ANNALS OF ECONOMICS AND FINANCE **20-1**, 247–295 (2019)

Residential Property Loans and Bank Performance during Property Price Booms: Evidence from Europe

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Residential mortgage loans constitute a large proportion of the portfolio of many banks and are one of the key assets in the determination of their performance. Using a dynamic panel model for a sample of 555 banks in the European Union (EU-15) we find that an increase in residential mortgage loans seems to improve bank's performance in terms of both profitability and credit risk in good market, pre-financial crisis, conditions. The results also show that credit risk and profitability are lower during the upturn in the residential property cycle.

Key Words: Residential property prices; Mortgage loans; Bank performance; Dynamic panel estimation.

JEL Classification Numbers: E44, G21, C33.

1. INTRODUCTION

The recent turmoil in the world's financial system, which originated in the US mortgage market, illustrates the very close relationship between the property market and the financial sector. Slumps in the property market tend to follow and exacerbate or spur banking crises[1], as demonstrated by Allen and Gale (2000) and as is illustrated by several historical crises[2]. Not only did the recent turbulence have its source in the US subprime crisis

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[1]Herring and Wachter (1999) state that "Real Estate Cycles may occur without banking crises and banking crises may occur without real estate cycles. But the two phenomena are correlated in remarkable number of instances ranging over a wide variety of institutional arrangements, in both advanced industrial nations and emerging economies".

[2]For example, in the US and Scandinavia (late 80's), in Mexico and Japan (early 90's) and in Southeast Asia (1997/1998). Please refer to Hilbers et al. (2001).

1529-7373/2019

but the resulting banking crisis' in several European markets were heavily related to and intensified by real estate lending.

There is almost universal agreement that the fundamental cause of the subprime crisis was a combination of extremely strong house price appreciation and a credit boom. Pezzuto (2012) refers to the combined impact of low interest rates, increased levels of leverage, "credit euphoria" from both lenders and borrowers and a more aggressive short-term orientation, as the factors which strongly contributed to the subprime crisis. Acharya et al. (2011) note that when the "bubble" burst, a severe economic crisis was bound to result. These events resulted in a collapse of the banking industry[3], severe negative responses in the stock market, a large decrease in liquidity in the credit market, economic recession and have contributed in a major fashion to the subsequent sovereign credit crisis. This crisis affected financial markets as well as real economies resulting, in drops in productivity growth, increases in unemployment, and a decrease in international trade. Horta et al. (2010) and Hwang et al. (2010) examined the contagion effects of the US subprime crisis on international stock markets. Hwang et al. (2010) found evidence of financial contagion during the crisis in both emerging and developed (in this case European) markets. Verick and Islam (2010) find that the Baltic States, Ireland and Spain were the European countries that suffered the most severe labour market impact and economic contraction as a result of the subprime crisis. In contrast, Germany and Austria were the least affected.

Of all the different assets that comprise banks' portfolios, real estate related ones are particularly important for two particular reasons. Firstly, residential mortgage loans represent one of its largest asset categories. Within the EU-15, for the period 2001 to 2008, the weight of residential property loans in total loans never fell below 21% (2008) and reached a maximum of 33% in 2003 (ECB, 2005 and 2010). Secondly, banks' exposure to the real estate sector is even larger owing to the widespread use of these assets as collateral for other types of loans. Furthermore, these figures if anything understate the importance of the sector when one adds in loans on commercial real estate and property development and construction.

Herring and Wachter (1999) argue that during an upswing of real estate prices, banks have a tendency to underestimate the default risk of loans directly or indirectly related to real estate. The existence of moral hazard and disaster myopia, caused by high competition and an emphasis on size growth, following the liberalisation of the banking sector and by the loss of institutional memory regarding the possibility of property prices reversals, leads to banks taking excessive risks whereas the charged risk premium may

[3]The list of banks that have been affected by the 2007-2012 global financial crisis can be seen in
http://en.wikipedia.org/wiki/List_of_bankrupt_or_acquired_banks_during_the_subprime_mortgage_crisis

be insufficient to cover potential losses[4]. Jimenez et al. (2006) state that during booms, riskier borrowers obtain credit more easily and collateral requirements decreases. Dell'Ariccia et al. (2012) also found evidence of a decrease in lending standards associated with substantial increases in the number of loan applications. The authors show that lending standards declined to a greater extent in areas that experienced faster credit growth. They also note that the entry of new lenders contributed to the decline in lending standards. With specific reference to the subprime experience in the US, Demyanyk and van Hemert (2011) report that loan quality consistently declined for the six years prior to the crisis in 2007. They argue that the high level of house price appreciation observed in the US during this period contributed to the decline in loan quality[5].

Gentle et al. (1994) examine the extent of negative equity[6] in the United Kingdom in the early 90s, noting that the "property owning democracy" turned into a "nation of debtors", after the collapse of property prices. The phenomenon of negative equity has also been observed by White (2010a, 2010b), who states that the collapse of property prices in the US resulted in an increasing number of defaults, since the property market prices fell below the original mortgage advance used to buy the property[7]. Koetter and Poghosian (2010) using a unique dataset for Germany illustrate the importance of not only considering pure price changes when examining the risk of default. It is imperative that factors such as the degree of deviation away from fundamental values are also factored in.

The interactions between financial institutions and real estate markets have received quite significant attention in the literature over recent few decades. Tripp and Smith (1993), Ambrose et al. (2003), and Igan and Pinheiro (2010) discuss the relationship between real estate lenders, interest rates, and the availability of real estate loans. Allen et al. (1995), He et al. (1997), Elyasiani et al. (2010) and Martins et al. (2016) examine the effects of real estate market conditions on bank stocks, and find that

[4]The Economist, 2003, reveals that the "six countries where houses appear to be overvalued (America, Britain, Australia, Ireland, the Netherlands and Spain) also share another bubble-like symptom: an explosion in mortgage borrowing in recent years. ... In the Netherlands the average new mortgage there is 110% of the value of a home, because lenders are happy to finance all the purchasing costs, including stamp duty and fees. ... This means that if prices were to drop, more households would be left with debts exceeding the value of their home than were a decade ago."

[5]For specific work on default and foreclosures in the US subprime market in recent years see papers such as Gerardi et al. (2007) and Daglish (2009).

[6]Negative equity refers to the situation whereby the market value of the property on the mortgage completion date is lower than the value of the capital owing to the bank.

[7]The impact of default in the US was particularly evident in loans originated post 2005 in part due to borrowers being more vulnerable to a market reversal and the corresponding decline into negative equity. In addition, as White (2010a, 2010b) there was also the issue of strategic default.

bank stock prices are very sensitive to changes in real estate prices. Davis and Zhu (2009) examine the relationship between commercial property price movements and the performance of individual banks in a range of industrialized economies. Finally, Gibilaro and Mattarocci (2013) use a representative sample of European banks to study the relationship between the property market trends and bank performance/risk exposure for the period between 2007 and 2011.

Despite this extensive literature on the relationship between bank loans and real estate prices at a macroeconomic level, only a few studies have been undertaken with a specific focus on the impact of real estate prices on bank profitability and credit risk. Davis and Zhu (2009) argue that most studies have failed to adequately highlight the role that real estate may play in the performance of banks. Furthermore results may be biased given that most studies separately examine the factors that determine either bank profitability or risk.

Studies on bank profitability (see, for example, Maudos and Guevara, 2004 and Valverde and Fernández, 2007) or bank credit risk (see, for example, Salas and Saurina, 2002) examine the role of macroeconomic factors (such as GDP growth and level of indebtedness) or microeconomic factors (such as market competition conditions, interest rate risk, credit risk, liquidity risk, default risk and operating costs), but ignore, or inadequately consider, the specific risks associated with banks' real estate loan portfolios (see Salas and Saurina, 2002)[8]. Davis and Zhu (2009) is one of the exceptions in the literature. They examine the effect of changes in commercial real estate market conditions on the risk and profitability of a group of banks from industrialised economies. The authors find that the performance of banks and bank loans are strongly correlated with asset price changes, particularly real estate assets, owing to banks' large direct and indirect exposure to the sector. A recent paper by Gibilaro and Mattarocci (2013) also consider the issue, this time considering residential property. Using a sample of European banks, for the period between 2007 and 2011, they find that real estate exposure positively affects the risk of banks. This supports the hypothesis that real estate banks are normally riskier than other banks.

The present study differs from the study undertaken by Davis and Zhu (2009) in three key respects. Firstly, it differs with regard to the category of real estate assets analysed. We analyse the importance of the exposure to residential mortgage loans instead of commercial real estate assets and of the changes in real estate prices on banks' risk and return. Secondly, our sample includes EU-15 banks whilst Davis and Zhu (2009) analyse a

[8]Salas and Saurina (2002) state that "within the loan category there are different levels of risk, with the riskiest loans being those to the real estate and construction sectors, followed by commercial and industrial loans and, finally, household mortgage".

sample of 904 banks from several industrialised counties (including 8 EU-15 countries). Thirdly, we propose a model of bank profitability vis a vis bank exposure to residential mortgage loans taking into account the level of bank credit risk.

We use dynamic panel data methods to estimate the influence of residential mortgage loans on bank profitability and risk, using a sample of 555 banks in the EU-15, over the period from 1995 to 2008[9]. Our results suggest that a higher exposure to residential mortgage loans on the balance sheet seems to improve bank's performance in both profitability and credit risk in pre-crisis times. The results obtained further show a reduction in both credit risk and profitability for banks during the upturn in the price cycle pertaining to the residential property sector. The paper is structured as follows. In the next section, we briefly characterise the European residential mortgage markets and provide a brief review of the factors determining bank profitability and credit risk, with a special emphasis on those pertaining to the real estate market. In section 3 we summarize the research questions and present the specification of the empirical models proposed. Section 4 sets out the results of the empirical analysis. Conclusions are presented in Section 5.

2. DETERMINANTS OF BANK PROFITABILITY AND CREDIT RISK

2.1. Residential Mortgage Loans in the European Market

We focus on the residential mortgage lending behavior of banks for three main reasons. Firstly, excessive risk taking in real estate lending is considered to be one of the primary factors which contributed to the recent financial crisis (Acharya et al. 2011). Therefore, an empirical examination of how linkages between dynamics in the housing market and residential mortgage loans potentially bank profitability and risk is of significant interest. Secondly, residential mortgage loans are by far the largest category in the loan portfolio of most banks. The ECB (2005 and 2010) show that the weight of residential property loans in total loans of EU bank's varied from a maximum value of 33% in 2003 to a minimum of 21% in 2008. Table 1 shows the importance of residential mortgage loans in terms of GDP, value per capita and its weight in the balance sheet of European banks. The table also reveals the existence of differing trends regarding the importance of residential mortgage loans across the European market. While residential mortgage loans in terms of GDP declined in Germany from 55.6% in 1999 to 43.2% in 2008, there was a substantial increase in

[9]In contrast, Gibilaro and Mattarocci (2013) analyze the period 2007 and 2011. They are therefore restricted in their ability to explain the patterns in lending observed during boom markets.

other countries. Specifically, Spain and Ireland saw an almost tripling in the value of residential loans during this period. Of interest is the strong housing markets seen in those markets during the same time period. Finally, a number of papers, including, Tsatsaronis and Zhu (2004), Acharya et al. (2011)[10] and Martins et al. (2015)[11], argue that there are significant differences between the EU countries with regard to the characteristics of the mortgage market[12]. These institutional differences may aid in explaining the differences observed in the volatility of prices, weight of residential mortgage loans and influence any differences observed in bank's risk-taking across European countries (see table 1).

2.2. Bank Risk and Profitability and Real Estate Prices

The review of the literature presented below looks into the relationship between property prices and bank risk and profitability. Whilst some studies examine how property prices impact bank's decisions in a macroeconomic perspective, others evaluate the role of real estate exposures in bank's profitability and risk.

2.2.1. The Impact of Residential Property Prices on the Banking Sector: the Macroeconomic Perspective

Several studies have pointed out that there is a strong financial and economic relationship between real estate and credit cycles, whereby decreased economic activity leads to a feedback cycle of falling asset prices, deteriorating balance sheets, tightening financing conditions and constrained external financing to fund profitable investment opportunities, and so forth. The most influential argument refers to the "financial accelerator" mechanism proposed by Bernanke et al. (1994) and Kiyotaki and Moore (1997). In-

[10] Acharya et al. (2011) identify the existence of three major funding models for mortgage credit in developed economies: the classic deposit-based system; the MBS — based system (used extensively in the US) and the mortgage or covered bond system (popular in continental Europe). Covered bonds are issued by banks and share many features with MBS, but they also differ in important ways. Most importantly, investors in covered bonds have not only a general claim on the issuing bank but also on the underlying mortgage collateral in the event that banks default. In Germany "Hypotheken Pfandbriefe" represented 44% of all the mortgage bonds issued in the EU, followed by Denmark (29%) and Sweden (15%).

[11] Martins et al. (2015) develop an analysis of clusters which reveals significant differences in terms of institutional characteristics across the EU-15 countries. Five clusters emerge. The cluster formed by Spain, Ireland and the United Kingdom, with a less conservative mortgage credit system, a sparse rental market and a generous fiscal system. On the other extreme, a second cluster characterized by conservative mortgage credit system, a large rental market and a less generous fiscal system is formed by Germany and Austria.

[12] These differences relate to a variety of aspects including: prevailing interest rates; the possibility of Equity withdrawal; the level of LTV (Loan-to-Value) ratios; accepted property valuation methods and the availability of asset securitization.

TABLE 1.

EU-15 Mortgage and Housing Markets

Country	1999			2006			2008			1997-2006		
	Residential Mortgage Loans as % GDP	Residential Mortgage Loans per capita (€000s)	Loans from Credit Institutions for Housing Purchase (€million)	Residential Mortgage Loans as % GDP	Residential Mortgage Loans per capita (€000s)	Loans from Credit Institutions for Housing Purchase (€million)	% Owner Occupied	Residential Mortgage Loans as % GDP	Residential Mortgage Loans per capita (€000s)	Loans from Credit Institutions for Housing Purchase (€million)	Outstanding Covered Bounds as % of Residential Lending	Real House Prices (National) Growth (%)
Austria	13.7%	3.69	23,620	23.5%	7.34	60,737	57.0%	25.3%	8.56	71,346	11.8%	−7, 20%
Belgium	27.6%	6.44	51,487	36.3%	10.86	107,378	78.0%	39.8%	12.86	86,346	n/a	98,07%
Denmark	76.2%	23.41	123,373	100.8%	40.90	217,629	54.0%	95.3%	40.57	253,168	100.0%	93,20%
Finland	30.3%	7.22	22,020	43.8%	13.93	55,307	59.0%	47.5%	16.67	67,633	n/a	74,04%
France	20.8%	4.74	280,963	32.2%	9.17	569,975	57.4%	35.9%	10.99	691,182	n/a	110,29%
Germany	55.6%	13.64	839,788	51.3%	14.36	976,123	43.2%	46.1%	13.96	959,840	18.9%	−10, 63%
Greece	7.3%	0.79	8,518	29.3%	5.14	52,313	80.6%	32.0%	6.93	65,267	6.4%	73,40%
Ireland	28.9%	7.02	24,944	70.1%	29.29	111,403	74.5%	80.0%	33.75	115,233	15.5%	147,07%
Italy	9.0%	1.78	80,354	18.7%	4.70	244,409	80.0%	19.8%	5.23	264,414	n/a	60,57%
Luxembourg	22.4%	10.43	4,744	34.3%	24.69	12,208	75.0%	43.5%	32.93	15,940	0.9%	72,53%
Netherlands	60.8%	14.90	190,626	98.4%	32.20	369,642	57.0%	99.1%	35.94	375,656	3.6%	84,71%
Portugal	36.9%	4.16	42,208	59.2%	8.69	91,916	76.0%	63.3%	9.91	105,222	11.5%	7,18%
Spain	26.7%	3.88	145,627	58.6%	13.07	551,506	84.5%	62.0%	14.89	658,094	46.7%	116,90%
Sweden	46.4%	12.47	6,154	56.7%	19.18	125,746	52.0%	60.6%	21.68	128,484	63.5%	101,33%
UK	54.2%	12.82	793,797	83.1%	26.22	1,152,822	59.0%	80.5%	23.64	787,213	12.9%	138,19%

This table shows the values of residential mortgage loans, as percentage of GDP and per capita and total value of residential mortgage loans across EU-15 countries, for three different time periods: 1999, 2006 and 2008. We also present the percentage of owner occupied residential houses and outstanding covered bounds as percentage of residential lending in 2008 and the real house prices growth rate across EU-15 countries between 1997 and 2006. The values were obtained from European Mortgage Federation (Hypostat 2008 and 2006 — A Review of Europe's Mortgage and Housing Markets) and ECB (2005 and 2010).

creasing property prices boost bank capital by increasing the value of real estate owned by the bank and the value of any collateral pledged by borrowers. In particular, property price appreciation discourages riskier mortgage borrowers from defaulting (Daglish, 2009). Thus, increasing property prices should reduce riskiness of banks' assets and decrease the likelihood of financial distress in the banking sector (Niinimaki, 2009). This collateral value hypothesis predicts a negative relation between property prices changes and banks' risk.

However, alternatively, an increase in property prices could fuel the accumulation of risks by banks due to moral hazard and adverse selection problems (Bernanke and Gertler, 1995). Rising property prices and lower

(perceived) risk of real estate financing may induce excessive lending to risky real estate borrowers at unreasonably low rates (e.g. Jimenez et al. 2006 and Dell'Ariccia et al. 2012). Herring and Wachter (1999) argue that banks may underestimate the default risk on mortgages loans during strong property market conditions. Specifically, banks have a tendency to disregard the danger of adverse selection when they expand lending within a short space of time. This tendency towards "disaster myopia" can arise as a result of poor risk management or a changing tolerance for risk[13].

Consequently, the quality of the loans portfolios is likely to deteriorate and the loans portfolio become much riskier during the maturity phase of the cycle[14]. A further element in this regard is that participants in residential property markets frequently display extrapolative or adaptive expectations (Case and Shiller, 1989, Poterba, 1991). This can contribute to the presence of myopic expectations in that participants may fail to account for potential reversals in price trends (Malpezzi and Wachter, 2005, Stevenson, 2008). Therefore, increasing property prices may encourage riskier investors to speculative on further price increases and demand credit from banks. Both factors lead to larger exposures and the accumulation of risky assets, which are prone to mis-pricing. Koetter and Poghosyan (2010) corroborate the importance of deviations from the fundamental value of real estate, rather than just price levels or changes alone, when assessing to bank stability.

Once a shock occurs, disaster myopia tends to become disaster magnification. This phenomenon is further worsened by the fact that many banks delay provisioning for loan losses to the recession phases of the property price cycle. This results in the economic cycle having a greater impact on bank capital and profitability (Laeven and Majnoni, 2003). The net result of this is that the disaster myopia phenomenon might lead to banks taking excessive risks, while the risk premium required may not be sufficient to compensate for potential losses.

Another related issue is concerned with the diversification versus focus debate (e.g. Diamond 1984, Winton 1999, Stomper 2006). Financial in-

[13] "Disaster myopia" can in part be attributable inter alia to inadequate data, measurement bias (Borio et al., 2001), pervasive incentives linked to the safety net, intensified competition following the liberalisation of the banking sector (e.g., Chan et al. 1986, Hellman et al. 2000 and Marquez 2002) or institutional memory loss over time regarding the possibility of property prices collapsing (Berger and Udell, 2004).

[14] Hellman et al. (2000) express the view that Japanese financial-market liberalization in 1990 increased competition and reduced the profitability and franchise value of domestic banks. This, together with others factors, lead to the East Asian financial crisis and a weaker financial system in Japan.

termediation theory suggests that banks should diversify to reduce risks or focus their lending on industries about which they have superior expertise to increase risk-adjusted returns. Traditional banking theory argues that banks should diversify their credit portfolio, given that through the expansion of their credit lines to new sectors, the bank's probability of default will be reduced (e.g. Diamond 1984). The idea is that due to asymmetric information, diversification reduces financial intermediation costs. Moreover, less diversified banks would be more vulnerable to economic downturns, since they expose themselves to few sectors. On the other hand, corporate finance theory supports the idea that firms should concentrate their activities on a specific sector or group of sectors in order to exploit the benefits of enhanced expertise in these sectors (e.g. Stomper 2006 and Acharya et al. 2006). Another argument against portfolio diversification is that it can result in increased competition with other banks, making this strategy less attractive. In particular, Winton (1999) argues that diversification only reduces the risk of bank failure in the case of moderated risks of default. When the risks are low, banks may benefit more from specialization than from diversification, since there is a low probability of failure. Conversely, when the probabilities of insolvency are high, diversification may even worsen the situation, since the bank will expose itself to many sectors, and the downturn of one may be enough to lead this bank to bankruptcy. The overall conclusion is that the relationship between bank's focus and return is U-shaped in risk. Finally, Wagner (2010 and 2011) shows that if diversification at financial institutions benefits the financial stability of financial system, it also entails a cost — makes systemic crises more likely. When systemic crises induce additional costs full diversification is no longer desirable as a result and the optimal degree of diversification may be arbitrarily low.

2.2.2. Other Determinants of Bank Risk and Profitability

Previous studies identify other risk and profitability determinants used that we briefly review below.

Credit Risk

a. Macroeconomic Factors

Empirical evidence would suggest that there is a close relationship between bank credit risk and the economic cycle. When economic growth is low or even negative, companies and households reduce their cash inflows (sales, wages), which in turn leads to increased default on payments to banks. In this paper we use the GDP growth rate to proxy economic activ-

ity as GDP is considered to be a more informative measurement than other macroeconomic variables, such as changes in unemployment, real wages and real interest rates (Salas and Saurina, 2002).

Depending on the level of indebtedness of companies and households, changes in aggregate economic activity may have different effects on credit risk. Moreover, such effects may vary from country to country due to differences in the debt composition of households and companies (short versus long-term debt), and differences in the relationship between banks and companies. Davis (1992) finds that in countries such as the US, the UK, Canada and France, a rise in a company's indebtedness increases the likelihood of bankruptcy. In contrast, in Japan the opposite effect is observed. Germany appears to be an intermediate case (non-significant relationship). In the Japanese financial system there is a close relationship between banks and corporates which leads to banks being highly informed about the financial situation of firms. Therefore, banks tend to be less reluctant to finance companies during periods of economic recession, even if the companies' debt ratio may be already high[15].

b. Microeconomic Factors

Salas and Saurina (2002) argue that the three main microeconomic variables which could explain the banks' risk decision-making are; the rate of credit growth, the composition of the loan portfolio and the incentives to pursue riskier credit policies.

Rapid credit growth is considered to be one of the primary causes of increased bank risk. Clair (1992) and Solttila and Vihriälä (1994) show that, after controlling for the composition of banks' loans portfolio, past loan growth aids in explaining current levels of bad debt. Kwan and Eisenbeis (1997) empirically demonstrate that banks with rapid credit expansion are riskier. Salas and Saurina (2002) illustrate that banks whom focus on increasing market share tend to register lower levels of quality required of their customers. Therefore, if another bank tries to encroach upon its market share, a bank may try to keep its best customers and will let go its lowest-quality customers. Consequently, if credit expansion is made in a new geographical area or sector in which the bank has no earlier experience, it is more likely to be affected by and exposed to problems of adverse selection.

Credit monitoring is also another key element in ensuring good credit policy. To this end, an effective risk analysis and internal control structure

[15]Petersen and Rajan (1994) show that the existence of a close relationship between a bank and a company increases the availability of funds for the latter.

needs to be in place. The shortage and misuse of resources allocated to this task may affect the bank's solvency. Berger and DeYoung (1997) find that decreases in costs efficiency are related to increases in bad debt. Kwan and Eisenbeis (1997) further state that inefficient banks are more prone to risk taking. Another factor which may affect credit risk is portfolio composition, and specifically that different loan types have differing credit risks. Therefore, the structure of the balance sheet, particularly the loan portfolio, reflects the credit risk accepted by managers. Pensala and Solttila (1993), Randall (1993), Murto (1994), Domowitz and Sartain (1999), amongst others, state that different credit categories have different levels of risk, with the real estate and construction sectors being the riskiest sectors, followed by commercial and industrial loans, and finally, household mortgages.

Keeton and Morris (1988) consider whether the high level of bad debt of some banks is the result of a deliberately riskier credit policy, though anticipated, by charging higher interest rates (a higher risk premium). The authors conclude that banks which charge highest interest rates are those which previously had higher levels of bad debt. The existence of incentives by managers to follow policies of taking high risks may be another factor determining bank credit risk. Banks with solvency problems can try to solve them by relying on rapid credit expansion in sectors with high profitability but also with higher risk. Contributing towards this situation is the fact that shareholders and managers have little to lose, given their limited liability and due to the fact that these banks have a low level of capital. A subtler case appears when bank margins decrease continuously. Managers can attempt to compensate for this slow but steady decrease by adopting riskier credit policies that could eventually lead to an increase in bad loans.

Profitability

a. Macroeconomic Factors

Valverde and Fernández (2007) use real GDP when analysing the factors determining the interest margins of European banks[16]. The authors posit that the relationship between banks' gross margin and economic growth depends upon the correlation between prices, costs and the economic cycle. Economic growth tends to be negatively related to bank prices and costs,

[16]Maudos and Guevara (2004), Valverde and Fernández (2007) and Lepetit et al. (2008b), amongst others, use the Net Interest Margin (NIM) variable as a proxy for bank profitability. The variable measures the difference, in terms of yield, between the active interest and passive interest from banking operations undertaken by banks, given the asset total. It is similar to the gross margin of non-financial companies.

however, the extent to which these variables are affected is varied. Carbó et al. (2003) state that the net effect of economic growth on bank margins is not clearly determined. In their analysis of the factors determining the gross margin in European terms, Valverde and Fernández (2007) include a dummy which indicates whether a bank operates under a bank-based system (in which bank balance-sheet activities are comparatively high in relation to bank credit activities) or a market-based system (in which capital markets activities are comparatively high in relation to bank credit activities).

b. Microeconomic Factors

A large part of the literature on the banking sector focuses on the determinants of interest margins. In their pioneering study, Ho and Saunders (1981) adopt the concept of banks as mere intermediaries between depositors and customers, and state that the interest margins have two basic components, namely the degree of competition of the markets and the interest rate risk to which the bank is exposed. This model has been extended by several studies: Allen (1988) widens it to permit the existence of different types of credits and deposits; McShane and Sharpe (1985) change the source of the interest rate risk, situating it in the uncertainty of the money market instead of the interest rate on credits and deposits; Angbanzo (1997) extends the model to take into account credit risk as well as interest rate risk.

According to the theoretical model developed by Maudos and Guevara (2004), the factors determining the "pure" interest margins are as follows: the competitive structure of the markets, average operating costs[17], risk aversion, the volatility of money market interest rates and the credit risk. Maudos and Guevara (2004) also state that, in practice, there may be other variables explaining the interest margins, capturing the influence of institutional, regulatory and quality of management aspects, which could potentially distort the "pure" interest margin. Saunders and Schumacher (2000) also argue that regulation, in the form of interest rate restrictions on deposits or minimum reserves and solvency ratios, might have a significant impact on banks' interest margins.

[17]Maudos and Guevara (2004) state that "the extension of the model realized in this paper yield the inclusion of an additional term, the average operating costs, in the explanatory equation of the interest margin. Consequently, firms that incur high unit costs will logically need to work with higher margins to enable them to cover their higher operating costs. Observe that, even in the absence of market power and of any kind of risk, a positive margin will be necessary in order to cover operating costs."

Acharya et al. (2006) find that a U-shape relationship between bank returns and the degree of concentration, is a function of the level of bank risk. Their results suggest that there can be diseconomies of diversification in the case of banks which expand their business activities into highly competitive sectors or sectors in which they have no prior experience. The results reveal that these effects can emerge in the deterioration of the banks' loan portfolio and simultaneously in reduced profitability. This is possibly driven by deterioration in the effectiveness of banking monitoring, adverse selection, increased general expenditure, or a combination of these factors.

3. SAMPLE AND METHODOLOGY

3.1. Research Question

The paper considers three core research questions.

I. What is the expected impact of the relative expansion of residential mortgage loans on bank credit risk? Does the impact vary over the property price cycle and is it influenced by the institutional characteristics of the country where the bank operates?

The marginal effect of increase in residential mortgage loans on bank credit risk can be written as:

$$\frac{d(RISK_t)}{d(RMShare_t)} = \alpha_{11} + \alpha_{12} \times RPPRICE_{t-1} \tag{1}$$

where $RISK$ is the proxy for credit risk; $RMShare$ is the weight of residential mortgage loans in the bank's total assets and RPPRICE is the growth rate in real residential property prices. The results will help to shed light on whether residential mortgage loans have a positive or negative impact on bank credit risk and whether the effect on credit risk increases or decreases with the rise in residential property market prices (given by parameter α_{12}).

Tsatsaronis and Zhu (2004), Acharya et. al. (2011) and Martins et al. (2015) note that there are significant differences across countries in terms of the characteristics of the mortgage credit markets. They show that markets with higher growth rates and less conservative lending practises (with for example, high leverage ratios and the possibility of extracting capital) also tend to have higher owner occupancy rates. By influencing the level of risk-taking by banks, the institutional differences pertaining to the mortgage market may help to explain some differences of the impact of residential mortgage loans on bank credit risk. It is expected that banks

in countries whose credit policy characteristics are less conservative have a greater propensity to take risks.

II. What is the expected impact of the relative expansion of residential mortgage loans on bank profitability? Does the impact vary over the residential property price cycle?

The marginal effect of increase in residential mortgage loans on bank profitability can be written as:

$$\frac{d(PROFIT_t)}{d(RMShare_t)} = \alpha_{12} + \alpha_{13} \times RPPRICE_{t-1} \tag{2}$$

where $PROFIT$ is the proxy for bank profitability; $RMShare$ is the weight of residential mortgage loans in the bank's total assets and $RPPRICE$ is the real residential property growth rate or the accumulated growth rate of real housing prices. The results will allow an evaluation of whether residential mortgage loans have a positive or negative impact on bank profitability and if the effect on bank profitability increases or decreases with the rise in residential property prices (given by parameter α_{13}).

Chan et al. (1986) show that increased competition erodes the surplus that banks can earn by identifying high-quality borrowers. The reduction in value leads banks to reduce their screening of potential borrowers and, thus overall credit quality in the portfolio declines. In a context of asymmetric information, Marquez (2002) notes that an increase in the number of banks in a market leads to a dispersion of borrower-specific information and will result in not only higher funding costs for low-quality borrowers but also in easier access to credit for low-quality borrowers. The customers to whom banks lend later in the cycle may not only be of lower credit quality but also borrow more in terms of LTV. This leads to a combined impact. Firstly, they are purchasing properties at higher prices due to buying later in the cycle. This together with higher borrowing, in terms of LTV, leads to such borrowers being more vulnerable to negative equity[18]. Thus it is likely that the impact of residential mortgage loans on bank profitability will vary over the residential property price cycle.

In order to test if the relationship between residential property loans focus and bank profitability has a non-linear relation on risk, as Winton (1999) and Acharya et al. (2006) defend, we employ interactions of RISK and RISK2 with residential property loans focus. This is the last question we address:

[18]This impact was particularly evident during the subprime crisis. Default and foreclosure rates for the loans originated in 2006 and 2007 were substantially higher than those originated prior to 2005.

III. Is the relationship between bank profitability and residential mortgage loans a non-linear function? Is the relationship between bank profitability and residential mortgage loans a function of the level of risk?

The marginal effect of the increase residential mortgage loans (RMShare) on bank profitability can be described as:

$$\frac{d(PROFIT_t)}{d(RMShare_t)} = \alpha_{12} + \alpha_{13} \times RISK_t + \alpha_{14} \times RISK_t^2 \tag{3}$$

where $PROFIT$ is the proxy for bank profitability; $RMSHARE$ is the weight of residential mortgage loans in the bank's total assets and $RISK$ is the proxy for bank credit risk. If the marginal effect of the concentration on residential mortgage loans on bank profitability is a U-shaped function of the level of risk, then $\alpha_{13} < 0$ and $\alpha_{14} > 0$. Thus, the focus on residential property loans would achieve better bank performance in both low and high risk scenarios.

3.2. Variables and Model Specifications

3.2.1. Bank Credit Risk Model

In order to study the effects of residential mortgage loans on bank credit risk, we estimate following model:

$$\begin{aligned} RISK_{it} &= \alpha_1 RISK_{it-1} + \sum_{h=0}^{1} \alpha_2 GDP_{t-h} + \alpha_3 DFAM_t + \alpha_4 DEMP_t \\ &+ \sum_{h=1}^{3} \alpha_5 LOAN_{TO_{ASSETS_{it-h}}} + \alpha_6 INEF_{it} + \alpha_7 SIZE_{it} \\ &+ \sum_{h=2}^{3} \alpha_8 NIM_{it-h} + \sum_{h=2}^{3} \alpha_9 EQUITY_{it-h} + \alpha_{10} PREM_{it-3} \\ &+ \alpha_{11} RMShare_{it} + \alpha_{12} RMShare_{it} \times RPPrice_{t-1} + T_i \\ &+ \eta_i + \varepsilon_{it} \end{aligned} \tag{4}$$

where $RISK$ is the proxy for bank i credit risk as measured by the ratio between loan loss provisions to net loans ($PROV$) or by the ratio of non-performing loans and the total of loans (NPL) in period t[19]; $RMSHARE$ is the weight of residential mortgage loans on total assets of the bank;

[19] Angbazo (1997), Salas and Saurina (2002), amongst others, use NPL as proxy of bank credit risk; Lepetit et al. (2008a, 2008b), use PROV as proxy of bank credit risk and Acharya et al. (2006) and Davis and Zhu (2009) use both proxies as a measurement of bank credit risk.

$RPPRICE$ is the rate of growth in real terms of the residential housing prices (in the country or region, for those banks whose exposure to the real estate market is at a regional level). Table 2 presents the residential housing price series used in this study.

We use the following control variables. GDP is real GDP growth; DFAM is the ratio between the liabilities of families and GDP; DEMP is the ratio between the liabilities of companies and GDP; LOAN_TO_ASSETS is the ratio between the bank's total credit and total assets; INEF is the ratio of operating costs to gross income; SIZEi is the ratio between the bank's assets and banking industry aggregate assets; NIM is the proxy for bank profitability measured by net interest margin (gross margin); $EQUITY$ is the ratio between equity capital and total assets; $PREM$ is the difference between interest income over total assets and the interbank interest rate; T_i and Δ_i captures any unobserved bank-invariant time effects and unobservable effects of the intrinsic characteristics of bank i (such as managers' risk-aversion and preferences), respectively. Δ_{it} is the error term. The detailed definition of the variables and the expected relationships are shown in table 3[20].

3.2.2. Profitability Model

We estimate the following linear regression:

$$\begin{aligned} PROFIT_{it} &= \alpha_1 PROFIT_{it-1} + \sum_{h=0}^{1} \alpha_2 GDP_{t-h} + \alpha_3 BBMB_{it} + \sum_{h=2}^{3} \alpha_4 RISK_{it-h} \\ &+ \alpha_5 \sum_{h=1}^{2} LIQ_{it-h} + \alpha_6 \sum_{h=1}^{2} SDR3M_{it-h} + \alpha_7 HHI_t + \alpha_8 INEF_{it} \\ &+ \alpha_9 \Delta LOAN_{it} + \sum_{h=2}^{3} \alpha_{10} EQUITY_{it-h} + \alpha_{11} IPP_{it} \\ &+ \alpha_{12} RMShare_{it} + \alpha_{13} RMShare_{it} \times RPPRICE_{t-1} + T_i \\ &+ \eta_i + \varepsilon_{it} \end{aligned} \tag{5}$$

We use the Net Interest Margin (NIM) and return on assets (ROA) as proxies for bank profitability ($PROFIT$)[21]. $RMSHARE$ and $RPPRICE$ are

[20] For a more depth explanation of risk management importance and determinants of credit risk, please refer to Freixas and Rochet (2008).

[21] Angbazo (1997), Saunders and Schumacher (2000), Maudos and Guevara (2004), and Lepetit et al. (2008b) amongst others, also use NIM as a proxy for bank profitability; Acharya et al. (2006) use ROA as a proxy for bank profitability and Davis and Zhu (2009) use both proxies as a measurement of bank profitability.

TABLE 2.

Residential Housing Prices Series

Country	Dwelling	Dwelling Type	Geographical Coverage	Prices	Description of Index	Period	Source
Austria	New and Second Hand Dwellings.	Houses and apartments.	Vienna	Transaction Prices.	Weighted average price	1976 -	Central Bank of Austria (www.oenb.at)
Belgium	New and Second Hand Dwellings.	Small and medium sized dwellings for sale by mutual agreement.	Nationwide	Transaction Prices.	Average price index weighted by the number of transactions for each type of housing.	1988 -	STADIM (private consultancy) (www.stadim.be)
Denmark	New and Second Hand Dwellings.	Houses, flats and holiday homes.	Nationwide (data collected at municipal level).	Transaction Prices.	Average price per square meter for municipalities weighted with the dwelling stock.	1971 -	Danish Mortgage Association (www.realkreditraadet.dk)
Finland	New and Second Hand Dwellings.	Houses and apartments.	Large Cities (with more than 100.000 inhabitants).	Transaction Prices.	Average price index weighted by the number of transactions for each type of housing.	1978 -	Central Bank of Finland (www.suomenpankki.fi)
France	Second Hand	Second-hand dwellings: more than 5 years old or sold a second	Paris.	Transaction Prices.	Paris: Average price per square meter observed in sales.	1980 -	Notaires - INSEE
	Dwellings.	time within the 1st 5 years.	Nationwide.		Country: Hedonic regression.	1994 -	(www.insee.fr)
Germany	Second Hand Dwellings.	Property offering a good quality of life in average to good locations. Terraced houses and flats.	Western Germany: Before 1989: 50 towns/cities. From 1990 onwards: 100 towns/cities. From 1995 onwards: 125 towns/cities (100 towns/cities in Western Germany and 25 towns/cities in Eastern Germany)	Typical values quantified by real estate experts who refer to price data of various types, including non-transaction prices.	Prices weighted through population. Aggregation based on the share of terraced houses and flats in the total living área.	1975 -	Central Bank of Germany. Figures are based on data from BulwienGesa AG. (www.bundesbank.de)
Greece	New and Second Hand Dwellings.	N/A	Athens and 17 major cities.	Transaction Prices.	Prices weighted with the dwelling stock (in square meters) in Athens and 17 major cities.	1994 -	Central Bank of Greece (www.bankofgreece.gr)
Ireland	New and Second Hand Dwellings.	All newly mortgaged residential property.	Nationwide.	Price at mortgage approval.	Simple average of house price for new and second hand dwellings in the period in question.	1971 -	Department of the Environment (www.environ.ie)
Italy	New and Second Hand Dwellings.	N/A	13 large urban areas.	Transaction Prices.	Weighted average price	1988 -	NOMISMA (www.nomisma.it)
Luxemburg	New and Second Hand Dwellings.	Flats and Houses.	Nationwide.	Transaction Prices.	Laspeyere price indices.	1974 -	Central Bank of Luxembourg (www.bcl.lu)
Netherlands	Second Hand Dwellings.	Detached house, corner house, terraced house, apartment, semi-detached house.	Nationwide.	Transaction Prices.	Weighted repeat sales.	1976 -	National Land Register (Kadaster) (www.kadaster.org)
Spain	New and Second Hand Dwellings.	All dwellings excluding those that have a market value over €1.050.000.	Nationwide (data collected for provinces and municipalities with more than 25.000 inhabitants.	Price is calculated by using official valuations: "Open market appraised housing"	Average price per square meter weighted with the number of valuations.	1987 -	Ministry of Housing (www.fomento.gob.es)
Portugal	New and Second Hand Dwellings.	Flats and Houses.	Nationwide (exclude islands)	Price is calculated by using official valuations.	Weighted price indices by hedonic regression and by housing type.	1988 -	Imométrica (www1.ipd.com)
Sweden	New and Second Hand Dwellings.	One and two dwelling buildings.	Nacional	N/A	Weighted average of the price indices of owner-occupied adjusted for ratable values and based on the legal registration.	1986 -	Statistics Sweden (www.scb.se/)
UK	New and Second Hand Dwellings.	Detached house, semi-detached house, bungalow, terraced house and flats.	Nationwide.	Transaction Prices.	Mixed Adjusted	1969 -	Department of Communities and Local Government (www.communities.gov.uk)

The table presents the sources of residential house price series with its description, source, prices type, dwelling type, geographical coverage and first observation. All these series were deflated using CPI. All series were obtained from Bank International Settlements (BIS): BIS House Prices.

TABLE 3.

Determinants of Bank Credit Risk: Variable Definition and Expected Relationships

Variable	Variable Definition	Coefficient Sign
	Dependent Variables (Bank Credit Risk Proxies)	
$PROV_{it-1}$	Ratio of loan loss provision to net loans from the previous period. The current ratio is closely related to that of the previous period, since loan loss provisions are not immediately written down in the bank balance sheet.	Positive
NPL_{it-1}	Ratio of non-performing loans and the total of loans from the previous period.	Positive
	Control Variables	
GDP_{t-h}	Real GDP Growth Rate. Measures the impact of aggregated economic activity. The larger the economic growth the lower the degree of default by economic agents.	Negative
$DFAM_t$	Ratio Between the Liabilities of Families and the GDP. This ratio measures the families' indebtedness level.	Positive
$DEMP_t$	Ratio Between the Liabilities of Company and GDP. This ratio measures the company's indebtedness level.	Positive
$\text{LOAN\_TO\_ASSETS}_{it-h}$	Ratio between Total Credit and Total Assets lagged one, two and three periods. A target of rapid increase in market share can force the bank to reduce the quality of its borrowers. However, since the loan is granted till it becomes a provision loans, there is a lag unknown and variable. In order to measure the temporal effects, we allow three lags, starting at $t-1$. If it were lagged less are than one period, it could be spuriously correlated with the dependent variable through the denominator.	Positive
$INEF_{it}$	Level of Bank Inefficiencies provided by the ratio "Operating Costs to Gross Income". A higher value for the ratio indicates that there are management inefficiencies. It is expected that banks with better management in place have a lower level of loan provisions.	Positive
$SIZE_{it}$	Bank's Relative Dimension provided by the ratio between bank assets i and total bank assets, during the period t. As we noted in section 2.2.2.1, some authors use this variable to measure risk diversification policies. A big balance sheet allows the managers to invest in different geographical or business segments to deal with asymmetric shocks. If the relative size is a good proxy for risk diversification, we should find a negative coefficient. On the other hand, this variable may capture the bank's market power. In this situation, we should expected a positive sign for the coefficient, because when the bank increases the market power, increase the probability of granting credit to companies with a higher credit risk.	Positive or Negative
$MARGIN_{it-h}$	Bank Interest Margin obtained by the variable "Net Interest Margin", lagged two and three periods. This variable is a measure of the difference between the interest income generated by banks and the amount of interest paid to their lenders (for example, deposits), relative to the amount of their (interest-earning) assets. It is similar to the gross margin of non-financial companies. The present variable not only reflects the profitability of bank credit, but also incorporates a risk premium. The increased risk will tend to provoke an increase in the gross margin, for which reason the variables are lagged.	Positive

defined as above. The following control variables are used. $BBMB$ is a dummy variable that takes the value 1 if the bank operates in a bank-based system and the value 0 if bank operates in a market-based system. $RISK$

TABLE 3—*Continued*

Variable	Variable Definition	Coefficient Sign
$EQUITY_{it-h}$	Solvency Ratio is provided by the ratio between Capital and Total Assets, lagged two and three periods. The impact of solvency difficulties is not straightforward. The loans provisions will appear later because it takes time to change credit policy. The higher the solvency ratio, the lower the incentives to take more risks. Therefore, a negative coefficient is expected for the coefficient. Nevertheless, lower capital ratios may induce banks to "gamble for resurrection", thereby causing the opposite impacts on bank decisions.	Positive or Negative
$PREM_{it-3}$	Credit Risk Premium. The higher ex post credit risk may be anticipated by the bank charging an ex ante risk premium in the interest of the loans. To control for this effect, we include $PREM_{it-3}$ (the difference between interest income over total assets and the interbank interest rate) as a proxy for the risk premium. The tree-year lags is designed to catch the ex ante component of risk premium. If the riskier loans are properly priced, the coefficient associated to the variable should be positive and statistically significant. However, it is possible that a positive impact may not be found if strong competition induces cross-subsidization of products inside banks.	Positive
$RMShare_{it}$	The weight of residential mortgage loans in the bank's assets.	?
$RPPRICE_{t-1}$	The rate of growth in real terms of the residential housing prices in the country (or in the region, for those banks whose exposure to the real estate market is at a regional level). Detailed information about residential housing price series appears in table 2.	?

is defined as above and lagged two and three periods. LIQ is the ratio of Liquid Assets to Short Term Funding. $SDR3M$ is a proxy for interest rate risk and is given by lagged annual standard deviation of daily interbank 3 month interest rates. HHI is the Herfindahl and Hirschman Index. $\Delta LOAN_i$ is the rate of growth of credit loans. IPP are Implicit Interest Payments given by the ratio of [Non-Interest Expenses — Non-Interest Revenues] to Total Assets. The other variables are defined as above. The detailed definition of these variables and the expected relationships are shown in table 4.

In order to assess if the relationship between bank profitability and residential mortgage loans credit is a U-shaped function of the level of risk we

TABLE 4.

Determinants of Bank Profitability: Variable Definition and Expected Relationships

Variable	Variable Definition	Coefficient Sign
	Dependent Variables (Bank Profitability Proxies)	
NIM_{It-1}	Bank Interest Margin from the previous period.	Positive
ROA_{It-1}	Return on Assets from the previous period.	Positive
	Control Variables	
GDP_{t-h}	Real GDP growth rate. The relationship between the bank margins and growth will depend on the correlation between prices, costs and the business cycle. Economic growth is negatively related to bank prices and costs, although the extent to which these variables are affected may be significantly different, meaning that the net effect on margin may not be clearly determined (Carbó et al., 2003).	Positive or Negative
$BBMB_t$	Bank-Based or Market-Based System. A dummy variable is used in order to show the potential effects of the differences in the bank margins according to the structure of the financial system. The dummy take the value 1 if the bank operates in a bank-based system and the value 0 if bank operates in a market-based system. Valverde and Fernández (2007) found positive and negative signs, statistically significant, for this proxy.	Positive or Negative
$RISK_{it-h}$	Credit Risk defined by the value of the ratio "Loan Loss Provisions to Net Loans" lagged into two and three periods. The values of this ratio are lagged since risk parameters are not expected to affect margins contemporaneously. A greater risk premium should be required by the bank when the credit risk increases.	Positive
LIQ_{it-h}	Liquidity risk provided by the ratio "Liquid Assets to Short Term Funding". The risk of insufficient liquidity may force banks to request emergency funds at excessive cost. Angbazo (1997) states that the liquidity risk tends to affect bank margin positively.	Positive
$SDR3M_{it-h}$	Volatility of the Market Interest Rate is used as the proxy for the interest rate risk. The uncertainty in the money market is reflected in the theoretical model by the variance of the market interest rate. The empirical proxy for this variable is consequently based on a measurement of volatility of the market interest rate, such as the annual standard deviation of the daily interbank interest rate at 3 months. The variable is lagged since the volatility of the market interest rate is not expected to affect the gross margin contemporaneously. It is expected that the interest rate risk increases banks' gross margin (Saunders and Schumacher, 2000).	Positive
HHI_t	Herfindahl and Hirschman Index computed from banks total assets on the domestic market. In theory, the level of concentration of banking activity and banks' gross margins tend to be positively related. However, this relationship may be influenced by third variables and the gross margins can be negatively affected by market concentration (see for example, Cetorelli and Gambera, 2002). The HHI variable was obtained from two reports from the European Central Bank (ECB, 2005 and 2010).	Positive or Negative

estimate the following regression:

$$\begin{aligned} PROFIT_{it} &= \alpha_1 PROFIT_{it-1} + \sum_{h=0}^{1} \alpha_2 GDP_{t-h} + \alpha_3 BBMB_{it} + \sum_{h=2}^{3} \alpha_4 RISK_{it-h} \\ &+ \alpha_5 \sum_{h=1}^{2} LIQ_{it-h} + \alpha_6 \sum_{h=1}^{2} SDR3M_{it-h} + \alpha_7 HHI_t + \alpha_8 INEF_{it} \\ &+ \alpha_9 \Delta LOAN_{it} + \sum_{h=2}^{3} \alpha_{10} EQUITY_{it-h} + \alpha_{11} IPP_{it} + \alpha_{12} RMShare_{it} \\ &+ \alpha_1 3 RMShare_{it} \times RISK_{it-1} + \alpha_{14} RMShare_{it} \times RISK_{it-1}^2 + T_i \\ &+ \eta_i + \varepsilon_{it} \end{aligned} \tag{6}$$

TABLE 4—*Continued*

Variable	Variable Definition	Coefficient Sign
$INEF_{it}$	Level of Bank Inefficiencies provided by the "Cost to Income Ratio". The existence of high operating costs implies increased operating inefficiency. Therefore, we expect those banks experiencing higher costs to increase prices to a greater extent (if they enjoy market power), so that inefficiency will result in higher margins (Altunbas et al., 2001). Maudos and Guevara (2004) state that this proxy may, alternatively, indicate the quality or efficiency of the management. There tends to be higher quality management when there is a lucrative composition of assets and a low cost composition of liabilities. Thus a higher ratio would imply lesser management efficiency or quality, which would reflect lower gross margins.	Positive or Negative
$\Delta LOAN_{it}$	Average Dimension of Operations or Credit Volume. In the estimation we use the loans growth rate as proxy. In the model developed by Maudos and Guevara (2004), the gross margins are a growing function of the average dimension of the operations realized. The reason for this is that for a certain risk value and market risk, a large operation will tend to involve greater risk of potential loss, so the bank will tend to require a greater margin. Thus, the potential loss will tend to be greater for banks with a high volume of credit volume. Davis and Zhu (2009) refer that if the bank's risk attitude remains the same across the credit cycle, its profitability should be higher as a compensation for the higher credit risk. Nevertheless, if the risk-taking behaviour is associated with distorted incentives, such as the "disaster myopia" tendency mentioned before, its linkage with bank profitability is more ambiguous.	Positive or Negative
$EQUITY_{it-h}$	Solvency Ratio provided by "Capital to Assets Ratio". Valverde and Fernández (2007) state that debt substitution for capital, lower the bank's insolvency risk and possibly decrease the funding costs for the bank. But as the capital is becoming a more costly source of funding, an increase in equity tends to increase the average cost of the capital. Thus, a higher gross margin will tend to be required ex-ante. Davis and Zhu (2009) state that the solvency ratio may have two opposite effects on bank profitability. If the cost-of-funding effect dominates, a higher equity ratio leads to higher bank profitability. If the "gamble for resurrection" effect dominates instead, banks with lower capitalisation will invest more on high-risk assets and the loan quality is impaired.	Positive or Negative
IPP_{it}	Implicit Interest Payments. Following Ho and Saunders (1981), Angbazo (1997) and Saunders and Schumacher (2000), the proxy "(Non-Interest Expenses − Non-Interest Revenues)/Total Assets" is used to measure the implicit interest payments. This variable reflects extra payments to depositors through service charge remission or other types of transfers due to competition in the market for deposits. These extra interest expenses should be mirrored in higher interest margins.	Positive
$RPPRICE_{it-1}$	Rate of growth in real terms of the residential housing prices in the country (or in the region, for those banks whose exposure to the real estate market is at a regional level) or the accumulated rate of growth in real terms of residential housing prices. Detailed information about residential housing price series appears in table 1.	?
$RMShare_{it}$	The weight of residential mortgage loans in the bank's assets.	?

We also consider the impact of mortgage credit market characteristics on bank credit risk and profitability. For this purpose, the variable LTV (the average loan to value ratio in the country where the bank operates) is added to equations (4) to (6). Finally, given that the sample include

investment banks[22] and a sample that covers part of the crisis period, we re-estimate the models excluding investment banks and for a period until 2006 (pre-crisis time) as a robustness check.

TABLE 5.

Distribution of Banks by Country and Specialization

Country	Number of Banks				
	Commercial	Cooperative	Real Estate & Mortgage	Others	Total
Austria	16	9	5	10	40
Belgium	8	1	0	5	14
Denmark	40	0	2	12	54
Finland	5	0	0	1	6
France	37	50	3	5	95
Germany	28	6	3	10	47
Greece	13	0	0	1	14
Ireland	11	0	3	1	15
Italy	27	16	0	17	60
Luxembourg	11	1	0	2	14
Netherlands	18	1	1	6	26
Portugal	7	1	1	9	18
Spain[1]	22	5	0	43	70
Sweden	5	0	4	7	16
United Kingdom	24	0	34	8	66
Total	272	90	56	137	555

This table shows the banks distribution by country and specialization. The sample was obtained from the database BANKSCOPE. We only consider banks with more than three consecutive years of observations between 1995 and 2008. The banks' specialization is in agreement with the classification used by database BANKSCOPE. The specialization category "Others" includes: "Bank Holdings & Holding Companies", "Savings Banks" and "Investment Banks".

[1] The column relating to "Others" has only Saving Banks given the importance of the Cajas de Ahorros in Spain.

3.3. Dynamic Panel Data Models

Salas and Saurina (2002) and Valverde and Fernández (2007) suggest using first-differences of the equations above in the estimation of the dynamic panel data models, in order to eliminate bank-specific effects (see Arellano and Bond, 1988 and 1991). The unobservable individual effects (Δ_i) in equations (4) to (6) tend to be correlated with other explanatory variables.

[22] The investment banks are characterized by not partaking in residential property lending.

For example, in the credit risk model, Δ_i tends to be correlated with the managers' (unobservable) risk preferences and with the lagged loan provision ratio. If equations (4), (5) and (6) are expressed in first differences, the individual effects will be eliminated. However, by using static panel data estimation, estimates would be biased given that the transformed lagged dependent variables will still be correlated with the transformed error terms. Furthermore, the explanatory variable weight, $RMShare$, is endogenous, and should therefore be defined with adequate instrumental variables. In particular, three variables are treated as endogenous in the estimation. These are the proxies for credit risk ($RISK$), profitability ($PROFIT$) and the weight of residential mortgage loans in total assets ($RMShare$).

To overcome the aforementioned biases, we use linear GMM estimation. The instrumental variables for the endogenous variables are the same variables lagged throughout a number of periods, (h), sufficient to prevent the second-order autocorrelation of residuals (Salas and Saurina, 2002)[23]. In equation (4) the dependent variable is transformed, since the ratio of loans provisions to loans is a truncated variable (between zero and one), and is therefore not suitable for the GMM procedure.

Jimenez et al. (2012) show that changes in EU monetary policy affect bank lending and bank risk-taking in all EU countries. They analyze the effects of monetary conditions and economic activity on the granting of loans with individual loan applications records depending on the strength of bank balance sheets measured by bank capital and liquidity ratios. To capture omitted variables, that vary across time (and affect all banks in EU), they control for time-varying observed and unobserved firms heterogeneity with firm-month fixed effects (i.e. there is a dummy for every-year or month combination). As in Jimenez et al. (2012) to analyze and quantify the effects of residential property loans on bank performance, we include observable bank characteristics and bank fixed and time fixed effects in the specifications, thereby inevitably weakening performance identification.

3.4. Sample

[23]The consistency of the GMM estimator depends both on the validity of the assumption of absence of serial correlation of the error term and on the validity of the instruments. Arellano and Bond (1991) suggest two tests to validate these assumptions. The first is the Sargan test of over-identifying restrictions. This statistic will be asymptotically chi-squared under the null hypothesis that the error term is uncorrelated with the instruments. The second test, examines the assumption of no serial correlation in the error terms. Under the null hypothesis of no second-order serial correlation, this test has a standard-normal distribution.

The sample is composed of an unbalanced panel of annual data, obtained from the financial reports and accounts of 555 banks within the EU-15 countries for the period from 1995 to 2008. The use of lagged variables reduces the time period of the estimations. The bank credit risk and profitability models are estimated from 1999 and 2002 respectively. The following table presents the distribution of the sample banks by country and by specialisation.

The data was obtained from BANKSCOPE. Banks with less than three consecutive years of observations, or missing information in terms of explanatory variables, were excluded. With regard to banks where there is no information available in BANKSCOPE concerning the amount of residential mortgage lending the information was collected from their annual reports and accounts[24]. The decision to solely consider residential mortgage loans, rather than all mortgage loans, was three-fold. Firstly, the poor quality and frequent lack of availability of price data for non-residential real estate markets in the majority of countries considered. Secondly, the lack of detailed segmentation of the non-residential mortgage loans. Finally, given the quite different characteristics of the residential and commercial property sectors, the focus on residential avoids a loss of clarity in the analysis and interpretation. The data relating to the concentration index, interbank market interest rates; residential housing prices; families' and companies' indebtedness ratios and GDP were obtained from the European Central Bank, Thompson Reuters Datastream, BIS House Prices and EUROSTAT, respectively.

Tables 6 and 7 present the descriptive statistics of the variables employed in the estimation of the credit risk and profitability models.

Preliminary analysis per country shows that Spain, United Kingdom, and Ireland are the countries with the highest weights of residential mortgage loans in terms of total bank assets. This is not particularly surprising given the high house price appreciation observed prior to 2007 in these countries. Additionally, banks in these countries operated under less conservative credit policies (Martins et al. 2015). Further, these markets have some of the highest owner-occupancy rates in the EU-15. In contrast, markets such as Germany and Austria not only have more conservative lending practices (Martins et al. 2015) but also experienced far lower rates of house

[24]IAS14 (substituted by IFRS 8 on 1st January 2008) "Operating Segments" require companies to disclose the main operating segments. Given the importance of residential mortgage loans in the activity of the banks analysed, it is possible — by looking at the annual report and accounts — to calculate the amount of residential mortgage loans.

TABLE 6.

Descriptive Statistics

Variable	Mean	Median	Standard Deviation	Minimum	Maximum
NPL (%)	2.843	2.075	3.043	0	44.400
PROV (%)	0.662	0.366	0.834	−2.297	35.353
GDP (%)	2.001	2.000	1.469	−3.000	6.500
DFAM (%)	72.871	63.720	27.989	24.240	148.280
DEMP (%)	201.861	192.850	49.795	90.230	379.400
LOAN_TO_ASSETS	59.055	65.622	22.824	0.523	99.130
INEF (%)	62.783	61.900	30.818	0.000	254.050
SIZE (%)	2.281	0.231	6.472	0.000	58.183
NIM (%)	2.613	1.925	10.533	−2.870	13.230
ROA (%)	0.707	0.560	1.764	−6.045	10.245
EQUITY (%)	8.317	6.719	6.745	−0.465	94.552
PREM (%)	1.890	1.532	13.444	−5.269	12.992
LIQ (%)	84.894	76.719	5.400	0.000	320.084
SDR3M	0.411	0.351	0.127	0.023	0.888
HH	685.148	551.000	489.445	158.000	3160.000
IPP (%)	1.187	0.752	15.862	−6.972	2.820
LOAN (%)	14.612	1.111	13.044	−37.672	54.000
LTV (%)	90.919	85.000	16.835	60.000	112.000
RMSHARE (%)	30.943	28.088	21.234	0.000	99.443
RPPRICE (%)	4.841	5.615	6.590	−14.742	23.222

This table shows the descriptive statistics of the 555 European Banks in the period between 1999 and 2008. As proxies of the bank's credit risk (RISK) we used the ratio of non-performing loans and the total of loans (NPL) and the ratio of loan losses provisions and the total net loans (PROV); GDP is the real GDP growth; DFAM is the ratio between the liabilities of families and the GDP; DEMP is the ratio between the liabilities of firms and GDP; LOAN_TO_ASSETS is the ratio of total loans to total assets; INEF is the ratio of operating costs to gross income; SIZE is the ratio between bank assets i and the total bank assets; NIM is the net interest margin (gross margin) — one of the proxies for bank profitability; ROA is the return on assets (proxy for bank profitability); EQUITY is the ratio between the capital and total assets; PREM is obtained from the difference between interest income over total assets and the interbank interest rate; LIQ is the ratio net loans to short term funding; SDR3M is the annual standard deviation of the daily interbank 3 month interest rate; HH is the Herfindahl e Hirschman Index obtained via total assets on the domestic market (the ratio was obtained from the ECB and range between 0 and 10.000); IPP is the ratio non-interest expenses — non-interest revenues)/total assets; $\Delta LOAN$ is the loans growth rate; LTV is the average loan to value ratio in the country where the bank operates; RMSHARE is the weight of residential mortgage loans in the total bank assets; RPPRICE is the rate of growth in real terms of the residential housing market prices.

price appreciation and the weight of residential mortgage loans in terms of total assets is substantially lower (see table 1).

TABLE 7.

Descriptive Statistics by Country

	NPL (%)	PROV (%)	GDP (%)	DFAM (%)	DEMP (%)	LOAN_TO_ASSETS	INEF (%)	SIZE (%)	NIM (%)	ROA (%)
GER	2.748	0.441	1.172	69.159	169.207	0.479	72.971	0.893	6.573	0.207
	(2.88)	(3.30)	(1.03)	(3.89)	(9.50)	(0.235)	(32.29)	(2.42)	(35.66)	(3.53)
AUS	3.663	0.853	2.095	51.522	153.853	0.554	66.592	2.897	1.892	0.581
	(3.49)	(6.04)	(1.06)	(2.58)	(24.34)	(0.194)	(31.87)	(5.02)	(1.31)	(2.07)
BEL	1.102	0.210	1.927	43.030	240.480	0.420	64.568	11.991	1.749	0.734
	(1.85)	(0.62)	(0.95)	(4.01)	(31.89)	(0.201)	(18.93)	(17.98)	(1.56)	(0.91)
DEN	2.822	0.657	1.270	125.740	172.505	0.650	58.308	1.519	3.763	1.312
	(2.49)	(0.99)	(1.30)	(13.42)	(23.11)	(0.107)	(16.53)	(5.20)	(1.66)	(0.95)
SPA	2.122	0.494	3.107	74.136	200.300	0.679	60.184	1.413	2.305	0.796
	(2.02)	(0.28)	(0.91)	(12.19)	(29.65)	(0.150)	(31.06)	(4.01)	(0.81)	(0.98)
FIN	1.304	0.093	3.175	46.452	213.366	0.563	67.547	16.002	2.035	0.803
	(1.24)	(0.21)	(1.24)	(9.15)	(19.22)	(0.262)	(18.66)	(27.90)	(1.18)	(0.66)
FRA	2.006	0.467	1.647	55.712	205.644	0.586	63.525	1.203	1.950	0.920
	(1.91)	(2.00)	(0.69)	(5.80)	(25.19)	(0.259)	(28.63)	(3.59)	(1.37)	(2.16)
GRE	4.656	1.317	3.764	40.782	107.190	0.612	71.475	5.929	2.921	0.305
	(2.64)	(1.90)	(1.35)	(12.13)	(13.67)	(0.150)	(36.21)	(6.74)	(1.03)	(1.29)
NET	4.558	1.760	1.991	109.062	239.409	0.495	63.553	2.672	1.478	0.478
	(3.34)	(7.14)	(1.17)	(11.06)	(15.10)	(0.278)	(34.44)	(6.24)	(0.99)	(0.91)
IRL	1.848	0.244	4.509	82.717	278.896	0.527	63.505	2.584	1.256	0.771
	(1.76)	(0.57)	(3.02)	(21.04)	(26.49)	(0.249)	(18.39)	(3.24)	(0.77)	(1.18)
ITA	2.946	0.686	0.824	38.852	146.100	0.611	45.31	0.975	2.769	0.679
	(2.51)	(1.06)	(1.02)	(5.66)	(8.47)	(0.225)	(44.18)	(3.25)	(1.33)	(1.09)
LUX	2.528	0.123	3.927	55.554	317.992	0.308	54.415	4.723	0.959	0.680
	(2.36)	(0.038)	(2.18)	(5.84)	(34.70)	(0.163)	(23.10)	(4.38)	(0.53)	(0.66)
POR	3.221	0.750	0.879	93.025	241.243	0.583	61.305	4.184	2.477	0.753
	(2.77)	(0.90)	(0.90)	(9.41)	(9.30)	(0.229)	(13.80)	(5.75)	(1.30)	(0.81)
UK	1.649	0.384	2.329	97.738	253.201	0.662	62.985	0.682	1.997	0.769
	(2.07)	(1.40)	(0.75)	(10.08)	(19.79)	(0.203)	(17.88)	(1.71)	(1.82)	(1.34)
SWE	2.358	0.549	2.320	68.591	264.141	0.672	55.020	7.054	1.563	0.856
	(2.55)	(5.26)	(1.44)	(6.58)	(26.80)	(0.277)	(29.26)	(10.84)	(1.05)	(0.97)

This table shows the descriptive statistics: mean and standard deviation by countries, in the period between 1999 and 2008. As proxies of the bank's credit risk (RISK) we used the ratio of non-performing loans and the total of loans (NPL) and the ratio of loan losses provisions and the total net loans (PROV); GDP is the real GDP growth; DFAM is the ratio between the liabilities of families and the GDP; DEMP is the ratio between the liabilities of firms and GDP; LOAN_TO_ASSETS is the ratio of total loans to total assets; INEF is the ratio of operating costs to gross income; SIZE is the ratio between bank assets i and the total bank assets; NIM is the net interest margin (gross margin) — one of the proxies for bank profitability; ROA is the return on assets (proxy for bank profitability); The table reports the mean and standard deviation for each variable and country. The standard deviation comes in brackets.

TABLE 7—*Continued*

	EQUITY (%)	PREM (%)	LIQ (%)	SDR3M	HH	IPP (%)	$\Delta LOAN$ (%)	RMSHARE (%)	RPPRICE (%)
GER	6.581	2.350	70.603	0.295	174.75	2.423	7.221	20.032	0.318
	(8.92)	(5.29)	(5.45)	(0.17)	(9.85)	(36.1)	(57.8)	(17.0)	(0.70)
AUS	7.525	1.798	100.21	0.304	545.37	0.912	11.767	20.902	1.903
	(9.93)	(2.17)	(8.24)	(0.18)	(42.97)	(2.3)	(20.85)	(11.1)	(4.93)
BEL	5.279	2.132	59.634	0.299	1971.00	0.423	9.208	16.932	7.373
	(2.59)	(3.61)	(2.93)	(0.17)	(167.74)	(1.1)	(31.7)	(10.8)	(3.09)
DEN	11.917	2.021	133.24	0.301	1132.37	1.422	16.101	27.923	5.271
	(4.99)	(1.52)	(2.90)	(0.17)	(42.50)	(1.2)	(15.93)	(14.2)	(8.11)
SPA	7.907	1.175	92.96	1.100	496.00	1.323	31.239	35.623	7.472
	(3.56)	(1.11)	(3.13)	(1.18)	(34.12)	(5.2)	(29.53)	(15.2)	(6.14)
FIN	7.158	0.245	80.64	0.299	2547.50	0.523	15.329	29.734	5.510
	(2.89)	(1.34)	(3.84)	(0.18)	(316.47)	(1.2)	(51.7)	(21.2)	(8.20)
FRA	8.907	1.810	132.55	0.304	648.75	0.323	12.719	29.821	7.296
	(4.76)	(1.66)	(4.92)	(0.18)	(60.00)	(3.2)	(65.0)	(18.3)	(6.60)
GRE	8.715	2.303	72.56	0.296	1117.75	1.623	38.086	23.523	4.536
	(6.51)	(1.47)	(2.46)	(0.17)	(33.24)	(2.2)	(23.5)	(11.2)	(4.76)
NET	6.476	1.765	135.11	0.285	1841.75	0.523	36.167	24.232	2.568
	(3.55)	(3.39)	(2.35)	(0.16)	(136.60)	(1.2)	(54.8)	(23.2)	(1.05)
IRL	5.184	1.006	84.65	0.295	597.87	0.223	23.905	32.321	4.210
	(2.89)	(1.61)	(4.06)	(0.17)	(81.96)	(1.6)	(69.9)	(26.2)	(6.90)
ITA	9.978	1.823	120.23	0.295	265.25	1.723	25.373	26.823	5.188
	(6.24)	(3.36)	(9.46)	(0.17)	(43.86)	(13.1)	(63.3)	(15.2)	(2.01)
LUX	5.253	3.930	41.58	0.289	293.75	0.156	12.651	11.012	6.316
	(2.36)	(3.82)	(2.57)	(0.18)	(15.10)	(1.4)	(25.7)	(8.3)	(4.55)
POR	8.417	2.216	85.69	0.296	1073.75	0.934	22.206	26.121	−2.255
	(8.21)	(1.97)	(3.47)	(0.17)	(64.16)	(1.6)	(46.4)	(15.2)	(2.16)
UK	7.859	2.413	93.97	0.384	370.75	0.534	6.254	34.523	4.791
	(9.18)	(37.99)	(7.94)	(0.24)	(52.12)	(30.4)	(22.8)	(28.2)	(10.12)
SWE	8.460	0.951	179.31	0.346	845.25	0.223	23.940	31.623	5.618
	(8.69)	(1.35)	(2.14)	(0.16)	(67.58)	(3.2)	(62.2)	(26.9)	(4.11)

This table shows the descriptive statistics: mean and standard deviation by countries, in the period between 1999 and 2008. EQUITY is the ratio between the capital and total assets; PREM is obtained from the difference between interest income over total assets and the interbank interest rate; LIQ is the ratio net loans to short term funding; SDR3M is the annual standard deviation of the daily interbank 3 month interest rate; HH is the Herfindahl e Hirschman Index obtained via total assets on the domestic market (the ratio was obtained from the ECB and range between 0 and 10.000); IPP is the ratio (non-interest expenses − non-interest revenues)/total assets; $\Delta LOAN$ is the loans growth rate; RMSHARE is the weight of residential mortgage loans in the total bank assets; RPPRICE is the rate of growth in real terms of the residential housing market prices. The table reports the mean and standard deviation for each variable and country. The standard deviation comes in brackets.

4. RESULTS

4.1. Credit Risk Model

Table 8 (panel A and D) shows the results for the estimates of the credit risk model regression (4) — non-performing loans (NPL) and loan losses provisions (PROV), respectively. Panel B and E shows the estimated coefficients for relevant subsamples of banks. Panel C and F report the estimation results with a constrained sample up until 2006 and excluding investment banks. The results suggest that banks that increase their exposure to residential mortgage loans decrease credit risk. These findings are consistent with Pensala and Solttila (1993), Randall (1993), Murto (1994), Domowitz and Sartain (1999). The results also show that during the upturn in residential market prices cycle, a rise in residential mortgage lending leads to a decrease in bank credit risk. Davis and Zhu (2009) have also shown that commercial property prices are negatively associated with bad loans ratios.

Martins et al. (2016) argue that due to the accentuated process of bank internationalisation and integration at a regional and international level, real estate assets tend to be related with regional or international residential prices. The authors therefore suggest the use of regional or international indices of residential housing prices as a proxy for the real estate risk factor. Regression VI in table 8 (panel A and D) assesses the effects of altering the proxy associated with residential property prices in the case of banks whose exposure to real estate is at a regional or international scale[25]. The results reveal that an increase in the weight of residential mortgage loans in total assets leads to a greater decrease in credit risk.

Despite the possibility of "disaster myopia", whereby the quality of bank assets may deteriorate without the banks being aware that they are accepting a higher risk level, Laeven and Majnoni (2003) state that there tends to be a policy of delaying the recognition of loan loss provisions until after property prices have reserved. This being the case, the relationship between residential mortgage loans and credit risk tends to be only recognized in bank balance sheets a posteriori, namely during a collapse in residential property prices. Therefore, these results must be taken with caution and in this context.

[25] Martins et al. (2016) consider that a bank is exposed to the real estate market at a regional level when its assets portfolio associated with the real estate sector on the international market represents 40% or more. In order to measure the geographical exposure to the real estate sector, they analyze the banks' annual reports and accounts, namely the primary and secondary segment reporting, which banks are obliged to disclose in accordance with IAS 14 and IFRS 8.

TABLE 8.

Determinants of Banks' Risk: Dynamic Panel Analysis

Panel A: Total Sample and Bank's Risk Proxy: Non-Performing Loans (NPL)

Variables	I	II	III	IV	V	VI
NPL_{it-1}	0.0768^{c} (1.75)	0.0765^{c} (1.73)	0.0801^{c} (1.81)	0.1915^{a} (3.06)	0.2229^{a} (3.89)	0.1063^{c} (1.98)
GDP_t	-0.0464^{a} (−4.27)	-0.0463^{a} (−4.25)	-0.0624^{a} (−5.11)	-0.0311^{a} (−3.30)	-0.0582^{a} (−8.73)	-0.0526^{a} (−4.46)
GDP_{t-1}	-0.0373^{a} (−3.60)	-0.0373^{a} (−3.59)	-0.0371^{a} (−3.38)	-0.0280^{a} (−3.01)	-0.0335^{a} (−6.29)	-0.0425^{a} (−4.02)
$DFAM_t$	0.0066^{b} (2.04)	0.0066^{b} (2.02)	0.0091^{a} (2.86)	0.0107^{a} (3.66)	0.0103^{a} (3.45)	0.0068^{b} (1.99)
$DEMP_t$	0.0006 (1.08)	0.0006 (1.04)	0.0006 (1.03)	-0.0010^{a} (−2.88)	-0.0008^{a} (−4.17)	0.0006 (0.98)
LOAN_TO_ASSETS$_{it-1}$	0.1099^{b} (2.63)	0.1058^{b} (2.52)	0.1285^{a} (2.88)	0.3573^{a} (2.91)	0.3992^{a} (2.87)	0.1049^{c} (1.87)
LOAN_TO_ASSETS$_{it-2}$	0.0790 (0.68)	0.0782 (0.68)	0.0637 (0.47)	-0.3213^{b} (−2.26)	-0.3235^{b} (−2.17)	−0.0285 (−0.29)
LOAN_TO_ASSETS$_{it-3}$	0.1001 (0.63)	0.64)0.1001 (	0.0777 (0.45)	0.1009 (0.99)	0.0743 (0.72)	0.0468 (0.31)
$INEF_{it}$	0.0006 (1.13)	0.0006 (1.13)	0.0008 (1.57)	0.0006 (1.24)	0.0003 (0.82)	0.0006 (1.02)
$SIZE_{it}$	-2.7257^{a} (−3.63)	-2.7249^{a} (−3.62)	-3.1320^{a} (−4.92)	-2.2740^{a} (−3.07)	-2.2731^{a} (−3.08)	-2.4447^{a} (−3.89)
NIM_{it-2}	0.0019^{b} (2.46)	0.0019^{b} (2.46)	0.0017^{c} (1.80)	0.0020^{a} (3.78)	0.0017^{a} (3.18)	0.0017^{c} (1.87)
NIM_{it-3}	−0.0055 (−1.36)	−0.0055 (−1.35)	−0.0053 (−1.21)	−0.0014 (−1.01)	−0.0011 (−0.90)	−0.0062 (−1.39)
$EQUITY_{it-2}$	0.3347 (0.80)	0.3324 (0.79)	0.4216 (0.99)	−0.1399 (−0.46)	−0.1755 (−0.54)	0.2768 (0.64)
$EQUITY_{it-3}$	0.4914 (1.24)	0.4939 (1.24)	0.6149 (1.43)	−0.0878 (−0.32)	−0.1335 (−0.46)	0.4805 (1.19)
$PREM_{it-3}$	0.0347 (1.52)	0.0347 (1.51)	0.0326 (1.28)	0.0096 (0.52)	0.0036 (0.58)	0.0357 (1.54)
RMSHARE$_{it}$	-1.4450^{a} (−5.45)	-1.4388^{a} (−5.41)		-0.8446^{a} (−5.38)		-1.5299^{a} (−5.85)
RPPRICE$_{t-1}$			-0.0524^{c} (−1.90)		-0.0041^{c} (−1.86)	
RMSHARE$_{it}$*RPPRICE$_{t-1}$		-0.0086^{a} (−2.86)	-0.0094^{c} (−1.94)	-0.0093^{a} (−3.58)	-0.0156^{a} (−3.31)	-0.0067^{a} (−2.75)
LTV$_t$				0.1028^{b} (1.99)	0.1022^{c} (1.74)	
Time Period	1999-2008	1999-2008	1999-2008	1999-2008	1999-2008	1999-2008
# Observations	4540	4540	4540	4540	4540	4540
Sargan Test (p-value)	0.270	0.265	0.291	0.273	0.268	0.271
AR (1) and p-value	-3.0^{a} (0.00)	-2.8^{a} (0.00)	-2.9^{a} (0.00)	-2.8^{a} (0.00)	-2.0^{b} (0.04)	-2.0^{b} (0.04)
AR (2) and p-value	−0.4 (0.77)	0.4 (0.79)	−1.2 (0.25)	−0.6 (0.61)	−1.1 (0.29)	−1.0 (0.26)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

This table reports the estimation results of six regressions based on equation (4). The dependent variable NPL is the ratio of non-performing loans and the total of loans and is used as a proxy of the bank's credit risk (RISK). This variable appears transformed (dependent variable $\ln(RISK_{it}/(1-RISK_{it}))$. GDP is the real GDP growth; DFAM is the ratio between the liabilities of families and the GDP; DEMP is the ratio between the liabilities of firms and GDP; LOAN_TO_ASSETS is the ratio of total loans to total assets; INEF is the ratio of operating costs to gross income; SIZE is the ratio between bank assets i and the total bank assets; NIM is the proxy for bank profitability measured by net interest margin (gross margin); EQUITY is the ratio between the capital and total assets; PREM is obtained from the difference between interest income over total assets and the interbank interest rate; RMSHARE is the weight of residential mortgage loans in the total bank assets; RPPRICE is the rate of growth in real terms of the residential housing market prices (or region, in the case of regression VI, for banks with regional or international exposure to the housing market). LTV is the average loan to value ratio in the country where the bank operates. We use the Dynamic Panel Analysis (Arellano and Bond, 1991) and GMM estimation procedure. t statistics are presented in brackets. ^{a}, ^{b} and ^{c} denote statistical significance at 1%, 5% and 10%, respectively.

TABLE 8—*Continued*

Panel B: Subsamples and Bank's Risk Proxy: Non-Performing Loans (NPL)

Variables	VII	VIII	IX	X
NPL_{it-1}	0.0382^{b} (2.35)	0.2002^{a} (8.33)	0.1481^{b} (2.27)	0.3947^{a} (16.30)
GDP_t	-0.0363^{c} (-1.87)	-0.1561^{a} (-2.78)	-0.0469^{a} (-2.63)	-0.0212^{b} (-2.54)
GDP_{t-1}	-0.0382^{b} (-2.47)	-0.0042 (-0.28)	-0.0576^{a} (-3.03)	-0.0067 (-0.84)
$DFAM_t$	0.0180^{a} (3.56)	0.0098^{b} (2.42)	0.0131^{c} (1.89)	0.0045^{b} (2.10)
$DEMP_t$	-0.0015 (-0.55)	-0.0003 (-0.27)	-0.0006 (-0.60)	-0.0011^{c} (-1.77)
LOAN_TO_ASSETS$_{it-1}$	0.2559^{c} (1.70)	0.8617^{a} (4.44)	0.4921^{c} (1.97)	0.5146^{a} (3.54)
LOAN_TO_ASSETS$_{it-2}$	-0.2329^{c} (-1.69)	0.0513 (0.32)	-0.1375 (-0.87)	0.1755 (0.93)
LOAN_TO_ASSETS$_{it-3}$	-0.0506 (-0.32)	0.0314 (0.14)	0.0425 (0.16)	0.3257^{c} (1.72)
$INEF_{it}$	0.0023^{a} (3.63)	0.0002 (0.24)	0.0011 (1.56)	0.0031^{b} (2.30)
$SIZE_{it}$	-7.9962^{a} (-4.69)	-3.1020^{b} (-2.02)	-4.8550^{c} (-1.68)	-8.3614^{c} (-1.67)
NIM_{it-2}	0.0007 (1.54)	0.0700^{b} (2.23)	0.0013^{c} (1.67)	0.0458 (1.31)
NIM_{it-3}	-0.0011 (-1.48)	0.0647^{a} (3.05)	-0.0031 (-1.36)	-0.0068 (-0.18)
$EQUITY_{it-2}$	0.8039^{c} (1.98)	0.4614 (0.59)	0.2544 (0.57)	-0.7931 (-1.55)
$EQUITY_{it-3}$	-0.6370^{a} (-2.94)	-1.1641 (-1.57)	0.2221 (0.52)	-0.8719 (-1.52)
$PREM_{it-3}$	0.0078^{c} (1.77)	-0.0045 (-0.34)	0.0249^{c} (1.86)	0.0129 (1.26)
RMSHARE$_{it}$	-9.7012^{a} (-3.35)	3.0927^{b} (2.11)	-15.4566^{a} (-2.59)	0.7686 (0.45)
RMSHARE$_{it}$*RPPRICE$_{t-1}$	0.0309^{c} (1.84)	-0.0120^{a} (-3.78)	-0.0385^{b} (-2.03)	-0.0041^{b} (-2.04)
Time Period	1999-2008	1999-2008	1999-2008	1999-2008
# Observations	688	1273	1011	1081
Sargan Test (p-value)	0.185	0.144	0.370	0.188
AR (1) and p-value	-5.0^{a} (0.00)	-2.6^{a} (0.00)	-2.8^{a} (0.00)	-3.3^{a} (0.00)
AR (2) and p-value	-0.3 (0.74)	0.2 (0.81)	0.3 (0.73)	-0.2 (0.83)
Bank Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes

This table reports the estimation results of four regressions based on equation (4), for subsamples. We use the Dynamic Panel Analysis (Arellano and Bond, 1991) and GMM procedure. The dependent variable NPL is the ratio of non-performing loans and the total of loans and is used as a proxy of the bank's credit risk (RISK). This variable appears transformed (dependent variable $\ln(RISK_{it}/(1-RISK_{it}))$. GDP is the real GDP growth; DFAM is the ratio between the liabilities of families and the GDP; DEMP is the ratio between the liabilities of firms and GDP; LOAN_TO_ASSETS is the ratio of total loans to total assets; INEF is the ratio of operating costs to gross income; SIZE is the ratio between bank assets i and the total bank assets; NIM is the proxy for bank profitability measured by net interest margin (gross margin); EQUITY is the ratio between the capital and total assets; PREM is obtained from the difference between interest income over total assets and the interbank interest rate; RMSHARE is the weight of residential mortgage loans in the total bank assets; RPPRICE is the rate of growth in real terms of the domestic residential housing market prices.
Regression VII includes the banks of Germany and Austria. Regression VIII includes de banks of Spain, Ireland and UK. Regressions IX and X are estimated for the first quartile and fourth quartile, according to the weight of residential mortgage loans in total loans, respectively. t statistics are presented in brackets. ^{a}, ^{b} and ^{c} denote statistical significance at 1%, 5% and 10%, respectively.

TABLE 8—*Continued*

Panel C: Total Sample without Investment Banks for Pre-Crisis Period and Bank's Risk Proxy: Non-Performing Loans (NPL)

Variables	XI	XII	XIII	XIV	XV	XVI
NPL_{it-1}	0.1099^{c} (1.70)	0.1099^{c} (1.70)	0.1068^{c} (1.67)	0.1999^{a} (3.84)	0.1993^{a} (3.73)	0.1936^{a} (3.67)
GDP_t	-0.0353^{a} (−3.35)	-0.0354^{a} (−3.35)	-0.0364^{a} (−3.34)	-0.0222^{a} (−3.84)	-0.0231^{a} (−3.99)	-0.0227^{a} (−4.01)
GDP_{t-1}	-0.0350^{a} (−3.09)	-0.0351^{a} (−3.09)	-0.0338^{a} (−2.94)	-0.0212^{a} (−3.86)	-0.0204^{a} (−3.69)	-0.0185^{a} (−3.39)
$DFAM_t$	0.0093^{b} (1.99)	0.0090^{b} (2.02)	0.0076^{a} (2.92)	0.0011^{a} (4.66)	0.0011^{a} (4.76)	0.0006^{b} (2.34)
$DEMP_t$	-0.0006^{c} (−1.67)	-0.0006^{c} (−1.73)	-0.0006^{c} (−1.80)	-0.0007^{a} (−3.25)	-0.0006^{a} (−2.78)	-0.0007^{a} (3.07)
$LOAN\_TO\_ASSETS_{it-1}$	0.4225^{b} (2.30)	0.4227^{b} (2.31)	0.4138^{b} (2.22)	0.5169^{a} (3.86)	0.4558^{a} (3.35)	0.4442^{a} (3.22)
$LOAN\_TO\_ASSETS_{it-2}$	0.1276 (0.25)	0.1266 (0.24)	0.1091 (0.21)	-0.4741^{b} (−2.37)	-0.4741^{b} (−2.40)	-0.4410^{b} (−2.29)
$LOAN\_TO\_ASSETS_{it-3}$	0.1049 (0.84)	0.1044 (0.84)	0.0727 (0.59)	0.1346 (0.93)	0.1047 (0.73)	0.1728 (1.22)
$INEF_{it}$	−0.0001 (−0,11)	−0.0002 (−0.12)	0.0000 (0.01)	0.0004 (0.72)	0.0004 (0.72)	0.0006 (0.97)
$SIZE_{it}$	-2.6363^{a} (−3.79)	-2.6336^{a} (−3.80)	-2.6109^{a} (−4.47)	-2.0914^{a} (−2.67)	-2.0814^{a} (−2,97)	-2.1931^{a} (−2.92)
NIM_{it-2}	0.0028^{a} (3.49)	0.0028^{a} (3.49)	0.0028^{a} (3.39)	0.0015^{a} (3.21)	0.0015^{a} (3.08)	0.0018^{a} (3.87)
NIM_{it-3}	−0.0050 (−1.25)	−0.0050 (−1.15)	−0.0050 (−1.15)	−0.0006 (−0.39)	−0.0009 (−0.65)	−0.0007 (−0.44)
$EQUITY_{it-2}$	0.7584 (1.21)	0.7560 (1.24)	0.8269 (1.33)	0.0080 (0.020)	0.1518 (0.38)	0.2049 (0.53)
$EQUITY_{it-3}$	0.4927 (1.17)	0.4926 (1.37)	0.4728 (1.31)	−0.2553 (−0.67)	−0.2966 (−0.76)	−0.4007 (−1.13)
$PREM_{it-3}$	0.0341 (1.35)	0.0341 (1.34)	0.0343 (1.34)	−0.0041 (−0.57)	−0.0016 (−0.23)	−0.0009 (−0.11)
$\mathbf{RMSHARE}_{it}$	-1.0517^{a} (−3.66)	-1.0561^{a} (−3.64)		-1.2469^{a} (−3.67)		-1.3366^{a} (−4.51)
$\mathbf{RPPRICE}_{t-1}$			-0.0626^{c} (−1.78)		-0.0040^{c} (−1.79)	
$\mathbf{RMSHARE}_{it}$*$\mathbf{RPPRICE}_{t-1}$		-0.0061^{a} (−3.29)	-0.0021^{c} (−1.81)	-0.0133^{a} (−4.66)	-0.0114^{b} (−2.00)	-0.0041^{b} (−2.14)
$\mathbf{LTV}_t$				0.2696^{a} (4.42)	0.2618^{a} (4.19)	
Time Period	1999-2006	1999-2006	1999-2006	1999-2006	1999-2006	1999-2006
# Observations	3297	3297	3297	3297	3297	3297
Sargan Test (p-value)	0.235	0.245	0.267	0.289	0.278	0.253
AR (1) and p-value	-3.3^{a} (0.00)	-2.9^{a} (0.00)	-2.7^{a} (0.00)	-2.8^{a} (0.00)	-2.1^{b} (0.03)	-2.0^{b} (0.04)
AR (2) and p-value	−0.4 (0.75)	0.4 (0.80)	−1.3 (0.20)	−0.5 (0.67)	−1.1 (0.29)	−0.9 (0.21)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

This table reports the estimation results of six regressions based on equation (4) for the total sample without investment banks and a period until 2006 (pre-crisis time). The dependent variable NPL is the ratio non-performing loans and the total of loans and is used as a proxy of the bank's credit risk (RISK). This variable appears transformed (dependent variable $\ln(RISK_{it}/(1-RISK_{it}))$. GDP is the real GDP growth; DFAM is the ratio between the liabilities of families and the GDP; DEMP is the ratio between the liabilities of firms and GDP; LOAN_TO_ASSETS is the ratio of total loans to total assets; INEF is the ratio of operating costs to gross income; SIZE is the ratio between bank assets i and the total bank assets; NIM is the proxy for bank profitability measured by net interest margin (gross margin); EQUITY is the ratio between the capital and total assets; PREM is obtained from the difference between interest income over total assets and the interbank interest rate; RMSHARE is the weight of residential mortgage loans in the total bank assets; RPPRICE is the rate of growth in real terms of the residential housing market prices (or region, in the case of regression XVI, for banks with regional or international exposure to the housing market). LTV is the average loan to value ratio in the country where the bank operates. We use the Dynamic Panel Analysis (Arellano and Bond, 1991) and GMM estimation procedure. t statistics are presented in brackets. ^{a}, ^{b} and ^{c} denote statistical significance at 1%, 5% and 10%, respectively.

TABLE 8—*Continued*

Panel D: Total Sample and Bank's Risk Proxy: Loan Losses Provisions (PROV)

Variables	I	II	III	IV	V	VI
$PROV_{it-1}$	-0.3599^{a}	-0.3610^{a}	-0.3598^{a}	-0.3736^{a}	-0.3746^{a}	-0.3590^{a}
	(-4.32)	(-4.40)	(-4.11)	(-4.20)	(-4.33)	(-4.42)
GDP_t	-0.0982^{a}	-0.0933^{a}	-0.0899^{a}	-0.1228^{a}	-0.1233^{a}	-0.0980^{a}
	(-5.94)	(-5.62)	(-5.40)	(-9.17)	(-9.32)	(-3.89)
GDP_{t-1}	-0.0778^{a}	-0.0739^{a}	-0.0699^{a}	-0.0282^{b}	-0.0276^{b}	-0.0777^{a}
	(-4.48)	(-4.25)	(-3.99)	(-2.01)	(-2.02)	(-3.77)
$DFAM_t$	0.0032^{b}	0.0036^{b}	0.0043^{c}	0.0172^{a}	0.0181^{a}	0.0033^{c}
	(1.97)	(1.99)	(1.76)	(2.85)	(2.99)	(1.79)
$DEMP_t$	-0.0013	-0.0011	-0.0009	-0.0014	-0.0010	-0.0012
	(-1.47)	(-1.26)	(1.03)	(-1.59)	(-1.22)	(-0.99)
$LOAN\_TO\_ASSETS_{it-1}$	0.3047^{c}	0.3084^{c}	0.3373^{c}	0.2090^{c}	0.2539^{c}	0.3035^{c}
	(1.75)	(1.82)	(1.88)	(1.68)	(1.77)	(1.84)
$LOAN\_TO\_ASSETS_{it-2}$	0.0389	0.0693	0.0643	0.2795	0.2472	0.0376
	(0.18)	(0.31)	(0.29)	(1.16)	(1.03)	(0.15)
$LOAN\_TO\_ASSETS_{it-3}$	-0.0297	-0.0567	-0.0901	0.0884	0.0349	-0.0291
	(-0.13)	(-0.24)	(-0.38)	(0.34)	(0.89)	(-0.11)
$INEF_{it}$	0.0014	0.0006	0.0004	0.0005	0.0003	0.0004
	(1.34)	(1.12)	(1.14)	(0.32)	(0.20)	(0.33)
$SIZE_{it}$	-0.4494	-0.4795	-0.5606	-0.5555	-0.6260	-0.4482
	(-0.54)	(-0.65)	(-0.76)	(-1.05)	(-1.17)	(-0.84)
NIM_{it-2}	0.0017^{b}	0.0017^{b}	0.0017^{b}	0.0033^{a}	0.0038^{a}	0.0017^{c}
	(2.57)	(2.52)	(2.48)	(2.85)	(2.73)	(1.90)
NIM_{it-3}	-0.0019	-0.0023	-0.0026	-0.0003	-0.0007	-0.0019
	(-0.57)	(-0.68)	(-0.77)	(-0.27)	(-0.52)	(-0.64)
$EQUITY_{it-2}$	-1.2752^{b}	-1.2256^{c}	-1.1785^{c}	-1.1552^{c}	-0.9985^{c}	-1.2767^{c}
	(-1.99)	(-1.91)	(-1.84)	(-1.75)	(-1.77)	(-1.69)
$EQUITY_{it-3}$	0.3475	0.3259	0.2797	-0.0137	-0.0350	0.3496
	(0.55)	(0.53)	(0.45)	(-0.13)	(-0.34)	(0.39)
$PREM_{it-3}$	0.0116	0.0133	0.0145^{c}	0.0063^{b}	0.0064^{b}	0.0116^{c}
	(1.32)	(1.51)	(1.65)	(1.99)	(2.22)	(1.72)
$\mathbf{RMSHARE}_{it}$	-0.6104^{a}	-0.5113^{a}		-0.3958^{a}		-0.6062^{a}
	(-3.69)	(-3.41)		(-2.89)		(-2.85)
$\mathbf{RPPRICE}_{t-1}$			-0.0134^{c}		-0.0179^{a}	
			(-2.68)		(-3.23)	
$\mathbf{RMSHARE}_{it}$*$\mathbf{RPPRICE}_{t-1}$		-0.0180^{a}	-0.0062^{c}	-0.0338^{a}	-0.0070^{b}	-0.0055^{b}
		(-2.60)	(-1.79)	(-4.69)	(-2.23)	(-2.16)
$\mathbf{LTV}_t$				0.0211^{b}	0.0288^{c}	
				(2.11)	(1.99)	
Time Period	1999-2008	1999-2008	1999-2008	1999-2008	1999-2008	1999-2008
# Observations	4540	4540	4540	4540	4540	4540
Sargan Test (p-value)	0.144	0.169	0.211	0.244	0.268	0.271
AR (1) and p-value	-2.6^{a} (0.00)	-2.7^{a} (0.00)	-2.8^{a} (0.00)	-2.9^{a} (0.00)	-2.7^{a} (0.00)	-2.5^{a} (0.00)
AR (2) and p-value	-0.2 (0.81)	0.4 (0.79)	-1.3 (0.20)	-0.5 (0.67)	-1.0 (0.36)	-1.0 (0.26)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

This table reports the estimation results of six regressions based on equation (4). The dependent variable PROV is the ratio of loan losses provisions and the total of net loans and is used as a proxy of the bank's credit risk (RISK). This variable appears transformed (dependent variable $\ln(RISK_{it}/(1-RISK_{it}))$. GDP is the real GDP growth; DFAM is the ratio between the liabilities of families and the GDP; DEMP is the ratio between the liabilities of firms and GDP; LOAN_TO_ASSETS is the ratio of total loans to total assets; INEF is the ratio of operating costs to gross income; SIZE is the ratio between bank assets i and the total bank assets; NIM is the proxy for bank profitability measured by net interest margin (gross margin); EQUITY is the ratio between the capital and total assets; PREM is obtained from the difference between interest income over total assets and the interbank interest rate; RMSHARE is the weight of residential mortgage loans in the total bank assets; RPPRICE is the rate of growth in real terms of the residential housing market prices (or region, in the case of regression VI, for banks with regional or international exposure to the housing market). LTV is the average loan to value ratio in the country where the bank operates. We use the Dynamic Panel Analysis (Arellano and Bond, 1991) and GMM estimation procedure. t statistics are presented in brackets. ^{a}, ^{b} and ^{c} denote statistical significance at 1%, 5% and 10%, respectively.

TABLE 8—*Continued*

Panel E: Subsamples and Bank's Risk Proxy: Loan Losses Provisions (PROV)

Variables	VII	VIII	IX	X
$PROV_{it-1}$	-0.3767^{a} (−9.48)	-0.6177^{a} (−7.33)	-0.4425^{a} (−8.99)	-0.3571^{a} (−10.46)
GDP_t	-0.0583^{b} (−2.09)	-0.2285^{a} (−10.43)	-0.1316^{a} (−4.66)	-0.1613^{a} (−7.74)
GDP_{t-1}	-0.0610^{b} (−2.19)	−0.0366 (−1.20)	−0.0293 (−0.75)	−0.0297 (−1.10)
$DFAM_t$	0.0109^{a} (2.86)	0.0093^{b} (2.09)	0.0235^{b} (2.18)	0.0108^{c} (1.82)
$DEMP_t$	−0.0025 (−0.81)	0.0006 (0.44)	-0.0053^{a} (−2.90)	0.0016 (1.28)
$LOAN\_TO\_ASSETS_{it-1}$	0.9857^{b} (2.34)	1.1974^{b} (2.53)	0.8375^{c} (1.77)	1.6597^{b} (2.32)
$LOAN\_TO\_ASSETS_{it-2}$	0.3235 (0.84)	−0.0028 (−0.01)	0.2999 (0.75)	0.4773 (0.64)
$LOAN\_TO\_ASSETS_{it-3}$	0.0868 (0.18)	−0.3137 (−0.71)	−0.2414 (−0.49)	1.2307^{b} (1.99)
$INEF_{it}$	0.0055^{c} (1.91)	−0.0011 (−0.46)	-0.0034^{c} (−1.86)	0.0106^{a} (3.05)
$SIZE_{it}$	−0.9575 (−0.42)	-2.2527^{b} (−2.11)	-6.9324^{c} (−1.87)	1.1485 (0.86)
NIM_{it-2}	0.0009 (0.64)	0.0700^{b} (2.23)	0.0031^{c} (1.72)	0.0692 (0.91)
NIM_{it-3}	0.0012 (0.60)	0.0647^{a} (3.05)	−0.0004 (−0.11)	−0.0293 (−0.44)
$EQUITY_{it-2}$	2.8718^{b} (2.31)	−1.1718 (−0.93)	−0.8191 (−0.76)	−0.1088 (−0.90)
$EQUITY_{it-3}$	−0.4308 (−0.29)	-3.8491^{b} (−2.52)	2.2014^{c} (1.89)	0.9004 (0.65)
$PREM_{it-3}$	0.0064^{a} (2.77)	0.0045^{b} (2.09)	0.0019 (0.80)	0.0608^{b} (2.23)
$\mathbf{RMSHARE}_{it}$	-3.9286^{a} (−3.02)	2.2963^{b} (2.05)	-7.1398^{a} (−3.17)	0.7762 (0.48)
$\mathbf{RMSHARE}_{it}$*$\mathbf{RPPRICE}_{t-1}$	1.71)0.0239^{c} (	-0.0259^{a} (−3.47)	-0.1232^{b} (−2.06)	-0.0285^{a} (−3.79)
Time Period	1999-2008	1999-2008	1999-2008	1999-2008
# Observations	688	1273	1011	1081
Sargan Test (p-value)	0.176	0.137	0.370	0.168
AR (1) and p-value	-4.6^{a} (0.00)	-2.5^{a} (0.00)	-2.7^{a} (0.00)	-3.0^{a} (0.00)
AR (2) and p-value	−0.3 (0.72)	0.2 (0.79)	0.3 (0.71)	−0.2 (0.80)
Bank Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes

This table reports the estimation results of four regressions based on equation (4), for subsamples. We use the Dynamic Panel Analysis (Arellano and Bond, 1991) and GMM procedure. The dependent variable PROV is the ratio of loan losses provisions and the total net loans (PROV) and is used as a proxy of the bank's credit risk (RISK). This variable appears transformed (dependent variable $\ln(RISK_{it}/(1-RISK_{it}))$. GDP is the real GDP growth; DFAM is the ratio between the liabilities of families and the GDP; DEMP is the ratio between the liabilities of firms and GDP; LOAN_TO_ASSETS is the ratio of total loans to total assets; INEF is the ratio of operating costs to gross income; SIZE is the ratio between bank assets i and the total bank assets; NIM is the proxy for bank profitability measured by net interest margin (gross margin); EQUITY is the ratio between the capital and total assets; PREM is obtained from the difference between interest income over total assets and the interbank interest rate; RMSHARE is the weight of residential mortgage loans in the total bank assets; RPPRICE is the rate of growth in real terms of the domestic residential housing market prices.

Regression VII includes the banks of Germany and Austria. Regression VIII includes de banks of Spain, Ireland and UK. Regressions IX and X are estimated for the first quartile and fourth quartile, according to the weight of residential mortgage loans in total loans, respectively. t statistics are presented in brackets. ^{a}, ^{b} and ^{c} denote statistical significance at 1%, 5% and 10%, respectively.

TABLE 8—*Continued*

Panel F: Total Sample without Investment Banks for Pre-Crisis Period and Bank's Risk Proxy: Loan Losses Provisions (PROV)

Variables	XI	XII	XIII	XIV	XV	XVI
$RISK_{it-1}$	-0.3494^{a} (−12.03)	-0.3517^{a} (−12.06)	-0.3515^{a} (−12.01)	-0.3647^{a} (−12.61)	-0.3648^{a} (−12.60)	-0.3498^{a} (−12.08)
GDP_t	-0.0432^{c} (−1.82)	-0.0400^{c} (−1.68)	-0.0374^{c} (−1.77)	-0.0180^{c} (−1.76)	-0.0131^{c} (−1.69)	-0.0421^{c} (−1.77)
GDP_{t-1}	−0.0264 (−1.26)	−0.0248 (−1.16)	−0.0223 (−1.05)	−0.0053 (−0.24)	−0.0014 (−0.07)	−0.0265 (−1.25)
$DFAM_t$	0.0113^{c} (1.83)	0.0117^{c} (1.88)	0.0118^{c} (1.90)	0.0288^{a} (4.16)	0.0293^{a} (4.16)	0.0112^{c} (1.80)
$DEMP_t$	−0.0003 (−0.21)	0.0001 (0.12)	0.0004 (0.28)	−0.0010 (−0.86)	−0.0008 (−0.63)	−0.0003 (−0.24)
$LOAN\_TO\_ASSETS_{it-1}$	0.7179^{b} (2.22)	0.7332^{b} (2.28)	0.7719^{b} (2.38)	0.7076^{b} (2.16)	0.7533^{b} (2.27)	0.7233^{b} (2.24)
$LOAN\_TO\_ASSETS_{it-2}$	0.1767 (0.53)	0.2106 (0.64)	0.1933 (0.57)	0.2700 (0.85)	0.2567 (0.79)	0.1703 (0.51)
$LOAN\_TO\_ASSETS_{it-3}$	0.3995 (1.10)	0.3599 (0.99)	0.3042 (0.82)	0.2704 (0.75)	0.1951 (0.53)	0.4000 (0.27)
$INEF_{it}$	-0.0033^{c} (−1.82)	-0.0032^{c} (−1.72)	-0.0031^{c} (−1.69)	−0.0029 (−1.58)	−0.0028 (−1.55)	-0.0033^{c} (−1.81)
$SIZE_{it}$	-0.9589^{c} (−1.82)	-0.9928^{c} (−1.90)	-1.0517^{c} (−1.66)	-1.1704^{c} (−1.75)	-1.2817^{c} (−1.83)	-0.9492^{c} (−1.69)
NIM_{it-2}	0.0030^{a} (2.65)	0.0029^{a} (2.61)	0.0029^{b} (2.46)	0.0022^{b} (1.99)	0.0021^{c} (1.83)	0.0030^{a} (2.65)
NIM_{it-3}	−0.0021 (−0.64)	−0.0026 (−0.81)	−0.0029 (−0.91)	−0.0026 (−0.78)	−0.0031 (−0.91)	−0.0021 (−0.65)
$EQUITY_{it-2}$	−0.9778 (−0.91)	−0.8817 (−0.81)	−0.8447 (−0.76)	−1.2976 (−1.27)	−1.2435 (−1.20)	−0.9859 (−0.91)
$EQUITY_{it-3}$	1.4028 (1.39)	1.3657 (1.35)	1.3122 (1.28)	1.3151 (1.33)	1.2458 (1.24)	1.4099 (1.39)
$PREM_{it-3}$	0.0123 (0.65)	0.0147 (0.79)	0.0159 (0.85)	0.0140 (0.73)	0.0158 (0.82)	0.0126 (0.67)
$\mathbf{RMSHARE}_{it}$	-0.7202^{a} (−3.01)	-0.6198^{a} (−2.89)		-0.6134^{a} (−2.78)		-0.7029^{a} (−3.25)
$\mathbf{RPPRICE}_{t-1}$			-0.0102^{b} (−1.97)		-0.0144^{a} (−2.74)	
$\mathbf{RMSHARE}_{it}$*$\mathbf{RPPRICE}_{t-1}$		-0.0177^{a} (−2.67)	-0.0019^{c} (−1.85)	-0.0272^{a} (−3.83)	-0.0022^{c} (−1.83)	-0.0035^{c} (−1.77)
$\mathbf{LTV}_t$				0.1883^{a} (4.37)	0.1938^{a} (4.44)	
Time Period	1999-2006	1999-2006	1999-2006	1999-2006	1999-2006	1999-2006
# Observations	3297	3297	3297	3297	3297	3297
Sargan Test (p-value)	0.199	0.201	0.227	0.275	0.233	0.253
AR (1) and p-value	-3.0^{a} (0.00)	-2.7^{a} (0.00)	-2.5^{a} (0.00)	-2.9^{a} (0.00)	-2.0^{b} (0.04)	
AR (2) and p-value	0.4 (0.77)	0.5 (0.60)	−1.1 (0.29)	−1.2 (0.25)	−1.1 (0.27)	−0.9 (0.18)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

This table reports the estimation results of six regressions based on equation (4) for the total sample without investment banks and a period until 2006 (pre-crisis time). The dependent variable PROV is the ratio of loan losses provisions and the total net loans (PROV) and is used as a proxy of the bank's credit risk (RISK). This variable appears transformed (dependent variable $\ln(RISK_{it}/(1-RISK_{it}))$. GDP is the real GDP growth; DFAM is the ratio between the liabilities of families and the GDP; DEMP is the ratio between the liabilities of firms and GDP; LOAN_TO_ASSETS is the ratio of total loans to total assets; INEF is the ratio of operating costs to gross income; SIZE is the ratio between bank assets i and the total bank assets; NIM is the proxy for bank profitability measured by net interest margin (gross margin); EQUITY is the ratio between the capital and total assets; PREM is obtained from the difference between interest income over total assets and the interbank interest rate; RMSHARE is the weight of residential mortgage loans in the total bank assets; RPPRICE is the rate of growth in real terms of the residential housing market prices (or region, in the case of regression XVI, for banks with regional or international exposure to the housing market). LTV is the average loan to value ratio in the country where the bank operates. We use the Dynamic Panel Analysis (Arellano and Bond, 1991) and GMM estimation procedure. t statistics are presented in brackets. ^{a}, ^{b} and ^{c} denote statistical significance at 1%, 5% and 10%, respectively.

Most of the control variables coefficients show the expected sign, although some are not statistically significant. The GDP growth rate (current and lagged one-year) has a negative effect on credit risk, as predicted by theory. For the other two macroeconomic variables, families and companies' indebtedness, the coefficient is, respectively positive and significant, as expected, and negative or not statistically significant in majority specifications. The weight of credit in bank assets and banks' relative size also affects the level of loan provision or non-performing loans, as expected. The results illustrate that larger banks seem to account for a lower relative weight of loan provisions or non-performing loans in their balance sheets.

The variables associated with the inefficiency level and solvency ratio are not statistically significant at conventional levels for the majority of estimations. This may be the result of multicolinearity issues. With regard to the solvency ratio, Davis and Zhu (2009) argue that its effect on credit risk is unclear. The authors state that when the solvency ratio is high, the incentives for taking risks are lower. Therefore, a negative sign is to be expected. However, capital ratios that are too-low may lead to banks to "gamble for resurrection". This may therefore, have the opposite impact on banks' lending decisions. Banks' interest margins are statistically significant. As for the proxy for the risk premium, it is not statistically significant in the specifications for all the banks (panels A, C and F), but statistically significant in 2 and 3 of the 4 specifications, in panel B and E, respectively, for the subsamples. Salas and Saurina (2002) argue that the lack of a positive impact may occur if strong competition introduces cross-subsidization of products inside banks.

The aim of the specifications IV, V, XIV and XV shown in table 8 (panels A and D and C and F) is to analyse the impact of institutional factors on bank credit risk. We use the "Loan-to-Value" (LTV) ratio, obtained from the ECB, which corresponds to the average loan-to-value ratio in the country where the bank operates. The LTV ratios are used due to the absence of information set out individually by banks regarding these ratios. Specifications IV, V, XIV and XV show that countries with higher LTV ratios observe higher level of loan losses provisions. In panels C and F (table 8) we estimate the regressions performed in panel A and D for total sample without investment banks and for a period until 2006 (pre-crisis time). The results obtained are in line with those obtained in panel A and D.

We repeat the regressions based on subsamples of banks (panel B and E). Specifications VII and VIII refer, respectively, to the clusters of Germany and Austria, and Spain, Ireland and the United Kingdom. Results suggest

that the impact of increasing residential mortgage loans on total assets leads to a credit risk reduction in the cluster formed by Germany and Austria. Moreover, the specification VIII shows that in the cluster of Spain, Ireland and United Kingdom, the impact of increasing residential mortgage loans on total assets leads to an increase in credit risk. Specifications IX and X analyze the effects of increasing residential mortgage loans on bank credit risk in the 1st and 4th quartiles of banks, divided on the basis of the weight of residential mortgage loans on total credit. The results reveal that an increase in residential mortgage loans results in a decrease in credit risk, in the case of 1st quartile (with less residential mortgage loans) and a positive but insignificant effect, in the case of 4th quartile.

In order to assess the robustness of the results we re-estimated the models under a variety of alternative specifications. Firstly, to avoid some of the multicolinearity issues, we remove from the model all of the lagged variables where the coefficient was not statistically significant. Our conclusions remain unchanged. Second, all the results (signs and significance of parameters) hold if the risk premium does not appear in regressions or if another proxy is used. Finally, we find that the basic results do not change when we apply static panel data procedures or when we estimate the model without time fixed effects. All of these results are available upon request from the authors. Finally, the hypotheses of the absence of a time series second order correlation (the regressions were estimated in the first difference) and of the validity of the instruments used (Sargan test) are not rejected.

4.2. Profitability Model

Table 9 (panel A to D) presents the results of the linear regressions between bank profitability and the weight of residential mortgage loans in total assets, as specified in equation (5). The results of the five specifications of panel B and D (total sample without investment banks for pre-crisis period) reveal that those banks increasing their weight of residential mortgage loans in total assets saw their profitability rise during the period analyzed (2002 to 2006). The coefficient associated with the variable $RMSHARE$ is positive and statistically significant. In contrast, the results obtained for the five regressions in panel A and C do not show the existence of a statistically significant relationship between the weight of residential mortgage loans in total assets and banks' profitability. By looking at specification II and III (panel A and C), we conclude that bank profitability tends to decrease during an upturn in the residential property cycle. This can be at least partly explained by the "disaster myopia" phe-

nomenon. As discussed above, in periods of house prices rises, banks tend to expand credit to riskier customers and collateral requirements tend to decrease. These conclusions are also corroborated by specifications IV and V, where the residential property prices variable is replaced by the cumulative real growth of residential property prices in the country (or region, in the case of specification V) where a bank operates.

The conclusion that bank profitability decreases during an upturn in the residential property cycle is also corroborated by specifications VII to X (panel B and D), estimated for total sample without investment banks and pre-crisis period. Identical results were obtained by Davis and Zhu (2009). The results obtained by them suggest a negative relationship between commercial property prices and bank's interest margin.

Table 9 (panel E) tests the hypothesis of a non-linear relationship between profitability and the weight of residential mortgage loans as specified in equation (6). Specifications XIII and XIV (total sample without investment banks for the pre-crisis period) reject the hypothesis of a non-linear relationship, as a function of bank risk, between profitability and residential mortgage exposure. Conversely, the specifications XI and XII support the hypothesis that there is a U-shaped non-linear relationship. The coefficients of the interaction variables, $RMSHARE_{it} \times RISK_{it-1}$ and $RMSHARE_{it} \times (RISK_{it-1})^2$, are negative and positive, respectively, and statistically significant at conventional levels. The results of the F-statistic to test for the significance of the linear and quadratic terms, separately and together, reveal that the coefficients of these variables are statistically significant, contributing towards increasing the explanatory power of the regression. If we analyze the roots of specifications XI and XII, we find risk variable to have the value of 0.0206 and 0.0944 (specification XI) and 0.0231 and 0.0846 (specification XII). Until 2.06% and 2.31%, for specification XI and XII, respectively, the effect of weight of residential mortgage loans on bank's profitability is positive — in our database, approximately 94.96% and 97.36%, for specification XI and XII, respectively, of the observations are of banks with a risk variable lower than these values. Between 2.06% and 9.44% (specification XI) and 2.31% and 8.46% (specification XII), the effect becomes negative — approximately 4.63% (specification XI) and 2.09% (specification XII) of the observations are of banks with a risk variable between these values. Finally, above 9.44% (specification XI) and 8.46% (specification XII), the effect is again positive, but only 0.41% (specification XI) and 0.55% (specification XII) have a risk variable higher. Given that the vast majority of values for the risk variable in our database are lower than the first root in specifications XI and XII, we may

TABLE 9.

Profitability Determinants: Dynamic Panel Analysis

Panel A: Linear Regressions and Bank's Profitability Proxy: Net Interest Margin (NIM)

Variables	I	II	III	IV	V
NIM_{it-1}	5.921^a (42.69)	5.935^a (40.05)	5.924^a (42.69)	5.918^a (41.53)	5.918^a (41.45)
GDP_t	0.080^c (1.75)	0.066^a (2.71)	0.079^c (1.73)	0.084^c (1.84)	0.085^c (1.84)
GDP_{t-1}	-0.014 (-0.28)	-0.017 (-0.26)	-0.015 (-0.28)	-0.008 (-0.15)	-0.007 (-0.14)
$BBMB_t$	0.105^c (1.97)	0.122^c (1.81)	0.107^c (1.98)	0.150^c (1.83)	0.147^c (1.90)
$RISK_{it-2}$	0.495^a (15.93)	0.499^a (16.67)	0.494^a (16.11)	0.491^a (15.66)	0.491^a (15.65)
$RISK_{it-3}$	0.832^a (19.52)	0.839^a (20.88)	0.833^a (19.68)	0.829^a (19.08)	0.829^a (19.06)
LIQ_{it-1}	0.013^a (3.20)	0.014^b (2.55)	0.013^a (3.00)	0.013^a (3.18)	0.013^a (3.17)
LIQ_{it-2}	0.011^a (2.61)	0.011^a (2.65)	0.012^a (2.71)	0.012^a (2.98)	0.012^a (2.97)
$SDR3M_{it-1}$	0.185^c (1.72)	0.190^b (2.01)	0.108^c (1.73)	0.103^c (1.69)	0.103^c (1.70)
$SDR3M_{it-2}$	0.181^c (1.92)	0.156^c (1.65)	0.212^b (2.20)	0.209^b (2.19)	0.208^b (2.19)
HH_t	-0.001 (-1.14)	-0.001 (-1.32)	-0.001 (-1.28)	-0.001 (-1.22)	-0.001 (-1.21)
$INEF_{it}$	-0.005^b (-2.12)	-0.005^b (-2.22)	-0.005^b (-2.10)	-0.005^b (-2.07)	-0.005^b (-2.07)
$\Delta LOAN_{it}$	-0.011^a (-5.11)	-0.010^a (-5.48)	-0.011^a (-5.23)	-0.011^a (-5.00)	-0.011^a (-4.99)
$EQUITY_{it-2}$	7.138^b (2.15)	7.810^b (2.27)	7.164^b (2.16)	7.019^b (-2.12)	6.993^b (2.12)
$EQUITY_{it-3}$	1.922 (0.63)	1.772 (0.56)	1.938 (0.64)	1.780 (0.58)	1.796 (0.59)
IPP_{it}	2.544^c (1.77)	2.062^c (1.84)	2.473 (1.05)	2.648 (1.09)	2.650 (1.09)
$\mathbf{RMSHARE}_{it}$	0.696 (0.66)	0.842 (0.78)	1.005 (0.93)	0.961 (0.89)	0.976 (0.91)
$\mathbf{RMSHARE}_{it}*\mathbf{RPPRICE}_{t-1}$		-0.023^b (-2.32)	-0.029^b (-2.42)	-0.017^b (-2.27)	-0.016^b (-2.22)
Time Period	2002-2008	2002-2008	2002-2008	2002-2008	2002-2008
# Observations	3555	3555	3555	3555	3555
Sargan Test (p-value)	0.179	0.169	0.130	0.126	0.158
AR (1) and p-value	-4.7^a (0.00)	-3.9^a (0.00)	-3.3^a (0.00)	-3.4^a (0.00)	-3.9^a (0.00)
AR (2) and p-value	-0.5 (0.29)	-0.3 (0.73)	-0.5 (0.22)	0.2 (0.66)	-0.2 (0.60)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes

This table reports the estimation results of 5 regressions on the profitability of banks based on equation (5). We use the Dynamic Panel Analysis (Arellano and Bond, 1991) and GMM procedure. The dependent variable NIM is measured by net interest margin (gross margin) and is used as the proxy for bank profitability (PROFIT). GDP is the real GDP growth; BBMB is a dummy that takes the value 1 for banks that operate in financial systems based on the banking sector and the value 0 for systems based on the capital market. The dummy variable takes the value 0 to the Netherlands, UK, Finland, Denmark and Ireland and the value 1 for the remaining countries of the EU-15; RISK is the proxy of the bank's credit risk and is measured by the ratio of provisions for loan losses and the total net loans; LIQ is the ratio of net loans to short term funding; SDR3M is the annual standard deviation of the daily interbank at 3 month interest rate; HH is the Herfindahl and Hirschman Index obtained via total assets on the domestic market (the ratio was obtained from the ECB and range between 0 and 10.000); INEF is the ratio of operating costs to gross income; $\Delta LOAN$ is the loans growth rate; EQUITY is the ratio between the capital and total assets; IPP is the ratio non-interest expenses — non-interest revenues)/total assets; RMSHARE is the weight of residential mortgage loans in the total bank assets; RPPRICE is the rate of growth in real terms of the domestic residential housing market prices (or region, in the case of regression III, for banks with regional or international exposure to the housing market). In the case of regressions IV and V, RPPRICE is the accumulated growth rate of real market prices of residential housing in the country (or region, in the case of regression V, for banks with regional or international exposure to the housing market). t statistics are presented in brackets. ^{a}, ^{b} and ^{c} denote statistical significance at 1%, 5% and 10%, respectively.

TABLE 9—*Continued*

Panel B: Linear Regressions: Total Sample without Investment Banks for Pre-Crisis Period Bank's Profitability Proxy: Net Interest Margin (NIM)

Variables	VI	VII	VIII	XIX	X
NIM_{it-1}	0.409^a (58.88)	0.408^a (53.95)	0.408^a (59.05)	0.408^a (58.36)	0.408^a (58.51)
GDP_t	0.019^c (1.67)	0.025^c (1.89)	0.020^c (1.67)	0.019 (1.55)	0.019 (1.55)
GDP_{t-1}	0.008 (0.84)	0.011 (1.11)	0.009 (0.90)	0.007 (0.75)	0.007 (0.75)
$BBMB_t$	0.210^c (1.82)	0.189^c (1.73)	0.198^c (1.95)	0.211^c (1.96)	0.207^c (1.95)
$RISK_{it-2}$	0.324^a (25.61)	0.325^a (24.89)	0.324^a (25.47)	0.323^a (26.18)	0.323^a (26.21)
$RISK_{it-3}$	0.304^a (23.74)	0.305^a (23.55)	0.305^a (23.71)	0.303^a (24.02)	0.303^a (24.01)
LIQ_{it-1}	0.024^b (2.16)	0.021^b (1.97)	0.025^b (2.28)	0.011^b (2.49)	0.011^b (2.50)
LIQ_{it-2}	0.015^a (2.97)	0.015^a (2.75)	0.018 (1.17)	0.048^b (2.42)	0.048^b (2.41)
$SDR3M_{it-1}$	0.106^c (1.81)	0.115 (1.45)	0.107^c (1.85)	0.245^b (2.11)	0.243^b (2.10)
$SDR3M_{it-2}$	0.049^b (2.46)	0.506^b (2.49)	0.051^b (2.57)	0.154 (1.03)	0.155 (1.04)
HH_t	−0.001 (−0.66)	−0.001 (−0.88)	−0.001 (−0.73)	−0.001 (−0.69)	−0.001 (−0.69)
$INEF_{it}$	-0.014^a (−2.92)	-0.014^a (−2.68)	-0.014^a (−2.93)	-0.014^a (−2.92)	-0.014^a (−2.92)
$\Delta LOAN_{it}$	-0.002^a (−7.84)	-0.002^a (−7.87)	-0.002^a (−7.92)	-0.021^a (−7.64)	-0.021^a (−7.66)
$EQUITY_{it-2}$	7.226^b (2.01)	7.135^b (2.09)	7.257^b (2.26)	7.441^c (1.83)	7.426^c (1.82)
$EQUITY_{it-3}$	0.741 (1.19)	0.741 (1.20)	0.724 (1.17)	0.733 (1.17)	0.728 (1.15)
IPP_{it}	3.379^a (4.72)	3.366^a (4.25)	3.375^a (4.74)	3.382^a (4.64)	3.383^a (4.64)
$\mathbf{RMSHARE}_{it}$	0.951^b (2.19)	1.056^b (2.13)	0.937^b (2.04)	0.914^b (1.99)	0.915^b (1.99)
$\mathbf{RMSHARE}_{it}$*$\mathbf{RPPRICE}_{t-1}$		-0.071^a (−2.63)	-0.037^b (−2.12)	-0.042^b (2.10)	-0.031^b (−2.07)
Time Period	2002-2006	2002-2006	2002-2006	2002-2006	2002-2006
# Observations	2338	2338	2338	2338	2338
Sargan Test (p-value)	0.177	0.145	0.132	0.158	0.149
AR (1) and p-value	-4.5^a (0.00)	-3.8^a (0.00)	-3.2^a (0.00)	-4.0^a (0.00)	-3.6^a (0.00)
AR (2) and p-value	−0.5 (0.38)	−0.2 (0.82)	−0.5 (0.20)	0.3 (0.55)	0.1 (0.78)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes

This table reports the estimation results of 5 regressions on the profitability of banks based on equation (5) for the total sample without investment banks and a period until 2006 (pre-crisis time). We use the Dynamic Panel Analysis (Arellano and Bond, 1991) and GMM procedure. The dependent variable NIM is measured by net interest margin (gross margin) (NIM) and is used as the proxy for bank profitability (PROFIT). GDP is the real GDP growth; BBMB is a dummy that takes the value 1 for banks that operate in financial systems based on the banking sector and the value 0 for systems based on the capital market. The dummy variable takes the value 0 to the Netherlands, UK, Finland, Denmark and Ireland and the value 1 for the remaining countries of the EU-15; RISK is the proxy of the bank's credit risk and is measured by the ratio of provisions for loan losses and the total net loans; LIQ is the ratio of net loans to short term funding; SDR3M is the annual standard deviation of the daily interbank at 3 month interest rate; HH is the Herfindahl and Hirschman Index obtained via total assets on the domestic market (the ratio was obtained from the ECB and range between 0 and 10.000); INEF is the ratio of operating costs to gross income; $\Delta LOAN$ is the loans growth rate; EQUITY is the ratio between the capital and total assets; IPP is the ratio non-interest expenses — non-interest revenues)/total assets; RMSHARE is the weight of residential mortgage loans in the total bank assets; RPPRICE is the rate of growth in real terms of the domestic residential housing market prices (or region, in the case of regression VIII, for banks with regional or international exposure to the housing market). In the case of regressions IX and X, RPPRICE is the accumulated growth rate of real market prices of residential housing in the country (or region, in the case of regression X, for banks with regional or international exposure to the housing market). t statistics are presented in brackets. ^{a}, ^{b} and ^{c} denote statistical significance at 1%, 5% and 10%, respectively.

TABLE 9—*Continued*

Panel C: Linear Regressions and Bank's Profitability Proxy: Return on Assets (ROA)

Variables	I	II	III	IV	V
ROA_{it-1}	0.678^{b} (2.07)	0.678^{b} (2.07)	0.678^{b} (2.06)	0.676^{b} (2.06)	0.676^{b} (2.06)
GDP_t	0.045^{c} (1.66)	0.047^{c} (1.67)	0.045^{c} (1.66)	0.043^{c} (1.70)	0.042^{c} (1.70)
GDP_{t-1}	0.011 (0.26)	0.014 (0.34)	0.011 (0.27)	0.007 (0.18)	0.007 (0.17)
$BBMB_t$	0.072^{b} (2.50)	0.076^{b} (2.56)	0.071^{b} (2.45)	0.066^{b} (2.13)	0.065^{b} (2.13)
$RISK_{it-2}$	1.888^{a} (2.83)	1.886^{a} (2.83)	1.886^{a} (2.82)	1.884^{a} (2.82)	1.884^{a} (2.82)
$RISK_{it-3}$	1.137 (1.47)	1.136 (1.47)	1.137 (1.46)	1.135 (1.46)	1.134 (1.46)
LIQ_{it-1}	0.032^{a} (2.99)	0.035^{a} (2.90)	0.030^{a} (2.89)	0.033^{a} (2.75)	0.033^{a} (2.75)
LIQ_{it-2}	0.054^{b} (2.13)	0.070^{b} (2.20)	0.056^{b} (2.20)	0.052^{b} (2.09)	0.052^{b} (2.08)
$SDR3M_{it-1}$	0.061^{c} (1.67)	0.056 (1.52)	0.064^{c} (1.68)	0.062^{c} (1.68)	0.062^{c} (1.69)
$SDR3M_{it-2}$	0.194^{a} (3.51)	0.181^{a} (3.11)	0.198^{a} (3.56)	0.195^{a} (3.53)	0.195^{a} (3.53)
HH_t	−0.002 (−0.57)	−0.002 (−0.46)	−0.002 (−0.61)	−0.002 (−0.46)	−0.002 (−0.46)
$INEF_{it}$	-0.016^{a} (−2.79)	-0.016^{a} (−2.79)	-0.016^{a} (−2.79)	-0.016^{a} (−2.79)	-0.016^{a} (−2.79)
$\Delta LOAN_{it}$	−0.006 (−1.06)	−0.006 (−1.06)	−0.006 (−1.07)	−0.006 (−1.10)	−0.006 (−1.10)
$EQUITY_{it-2}$	4.012^{c} (1.82)	3.988^{c} (1.71)	4.007^{c} (1.73)	4.031^{c} (1.69)	4.035^{c} (1.69)
$EQUITY_{it-3}$	−0.695 (−0.26)	−0.693 (−0.26)	−0.708 (−0.27)	−0.649 (−0.25)	−0.645 (−0.25)
IPP_{it}	1.093^{a} (9.06)	1.094^{a} (9.04)	1.093^{a} (9.06)	1.093^{a} (9.08)	1.092^{a} (9.09)
$\mathbf{RMSHARE}_{it}$	−1.548 (−1.56)	−1.495 (−1.51)	−1.502 (−1.51)	−1.619 (−1.59)	−1.630 (−1.60)
$\mathbf{RMSHARE}_{it}$*$\mathbf{RPPRICE}_{t-1}$		-0.009^{c} (−1.89)	-0.006^{c} (−1.87)	-0.005^{c} (−1.77)	-0.005^{c} (−1.86)
Time Period	2002-2008	2002-2008	2002-2008	2002-2008	2002-2008
# Observations	3555	3555	3555	3555	3555
Sargan Test (p-value)	0.155	0.190	0.142	0.133	0.166
AR (1) and p-value	-4.1^{a} (0.00)	-3.5^{a} (0.00)	-3.2^{a} (0.00)	-3.6^{a} (0.00)	-3.7^{a} (0.00)
AR (2) and p-value	−0.5 (0.22)	−0.3 (0.70)	−0.5 (0.20)	0.3 (0.74)	−0.3 (0.72)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes

This table reports the estimation results of 5 regressions on the profitability of banks based on equation (5). We use the Dynamic Panel Analysis (Arellano and Bond, 1991) and GMM procedure. The dependent variable ROA is the return on assets and is used as the proxy for bank profitability (PROFIT). GDP is the real GDP growth; BBMB is a dummy that takes the value 1 for banks that operate in financial systems based on the banking sector and the value 0 for systems based on the capital market. The dummy variable takes the value 0 to the Netherlands, UK, Finland, Denmark and Ireland and the value 1 for the remaining countries of the EU-15; RISK is the proxy of the bank's credit risk and is measured by the ratio of provisions for loan losses and the total net loans; LIQ is the ratio of net loans to short term funding; SDR3M is the annual standard deviation of the daily interbank at 3 month interest rate; HH is the Herfindahl and Hirschman Index obtained via total assets on the domestic market (the ratio was obtained from the ECB and range between 0 and 10.000); INEF is the ratio of operating costs to gross income; $\Delta LOAN$ is the loans growth rate; EQUITY is the ratio between the capital and total assets; IPP is the ratio non-interest expenses — non-interest revenues)/total assets; RMSHARE is the weight of residential mortgage loans in the total bank assets; RPPRICE is the rate of growth in real terms of the domestic residential housing market prices (or region, in the case of regression III, for banks with regional or international exposure to the housing market). In the case of regressions IV and V, RPPRICE is the accumulated growth rate of real market prices of residential housing in the country (or region, in the case of regression V, for banks with regional or international exposure to the housing market). t statistics are presented in brackets. ^{a}, ^{b} and ^{c} denote statistical significance at 1%, 5% and 10%, respectively.

TABLE 9—*Continued*

Panel D: Linear Regressions: Total Sample without Investment Banks for Pre-Crisis Period and Bank's Profitability Proxy: Return on Assets (ROA)

Variables	VI	VII	VIII	XIX	X
ROA_{it-1}	0.350^{a} (5.15)	0.349^{a} (5.14)	0.350^{a} (5.14)	0.350^{a} (5.16)	0.351^{a} (5.16)
GDP_t	0.032^{c} (1.87)	0.036^{c} (1.90)	0.042^{b} (1.99)	0.027^{c} (1.87)	0.026^{c} (1.85)
GDP_{t-1}	0.020 (1.00)	0.022 (1.07)	0.022 (1.04)	0.020 (0.93)	0.019 (0.92)
$BBMB_t$	0.347^{c} (1.75)	0.366^{c} (1.81)	0.384^{c} (1.88)	0.306^{c} (1.72)	0.307^{c} (1.75)
$RISK_{it-2}$	0.758^{a} (4.04)	0.755^{a} (4.02)	0.759^{a} (4.03)	0.761^{a} (4.07)	0.761^{a} (4.07)
$RISK_{it-3}$	0.036 (0.18)	0.033 (0.17)	0.036 (0.18)	0.037 (0.19)	0.038 (0.19)
LIQ_{it-1}	0.033^{b} (2.23)	0.031^{b} (2.11)	0.036^{b} (2.35)	0.035^{b} (2.25)	0.035^{b} (2.25)
LIQ_{it-2}	0.028^{a} (2.64)	0.028^{a} (2.65)	0.033^{a} (2.87)	0.028^{a} (2.66)	0.028^{a} (2.66)
$SDR3M_{it-1}$	0.054^{b} (2.21)	0.054^{b} (2.20)	0.051^{b} (2.09)	0.053^{b} (2.16)	0.053^{b} (2.16)
$SDR3M_{it-2}$	0.116^{a} (3.29)	0.116^{a} (3.29)	0.121^{a} (3.34)	0.117^{a} (3.32)	0.117^{a} (3.32)
HH_t	−0.002 (−0.87)	−0.002 (−0.94)	−0.002 (−0.94)	−0.002 (−0.90)	−0.002 (−0.90)
$INEF_{it}$	-0.011^{a} (−2.62)	-0.011^{a} (−2.61)	-0.011^{a} (−2.60)	-0.011^{a} (−2.60)	-0.011^{a} (−2.60)
$\Delta LOAN_{it}$	-0.001^{c} (−1.82)	-0.001^{c} (−1.82)	-0.001^{c} (−1.83)	-0.001^{c} (−1.83)	-0.001^{c} (−1.84)
$EQUITY_{it-2}$	5.961^{b} (2.13)	5.963^{b} (2.12)	5.975^{b} (2.13)	5.922^{b} (2.12)	5.926^{b} (2.12)
$EQUITY_{it-3}$	1.985^{b} (2.23)	1.974^{b} (2.21)	1.965^{b} (2.20)	1.977^{b} (2.24)	1.976^{b} (2.24)
IPP_{it}	3.622^{a} (6.59)	3.627^{a} (6.60)	3.622^{a} (6.57)	3.614^{a} (6.65)	3.614^{a} (6.65)
$\mathbf{RMSHARE}_{it}$	0.252^{b} (2.06)	0.069^{b} (2.33)	0.029^{b} (2.00)	0.065^{b} (2.15)	0.079^{b} (2.22)
$\mathbf{RMSHARE}_{it}$*$\mathbf{RPPRICE}_{t-1}$		-0.039^{b} (−2.20)	-0.066^{c} (−1.92)	-0.019^{c} (−1.77)	-0.017^{c} (−1.71)
Time Period	2002-2006	2002-2006	2002-2006	2002-2006	2002-2006
# Observations	2338	2338	2338	2338	2338
Sargan Test (p-value)	0.150	0.166	0.152	0.177	0.159
AR (1) and p-value	-4.2^{a} (0.00)	-4.1^{a} (0.00)	-3.5^{a} (0.00)	-3.9^{a} (0.00)	-3.7^{a} (0.00)
AR (2) and p-value	−0.2 (0.80)	0.3 (0.55)	−0.4 (0.75)	0.1 (0.80)	0.2 (0.66)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes

This table reports the estimation results of 5 regressions on the profitability of banks based on equation (5) for the total sample without investment banks and a period until 2006 (pre-crisis time). We use the Dynamic Panel Analysis (Arellano and Bond, 1991) and GMM procedure. The dependent variable ROA is the return on assets and is used as the proxy for bank profitability (PROFIT). GDP is the real GDP growth; BBMB is a dummy that takes the value 1 for banks that operate in financial systems based on the banking sector and the value 0 for systems based on the capital market. The dummy variable takes the value 0 to the Netherlands, UK, Finland, Denmark and Ireland and the value 1 for the remaining countries of the EU-15; RISK is the proxy of the bank's credit risk and is measured by the ratio of provisions for loan losses and the total net loans; LIQ is the ratio of net loans to short term funding; SDR3M is the annual standard deviation of the daily interbank at 3 month interest rate; HH is the Herfindahl and Hirschman Index obtained via total assets on the domestic market (the ratio was obtained from the ECB and range between 0 and 10.000); INEF is the ratio of operating costs to gross income; $\Delta LOAN$ is the loans growth rate; EQUITY is the ratio between the capital and total assets; IPP is the ratio non-interest expenses — non-interest revenues)/total assets; RMSHARE is the weight of residential mortgage loans in the total bank assets; RPPRICE is the rate of growth in real terms of the domestic residential housing market prices (or region, in the case of regression VIII, for banks with regional or international exposure to the housing market). In the case of regressions IX and X, RPPRICE is the accumulated growth rate of real market prices of residential housing in the country (or region, in the case of regression X, for banks with regional or international exposure to the housing market). t statistics are presented in brackets. ^{a}, ^{b} and ^{c} denote statistical significance at 1%, 5% and 10%, respectively.

TABLE 9—*Continued*

Panel E: Quadratic Regressions

Variables	XI	XII	XIII	XIV
NIM_{it-1}	5.525^{a} (19.44)	5.514^{a} (22.32)	0.514^{a} (6.90)	0.817^{a} (9.60)
GDP_t	0.069^{c} (1.68)	0.078^{c} (1.85)	0.021^{b} (2.37)	0.069^{c} (1.87)
GDP_{t-1}	-0.062 (-1.20)	0.026 (0.53)	-0.005 (-1.07)	0.007 (1.06)
$BBMB_t$	0.157^{b} (2.52)	0.156^{b} (2.52)	0.066^{a} (9.13)	0.133^{a} (4.42)
$RISK_{it-2}$	4.214^{c} (1.70)	10.168^{c} (1.99)	2.308 (1.48)	6.944^{c} (1.78)
$RISK_{it-3}$	-7.164 (-1.22)	-5.189 (-0.98)	1.329^{a} (2.59)	-1.057 (-1.10)
LIQ_{it-1}	0.183^{a} (3.41)	0.161^{a} (3.30)	0.036^{a} (2.92)	0.025^{a} (2.72)
LIQ_{it-2}	0.071 (1.45)	0.056 (1.01)	0.000 (0.37)	0.000 (0.74)
$SDR3M_{it-1}$	0.125^{c} (1.86)	0.118^{c} (1.79)	0.012^{c} (1.69)	0.022^{c} (1.84)
$SDR3M_{it-2}$	0.192^{b} (2.10)	0.204^{b} (2.22)	0.071^{a} (4.24)	0.085^{b} (2.18)
HH_t	-0.096^{c} (1.79)	-0.125^{b} (-2.43)	-0.042^{a} (-3.12)	0.000 (1.08)
$INEF_{it}$	-0.007^{a} (-2.85)	-0.008^{a} (-3.12)	-0.017^{a} (-8.84)	-0.004^{b} (-2.27)
$\Delta LOAN_{it}$	-0.030^{b} (-2.15)	-0.035^{a} (-2.91)	-0.038^{b} (-2.12)	-0.008^{a} (-5.83)
$EQUITY_{it-2}$	6.222^{b} (2.12)	7.619^{b} (2.50)	-1.148 (-1.43)	7.619^{b} (2.50)
$EQUITY_{it-3}$	0.959 (0.24)	1.607 (0.43)	2.528^{a} (2.60)	3.408^{b} (1.99)
IPP_{it}	9.667^{b} (2.01)	10.790^{b} (2.57)	4.144^{a} (5.25)	8.854^{b} (2.04)
$\mathbf{RMSHARE}_{it}$	3.084^{c} (1.85)	3.879^{b} (2.26)	1.669^{a} (2.85)	-0.088 (-0.96)
$\mathbf{RMSHARE}_{it}$*$\mathbf{RISK}_{it-1}$	-182.122^{a} (-2.74)	-213.578^{a} (-2.93)	-0.150 (-0.02)	-14.837 (-0.73)
$\mathbf{RMSHARE}_{it} * (\mathbf{RISK}_{it-1})^2$	1582.752^{c} (1.89)	1982.967^{b} (2.56)	111.77 (1.01)	174.467^{b} (2.26)
$\mathbf{LTV}_t$		0.531^{a} (5.60)		0.199^{a} (2.71)
Time Period	2002-2008	2002-2008	2002-2006	2002-2006
# Observations	3554	3554	2335	2335
Sargan Test (p-value)	0.166	0.171	0.175	0.157
AR (1) and p-value	-4.2^{a} (0.00)	-3.9^{a} (0.00)	-4.8^{a} (0.00)	-3.6^{a} (0.00)
AR (2) and p-value	0.4 (0.48)	-0.4 (0.51)	0.2 (0.88)	-0.6 (0.26)
Bank Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes

This table reports the estimation results of 4 regressions on the profitability of banks based on equation (6). We use the Dynamic Panel Analysis (Arellano and Bond, 1991) and GMM procedure. The dependent variable NIM is measured by net interest margin (gross margin) and is used as the proxy for bank profitability (PROFIT). GDP is the real GDP growth; BBMB is a dummy that takes the value 1 for banks that operate in financial systems based on the banking sector and the value 0 for systems based on the capital market. The dummy variable takes the value 0 to the Netherlands, UK, Finland, Denmark and Ireland and the value 1 for the remaining countries of the EU-15; RISK is the proxy of the bank's credit risk and is measured by the ratio of provisions for loan losses and the total net loans; LIQ is the ratio of net loans to short term funding; SDR3M is the annual standard deviation of the daily interbank at 3 month interest rate; HH is the Herfindahl and Hirschman Index obtained via total assets on the domestic market (the ratio was obtained from the ECB and range between 0 and 10.000); INEF is the ratio of operating costs to gross income; $\Delta LOAN$ is the loans growth rate; EQUITY is the ratio between the capital and total assets; IPP is the ratio non-interest expenses — non-interest revenues)/total assets; RMSHARE is the weight of residential mortgage loans in the total bank assets; LTV is the average loan to value ratio, by country. Regressions XI and XII include all the banks for the period 2002 to 2008. Regressions XIII and XIV are estimated for the total sample without investment banks and a period until 2006 (pre-crisis time). t statistics are presented in brackets. ^{a}, ^{b} and ^{c} denote statistical significance at 1%, 5% and 10%, respectively.

conclude that this U-shaped relation is almost equal to a linear relation with downward trend.

With regard to the control variables, the lagged PROFIT variable reveals a statistically significant positive sign. In the majority of the specifications, credit risk, liquidity risk, interest rate risk and the concentration index are also statistically significant with a positive effect on banks' profitability. This is consistent with previous findings (e.g. Angbazo, 1997). The results also illustrate that inefficient banks tend to have lower profitability margins, in line with studies such as Maudos and Guevara (2004). The positive statistically significant sign associated with the solvency ratio, in the majority of specifications, could suggest that banks require a premium in their margins, due to the pressures of ensuring solvency by regulators. The negative and statistically significant coefficient of the $\Delta LOAN$ variable (loan growth rate) suggests that banks that register high loan growth may be required to work with lower banking margins, as suggested by Petersen and Rajan (1995) and supported by the findings of Valverde and Fernandéz (2007). The IPP variable (implicit interest payments) has a positive coefficient and is statistically significant, for the majority of regressions. This variable reflects extra payments to depositors through service charge remission or other types of transfers due to competition in the market for deposits. These extra payments tend to cause an increase in the banks gross margins consistent with the results of Angbazo (1997). The GDP growth rate also shows a positive and statistically significant effect on banks' gross margins. Finally, the dummy associated with the structure of financial systems, reveals that a bank-based system tends to produce larger gross margins than countries that operate a market-based financial system.

The coefficient associated with the country's average LTV ratio, which is acting as a proxy for the institutional characteristics of the mortgage market, is positive and statistical significant. This would suggest that banks in countries where credit-granting practices are less conservative (high leverage ratios) tend to require a higher profitability margins. Finally, the non-rejection of the null hypotheses of the Sargan test and the second-order autocorrelation test allow us to conclude drawn from the estimated models appear supported. We find that the basic results do not change when we apply static panel data procedures or when we estimate the regression without time fixed effects[26].

[26] These results are available from the authors upon request.

5. CONCLUSION

This paper has evaluated the effects of residential mortgage loan lending on the risk and profitability of a sample over 500 EU-15 banks. The sample, running from 1995 through 2008 captures much of the recent cycle, and especially the increase in residential lending observed in many markets prior to the 2007-8 financial crisis. The results illustrate the importance of residential property lending and the significant impact it may have on bank performance. Broadly, the results indicate that increasing residential mortgage lending during strong property market conditions, in our case pre-2007, leads to an improvement in the performance of banks. This is found to be the case both with respect to profitability and credit risk. These findings can in part be explained by the fact that the asset is used as collateral to obtain other loans and is perceived by banks as contributing towards reducing credit risk.

When we take into account the behaviour and dynamics of the residential property market we find that impact of increasing property prices on banks' lending behavior is consistent with the theoretical predictions of the financial accelerator. Increasing residential property prices encourage banks to lend more, and risk premiums shrink when property prices rise. The results show that the decrease in credit risk as result of an increase in the weight of residential mortgage loans is higher during an upturn in the property cycle and in countries with more conservative lending practices. However, the results also illustrate that bank profitability tends to decrease during an upturn in the residential market. The results do also appear to indicate that house price appreciation leads to a fall in provisions and in non-performing loans. Whilst this in part may be due to the fact that mortgage loans rarely default during periods of price appreciation, there are other considerations. It may also be the result of banks delay provisions, with the result that risk emerges at a later date.

The results highlight the need to develop indicators of bank's individual exposure to the real estate market in order to calibrate the potential impact of changes in weights and prices of residential housing assets on bank risk and profitability. Given that our sample period only covers a small part of the crisis period, we suggest further analysis and research about the relationship between residential property loans and bank performance for the crisis period. As Koetter and Poghosyan (2010) have shown, deviations from fundamental value of real estate tend to contribute to bank instability. These results given the policy of delaying the recognition of loan losses provisions may be more fully captured by a wider temporal sample.

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