is consistent with the intermediation approach. The unit price of borrowed funds (W_1), the price of labour (W_2); and the price of capital (W_3). The input prices are followed by a set of output bank-specific factors that are relevant to the modern banking industry. Bank-specific factors are additional explanatory variables which reflect differences in risk, deposit structure, and deposit mix, to allow for bank heterogeneity in the samples. Theoretically, these variables should, at least, descend from the marginal revenue and cost functions underlying the empirical P-R model (Bikker and Haaf, 2001).

The size variable logarithm of TA is used as a proxy for economies or diseconomies of scale, given the wide range of bank asset sizes in the U.S. commercial banking system. Additionally, larger banks have greater access to capital markets and thus more flexibility to adjust to unexpected liquidity and capital shortfalls. However, such banks can exhibit too big to fail effects, resulting in higher incentives for risk-taking. This measure is used by Leaven and Levine (2009) and Fu, Lin and Molyneux (2014).

The two different risk variables employed are the logarithmic ratio of equity to TA and the logarithmic ratio of loans to TA. Loans generally represent the main proportion of earning assets and also convey information about a bank's risk preferences. We expect a positive coefficient for the loans to TA ratio, since more interest revenue is generated with increasing levels of loans. The coefficient for the ratio of other income to TA is expected to be negative because the generation of other income may be at the expense of interest income (Staikouras etal., 2004). The equity to TA ratio is included to capture the

effect of different risk levels among banks, with better capitalization ratios indicating lower risk. Lower capitalization may imply a more aggressive approach to lending, with an expectation of higher revenues. For that reason, the coefficient on the capital ratio is expected to be negative (Yildirim, 2002).

3.4 Empirical results

3.4.1 Competition patterns in U.S. commercial banks: H-statistics

Previous studies employing the P-R method of evaluating competitive structure generally concentrated on the examination of a single country or a sample of several countries. The unique structure of the U.S. banking markets and the availability of the banking data for longer periods provides an opportunity to perform analyses in several dimensions. We first conducted the estimations of H-statistics using a panel approach for each state, with time horizons 1987-2010, on a pooled data set, with state dummy variables added into the model in Equation (3.1) to obtain a general picture of the competitive structure in each state separately over the sample period. We then also examined the competitive conditions using the GMM dynamic panel approach.

Table 3.3 presents trends in the H-statistic, as a measure of competition, from 1987 to 2010 for 41 U.S. states. Figure 3.1 displays the H-statistic evolution for the period under study, while Figure 3.2 shows the mean H-statistic by state. There are four main findings. First, the average H-statistic is significantly positive for all years and states, with a value of 0.39. The F-statistics for testing the hypotheses H=0 and H=1 indicate that we can reject the null hypotheses at 1% level of significance. These results suggest that the value of H is positive and statistically different from 0 and unity, rejecting both the monopoly and perfect competition hypotheses. The economic interpretation of these statistics is that

U.S. commercial banks have, on average, operated under monopolistic competition between 1987 and 2010. The results are consistent with findings from previous research (e.g. Claessens and Laeven, 2004; Yildirim and Mohanty, 2010). The average H-statistic values increased from 0.25 in 1987 to about 0.45 in 2010, suggesting an increase in competition.

The goods and services provided by the banks are similar, but slight differences in product quality and advertising often exist. As such, banks in a monopolistically competitive market structure are not price takers and each has slight power as to what to charge for their products and services. Monopolistic competition is much closer to the perfect competition condition.

The second main finding is that the overall picture for evolving trends for H-statistic means across states over time is rather homogenous. However, the average H-statistic for individual states varies, with some states reflecting more competitive behaviour, others displaying less competitive conditions.

Figure 3.1 presents the evolution of average H values for all U.S. banks in the sample between 1987and 2010. The values display mixed trends. The net effect of the decline in mixed trends for input prices has generated descending Lerner values over the sub-periods of 1987-94, 2001-05 and 2009- 2010, and declining H values for the sub-periods of 1999-2000 and 2006-08, whereas between 1994 and 1998, stable values are observed. Similar patterns are detected by Yildirim and Mohanty (2010), who examine the competitive conduct of the U.S. banking industry over the period 1976-2005. They find a certain level of decline in the H-statistics following the interstate branching deregulation, although the estimated coefficients indicate that banks were still operating under monopolistic competition during pre- and post-deregulation periods. They conclude that the decline

seems to have been caused by the change in the competitive conduct of large banks, as we find that the test statistic stays virtually the same for small banks during both periods. However, we note that comparison of our results with Yildirim and Mohanty's (2010) should be made with caution, since their datasets are pre-crises and slightly different methodologies are used.

In our study, the H-statistic exhibits varying degrees of competition across states, with insignificant differences. On average, banks operating in the states of Massachusetts, Colorado, South Dakota, and Arizona experience the most competitive markets compared with banks in other states; in Maryland, Connecticut and Wisconsin, for example, banks operate under the least competitive conditions and have more MP.

The results of the competitive position tests for the pooled data are reported in Table 3.4, Table 3.5 and Table 3.6 in the list of tables and figures. Almost all of the estimated coefficients are statistically significant at the 5% level. All tests confirm the good fit of models with R2 values ranging from a low of 0.97 for Arkansas and Florida to above 0.99 for many states. The estimated regression equations explain 98% of the variability in revenues for the overall sample. Specification tests fail to reject the null hypothesis of no specification error. However, the parameter estimates for the majority of the state dummies are statistically significant.

Although the coefficients for bank-specific factors are of secondary interest to our analysis, we report them for the overall sample along with H-statistics in Table 3.4, Table 3.5 and Table 3.6. For the pooled sample, the sign on the size coefficient is positive and significant in all states, suggesting that size differentials in assets among banks lead to higher total revenues per dollar of assets for the commercial banks. Another significant variable with a positive coefficient is Loans, which suggests that more interest revenue is

generated with increasing levels of loans. As noted above, loans generally represent the largest proportion of earning assets and also convey information about risk preferences. The positive coefficient on TA indicates the presence of economies of scale. Banks of large size tend to enjoy scale economies and achieve higher revenue.

The sign on the coefficients for the three input price proxies (W_1, W_2 and W_3) are highly statistically significant and positive in all cases, except for the cost of physical capital (W_3) in Connecticut, North Carolina and Utah, which is found to be negative. The coefficients for the price of labour (W_1) and price of physical capital (W_3) make the largest contributions to the H-statistic, as estimates range from a low of 0.015 for Washington to 0.39 for many states, while the coefficient for the unit price of capital (W_2) provides the least contribution, ranging from a low of 0.039 for Connecticut to above 0.050 for many states. These results are reported in Table 3.4, Table 3.5 and Table 3.6 in the tables and figures section.

Table 3.7.reports the results from applying the two-step version of the GMM estimator. The validity of over-identifying restrictions is accepted in all 42 estimations, with operating income as the dependent variable. This validity is important because by using a dynamic approach, we introduce in our equation values of variables from previous periods. The test for second-order autocorrelation in the residuals is insignificant in all cases.

Table 3.7 shows, for example, that the average dynamic H-statistic is 0.78 for the entire U.S. sample while the average H-statistic is 0.38. The implications of GMM estimation results for each state can be summarized as follows. For Arkansas, Colorado, Iowa, Minnesota, North Dakota and Oklahoma, we are able to reject the null hypothesis for monopoly or monopolistic competition and conclude that revenue appears to have been

earned in conditions of perfect competition during the sample period. For Illinois, Kansas, Missouri and Texas, the results enable us to reject the null hypothesis for monopoly, favouring both monopolistic competition and perfect competition, as they are in the borderline to one. For the remaining states, both hypotheses for monopoly and perfect competition are rejected in favour of monopolistic competition. Finally, for Mississippi, with the only negative dynamic H-statistic, we are able to reject the null hypothesis for both monopolistic competition and perfect competition, leading to the conclusion that revenue appears to be earned in conditions of monopoly.

The persistence coefficient (δ_1) is positive and significant for the U.S. sample as a whole and 40 states (Arizona being the exception), and we are able to reject H0: (δ_1)=0 in favour of H1: (δ_1) > zero for all the U.S. sample and 41 individual states. The significance of (δ_1) in the majority of cases suggests that the inclusion of partial adjustment mechanisms in the revenue equation is required, and that the dynamic revenue equation is preferred to the static revenue equation. This being so, the fact that in every case the dynamic H-statistic turns out to be larger than the H-statistic is entirely consistent with the principal conclusion of the Monte Carlo simulations, where the fixed effect estimator HF is severely biased towards zero. This finding corroborates the finding of Goddard and Wilson (2007), who argue that FE generally reports results of the H-statistic that are relatively biased downwards.

In the GMM estimates of the revenue equation, with interest income as the dependent variable, the coefficients for log (equity/TA) are negative and significant at the 5% level for 36 of the states and for the U.S as a whole, and positive and significant for Connecticut, Maryland, North Carolina, Oregon and Virginia. The coefficients of W_2 (cost of capital) are positive and significant at the 1% level for 35 States and the entire

U.S. sample, and negative and significant for Louisiana, Maryland, Mississippi, New Jersey, North Caroline, Utah and West Virginia. The coefficients ofW_3 are negative and significant at the 1% level for most states. These results are reported in Table 3.8, 3.9, and 3.10.

3.4.2 Marginal costs and Lerner values

In this section, we report the results from the LI of MP estimations in Equation 3.3. As noted previously (see 3.4.2), the higher the Lerner values, the higher the MP and lower the level of competition. MC are obtained from the estimated translog function in Equation 3.4 for the pooled sample. It is worth noting that we estimate LIs for individual states and the results are not statistically different from the pooled data.

The first and second order of the output coefficients, elasticity of outputs is positive and significant as well as the magnitude of the coefficient is close to one. The first order of the input price coefficients are significantly positive in line with the theory and expectations. Based on the measure of fit, it can conclude that the model best explains the data of US banks. The estimated input price coefficients indicates that the most important input price of banks is the price of W2. Control variable (net put) like Assets quality, Fixed assets, Equity are also significant and should be included into the cost function model, Only Asset quality (llp) is negatively related as expected and reported the literature. Inclusion of the trend variable is important and the trend is significant even with cross term with the outputs and input prices (see Table 3.11)..

Tables 3.12 and 3.13 present the trends in MC and LI of MP, respectively, from 1987 to 2012 for 39 U.S. states. We start by observing the evolution of MP in U.S. banking over

the period 1987-2012. Figures 3.3 displays the evolution of Lerner values for the period under study, while Figures 3.4 shows the mean Lerner values by state.

There are four main findings. First, the average Lerner value for all states for the entire period studied is 0.34, suggesting that U.S. banks price their products nearly a third above marginal costs. The average Lerner values increased from 0.15 in 1987 to 0.55 in 2011, suggesting an increase in market power and lower competition. Second, the overall picture for trends in Learner means over time across states is rather homogenous. However, the average Lerner value for individual states is mixed, with some states reflecting more competitive conditions and other states displaying less. The third main finding is that when we consider the financial crisis years (2007-2009), Lerner values are seen to fall in all states in 2010 compared to 2007.

Figure 3.3 shows time-series plots of the average estimated marginal cost (expressed as a proportion of average revenue) and the average Lerner index. From the definition of the Lerner index, these two series are inversely related. The trend over the full observation period is for a decline in the marginal cost, and an increase in the Lerner index, indicating an increase in the average level of market power. It is interesting to note that the sharpest increases in the Lerner index appear to correspond approximately with financial crises and recessions: the late-1980s and early-1990s, the early 2000s, and the late-2000s.

A similar pattern is detected by Fu, Lin and Molyneux (2014), who examine market power for 14 Asia Pacific countries between 2003 and 2010. They find a decreasing trend for the LI between 2005 and 2008, suggesting a decrease in pricing power, but an increasing trend between 2008 and 2010, indicating an increase in MP after the crisis. Similarly, Cubillas and Suarez (2013) show that the greater the severity of the banking crisis, the higher the increase in bank MP.

In our study, the LI shows varying degrees of MP across states, with insignificant differences. On average, banks operating in the states of Utah, Oregon, California and New Mexico have more MP than banks in other states, whereas banks in North Dakota and Indiana operate under more competitive conditions.

The overall results show that even though U.S. banks reduce their MC over the period, they tend to operate under less competitive conditions than banks in Europe, Asia and Latin America. Amidu and Wolfe (2013) report a mean Lerner value of 0.25 for a sample of 978 banks in 55 emerging and developing countries between 2000 and 2007. Cubillasa and Suarez (2013) find that banks in 64 developed and developing countries price their products at around 38% above MC between 1989 and 2007.However, it is important to note that comparison with results in the literature should be made with care, since different datasets and methodologies are used.

3.4.3 Cross-state consistency of competition measures

LI values estimated for individual states suggest that Arizona, Florida and North Carolina banking systems are the most competitive, while Utah, Nebraska and Maryland are the least competitive. However, average Lerner values for all years and states is 0.41(as shown in Table 3.14), suggesting that over the period under study, U.S. banks price their products at approximately a third above MC. The average Lerner values increase from 0.39 in 1987 to about 0.44 in 2010, suggesting an increase in MP and reduction in competition (see Table 3.14).

Turning to the P-R H-statistic, Maryland, Connecticut, Wisconsin and Wyoming appear to have the least competitive banking systems, whereas Massachusetts, Colorado and

South Dakota have the most competitive. All estimates fall in the monopolistic competition range, similar to the previous findings. Looking at the values of the dynamic H-statistic, these tend to differ greatly from the H-statistics for most of the states. These findings suggest conditions of perfect competition exist in Arkansas, Colorado, Iowa, Kansas, Minnesota, Missouri, North Dakota and Oklahoma, while Mississippi experiences monopoly.

Overall, the different competition measures hardly yield consistent findings. For instance, South Dakota and Massachusetts; both have a high LI and H-statistic– both not inferring relatively opposite each other and this mislead the clarification for levels of competition.

3.5 Conclusion

Our empirical findings as outlined by Panzar and Rosse (1987) are generally in line with our expectations and suggest consistency with the literature that proposes that banks, on average and for every state, operate under monopolistic competition over the sample period. The average H-statistic values increased from 0.25 in 1987 to about 0.45 in 2010, suggesting an increase in competition. However, this conclusion does not hold under a dynamic GMM approach. We observe a significant increase in the dynamic H-statistic for the overall sample and for every state.

We find the average Lerner value for all years and states is 0.34, suggesting that over the period under study U.S. banks price their products nearly a third above the marginal costs. We also find that the average Lerner values increased from 0.39 in 1987 to about 0.44 in 2010, suggesting an increase in MP and lower competition. Second, the overall picture for the evolving trends for Lerner means across states over time is rather homogenous; however, the average Lerner value for states is mixed, with some states reflecting more competitive behaviour, whereas others display less competitive conditions. Finally, in all states, the Lerner values fall in 2007 compared to 2010, when we consider the financial crisis years (2007-2009).

3.6 Tables and Figures.

Table 3.1: Overview of the selected sample number of banks per state and pre year

States	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Alabama	189	197	198	203	187	199	202	199	175	176	166	153	150	152	148	141	136	137	131	129	131	125	122	113	3859
Arizona	35	34	34	33	32	30	30	25	24	24	27	23	21	18	16	14	16	14	18	16	11	9	10	9	523
Arkansas	237	243	245	242	245	249	251	250	234	226	218	194	186	175	170	160	154	154	146	142	140	132	125	120	4638
California	333	341	334	319	296	273	255	240	238	228	220	212	193	171	153	146	144	126	121	111	113	105	92	83	4847
Colorado	332	337	337	329	305	277	272	250	198	191	182	163	152	151	142	136	135	128	123	116	109	106	104	77	4652
Connecticut	53	53	58	50	45	40	36	34	33	23	22	20	18	15	14	14	11	9	11	11	11	11	10	9	611
Florida	292	312	327	336	328	321	308	299	276	235	212	194	194	184	173	170	161	154	159	156	158	142	133	110	5334
Georgia	301	330	349	365	353	359	355	347	346	321	312	304	296	281	265	258	259	255	256	247	241	224	203	176	7003
Illinois	1006	1014	1001	992	953	925	885	840	800	767	724	692	658	644	624	609	602	577	538	526	515	506	480	460	17338
Indiana	294	300	301	289	271	261	232	217	207	201	181	162	154	145	144	140	138	128	120	109	101	99	91	91	4376
Iowa	500	499	509	507	496	492	479	475	450	417	407	398	393	385	378	369	358	354	355	349	342	329	324	319	9884
Kansas	496	491	497	490	468	455	432	407	383	371	360	358	347	341	337	333	327	323	321	314	308	305	296	281	9041
Kentucky	303	311	307	307	275	282	285	264	256	253	248	237	225	214	211	203	197	194	188	181	171	163	165	163	5603
Louisiana	209	217	215	213	204	201	195	187	171	163	150	138	140	136	132	131	128	129	128	127	127	125	125	123	3814
Maryland	83	86	90	90	87	84	83	83	85	80	74	72	71	68	66	65	60	55	52	51	40	39	36	35	1635
Massachusetts	84	87	87	70	58	48	49	41	40	37	32	31	33	31	32	29	27	26	26	26	20	19	18	18	969
Michigan	257	260	260	229	217	208	200	193	173	169	153	155	160	152	145	141	141	134	134	132	122	117	108	103	4063
Minnesota	577	578	580	577	562	551	536	531	490	482	481	464	459	446	439	426	421	407	392	370	367	356	337	326	11155
Mississippi	109	115	116	113	105	110	105	103	102	106	100	93	95	94	94	91	89	88	86	85	84	83	82	81	2329
Missouri	502	509	520	517	495	481	463	452	440	413	388	362	350	346	334	332	324	322	321	313	307	294	288	278	9351
Montana	155	153	159	146	135	116	113	108	95	91	88	87	82	80	77	76	72	71	72	74	68	67	64	61	2310
Nebraska	321	332	335	329	332	329	310	305	291	277	278	285	263	241	230	224	216	208	209	205	201	200	192	184	6297
New Jersey	87	95	98	95	86	85	78	70	66	54	55	53	54	55	50	50	46	42	37	36	37	36	35	34	1434
New Mexico	85	84	85	83	78	79	77	68	67	66	54	54	51	49	50	46	47	44	44	42	44	46	45	44	1432
New York	141	147	144	144	135	132	129	124	123	130	122	124	121	116	111	104	105	95	92	84	78	72	72	68	2713
North Carolina	60	64	69	68	69	66	62	59	52	44	45	45	50	52	48	47	46	48	48	53	52	49	49	46	1291
North Dakota	140	143	141	139	131	133	131	127	117	115	108	109	109	104	96	94	94	93	91	86	86	86	86	84	2643
Ohio	266	264	267	261	245	251	237	238	244	242	217	201	198	190	184	181	176	163	159	159	150	139	134	131	4897
Oklahoma	381	385	387	383	360	348	334	320	319	313	300	296	285	271	267	257	253	252	249	244	239	233	232	229	7137
Oregon	46	46	46	47	47	45	42	41	39	37	34	34	34	30	24	24	24	23	23	23	22	21	19	16	787
Pennsylvania	250	256	252	256	238	242	225	218	200	192	188	175	170	164	155	150	146	141	131	124	120	112	108	102	4315
South Carolina	63	67	71	74	73	75	73	70	65	69	71	67	67	67	65	64	62	61	61	62	59	57	57	51	1571
South Dakota	112	111	114	111	112	110	108	109	101	100	88	85	85	82	84	86	83	83	83	79	79	77	71	70	2223
Tennessee	234	241	247	236	223	226	227	227	224	223	218	190	182	174	164	166	159	157	152	150	150	144	143	141	4598
Texas	1138	1156	1155	1078	1007	983	934	922	875	829	790	747	704	663	634	621	596	577	561	543	540	523	500	486	18562
Utah	34	34	34	34	32	32	30	28	27	25	23	23	22	23	23	23	21	19	20	20	20	20	17	14	598
Virginia	134	144	144	146	143	139	137	146	146	147	142	139	132	125	118	109	105	101	99	82	74	72	73	72	2869
Washington	75	77	82	84	83	80	73	73	69	58	57	55	55	52	50	48	46	44	46	47	48	48	44	36	1430
West Virginia	164	172	171	162	142	148	132	116	112	106	97	86	80	68	69	66	63	62	59	59	58	57	56	56	2361
Wisconsin	480	484	486	453	439	428	419	387	372	348	339	328	321	298	262	256	249	248	239	241	231	220	220	216	7964
Wyoming	59	63	62	61	52	54	48	48	47	50	48	46	44	43	44	43	40	37	37	38	37	33	31	30	1095
Total	10617	10832	10914	10661	10144	9947	9572	9241	8772	8399	8019	7654	7404	7096	6822	6643	6477	6283	6138	5962	5811	5601	5397	5146	189552

NOTE: We select banks with available balance sheets and income statement in Federal Reserve Bank of Chicago for the years 1987-2010.

Table 3.2: Descriptive statistics

Variable	No. Obs	Mean	Std. Dev.	Min	Max
w1	189552	0.0161207	0.006961	0.0000284	0.4901032
w2	189552	1.26647	4.504153	0.0042761	1041.565
w3	189552	7.159936	1.341631	0.9791265	17.04805
equity	189552	0.0971208	0.0357249	0.0000613	0.9708495
lnassets	189552	11.41223	1.291401	6.798632	21.2036
loans	189552	0.5723951	0.1506194	0.0000659	0.989092
lnTC	148498	-0.40042	0.832344	-5.57722	5.903258
Lq	148498	2.394359	0.309007	0.160992	8.605713
lnW1	148498	-12.4382	1.321741	-22.7758	-5.68209
lnW2	148498	-4.14977	1.452537	-14.2634	2.675852
lnLLp	148498	-3.73902	1.234239	-10.3331	5.810808

Where: w1 Cost of labour= Salaries and benefits /Total assets; w2 Cost of capital= Non-interest expenses minus salaries and benefits/ premises and fixed assets; w3 Cost of physical capital= Non-interest expenses/ the Salaries and benefits; equity = total equity / total assets; loans= Net Loan / total assets; lnassets = Log of Total assets; TC is total costs, including financial and operating costs; lnLLp log of loan loss provision.

Table 3.3: Evolution of H-statistic for all U.S. banks in the sample across states in all years (1987-2010).

States	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Mean
Alabama	0.30	0.52	0.49	0.17	0.20	0.27	0.24	0.26	0.26	0.44	0.61	0.18	0.48	0.15	0.26	0.22	0.43	0.31	0.34	0.41	0.57	0.17	0.18	0.16	0.32
Arizona	0.58	0.42	0.88	0.70	0.42	0.41	0.61	0.40	0.57	-0.06	0.48	0.36	0.59	0.37	0.16	0.28	0.84	0.59	0.76	0.75	0.34	-0.17	0.26	0.32	0.49
Arkansas	0.18	0.18	0.38	0.49	0.59	0.61	0.54	0.36	0.81	0.30	0.23	0.52	0.61	0.26	0.32	0.42	0.37	0.50	0.55	0.31	0.63	0.53	0.79	0.47	0.45
California	0.42	0.37	0.28	0.35	0.38	0.45	0.61	0.46	0.55	0.62	0.52	0.54	0.40	0.38	0.69	0.73	0.67	0.64	0.54	0.25	0.41	0.30	0.26	0.34	0.46
Colorado	0.29	0.34	0.80	0.57	0.44	0.55	0.89	0.56	0.53	0.62	0.61	0.76	0.25	0.44	0.86	0.73	0.57	0.44	0.31	0.56	0.30	0.40	0.28	0.49	0.54
Connecticut	0.06	0.19	-0.08	0.07	0.30	0.24	0.22	0.29	0.70	0.68	0.74	0.56	0.48	0.38	0.22	0.36	0.42	0.24	0.06	0.47	-0.06	0.07	0.35	-0.12	0.26
Florida	0.56	0.53	0.51	0.36	0.41	0.37	0.58	0.45	0.40	0.43	0.44	0.39	0.57	0.47	0.46	0.54	0.42	0.41	0.40	0.12	0.45	0.44	0.23	0.40	0.44
Georgia	0.31	0.29	0.23	0.22	0.31	0.61	0.36	0.51	0.48	0.36	0.35	0.53	0.33	0.27	0.61	0.63	0.64	0.61	0.43	0.32	0.24	0.26	0.32	0.33	0.40
Illinois	0.12	0.23	0.11	0.23	0.53	0.49	0.40	0.40	0.45	0.40	0.35	0.31	0.38	0.28	0.20	0.34	0.33	0.30	0.26	0.34	0.31	0.40	0.26	0.32	0.32
Indiana	0.15	0.32	0.33	0.64	0.25	0.23	0.26	0.53	0.25	0.81	0.24	0.18	0.29	0.26	0.32	0.27	0.38	0.42	0.38	0.35	0.27	0.84	0.21	0.20	0.35
Iowa	0.13	0.16	0.12	0.15	0.37	0.37	0.28	0.56	0.26	0.34	0.44	0.41	0.24	0.61	0.49	0.46	0.42	0.46	0.19	0.16	0.34	0.13	0.19	0.64	0.32
Kansas	0.19	0.32	0.18	0.31	0.36	0.40	0.51	0.59	0.40	0.28	0.41	0.37	0.67	0.41	0.39	0.47	0.63	0.51	0.53	0.43	0.72	0.58	0.59	0.62	0.43
Kentucky	0.31	0.28	0.40	0.40	0.41	0.28	0.40	0.48	0.61	0.57	0.47	0.37	0.21	0.17	0.44	0.26	0.33	0.30	0.25	0.43	0.31	0.21	0.28	0.31	0.36
Louisiana	0.26	0.62	0.25	0.48	0.26	0.45	0.32	0.54	0.64	0.31	0.32	0.36	0.32	0.53	0.27	0.29	0.34	0.33	0.57	0.42	0.37	0.37	0.43	0.44	0.40
Maryland	0.22	0.22	0.44	0.02	0.07	0.13	0.38	0.12	0.22	0.24	0.15	0.32	0.24	0.35	0.25	0.23	0.51	0.21	0.22	0.24	0.11	0.04	0.16	0.24	0.23
Massachusetts	0.46	0.75	0.54	0.54	0.59	0.56	0.97	0.34	0.29	0.59	0.17	0.50	0.55	0.44	0.71	0.58	0.60	0.62	0.55	0.47	0.26	0.04	0.92	0.99	0.55
Michigan	0.22	0.19	0.20	0.30	0.17	0.43	0.40	0.53	0.47	0.30	0.68	0.46	0.33	0.25	0.29	0.35	0.66	0.29	0.35	0.85	0.71	0.25	0.44	0.52	0.38
Minnesota	0.22	0.18	0.12	0.24	0.12	0.53	0.55	0.26	0.35	0.39	0.65	0.31	0.46	0.21	0.37	0.48	0.40	0.58	0.50	0.50	0.34	0.26	0.19	0.42	0.35
Mississippi	0.25	0.15	0.14	0.12	0.17	0.17	0.22	0.26	0.47	0.24	0.23	0.38	0.40	0.26	0.31	0.37	0.38	0.38	0.34	0.30	0.29	0.38	0.38	0.47	0.28
Missouri	0.25	0.19	0.22	0.30	0.78	0.39	0.28	0.31	0.38	0.41	0.65	0.27	0.34	0.27	0.46	0.49	0.59	0.41	0.33	0.50	0.49	0.51	0.54	0.28	0.39
Montana	0.18	0.24	0.31	0.14	0.20	0.22	0.28	0.58	0.23	0.79	0.21	0.39	0.27	0.81	0.22	0.11	0.23	0.29	0.29	0.65	0.20	0.29	0.23	0.19	0.30
Nebraska	0.19	0.24	0.26	0.53	0.29	0.44	0.28	0.36	0.49	0.45	0.45	0.46	0.29	0.30	0.51	0.36	0.52	0.72	0.69	0.62	0.60	0.41	0.64	0.71	0.43
New Jersey	0.48	0.44	0.38	0.25	0.34	0.25	0.27	0.54	0.21	0.63	0.68	0.38	0.62	0.63	0.52	0.46	0.33	0.37	0.22	0.12	0.66	0.33	0.43	0.48	0.41
New Mexico	0.16	0.21	0.17	0.19	0.32	0.06	0.22	0.84	0.34	0.19	0.23	0.69	0.29	0.42	0.76	0.30	0.26	0.30	0.81	0.19	0.26	0.87	0.87	0.34	0.36
New York	0.39	0.46	0.40	0.42	0.25	0.44	0.42	0.31	0.35	0.37	0.41	0.50	0.50	0.61	0.45	0.41	0.46	0.54	0.89	0.71	0.20	0.47	0.26	0.32	0.44
North Carolina	0.42	0.41	0.33	0.44	0.35	0.29	0.46	0.29	0.53	0.24	0.21	0.29	-0.03	0.10	0.42	0.50	0.46	0.60	0.13	0.14	0.13	0.10	0.38	0.41	0.32
North Dakota	0.06	0.08	0.09	0.25	0.13	0.45	0.62	0.53	0.57	0.22	0.26	0.71	0.29	0.31	0.63	0.59	0.40	0.39	0.37	0.53	0.34	0.39	0.39	0.56	0.37
Ohio	0.30	0.23	0.30	0.37	0.39	0.35	0.67	0.56	0.41	0.46	0.55	0.52	0.47	0.44	0.46	0.52	0.56	0.36	0.32	0.36	0.64	0.35	0.29	0.20	0.42
Oklahoma	0.26	0.58	0.18	0.35	0.54	0.51	0.29	0.53	0.62	0.45	0.38	0.48	0.53	0.40	0.30	0.61	0.61	0.39	0.53	0.25	0.28	0.34	0.68	0.73	0.44
Oregon	0.16	0.18	0.15	0.61	0.80	0.71	0.65	0.47	0.30	0.64	0.36	0.48	0.32	0.73	0.61	0.93	0.33	0.75	0.32	0.28	0.30	0.24	0.18	0.30	0.46
Pennsylvania	0.59	0.15	0.25	0.06	0.14	0.17	0.39	0.34	0.19	0.24	0.31	0.28	0.32	0.39	0.42	0.37	0.33	0.62	0.26	0.30	0.40	0.55	0.34	0.40	0.31
South Carolina	0.64	0.42	0.35	0.50	0.41	0.60	0.55	0.22	0.62	0.48	0.42	0.49	0.40	0.34	0.35	0.51	0.59	0.50	0.42	0.19	0.31	0.32	0.75	0.47	0.45
South Dakota	0.71	0.20	0.29	0.24	0.34	0.46	0.51	0.49	0.40	0.50	0.77	0.57	0.58	0.65	0.57	0.61	0.63	0.68	0.58	0.54	0.50	0.55	0.45	0.83	0.51
Tennessee	0.32	0.24	0.50	0.14	0.21	0.48	0.58	0.43	0.60	0.65	0.66	0.24	0.29	0.36	0.19	0.53	0.38	0.45	0.31	0.39	0.57	0.21	0.60	0.46	0.41
Texas	0.21	0.36	0.23	0.48	0.34	0.49	0.56	0.57	0.56	0.61	0.66	0.65	0.62	0.43	0.54	0.49	0.62	0.47	0.57	0.41	0.60	0.61	0.36	0.64	0.49
Utah	0.36	0.48	0.37	0.33	0.35	0.55	0.44	0.64	0.51	0.56	0.67	0.60	0.48	0.33	0.28	0.18	0.32	0.28	0.44	0.66	0.42	0.08	-0.13	0.21	0.41
Virginia	0.33	0.06	0.47	0.08	0.11	0.16	0.17	0.33	0.30	0.26	0.34	0.14	0.32	0.12	0.18	0.36	0.41	0.46	0.64	0.47	0.47	0.47	0.45	0.32	0.29
Washington	0.33	0.35	0.34	0.48	0.33	0.36	0.27	0.31	0.21	0.58	0.33	0.74	0.14	0.17	0.25	0.27	0.65	0.32	0.17	0.10	0.11	0.06	0.19	0.95	0.33
West Virginia	0.28	0.20	0.18	0.51	0.62	0.63	0.17	0.43	0.92	0.31	0.32	0.40	0.46	0.21	0.35	0.34	0.35	0.32	0.32	0.30	0.27	0.41	0.43	0.44	0.39
Wisconsin	0.15	0.16	0.17	0.20	0.25	0.26	0.36	0.42	0.34	0.26	0.24	0.39	0.24	0.13	0.21	0.47	0.50	0.31	0.23	0.33	0.27	0.23	0.28	0.27	0.27
Wyoming	0.16	0.22	0.07	0.22	0.17	0.75	0.31	0.48	0.24	0.45	0.17	0.11	0.10	0.10	0.24	0.25	0.21	0.25	0.58	0.41	0.36	0.39	0.44	0.36	0.28
Mean	0.25	0.29	0.26	0.32	0.36	0.42	0.43	0.45	0.45	0.43	0.45	0.42	0.40	0.35	0.40	0.45	0.48	0.44	0.41	0.39	0.42	0.38	0.38	0.45	0.39

Model Estimated: ln(REit)=α+ β1 ln(W1,it)+β2 ln(W2,it)+β3 ln(W3,it)+β4 ln(Y1,it)+β5 (Y2,it)+β_6 (Y3,it)+εit ; The P-R H-statistic is given by the sum of the elasticities of revenue with respect to input prices: H=β1+β2+β3 per state and pre year. Under monopoly, P-RH< 0; under perfect competition, P-RH = 1; and under monopolistic competition, 0 < P-RH < 1

Table 3.4: Average coefficients of H-Statistic estimation results of equation (3.1) for the period 1987-2010 by States

Variable	Alabama	Arizona	Arkansas	California	Colorado	Connecticut	Florida	Georgia	Illinois	Indiana	Iowa	Kansas	Kentucky	Louisiana
w1	0.234	0.291	0.260	0.283	0.308	0.292	0.269	0.212	0.206	0.241	0.211	0.232	0.210	0.218
	(0.048)	(0.224)	(0.044)	(0.048)	(0.047)	(0.193)	(0.051)	(0.034)	(0.020)	(0.040)	(0.025)	(0.028)	(0.038)	(0.047)
w2	0.066	0.041	0.076	0.043	0.059	0.019	0.046	0.095	0.055	0.059	0.051	0.065	0.056	0.045
	(0.020)	(0.086)	(0.017)	(0.022)	(0.019)	(0.069)	(0.020)	(0.014)	(0.008)	(0.018)	(0.009)	(0.011)	(0.015)	(0.018)
w3	0.019	0.121	0.120	0.137	0.157	-0.026	0.116	0.091	0.061	0.050	0.069	0.156	0.087	0.133
	(0.041)	(0.223)	(0.044)	(0.045)	(0.042)	(0.220)	(0.048)	(0.032)	(0.017)	(0.036)	(0.021)	(0.024)	(0.033)	(0.042)
lnassets	0.991	0.906	0.911	0.885	0.872	1.083	0.907	0.927	0.959	0.971	0.957	0.886	0.926	0.870
	(0.041)	(0.238)	(0.046)	(0.045)	(0.046)	(0.213)	(0.048)	(0.032)	(0.018)	(0.037)	(0.023)	(0.025)	(0.034)	(0.043)
equity	-0.091	-0.076	-0.051	-0.080	-0.062	0.013	-0.093	-0.104	-0.039	-0.032	-0.010	0.013	-0.046	-0.027
	(0.042)	(0.187)	(0.040)	(0.047)	(0.047)	(0.125)	(0.039)	(0.029)	(0.020)	(0.039)	(0.025)	(0.025)	(0.032)	(0.035)
loans	0.102	0.301	0.143	0.171	0.122	0.104	0.102	0.235	0.141	0.173	0.142	0.163	0.132	0.109
	(0.043)	(0.280)	(0.041)	(0.061)	(0.037)	(0.123)	(0.040)	(0.046)	(0.019)	(0.042)	(0.026)	(0.024)	(0.037)	(0.033)
cons	-1.760	-1.345	-1.355	-1.282	-1.071	-2.203	-1.467	-1.594	-1.739	-1.609	-1.658	-1.314	-1.497	-1.150
	(0.206)	(0.820)	(0.216)	(0.204)	(0.217)	(0.672)	(0.198)	(0.161)	(0.094)	(0.193)	(0.128)	(0.128)	(0.170)	(0.188)
N	3859	523	4638	4847	4652	611	5334	7003	17338	4376	9884	9041	5603	3814
H	0.32	0.45	0.46	0.46	0.52	0.29	0.43	0.40	0.32	0.35	0.33	0.45	0.35	0.40
chi2	0.99***	0.99***	0.97***	0.98***	0.98***	0.99***	0.97***	0.98***	0.98***	0.99***	0.98***	0.98***	0.99***	0.99***
F_h0	63.93	18.92	204.14	180.41	250.55	39.03	150.74	199.04	321.67	124.61	227.80	344.09	111.52	125.95
p_h0	0.00	0.13	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p_h1	0.00	0.08	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F_h1	338.92	17.38	376.08	239.07	164.63	108.79	243.98	391.55	1677.10	435.69	1582.08	561.69	367.73	295.01

Where: Cost of labour (w1)= Salaries and benefits /Total assets; Cost of capital (w2) = Non-interest expenses minus salaries and benefits/ premises and fixed assets; Cost of physical capital (w3) = Non-interest expenses/ the Salaries and benefits; equity = total equity / total assets; loans= Net Loan / total assets ; lnassets= Log of Total assets; standard errors (s.e.) are shown in italics: H is Panzae-Rosse H- statistic; standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels; The Wald test is used to test H=0 and H=1.

Table 3.5: Average coefficients of H-Statistics estimation results of equation (3.1) for the period 1987-2010 by States (continued)

Variable	Maryland	Massa-chusetts	Michigan	Minnesota	Mississippi	Missouri	Montana	Nebraska	New Jersey	New Mexico	New York	North Carolina	North Dakota	Ohio	Oklahoma
w1	0.177	0.361	0.264	0.223	0.198	0.253	0.206	0.203	0.270	0.280	0.245	0.332	0.201	0.117	0.256
	(0.063)	(0.105)	(0.046)	(0.022)	(0.052)	(0.027)	(0.046)	(0.033)	(0.087)	(0.075)	(0.051)	(0.097)	(0.039)	(0.042)	(0.032)
w2	0.029	0.040	0.040	0.058	0.038	0.080	0.037	0.064	0.085	0.042	0.056	0.059	0.054	0.080	0.063
	(0.026)	(0.046)	(0.021)	(0.009)	(0.020)	(0.012)	(0.019)	(0.012)	(0.043)	(0.034)	(0.026)	(0.045)	(0.016)	(0.017)	(0.013)
w3	0.017	0.142	0.098	0.079	0.057	0.068	0.071	0.182	0.061	0.065	0.138	-0.075	0.127	0.223	0.132
	(0.055)	(0.098)	(0.045)	(0.020)	(0.043)	(0.026)	(0.042)	(0.026)	(0.092)	(0.065)	(0.053)	(0.090)	(0.033)	(0.035)	(0.029)
lnassets	0.992	0.884	0.924	0.945	0.950	0.957	0.950	0.863	0.978	0.952	0.888	1.086	0.906	0.799	0.886
	(0.056)	(0.101)	(0.046)	(0.021)	(0.042)	(0.027)	(0.044)	(0.029)	(0.095)	(0.066)	(0.054)	(0.090)	(0.036)	(0.036)	(0.031)
quity	-0.020	0.035	-0.051	-0.012	0.012	-0.051	-0.008	0.004	-0.137	-0.062	0.051	-0.195	0.053	0.005	-0.020
	(0.055)	(0.114)	(0.043)	(0.025)	(0.048)	(0.027)	(0.054)	(0.032)	(0.077)	(0.078)	(0.046)	(0.078)	(0.047)	(0.035)	(0.030)
loans	0.266	0.100	0.231	0.202	0.214	0.204	0.240	0.163	0.099	0.136	0.053	0.155	0.183	0.092	0.104
	(0.084)	(0.088)	(0.053)	(0.027)	(0.048)	(0.029)	(0.064)	(0.036)	(0.077)	(0.063)	(0.039)	(0.142)	(0.043)	(0.040)	(0.027)
cons	-1.837	-0.749	-1.360	-1.511	-1.426	-1.526	-1.533	-1.343	-2.073	-1.399	-1.199	-2.058	-1.337	-1.358	-1.141
	(0.292)	(0.479)	(0.225)	(0.121)	(0.229)	(0.134)	(0.225)	(0.155)	(0.365)	(0.353)	(0.177)	(0.385)	(0.227)	(0.172)	(0.145)
N	1635	969	4063	11155	2329	9351	2310	6297	1434	1432	2713	1291	2643	4897	7137
H	0.22	0.54	0.40	0.36	0.29	0.40	0.31	0.45	0.42	0.39	0.44	0.32	0.38	0.42	0.45
chi2	0.99***	0.99***	0.98***	0.98***	0.99***	0.98***	0.99***	0.99***	0.99***	0.98***	0.99***	1.0***	0.99***	0.99***	0.98***
F_h0	19.30	65.33	111.09	287.14	40.45	276.64	65.30	239.86	36.24	34.95	147.77	22.54	101.46	172.59	278.83
p_h0	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.08	0.00	0.00	0.00
p_h1	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
F_h1	263.58	49.65	264.40	1225.50	359.96	686.34	300.32	541.21	79.89	150.22	241.06	95.62	381.50	319.93	497.21

Where: Cost of labour (w1)= Salaries and benefits /Total assets; Cost of capital (w2) = Non-interest expenses minus salaries and benefits/ premises and fixed assets; Cost of physical capital (w3) = Non-interest expenses/ the Salaries and benefits; equity = total equity / total assets; loans= Net Loan / total assets ; lnassets= Log of Total assets; standard errors (s.e.) are shown in italics: H is Panzae-Rosse H- statistic; standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels; The Wald test is used to test H=0 and H=1.

Table 3.6: Average coefficients of H-Statistics estimation results of equation (3.1) for the period 1987-2010 by States (continued)

Variable	Oregon	Pennsylvania	South Carolina	South Dakota	Tennessee	Texas	Utah	Virginia	Washington	West Virginia	Wisconsin	Wyoming
w1	0.294	0.200	0.335	0.128	0.285	0.278	0.373	0.081	0.289	0.172	0.181	0.147
	(0.153)	(0.038)	(0.076)	(0.047)	(0.048)	(0.024)	(0.110)	(0.046)	(0.084)	(0.063)	(0.026)	(0.073)
w2	0.099	0.050	0.069	0.060	0.065	0.065	0.037	0.048	0.030	0.068	0.046	0.047
	(0.057)	(0.018)	(0.036)	(0.023)	(0.020)	(0.009)	(0.040)	(0.027)	(0.035)	(0.025)	(0.011)	(0.027)
w3	0.056	0.076	0.047	0.337	0.058	0.160	-0.018	0.180	0.015	0.142	0.050	0.100
	(0.110)	(0.039)	(0.074)	(0.039)	(0.042)	(0.021)	(0.105)	(0.043)	(0.077)	(0.057)	(0.021)	(0.058)
lnassets	0.953	0.937	0.978	0.697	0.954	0.865	1.048	0.850	1.012	0.878	0.962	0.919
	(0.116)	(0.040)	(0.076)	(0.046)	(0.043)	(0.021)	(0.113)	(0.046)	(0.080)	(0.058)	(0.023)	(0.060)
quity	0.129	-0.029	-0.150	0.153	-0.071	-0.020	0.087	-0.023	-0.131	-0.015	-0.017	-0.024
	(0.099)	(0.037)	(0.067)	(0.058)	(0.042)	(0.020)	(0.093)	(0.049)	(0.067)	(0.052)	(0.026)	(0.079)
loans	0.291	0.117	0.134	0.202	0.142	0.074	0.296	0.270	0.249	0.150	0.205	0.153
	(0.164)	(0.041)	(0.099)	(0.064)	(0.052)	(0.016)	(0.153)	(0.078)	(0.083)	(0.052)	(0.036)	(0.061)
cons	-0.775	-1.606	-1.563	-0.467	-1.338	-1.070	-1.088	-1.765	-1.860	-1.445	-1.698	-1.725
	(0.514)	(0.181)	(0.355)	(0.276)	(0.228)	(0.098)	(0.458)	(0.254)	(0.316)	(0.238)	(0.127)	(0.325)
N	787	4315	1571	2223	4598	18562	598	2869	1430	2361	7964	1095
H	0.45	0.33	0.45	0.53	0.41	0.50	0.39	0.31	0.33	0.38	0.28	0.29
chi2	0.98***	0.99***	0.99***	0.99***	0.98***	0.99***	1.0***	0.99***	0.99***	0.98***	0.99***	0.99***
F_h0	22.76	98.72	47.76	141.08	109.39	771.54	31.65	42.26	36.75	78.52	142.69	24.91
p_h0	0.01	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.04	0.00	0.00	0.02
p_h1	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
F_h1	67.21	589.19	73.36	155.89	231.79	933.91	1.0***	236.05	103.94	210.87	1151.18	186.90

Where: Cost of labour (w1)= Salaries and benefits /Total assets; Cost of capital (w2) = Non-interest expenses minus salaries and benefits/ premises and fixed assets; Cost of physical capital (w3) = Non-interest expenses/ the Salaries and benefits; equity = total equity / total assets; loans= Net Loan / total assets ; lnassets= Log of Total assets; standard errors (s.e.) are shown in italics: H is Panzae-Rosse H- statistic; standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels; The Wald test is used to test H=0 and H=1.

Table 3.7: Evolution of dynamic H-statistic for all U.S. banks in the sample across states.

Variable	N	δ1	S.E	HD	AR1	AR2	SIG2	SARG
All U.S.A.	159026	0.22	(0.0030)	0.78	-13.10	-3.49	0.010	8772
Alabama	3270	0.16	(0.0001)	0.67	-1.52	-2.05	0.008	238
Arizona	388	-0.01	(0.0028)	0.67	-0.64	-0.84	0.012	51
Arkansas	3976	0.17	(0.0001)	PC 1.00	-1.40	-1.10	0.009	285
California	3694	0.06	(0.0001)	0.80	-1.40	-3.78	0.010	349
Colorado	3744	0.14	(0.0001)	PC 1.0	-1.21	-4.16	0.009	313
Connecticut	446	0.26	(0.0031)	0.53	0.31	-0.08	0.009	61
Florida	4269	0.18	(0.0006)	0.80	-1.64	-3.61	0.010	390
Georgia	5980	0.21	(0.0013)	0.81	-1.46	-4.11	0.008	422
Illinois	14627	0.25	(0.0047)	0.90	-4.63	-1.66	0.009	869
Indiana	3664	0.07	(0.0003)	0.69	-0.78	-0.73	0.008	285
Iowa	8406	0.23	(0.0022)	PC 1.0	-2.77	-1.29	0.008	504
Kansas	7609	0.25	(0.0019)	PC 0.94	-3.22	-2.94	0.010	478
Kentucky	4727	0.23	(0.0005)	0.64	-2.53	-2.17	0.007	348
Louisiana	3253	0.25	(0.0002)	0.66	-2.38	-1.43	0.007	232
Maryland	1379	0.26	(0.0003)	0.35	-0.97	-0.14	0.005	110
Massachusetts	751	0.20	(0.0021)	0.80	0.50	-2.28	0.009	79
Michigan	3390	0.21	(0.0001)	0.84	-0.96	-1.53	0.007	281
Minnesota	9555	0.22	(0.0030)	PC 0.97	-4.02	-2.50	0.009	560
Mississippi	1996	0.33	(0.0003)	-0.44	-2.01	-1.11	0.006	138
Missouri	8018	0.19	(0.0016)	PC 0.94	-1.80	-3.01	0.010	521
Montana	1924	0.15	(0.0003)	0.90	-0.80	-1.20	0.007	158
Nebraska	5217	0.20	(0.0012)	0.77	-1.57	-0.84	0.008	355
New Jersey	1137	0.14	(0.0003)	0.49	-1.45	-1.37	0.007	120
New Mexico	1203	0.14	(0.0002)	0.82	-0.49	-0.73	0.009	100
New York	2216	0.02	(0.0001)	0.74	0.19	-1.95	0.010	175
North Carolina	1048	0.21	(0.0004)	0.25	-0.11	-3.17	0.007	107
North Dakota	2242	0.30	(0.0001)	PC 1.16	-2.18	-3.40	0.008	147
Ohio	4166	0.28	(0.0001)	0.59	-2.40	-1.92	0.007	293
Oklahoma	6077	0.23	(0.0011)	PC 1.03	-1.81	-1.77	0.009	375
Oregon	663	0.12	(0.0018)	0.64	-1.23	-0.31	0.008	55
Pennsylvania	3627	0.22	(0.0001)	0.54	-1.35	0.17	0.006	270
South Carolina	1319	0.14	(0.0003)	0.62	0.55	-2.94	0.008	110
South Dakota	1902	0.27	(0.0002)	0.85	-1.38	-2.21	0.009	122
Tennessee	3893	0.19	(0.0002)	0.71	-2.10	-0.90	0.008	289
Texas	15499	0.18	(0.0041)	0.91	-3.91	-2.15	0.010	954
Utah	503	0.24	(0.0066)	0.39	-1.40	-1.36	0.007	38
Virginia	2392	0.22	(0.0001)	0.29	-1.04	-2.08	0.006	199
Washington	1158	0.13	(0.0004)	0.83	3.26	-2.14	0.007	109
West Virginia	1937	0.18	(0.0002)	0.81	-1.38	0.80	0.006	166
Wisconsin	6841	0.20	(0.0011)	0.48	-2.61	-0.51	0.007	442
Wyoming	920	0.04	(0.0006)	0.60	-0.15	0.20	0.008	72

Where: N is the number of observation used in the estimation; δ1 is the GMM estimated revenue (see equation 3.2); HD is the GMM Panzae-Rosse H- statistic; Standard errors (S.E) are shown in parentheses; SIG2 is the p-value for the SARG test for the validity of over-idetification restrictions in the GMM estimation; AR1 and AR 2 is the z-statistic for the test for the first and second-order autocorrelation in the residual from the GMM estimation. PC means estimate H-statistic is not significant different from one.

Table 3.8. Average coefficients dynamic H-statistic using (GMM) estimation results of equation (3.2) for the period 1987-2010 by States

Variable	All U.S.A.	Alabama	Arizona	Arkansas	California	Colorado	Connecticut	Florida	Georgia	Illinois	Indiana	Iowa	Kansas	Kentucky
δ1	0.219	0.165	-0.009	0.171	0.059	0.141	0.257	0.176	0.210	0.252	0.071	0.231	0.247	0.226
	(0.0030)	(0.0001)	(0.0028)	(0.0001)	(0.0001)	(0.0001)	(0.0031)	(0.0006)	(0.0013)	(0.0047)	(0.0003)	(0.0022)	(0.0019)	(0.0005)
w1	0.593	0.619	0.554	0.690	0.774	0.688	0.494	0.676	0.750	0.678	0.621	0.718	0.677	0.526
	(0.0089)	(0.0005)	(0.0084)	(0.0002)	(0.0005)	(0.0003)	(0.0123)	(0.0013)	(0.0034)	(0.0081)	(0.0005)	(0.0048)	(0.0032)	(0.0012)
w2	0.025	0.021	-0.022	0.109	0.001	0.079	-0.012	0.022	0.009	0.029	0.030	0.036	0.037	0.015
	(0.0022)	(0.0002)	(0.0051)	(0.0001)	(0.0004)	(0.0001)	(0.0030)	(0.0006)	(0.0019)	(0.0035)	(0.0005)	(0.0016)	(0.0020)	(0.0005)
w3	-0.009	-0.078	0.142	0.029	-0.022	0.132	-0.089	-0.035	-0.121	-0.032	-0.010	0.018	-0.004	-0.045
	(0.0047)	(0.0003)	(0.0090)	(0.0003)	(0.0004)	(0.0004)	(0.0071)	(0.0010)	(0.0038)	(0.0068)	(0.0003)	(0.0032)	(0.0039)	(0.0008)
lnassets	0.613	0.720	0.849	0.671	0.920	0.715	0.691	0.771	0.791	0.638	0.726	0.571	0.617	0.653
	(0.0058)	(0.0005)	(0.0083)	(0.0002)	(0.0003)	(0.0005)	(0.0064)	(0.0011)	(0.0040)	(0.0089)	(0.0006)	(0.0059)	(0.0054)	(0.0010)
quity	-0.130	-0.152	-0.034	-0.289	-0.056	-0.037	0.050	-0.008	-0.006	-0.192	-0.375	-0.327	-0.374	-0.109
	(0.0054)	(0.0003)	(0.0173)	(0.0003)	(0.0003)	(0.0002)	(0.0016)	(0.0006)	(0.0026)	(0.0087)	(0.0005)	(0.0067)	(0.0048)	(0.0008)
loans	0.136	0.236	0.374	0.230	0.318	0.146	0.105	0.245	0.129	0.089	0.110	-0.074	0.100	0.134
	(0.0056)	(0.0005)	(0.0072)	(0.0002)	(0.0005)	(0.0003)	(0.0062)	(0.0012)	(0.0056)	(0.0097)	(0.0004)	(0.0068)	(0.0046)	(0.0014)
cons	2.218	2.176	0.537	1.918	1.177	1.338	1.762	1.734	2.058	2.027	1.922	2.314	1.503	1.800
	(0.0430)	(0.0032)	(0.0337)	(0.0037)	(0.0052)	(0.0037)	(0.0742)	(0.0106)	(0.0208)	(0.0593)	(0.0067)	(0.0454)	(0.0312)	(0.0081)
HD	0.78	0.67	0.67	1.00	0.80	1.05	0.53	0.80	0.81	0.90	0.69	1.00	0.94	0.64
N	159026	3270	388	3976	3694	3744	446	4269	5980	14627	3664	8406	7609	4727
chi2	81300	81000***	408000***	65800***	85100***	22900***	13800***	38200***	2640***	47300***	285000***	15300***	2230***	31200***
artests	2	2	2	2	2	2	2	2	2	2	2	2	2	2
AR1	-13.1	-1.5	-0.6	-1.4	-1.4	-1.2	0.3	-1.6	-1.5	-4.6	-0.8	-2.8	-3.2	-2.5
AR2	-3.5	-2.0	-0.8	-1.1	-3.8	-4.2	-0.1	-3.6	-4.1	-1.7	-0.7	-1.3	-2.9	-2.2
sig2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SAEG	8771.7	238.4	50.6	284.9	348.7	313.0	60.7	389.8	421.6	868.5	285.0	503.7	477.5	348.4

Where: Cost of labour (w1)= Salaries and benefits /Total assets; Cost of capital (w2) = Non-interest expenses minus salaries and benefits/ premises and fixed assets; Cost of physical capital (w3) = Non-interest expenses/ the Salaries and benefits; equity = total equity / total assets; loans= Net Loan / total assets; lnassets= Log of Total assets; standard errors (s.e.) are shown in italics: δ1 is the GMM estimated revenue (see equation 3.2); HD is theGMM ; Panzae-Rosse H- statistic; AR1 And AR 2 is the z-statistic for the test for the first and second-order autocorrelation in the residual from the GMM estimation;SIG2 is the p-value for sargen test for the validity of Pobust standard errors are reported Sarg is the p-value for the sargen test for the validity of Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Table 3.9: Average coefficients dynamic H-statistic using (GMM) estimation results of equation (3.2) for the period 1987-2010 by States (continued)

Variable	Louisiana	Maryland	Massachusetts	Michigan	Minnesota	Mississippi	Missouri	Montana	Nebraska	New Jersey	New Mexico	New York	North Carolina	North Dakota
δ1	0.250	0.255	0.205	0.207	0.221	0.335	0.185	0.151	0.203	0.136	0.136	0.022	0.210	0.300
	(0.0002)	(0.0003)	(0.0021)	(0.0001)	(0.0030)	(0.0003)	(0.0016)	(0.0003)	(0.0012)	(0.0003)	(0.0002)	(0.0001)	(0.0004)	(0.0001)
w1	0.291	0.305	0.667	0.644	0.707	-0.223	0.793	0.644	0.518	0.450	0.667	0.704	0.221	0.690
	(0.0005)	(0.0007)	(0.0019)	(0.0003)	(0.0052)	(0.0012)	(0.0046)	(0.0006)	(0.0022)	(0.0011)	(0.0005)	(0.0003)	(0.0013)	(0.0003)
w2	-0.017	-0.030	0.051	0.071	0.033	-0.012	0.076	0.045	0.042	-0.020	0.011	0.002	-0.018	0.012
	(0.0003)	(0.0002)	(0.0009)	(0.0001)	(0.0026)	(0.0002)	(0.0015)	(0.0003)	(0.0009)	(0.0009)	(0.0002)	(0.0004)	(0.0004)	(0.0002)
w3	0.223	-0.015	-0.084	-0.053	0.022	-0.055	-0.101	0.071	0.051	-0.006	0.033	0.017	-0.009	0.108
	(0.0002)	(0.0002)	(0.0017)	(0.0002)	(0.0043)	(0.0005)	(0.0041)	(0.0003)	(0.0016)	(0.0007)	(0.0004)	(0.0003)	(0.0004)	(0.0003)
Lnasset	0.345	0.620	0.715	0.662	0.607	0.471	0.720	0.661	0.558	0.766	0.669	0.773	0.647	0.488
	(0.0005)	(0.0007)	(0.0014)	(0.0003)	(0.0054)	(0.0006)	(0.0054)	(0.0003)	(0.0024)	(0.0007)	(0.0004)	(0.0004)	(0.0010)	(0.0004)
quity	-0.108	0.018	-0.051	-0.116	-0.215	0.006	-0.234	-0.123	-0.264	-0.103	-0.076	-0.149	0.041	-0.185
	(0.0004)	(0.0004)	(0.0031)	(0.0003)	(0.0069)	(0.0004)	(0.0041)	(0.0005)	(0.0026)	(0.0007)	(0.0005)	(0.0004)	(0.0004)	(0.0003)
Loans	0.128	0.266	0.260	0.138	-0.076	0.414	0.015	0.012	-0.099	0.333	0.299	0.204	0.370	-0.180
	(0.0004)	(0.0005)	(0.0029)	(0.0004)	(0.0074)	(0.0007)	(0.0054)	(0.0007)	(0.0017)	(0.0009)	(0.0008)	(0.0002)	(0.0006)	(0.0005)
cons	2.135	1.197	2.505	2.442	2.096	0.367	2.483	1.814	1.680	0.918	2.600	2.692	1.087	2.127
	(0.0041)	(0.0042)	(0.0170)	(0.0047)	(0.0375)	(0.0052)	(0.0327)	(0.0047)	(0.0157)	(0.0098)	(0.0028)	(0.0045)	(0.0068)	(0.0031)
HD	0.66	0.35	0.80	0.84	0.98	-0.44	0.94	0.90	0.77	0.49	0.82	0.74	0.25	1.16
N	3253	1379	751	3390	9555	1996	8018	1924	5217	1137	1203	2216	1048	2242
chi2	62100***	32300***	99500***	35200***	99600***	14400***	2520***	679000***	5800***	15100***	176000***	3730***	15400***	19600***
artests	2	2	2	2	2	2	2	2	2	2	2	2	2	2
AR1	-2.38	-0.97	0.50	-0.96	-4.02	-2.01	-1.80	-0.80	-1.57	-1.45	-0.49	0.19	-0.11	-2.18
AR2	-1.43	-0.14	-2.28	-1.53	-2.50	-1.11	-3.01	-1.20	-0.84	-1.37	-0.73	-1.95	-3.17	-3.40
sig2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
sargan	231.6	109.8	78.6	281.3	559.6	137.5	520.9	158.3	355.1	120.0	100.2	175.3	106.6	147.3

Where: Cost of labour (w1)= Salaries and benefits /Total assets; Cost of capital (w2) = Non-interest expenses minus salaries and benefits/ premises and fixed assets; Cost of physical capital (w3) = Non-interest expenses/ the Salaries and benefits; equity = total equity / total assets; loans= Net Loan / total assets; lnassets= Log of Total assets; standard errors (s.e.) are shown in italics δ1 is the GMM estimated revenue (see equation 3.2); HD is the GMM ; Panzae-Rosse H- statistic; AR1 And AR 2 is the z-statistic for the test for the first and second-order autocorrelation in the residual from the GMM estimation;SIG2 is the p-value for sargen test for the validity of Pobust standard errors are reported Sarg is the p-value for the sargen test for the validity of Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Table 3.10: Average coefficients dynamic H-statistic using (GMM) estimation results of equation (3.2) for the period 1987-2010 by States (continued)

Variable	Ohio	Oklahoma	Oregon	Pennsylvania	South Carolina	South Dakota	Tennessee	Texas	Utah	Virginia	Washington	West Virginia	Wisconsin	Wyoming
δ1	0.281	0.235	0.123	0.222	0.139	0.272	0.190	0.180	0.241	0.220	0.132	0.175	0.200	0.040
	(0.0001)	(0.0011)	(0.0018)	(0.0001)	(0.0003)	(0.0002)	(0.0002)	(0.0041)	(0.0066)	(0.0001)	(0.0004)	(0.0002)	(0.0011)	(0.0006)
w1	0.406	0.648	0.509	0.434	0.597	0.315	0.570	0.549	0.389	0.165	0.713	0.545	0.457	0.579
	(0.0002)	(0.0019)	(0.0038)	(0.0003)	(0.0025)	(0.0006)	(0.0003)	(0.0110)	(0.0185)	(0.0002)	(0.0008)	(0.0004)	(0.0020)	(0.0033)
w2	0.026	0.058	0.047	-0.026	0.052	0.043	0.079	0.041	-0.052	0.020	0.005	-0.003	0.004	0.070
	(0.0001)	(0.0010)	(0.0012)	(0.0002)	(0.0007)	(0.0003)	(0.0001)	(0.0042)	(0.0046)	(0.0001)	(0.0005)	(0.0002)	(0.0008)	(0.0009)
w3	-0.005	0.085	0.007	0.012	-0.115	0.264	-0.072	0.156	-0.042	0.038	0.002	0.123	-0.079	-0.074
	(0.0002)	(0.0019)	(0.0019)	(0.0003)	(0.0016)	(0.0008)	(0.0001)	(0.0071)	(0.0099)	(0.0002)	(0.0006)	(0.0003)	(0.0014)	(0.0039)
lnassets	0.521	0.587	0.763	0.567	0.828	0.347	0.643	0.473	0.616	0.573	0.763	0.532	0.708	0.904
	(0.0002)	(0.0025)	(0.0020)	(0.0004)	(0.0017)	(0.0010)	(0.0003)	(0.0090)	(0.0096)	(0.0003)	(0.0007)	(0.0006)	(0.0019)	(0.0048)
equity	-0.096	-0.272	0.011	-0.178	-0.077	-0.118	-0.207	-0.127	-0.076	0.021	-0.025	-0.049	-0.281	-0.054
	(0.0004)	(0.0024)	(0.0033)	(0.0001)	(0.0014)	(0.0009)	(0.0001)	(0.0064)	(0.0041)	(0.0002)	(0.0007)	(0.0002)	(0.0019)	(0.0022)
loans	0.093	-0.052	0.185	0.275	0.319	-0.076	0.360	0.150	0.352	0.330	0.216	0.076	0.157	0.071
	(0.0001)	(0.0027)	(0.0009)	(0.0003)	(0.0018)	(0.0010)	(0.0002)	(0.0088)	(0.0091)	(0.0002)	(0.0010)	(0.0002)	(0.0023)	(0.0018)
cons	2.113	1.400	1.293	2.132	1.519	1.617	2.545	2.760	1.736	1.138	1.917	2.655	0.914	1.048
	(0.0044)	(0.0146)	(0.0157)	(0.0044)	(0.0145)	(0.0046)	(0.0037)	(0.0600)	(0.0819)	(0.0022)	(0.0036)	(0.0052)	(0.0146)	(0.0111)
HD	0.59	1.03	0.64	0.54	0.62	0.85	0.71	0.91	0.39	0.29	0.83	0.81	0.48	0.60
N	4166	6077	663	3627	1319	1902	3893	15499	503	2392	1158	1937	6841	920
chi2	1210***	5190***	89000***	114000***	33500***	43000***	74400***	330***	2540***	14700***	26200***	679000***	6080***	36100***
artests	2	2	2	2	2	2	2	2	2	2	2	2	2	2
AR1	-2.40	-1.81	-1.23	-1.35	0.55	-1.38	-2.10	-3.91	-1.40	-1.04	3.26	-1.38	-2.61	-0.15
AR2	-1.92	-1.77	-0.31	0.17	-2.94	-2.21	-0.90	-2.15	-1.36	-2.08	-2.14	0.80	-0.51	0.20
sig2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
sargan	293.3	375.3	55.0	269.7	109.5	122.4	289.4	954.4	38.0	199.0	109.1	165.9	441.8	71.8

Where: Cost of labour (w1)= Salaries and benefits /Total assets; Cost of capital (w2) = Non-interest expenses minus salaries and benefits/ premises and fixed assets; Cost of physical capital (w3) = Non-interest expenses/ the Salaries and benefits; equity = total equity / total assets; loans= Net Loan / total assets; lnassets= Log of Total assets; standard errors (s.e.) are shown in italics: δ1 is the GMM estimated revenue (see equation 3.2); HD is theGMM ; Panzae-Rosse H- statistic; AR1 And AR 2 is the z-statistic for the test for the first and second-order autocorrelation in the residual from the GMM estimation;SIG2 is the p-value for sargen test for the validity of Pobust standard errors are reported Sarg is the p-value for the sargen test for the validity of Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Table 3.11.Translog regression to calculate the marginal costs

		Coef.	Std.Err.	z	P>z
Y_{it}	β	0.99***	0.0263	37.56	0
$\ln\left(\frac{W_1}{W_3}\right)$	γ_1	0.08***	0.0052	14.64	0
$\ln\left(\frac{W_2}{W_3}\right)$	γ_2	0.41***	0.0077	52.46	0
E_1	κ_1	-0.01***	0.0039	-3.77	0
E_2	κ_2	0.11***	0.0154	6.87	0
E_3	κ_3	0.20***	0.0031	63.38	0
Trend	Ψ	0	0.0058	-0.38	0.702
$[lnY]^2$	η	0.19***	0.0069	27.25	0
$\ln\left(\frac{W_1}{W_3}\right)$ $\ln\left(\frac{W_1}{W_3}\right)$	δ_1	-0.01***	0.0003	-44.37	0
$\ln\left(\frac{W_2}{W_3}\right)$ $\ln\left(\frac{W_2}{W_3}\right)$	δ_2	0.00***	0.0008	3.55	0
$\ln\left(\frac{W_1}{W_3}\right)$ $\ln\left(\frac{W_2}{W_3}\right)$	δ_3	0.05***	0.0004	138.13	0
$[lnTrend]^2$	π	-0.05***	0.0004	-122.57	0
$lnY\ ln\left(\frac{W_1}{W_3}\right)$	ϖ_1	0.10***	0.0012	85.06	0
$lnY\ ln\left(\frac{W_2}{W_3}\right)$	ϖ_2	0.06***	0.002	30.41	0
lnY lnTrend	θ	-0.07***	0.0015	-50.36	0
$\ln E_1 \ln\left(\frac{W_1}{W_3}\right)$	φ_{11}	-0.00***	0.0002	-9.48	0
$\ln E_2 \ln\left(\frac{W_1}{W_3}\right)$	φ_{21}	-0.10***	0.0007	-132.12	0
$\ln E_3 \ln\left(\frac{W_1}{W_3}\right)$	φ_{31}	0.03***	0.0003	107.34	0
$\ln E_1 \ln\left(\frac{W_2}{W_3}\right)$	φ_{12}	-0.00***	0.0003	-4.44	0
$\ln E_2 \ln\left(\frac{W_2}{W_3}\right)$	φ_{22}	-0.05***	0.0014	-37.81	0
$\ln E_3 \ln\left(\frac{W_2}{W_3}\right)$	φ_{32}	-0.05***	0.0005	-90.3	0
$lnTrend\ lnE_1$	ϕ_1	0.00***	0.0002	3.92	0
$lnTrend\ lnE_2$	ϕ_2	0.07***	0.0009	72.02	0
$lnTrend\ lnE_3$	ϕ_3	0.01***	0.0007	8.17	0
_cons	α	-89.65***	4.672	-19.19	0
/mu		90.22***	4.6725	19.31	0
/eta		-0.00***	0	-19.32	0
/lnsigma2		-4.21***	0.0121	-348.54	0
/ilgtgamma		0.40***	0.0221	18.31	0
sigma2		0.0148	0.0002		
gamma		0.5996	0.0053		
sigma_u2		0.0089	0.0002		
sigma_v2		0.0059	0		
Log likelihood		152960.07			
Wald chi2(27)		6070000			

Table 3.12: Evolution of marginal costs for all U.S. banks in the sample across states in all years (1987-2012).

States	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Mean
Alabama	0.055	0.058	0.062	0.063	0.061	0.050	0.044	0.044	0.048	0.049	0.049	0.049	0.047	0.050	0.048	0.037	0.033	0.031	0.033	0.039	0.047	0.042	0.036	0.032	0.047
Arizona	0.071	0.075	0.079	0.086	0.075	0.055	0.050	0.047	0.049	0.049	0.049	0.049	0.057	0.056	0.055	0.041	0.036	0.033	0.034	0.048	0.051	0.049	0.041	0.038	0.057
Arkansas	0.053	0.054	0.058	0.056	0.053	0.042	0.038	0.039	0.043	0.045	0.045	0.045	0.045	0.049	0.047	0.037	0.033	0.031	0.035	0.042	0.045	0.040	0.034	0.032	0.044
California	0.061	0.059	0.062	0.071	0.069	0.061	0.057	0.055	0.057	0.053	0.051	0.050	0.050	0.051	0.047	0.035	0.030	0.028	0.032	0.039	0.042	0.036	0.033	0.028	0.053
Colorado	0.065	0.063	0.067	0.069	0.064	0.053	0.045	0.046	0.048	0.049	0.050	0.049	0.049	0.052	0.048	0.040	0.036	0.035	0.038	0.044	0.045	0.040	0.035	0.034	0.052
Connecticut	0.048	0.052	0.063	0.073	0.063	0.051	0.045	0.044	0.046	0.046	0.050	0.047	0.050	0.051	0.042	0.038	0.029	0.026	0.031	0.034	0.039	0.035	0.031	0.030	0.050
Florida	0.062	0.060	0.065	0.069	0.064	0.052	0.048	0.046	0.051	0.051	0.053	0.052	0.052	0.054	0.051	0.040	0.035	0.030	0.033	0.042	0.049	0.043	0.039	0.034	0.052
Georgia	0.058	0.060	0.067	0.068	0.066	0.055	0.049	0.047	0.051	0.052	0.052	0.052	0.050	0.053	0.050	0.040	0.036	0.034	0.038	0.043	0.049	0.044	0.040	0.036	0.051
Illinois	0.053	0.053	0.058	0.060	0.057	0.047	0.041	0.041	0.045	0.045	0.046	0.046	0.045	0.047	0.045	0.036	0.032	0.030	0.033	0.039	0.042	0.038	0.033	0.030	0.045
Indiana	0.053	0.054	0.058	0.060	0.058	0.048	0.043	0.042	0.046	0.046	0.047	0.046	0.044	0.048	0.046	0.038	0.034	0.032	0.036	0.040	0.043	0.038	0.034	0.030	0.047
Iowa	0.051	0.052	0.056	0.056	0.054	0.045	0.040	0.040	0.044	0.044	0.045	0.044	0.044	0.046	0.044	0.036	0.032	0.030	0.033	0.038	0.041	0.036	0.030	0.027	0.043
Kansas	0.054	0.055	0.060	0.060	0.057	0.048	0.042	0.043	0.048	0.048	0.047	0.047	0.047	0.050	0.048	0.039	0.035	0.033	0.036	0.041	0.044	0.040	0.034	0.031	0.047
Kentucky	0.052	0.055	0.060	0.061	0.058	0.047	0.041	0.042	0.046	0.048	0.048	0.048	0.047	0.050	0.048	0.039	0.035	0.034	0.037	0.042	0.045	0.041	0.036	0.033	0.047
Louisiana	0.062	0.062	0.067	0.066	0.061	0.048	0.044	0.044	0.048	0.049	0.048	0.048	0.048	0.050	0.047	0.039	0.036	0.035	0.036	0.041	0.045	0.039	0.034	0.032	0.049
Maryland	0.050	0.052	0.057	0.063	0.060	0.049	0.042	0.042	0.045	0.046	0.045	0.044	0.044	0.046	0.042	0.035	0.031	0.030	0.032	0.037	0.043	0.039	0.035	0.033	0.045
Massachusetts	0.048	0.065	0.072	0.087	0.080	0.054	0.047	0.044	0.048	0.059	0.046	0.052	0.052	0.043	0.040	0.034	0.032	0.029	0.032	0.039	0.042	0.037	0.032	0.026	0.054
Michigan	0.053	0.054	0.058	0.061	0.059	0.049	0.045	0.044	0.048	0.048	0.050	0.049	0.047	0.050	0.048	0.039	0.036	0.034	0.037	0.043	0.046	0.042	0.038	0.035	0.048
Minnesota	0.056	0.057	0.061	0.061	0.058	0.049	0.044	0.044	0.047	0.047	0.048	0.047	0.047	0.049	0.046	0.037	0.034	0.032	0.035	0.041	0.044	0.040	0.035	0.031	0.047
Mississippi	0.055	0.059	0.063	0.063	0.058	0.047	0.042	0.042	0.046	0.048	0.049	0.048	0.047	0.051	0.049	0.040	0.035	0.034	0.035	0.042	0.047	0.042	0.037	0.033	0.047
Missouri	0.053	0.054	0.058	0.060	0.056	0.046	0.041	0.041	0.045	0.046	0.046	0.047	0.046	0.049	0.047	0.037	0.033	0.031	0.035	0.042	0.045	0.041	0.035	0.032	0.046
Montana	0.056	0.057	0.060	0.061	0.056	0.047	0.043	0.043	0.047	0.048	0.051	0.050	0.048	0.051	0.048	0.041	0.035	0.032	0.034	0.038	0.044	0.040	0.035	0.032	0.048
Nebraska	0.052	0.052	0.057	0.058	0.055	0.046	0.042	0.042	0.047	0.047	0.048	0.046	0.045	0.046	0.045	0.038	0.034	0.036	0.038	0.045	0.046	0.038	0.033	0.029	0.046
New Jersey	0.050	0.050	0.059	0.062	0.056	0.046	0.040	0.038	0.044	0.042	0.044	0.044	0.042	0.046	0.041	0.032	0.028	0.026	0.030	0.038	0.039	0.034	0.032	0.031	0.044
New Mexico	0.063	0.063	0.066	0.066	0.061	0.051	0.045	0.046	0.050	0.051	0.051	0.049	0.047	0.049	0.046	0.037	0.034	0.032	0.034	0.040	0.043	0.038	0.032	0.030	0.049
New York	0.049	0.054	0.061	0.066	0.060	0.050	0.045	0.044	0.050	0.048	0.048	0.050	0.047	0.049	0.046	0.040	0.032	0.031	0.035	0.041	0.040	0.035	0.030	0.027	0.047
North Carolina	0.056	0.059	0.065	0.067	0.066	0.055	0.047	0.048	0.050	0.052	0.048	0.048	0.046	0.050	0.048	0.037	0.034	0.032	0.036	0.043	0.046	0.042	0.035	0.033	0.049
North Dakota	0.053	0.053	0.058	0.057	0.055	0.046	0.040	0.040	0.045	0.047	0.047	0.048	0.046	0.048	0.046	0.037	0.033	0.032	0.034	0.041	0.044	0.038	0.032	0.028	0.045
Ohio	0.053	0.053	0.057	0.061	0.059	0.048	0.043	0.044	0.046	0.048	0.050	0.049	0.047	0.050	0.047	0.040	0.036	0.032	0.036	0.040	0.043	0.038	0.033	0.030	0.047
Oklahoma	0.059	0.060	0.064	0.064	0.061	0.050	0.045	0.046	0.050	0.050	0.050	0.050	0.050	0.053	0.050	0.041	0.036	0.035	0.038	0.043	0.046	0.041	0.035	0.032	0.049
Oregon	0.063	0.063	0.065	0.068	0.064	0.058	0.055	0.053	0.057	0.054	0.056	0.054	0.053	0.058	0.061	0.053	0.035	0.031	0.036	0.043	0.048	0.046	0.040	0.034	0.055
Pennsylvania	0.050	0.051	0.056	0.059	0.056	0.046	0.041	0.040	0.044	0.044	0.044	0.044	0.044	0.047	0.044	0.037	0.033	0.031	0.033	0.038	0.041	0.037	0.033	0.030	0.045
South Carolina	0.055	0.058	0.062	0.068	0.064	0.052	0.047	0.046	0.049	0.049	0.048	0.048	0.046	0.051	0.048	0.038	0.035	0.032	0.036	0.042	0.046	0.042	0.036	0.034	0.048
South Dakota	0.049	0.052	0.058	0.059	0.056	0.049	0.043	0.045	0.049	0.058	0.062	0.059	0.057	0.058	0.052	0.043	0.038	0.039	0.040	0.044	0.047	0.039	0.033	0.029	0.049
Tennessee	0.055	0.057	0.063	0.064	0.060	0.048	0.043	0.043	0.051	0.051	0.052	0.050	0.049	0.057	0.051	0.040	0.036	0.034	0.038	0.044	0.048	0.044	0.038	0.035	0.049
Texas	0.060	0.061	0.067	0.064	0.061	0.048	0.042	0.043	0.047	0.047	0.047	0.047	0.047	0.050	0.047	0.039	0.034	0.032	0.035	0.040	0.043	0.038	0.033	0.030	0.048
Utah	0.063	0.063	0.067	0.069	0.063	0.053	0.048	0.049	0.054	0.053	0.053	0.055	0.053	0.053	0.048	0.040	0.037	0.035	0.038	0.042	0.046	0.041	0.037	0.037	0.052
Virginia	0.053	0.056	0.062	0.067	0.063	0.051	0.044	0.044	0.047	0.046	0.046	0.046	0.047	0.049	0.046	0.037	0.035	0.034	0.036	0.043	0.047	0.041	0.038	0.034	0.048
Washington	0.063	0.064	0.064	0.066	0.063	0.053	0.049	0.049	0.055	0.054	0.052	0.052	0.051	0.056	0.051	0.041	0.038	0.036	0.039	0.044	0.046	0.043	0.037	0.033	0.052
West Virginia	0.056	0.056	0.061	0.062	0.058	0.048	0.042	0.041	0.046	0.046	0.046	0.046	0.045	0.048	0.046	0.038	0.034	0.032	0.034	0.039	0.041	0.038	0.034	0.031	0.048
Wisconsin	0.054	0.054	0.058	0.060	0.058	0.049	0.043	0.042	0.047	0.047	0.047	0.046	0.045	0.048	0.046	0.037	0.034	0.031	0.034	0.040	0.043	0.038	0.033	0.030	0.046
Wyoming	0.057	0.057	0.059	0.059	0.053	0.046	0.041	0.041	0.046	0.045	0.045	0.047	0.046	0.046	0.042	0.035	0.031	0.030	0.033	0.040	0.045	0.041	0.035	0.033	0.045
Mean	0.055	0.056	0.061	0.063	0.059	0.049	0.043	0.043	0.047	0.048	0.048	0.048	0.047	0.050	0.047	0.038	0.034	0.032	0.035	0.041	0.044	0.039	0.034	0.031	0.047

Model Estimated: per state and pre year translog frontier cost function to derive MC see Equation 3.4

Table 3.13: Evolution of Lerner values for all U.S. banks in the sample across states in all years (1987-2012).

State	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Mean
Alabama	0.40	0.38	0.36	0.36	0.36	0.42	0.44	0.44	0.41	0.41	0.41	0.40	0.40	0.39	0.40	0.46	0.47	0.48	0.46	0.43	0.40	0.38	0.39	0.42	0.41
Arizona	0.29	0.28	0.29	0.26	0.29	0.35	0.37	0.40	0.39	0.41	0.41	0.40	0.41	0.39	0.39	0.43	0.40	0.45	0.38	0.33	0.31	0.28	0.28	0.31	0.35
Arkansas	0.42	0.41	0.40	0.39	0.40	0.46	0.47	0.45	0.42	0.44	0.43	0.42	0.41	0.39	0.40	0.45	0.47	0.47	0.44	0.39	0.38	0.40	0.43	0.45	0.42
California	0.39	0.41	0.43	0.36	0.34	0.36	0.36	0.38	0.38	0.39	0.40	0.40	0.41	0.43	0.42	0.47	0.50	0.52	0.50	0.47	0.43	0.42	0.43	0.48	0.40
Colorado	0.35	0.36	0.37	0.34	0.35	0.40	0.43	0.44	0.43	0.42	0.41	0.41	0.40	0.39	0.39	0.43	0.43	0.43	0.42	0.39	0.38	0.39	0.42	0.39	0.39
Connecticut	0.41	0.41	0.37	0.28	0.32	0.37	0.40	0.42	0.41	0.41	0.42	0.43	0.45	0.42	0.43	0.45	0.46	0.49	0.46	0.42	0.40	0.39	0.42	0.43	0.39
Florida	0.36	0.36	0.35	0.32	0.33	0.38	0.40	0.40	0.39	0.38	0.38	0.36	0.36	0.35	0.34	0.39	0.42	0.44	0.44	0.38	0.32	0.30	0.28	0.32	0.36
Georgia	0.40	0.38	0.37	0.35	0.34	0.39	0.41	0.43	0.42	0.41	0.41	0.40	0.40	0.39	0.38	0.43	0.45	0.46	0.45	0.42	0.37	0.33	0.32	0.35	0.39
Illinois	0.40	0.40	0.40	0.37	0.37	0.41	0.43	0.43	0.41	0.40	0.40	0.39	0.38	0.38	0.38	0.44	0.45	0.46	0.43	0.39	0.36	0.38	0.40	0.43	0.40
Indiana	0.40	0.41	0.40	0.38	0.38	0.42	0.44	0.44	0.42	0.42	0.41	0.41	0.40	0.40	0.40	0.44	0.44	0.44	0.43	0.40	0.38	0.39	0.43	0.46	0.41
Iowa	0.43	0.43	0.42	0.40	0.41	0.45	0.47	0.46	0.43	0.43	0.42	0.41	0.41	0.39	0.40	0.45	0.46	0.47	0.44	0.40	0.39	0.42	0.46	0.48	0.43
Kansas	0.40	0.40	0.39	0.37	0.38	0.42	0.43	0.42	0.41	0.40	0.41	0.40	0.40	0.39	0.39	0.42	0.43	0.44	0.43	0.40	0.40	0.41	0.43	0.44	0.41
Kentucky	0.42	0.40	0.40	0.38	0.38	0.43	0.45	0.45	0.43	0.42	0.41	0.41	0.41	0.39	0.39	0.43	0.44	0.45	0.43	0.40	0.38	0.38	0.39	0.42	0.41
Louisiana	0.35	0.36	0.34	0.34	0.37	0.44	0.45	0.44	0.43	0.42	0.42	0.41	0.40	0.40	0.40	0.44	0.45	0.45	0.44	0.42	0.41	0.41	0.44	0.45	0.41
Maryland	0.43	0.42	0.40	0.36	0.36	0.41	0.45	0.46	0.43	0.44	0.44	0.44	0.45	0.44	0.44	0.49	0.50	0.49	0.48	0.45	0.40	0.38	0.39	0.42	0.43
Massachusetts	0.43	0.43	0.41	0.34	0.34	0.39	0.40	0.44	0.43	0.43	0.42	0.43	0.43	0.44	0.45	0.46	0.47	0.48	0.46	0.42	0.37	0.39	0.42	0.48	0.42
Michigan	0.41	0.42	0.41	0.38	0.38	0.42	0.43	0.43	0.41	0.40	0.40	0.40	0.39	0.39	0.39	0.44	0.45	0.44	0.43	0.39	0.36	0.35	0.37	0.40	0.40
Minnesota	0.40	0.40	0.39	0.38	0.38	0.43	0.44	0.44	0.42	0.43	0.42	0.41	0.41	0.40	0.40	0.45	0.46	0.46	0.44	0.40	0.38	0.38	0.40	0.42	0.41
Mississippi	0.40	0.38	0.37	0.37	0.40	0.45	0.47	0.47	0.45	0.44	0.43	0.42	0.41	0.39	0.38	0.44	0.45	0.45	0.43	0.41	0.38	0.39	0.40	0.42	0.42
Missouri	0.40	0.40	0.40	0.37	0.39	0.43	0.45	0.45	0.43	0.42	0.41	0.39	0.39	0.38	0.38	0.43	0.45	0.45	0.43	0.39	0.36	0.37	0.40	0.43	0.41
Montana	0.40	0.39	0.41	0.39	0.40	0.45	0.46	0.47	0.45	0.43	0.42	0.40	0.41	0.39	0.40	0.44	0.46	0.48	0.46	0.45	0.41	0.42	0.42	0.43	0.42
Nebraska	0.43	0.43	0.42	0.40	0.41	0.45	0.46	0.45	0.44	0.43	0.43	0.43	0.43	0.42	0.42	0.46	0.47	0.47	0.45	0.41	0.39	0.42	0.45	0.47	0.43
New Jersey	0.45	0.43	0.42	0.36	0.36	0.41	0.44	0.46	0.43	0.43	0.44	0.42	0.40	0.39	0.42	0.47	0.48	0.49	0.46	0.41	0.36	0.39	0.42	0.45	0.42
New Mexico	0.36	0.37	0.37	0.36	0.36	0.42	0.44	0.44	0.43	0.42	0.41	0.39	0.41	0.40	0.39	0.45	0.44	0.46	0.46	0.44	0.43	0.42	0.46	0.46	0.41
New York	0.45	0.44	0.43	0.37	0.37	0.42	0.44	0.45	0.42	0.42	0.42	0.41	0.43	0.41	0.42	0.46	0.47	0.48	0.46	0.43	0.40	0.42	0.45	0.48	0.43
North Carolina	0.35	0.35	0.34	0.30	0.31	0.34	0.38	0.38	0.37	0.37	0.37	0.37	0.38	0.36	0.35	0.43	0.42	0.43	0.43	0.39	0.33	0.31	0.37	0.40	0.36
North Dakota	0.42	0.42	0.40	0.39	0.40	0.45	0.46	0.46	0.43	0.42	0.42	0.41	0.40	0.40	0.40	0.44	0.45	0.46	0.45	0.40	0.38	0.40	0.43	0.46	0.42
Ohio	0.42	0.42	0.42	0.39	0.39	0.44	0.45	0.45	0.43	0.43	0.43	0.42	0.41	0.41	0.41	0.44	0.46	0.45	0.43	0.40	0.38	0.39	0.42	0.45	0.42
Oklahoma	0.39	0.38	0.37	0.36	0.37	0.42	0.43	0.42	0.40	0.40	0.40	0.40	0.39	0.38	0.39	0.42	0.44	0.45	0.43	0.40	0.39	0.41	0.44	0.45	0.40
Oregon	0.34	0.36	0.37	0.34	0.33	0.39	0.42	0.43	0.43	0.43	0.42	0.41	0.41	0.39	0.42	0.46	0.48	0.49	0.48	0.44	0.40	0.36	0.36	0.41	0.40
Pennsylvania	0.44	0.43	0.42	0.38	0.39	0.44	0.46	0.46	0.43	0.44	0.43	0.42	0.42	0.41	0.41	0.44	0.45	0.46	0.44	0.41	0.39	0.40	0.42	0.45	0.43
South Carolina	0.37	0.36	0.34	0.31	0.33	0.39	0.41	0.41	0.39	0.40	0.39	0.39	0.39	0.36	0.38	0.44	0.44	0.44	0.45	0.38	0.37	0.34	0.36	0.38	0.38
South Dakota	0.43	0.43	0.42	0.41	0.43	0.45	0.47	0.47	0.44	0.43	0.43	0.42	0.43	0.43	0.41	0.44	0.47	0.49	0.48	0.45	0.44	0.44	0.47	0.48	0.44
Tennessee	0.41	0.39	0.37	0.36	0.37	0.43	0.44	0.44	0.41	0.41	0.41	0.40	0.40	0.37	0.36	0.42	0.43	0.44	0.42	0.38	0.35	0.34	0.36	0.39	0.40
Texas	0.35	0.35	0.35	0.34	0.35	0.42	0.44	0.44	0.42	0.42	0.41	0.40	0.40	0.40	0.39	0.43	0.44	0.45	0.45	0.42	0.40	0.40	0.43	0.44	0.40
Utah	0.39	0.40	0.40	0.37	0.38	0.46	0.46	0.48	0.46	0.47	0.45	0.44	0.45	0.43	0.43	0.48	0.48	0.48	0.50	0.48	0.45	0.41	0.37	0.41	0.44
Virginia	0.40	0.38	0.37	0.33	0.34	0.39	0.42	0.43	0.42	0.43	0.43	0.42	0.40	0.38	0.38	0.44	0.45	0.46	0.44	0.41	0.38	0.39	0.40	0.42	0.40
Washington	0.35	0.36	0.36	0.33	0.34	0.39	0.42	0.41	0.39	0.38	0.39	0.37	0.37	0.35	0.37	0.43	0.43	0.44	0.42	0.40	0.39	0.38	0.35	0.39	0.38
West Virginia	0.38	0.38	0.38	0.37	0.38	0.43	0.45	0.46	0.43	0.43	0.43	0.42	0.40	0.38	0.39	0.43	0.45	0.46	0.45	0.43	0.41	0.42	0.43	0.45	0.41
Wisconsin	0.40	0.40	0.40	0.37	0.38	0.42	0.44	0.44	0.41	0.41	0.40	0.40	0.40	0.39	0.40	0.45	0.46	0.46	0.44	0.40	0.37	0.39	0.42	0.46	0.41
Wyoming	0.38	0.39	0.40	0.38	0.39	0.43	0.45	0.45	0.42	0.43	0.43	0.42	0.41	0.42	0.42	0.46	0.47	0.47	0.45	0.40	0.37	0.38	0.41	0.39	0.42
Grand Total	0.40	0.39	0.39	0.37	0.37	0.42	0.44	0.44	0.42	0.42	0.41	0.40	0.40	0.39	0.39	0.44	0.45	0.46	0.44	0.41	0.38	0.39	0.41	0.43	0.41

Model Estimated: per state and pre year calculation of the LI of MP (Lerner, 1934) see Equation 3.3

Table 3.14: Cross-states consistency of market competition measures.

States	LERNER	H-STATISTIC	H-DYNAMIC
Alabama	0.41	0.32	0.67
Arizona	0.35	0.49	0.67
Arkansas	0.42	0.45	1
California	0.4	0.46	0.8
Colorado	0.39	0.54	1.05
Connecticut	0.39	0.26	0.53
Florida	0.36	0.44	0.8
Georgia	0.39	0.4	0.81
Illinois	0.4	0.32	0.9
Indiana	0.41	0.35	0.69
Iowa	0.43	0.32	1
Kansas	0.41	0.43	0.94
Kentucky	0.41	0.36	0.64
Louisiana	0.41	0.4	0.66
Maryland	0.43	0.23	0.35
Massachusetts	0.42	0.55	0.8
Michigan	0.4	0.38	0.84
Minnesota	0.41	0.35	0.98
Mississippi	0.42	0.28	-0.44
Missouri	0.41	0.39	0.94
Montana	0.42	0.3	0.9
Nebraska	0.43	0.43	0.77
New Jersey	0.42	0.41	0.49
New Mexico	0.41	0.36	0.82
New York	0.43	0.44	0.74
North Carolina	0.36	0.32	0.25
North Dakota	0.42	0.37	1.16
Ohio	0.42	0.42	0.59
Oklahoma	0.4	0.44	1.03
Oregon	0.4	0.46	0.64
Pennsylvania	0.43	0.31	0.54
South Carolina	0.38	0.45	0.62
South Dakota	0.44	0.51	0.85
Tennessee	0.4	0.41	0.71
Texas	0.4	0.49	0.91
Utah	0.44	0.41	0.39
Virginia	0.4	0.29	0.29
Washington	0.38	0.33	0.83
West Virginia	0.41	0.39	0.81
Wisconsin	0.41	0.27	0.48
Wyoming	0.42	0.28	0.6
All U.S.A.	0.41	0.39	0.67

Figures 3.3. Evolution of Lerner values and marginal costs for all U.S. banks between 1987 and 2012

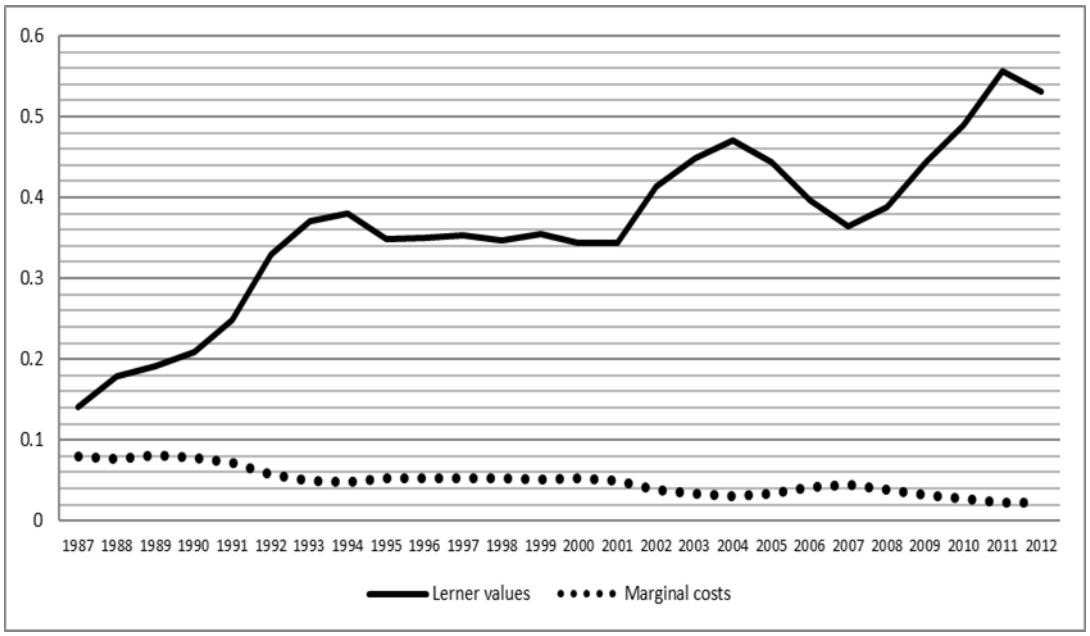
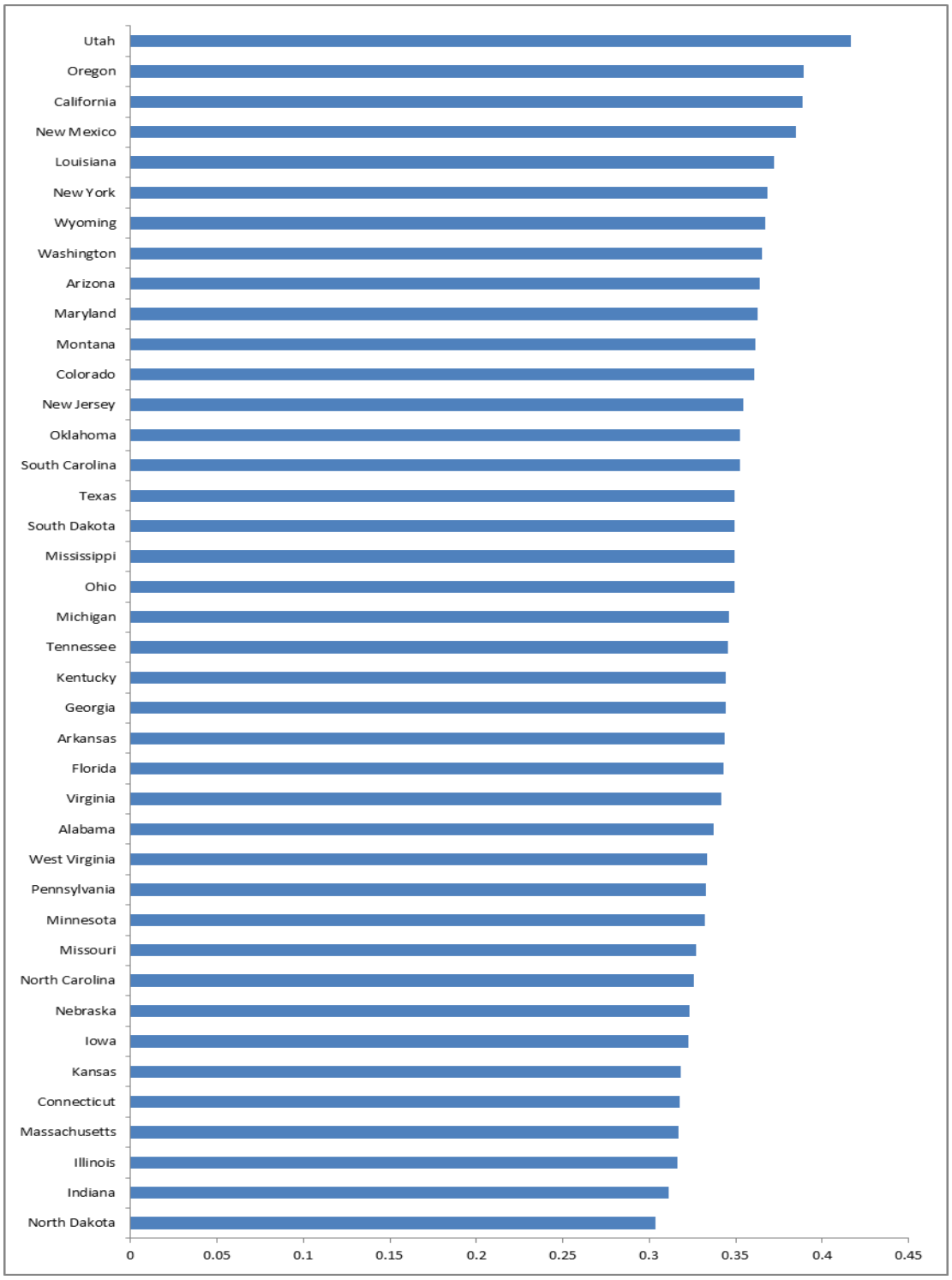


Figure 3.4. Average Lerner values per state between 1987 and 2012



CHAPTER FOUR

COMPETITION, BANK LENDING CHANNEL AND MONETARY POLICY IN THE U.S.

4.1 Introduction

This paper examines the effect of competition on the transmission of monetary policy through the bank lending channel. A survey report by the Federal Reserve in July 2010 claims that increased banking competition in the U.S. leads to more lending. This issue has come to the fore as a result of the financial crisis which erupted in 2007 and intensified in 2008. Many central banks reacted to the crisis by introducing loosened monetary policy to affect key economic variables. In the U.S., the Federal Reserve responded to pressures in credit markets by injecting liquidity into the system using quantitative easing and decreasing policy rates. In October 2008, a bailout programme of $700bn was approved to buy troubled assets from U.S. financial institutions. In late November 2008, the Federal Reserve started purchasing $600 billion in mortgage-backed securities (MBS). By March 2009, it held $1.75 trillion of bank debt, MBS and Treasury notes, and this reached a peak of $2.1trillion in June 2010. In November 2010, the Federal Reserve announced a second round of quantitative easing, or "QE2", buying $600 billion of Treasury securities by the end of the second quarter of 2011. As to interest rate policy, the Federal Reserve reacted to the crisis by decreasing the policy interest rate. As of December 16 2008, the Federal Open Market Committee (FOMC) cut the federal funds rate from 1.0% to a target range of zero to 0.25%.

The effectiveness of monetary policy in abetting bank lending activities has been recently debated, with a particular focus on the role of bank competition in this relationship. The

literature supporting the existence of the bank lending channel as a locomotive of monetary policy changes finds the effectiveness of such transmission is influenced by the cross-sectional heterogeneity of bank characteristics. In particular, as discussed in Section 2.2 (pp. 26-32), liquidity, capitalisation and size are found to impact on banks' responses to monetary shocks and their ability to supply loans.

Kishan and Opiela (2000) find that the effects of monetary policy on bank loans depend on bank capitalisation and size during times of contractionary monetary policy. Undercapitalized and small banks are more responsive to monetary shocks than well capitalized and large banks. This can be explained by their inability to raise alternative funding for loans under contractionary monetary policy. Gambacorta (2005) finds heterogeneity in monetary policy transmission across banks with different capitalisation and liquidity levels, and finds no bank size effect. However, Olivero, Li and Jeon (2011b) find that in Latin America, bank size, liquidity and capitalisation levels influence transmission of monetary policy through the lending channel. Loupias et al. (2002) find a similar role played by liquidity, as found by Kashyap and Stein (2000), but report no significant impact of size and capitalisation.

Alper, Hulagu and Keles (2012) use data from Turkey to analyze whether monetary policies that are able to manipulate liquidity positions of banks can affect bank lending. They find that bank-specific liquidity is important in credit supply. Moreover, in determining their lending, banks consider not only their individual liquidity position but also the systemic liquidity. Hence, any monetary policy which can alter liquidity will potentially impact on credit supply.

In addition to the research findings highlighted in Section 2.2,several studies, have examined the implications of market structure on the bank lending channel of the

monetary policy transmission mechanism, (Adams and Amel, 2005; Adams and Amel 2011 and Olivero, Li and Jeon 2011b).

The remainder of the paper is organised as follows: Section 4.2 reviews the findings of previous studies. Section 4.3 describes the empirical methods used in our analysis, while Section 4.4 reports the results. Section 4.5 outlines the robustness tests employed and Section 4.6 presents the paper's conclusions.

4.2 Literature review

In recent years the banking industry has experienced significant changes in competitive conditions. Factors that have contributed to these important changes in market structure include international financial integration, privatization, and deregulation, a wave of mergers and acquisitions that raised market concentration, along with increased foreign bank penetration. In addition, there have been financial reforms to bail out banks affected by crises, including the recent 2008–9 global financial crisis.

Changes in competition are expected to affect the transmission of monetary policy through the bank lending channel. Plausible channels include the following. First, if an increase in competition is caused by an increased market share held by larger banks, this should weaken the bank lending channel (Olivero, Li and Jeon, 2011b).

Second, increased competition can weaken the bank lending channel of monetary policy if the increase in competition is associated with a reduction in the informational asymmetries across banks over their borrowers' creditworthiness (Olivero, Li and Jeon, 2011b). These informational frictions and the fact that incumbent banks accumulate proprietary information about their customers typically make it costly for borrowers to switch from the incumbent bank (from which they have been borrowing for a period of

time) to a new rival bank. These switching costs create a customer ‘‘lock-in” or ‘‘hold-up” effect. Thus, following a monetary policy tightening, small banks (who are typically more severely affected by the tightening) will shrink their loan supply. If borrowers cannot switch among lenders without incurring costs, the excess demand left by these small banks cannot be picked up by larger banks (who can better protect their loan supply). Therefore, when increased competition in banking markets lowers these costs, the impact of a given monetary policy shock should also diminish.

Third, competition in banking can impact the effectiveness of monetary policy through its effect on the sensitivity of bank loan rates to monetary policy shocks. Thus, an increase in competition (which makes a bank’s prices more sensitive to changes in the marginal costs) can make monetary policy stronger if it implies that changes in the interest rates on deposits caused by a shock to reserves are more directly transmitted to the interest rates on loans.

The issue of how the degree of competition in the market for bank credit impacts the effectiveness of monetary policy was first examined from a theoretical standpoint by Aftalion and White (1978) and Van Hoose (1983, 1985). They show that bank market structure can have an important impact on the appropriate choice of monetary policy targets and instruments. Specifically, Van Hoose (1983) shows that the federal funds rate becomes an ineffective monetary policy tool in a competitive banking system. Bernanke and Blinder (1988) provide a simple IS-LM based theoretical model of the bank lending channel, where banks rely on a single deposit source for funds (see Section 2.2 for further details).

Kashyap and Stein (1997) and Cecchetti (1999) consider national concentration ratios in their analysis of the effectiveness of monetary policy in Europe. Both studies use three-

firm and five-firm concentration ratios, not because they are related to competition, but because they are measures of bank size or of a banking system's reliance on reserves. Banks in nations with higher concentration measures (i.e. with a few banks controlling a large percentage of total banking assets) are less sensitive to reserve contractions, since they have access to alternative forms of financing.

Kashyap and Stein (2000) conduct an extensive analysis of the bank-lending channel for U.S. monetary policy. They use Call Report data on a very large panel dataset of American banks over 1976-1993 to see if there are cross-sectional differences in the ways in which banks react to monetary policy shocks. They find that a bank-lending channel exists and that it is large enough to be of economic significance. Their results suggest that the channel works primarily through smaller banks that do not have access to alternative sources of funding in the money markets. The effect of monetary policy is stronger for commercial and industrial loans than for other types of bank lending. In related research, Jayaratne and Morgan (2000) examine bank investment and cash flows to see if there is evidence of market imperfections that would give monetary policy scope to affect bank lending. Like Kashyap and Stein (2000), they find that there are imperfections in markets for uninsured bank funds, and that these frictions are larger for smaller banks than for banks large enough to more easily use the capital markets as alternative sources of funds.

Research on monetary policy and bank competition in the EU has found similar results. Lensink and Sterken (2002) recognize the relationship between monetary transmission and competition in their overview of the subject, but empirical studies using European data either confirm the existence of the bank-lending channel and find that it operates much as it does in the U.S. (Kakes and Sturm, 2002; Altunbas, Fazylov and Molyneux, 2002), or confirm the price-concentration relationship in European banking markets

(Corvoisier and Gropp, 2002; Bikker and Haaf, 2002). However, no study directly analyzes the relationship between the bank-lending channel and competition in Europe.

Adams and Amel (2005) study the relationship between banking competition and the transmission of monetary policy through the bank lending channel in the U.S. system. Using business small loan origination data provided by the Community Reinvestment Act from 1996-2002, they are able to reaffirm the existence of the bank lending channel of monetary transmission. Moreover, they find that the impact of monetary policy on loan originations is weaker in more concentrated markets.

Two more recent studies, by Halvorsen and Jacobsen (2009) and Abildgren (2012), make use of a financing mix variable to study the role of credit supply shocks outside the context of the monetary policy transmission mechanism. The mix variable used by Halvorsen and Jacobsen (2009) is the ratio of total bank lending to households and non-financial firms to total credit to the same borrowers. The authors interpret an unexpected decline in the mix as a bank lending shock because a change in general loan demand would leave the mix fairly unaltered, since all types of credit should change in a roughly proportional way. They estimate a VAR for Norway and the UK from 1988 to 2009, also including house prices. Their results show that negative bank lending shocks lead to a significant contraction in the output gap. A similar study for Denmark using a long sample period, from 1922 to 2011, has been conducted by Abildgren (2012). He defines the mix variable as the ratio between credit to the domestic non-bank sector extended by resident commercial/savings banks and credit to the domestic non-bank sector extended by resident commercial/savings banks and mortgage banks. The argument for constructing the mix in this way is that: ‘credit from mortgage banks is the closest and most important alternative low-cost source of financing for the private non-financial sector in Denmark’

(Abildgren, 2012: 3). A shock in the mix should be associated with variations in credit supply and not credit demand, as 'a general change in the demand for credit, all else being equal, will change the demand for credit from the deposit-financed commercial/savings banks and the bond-financed mortgage banks in equal proportions, thereby not altering the credit mix' (Abildgren, 2012: 11).

Another strand of research identifies credit supply shocks using bank loan surveys or information about bank health. Lown and Morgan (2006) study how economic activity depends on availability of C&I loans, and vice versa, using data from the Fed's Senior Loan Office Opinion Survey (SLOOS). They find that shocks to lending standards are significantly correlated with innovations in loans and in real output, and account for a sizable share of their variance decomposition even when including loan demand proxies. Ciccarelli et al. (2012) also use the information about the change in the C&I loan standards from the SLOOS data for the U.S., together with similar data from a bank lending survey for the Euro area to disentangle the bank lending channel, the (non-financial borrower) balance-sheet channel, and the credit demand channel. They show that the credit channel implies the effects of a monetary policy shock on GDP and inflation through the balance sheets of households, firms and banks. Moreover, tighter standards for mortgages significantly reduced GDP during the financial crisis. Based also on SLOOS data, Bassett et al. (2014) identify the macroeconomic effects of bank loan supply shocks through unexplained changes in lending standards. They also find large and asymmetric effects of such supply shocks on GDP. Other studies (e.g. Peek et al., 2003) use supervisory information about bank health, using measures such as capital, asset, management, earnings and liquidity (CAMEL) ratings. Peek et al. (2003) find that loan supply shocks are particularly important for explaining inventory movements, the component of GDP which is most dependent on bank lending.

4.3 Data and methodology

4.3.1 Data

In this paper, the dataset consists of bank-level financial statements of U.S. banks for the period from 1987 to 2010, extracted from the Federal Reserve Bank of Chicago Reports of Condition and Income (Call Reports). The original sample is filtered by removing all banks for which data are inconsistent or unavailable, including observations that have negative values for the main variables in our analysis. We also exclude all state markets that have fewer than 20 observations a year and banks whose credit activity represents a proportion of the balance sheet of less than 20% (Leroy, 2014). This process reduces the sample to an unbalanced panel of 13,043 banks in 41 states, with a total of 193,976 observations, recorded between 1992 and 2010 year-end. Table 4.1 summarizes the sample statistics; all values are presented in natural logarithm.

Analysis of the bank lending channel requires study of the relationship between credit supply growth and monetary shocks. Following Leroy (2014), the first stage is to determine these two variables. Credit growth is calculated as the logarithmic growth rate of loans between time t and time t+1, whereas the stance of monetary policy is proxied by the federal funds rate, obtained from the Fed website.

4.3.2 Methodological approach

We apply a fundamental approach by using a bank-level indicator of competition, rather than market level (such as concentration ratio), in order to explore bank reaction to changes in monetary policy under the prevailing competitive conditions. Following the

literature, bank-level differences are included in the models to test for the claim that the reaction should depend on the individual characteristics of banks.

This paper follows the two-step approach used by Olivero, Li, and Jeon (2011b) and Adams and Amel (2011). As a first step, the degree of competition is estimated using the Lerner Index (LI) of Market Power (MP) (Berger, Klapper and Turk-Ariss, 2009). In the second step, we examine how banking competition conditions impact transmission of monetary policy through the lending channel. This relationship is analysed for banks with different characteristics (size, liquidity and capitalisation).

4.3.2.1 Measurement of the LI of MP

This paper uses the conventional Lerner index of MP to examine the effects of market competition on the effects of monetary policy through the lending channel of banks in the U.S. Details of the equation and method used for estimation of the Lerner index are provided in Section 3.3.2 equation 3.3.

4.3.2.2 Impact of bank competition on the monetary transmission

In the second step of our empirical application, we investigate the impact of market competitive conditions on the stance of monetary policy through the bank lending channel. For this purpose, a reduced-form model is estimated. We run an equation in which the relationship between the bank lending channel, market policy measure, and market structure is depicted. The lending channel model is given by Equation4.1:

$$\Delta \ln Loans_{i,t} = \alpha_i + \beta_1 \Delta \ln Loans_{i,t-1} + \beta_2 \Delta \ln FFR_t + \beta_3 \Delta \ln LERNER_{i,t} + \beta_4 \Delta(\ln FFR_t \ln LERNER_t) + \sum \gamma \ln X_{i,t} + \sum \Omega \ln Z_{i,t} + \epsilon_{i,t} \quad [4.1]$$

Here, i indexes banks, and t indexes the year. In Equation 4.1, Δ is the difference operator. lnLoans is the dollar amount of loans supplied by bank i in year t; FFR is the federal funds rate, used as an indicator of stance of monetary policy; LERNER is an index of market competition; X is a vector of bank-specific variables that controls for differences across banks; Z is a vector of economic variables that includes growth rate of GDP. α_i is a constant that captures individual bank-level effects; β, γ and Ω are coefficients to be estimated.

The specification in Equation 4.1 assumes that the impact of monetary policy is derived from its effects on bank MC of loanable funds. Therefore, based on Bernanke and Blinder (1988), and following Adams and Amel (2011), we measure the stance of monetary policy through changes in the federal funds rate.

In Equation 4.1, ΔFFRtlnLERNERt is an interaction term between the measure of competition, LERNER, and the measure of the proxy for monetary policy, FFR, which is intended to capture the marginal effect of competition on the impact of monetary policy changes on bank lending. It indicates how the degree of market competition and level of policy rate, indicated by the federal funds rate, interact to impact bank lending.

In Equation 4.1, we include bank-level data in the vector X to the reaction of bank lending as a response of loan supply to monetary policy shocks depending on the different

characteristics and financial strength of each bank. Three variables in vector X measure bank-level characteristics, namely: bank SIZE, LIQUIDITY and CAPITALISATION, respectively.

Bank SIZE is the logarithm of total assets. It is expected that larger banks face lower external finance premia and find it easier to isolate shocks to deposits by switching to alternative sources of funding.

A second measure of financial strength is bank LIQUIDITY. This is calculated as the ratio of liquid assets (the sum of cash, federal reserves and securities) to TA. Banks with more liquid balance sheets may be better prepared to insulate their loan supply from unexpected shocks to deposits.

A third measure of financial strength is bank CAPITALISATION, computed as the share of equity capital in TA. Banks with high capitalisation tend to pay lower risk premia for uninsured debt financing, and should therefore also be better prepared to insulate their loan supply from unexpected shocks to reserves caused by monetary policy tightening.

There are possible endogeneity problems associated with the inclusion of these bank-level variables, which might yield biased coefficient estimates. For SIZE, a bank may become larger only because its loans grow rapidly. Regarding CAPITALISATION, a bank may become better capitalised because initially it faced a higher external finance premium. Therefore, it is not clear whether a highly capitalised bank is less liquidity-constrained.

Also, capitalisation could decrease with bank size and may not, therefore, be a good indicator of liquidity constraints. Bank liquidity can also be a biased measure of financial constraints, because a bank, might choose to have more liquid assets to compensate for stronger constraints on financing.

We expect an increase in the interest rate to reduce the growth of bank lending, so that the coefficient on the federal funds rate monetary policy indicator is expected to have a negative sign. According to the research findings presented in Section 2.2, competition in banking could weaken or strengthen the monetary policy transmission mechanism through the bank lending channel, implying that the coefficient on the interaction term / can be positive or negative. A positive (negative) sign for this coefficient implies that higher competition leads to a weaker (stronger) monetary policy transmission.

The level of capitalisation measured by the equity to assets ratio is an important factor in a banks' reaction to monetary policy changes. Banks that have lower levels of equity to assets and are exposed to difficult conditions in raising capital may reduce their lending, especially in times of contractionary monetary policy. Kishan and Opiela (2000) find that small and undercapitalised banks are most affected by monetary policy. Gambacorta (2005) too finds that lending of undercapitalised Italian banks is adversely affected by contractionary monetary policy.

Other state-level explanatory variables are included to control for the differences across states, different loan-demand effects, and also for cyclical economic differences at the market level that may affect the demand for loans. The set of these variables are the growth rates of total real GDP and the growth rates of CPI (inflation rates).

Figure 4.1 displays the evolution of the mean values of competition measures used in our study over the period under analysis. For the Lerner index , the mean is close to 0.20, which is in line with Koetter et al. (2008), who find an average Lerner index of 0.20 for U.S. banks.

4.4 Empirical results

Applying the two-step estimation approach, we first report the estimates of the measures of competition for the whole sample and for each state. We then introduce the estimated measures of competition into the static and dynamic loan equations to examine the impact of competition on the bank lending channel as a monetary transmission mechanism. The robustness of our main estimations are checked by substituting the Lerner index of MP with two alternative competition indicators: the P-RH-statistic (see Section 2.4.2) and the HHI (see Section 2.3).

4.4.1 Main estimation: Regression results for the impact of competition on monetary transmission

In this section, we report the results of empirical estimations regarding the effect of competition on monetary policy transmission in U.S. Three specifications are presented in Table 4.2. In Specification 1, we estimate equation (4.1), including the three bank-specific variables commonly used in the literature (SIZE, LIQUIDITY, CAPITALISATION). Specification 2 excludes the bank-specific variables and considers only the Lerner index of MP. In Specification 3, the Lerner index is added to Specification 1. In all specifications, the appropriate interaction terms with the monetary policy rate are included. All diagnostics are reported below the estimations. The Hansen test does not reject the over-identification conditions; and the GMM statistic of endogeneity does not reject the exogeneity conditions.

The results in Table 4.2 indicate the existence of a bank lending channel in U.S. banking across all specifications. The coefficient of the monetary policy indicator shows an inverse relationship with monetary policy, suggesting that restrictive/ expansionary monetary policy in the form of an increase/decline in policy rates has a negative/positive

effect on bank lending growth. The effect is statistically significant at the 1% significant level. We find that a 1% rise (decline) in monetary policy rate leads banks to reduce (increase) their lending within a range of 6.4% to - 11%. This result is similar others reported found in the literature (Adams and Amel, 2011; Olivero, Liand Jeon, 2011b; Fungacova et al., 2014; Leroy, 2014).

Furthermore, the results in Table 4.2 show that CAPITALISATION and SIZE are the bank-specific variables that affect the growth of credit supply. The coefficients on LIQUIDITY are statistically insignificant, suggesting that it has a negligible effect on credit supply. In all specifications, the coefficient on CAPITALISATION is negative, implying that well-capitalised banks tend to operate with lower loan growth rates. This may be explained by the fact that well-capitalised banks are subject to binding risk-based capital requirements, and therefore reduce their lending in order to preserve their capitalisation levels in line with those requirements.

The coefficient of SIZE suggest larger banks enjoy faster credit growth. Leroy (2014) finds similar results and argues that larger banks have better access to financial markets, and that their balance sheet structure can more easily absorb additional lending financed by debt (Kashyap and Stein, 1995).

Regarding MP, the coefficient on the Lerner index is positive and significant, indicating that MP is a significant factor in enhancing the ability of banks to strengthen their credit growth.

The coefficient of the interaction term between the change in the FFR,as a monetary policy rate, and banking competition, measured by the Lerner index of MP, is unexpectedly negative and significant when we either retain or exclude other bank-

specific characteristics. Our results differ from those of Fungacova et al. (2014) and Leroy (2014), who obtain positive signs for the monetary policy interaction term for the Lerner Index. Our result implies that banks with greater market power reduce their loan supply to greater extent in periods of monetary contraction. This suggests that weaker bank competition strengthens the transmission of monetary policy through the bank lending channel. We provide evidence in favour of a relationship between the effectiveness of monetary policy tools and market imperfection.

The other expected result in Table 4.2 is that certain bank characteristics can enhance the effectiveness of the bank lending channel. The interactions of bank-specific variables and monetary policy indicators show statistically significant relationships, except for LIQUIDITY. We find that CAPITALISATION and SIZE interact significantly with the monetary policy changes. This result suggests that well-capitalised banks tend to reduce/increase their credit supply when policy rates increase/decrease. In addition, larger banks appear to be less sensitive to changes in monetary policy. This may be explained by the fact that they can access capital markets to raise external funds to shield their lending growth from monetary policy shocks. However, LIQUIDITY is found to be insignificant in explaining bank lending responses to monetary policy shocks.

Finally, the coefficient of the GDP growth rate as a measure of demand is positive and statistically significant, indicating that the growth rate of loans is larger when the economy is growing. The results in Table 4.2 suggest that, for our data, the effectiveness of the bank lending channel for monetary policy transmission depends upon the level of competition in the banking market, and the level of bank capitalisation.

We contend that MP can affect the intensity of the monetary transmission mechanism. In specifications 2 and 3, the coefficients for the interaction terms between the LI of MP, as

a measure of competition, and the stance of monetary policy are positive and statistically significant at the 1% level. These results are consistent with other reported precisely in the literature (Fungacova et al., 2014). This suggests that banks with greater MP are less dependent on the credit channel, and are able to insulate their lending activities from monetary policy shocks. The results also indicate that banks with greater MP are more sensitive to changes in the monetary policy rate. Thus, MP enhances the effectiveness of monetary policy.

In line with Leroy (2014), we explain our results, first, in terms of the fact that MP enhances access to financial markets (i.e. to alternative sources of funding) and offers better financial conditions, which reduce the effects of a monetary policy shock. Second, margins and profitability arising from MP may create a "buffer" against monetary policy shock. In contrast, banks with low MP are more sensitive to monetary and macroeconomic volatility. These banks may have a limited ability to shield themselves from monetary policy shocks. An adjustment through the quantity of loans is the most viable solution: already compressed margins prevent price adjustment.

4.4.2 Competition and lending during the 2007-2010 financial crisis

As our period under study covers the 2007-10 financial crisis, we examine the effectiveness of conventional monetary policy on the bank lending channel as a transmission mechanism of monetary policy. The crisis has troubled the balance sheets of banks and affected assets and liabilities valuations. The Federal Reserve responded by a number of traditional and unconventional monetary policy tools. The results are presented in Table 4.3.. A number of results can be noted.

First, the interaction terms between the monetary policy measure and the Lerner index of MP power were negative during the crisis. The term is, however, statistically significant in Specification 5 only, where only the LI of MP is included. This result indicates that banks with greater MP reduce their lending growth during the financial crisis.

Second, the monetary policy interaction terms for bank characteristics show that CAPITALISATION and LIQUIDITY significantly and positively interact with the monetary policy indicator on bank lending. The interaction term for SIZE is insignificant. Our results imply that during times of crisis, well-capitalised and more liquid banks are able to shield their lending from monetary policy shocks.

These results show that during times of crisis the bank lending channel operates more effectively through the market structure.

4.4.3 Robustness check: P-RH-statistic

As a robustness check estimate equation 4.1 using the P-RH-statistic as an alternative measure of competition in place of the Lerner index. The results are displayed in Table 4.4.

In Table 4.4, we observe negative and significant coefficients for the monetary policy interaction term for the H-statistic as a measure of competition. This result indicates that greater bank competition supports the effectiveness of the monetary policy via the bank lending channel. This result is similar to that of Adams and Amel (2011) who find a positive association between bank competition and the bank lending channel in the U.S. banking markets and Fungacova (2014) for Euro area countries, but differ from Olivero et al. (2011b) who find evidence of negative impact of bank competition on the bank lending channel in developing countries in Asia and Latin America.

Thus, our contrary results are confirmed by the robustness tests and support the view that an increase in H-statistic (more competition) makes bank lending more sensitive to FFR. Again, comparison of our results for the differences in the direction of the effects in the monetary policy transmission estimation may simply reflect inconsistent between the competition measures themselves; the HHI, Lerner index and P-RH-statistic do not always give consistent indication of the intensity of competition.

As before, the coefficients on CAPITALISATION and SIZE are statistically significant, indicating an effective impact on the growth rate of loans. Larger banks tend to increase their loan supply faster, and better capitalised banks tend to increase their loan supply more sharply. As before LIQUIDITY appears to have no effect.

4.4.4 Robustness check: HHI as a measure of concentration

For further robustness tests, we use another alternative measure of bank competition. We perform the estimations using the HHI measure of concentration as an indicator of competition. Greater market concentration estimated by the HHI signifies less competitive conditions. The results are displayed in Table 4.5.

The results in Table 4.5 show significant and positive coefficients for the interaction of the monetary policy stance with the concentration measure of HHI. Higher policy rates and higher market concentration (thus less competition) are both associated with lower bank lending. This result implies that lower market concentration, thus greater competition, strengthens the effectiveness of monetary policy via the bank lending channel; that is, lending growth is less sensitive to changes in policy rates at lower levels of competition. This finding is in line with the literature of Adams and Amel (2005) and

Olivero, Li and Jeon (2011a) as regards the effects of bank concentration on the bank lending channel respectively in the US and Asian and Latin American countries.

4.5 Conclusion

This paper examines the impact of bank competition on the bank lending channel in the U.S. between 1992 and 2014. We find that a higher level of bank competition, measured as less MP, strengthens the transmission of monetary policy via the bank lending channel. We interpret this result to mean that a higher degree of bank competition reduces the access to alternative sources of funding and thereby renders banks more responsive to monetary policy.

Our results for the period during the crisis show that greater competition measured by lower MP is associated with a reduced growth rate of loans. During crisis periods, banks that have greater MP tend to increase their loan supply. The interaction term for the competition measure on the FFR was found to be negative, implying that competition influences the transmission of monetary policy. In addition, we obtain evidence in favour of the bank lending channel for the bank-specific characteristics (SIZE, CAPITALISATION and LIQUIDITY). Liquidity is found to play a neutral role. Less capitalized banks and larger banks increase their lending more in the presence of a monetary expansion. Overall, we observe that during the crisis the bank lending channel via competition and specific bank characteristics continues to be a significant channel of monetary policy transmission.

Our results can be used for policy purposes. This paper has shown that the level of bank competition is a significant factor for monetary policy transmission. It is, therefore, considered that improved market structure and creating competitive conditions should be seen as objectives to achieve the general goal of making monetary policy effective.

4.6 Tables and Figures

Table 4.1: Selected statistics for our sample

Variable	Obs	Mean	Std. Dev.	Min	Max
LnLoans	193976	11.1591	1.4408	6.4184	20.5553
lnFFR	193976	-3.9453	1.3893	-7.0131	-2.7742
lnSIZE	193976	11.6862	1.3597	7.6089	21.4532
lnCapitalisation	193976	-2.3118	0.2906	-8.3953	-0.0126
lnLiquidity	193973	-0.7896	0.843	-12.5351	1.4218
ln Loans to assets	193976	-0.5272	0.2781	-1.6607	-0.0076
LnRealGDPgrowth	193976	0.2876	0.1725	0	0.5515
lnCPIgrowth	187713	-3.0403	0.2984	-4.1038	-2.7399

lnLoans is the dollar amount of loans supplied by bank; FFR is the federal funds rate, used as an indicator of stance of monetary policy; SIZE is the logarithm of total assets; CAPITALISATION share of equity capital in total assets; LIQUIDITY isthe ratio of liquid assets (the sum of cash, federal reserves and securities) to total assets; Loans to total assets;RealGDPgrowth is the growth rates of total real GDP and CPIgrowth is the growth rates of CPI (inflation rates).

Table 4.2: Main estimations (1992-2010)

Specification	Specification 1: Bank lending channel		Specification 2: Lerner Index only		Specification 3: Bank lending channel with Lerner Index included	
	Coef	St. Error	Coef	St. Error	Coef	St. Error
Constant	-0.295***	0.052	-0.148***	0.019	-0.282***	0.048
$\Delta ln\,\text{loans}_{t-1}$	0.132	0.114	0.170*	0.102	0.148	0.11
$\Delta lnFFR_{t-1}$	-0.102***	0.015	-0.064***	0.007	-0.110***	0.016
$ln\,\text{CAP}_{t-1}$	-0.026***	0.006			-0.026***	0.006
$ln\,\text{LIQ}_{t-1}$	0.002	0.003			0.002	0.003
$ln\,\text{SIZE}_{t-1}$	0.007***	0.002			0.006***	0.001
$lnLERNER_{t-1}$			0.005***	0.002	0.004***	0.001
$\Delta lnFFR_{t-1} * lnCAP_{t-1}$	-0.010***	0.003			-0.009***	0.003
$\Delta lnFFR_{t-1} * lnLIQ_{t-1}$	-0.001	0.001			-0.001	0.001
$\Delta lnFFR_{t-1} * lnSIZE_{t-1}$	0.002**	0.001			0.002**	0.001
$\Delta lnFFR_{t-1} * lnLERNER_{t-1}$			-0.004***	0.001	-0.005***	0.001
$\Delta lnRGDP_{t-1}$	9.580***	1.126	9.472	1.123	9.452***	1.102
Year dummies	Yes		Yes		Yes	
No. obs	145,582		145,486		145,486	
Wald chi / p-value	10,177***	0	9,463***	0	10,364***	0
R-squared	0.095		0.094		0.139	

The dependent variable is the loan growth rate.The monetary policy variable is the 1-period lag of the difference in federal funds rates for the current period against the previous period. The explanatory variables are lagged one period. Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Table 4.3: Estimation for the financial period crisis (2007-2010)

Specification	Specification 4: Bank lending channel		Specification 5: Lerner Index only		Specification 6: Bank lending channel with Lerner Index included	
	Coef	St. Error	Coef	St. Error	Coef	St. Error
Constant	-0.092**	0.043	0.103***	0.009	-0.084**	0.041
Δlnloanst-1	0.054	0.115	0.093	0.105	0.06	0.113
ΔlnFFRt-1	0.043***	0.014	-0.022***	0.005	0.034**	0.014
lnCAPt-1	-0.039***	0.007			-0.040***	0.007
lnLIQt-1	-0.001	0.004			-0.001	0.004
lnSIZE-t-1	0.008***	0.002			0.008***	0.002
lnLERNERt-1			0.004**	0.002	0.003**	0.001
ΔlnFFRt-1 * lnCAPt-1	0.016***	0.005			0.017***	0.006
ΔlnFFRt-1 * lnLIQt-1	0.008***	0.002			0.008***	0.002
ΔlnFFRt-1 * lnSIZEt-1	-0.001	0.001			0	0.001
ΔlnFFRt-1 * lnLERNERt-1			-0.007**	0.003	-0.004	0.003
ΔlnRGDPt-1	-0.187	0.513	-0.324	0.489	-0.218	0.507
Year dummies	Yes		Yes		Yes	
No. obs	101,079		100,999		100,999	
Wald chi / p-value	2,633.00***		1,533.60***		2644.52***	
R-squared	0.048		0.047		0.05	

The dependent variable is the loan growth rate.The monetary policy variable is the 1-period lag of the difference in federal funds rates for the current period against the previous period. The explanatory variables are lagged one period. Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Table 4.4: Robustness test: Estimation with h-statistic

Specification	Specification 2: h-statistic only		Specification 3: Bank lending channel h-statistic included	
	Coef	St. Error	Coef	St. Error
Constant	-0.447***	(0.035)	-0.587***	(0.072)
Δln loans$_{t-1}$	0.15	(0.108)	0.132	(0.114)
$\Delta lnFFR_{t-1}$	-0.954***	(0.089)	-0.999***	(0.103)
ln CAP$_{t-1}$			-0.026***	(0.006)
ln LIQ$_{t-1}$			0.002	(0.003)
ln SIZE$_{t-1}$			0.007***	(0.002)
$lnHSTAT_{-1}$	-0.773***	(0.064)	-0.776***	(0.072)
ΔlnFFR$_{t-1}$ * lnCAP$_{t-1}$			-0.010***	(0.003)
ΔlnFFR$_{t-1}$ * lnLIQ$_{t-1}$			-0.001	(0.001)
ΔlnFFR$_{t-1}$ * lnSIZE$_{t-1}$			0.002**	(0.001)
ΔlnFFR$_{t-1}$ * lnHSTAT$_{t-1}$	-1.879***	(0.179)	-1.884***	(0.192)
ΔlnRGDP$_{t-1}$	6.578***	(0.518)	6.525***	(0.542)
Year dummies	Yes		Yes	
No. obs	145,582		145,582	
Wald chi / p-value	9,079***	0	10,177***	0
R-squared	0.091		0.095	

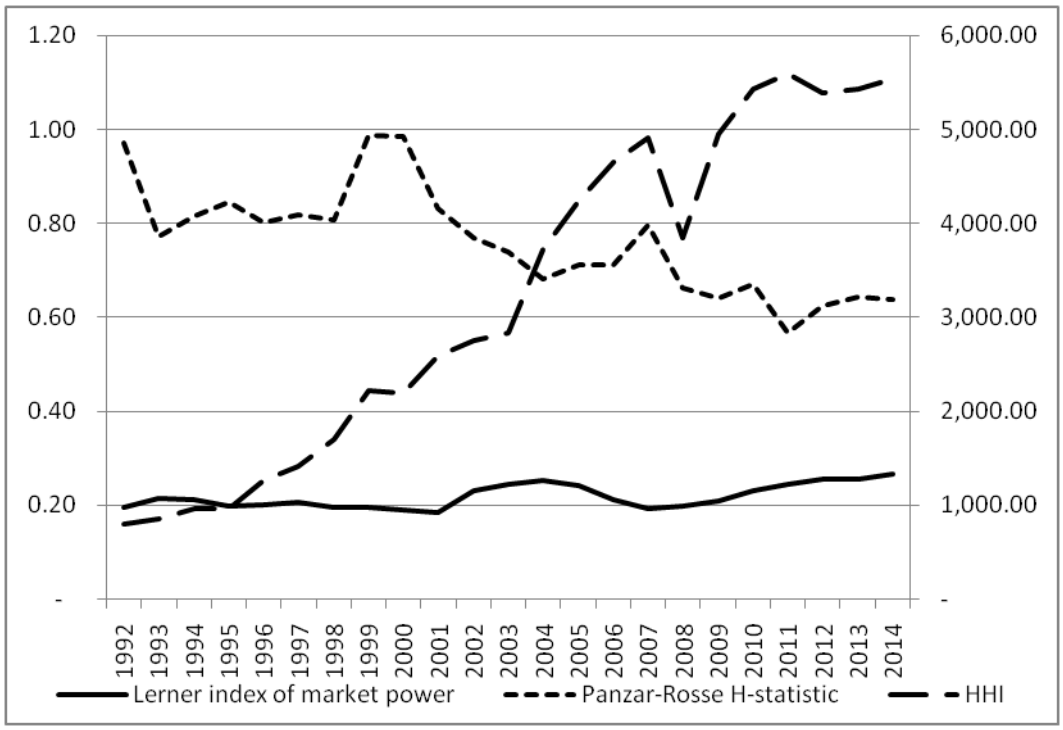
the dependent variable is the loan growth rate.The monetary policy variable is the 1-period lag of the difference in federal funds rates for the current period against the previous period. The explanatory variables are lagged one period. Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Table 4.5: Robustness test: Estimation with HHI

Specification	Specification 4: HHI only		Specification 5: Bank lending channel HHI included	
	Coef	St. Error	Coef	St. Error
Constant				
$\Delta lnloans_{t-1}$	0.15	(0.108)	0.133	(0.114)
$\Delta lnFFR_{t-1}$	-6.365***	(0.942)	-6.276***	(0.887)
$lnCAP_{t-1}$			-0.026***	(0.006)
$lnLIQ_{t-1}$			0.002	(0.003)
$lnSIZE_{-t-1}$			0.007***	(0.002)
$lnHHI_{-1}$	-0.011***	(0.002)	-0.027***	(0.005)
$\Delta lnFFR_{t-1} * lnCAP_{t-1}$			-0.010***	(0.003)
$\Delta lnFFR_{t-1} * lnLIQ_{t-1}$			-0.001	(0.001)
$\Delta lnFFR_{t-1} * lnSIZE_{t-1}$			0.002**	(0.001)
$\Delta lnFFR_{t-1} * lnHHI_{t-1}$	0.734***	(0.109)	0.719***	(0.102)
$\Delta lnRGDP_{t-1}$	7.042***	(0.784)	6.945***	(0.756)
Year dummies	Yes		Yes	
No. obs	145,582		145,582	
Wald chi / p-value	48,915.37		50187	
R-squared	0.091		0.095	

The dependent variable is the loan growth rate.The monetary policy variable is the 1-period lag of the difference in federal funds rates for the current period against the previous period. The explanatory variables are lagged one period. Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Figure 4.1. Measures of competition (1992-2010)



CHAPTER FIVE

COMPETITION, STABILITY AND CRISIS: ANALYSIS OF U.S. BANKING SYSTEM

5.1 Introduction

Understanding and quantifying the extent to which the degree of competition in banking may affect the stability of the whole financial system continues to be an important issue in the literature, and has intensified in the wake of the 2007-09 crisis (Amidu and Wolfe, 2013; Beck, De Jonge and Schepens, 2013; Cubillasa and Suárezb, 2013; Soedarmonoa, Machrouh and Tarazi, 2013; Fu, Lin and Molyneux, 2014). As discussed in detail in Section 2.5.3, the literature remains ambivalent on the issue of the relationship between bank competition and financial stability. While some results support the view that competition improves stability, others suggest adverse effects.

There are two main views on the causal relation between competition and stability in banking: the competition-stability view and the opposing competition-fragility view. The competition-fragility view suggests that collusive behaviour prevailing in less competitive systems may consolidate returns and enhance financial stability by enabling banks to hold higher levels of capital as a buffer against adverse economic and liquidity shocks. However, if a bank exhibits strong profit generation as a result of its greater market power, its potential losses will escalate if it chooses to engage in risk-taking behaviour.

This view is shared by Keeley (1990) and Hellmann, Murdock and Stiglitz (2000) under the franchise value hypothesis, which argues that managers and shareholders alike will not take on high-risk investment in order to protect their franchise value in case bankruptcy occurs. Additionally, banks with greater market power can adequately differentiate loan applications to allocate funds to higher quality investments, which may improve the efficiency of the process, capital allocation, and, therefore, contribute to economic growth. Thus, effective credit screening can enhance the financial stability of banks (Boot and Thakor, 2000). This view is shared by Cetorelli and Peretto (2000), who claim that banks can improve the quality of their loan portfolios in a system characterised by increased concentration and reduced information asymmetry.

In the literature, a growing number of studies have addressed the issue of whether competition enhances the financial soundness and stability of the banking system (Berger, Klapper, and Turk-Ariss2009; Amidu and Wolfe, 2013). There are two main opposing views on the competition-stability nexus. Hellmann, Murdock and Stiglitz (2000) and Allen and Gale (2004) contend that competition increases the fragility of banks because it pressurises them to follow more risk-taking behaviour, thereby maintaining a minimum level of capital.

Studies supporting the competition-fragility (or concentration-stability) view state that in less competitive markets, banks are less prone to adopt risk-taking behaviour, because the prevailing conditions allow for realising higher profit as a result of being price-makers, and thus raising the capital buffer (Hellmann, Murdock and Stiglitz (2000).

For Keeley (1990), competition compels banks to follow more risky behaviour to increase shareholder gains. Allen and Gale (2004) also contend that competition increases risk, which could result in raising the probabilities of bank failure by contagion in cases of

adverse shock. Broecker (1990) and Shaffer (1998) prefer the view that more competition, supported by relaxed entry regulation, intensifies the adverse selection problem. Tabak, Fazio, and Cajueiro (2012) explain that when the market is populated by many banks, the probability of granting bad loans increases for a number of banks, thus worsening the quality of loans of the whole system.

In contrast to the competition-fragility view, supporters of the competition-stability (or concentration-fragility) view claim that a less competitive banking market worsens financial stability. Boyd and De Nicolo (2005) suggest that collusion may bring about a systemic crisis due to adverse selection. Banks take higher premia by charging higher interest rates, which attract poor quality borrowers, resulting to a rise in the probability of default. Alternatively, monopoly rents that banks derive from higher loan rates may increase insolvency risks due to a moral hazard problem arising from the borrowers' actions (Tabak, Fazio and Cajueiro, 2012). Borrowers take more risk to secure loans that charge higher rates.

Turk-Ariss (2009) find a direct relationship between competition and bank stability through the mechanism of cost efficiency. Tabak, Fazio, and Cajueiro (2012) reveal that bank size and capitalisation are important dimensions that explain the nexus between competition and bank risk-taking behaviour. Amidu and Wolfe (2013) suggest that competition exerts pressures on banks to accommodate diversification strategies, which have a significant effect on their performance, and thereby their insolvency risk. Some studies have considered environmental factors in the relations between competition and bank stability. Beck, De Jonge and Schepens (2013) contend that the impact of greater competition on levels of stability is more pronounced in countries characterised by

stringent activity restrictions, more developed stock markets, and more effective systems of credit information sharing.

As discussed previously (see Section 2.3), competition may be quantified using different methods and measures. Earlier studies employed market structure indicators, such as the number of banks in the market, concentration ratios and market shares (Smirlock 1985; Berger and Hannan, 1989; Molyneux and Thornton, 1992; Berger, 1995; Rhoades, 1995). More recent studies employed both the H-statistic and the Lerner Index of market power (Panzar and Rosse, 1987; De Brant and Davies, 2000; Bikker and Haaf, 2002; Maudos and Guevara, 2007; Berger, Klapper and Turk-Ariss, 2009; Carbo et al., 2009; Olivero, Li and Jeon, 2011; Turk-Ariss, 2009 and 2010). A growing number of papers are approximating competition by the innovative Boone indicator (Boone, 2008), which measures the effect of marginal costs on market share (Schaeck and Cihak, 2010; Leuvensteijin et al., 2011; Tabak, Fazio and Cajueiro, 2012).

In this paper, we explore how size and the recent financial crisis individually and interactively affect the relationship between competition and stability, using data from U.S. banking. The literature is not conclusive about this effect. The concentration-stability view contends that larger banks appear to perform better in less competitive conditions. We test whether this view is valid by interacting the competition measure with a SIZE variable. The crisis has intensified the interest of regulators in large banks, as they are subject to a ‘‘too big to fail’’ (TBTF) moral hazard effect, because of their systemic importance. Large banks are likely to engage in risky activities driven by the belief that assistance will be provided if problems occur due to their large size. Demirguc-Kunt and Huizinga (2010) argue that large banks contribute to instability of the financial system and become a societal problem since they are too costly to save.

The 2007-09 financial crisis raised awareness of the relationship between overall system stability and the various measures of competition and stability. The adoption of the Basel III accord imposes stricter restrictions on systemically important banks, forcing them to use a larger fraction of their own capital in their operations. The objective is to reduce both the exposure to contagion and risk-taking behaviour. In this study, we include an interaction between competition and the crisis dummy to determine if the relationship between competition and stability is altered as an effect of crisis.

The findings in the literature support the notion that financial crises play a relevant role in the relationship between competition and stability in banking. Schaeck, Cihak and Wolfe (2009) present evidence that more competitive banking systems are less prone to systemic crises. They can alter moral hazard and the degree of competition prevailing in the market, make banks adjust their risk behaviour, and drive innovative regulatory and supervisory responses in favour of enforcing capitalisation and market stability, and reducing bank exposure to risk.

Motivated by the processes of deregulation, consolidation and the 2007-09 financial crisis in the U.S, this paper explores whether competition has any effect on banks' overall stability and soundness within the context of the two rival views in the literature: the competition-stability versus competition-fragility view. We also examine whether the relationship between competition and U.S. banks' financial stability has been affected by the recent crisis, and whether size was a significant factor in this relationship. The rest of the paper is organised as follows: Section 5.2 reviews both theoretical and empirical arguments around the relationship between banking sector competition and stability; Section 5.3 specifies the measurement and construction of the key variables, data and

econometric specifications; Section 5.4 reports and discusses the empirical results; Section 5.5 presents the paper's conclusions.

5.2 Literature review

The competition-fragility view suggests that collusive behaviour prevailing in less competitive systems may consolidate returns and enhance financial stability by enabling banks to hold higher levels of capital as a buffer against adverse economic and liquidity shocks. If a bank exhibits strong profit generation as a result of its greater market power, its potential losses will escalate if it chooses to engage in risk-taking behaviour. This view is developed by Keeley (1990) and Hellman et al. (2000) under the franchise value hypothesis. This argues that managers and shareholders alike will not take on more risky investment in order to protect their franchise value in case bankruptcy occurs. Additionally, banks with greater Market Power (MP) can adequately screen loan applications and provide higher quality loans, which may improve the efficiency of the process, capital allocation, and therefore, contribute to economic growth. Thus, effective credit screening would enhance the financial stability of banks (Boot and Thakor, 2000), which can improve the quality of their loan portfolios in a system characterised by increased concentration and reduced information asymmetry. The empirical results of Beck, Demirguc-Kunt and Levine (2006) suggest that crises are less likely to occur in more concentrated banking systems, and bank fragility increases with more competition.

The advocates of the competition-stability view contend that larger banks, especially those with greater MP, are likely to engage in risky activities and are therefore less state. These banks know that, because of their systemically important size, they will be protected by the government safety net, under the too-big-to-fail hypothesis developed by

Mishkin (1999). According to this hypothesis, when banks become too large, the moral hazard problem intensifies for those with more risky loan portfolios, in the knowledge of being protected by public funds. Additionally, monopolistic banks tend to charge higher loan rates to increase their return premia, which may attract borrowers with more risky projects to cover the higher loan repayments (Tabak, Fazio, and Cajueiro, 2012). In this case, the probability of defaults rises, and the stability of banks deteriorates, leading to failure (Boyd and De Nicolo, 2005). Moreover, large banks can expand across multiple geographical markets and develop complex business lines and financial instruments which can be detrimental to their stability (Amidu and Wolfe, 2013).

The empirical literature investigating the competition-stability nexus has not produced unambiguous results. De Nicolo et al. (2004) and De Nicolo and Loukoianova (2006) suggest that concentration may induce higher levels of systemic risk. Boyd et al. (2009) found a positive and significant relationship between the probability of failure and concentration. Uhde and Heimeshoff (2009) reveal that bank concentration is negatively associated with financial soundness.

Amidu and Wolfe (2013) investigate the competition-stability relationship by examining the complex interaction between three key variables: the degree of MP, diversification and stability. The results show that competition improves stability via the income diversification channel. The empirical results of Soedarmonoa, Machrouh and Tarazi (2013) indicate that a higher degree of MP in the banking market is positively associated with capital ratios, income volatility and insolvency risk.

However, Beck, Demirguc-Kunt and Levine (2006) find that increased concentration does not harm bank stability. Schaeck, Cihak and Wolfe (2009) show that there is a trade-off between competition and risk-taking. They argue that, when banks operate in a less

collusive environment, they tend to maintain higher capital levels, making them less exposed to the adverse consequences of a systemic crisis. In contrast, Berger, Klapper and Turk-Ariss (2009) find evidence for both the competition-stability and competition-fragility views. In support of the competition-stability position, they find that banks with more MP tend to have greater loan portfolio risk. For the competition-fragility view, banks with more market power are found to be less exposed to overall risk.

Allen, Carletti and Marquez (2005) and Schaeck and Cihak (2010) explore the relationship between competition and capitalisation levels. Their results reveal that where competition prevails in the credit market, market discipline arising from the asset side pressurises banks to maintain higher levels of capital in order to improve monitoring and attract quality borrowers. Generally, there are two opposing effects of capitalisation on risk-taking. The capital ratio can discipline banks via the capital-at-risk effect because, by operating with their own capital, banks bear part of the risk for their activities. On the other hand, a greater equity ratio may decrease stability through the franchise-value effect; that is, because maintaining higher levels of capital has higher opportunity costs, future profits will be lower, causing banks to take more risks to restore their profits and their franchise (Hellman et al., 2000).

Additionally, the relationship between economic growth and bank competition has been investigated in the literature. Pagano (1993) contends that MP has a direct negative effect on the rate at which the economy can grow. When banks are allowed to maximise their lending rates and minimise their deposit rates, this will have direct consequences on the funds available for lending. Jayaratne and Strahan (1996) examine the effect of branching deregulation in the U.S. on state income growth. The elimination of inter-state branching restrictions was intended to enforce competition in the system. The findings suggest a

positive impact of bank competition on economic growth as personal income and output growth accelerates after the removal of such restrictions. Guzman (2000) explains banks operating in a less competitive environment tend to generate negative effects in relation to the capital accumulation necessary for economic growth. This is because banks bear higher monitoring costs, and therefore divert funds that could be used for lending. Allen and Gale (2004) claim that competition in the banking sector is important for overall industrial an economic growth.

5.3 Methodology and data

This section describes the methodology, models and models and variables used in our study. First, we outline the equations that examine the relationship between MP and risk-taking. Second, we estimate models that investigate the impact of size on the relationship between MP and risk-taking. Third, we assess how the recent banking crisis affected the relationship between these variables.

5.3.1 Relationship between MP and risk taking

In order to evaluate the relationship between banking competition and risk taking (financial stability/ fragility), we run several panel data regressions following the baseline model:

RISK= f (competition, bank specific variables, state specific variables)

The dependent variable RISK reflects bank stability and risk-taking, captured by four alternative risk indicators (Z-score ROA, Z-score ROE, equity to capital ratio, and loan loss reserves to total net loans ratio). The bank- and state-specific variables control for

the characteristics of the banks in the sample, and macroeconomic conditions, respectively.

Our model to examine the nexus between bank MP and risk taking can be specified as in Equation 5.1:

$$RISK_{i,j,t}=\alpha_0+\alpha_1 LERNER_{i,j,t}+\sum_{k=1}^{m}\beta_k X_{k,i,t}+\sum_{L=1}^{n}\theta_l Z_{l,j,t}+\varepsilon_{i,j,t} \quad [5.1]$$

where RISK denotes a risk-taking measure for bank i in year t; LERNER is the Lerner index value of MP for bank i in year t; X and Z are sets of bank and state specific control variables, respectively; α_0 is a constant; α_1 is the coefficients estimating the relationship between MP and risk taking; β_k is the set of parameters of the bank specific variables; θ_l is the set of coefficients of the state specific variables; m and n are the number of bank and state specific variables, respectively; ε is an error term.

5.3.2 Measure of bank MP: LI

To assess the degree of competition between banks, we employ the LI of MP, which is well-established in the literature as a measure of the degree of competition. We calculate the LI, an indicator of MP, as the mark-up of output prices over MC, according to Equation 3.3 in Section 3.3.2.

5.3.3 Measures of bank stability

The Z-score indicator is widely employed in the literature capturing bank risk-taking behaviour (Mercieca et al., 2007; Laeven and Levine, 2009; Houston et al., 2010; Demirguc-Kunt and Huizinga, 2010; Beck, De Jonge and Schepens, 2013; Cubillasa and Suárez, 2013). It is defined as a distance-to-risk indicator, quantifying how far a bank is from insolvency. The measure includes profitability, leverage and profit volatility, therefore higher Z-scores can be interpreted as indicative of a decreased insolvency risk. When equity is insufficient to absorb losses, a bank can technically be considered insolvent (Roy, 1952). Stability and risk insolvency are inversely related.

The Z-score, which is our primary stability indicator, measures the number of standard deviations that a bank's rate of return has to fall below its expected value before equity is completely exhausted. In this paper, we use a three-year moving window to calculate the standard deviation of the rate of return. To reduce the skewness of the Z-score, we employ the natural logarithm of Z-score (Cubillasa and Suárezb, 2013).

In this paper, bank stability is captured by four indicators: Z-scores based on ROE and ROA (ZROE and ZROA, respectively), the ratio of total equity to TA, and the ratio of total loan reserves to total net loans. The Z-scores based on ROE and ROA are included to allow for robustness checks. These indicators are formulated by Equations 5.2 and 5.3.

$$\mathrm{ZROE}_{i,t} = \frac{\mathrm{ROE}_{i,t} + \mathrm{EQTA}_{i,t}}{\mathrm{StROE}_{i,t}} \qquad [5.2]$$

$$\mathrm{ZROA}_{i,t} = \frac{\mathrm{ROA}_{i,t} + \mathrm{EQTA}_{i,t}}{\mathrm{StROE}_{i,t}} \qquad [5.3]$$

In both equations, i and t denote bank and year, respectively; ZROE and ZROA are the Z-scores based on ROE and ROA, respectively; StROE and StROA are the standard deviations of ROE and ROA, respectively, calculated over a three-year period; EQ/TA is the ratio of total equity to TA. Based on these subcomponents, bank stability declines (increases) with lower (higher) levels of profitability and capitalisation and volatile (stable) earnings, as measured by higher (lower) standard deviations of the return rates.

Additionally, following Soedarmonoa et al. (2013), we study the relationship between MP and competition. We specify an equation where the Z-score is replaced by capitalisation, which is measured by the ratio of total equity to TA (EQ/TA). Additionally, and following Lepetit et al. (2008), we include the ratio of loan loss reserves to loans as another measure of risk, and explore the impact of MP on this measure. Similar to our approach using Z-scores, we employ the natural logarithms of the risk measures to limit skewness.

5.3.4 Bank specific variables

As discussed previously, a number of bank characteristics are important factors explaining bank stability and risk taking behaviour (see Section 2.6) In our empirical investigation, following other empirical literature (Shaeck and Cihak, 2009; Laeven and Levine, 2009; Uhde and Heimeshoff, 2009; Fu, Lin and Molyneux, 2014), the bank level variables are: bank asset size, assets growth, loan portfolio, revenue diversification, overhead costs, and loans quality.

The size of a bank (SIZE) may be an important characteristic determining stability (as discussed in Section 2.5.3.2). SIZE is defined as the natural logarithm of TA. Several

papers predicted a positive relation between bank asset size and risk taking (Leaven and Levine, 2009; Fu, Lin and Molyneux, 2014). Banks with larger size can exhibit "too big to fail" effects resulting in higher incentives to risk-taking. Alternatively, larger banks can exhibit greater stability driven by their enhanced diversification opportunities and economies of scale in information production, monitoring and transaction costs.

Banks' exposure to risk can be initially observed by the relative importance of loans in the balance sheet, for loans are the major source of risk. We therefore include the ratio of total net loans to total assets as a measure of credit risk (LOANS). In addition, when banks take on more risk, they tend to incur additional monitoring costs, which can result in greater cost inefficiencies and may lead to instability. Inefficiency is measured by the ratio of operating cost to TA (INEFFICIENCY). The revenue mix of banks also has risk-taking implications, as extensively explained by Amidu and Wolfe (2013). It is captured by the share of non-interest income to total income (DIVERSIFICATION). This ratio measures the income generated by non-traditional banking activities, which are generally riskier and less stable compared to more traditional activities. Finally, we use the ratio of loan-loss provisions (LLP) to total loans to measure how much banks make provision for credit risk.

5.3.5 Diagnosis tests

In order to reduce the potential presence of endogeneity, heteroskedasticity and autocorrelation problems in our data, we use the two-step panel data approach with the system GMM estimator (Bond & Blundell 1998).

It has been shown in the literature that empirical models for the relationship between stability and competition may be subject to endogeneity concerns (Berger, Klapper and

Turk-Ariss, 2009). As a result, in order to ensure that the direction of the relationship goes uniquely from competition to risk-taking, we use instrumental variables. As we use panel data, the model specification includes time and bank effects to overcome the issue of reverse causality. To be consistent with the literature on the relationship between bank stability and competition (Soedarmonoa, Machrouh and Tarazi, 2013; Fu, Lin and Molyneux, 2014), the selected instruments are the levels and first lags of the independent bank-specific variables.

The validity of the system GMM estimation approach relies on two testable assumptions, among others. First, for the instruments to be valid, they need to be uncorrelated with the error term. We employ the Hansen J-statistic of over-identifying restrictions to test this assumption, where statistically insignificant values confirm the validity of the instruments. Second, the system GMM estimator requires alleviation of endogeneity in the independent variable when we employ bank-specific data. We use the GMM C statistic Chi2 test for this assumption, where insignificant values confirm the absence of endogeneity.

We adopt the Z-score as our preferred bank risk measure. The Z-score combines equity ratio, rate of return, and volatility of returns to arrive at a stability indicator, which is adopted as our preferred bank risk measure. We also explore the response of the equity ratio and volatility of returns to the degree of competition. We check the robustness of our results for the Z-score using the two risk sub-components (equity ratio and volatility of returns). We further extend our robustness check by replacing the Z-score with the ratio of loan loss reserves to loans ratio as a potential alternative bank risk measure.

To examine the impact of size and the financial crisis (2007-09) on the relationship between stability and competition, we augment Equation 5.1 with interaction terms

between the competition measure, size and the financial crisis. Since the financial crisis started in 2007 and continued into 2009, we classify the three years of 2007, 2008 and 2009 as the crisis period. We construct a dichotomous variable (termed CRISIS), which is equal to one for 2007, 2008 and 2009, and zero otherwise. Next, we interact this variable with the competition measure. The coefficient of this variable reveals the impact of the crisis on the relationship between competition and risk-taking.

This approach allows us to estimate the relevant parameters of the empirical model using both temporal and cross-sectional data. At the same time, bank effects allow us to control for non-observed heterogeneity, which is an important factor. Otherwise, the regressions could be affected by the omitted variables. The time and bank effects capture the determinants of stability, which do not suffer variations over time, and which are not explicitly included in our regression specifications. Table 5.1. shows variables' definitions.

5.3.6 Data

Our dataset includes U.S. commercial banks from 39 states, over the period from 1987 to 2012. All Financial information is obtained from the Call report published by the Chicago Federal Reserves, and supplemented by economic information from the Labour Bureau of Statistics.

After excluding banks with missing values for LLR and missing Z-score values, we obtain a final sample that includes unbalanced panel data for 39 U.S. states, with more than 130,000 observations (see Table 5.1). All our data are deflated by their corresponding year CPIs to the 2005 price level to remove inflation effects.

Table 5.2 presents the descriptive statistics for all variables used in the study. All bank level variables are averaged by bank for the period from 1987 to 2013.

5.4 Empirical Results

Table 5.3 shows the estimates of financial stability. In Columns 1 and 2, the average values for the insolvency risk Z-score based on ROE (ZROE) and ROA (ZROA), respectively, are reported. In Columns 3 and 4, income volatility indicators, measured as the standard deviation of ROE (SROE) and standard deviation of ROA (SROA), are estimated. The standard deviations of the ROA and ROE show that the volatility of profit growth rates rose dramatically from 2007 to 2010, reflecting a decrease in profits over the crisis period. Similar results for Z-score values can be observed.

Figure 5.1 displays the variations in ZROE and ZROA between 1987 and 2012. Based on these results, it appears that insolvency risk increases dramatically during the crisis period (2007-09), implying that U.S. banking is severely affected by the financial turmoil, but starts to recover from 2010. Table 5.4 reports the comparison of the some indicators across states. On average, banks operating in Pennsylvania, Ohio, Michigan and Maryland are the least fragile. On the other hand, banks in the states of Connecticut, Massachusetts, Florida, California, Colorado and Arizona are exposed to higher risk than those in other states.

5.4.1 Correlation matrix

We first display the pair-wise correlations between MP, bank stability and soundness indicators, and bank-specific and economic variables. This provides preliminary insights

into the sources of the heterogeneity in the market competition-stability relationship. The correlation values are reported in Table 5.5.

The correlation matrix reported in Table 5.5 shows that the competition measure (LERNER) has a statistically significant relationship with all variables, except for the business cycle variable (GROWTH). Observing the signs on the pair-wise correlation estimates, higher levels of bank MP are associated with lower Z-score values, higher income volatility, higher levels of capitalisation and lower LLR, and this relationship seems to be most pronounced for larger banks. The SIZE variable shows a positive and statistically significant relationship with income volatility measures and a negative and statistically significant nexus with Z-score values, LLR and capitalisation. The signs on the correlation coefficients or measures of stability indicate that banks with higher levels of stability tend to have five characteristics. First, non-interest expenses to total operating expenses (EFFICIENCY) are higher; secondly, loan loss provisions to total loans (LLP) are higher; thirdly, non-interest income to total operating income (DIVERSIFICATION) is lower; fourthly, levels of capitalisation (EQUITY) are lower, and, finally, banks are larger (SIZE). For the economic variables, only INFLATION is found to have statistically significant correlations with bank-level data. For the CRISIS variable, the correlation estimates show that during the recent crisis competition decreased, bank Z-score values (ZROE) increased, income volatility declined and capitalisation improved.

5.4.2 The relationship between stability and MP

This section analyses the relationship between the LI of MP as a competition indicator and measures of stability and capitalisation. In the following sections, we further our analysis by considering whether the financial crisis and bank size affect this relationship.

Table 5.6 reports the GMM regression results that have the following dependent variables: bank insolvency risk, measured by ZROE and ZROA for models 1 and 2, 7 and 8; income volatility, based on SROE and SROA for models 3, 4, 9 and 10; capitalisation ratio (equity/assets) for models 5 and 11, and loan portfolio risk (ratio of LLR to total loans) for models 6 and 12. Table 5.6 is also divided into two panels. Panel A presents the main relationship of interest between competition and stability, using bank-level data only. Panel B extends the models in Panel A to include the state-specific variables of inflation rates and real economic growth rates. The results of the post-estimation tests for endogeneity and over-identification are reported at the bottom of Table 5.6.

In Panels A and B of Table 5.6, the coefficient of the LI in the insolvency risk models where the Z-score of the profit rates are the dependent variables (models 1, 2, 7 and 8) is negative and statistically significant at the 1% level, suggesting that an increase in competition has a significant positive effect on the overall stability of banks in the context of U.S. banking. An increase in MP increases the insolvency risk of banks, manifested by a declining Z-score, in contrast to the franchise value paradigm in U.S. banking. Next, for income volatility models (models 3, 5, 9 and 10) in panels A and B of Table 5.6, the LI of MP has a positive and statically significant coefficient, implying that greater competition (and lower MP) reduces income variability, therefore increasing stability.

In addition, in models 6 and 12 in Table 5.6, where the ratio of LLR to total loans is specified as the dependent variable, the coefficient of the Lerner variable is negative and statistically significant, suggesting that in a more competitive environment banks tend to reduce their loan portfolio risk. Amidu and Wolfe (2013) find a significant relationship between competition and loan portfolio risk measures. They explain that when competition is high, bank interest rates are generally low so borrowers' returns on

investment increase, which decreases the risk of default. Consequently, the number of non-performing loans will be lower, as will levels of reserve allocation.

Our findings from the stability measures GMM specifications provide empirical evidence in favour of the competition-stability view proposed in the literature, and are consistent with the empirical findings of many studies, including those of De Nicolo et al. (2004), Uhde and Heimeshoff (2009), and Amidu and Wolfe (2013). However, our results do not correspond to the findings of Beck et al. (2006) and Beck, De Jonge and Schepens (2013). To illustrate, Beck, De Jonge and Schepens (2013) report a positive and significant relationship between MP and bank soundness, proxied by the Z-score. They suggest that an increase in competition erodes banks' pricing power, reduces risk aversion, and is hence detrimental to financial stability.

Models 5 and 11 of Table 5.6 seek to establish whether banks operating under more competitive conditions maintain greater levels of equity capital, which are generally held as a buffer against potential losses from non-performing loans. The results in Table 5.6 indicate a positive and statistically significant relationship between market power and capitalisation, implying that banks maintain a higher capital ratio as their MP increases. This finding is similar to that of Berger, Klapper and Turk-Ariss (2009), who suggest that banks with greater MP tend to hold higher levels of capitalisation. However, the relationship between competition and capital levels remains inconclusive in the literature. Schaeck and Cihak (2010) find that competition provides incentives for banks to maintain higher capital ratios. Beck, De Jonge and Schepens (2013) also report a positive relationship between competition and capitalisation.

In both panels of Table 5.6, the variable SIZE enters the insolvency risk models and loan risk models with a positive sign and statistically significant coefficient, whereas it enters

the income variability and capitalisation regressions with a negative and statistically significant coefficient. These findings suggest that larger banks are less exposed to overall insolvency risk compared to smaller banks. They also tend to have better levels of LLR, exhibit lower income volatility and maintain lower levels of capital.

In addition, with regards to the effect of asset growth (D.ASSETS) on bank stability and capitalisation, the models in Panel A in Table 5.6 reports statistically significant coefficients only where RSOA, EQAS and LLR are the dependent variables. When the economic variables of INFLATION and GROWTH are included in the models in Panel B, the coefficient is statistically significant, except where ROA is the dependent variable. The shift in the statistical significance demonstrates the link between asset growth and the state of the economy. In panel B, the coefficient of D.ASSETS is positive in the specification where the variability of ROE is the explained variable, but negative in all other models. These findings imply that when a bank grows in size, this growth will be associated with a greater volatility in its profits, lower levels of capital, lower levels of LLR and an overall increase in insolvency risk. This may be because banks tend to pursue aggressive lending behaviour during periods of growth.

In both panels of Table 5.6, the coefficient of loan to assets ratio (LOANS) is positive and statistically significant in the insolvency risk and LLR models, implying that when bank lending increases, insolvency risk decreases and LLR, as a buffer against bad loans, increase. On the other hand, the variable LOANS enters the income variability and capitalisation regressions with negative and statistically significant coefficients, suggesting that, as banks increase their lending, capitalisation levels decrease and profit variability lessens. Generally, banks that provide quality loans maintain low levels of capital and, consequently, do not need additional capital to absorb losses. In addition,

regulation has enforced the lending behaviour of banks by making them hold appropriate levels of reserves. Furthermore, the profitability level of such banks is enhanced because low provisions are made in connection to loan losses.

Panel B of Table 5.6 reports models with specifications extended to include the two macroeconomic indicators inflation rates (INFLATION) and real growth rates (GROWTH). The coefficient on the GROWTH variable is statistically significant only in the insolvency risk and loan portfolio risk models, suggesting that higher economic growth rates improve the stability of banks and reduce the levels of LLR. The coefficient on the INFLATION variable is negative and statistically significant in the specifications where insolvency risk (ZROE and ZROA), capitalisation (SROE and SROA), and loan portfolio risk (LLR) are the dependent variables. These results suggest that during times of higher inflation, insolvency risk increases, and capitalisation and LLR tend to decline. Our findings are consistent with the literature on the relationship between financial development and inflation. Bittencourt (2011), for example, finds that inflation has negative effects on financial development.

The coefficient on non-interest expenses to total operating expenses variable (EFFICIENCY), as a measure of cost efficiency, is statistically significant in all models, but positive in the insolvency risk and loan portfolio risk models, and negative in the variability of returns and capitalisation models. These results indicate that banks which decrease their operating costs can increase overall stability and reduce income variability, but this will be associated with increasing loan reserve ratios and decreasing capital ratios, as a result of declining profit. Overall, this result contrasts with the agency hypothesis that bank management engages in inefficient behaviour by investing in more risky assets.

The coefficient on the DIVERSFICATION variable, measured by the ratio of non-interest income to total operating income, is positive in the capitalisation models and negative in all other specifications. These results imply that income diversification improves the capitalisation level of banks, reduces the variability of their profits and loan-loss exposure, but increases their overall insolvency risk. Finally, the coefficient on the LLP variable is statistically significant in all models. LLP enters the insolvency risk models with a positive sign, but has a negative sign in the income variability and capitalisation models. These findings suggest that holding higher levels of provision against bad loans improves the stability of banks, but decreases their level of capitalisation.

To further our investigation of the relationship between competition and stability, and following Berger, Klapper and Turk-Ariss (2009) and Turk-Ariss (2010), we include a quadratic term in the LI to allow for a non-linear relationship between MP and each of the measures of bank stability. Table 5.7 reports the system GMM estimation results for specifications that include the quadratic term for the LI and have as the dependent variables: bank insolvency risk (measured by ZROE and ZROA) for models 1 and 2, 7 and 8; income volatility (SROE and SROA) for models 3, 4, 9 and 10; capitalisation ratio (equity/assets) for models 5 and 11; and loan portfolio risk (LLR to total loans) for models 6 and 12. Table 5.7 is also divided into two panels. Panel A presents the main relationships of interest between competition and stability using bank level data only. Panel B extends the models in Panel A to include the state specific variables of inflation rates and real economic growth rates. The results of the post-estimation tests for endogeneity and over-identification are reported at the bottom of Table 5.7.

The sign of the non-linear relationship between the LI variable and each of the risk indicators is established by computing the inflection point for each specification. This

point is calculated by setting the first-order derivative to zero and comparing its value to the empirical distribution of the LI data (Turk-Ariss, 2009). For example, the inflection point of Model 1 of Panel A in Table 5.7 is -2.05, while the 5th percentile of the LI data occurs at -2.05, implying that more than 95% of the degree of MP data lies above the inflection point. Given that the sign of the quadratic coefficient in Model 1 is negative, the resulting estimated function is a downward oriented or reverse parabola that decreases above the inflection point. Therefore, the empirical estimation supports a negative association between competition and insolvency risk.

A similar analysis for each estimated model reports the sign (+/-) of the non-linear relationship between the variables of interest. The significant positive relationship between competition and measures of stability holds across all specifications, with the exception of the regressions, where the volatility of ROE (models 3 and 8) is specified as the dependent variable. Generally, our findings suggest that, in an environment where competitive conditions are high, banks tend to be more stable. These results establish a positive relationship between the level of competition and stability, in support of the competition-stability view.

The results from the analysis of bank-specific variables suggest that banks which lend a greater portion of their assets exhibit significantly higher Z-score values. This implies that they have higher credit risk exposure (higher loan to asset ratios) but are in fact exposed to lower levels of overall risk, and this effect is more marked for larger banks. It could be the case that banks which are active in extending credit hedge their portfolios (with more LLP) in order to reduce their risk potential and ensure that their overall stability is safeguarded. Overall, it appears that banks that engage in more lending activities are able to achieve greater levels of stability, and the effect is more pronounced

for larger banks. Similar results were found by Turk-Ariss (2010). However, our results do not agree with those of Laeven and Levine (2009) and Fu, Lin and Molyneux (2014), who reported that larger banks face greater risk.

The coefficients of loan portfolio composition (loans to total assets) and bank size are positive and significant in the insolvency risk and loan-loss risk models, suggesting that larger banks, and those with greater levels of loan to asset ratios, have higher levels of stability, and their loan losses are well covered by reserves. On the other hand, these two variables enter the models of income volatility and capitalisation with negative signs, implying that size and loan composition reduce the capitalisation of banks, and expose them to lower levels of income variability.

5.4.3 Effects of 2007-09 crisis on the relationship between MP and stability

Table 5.8 reports the results of our models which include CRISIS as an independent variable to capture the effect of the 2007-09 financial turmoil on bank stability in the U.S. Panel A displays the results of the models that have bank specific variables and the dummy CRISIS as the independent variable. Panel B in reports the results of the models where the bank and state characteristics and the CRISIS variable are the explanatory variables. In all regressions in Table 5.8, the coefficient of the CRISIS variable is statistically significant at the 1% critical level, implying a direct impact of the 2007-09 financial crisis on the various indicators of bank stability. The coefficient of the CRISIS variable carries a positive sign in the capitalisation models and negative sign in all other models.

These findings suggest that during the 2007-09 financial turmoil, banks tend to be more fragile, and their levels of LLR as a proportion of loans decrease. On the other hand, the results indicate that banks confront financial crises by increasing their capital ratios; that is, they are more fragile but tend to counter the adverse effects of the crisis by increasing capital ratios. Our results indicate that during financial turmoil, banks experience a decline in their stability by increasing their capital ratios to avoid eroding their franchise value.

Our results are consistent with the findings in the literature. Fu, Lin and Molyneux (2014) find the CRISIS dummy to be positively and significantly related to risk, suggesting that banks are more fragile during financial turmoil. Berger and Bouwman (2009) propose that during a financial crisis banks tend to diminish loans and enforce capital ratios, since capital is used as a buffer against the shocks of the crisis and can help banks to increase competitive advantage in the market. Higher risk aversion of banks can thus moderate moral hazard in terms of excessive lending.

Our results are in line with Brownbridge and Kirkpatrick (1999), who point out that banks can behave imprudently during a crisis due to a massive decline in bank capital ratios and an increase in maturity mismatch. This is because such situations erode the franchise value of banks, encouraging risky or fraudulent behaviour. This view is shared by other authors (Borio, Furfine and Lowe, 2001; Ayuso, Perez and Saurina, 2004; Jokipii and Milne, 2008), who suggest that during a financial downturn, banks tend to reduce their lending and alternatively build up capital ratios.

In order to further investigate the competition-stability nexus during the 2007-09 financial crisis, we add an interaction term (LERNER-CRISIS) to the estimations conducted in the previous sections. Table 5.9 reports the results of the various specifications in which the

LI of MP is interacted with the LERNER_CRISIS term. The results show that the interaction term is statistically significant in all models, apart from two, 1 and 7, where ZROE is specified as the dependent variable.

In addition, the coefficient on the interaction term is negative in models 2 and 7, where ZROA is the dependent variable; the corresponding coefficient is also negative in the other regressions (income variability, capitalisation and credit portfolio risk). These results suggest that, during a financial crisis, competition has a positive effect on the overall stability and soundness of banks, as measured by ZROA. Results from the credit portfolio risk analysis show that, when banks operate in a more competitive environment, they tend to respond to the crisis by increasing their LLR. Further, the capitalisation models suggest that banks with more MP were better capitalised during the 2007-09 crisis.

Table5.9 Model 1, before the crisis, the coefficient on LERNER is -0.020. This mean banks within more power operates with a smaller ZROA. Banks with more market power were higher risk. During the crisis, the coefficient on LERNER is (-0.02+0.01) =0.01. Bank with more MP still operated with smaller ZROE, but this relationship weaker than before the crisis.

5.4.4 Effects of bank size on the relationship between MP and stability

Table 5.10 reports the results of the models in which we interact the SIZE variable and LERNER (LI of MP). Panel A shows the results of the specifications (models 1 to 6) which include bank level variables, in addition to the SIZE_LERNER interaction term.

Panel B augments the specifications in Panel A by adding the INFLATION and GROWTH variables (models 7 to 12).

In Table 5.10, the SIZE_LERNER interaction variable enters all specifications with a statistically significant and positive sign, suggesting that SIZE has direct and positive effects on the relationship between MP and insolvency risk, income volatility and capitalisation. In models 3 and 9, however, where the dependent variable is the SROE, the coefficient of the interaction variable is not significant.

For models 1, 2 and 7, the coefficient sign of the SIZE_LERNER interaction variable is positive, suggesting that for larger banks, greater MP reduces the insolvency risk. For models 4 and 10, the interaction variable is positive, implying that for larger banks, greater MP increases income volatility, as measured by the standard deviation of the ROA. For models 6 and 12, the SIZE_LERNER interaction variable is positive, indicating that when larger banks increase their market power, this would be accompanied by increasing levels of the LLR ratio.

According to the competition-stability hypothesis, market power leads to financial instability because banks with more market power set higher lending rates, and borrowers take more risks in order to service their loans. If this hypothesis is correct, the coefficient on LERNER in a regression for ZROE (for example) should be negative. The inclusion of a LERNER × SIZE interaction enables us to investigate whether this underlying relationship between LERNER and ZROE depends on SIZE. Is the tendency for small banks with market power to place pressure on borrowers to take risks more pronounced than the same tendency for large banks with market power? The positive and significant coefficient on the LERNER × SIZE interaction is consistent with this hypothesis. We might speculate that large banks with market power are less inclined to raise lending rates

than small banks with market power, perhaps because large banks have more capability to generate profits by other means, such as exploitation of economies of scale.

The results in Table 5.10 provide evidence that size is an important factor in the relationship between competition and stability in banking, as suggested by the concentration-stability literature. Larger banks in collusive markets exhibit greater stability; have better capitalisation ratios and increase their loan loss reserves to cover loan losses. Our results are similar to the findings of Berger, Klapper and Turk-Ariss (2009); also those of Amidu and Wolfe (2013), who find that larger banks engage in less risk-taking than smaller banks in a competitive environment

The inverse effect of bank size on stability as a function of competition appears in models 1 and 2, where ZROE and ZROA are specified as the dependent variables. From the positive sign on the SIZE_LERNER interaction term, we find that large banks appear to exhibit greater stability in more collusive markets. These findings support the concentration-stability view, which claims that larger banks are more stable in such markets. The explanation is that larger banks can more securely engage in risk-taking activities because their scale gives them an advantage over smaller ones. Therefore, a market with less competitive conditions appears to improve the stability of large banks.

Supporting the findings from the Z-score models, the negative effect of size on stability as a function of competition can be captured in models 5 and 11, where the ratio of equity to assets (EQ/AS) is the dependent variable. For models 5 and 11, the SIZE_LERNER interaction variable has a positive sign, indicating that for larger banks greater MP has a positive impact on the level of capitalisation, and therefore on bank stability. The statistical significance of the coefficient and its relatively large magnitude suggest that the impact of size on the relationship between capitalisation and competition is

pronounced, supporting other evidence that larger banks tend to be more stable in collusive markets. In addition, the results for credit portfolio risk (models 6 and 12 in Table 5.10) show that the SIZE_LERNER interaction variable is positive, indicating that when larger banks increase their MP, this would be accompanied by higher levels of the LLR ratio. Boyd and De Nicolo (2005), Berger, Klapper and Turk-Ariss (2009), and Amidu and Wolfe (2013) argue that even if collusion leads to riskier loan portfolios, banks may increase their equity capital to maintain their overall stability. Berger, Klapper and Turk-Ariss (2009) argue that banks consolidate their capitalisation levels to improve stability. Amidu and Wolfe (2013) suggest that an effective regulatory measure to improve financial stability would be the imposition and enforcement of higher capital requirements.

5.4.5 Effects of size on the relationship between MP and stability during the 2007-09 crisis

In this section, we seek to establish whether size was an important factor in the relationship between competition and stability during the 2007-09 crisis. Our estimations control for the severity of the crisis, and then concentrate on the interaction between size, crisis and the LI, represented by the interaction variable SIZE_CRISIS_LERNER. The results are presented in Table 5.11, where the models are designed in a similar way to the previous specifications.

In both Panels A and B in Table 5.11, the coefficients of interaction between the variables SIZE, CRISIS and LERNER (SIZE_CRISIS_LERNER) are not statistically significant in all model specifications. These results indicate that bank size appears to be an insignificant factor in the competition-stability relationship during a crisis. Our findings

are important and suggest that during a crisis all banks are subject to its effects, regardless of size. The positive and statistically significant coefficient on the SIZE and LERNER interaction in the models where the Z-score is the independent variable confirms our previous result that size affects the relationship between competition and stability regardless of the business cycle and is characterised by decreasing and negative economic growth rates; that is, larger banks with more MP are characterised by greater stability.

5.5 Conclusion

The purpose of this paper is to determine whether competition improves or reduces banking stability for U.S. banks between 1987 and 2012. We calculate, as a measure of competition, the LI of MP. The MC are estimated from a translog equation. We then regress the Lerner variable on various measures of stability, income volatility, capitalisation and risk-taking, to identify the effects of competition on bank stability and soundness. Finally, we evaluate how the competition-stability nexus was affected during the 2007-09 financial turmoil, and how this relationship changes according to bank size.

Generally, our findings indicate a direct and significant relationship between competition and stability risk-taking, providing empirical support for the competition-stability (or concentration-fragility) view in the literature. Banks with greater market power are associated with greater levels of instability, and this is most pronounced for larger banks. On the other hand, market power seems to be positively correlated with greater levels of capitalisation.

5.6 Tables and Figures

Table 5.1: Variables definition

Variable	Proxy	Definition
Panel A: Dependent variables		
ZROE	Z-score of ROE	Average return on equity Plus equity to total assets divided by the standard deviation of return equity
ZROA	Z-score of ROA	Average return on assets Plus equity to total assets divided by the standard deviation of return assets
SROE	Standard deviation of ROE	Standard deviation of ROE calculated over 3-year period window
SROA	Standard deviation of ROA	Standard deviation of ROA calculated over 3-year period window
LLR	Loan portfolio risk	Loan loss reserves to total net loans
EQTA	Capitalisation	Equity to assets
Panel B: Bank-specific variables		
LERNER	Competition measure	Lerner Index of MP: Bank's ability to set prices above marginal costs
SIZE	Bank size	The natural logarithm of total assets
ASSETS GROWTH	Growth in assets	The percentage difference between Assets(t) and Assets(t-1)
LOANS	Loan size in the balance sheet	Total net loans to total assets
EFFICINECY	Cost efficiency	Total non-interest operating expenses to total operating expenses
DIVERSIFICATION	Diversification effect	Non-interest income to total operating income
LLP	Ex-post loan losses	Loan loss provisions to total net loans
Panel C: State-specific variables		
GROWTH	Business cycle	Annual real GDP growth rate
INFLATION	Inflation	Inflation rates measured as the difference in the log of CPI
CRISIS	Global Financial crisis	Takes on values of 1 for crisis year (2007-2009) and 0 otherwise

Note: the table presents the variables used in the various models to examine the relationship between bank risk taking and MP, for the whole period and during the 2007-2009 crisis.

Table 5.2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
LLR	148489	-4.06	0.57	-10.39	0.25
SROE	147831	0.08	0.15	-5.5	1.11
SROA	148498	0.01	0.01	-0.2198	0.28
ZROE	130906	3.55	0.01	3.55	5.61
ZROA	130906	1.82	0	1.82	1.85
LERNER	147911	0.02	0.52	0.86	0.8
SIZE	148498	11.36	0.92	9.21	13.46
LOANS	148498	0.46	0.09	0.02	0.68
EFFICIENCY	148498	-0.69	0.29	-2.34	0
DIVERSIFICATION	148498	-0.11	0.11	-4.17	0.42
EQUITY	148498	-2.39	0.31	-8.61	-0.16
LLP	148498	0.01	0.01	0	0.75
INFLATION	130914	0.02	0.04	-0.35	0.15
GROWTH	130914	0	0.48	-4.92	4.82

ZROE = Average return on equity + equity to total assets / the standard deviation of return equity; **ZROA** = Average return on assets + equity to total assets / the standard deviation of return assets; **SROE** = Standard deviation of ROE calculated over 3-year period window; **SROA** = Standard deviation of ROAcalculated over 3-year period window; **LLR** = Loan loss reserves to total net loans; **EQTA** = Equity to assets; Panel B: Bank-specific variables, **LERNER** is Lerner Index of MP; **SIZE** is the natural logarithmof total assets; **ASSETS GRWOTH** is the percentage difference between assets(t) and Assets(t-1); **LOANS** = Total net loans to total assets; **EFFICINECY** = Total non-interest operating expenses / total operating expenses; **DIVERSIFICATION** is Non-interest income /total operating income; **LLP** = Loan loss provisions /total net loans; **GROWTH** is annual real GDP growth rate INFLATION is inflation ratesmeasured as the difference in the log of CPI

Table 5.3: Evolution of risk measures between 1989 and 2013

Year	Z-ROE	Z-ROA	S-ROE	S-ROA
1989	14.63	78.78	0.1103	0.0044
1990	15.21	82.51	0.1687	0.004
1991	15.71	81.84	0.0947	0.004
1992	15.87	73.52	0.0772	0.004
1993	17.17	82.03	0.0561	0.0037
1994	18.83	93.26	0.0471	0.0031
1995	19.27	103.42	0.0464	0.0029
1996	23.12	118.53	0.0467	0.0026
1997	24.54	120.71	0.0437	0.0027
1998	23.94	124.78	0.0402	0.0027
1999	23.71	122.86	0.0395	0.0027
2000	22.81	121.49	0.0322	0.0028
2001	19.47	101.13	0.0441	0.0031
2002	20.19	98.67	0.0347	0.0031
2003	20.56	103.84	0.0341	0.003
2004	22.04	120.28	0.0306	0.0028
2005	23.55	116.34	0.0361	0.0028
2006	23.23	106.73	0.0319	0.003
2007	18.63	104.82	0.038	0.0033
2008	13.84	75.18	0.062	0.0049
2009	11.87	63	0.075	0.0059
2010	12.86	70.81	0.073	0.005
2011	14	74.44	0.0598	0.0048
2012	15.35	88.36	0.0456	0.0039
Mean	**18.65**	**96.24**	**0.062**	**0.0035**

Z-ROE = Average return on equity + equity to total assets / the standard deviation of return equity;
Z-ROA = Average return on assets + equity to total assets / the standard deviation of return assets;
S-ROE = Standard deviation of ROE calculated over 3-year period window;
S-ROA = Standard deviation of ROAcalculated over 3-year period window.

Table 5.4: Risk measures banks across states between 1989 and 2012

States	Z-score ZROE	Z-score ZROA	Stdev SROE	Stdev SROA
Alabama	18.75	112.83	0.0372	0.0031
Arizona	7.01	47.16	0.1928	0.0082
Arkansas	19.39	99.13	0.0434	0.003
California	10.45	60.66	0.1244	0.006
Colorado	12.11	60.45	0.091	0.0048
Connecticut	11.8	64.97	0.195	0.0069
Florida	11.54	61.19	0.0758	0.005
Georgia	19.04	90.11	0.0531	0.0039
Illinois	20.22	110.46	0.0414	0.003
Indiana	23.85	121.78	0.0297	0.0024
Iowa	20.94	104.13	0.0377	0.0027
Kansas	20.1	99.75	0.042	0.0033
Kentucky	20.83	110.63	0.0409	0.003
Louisiana	16.29	84.58	0.0944	0.004
Maryland	27.8	124.93	0.0393	0.0032
Massachusetts	11.55	63.67	0.3082	0.0057
Michigan	25.34	129.7	0.0466	0.0027
Minnesota	18.37	88.54	0.0433	0.0033
Mississippi	23.15	114.74	0.0473	0.0029
Missouri	19.72	98.56	0.0394	0.0028
Montana	18.03	83.24	0.0362	0.0033
Nebraska	18.64	102.95	0.0364	0.003
New Jersey	12.44	87.86	0.0914	0.0046
New Mexico	16.69	73.39	0.1194	0.0038
New York	23.27	120.3	0.0478	0.0032
North Carolina	19.4	102.39	0.0662	0.0039
North Dakota	16.9	91.43	0.0364	0.0029
Ohio	24.95	139.33	0.0316	0.0025
Oklahoma	16.55	80.19	0.0522	0.0037
Oregon	14.81	83.29	0.0519	0.0048
Pennsylvania	26.69	141.42	0.0419	0.0026
South Carolina	24.87	121.39	0.0384	0.0033
South Dakota	19.27	92.03	0.0469	0.0043
Tennessee	19.73	99.47	0.043	0.0034
Texas	14.3	70.32	0.127	0.0044
Utah	15.45	76.35	0.0578	0.0054
Virginia	19.88	110.79	0.0558	0.0033
Washington	15.6	79.24	0.0605	0.0045
West Virginia	21.68	123.47	0.0324	0.0025
Wyoming	14.65	73	0.0432	0.0036
Mean	18.3	95	0.0685	0.0038
Mean	18.65	96.24	0.062	0.0036

Z-ROE = Average return on equity + equity to total assets / the standard deviation of return equity;

Z-ROA = Average return on assets + equity to total assets / the standard deviation of return assets;

S-ROE = Standard deviation of ROE calculated over 3-year period window;

S-ROA = Standard deviation of ROAcalculated over 3-year period window.

Table 5.5: Correlation matrix

	LLR	SROE	SROA	ZROE	ZROA	LERNER	SIZE	LOANS	EFFICIENCY	DIVERSIFICATION	EQUITY	LLP	INFLATION	GROWTH
SROE	-0.1678***	1												
SROA	-0.1692***	0.7693***	1											
ZROE	0.0796***	-0.1042***	-0.1948***	1										
ZROA	0.2155***	-0.394***	-0.4524***	0.3283***	1									
LERNER	-0.1962***	0.2047***	0.3105***	-0.061***	-0.1497***	1								
SIZE	-0.1474***	0.0938***	0.1112***	-0.0293***	-0.1092***	0.3871***	1							
LOANS	-0.2987***	0.0076***	-0.0248***	0.001	0.0019	0.2483***	0.2384***	1						
EFFICIENCY	-0.1483***	-0.0946***	-0.1002***	0.0065**	0.103***	0.5925***	0.0954***	0.1615***	1					
DIVERSIFICATION	0.0053**	-0.0348***	-0.117***	-0.0162***	-0.1277***	-0.2972	-0.1238	0.0169	-0.432	1				
EQUITY	-0.1027***	0.1088***	0.2887***	-0.2255***	-0.1372***	0.1800***	-0.0824***	-0.1081***	0.1488***	0.0076***	1			
LLP	0.3739***	-0.5201***	-0.5647***	0.1666***	0.4777***	-0.1322***	-0.0654***	-0.0751***	0.0013	-0.0999***	-0.1865***	1		
INFLATION	0.0318***	-0.037***	-0.0536***	0.015***	0.0437***	-0.1046***	-0.0291***	-0.023***	-0.0057**	-0.0033	-0.0563***	0.0375***	1	
GROWTH	-0.0011	-0.0017	0.0006	-0.0016	-0.0025	-0.0025	0.0032	-0.0027	0.0061	-0.0045	0.0026	0.0025	0.0078***	1
CRISIS	-0.1375***	-0.0894***	-0.1083***	-0.003	0.0534***	0.1331***	0.1257***	0.1583***	0.145***	-0.024***	0.0961***	0.0377***	0.0154***	0.004

ZROE = Average return on equity + equity to total assets / the standard deviation of return equity; **ZROA** = Average return on assets + equity to total assets / the standard deviation of return assets; **SROE** = Standard deviation of ROE calculated over 3-year period window; **SROA** = Standard deviation of ROA calculated over 3-year period window; **LLR** = Loan loss reserves to total net loans; **EQTA** = Equity to assets; Panel B: Bank-specific variables, **LERNER** is Lerner Index of MP; **SIZE** is the natural logarithm of total assets; **ASSETS GRWOTH** is the percentage difference between assets(t) and Assets(t-1); **LOANS** = Total net loans to total assets; **EFFICINECY** = Total non-interest operating expenses / total operating expenses; **DIVERSIFICATION** is Non-interest income / total operating income; **LLP** = Loan loss provisions /total net loans; **GROWTH** is annual real GDP growth rate; **INFLATION** is inflation ratesmeasured as the difference in the log of CPI; **CRISIS** is takes on values of 1 for crisis year (2007-2009) and 0 otherwise and Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Table 5.6: GMM regression of the relationship between competition and stability with bank specific and economic variables

Models	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Independent variables	**ZROE**	**ZROA**	**SROE**	**SROA**	**EQASS**	**LLR**	**ZROE**	**ZROA**	**SROE**	**SROA**	**EQASS**	**LLR**
LERNER	-0.038***	-0.008***	0.160***	0.014***	0.633***	-5.597***	-0.035***	-0.008***	0.140***	0.011***	0.535***	-5.199***
	-0.008	0.001	0.047	0.003	0.074	0.614	0.007	0.001	0.049	0.003	0.072	0.588
SIZE	0.005***	0.001***	-0.014***	-0.001***	-0.081**	0.679*	0.004***	0.001***	-0.012	-0.001**	-0.07***	0.614***
	0.001	0	0.006	0	0.011	0.081	0.001	0	0.007	0	0.01	0.078
D.ASSETS	-0.001	0	0.045***	0	-0.104***	-0.184***	-0.004***	-0.001***	0.054***	0	-0.131***	-0.714***
	0	0	0.005	0	0.011	0.064	0.001	0	0.006	0	0.011	0.052
LOANS	0.018***	0.003***	-0.076***	-0.007***	-0.545***	0.507*	0.015***	0.003***	-0.066***	-0.006***	-0.514***	0.333
	0.003	0	0.02	0.001	0.04	0.295	0.002	0	0.021	0.002	0.037	0.278
EFFICIENCY	0.031***	0.007***	-0.206***	-0.018***	-0.274***	4.295***	0.028***	0.006***	-0.188***	-0.015***	-0.195***	3.939***
	0.006	0	0.04	0.003	0.063	0.517	0.006	0	0.042	0.003	0.061	0.497
DIVERSIFICATION	-0.006***	-0.002***	-0.185***	-0.019***	0.192***	-0.942***	-0.006***	-0.002***	-0.188***	-0.02***	0.170***	-0.879***
	0.001	0	0.018	0.003	0.048	0.138	0.001	0	0.018	0.003	0.048	0.131
LLP	0.108***	0.015***	-7.476***	-0.475***	-2.836***		0.107***	0.015***	-7.499***	-0.477***	-3.075***	
	0.032	0.002	0.368	0.027	0.32		0.032	0.002	0.373	0.027	0.325	
INFLATION							-0.025***	-0.005***	0.080*	0	-0.224***	-4.066***
							0.004	0	0.043	0.003	0.069	0.481
GROWTH							0.000*	0.000***	0	0	0.002	-0.023**
							0	0	0.001	0	0.002	0.009
CONSTANT	3.471***	1.801***	0.34***	0.032***	-0.687***	-15.214**	3.479***	1.802***	0.295***	0.026***	-0.872***	-14.08***
	0.017	0.001	0.103	0.007	0.172	1.376	0.015	0.001	0.109	0.007	0.164	1.302
N	113256	113256	112749	113262	113262	113255	113256	113256	112749	113262	113262	113255
chi2	153.88**	877.76***	1468.17***	1306.96**	1783.37**	639.23***	155.63***	959.18***	2170.41***	3376.44***	2550.20***	729.16***
First stages statistics												
asj R-sq	0.5206	0.5206	0.5846	0.5806	0.5806	0.5687	0.5874	0.5874	0.5916	0.5875	0.5875	0.5751
Partial R-sq	0.0117	0.0117	0.0105	0.0117	0.0117	0.0014	0.0119	0.0119	0.0107	0.0119	0.0119	0.0013
Robust F	62.27	62.27	62.46	62.26	62.3	27.63	60.15	60.15	60.042	60.14	60.14	26.12
Endogeneity test												
GMM C statistic chi2(1)	1.72	0.1	0.06	0.04	0.04	4.01	0.65	0	0	0.07	0.51	2.21
p-value	0.1891	0.7548	0.8024	0.8427	0.8399	0.0453	0.4198	0.9566	0.9346	0.7894	0.4739	0.1374
Over-identification test												
Hansen's J chi2(5)	2.12	4.71	5.32	8.98	9.73*	8.45	3.5	7.65	5.94	9.47*	9.45*	10.92**
p-value	0.8323	0.4526	0.3778	0.11	0.083	0.0764	0.6239	0.1765	0.3124	0.092	0.092	0.028

ZROE = Average return on equity + equity to total assets / the standard deviation of return equity; **ZROA** = Average return on assets + equity to total assets / the standard deviation of return assets; **SROE** = Standard deviation of ROE calculated over 3-year period window; **SROA** = Standard deviation of ROAcalculated over 3-year period **window; LLR** = Loan loss reserves to total net loans; **EQTA** = Equity to assets; Panel B: Bank-specific variables, **LERNER** is Lerner Index of MP; **SIZE** is the natural logarithmof total assets; **ASSETS GRWOTH** is the percentage difference between assets(t) and Assets(t-1); **LOANS** = Total net loans to total assets; **EFFICINECY** = Total non-interest operating expenses / total operating expenses; **DIVERSIFICATION** is Non-interest income /total operating income; **LLP** = Loan loss provisions /total net loans; GROWTH is annual real GDP growth rate; **INFLATION** is inflation ratesmeasured as the difference in the log of CPI; **CRISIS** is takes on values of 1 for crisis year (2007-2009) and 0 otherwiseand Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Table 5.7: GMM regression of the non-linear relationship between competition and stability with bank specific and economic variables

Variable	Panel A						Panel B					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
	ZROE	ZROA	SROE	SROA	EQASS	LLR	ZROE	ZROA	SROE	SROA	EQASS	LLR
LERNER	-0.168***	-0.032***	0.425**	0.048***	4.691***	-13.309***	-0.171***	-0.035***	0.394**	0.043***	4.429***	-17.068***
	0.046	0.004	0.186	0.012	0.782	2.184	0.047	0.005	0.199	0.012	0.768	3.093
LERNER_SQUARED	-0.041***	-0.008***	0.074	0.009***	1.220***	-3.228***	-0.041***	-0.009***	0.065	0.008**	1.166	-4.188***
	0.012	0.001	0.048	0.003	0.231	0.593	0.012	0.001	0.051	0.003	0.226	0.829
SIZE	0.008***	0.002***	-0.025***	-0.003***	-0.232***	0.628***	0.009***	0.002***	-0.024**	-0.003***	-0.217***	0.812***
	0.002	0	0.009	0.001	0.03	0.1	0.002	0	0.01	0.001	0.029	0.145
D.ASSETS	-0.003***	0***	0.05***	0	-0.052***	-0.366***	-0.007***	-0.001***	0.063***	0.001**	-0.050**	-0.758***
	0.001	0	0.006	0	0.02	0.05	0.002	0	0.007	0	0.023	0.077
LOANS	0.018***	0.003***	-0.097***	-0.010***	-0.734***	-0.337	0.018***	0.003***	-0.094***	-0.01***	-0.708***	-0.033
	0.004	0	0.015	0.001	0.065	0.221	0.004	0	0.016	0.001	0.063	0.304
EFFICIENCY	0.060***	0.011***	-0.284***	-0.028***	-1.261***	4.286***	0.06***	0.011***	-0.273***	-0.027***	-1.152***	5.401***
	0.015	0.001	0.061	0.004	0.194	0.689	0.015	0.001	0.066	0.004	0.192	0.986
DIVERSIFICATION	-0.021***	-0.005***	-0.157***	-0.015***	0.745***	-1.817***	-0.022***	-0.005***	-0.158***	-0.016***	0.697***	-2.350***
	0.006	0.001	0.03	0.004	0.114	0.365	0.006	0.001	0.032	0.004	0.112	0.498
LLP	0.036**	0.002***	0.353***	0.029***	0.41***		0.037**	0.002***	0.358***	0.029***	0.419***	
	0.036	0.002	0.353	0.029	0.41		0.037	0.002	0.358	0.029	0.419	
INFLATION							-0.039***	-0.006***	0.127***	0.006***	0.041	-4.341***
							0.008	0.001	0.039	0.002	0.104	0.592
GROWTH							0	0	0	0.000**	0.002	-0.001
							0	0	0.001	0	0.003	0.012
CONSTANT	3.358***	1.782***	0.612***	0.069***	3.288***	-18.568***	3.355***	1.779***	0.579***	0.063***	2.949***	-22.799***
	0.05	0.004	0.207	0.014	0.769	2.352	0.05	0.005	0.222	0.014	0.756	3.373
	0	0	0.003	0	0	0	0	0	0.009	0	0	0
N	113256	113256	112749	113262	113262	113255	113256	113256	112749	113262	113262	113255
chi2	121.82***	294.37***	1715.83***	2014.91***	327.29***	685.70***	117.31***	278.76***	2041.97***	3136.65***	555.31***	462.39***
Inflection points	-2.05	-2	-2.87	-2.67	-1.92	-2.06	-2.09	-1.94	-3.03	-2.69	-1.9	-2.04
Sign of relation	-	-	+	+	+	-	-	-	+	+	+	-
First stage statistics												
AdjR-sq	0.9272	0.9272	0.9268	0.9272	0.9272	0.9267	0.9274	0.9274	0.9271	0.9274	0.9274	0.9269
Partial R-sq	0.0032	0.0032	0.0029	0.0032	0.0032	0.0013	0.0032	0.0032	0.0029	0.0032	0.0032	0.0013
Robust F	23.97***	23.97***	22.97***	23.98***	23.98***	21.61***	24.27***	24.27***	21.12***	24.27***	24.27***	21.11***
Endogeneity test												
GMMCstatisticchi2(1)	0.01	6.3	0.1	1.03	1.99	2.28	0.15	3.36	0.05	0.43	0.91	2.33
p-value	0.9386	(0.021)**	0.7524	0.31	0.1579	0.131	0.6972	(0.067)*	0.8302	0.5142	0.3411	0.1266
Over-identification test												
Hansen'sJchi2(5)	2.36	2.41	4.52	6.64	6.96	4.3	1.42	2.59	5.59	8.36	7.13	4.18
p-value	0.7973	0.7908	0.4773	0.2484	0.2236	0.3674	0.9218	0.7626	0.3477	0.1377	0.2109	0.3823

ZROE = Average return on equity + equity to total assets / the standard deviation of return equity; **ZROA** = Average return on assets + equity to total assets / the standard deviation of return assets; **SROE** = Standard deviation of ROE calculated over 3-year period window; **SROA** = Standard deviation of ROAcalculated over 3-year period window; **LLR** = Loan loss reserves to total net loans; **EQTA** = Equity to assets; Panel B: Bank-specific variables, **LERNER** is Lerner Index of MP; **SIZE** is the natural logarithmof total assets; **ASSETS GRWOTH** is the percentage difference between assets(t) and Assets(t-1); **LOANS** = Total net loans to total assets; **EFFICINECY** = Total non-interest operating expenses / total operating expenses; **DIVERSIFICATION** is Non-interest income /total operating income; **LLP** = Loan loss provisions /total net loans; GROWTH is annual real GDP growth rate; **INFLATION** is inflation ratesmeasured as the difference in the log of CPI; **CRISIS** is takes on values of 1 for crisis year (2007-2009) and 0 otherwiseand Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Table 5.8: The effects of the 2007-09 crisis on the relationship between MP and stability

	Panel A						**Panel B**					
	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8	Model9	Model10	Model11	Model12
	ZROE	ZROA	SROE	SROA	EQASS	LLR	ZROE	ZROA	SROE	SROA	EQASS	LLR
LERNER	-0.037***	-0.008***	0.181***	0.015***	0.457***	-5.742***	-0.034***	-0.008***	0.159***	0.013***	0.360***	-5.170***
	0.008	0.001	0.046	0.003	0.071	0.644	0.007	0	0.049	0.003	0.069	0.586
SIZE	0.005***	0.001***	-0.016***	-0.001***	-0.064***	0.711***	0.004***	0.001***	-0.013**	-0.001***	-0.053***	0.623***
	0.001	0	0.006	0	0.01	0.085	0.001	0	0.007	0	0.01	0.078
D.ASSETS	-0.001	0	0.043***	0	-0.099***	-0.187***	-0.004***	-0.001***	0.055***	0	-0.140***	-0.731***
	0	0	0.006	0	0.01	0.066	0.001	0	0.006	0	0.011	0.052
LOANS	0.018***	0.003***	-0.072***	-0.007***	-0.55***	0.719***	0.015***	0.003***	-0.061***	-0.006***	-0.524***	0.474*
	0.003	0	0.019	0.001	0.04	0.315	0.002	0	0.022	0.002	0.038	0.282
EFFICIENCY	0.031***	0.007***	-0.22***	-0.019***	-0.139**	4.497***	0.027***	0.006***	-0.201***	-0.016***	-0.061	3.996***
	0.006	0	0.039	0.003	0.061	0.543	0.006	0	0.042	0.003	0.058	0.496
DIVERSIFICATION	-0.005***	-0.002***	-0.183***	-0.019***	0.154***	-0.897***	-0.005***	-0.002***	-0.185***	-0.020***	0.134***	-0.818***
	0.001	0	0.018	0.003	0.051	0.145	0.001	0	0.019	0.003	0.051	0.133
LLP	0.119***	0.015***	-7.385***	-0.485***	-3.589***		0.120***	0.016***	-7.395***	-0.484***	-3.817***	
	0.032	0.002	0.352	0.025	0.32		0.032	0.002	0.36	0.024	0.325	
CRISIS	-0.001***	-0.000**	-0.029***	-0.002***	0.100***	-0.272***	-0.001***	-0.000***	-0.029***	-0.002***	0.097***	-0.265***
	0	0	0.002	0	0.004	0.023	0	0	0.002	0	0.004	0.02
INFLATION							-0.024***	-0.005***	0.095**	0.002	-0.353***	-4.075***
							0.004	0	0.042	0.003	0.065	0.479
GROWTH							0.000***	0.000***	0	0.000*	0.001	-0.022**
							0	0	0.001	0	0.002	0.009
CONSTANT	3.473***	1.801***	0.374***	0.034***	-0.993***	-15.675***	3.482***	1.802***	0.323***	0.028***	-1.170***	-14.154***
	0.016	0.001	0.102	0.007	0.168	1.448	0.014	0.001	0.109	0.008	0.162	1.304
N	113256	113256	112749	113262	113262	113255	113256	113256	112749	113262	113262	113255
chi2	167.85***	926.77***	2589.70***	2673.38***	2206.32***	671.18***	159.29***	1018.07***	3557.61***	4617.07***	3162.81***	796.03***
First stages statistics												
Adj R-sq	0.5848	0.5848	0.5848	0.5808	0.5808	0.5689	0.5876	0.5876	0.5918	0.5877	0.5877	0.5753
Partial R-sq	0.012	0.012	0.0109	0.012	0.012	0.0014	0.0121	0.0121	0.011	0.0121	0.0121	0.0012
Robust F	63.71***	63.71***	64.29***	63.70***	63.70***	27.55***	61.30***	61.30***	61.52***	61.30***	61.30***	25.91***
Endogeneity test												
GMMCstatisticchi2(1)	0.78	0.24	0.08	0.05	0.35	3.58*	0.32	0.01	0	0.05	1.19	2.14
p-value	0.376	0.6257	0.7785	0.8258	0.5539	0.0583	0.5688	0.9162	0.09704	0.8212	0.2745	0.1437
Overidentification test												
Hansen'sJchi2(5)	2.62	4.78	3.76	9.07	10.87*	10.59**	4.19	7.72	5.21	10.22*	10.14*	13.55***
p-value	0.7588	0.4429	0.5844	0.1065	0.054	0.0315	0.5229	0.1722	0.3906	0.0693	0.0713	0.009

ZROE = Average return on equity + equity to total assets / the standard deviation of return equity; **ZROA** = Average return on assets + equity to total assets / the standard deviation of return assets; **SROE** = Standard deviation of ROE calculated over 3-year period window; **SROA** = Standard deviation of ROAcalculated over 3-year period **window; LLR** = Loan loss reserves to total net loans; **EQTA** = Equity to assets; Panel B: Bank-specific variables, **LERNER** is Lerner Index of MP; **SIZE** is the natural logarithmof total assets; **ASSETS GRWOTH** is the percentage difference between assets(t) and Assets(t-1); **LOANS** = Total net loans to total assets; **EFFICINECY** = Total non-interest operating expenses / total operating expenses; **DIVERSIFICATION** is Non-interest income /total operating income; **LLP** = Loan loss provisions /total net loans; GROWTH is annual real GDP growth rate; **INFLATION** is inflation ratesmeasured as the difference in the log of CPI; **CRISIS** is takes on values of 1 for crisis year (2007-2009) and 0 otherwiseand Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Table 5.9: The effects of the 2007-09 crisis on the relationship between MP and stability with an interaction term

	Panel A						**Panel B**					
	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8	Model9	Model10	Model11	Model12
	ZROE	ZROA	SROE	SROA	EQASS	LLR	ZROE	ZROA	SROE	SROA	EQASS	LLR
LERNER	-0.020*	0.002***	0.244***	-0.008	-0.566**	-6.576***	-0.011	0.002***	0.129**	-0.008	-1.066***	-5.493***
	0.012	0.001	0.068	0.005	0.268	0.695	0.007	0.001	0.059	0.005	0.23	0.538
SIZE	0.002	0.000***	-0.025***	0.001**	0.05	0.790***	0.001	0.000***	-0.011	0.001***	0.119***	0.639***
	0.001	0	0.009	0.001	0.034	0.09	0.001	0	0.008	0.001	0.029	0.07
D.ASSETS	-0.001*	0.000***	0.042***	0.001	-0.185***	-0.11	-0.003***	0	0.055***	-0.001***	-0.250***	-0.706***
	0.001	0	0.005	0.001	0.017	0.074	0.001	0	0.006	0	0.019	0.052
LOANS	0.012***	0	-0.094***	0.003	-0.295***	1.227***	0.008***	0	-0.042	0.003	-0.06	0.747***
	0.004	0	0.032	0.003	0.118	0.362	0.002	0	0.029	0.002	0.101	0.281
EFFICIENCY	0.017*	-0.001**	-0.279***	0.001	0.628***	5.004***	0.009*	-0.001***	-0.182***	0	1.037***	4.136***
	0.009	0.001	0.058	0.005	0.219	0.577	0.005	0	0.051	0.004	0.191	0.451
DIVERSIFICATION	-0.002	0.000***	-0.165***	-0.021***	0.069	-0.784***	-0.001	0.000***	-0.177***	-0.022***	0.003	-0.677***
	0.002	0	0.017	0.003	0.087	0.15	0.001	0	0.017	0.003	0.087	0.127
LLP	0.185***	0.044***	-7.144***	-0.528***	-6.612***		0.213***	0.044***	-7.377***	-0.523***	-8.288***	
	0.047	0.002	0.36	0.029	0.705		0.035	0.002	0.366	0.028	0.636	
INFLATION							-0.008*	0.001***	0.106**	-0.011***	-1.144***	-3.839***
							0.004	0	0.05	0.004	0.166	0.419
GROWTH							0	0	0	0	-0.002	-0.025***
							0	0	0.001	0	0.004	0.009
CRISIS	0.009	-0.002***	0.052	0.019***	0.493***	3.528***	0.003	-0.002***	0.116***	0.019***	0.768***	2.824***
	0.007	0	0.037	0.003	0.147	0.393	0.004	0	0.032	0.003	0.122	0.296
CRISIS_LERNER	0.01	-0.002***	0.087**	0.023***	0.434***	4.149***	0.005	-0.002***	0.157***	0.023***	0.727***	3.371***
	0.008	0	0.041	0.003	0.163	0.44	0.005	0	0.035	0.003	0.136	0.33
CONSTANT	3.51***	1.822***	0.519***	-0.016	-2.942***	-17.336***	3.531***	1.823***	0.268**	-0.015	-4.074***	-14.684***
	0.025	0.001	0.15	0.012	0.579	1.55	0.015	0.001	0.131	0.01	0.493	1.189
N	113256	113256	112749	113262	113262	113255	113256	113256	112749	113262	113262	113255
chi2	229.639	2227.582	2362.742	2225.218	1422.771	621.442	302.99	2049.823	3270.275	2522.946	989.627	873.19
First stages statistics												
Adj R-sq	0.5916	0.5916	0.5958	0.5916	0.5916	0.5848	0.5979	0.5979	0.6023	0.5979	0.5979	0.5906
Partial R-sq	0.0015	0.0015	0.0014	0.0015	0.0015	0.0015	0.0022	0.0022	0.0021	0.0022	0.0022	0.0016
Robust F	32.83***	32.52***	31.09***	32.82***	32.82***	29.52***	44.31***	44.31***	41.99***	44.30***	44.30***	34.82***
Endogeneity test												
GMMCstatisticchi2(1)	1.66	1.55	0.71	0.77	1.03	3.95**	0.74	3.69*	0.01	2.4	2.95*	1.74
p-value	0.1976	0.2139	0.4008	0.3817	0.3093	0.0469	0.3916	0.0547	0.9112	0.1213	0.086	0.1874
Overidentification test												
Hansen'sJchi2(5)	2.59	11.05**	4.57	4	6.91	6.95	5.31	8.03	5.51	3.84	6.49	11.67***
p-value	0.6278	0.026	0.334	0.4061	0.3093	0.1387	0.2567	0.0905*	0.2385	0.4284	0.1653	0.02

ZROE = Average return on equity + equity to total assets / the standard deviation of return equity; **ZROA** = Average return on assets + equity to total assets / the standard deviation of return assets; **SROE** = Standard deviation of ROE calculated over 3-year period window; **SROA** = Standard deviation of ROAcalculated over 3-year period **window; LLR** = Loan loss reserves to total net loans; **EQTA** = Equity to assets; Panel B: Bank-specific variables, **LERNER** is Lerner Index of MP; **SIZE** is the natural logarithmof total assets; **ASSETS GRWOTH** is the percentage difference between assets(t) and Assets(t-1); **LOANS** = Total net loans to total assets; **EFFICINECY** = Total non-interest operating expenses / total operating expenses; **DIVERSIFICATION** is Non-interest income /total operating income; **LLP** = Loan loss provisions /total net loans; GROWTH is annual real GDP growth rate; **INFLATION** is inflation ratesmeasured as the difference in the log of CPI; **CRISIS** is takes on values of 1 for crisis year (2007-2009) and 0 otherwiseand Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Table 5.10: The effects of size on the relationship between MP and stability

	Panel A						Panel B					
Variable	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8	Model9	Model10	Model11	Model12
	ZROE	ZROA	SROE	SROA	EQASS	LLR	ZROE	ZROA	SROE	SROA	EQASS	LLR
LERNER	-0.435***	-0.076***	0.59	-0.076**	-2.134*	-10.918***	-0.413***	-0.076***	0.153	-0.094**	-2.200*	-6.807***
	0.123	0.011	0.647	0.036	1.282	2.412	0.118	0.011	0.649	0.037	1.219	2.232
SIZE	0.038***	0.007***	-0.055	0.007*	0.223*	0.946***	0.036***	0.007***	-0.014	0.008**	0.230**	0.576***
	0.011	0.001	0.061	0.003	0.119	0.226	0.01	0.001	0.061	0.004	0.113	0.209
D.ASSETS	0.001*	0.000***	0.042***	0	-0.126***	-0.379***	0	0.00**	0.058***	0.001*	-0.148***	-0.532***
	0.001	0	0.007	0	0.012	0.018	0.001	0	0.007	0.001	0.011	0.02
LOANS	0.007***	0.001***	-0.088***	-0.008***	-0.498***	-1.408***	0.007***	0.001***	-0.087***	-0.008***	-0.494***	-1.445***
	0.001	0	0.008	0.001	0.03	0.052	0.001	0	0.008	0.001	0.031	0.047
EFFICIENCY	-0.008**	-0.002***	-0.207***	-0.022***	-0.184***	-0.351***	-0.007**	-0.002***	-0.221***	-0.022***	-0.183***	-0.226***
	0.003	0	0.021	0.001	0.042	0.082	0.003	0	0.021	0.001	0.04	0.077
DIVERSIFICATION	0.008***	0.001***	-0.19***	-0.017***	0.175***	0.013	0.008***	0.001***	-0.179***	-0.017***	0.176***	-0.088
	0.003	0	0.021	0.003	0.061	0.078	0.003	0	0.02	0.003	0.06	0.068
LLP	0.166***	0.03***	-7.5***	-0.475***	-3.497***		0.165***	0.03***	-7.56***	-0.474***	-3.56***	
	0.024	0.002	0.351	0.028	0.351		0.024	0.002	0.357	0.028	0.351	
INFLATION							-0.006***	0***	0.107***	0.002***	-0.174***	-0.815***
							0.002	0	0.015	0.001	0.027	0.056
GROWTH							0*	0***	0	0	-0.002	0
							0	0	0.001	0	0.002	0.004
SIZE_LERNER	0.039***	0.007***	-0.038	0.008**	0.228*	0.986***	0.037***	0.007***	0.002	0.010***	0.234**	0.610***
	0.011	0.001	0.059	0.003	0.117	0.22	0.011	0.001	0.059	0.003	0.111	0.204
CONSTANT	3.121***	1.739***	0.81	-0.057	-4.304***	-14.222***	3.144***	1.739***	0.351	-0.076*	-4.387***	-10.025***
	0.122	0.012	0.687	0.04	1.347	2.561	0.117	0.012	0.69	0.041	1.28	2.371
N	113256	113256	112749	113262	113262	113255	113256	113256	112749	113262	113262	113255
chi2	89.03***	439.44***	2912.67***	7843.91***	2359.01***	2400.21***	92.70***	438.78***	3417.08***	8850.62***	2751.72***	2981.96***
First stages statistics												
asjR-sq	0.9931	0.9931	0.9931	0.9931	0.9931	0.9931	0.9931	0.9931	0.993	0.9931	0.9931	0.9931
PartialR-sq	0.0022	0.0022	0.0022	0.0022	0.0022	0.001	0.0022	0.0022	0.0023	0.0022	0.0022	0.001
RobustF	23.94***	23.94***	24.18***	23.93***	23.93***	24.63***	24.08***	24.08***	24.32***	24.07***	24.07***	24.89***
Endogeneity test												
GMMCstatisticchi2(1)	1.12	0.9	0.83	0.01	1.77	0.65	0.69	0.94	0.34	0.01	2.29	0.23
p-value	0.2894	0.3439	0.3636	0.9323	0.1831	0.4194	0.4046	0.3314	0.5605	0.9107	0.1306	0.6287
Overidentification test												
Hansen'sJchi2(5)	7.96	14.32**	5	7.93	11.83**	16.29***	8.61	14.67**	6.38	8.51	11.70**	17.10***
p-value	0.1585	0.014	0.4163	0.16	0.037	0.003	0.1258	0.012	0.271	0.1302	0.039	0.0014

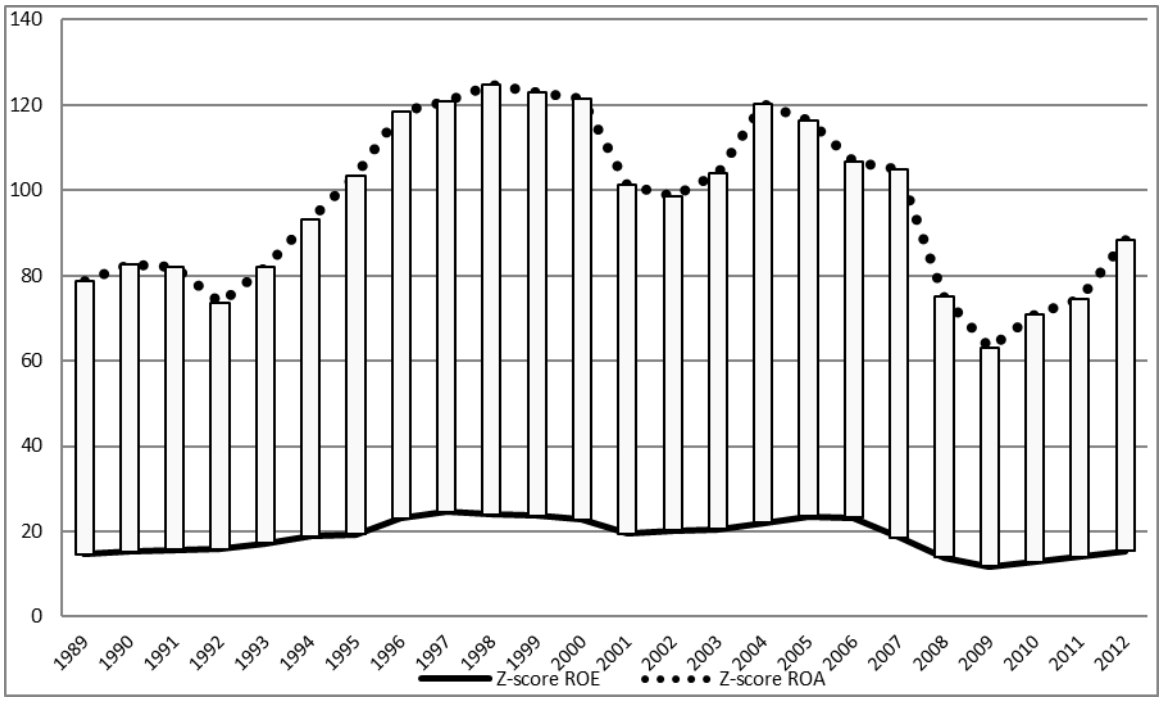
ZROE = Average return on equity + equity to total assets / the standard deviation of return equity; **ZROA** = Average return on assets + equity to total assets / the standard deviation of return assets; **SROE** = Standard deviation of ROE calculated over 3-year period window; **SROA** = Standard deviation of ROAcalculated over 3-year period **window; LLR** = Loan loss reserves to total net loans; **EQTA** = Equity to assets; Panel B: Bank-specific variables, **LERNER** is Lerner Index of MP; **SIZE** is the natural logarithmof total assets; **ASSETS GRWOTH** is the percentage difference between assets(t) and Assets(t-1); **LOANS** = Total net loans to total assets; **EFFICINECY** = Total non-interest operating expenses / total operating expenses; **DIVERSIFICATION** is Non-interest income /total operating income; **LLP** = Loan loss provisions /total net loans; GROWTH is annual real GDP growth rate; **INFLATION** is inflation ratesmeasured as the difference in the log of CPI; **CRISIS** is takes on values of 1 for crisis year (2007-2009) and 0 otherwiseand Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Table 5.11: The effects of size on the relationship between MP and stability during the 2007-09 financial crisis

Variable	m1	m2	m3	m4	m5	m6	m1	m2	m3	m4	m5	m6
	ZROE	ZROA	SROE	SROA	EQASS	LLR	ZROE	ZROA	SROE	SROA	EQASS	LLR
LERNER	-0.531***	-0.105***	1.188	-0.055	-0.248	-12.232*	-0.450***	-0.097***	0.197	-0.078	-1.506	-8.857
	0.202	0.02	0.766	0.083	2.317	7.184	0.192	0.017	1.043	0.087	2.183	7.512
SIZE	0.047***	0.010***	-0.122*	0.004	0.04	1.110*	0.040**	0.009***	-0.037	0.006	0.154	0.806
	0.017	0.002	0.074	0.007	0.21	0.605	0.016	0.001	0.088	0.007	0.2	0.635
D.ASSETS	0.001	0.000***	0.036***	0	-0.150***	-0.453***	0	0.000*	0.062***	0.001	-0.157***	-0.551***
	0.002	0	0.007	0.001	0.023	0.059	0.001	0	0.01	0.001	0.019	0.063
LOANS	0.003	0	-0.078***	-0.007***	-0.549***	-1.477***	0.004	0	-0.071***	-0.007***	-0.547***	-1.456***
	0.002	0	0.011	0.001	0.05	0.102	0.002	0	0.013	0.001	0.049	0.104
EFFICIENCY	-0.012**	-0.002**	-0.194***	-0.021***	-0.182***	-0.626***	-0.01***	-0.002***	-0.201***	-0.022***	-0.207***	-0.523**
	0.005	0.001	0.026	0.002	0.059	0.22	0.005	0	0.024	0.002	0.055	0.238
DIVERSIFICATION	0.010***	0.001**	-0.190**	-0.017**	0.185***	0.186	0.009**	0.001**	-0.168***	-0.016***	0.197***	0.143
	0.004	0	0.023	0.003	0.071	0.23	0.004	0	0.021	0.003	0.07	0.256
LLP	0.165***	0.032***	-7.415***	-0.489***	-4.220***		0.159***	0.03***	-7.314***	-0.489***	-4.241***	
	0.026	0.004	0.365	0.03	0.538		0.029	0.004	0.429	0.032	0.51	
INFLATION							-0.004	-0.001	0.110***	0.003	-0.174***	-0.479***
							0.005	0.001	0.025	0.002	0.063	0.163
GROWTH							0	0.000***	0	0	0.001	-0.001
							0	0	0.001	0	0.003	0.008
CRISIS	-0.635	0.318	-15.58	-0.749	-46.898	-125.876	-1.736	0.169	-3.566	-0.709	-38.706	-145.665
	1.607	0.315	11.033	0.857	35.868	84.621	1.907	0.277	11.337	0.94	34.195	96.794
CRISIS_LERNER	-0.348	0.408	-14.928	-0.737	-52.94	-125.052	-1.613	0.236	-1.248	-0.635	-43.822	-148.503
	1.85	0.336	10.748	0.988	37.828	89.896	2.116	0.296	13.07	1.084	36.065	102.278
SIZE_LERNER	0.048***	0.010***	-0.09	0.007	0.056	1.130*	0.041**	0.009***	-0.001	0.009	0.171	0.819
	0.019	0.002	0.07	0.008	0.212	0.663	0.018	0.002	0.096	0.008	0.199	0.694
SIZE_CRISIS	0.05	-0.028	1.304	0.064	3.993	10.584	0.144	-0.015	0.299	0.06	3.289	12.295
	0.138	0.027	0.929	0.073	3.052	7.178	0.163	0.024	0.97	0.081	2.911	8.207
SIZE_CRISIS_LERNER	0.025	-0.036	1.257	0.063	4.517	10.565	0.134	-0.021	0.106	0.054	3.729	12.598
	0.159	0.029	0.908	0.085	3.236	7.669	0.182	0.025	1.124	0.093	3.085	8.718
CONSTANT	3.028***	1.712***	1.599***	-0.028***	-2.256***	-15.882	3.106***	1.719***	0.636	-0.046	-3.522	-12.480*
	0.19	0.019	0.835	0.076	2.372	6.696	0.181	0.016	0.981	0.08	2.257	7.021
N	113256	113256	112749	113262	113262	113255	113256	113256	112749	113262	113262	113255
chi2	112.61***	302.57***	2186.24***	7102.15***	2180.30***	908.93***	98.65***	397.23***	3725.49***	7856.87***	2552.63***	944.38***
First stages statistics												
Adj R-sq	0.9936	0.9936	0.9935	0.9936	0.9936	0.9936	0.9936	0.9936	0.9936	0.9936	0.9936	0.9936
Partial R-sq	0.0022	0.0022	0.0022	0.0022	0.0022	0.001	0.0022	0.0022	0.0022	0.0022	0.0022	0.0014
Robust F	31.95***	31.95***	31.75***	31.93***	31.93***	33.44***	32.04	32.04***	31.86***	31.02***	32.02***	33.41***
Endogeneity test												
GMMCstatisticchi2(1)	1.02	1.68	0.23	0	0.89	1.51	0.98	9.02***	0.09	0.02	1.31	0.87
p-value	0.3122	0.195	0.6329	0.9794	0.3456	0.2197	0.3232	0.0027	0.7679	0.8764	0.2527	0.3504
Overidentification test												
Hansen'sJchi2(5)	4.1	9.87*	1.98	7.73	10.57*	17.17***	5.02	10.81	4.41	8.48	11.00*	17.74***
p-value	0.5345	0.079	0.852	0.1718	0.0541	0.0018	0.413	0.0552*	0.4919	0.1319	0.0514	0.0014

ZROE = Average return on equity + equity to total assets / the standard deviation of return equity; **ZROA** = Average return on assets + equity to total assets / the standard deviation of return assets; **SROE** = Standard deviation of ROE calculated over 3-year period window; **SROA** = Standard deviation of ROAcalculated over 3-year period **window; LLR** = Loan loss reserves to total net loans; **EQTA** = Equity to assets; Panel B: Bank-specific variables, **LERNER** is Lerner Index of MP; **SIZE** is the natural logarithmof total assets; **ASSETS GRWOTH** is the percentage difference between assets(t) and Assets(t-1); **LOANS** = Total net loans to total assets; **EFFICINECY** = Total non-interest operating expenses / total operating expenses; **DIVERSIFICATION** is Non-interest income /total operating income; **LLP** = Loan loss provisions /total net loans; GROWTH is annual real GDP growth rate; **INFLATION** is inflation ratesmeasured as the difference in the log of CPI; **CRISIS** is takes on values of 1 for crisis year (2007-2009) and 0 otherwiseand Robust standard errors are reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels.

Figure 5.1: Evolution of Z-score values between 1987 and 2012



CHAPTER SIX

CONCLSION AND POLICY IMPLICATIONS

Differences in the structure and development of a country's financial sector may have led to diversity in banks' activities. It is well documented that banks and financial intermediaries as a whole play a crucial role in the healthy functioning of modern economies, due to their comparative advantage in terms of information gathering, screening and monitoring which result in economies of scale and scope (Diamond 1984). "*Competitive conditions in the banking industry and their evolution over time are of interest to policy makers responsible for monetary and financial stability. While competition could lower financial intermediation costs and contribute to improvements in efficiency, it could reduce MP and profitability of banks; thereby weakening their ability to withstand adverse developments*" (Koutsomanoli-Fillipaki and Staikouras, 2005). The study intends to provide an in-depth investigation of the commercial banking industry, focusing in particular on the banks' behaviour with respect to competition, bank lending, monetary policy, financial stability and risk-taking behaviours in the context of U.S. banking between 1987 and 2013.

In particular, this thesis can be separated into the following three main research questions:

1) What kind of competitive conditions characterise the commercial banking industry?

2) What are the impacts on the intensity of competition in the lending market? And how do banks respond to the monetary policy of the Federal Reserve according to their characteristics and their MP?

3) What are the effects of bank competition on financial stability and risk-taking behaviours?

This research systematically examines these aspects of the impact of competition with reference to U.S. commercial banking, using a uniform database and a consistent theoretical framework. Furthermore, taking advantage of the unique experience of U.S. banking, this research examines the overall impact of competition in general and the shift of policy focus (1987-2013).

As outlined in in the thesis, U.S. banking markets have immensely changed over the last few decades. A wave of intrastate deregulations that started in 1976 was concluded with full inter-state national deregulation in 1994, a process that impacted the market structure and bank behaviour of banking markets. As such, the number of banks in the U.S. declined drastically, and consolidation activities accelerated resulting in larger ‘‘mega’’ banks. Simultaneously, technological advances, product innovations and scope and scale economies motivated banks to continuously develop the way financial intermediation relate to the real sector.

The first part of this dissertation makes several contributions to the existing literature and furthers the understanding of the impact of financial reforms on banks’ behaviour with respect to monetary policy, bank competition, bank lending, financial stability and risk-taking behaviour.

The empirical literature on the standard view of a transmission mechanism focuses on the how shifts in monetary policy stances bank lending. According to this view a monetary shocks are transmitted to the real sector might lead to distortions and higher volatility of interest rates and inflation. The argument underlying this transmission channel is the change in loan demand following an interest rate rise due to lower demand for investments, which will discourage economic activity. A reduction in the loan growth rate is therefore only due to a lower demand for loans and not due to reduced loan supply. We conclude our argument about how the changes in banking competition are expected to affect the transmission of monetary policy through the bank lending channel. First, if an increase in competition is caused by an increased market share held by larger banks, this should weaken the bank lending channel of monetary policy transmission. Second, increased competition can weaken the bank lending channel of monetary policy if the increase in competition is associated with a reduction in the informational asymmetries across banks over their borrowers' creditworthiness (Olivero, Li and Jeon, 2011b).

We outline the theoretical aspects of the existing approaches to the measurement of competition. Structural approaches to the measurement of competition seem not inconsistent. Our argument clearly highlighted the recent literature which has mainly relied on a static approach, the so-called New Empirical Industrial Organization (NEIO) literature. This literature contends that indicators of the mark-up of price (average revenue) over marginal costs (giving a Lerner Index) and the degree to which input price changes are reflected in average revenues (the H-statistic) provide ''realized'' measures of the degree of banking market competition.

In addition to this, we reviewed the relevant theoretical and empirical literature on the impact of competition on the banking system, taking into account the impact of

competition on banks; efficiency, access to finance, and stability. The literature generally yields contradictory results. First, it provides conflicting arguments with respect to the sign and direction of causality between competition and efficiency. The empirical literature tends to support a negative relation. Second, the traditional view of industrial organisation advocating the concept of the MP hypothesis argues that competition in the banking market reduces the cost of finance and increases the availability of credit. On the other hand, the information hypothesis (Petersen and Rajan, 1995) suggests that in the presence of information asymmetries and agency costs, competition can reduce access by making it more difficult for banks to forgo any interest rate premiums they might otherwise have to charge when lending to small and risky distressed firms.

Recent research which focuses on direct measures of competition and contestability shows that firms have greater access to funds in more competitive banking markets. They find this effect to be dependent on the wider economic and financial environment in which the firms operate. In particular, they find that higher levels of financial development and greater availability of credit information reduce this adverse effect, while high levels of government ownership of bank assets are associated with a stronger negative impact of bank MP (Love and Peria 2012).

Third, is the question of whether competition increases or decreases the stability of the banks. We critically clarify three arguments arising from the theoretical studies to explain the relation between competition and stability. Firstthe ‘competition-fragility’ view, which states that competitive banking systems are less stable and more fragile because competition reduces bank profits and erodes the ‘franchise value’ of banks, consequently increasing incentives for excessive risk taking (Chan, Greenbaum, and Thakor 1986; Keeley 1990).The second view is the so called “competition-stability” concept, which

argues that as the banking system becomes more competitive, it is less prone to risk of bank failures, which in turn enhances financial system stability. The third view highlights that the relationship between market structure of banks and stability is complex and has important interactions with the macroeconomic, regulatory and institutional framework of the economy. Previous and recent literature remains unconducive on the issue of the relationship between competition and stability. While some results support the view that competition improves stability, others suggest adverse effects.

In order to answer this question we conduct non-structural measures to gauge competitive conditions in 41 U.S. States' commercial banking systems. Our empirical findings are as outlined by Panzar and Rosse (1987) and are generally in line with our expectations and suggesting consistency with the literature that banks on average, and for every state, operated under monopolistic competition over the sample period. Results show that, on average, H-Statistic values increased from 0.25 in 1987 to about 0.45 in 2010, suggesting an increase in competition. But this conclusion did not hold, when we used a dynamic approach (GMM). We observe a significant increase in dynamic H-statistic for the overall sample and for every state.

Our results for the Lerner Index of MP shows the marginal costs are estimated from a translog equation. We find the average Lerner values for all years and states is 0.34, suggesting that over the period under study U.S. banks price their products nearly a third above the marginal costs. We also find the average Lerner values increased from 0.39 in 1987 to about 0.44 in 2010, suggesting an increase in MP and lower competition. Second, the overall picture for the evolving trends over time across state Lerner means is rather homogenous.However, the average Lerner for states is mixed, with some states reflecting more competitive behaviour, while other states display less competitive conditions. Third,

in all states, the Lerner values fall in 2007 compared to 2010, when we consider financial the crisis years (2007-2009). Finally, we find as in Carbo et al (2009), that competition measures tend to provide inconsistent results and the measures are statistically unrelated.

RQ2 What are the impacts on the intensity of competition in the lending market? And how do banks respond to the monetary policy of the Federal Reserve according to their characteristics and their MP?

Further, we studied the impact of bank competition on the bank lending channel in the U.S. between 1992 and 2014. We found that higher level of bank competition, measured as less MP, strengthens the transmission of monetary policy via the bank lending channel. This implies that a higher degree of bank competition reduces the access to alternative sources of funding and thereby renders banks more responsive to monetary policy.

In another chapter, we determine whether competition improves or reduced banking stability for U.S. banks between 1987 and 2012. The literature is inconclusive as to whether competition stimulates banks to increase their exposure to risk. While some studies found support for the "competition-stability" view, other found evidence for the "competition-fragility" view.Generally, our findings support a direct and significant relationship between competition and stability, providing empirical support for the "competition-stability". Banks with greater MP are associated with greater levels of instability, and this is most pronounced for larger banks.

This paper aims to empirically assess the competitive structure of the U.S. commercial banking system over the period 1987-2010. The deregulation of financial services in the U.S, technological advancement and the recent global financial crises could have an implication on the competitiveness of the system. We use a variety of structural and non-

structural measures to gauge competitive conditions in U.S. states banking systems. Our empirical findings suggest consistency with the literature that banks on average and for each state operated under monopolistic competition. The average H-Statistic values increased from 0.25 in 1987 to about 0.45 in 2010, suggesting improvements in competitive conditions. In contrast, the Lerner values generated different results. We find the average Lerner values for all years and states is 0.34, suggesting that over the period under study; U.S. banks price their products nearly a third above their marginal costs. The average Lerner values increased from 0.39 in 1987 to about 0.44 in 2010, suggesting an increase in MP and lower competition. In all states, the Lerner values fell in 2007 compared to 2010, when we consider financial crisis years (2007-2009).

In another paper, we examine the impact of bank competition on the bank lending channel in the U.S. between 1992 and 2014. We find that a higher level of bank competition, measured as less MP, strengthens the transmission of monetary policy via the bank lending channel. This implies that a higher degree of bank competition reduces the access to alternative sources of funding and thereby renders banks more responsive to monetary policy.

Our results for the period during the crisis show that greater competition measured by lower MP is associated with reduced growth rate of loans. During crisis, banks with greater MP tend to increase their loan supply. We observe that during the crisis the bank lending channel via competition and bank characteristics continue to be a significant channel of monetary policy transmission.

We also examined whether competition influence banking stability via risk taking. While some studies found support for the “competition-stability” view, other found evidence for the “competition-fragility” view. Generally, our findings support the existence of a direct

and significant relationship between competition and risk-taking, providing empirical support for the “competition-stability” (or “concentration-fragility”) view. Banks with greater MP are associated with greater levels of instability, and this is most pronounced for larger banks.

Overall, our results can be used for policy purposes. The level of bank competition is a significant factor for monetary policy transmission. The view that improved market structure and competitive conditions should be used as another objective to achieve the general goal of making the monetary policy effective and reduce the exposure of banks to risk and improve the stability of credit markets.

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