How Does Competition Impact Bank Risk-Taking?

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ABSTRACT: A common assumption in the academic literature and in the actual supervision of banking systems worldwide is that franchise value plays a key role in limiting bank risk-taking. As the underlying source of franchise value is assumed to be market power, reduced competition has been considered to promote banking stability. Boyd and De Nicoló (2005) propose an alternative view where concentration in the loan market could lead to increased borrower debt loads and a corresponding increase in loan defaults that undermine bank stability. Martínez-Miera and Repullo (2007) encompass both approaches by proposing a nonlinear relationship between competition and bank risk-taking. Using unique datasets for the Spanish banking system, we examine the empirical nature of that relationship. After controlling for macroeconomic conditions and bank characteristics, we find that standard measures of market concentration do not affect the ratio of non-performing commercial loans (NPL), our measure of bank risk. However, using Lerner indexes based on bank-specific interest rates, we find a negative relationship between loan market power and bank risk. This result provides evidence in favor of the franchise value paradigm.

Key words: bank competition, franchise value, Lerner index, credit risk, financial stability

JEL codes: G21, L11

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1. Introduction

A standard principle of banking supervision is that excessive competition among banks could threaten the solvency of particular institutions and, at an aggregate level, hamper the stability of the entire banking system. Competition arising from the liberalization of the banking system should erode the franchise value of a bank and encourage it to pursue riskier policies in an attempt to maintain its former profits; see Keeley (1990). Examples of riskier policies are taking on more credit risk in the loan portfolio, lowering capital levels, or both. These riskier policies should increase the probability of higher non-performing loan ratios and more bank bankruptcies. In contrast, restrained competition should encourage banks to protect their higher franchise values by pursuing safer strategies that contribute to the stability of the whole banking system. This "franchise value" paradigm has been supported both theoretically and empirically over time in the banking literature.

Recently, Boyd and De Nicoló (BDN, 2005) proposed a very interesting and challenging view. Within their model, less competition among banks could result in higher interest rates charged on business loans, which might raise the credit risk of borrowers as a result of moral hazard (as in Stiglitz and Weiss, 1981). This increase in firm default risk could lead to increased bank problem loans and greater bank instability. The authors argue that this loan market channel could eliminate the trade-off between competition and financial stability implied by the deposit channel of the franchise value paradigm; that is, the economic rents that banks earn from depositors provide the only incentives to carry out conservative asset side policies. Their proposed "risk-shifting" paradigm argues that more competition across the loan and deposit markets could decrease borrower credit risk and enhance financial stability. In fact, Boyd, De Nicoló and Al Jalal (2006) as well as De Nicoló and Loukoianova (2007) provide empirical evidence of a positive relationship between banking market concentration and bank risk-taking.

Allen and Gale (2000, 2004) show that different models can provide different results regarding the trade-off between banking competition and stability.[2] More recently, Martínez-Miera

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[2] Carletti and Hartmann (2003) survey the literature on financial stability and competition.

and Repullo (MMR, 2007) extend the BDN model by allowing for imperfect correlation across individual firms' default probabilities. They identify a risk-shifting effect accounting for more defaults when interest rates increase (i.e., a lower competition environment) but realize that, at the same time, there is a margin effect that generates more revenue for the bank coming from those non-defaulted borrowers that pay a higher interest rate. In their model, the relation between competition and stability can be U-shaped; that is, as the number of banks increases, the probability of bank default first declines but increases beyond a certain point.

The objective of this paper is to examine empirically whether the relationship between bank competition and risk is linear, as suggested by both franchise value and risk-shifting models, although with opposite signs, or is U-shaped, as in the MMR model. We examine this relationship between competition and bank risk by examining the Spanish banking system. Some papers have looked at cross-country evidence to examine the trade-off between banking competition and stability. Although this type of analysis can take into account quite different banking systems, this benefit might come at the cost of a lack of comparability across variables, both dependent and independent. Our focus on a single banking system avoids this concern.

Analysis of the Spanish banking system permits us to use detailed databases to construct the most appropriate variables. Specifically, we take advantage of the Banco de España's interest rate database that contains monthly information about the marginal interest rates charged by each bank for several banking products, such as commercial loans and deposits. We also use the Banco de España's credit register database to extract banks' risk premiums from the former marginal interest rates and to obtain banks' commercial non-performing loan ratios (NPL), which are our empirical measure of bank risk. Using the interest rate information, we can produce Lerner indexes for commercial lending in order to examine the BDN and MMR models as closely as possible. In addition to these measures of market power, we also use standard proxies of market concentration, such as Herfindahl-Hirschmann indexes and the number of banks operating in a market, although these results are not statistically significant in general.

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Our empirical results suggest a negative relationship between market power and risk-taking; as bank market power increases, bank NPL ratios decline. These results do not support the risk-shifting paradigm in the BDN model. Furthermore, we find little evidence of a U-shaped relationship between competition and risk, as per the MMR model. In summary, our empirical results for the Spanish banking system provide evidence in support of the franchise value paradigm that has guided much bank supervision over the past decades.

The rest of the paper is organized as follows. Section 2 contains a brief discussion of the theoretical and empirical literature on the topic. In Section 3, we present the databases, variables and methodology used to empirically examine the trade-off between competition and bank risk. In Sections 4 and 5, we present the baseline results as well as several robustness exercises. Section 6 concludes.

2.   Literature review

2.1. Theoretical literature

The "franchise value" paradigm for bank risk-taking, both with and without government regulation, is well established in the banking literature. Simply stated, the idea is that banks limit their risk-taking in order to protect the quasi-monopoly rents granted by their government charters. Increased competition would erode these rents and the value of the charters, which would likely lead to greater bank risk-taking and greater financial instability.

Marcus (1984) used a one period model to show that franchise value declines as a bank engages in riskier policies. Dermine (1986) extended the Klein-Monti model to incorporate bankruptcy risk and deposit insurance and found a negative relationship between the level of bank credit risk and its deposit market power. Chan, Greenbaum and Thakor (1986) showed 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

portfolio credit quality declines. Keeley (1990), following Furlong and Keeley (1989), used a state preference model with two periods to show that a decline in franchise value enhances bank risk-taking. Broecker (1990) showed that increased competition, measured as an increased number of banks, had a negative effect on the average credit-worthiness of the banking system. Besanko and Thakor (1993) showed that increased competition erodes informational rents originated from relationship banking and enhances risk-taking by banks. In a context of asymmetric information, Marquez (2002) showed that an increase in the number of banks in a market disperses the borrower-specific information and will result in higher funding costs for low-quality borrowers but also in a higher access to credit for low-quality borrowers.

Using a dynamic optimization model with an infinite horizon, Suárez (1994) showed a trade-off between market power and solvency. If the market power of the bank decreases, the incentive to engage in riskier policies increases significantly. As the franchise value of the bank is a component of bankruptcy costs, it should encourage the bank to carry out prudent policies that increase the solvency of the bank.[3] Matutes and Vives (1996, 2000) in a framework of imperfect competition (i.e., product differentiation) showed that higher market power reduces a bank's default probability. Hellmann, Murdock and Stiglitz (2000) in a dynamic model of moral hazard showed that competition can have a negative impact on prudent bank behavior. Capital requirements are not enough to reduce the gambling incentives and they need to add deposit rate controls as a regulatory instrument. Building on the former paper, Repullo (2004) used a dynamic model of imperfect competition in banking to show that in the absence of regulation, more competition (i.e., lower bank margins) leads to more risk. Risk-based capital requirements were found to effectively control the risk-shifting incentives.

As an important challenge to the franchise value paradigm, Boyd and De Nicoló (BDN, 2005) develop a model, modifying one presented by Allen and Gale (2000), where an increase in the bank market power both in the loan and deposit markets translates into higher loan rates charged to borrowers. In a moral hazard environment (as in Stiglitz and Weiss, 1981), entrepreneurs facing

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[2] Chan, Greenbaum and Thakor (2002) also consider the franchise value a component of the private cost of bankruptcy.

higher interest rates on their loans would choose to increase the risk of their investment projects, a practice that would lead to more problem loans and a higher bankruptcy risk for banks. They find a monotonic declining relationship between competition, measured as the number of banks lending in a market, and bank risk; that is, as the number of banks and competition increases, the level of bank risk would decline.

In a recent paper, Martínez-Miera and Repullo (MMR, 2007) propose a way to reconcile the franchise value paradigm and the insights of the BDN model. They show that the former monotonic relationship might become a U-shaped relationship if there is imperfect default correlation across firms. Under the assumption, the risk-shifting effect (i.e., higher risk of firm failure as loan interest rates increase) has to be balanced against the effect of the higher margins obtained from firms that are able to repay even at the higher interest rates. Depending on the degree of default correlation across firms and the intensity of the risk-shifting effect, it is possible to find an initial decline in risk as the number of banks increases (i.e., as bank competition increases), but an eventual increase in risk as the number of banks operating in a market keeps growing.[4]

2.2. Empirical literature

The empirical literature that we address in this paper focuses on the relationship between competition in banking markets and bank riskiness. The extant studies use different measures of bank competition, which often highlight deposit market competition, and bank risk exposures. Keeley (1990) measured the degree of bank competition using banks' market power using Tobin's q, which is defined as the ratio of a bank's equity market valuation to its book value. First, he showed that liberalization measures eroded Tobin's q, controlling for macroeconomic variables and bank characteristics. Secondly, he related two measures of bank risk to his measures of market power finding that: (1) a bank's solvency ratio, defined as the market value of capital divided by the market value of assets, has a positive relationship (i.e., a higher market power means a larger solvency coefficient), and (2) funding costs for certificates of deposit have a negative relationship (i.e., as the

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[4] Caminal and Matutes (2002) had already shown that the relationship between market power and bank failures is

market power declines the perceived bankruptcy risk of the bank increases and so does the cost of uninsured large CD's). On aggregate, these results support the franchise value paradigm.

Demsetz, Saidenberg and Strahan (1996) showed that U.S. banks with greater market power also have the largest solvency ratios and a lower level of asset risk. Saunders and Wilson (1996), for a sample of U.S. bank and a period of a century, found support for Keeley's results in the period from 1973 to 1992.[5] For a sample of publicly traded U.S. thrifts, Brewer and Saidenberg (1996) found a negative relationship between franchise value and risk measured as the volatility of their stock prices. Hellmann, Murdock and Stiglitz (2000) have the view that financial-market liberalization in the 1990s increased competition and reduced the profitability and franchise value of domestic banks, which, jointly with other factors, lead to the East Asian financial crisis and a weaker financial system in Japan. Salas and Saurina (2003) replicated Keeley's work for Spain, finding a very significant and robust relationship between Tobin's q and the solvency and non-performing loan ratios of Spanish banks. Greater market power was found to be correlated with higher bank solvency ratios and lower credit risk losses. For Italy, Bofondi and Gobbi (2004) found that a bank's loan default rate increases as the number of banks in a market increases.

In contrast, Jayaratne and Strahan (1998) showed that bank performance, measured using return on assets, return on equity, and several indicators of credit quality, improved significantly after restrictions on banks' geographic expansion were lifted in the U.S. Moreover, loan losses decreased sharply after statewide branching was permitted. Thus, an increase in competition seems to have had the opposite effect of the franchise value paradigm. Nevertheless, Dick (2006) provides evidence of a positive and significant relationship between banking deregulation and increases in loan losses, while Hannan and Prager (1998) showed that liberalization of interstate branching and operations increased competition in the deposit market and reduced profitability, ceteris paribus. Moreover, the literature focusing on new bank entrants finds that increases in loan market competition may lead to increase loan losses due to the winner's curse arising from larger degrees of

ambiguous.
[5] In fact, Rhoades and Rutz (1982) had already found, using a quite different methodology, that banks with higher market power (measured using a concentration index) were more risk-averse.

asymmetric information (see Shaffer, 1998).

In the above-mentioned studies, differences in the degree of bank competition were either cross-sectional or caused by key changes in regulation within one country. Several studies have examined this relationship in a cross-country setting. Beck, Demirgüç-Kunt and Levine (2006) examine banking data for 69 countries over a 20 year period, and they found that more concentrated national banking systems are subject to a lower probability of systemic banking crisis and hence are more stable. However, they cast doubts on the appropriateness of the share of assets of the three largest banks in the banking system of each country (i.e., their C3 measure) and related measures as proxies for competitiveness in a national banking system. Claessens and Laeven (2004) showed a positive and significant relationship between bank concentration measured as C5 and the H-statistic, a measure of the intensity of competition in a market according to Panzar and Rosse (1987). Robustness analyses of this result showed that the relationship between concentration and the H-statistic could also be insignificant, and they concluded that bank concentration is not a good summary of the bank competitive environment.[6] Also using the H-statistic as the measure of competitiveness, Levy-Yeyati and Micco (2007) found an increase in bank risk as bank competition increased in for eight Latin American countries. Overall, there seems to be a significant amount of literature supporting the franchise value paradigm.

In contrast, Boyd, De Nicoló and Al Jalal (2006) provide empirical evidence supporting the risk-shifting model using several measures of bank risk – namely a z-score measure based on bank returns on assets (ROA), its dispersion measured as σ(ROA), and the ratio of equity to total assets -- and bank competition measured using a Herfindahl-Hirschmann index. They examine two data samples: a cross section of around 2,500 small, rural banks operating in only one market area within the U.S and a panel of about 2,700 banks from 134 countries, excluding Western countries. In both samples, they found a negative and significant relationship between the bank concentration index and z-score; thus, more concentrated banking markets are associated with greater risk of bank failures. Moreover, De Nicoló and Loukoianova (2007) find that the former result is stronger when

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[6] A survey of the literature on bank concentration and competition is in Berger et al (2004).

bank ownership is taken into account. Also in a cross-country setting, Schaeck, Cihák and Wolfe (2006) find that more competitive national banking systems are less prone to systemic crises based on their analysis of 38 countries over the period from 1980 to 2003 again using the H statistic.

3. Data and model description

3.1. Data

In this paper, we use precise measures of bank market power and risk-taking to test whether the franchise value paradigm, the risk-shifting paradigm, or both (as per the MMR model) apply to the Spanish banking system. Our dependent variable measure of risk-taking is a bank's commercial non-performing loan (NPL) ratios, which is an ex-post measure of credit risk. We focus on commercial credit risk for two reasons. First, the BDN and MMR models are based importantly on the borrowing behavior of commercial firms, and second, credit risk is the primary driver of risk for most banks, although other risks exist. The NPL ratios for Spanish banks are obtained from the credit register maintained by the Banco de España, which is known as the *Central de Información de Riesgos* (CIR). The CIR contains information on any loan, including mortgages and consumer loans, above a minimum threshold of €6,000 granted by any bank operating in Spain. Therefore, it contains a full census of commercial loans granted in Spain. We have monthly information starting in 1984, but for practical reasons, we use only annual data based on the month of December without loss of generality.

As discussed previously, various measures of the degree of bank competition have been used in the banking literature. While many papers have used concentration measures as proxies for bank competition, we share the concern expressed by Claessens and Laeven (2004) regarding the meaning of these concentration variables. For our paper, we take advantage of another database maintained by the Banco de España that records the *marginal* interest rate each bank charges on an array of banking products -- credit lines, receivables (defined as credit granted against invoices or other payment documents), mortgages, term deposits, repo deposits guaranteed with government debt,

etc.-- each month during the period from 1988 through 2003. That is, for each bank and each banking product, we have its average interest rate set on that product for *new* transactions.[7] Using this interest rate information, we can produce a Lerner index for commercial loan products for each bank in our sample. The Lerner index is a commonly used measure of market power that captures the degree to which a firm can increase their marginal price beyond their marginal cost.

The Lerner index is a more accurate measure of market power than the standard concentration measures.[8] However, the computation of the Lerner index requires a proper estimation of the marginal cost of the product, which for bank loans requires a measure of the risk premium charged. Failure to take the risk premium into account would result in significant biases in measuring bank market power.[9] If the interest rate on a loan is denoted as R_l, the Lerner index (or gross profit margin relative to the market price) is defined as $(R_l - R)/R_l$, where R is the marginal cost of the loan. If we introduce the realistic assumption that the marginal operating costs of loans and deposits are either fixed in the very short term or impossible to calculate separately, we assume that banks have a lower bound on the marginal cost for their loans equal to the interest rate offered in the interbank market.[10]

However, banks must introduce a risk premium into their prices to account for credit risk. Let *PD* be the probability that a loan, with a normalized face value of one, will default over a specified horizon, and let *LGD* be the amount of the loan's value that the bank cannot collect in case of default. If the interbank interest rate *r* is assumed to be risk-free, the marginal opportunity cost of the loan for a risk-neutral bank will be the interest rate *R* that satisfies the condition that the risk-free value of the loan equals the expected value of the loan, given the PD and LGD parameters. From this simple identity, the marginal cost $R = (r + PD \cdot LGD)/(1 - PD \cdot LGD)$. For our calculations, the risk-free interest rate *r* is the annual average of the daily interbank rate. The bank-specific, not borrower-specific, *PD* is obtained directly from the CIR; for a given bank and loan product at the end of year t,

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[7] A more detailed description of this database can be found in Martín, Salas and Saurina (2007).
[8] Under conventional assumptions, Tirole (1988) shows that the Lerner index can be related to measures of welfare losses such as the Harberger's (1964) triangle.
[9] We follow Martín, Salas and Saurina (2006) in what follows to properly construct the Lerner indexes.
[10] Freixas and Rochet (1997) review bank pricing models in different competitive regimes and information conditions.

PD equals the bank's ratio of defaulted loans divided by total outstanding loans of that type. Since we do not have bank-specific information regarding *LGD*, we use the value 45% set by the Basel Committee of Banking Supervisors in its new capital framework.

For our analysis, we calculate Lerner indexes for commercial banking receivables and credit lines as well as all loans, including mortgages and consumer loans. We also compute Lerner indexes for deposits by assuming separability between loan and deposit pricing and that the interbank rate acts as upper bound for deposit rates. The Lerner index for a deposit product is calculated as (r-R_d)/r, where R_d is the bank's offered rate on that deposit product. We also calculate an average Lerner index for loans and deposits. In addition to these more accurate measures of market power, we also examine standard concentration variables -- C5, Herfindahl-Hirschmann indexes (HHI) and the number of banks operating in each market -- as proxies for market power. Note that the last variable is the one used explicitly in the BDN and MMR models.

Given that our dependent variable is the level of credit risk at each bank and that the Spanish credit market is segmented geographically into 50 provinces, the concentration measures reflect the degree of concentration each bank faces in each of the regional markets where it operates. We construct an aggregate measure for each bank using a weighted average, where the weights are the market share of commercial loans each bank holds in each province. If a bank only operates in a province, it faces the concentration indicators of that province; whereas if a bank operates nationwide, it has a nationwide weighted index for each of the concentration measures.[11] Again, the concentration variables refer to the commercial loan market to be consistent with our other risk and competition measures and to test the risk-shifting paradigm.

Finally, in our analysis, we also use a database on banks' accounting data to control for individual bank characteristics, such as return on assets (ROA). Our period of analysis is from 1988

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[11] In the robustness section, we show that this aggregation procedure has no impact on the results of the paper.

to 2003 due to the availability of the interest rate data. We focus on commercial and savings banks, 95% of the credit market to firms.[12]

Table 1 presents the descriptive statistics for the variables used. We have 1,262 bank-year observations for more than one hundred commercial and savings banks over the 14-year sample.[13] The average NPL ratio is 4.4% with a large degree of dispersion across banks; ranging from 0% to above 38%. As shown in Figure 1, there is a significant variability over time in this variable with the median NPL ratio at around 1% in recent years and around 2% at the beginning of the sample period, but rising to a median value of 7% in 1993. These time dynamics are tied to the Spanish business cycle, which experienced a deep recession around 1993 and two important expansion periods before and after 1993. Real interest rates have been declining steadily but significantly along the period, as the Spanish economy was converging to the euro zone countries.

Next, we summarize our various concentration measures as proxies for the degree of bank competition. While there are a reasonably large number of banks operating in each provincial credit market, there is a high degree of dispersion, ranging from provinces with 22 banks to 150 banks in certain years. We do not have more detailed geographical market breakdowns but, in general, it is easy to see a significant correlation between the size of the province (in terms of population) and the number of banks operating there. Madrid and Barcelona, by far the most populated provinces, have a much higher number of banks. The correlation coefficient for the log province population and the log of the number of banks in the province is stable at 0.88 in 1990 and 0.85 in 2000. Across provinces, we observe a variety of patterns regarding the number of banks.

The market share of the first five commercial lenders in each province, denoted as C5, is relatively high with an average of 58%, ranging from 40% to 75%. Across provinces and time, there are occasional jumps in the C5 index as large banks merge. Regarding mergers, we have treated

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[12] Credit cooperatives and specialized lenders are excluded because of lack of data of interest rates although their market share is very small (the remaining 5%).

[13] These are the final number of observations used to run the regressions after taking differences and allowing for lags in the instruments. The original number is 1,632. The data is uniformly distributed across the 16 years of the sample period.

banks merged as two separate entities before the merge and as a new one after it.

The HHI for commercial loans has an average of around 8, which roughly implies 12 banks of equal size per market. Since this number is well below the average number of 75 banks per province, there must be a significant number of banks in each market with a tiny market share; that is, they might have only one or a few branches in the province. This fact further points towards the careful use of the number of banks as a proxy for competition in a market, even though it is the one that comes out of theoretical models. The loan HHI shows no clear cross-sectional pattern across provinces.

The average Lerner index for receivables is positive, although relatively small; receivables margins are only about 15% of receivables rates once the risk premium has been accounted for. For credit lines, the index is negative on average and zero at the median, suggesting that the median interest rate on credit lines only covers the funding cost plus the risk premium applied to the borrower. The Lerner index for the whole loan portfolio is on average positive, but again quite small; banks earn only a 5% margin, on average, on all of their lending. As shown in Figure 2A, this Lerner index has an upward trend as of 1995, partly due to a decline in the interbank rate as European monetary unification approached. On the other hand, the Lerner index for all deposits declined during the first half of the sample period and later on fluctuated at 33% of average deposits rates, as shown in Figure 2B. For repo transactions, the Lerner index is quite close to zero, while for sight accounts (i.e., demand deposits) and total deposits it is higher at 45% and 40% margins, respectively. The joint Lerner index for loans and deposits averages about 40% with a maximum value of 100% but with some negative values; in which case, the loan interest rate does not cover the deposit rate and the risk premium.

Finally, Table 1 also shows that commercial and savings banks have an average ROA of 0.66% for the period analyzed, with a high degree of heterogeneity. In the sample, we measure bank size using the share of total CIR loans that the bank originated. The average value is 0.7%, which is relatively small, but the range goes up to a maximum value of 9.3%; thus, we have also

heterogeneity on bank sizes. Finally, there is a significant difference in degrees of specialization in the commercial lending as some banks concentrate on commercial lending (as high as 90%), while others almost do not operate in that market segment.

3.2. Model description

To examine the various hypotheses regarding the franchise value paradigm, the risk-shifting hypothesis of the BDN model and the encompassing, U-shaped relationship in the MMR model, we estimate the general regression:

$$RISK_{it} = f(COMPETITION\ INDEX_{it},\ BUSINESS\ CYCLE_{it},\ BANK\ CONTROL\ VARIABLES_{it}),\quad (1)$$

where the i subscript refers to a bank and the t subscript refers to the year. The model sets the relationship between the specified bank risk measure and the specified bank market competition measure, controlling for bank characteristics and the state of the business cycle. The actual model specification we examine is:

$$\ln\left(\frac{NPL_{it}}{100-NPL_{it}}\right) = \alpha + \beta\ln\left(\frac{NPL_{it-1}}{100-NPL_{it-1}}\right) + \delta_1 COMPETE_{it} + \delta_2 COMPETE^2$$

$$+ \gamma_1 GDPG_t + \gamma_2 GDPG_{t-1} \tag{2}$$

$$+ \phi_1 ROA_{it} + \phi_2 SIZE_{it} + \phi_3 LOAN\ RATIO_{it} + \eta_i + \varepsilon_{it}.$$

The dependent bank risk variable is the log-odds transformation of a bank's NPL ratio. We use the logit transformation to change the variable's support from the unit interval to the real number line. There is a significant degree of persistence in the transformed NPL variable, since the average value of the first-order autocorrelation is 0.68. Hence, we include the lagged dependent variable as an explanatory variable.[14]

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[14] See Salas and Saurina (2002) for the Spanish case.

We control for the business cycle by introducing the GDP real growth rate, current and lagged one year, since problem loans evolve significantly along the cycle. We also control for the profitability of the bank, its size, and its specialization in commercial lending using its contemporaneous ROA, its market share in terms of CIR total loans ($SIZE_{it}$), and its percentage of total assets that represent commercial loans (LOAN $RATIO_{it}$), respectively.

Our primary variables of interest here are those related to the degree of bank market competition, denoted $COMPETE_{it}$. For the loan market, we use the number of banks, C5, HHI as well as the Lerner index for receivables, credit lines and all loans. For the deposit market, we use the Lerner index for total deposits, repo operations, and sight accounts, which is defined as deposits that can be drawn at any time. We also examine the sum of the Lerner indexes for the broadest loan and deposit categories. We also include the squared $COMPETE_{it}$ term in our regressions to address the hypothesis within the MMR model that the relationship between the number of banks and bank risk might not be linear. We include the bank fixed effect η_i to control for unobservable bank characteristics constant over time, and ε_{it} is a random error that has a normal distribution.

In our model specification, positive and significant values for δ_1 and δ_2 would provide evidence in support of the risk-shifting paradigm; that is, as bank competition measures increase, bank riskiness as measured by NPL ratios would also increase. In contrast, if these parameters are negative and significant, lower bank competition would lead to less bank risk, which is supportive of the franchise value paradigm. If δ_1 is significantly negative and δ_2 is significantly positive, the results would support the U-shaped pattern proposed in the MMR model.[15]

Regarding the other explanatory variables, we expect a significant positive coefficient for the lagged dependent variable and a significant negative effect for the GDPG variables, since problem loans increase in bad times and *vice versa*. We do not have clear expectations for the bank characteristics. In general, there should be a positive, long-term relationship between risk and return,

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[15] Note that we also estimated the regression model without the quadratic term, and the overall results are qualitatively

but banks with high NPL ratios might experience significant losses in a particular year. The specialization of a bank should be indicative of improved monitoring and screening of borrowers, while, at the same time, specialized banks might be willing to take more risks. Finally, there is no general support for a certain relationship between the size of the bank and its risk level. A larger bank benefits from risk diversification but, at the same time, bank managers could take advantage of that in order to push further the risk profile of the bank.[16]

It is possible that unobservable bank characteristics are correlated with the bank NPL ratios; for example, the risk aversion of bank managers and/or shareholders. In this case, an OLS estimation of model (2) would produce biased parameters due to the lagged dependent variable. To address these estimation problems, we use the Arellano and Bond (1991) procedure and estimate the model in first-difference form using GMM estimation techniques. We thus treat bank characteristics as endogenous and use up to three lags to instrument for them. The validity of these instruments is tested using the standard Hansen test. Since we take first differences, we should observe first-order autocorrelation and no second-order autocorrelation in the residuals.[17]

4. Empirical results

4.1. Correlations

Table 2 presents the pairwise correlations between the variables. We find a negative relationship between all our measures of bank market power in both, the loan and deposit markets and bank's commercial NPL ratios, our measure of bank risk. The correlations for the different loan market Lerner indexes range from -0.56 to -0.20, while for the deposit market, these values are generally smaller, ranging from -0.10 to +0.03. Both the C5 and HHI measures for both markets show a negative, although low correlation, with ex-post credit risk. Therefore, simple correlation analysis suggests a negative relationship between market power and bank risk, supporting the

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unchanged.
[16] See, for instance, Hughes et al. (1996) for this last result.
[17] Note that we also estimated the model using just two lags as well as all available lags as instruments, but the overall

franchise value paradigm.

As expected, commercial NPL ratios are correlated negatively with the business cycle. Specialization in commercial lending is correlated with lower NPL ratios, probably due to enhanced screening and monitoring of borrowers. We find that current problem loans have a negative impact on current profitability. The correlation between size of the bank and risk in business loans seems weak. Profitability of banks seems to be inversely related to the number of banks operating in each local market and positively related to the standard concentration measures as well as market power indicators. However, the absolute value of correlation coefficients is, in general, low and in the range of [0.16, 0.24] for loans and [-0.18, +0.11] for deposits. The correlation with the number of banks is actually -0.36.

With the data available for this study, we can examine in greater empirical detail the key theoretical concept on bank market concentration proposed by Boyd and De Nicoló (2005); namely, the distinction between concentration in the deposit and the loan markets. Among concentration measures, there is a strong negative correlation between the number of banks operating in a market and the C5 and HHI measures for both loan and deposit markets, ranging from -0.67 to -0.42. The C5 and HHI measures for both markets are highly correlated (around 0.85) with each other. Across the two markets, the correlations based on these concentration measures are also high at +0.82 for the C5 measure and +0.59 for the HHI measure. Therefore, C5 and HHI seem to be interchangeable as concentration proxies.

However, a very different picture emerges for the Lerner measures of market power. Within markets, the correlations between the Lerner measures and the two concentration measures drop sharply to between +0.15 and +0.21. The correlation between concentration and market power variables is positive, but generally weak. A proper test of the franchise value paradigm needs, therefore, a more direct measure of market power than the usual concentration proxies used in the literature. Across the markets, the correlations between the Lerner indexes are quite low at +0.12,

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qualitative results were unchanged. .

suggesting that loan and deposit markets might behave separately. Within markets, the Lerner indexes for the different product types are more highly correlated for loan products than for deposit products.

Finally, it should be noticed that, in general, market power is procyclical, especially for loan products; that is, macroeconomic improvements seem to increase market power in the Spanish market. Concentration measures are also positively correlated with the business cycle indicator, but with low values.

4.2 Regression results

Table 3 presents the estimation result for our baseline model. The table's six columns differ only by the competition measure used. The validity of the instruments for our specification is satisfactory in all cases, as shown by the Hansen test. Moreover, as expected since we estimate the model in first differences, there is significant first-order serial autocorrelation in the residuals, but no significant second-order autocorrelation.

In all six regressions, the lagged endogenous variable is significant at the 1% level with a parameter value around 0.5, confirming the persistence shown in the NPL ratios. The contemporaneous GDP growth rate is negative and significant at the 1% level, while the lagged GDP growth rate is always negative but only significant in the last four columns based on the Lerner measures. The parameters for these lagged values are, in absolute terms, always less than half of the contemporaneous values, indicating that business cycle changes quickly influence firms' problem loans.

For the bank characteristics, larger banks have lower NPL ratios in all six regressions. Thus, it seems that portfolio diversification and possibly better managerial ability at larger banks play a role in mitigating credit risk within Spain. We find that the more specialized a bank is in commercial lending, the lower its problem loan ratio. This result is statistically significant for the first four

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regressions at the 1% level, insignificant for the fifth, and significant only at the 10% level for the sixth. These results suggest that specialization improves the screening and monitoring abilities of banks. Finally, ROA as a measure of bank profitability is insignificant, although negative, in the six regressions.

Regarding the competition variables, the first column of Table 3 shows that the number of banks operating in a market does not seem to have any effect on bank risk-taking. Therefore, the strict risk-shifting propositions in the BDN and MMR models are not confirmed by the data.[18] We have claimed that concentration measures are rough proxies for market power, and the results for the C5 and HHI measures support this claim. Columns 2 and 3 show that the C5 concentration measure for commercial loans has no significant impact on NPL ratios, while the HHI measure for loans is only significant at the 10% in the linear term. In fact, the sign is negative, suggesting that an increase in concentration brings about a decline in credit risk, which is in line with the franchise value paradigm.

More interesting are the three last columns based on the Lerner market power measures. The δ_1 and δ_2 estimates are both negative and significant at the 1% level in all cases. An increase in market power for loans, measured as an increase in the Lerner indexes for receivables, credit lines and total loans, produces a decline in the risk profiles of the banks in our sample. Thus, we find strong empirical evidence supporting the franchise value paradigm. Furthermore, since both coefficients are negative, we are able to reject the U-shaped relationship between risk and competition put forward by Martínez-Miera and Repullo (2007).

What if the source of market power does not come from the asset side (i.e., loan markets) but from the liability side (i.e., deposit markets)? It might be that banks earn monopoly rents in the deposit market and that has a different impact on the loan market. For instance, more market power in deposits could allow banks to be more aggressive in the loan market and be prepared to lend to riskier borrowers with the short term objective of increasing market share or total assets. Table 4

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[18] Proposition 2 in Boyd and De Nicoló (2005) states that, in a symmetric interior Nash equilibrium, the equilibrium level

presents our empirical analysis of these issues using our baseline specification, but with deposit market competition measures. For these concentration measures, the regression results in the first two columns show that the relationship is not linear, fitting the non-linear pattern proposed by Martínez-Miera and Repullo (2007). For low values of these concentration measures, increases in concentration cause an increase in NPL ratios, but beyond an inflection point situated at roughly a C5 value of 60.5% and an HHI value of 14.7, increases in concentration are correlated negatively with NPL ratios. These calculated inflection points are situated at the sixth percentile for the C5 measure and at the 24th percentile for the HHI measure. In a sense, these results suggest that the franchise value paradigm is not rejected 94% and 76% of the time, respectively, by these deposit market concentration measures.

The following four columns of Table 4 present the Lerner index results. Market power in repo transactions and demand deposits do not seem to have an impact on bank risk-taking. Only for total deposits (column 5) is greater market power negatively correlated with risk, but only at a 10% significance level. These results support the assumption of a separation between the loan and deposit markets we used before to derive the marginal cost for the Lerner indexes. The last column in Table 4 shows clear evidence in favor of the franchise value paradigm as more market power, coming either from the loan or deposit markets, leads to less bank risk-taking.

Overall, we find evidence supporting the franchise value paradigm in that market power in loan markets leads to less bank risk-taking in that markets. Concentration in the loan market has no impact on problem loans, while deposit concentration seems to support the franchise value paradigm in most cases.

5. Robustness analysis

In this section, we present the results of four robustness tests.[19] The first examines the concern that the overall level of interest rates, a key determinant of funding costs, do not follow the

of risk-shifting is strictly decreasing in the number of banks.

business cycle perfectly. To address this concern, we include an annual average of the overnight interbank interest rate in the regression.

Table 5 shows the results after including the current and the lagged level of real interest rates as an additional control variable. The new variables are positive and significant, except in the last three columns where only the lagged value is significant. The GDP growth rate variable is still negative and significant although its absolute value has declined, in particular, for the contemporaneous period. These results suggest that real interest rates are important macroeconomic determinants of NPL ratios, but they do not displace the standard business cycle indicator. Bank characteristics are now less significant, and the results do not change much overall. Regarding the main variables of interest, the concentration measures of the number of banks and the C5 index are again found not to be significant, while the HHI linear parameter is now positive and significant at the 10% level. The last three columns show negative and very significant parameters for the three loan market Lerner indexes. Therefore, we find again a positive relationship between market power and the solvency of Spanish banks as measured by NPL ratios. Furthermore, a substitution of time dummies for our macroeconomic effects does not change the overall qualitative nature of our results.

The second robustness test addresses the concern that other controls for bank characteristics are needed to capture the firm-specific variation in the data. If we add to the baseline model a solvency ratio (calculated as equity over total assets), we find that it is not statistically significant. The sign and significance level of the other variables do not change. This result suggests that the variables we used are probably sufficient for our analysis. We also address the specification of bank size by using an alternative measure based on the logged total assets. We find similar results for our concentration and market power variables, but the other bank control variables are no longer significant.

For the third set of robustness tests, we take advantage of the level of detail in the interest rate database. We estimated our baseline model separately for the ratio of non-performing loans in

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[19] All results not shown here are available upon request.

receivables and in credit lines.[20] Similarly, we construct all of the competition variables based just on the separate product lines. The results are very similar to those for the prior aggregated estimation. The concentration measures are never significant at the 5% level. The parameters on the Lerner index based just on receivables are both negative and significant at the 1% level, while only the linear term for the Lerner index based on credit lines is negative and very significant. Therefore, even if we focus specifically in the two main segments of corporate lending separately, we find strong support for the franchise value paradigm.

We also used the data set to examine the impact of the risk premium component of the Lerner indexes for commercial loan products. Specifically, we substituted the banks' overall PD measure (that is, considering mortgages and consumer loans as well as commercial loans) into the product-line Lerner indexes instead of the product-line PDs. This approach should mitigate concerns about the potential endogeneity of those Lerner measures.[21] Again, we find similar qualitative results as in Table 3.

Finally, since we have used weighted averages across all provinces for our competition measures, we examined alternative weighting schemes. For example, we excluded national banks with a presence in all provinces in order to focus more closely on local bank competition. The empirical results remain similar to those presented in Tables 3 and 4. Similarly, if we remove banks that operate in half (i.e., 25) of the provinces and if we focus only on those banks that operate in less than 5 provinces (i.e., truly local banks), all the results regarding the relationship between market power and risk measures remain intact even though the number of observations declines significantly.

Overall, our baseline results seem reasonably robust to various changes in the specification of the variables. Therefore, we have found robust support for the franchise value paradigm in contrast to the BDN and MMR models that allow for greater bank competition to lead to less bank

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[20] We thank Allen Berger for suggesting this robustness exercise.
[21] For example, the simple correlation between NPL ratios for commercial loans and the PD of mortgage loans is 0.11, as compared to 0.37 for the PD of total loans. Moreover, endogeneity concerns between NPL and the Lerner indexes are

risk and more financial stability. At least for Spanish banks during a period of 16 years, there is evidence of a trade-off between bank competition and stability.

6. Conclusions

In the academic literature and in the actual supervision of banking systems worldwide, the dominant paradigm is that franchise value plays a key role in limiting the riskiness of individual banks and hence of banking systems more broadly (e.g., Keeley, 1990). That is, as a bank's franchise value increases, its management and shareholders will typically limit and/or reduce its risk exposure to preserve this value. The underlying source of franchise value is typically assumed to be market power and, hence, reduced competition or, equivalently, market concentration has been considered to promote banking stability.

Boyd and De Nicoló (BDN, 2005) challenge the traditional view through what we call the "risk-shifting" paradigm. They argue that market concentration could impact bank stability in different ways, depending on the net effect across deposit and loan markets. In particular, they claim that the current consensus has ignored the "loan market channel" and hence may lead to incorrect conclusions. Specifically, the authors suggest that concentration in the loan market could lead to increased lending rates that both raise the borrowers' debt loads and default probabilities as well as their incentive to engage in riskier projects (via moral hazard as in Stiglitz and Weiss, 1981). More recently, Martínez-Miera and Repullo (MMR, 2007) extend the BDN model to allow for a U-shaped relationship between competition and bank risk-taking, so that, both franchise value and risk-shifting could be possible.

Using unique datasets regarding the Spanish banking system, we explicitly examine the relationship between bank competition and risk. Our dependent variable is a bank's ratio of non-performing commercial loans, which is the variable addressed directly in the BDN and MMR

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properly addressed through the GMM estimation procedure.

models. After controlling for macroeconomic conditions and bank characteristics, we examine the impact of various measures of competition in both the loan and deposit markets. We find that the number of banks, which is the measure highlighted in both models, has no effect on NPL ratios or, if any, it is positive. In addition, other concentration measures, such as the C5 and HHI indexes for loan and deposit markets separately and together, do not affect bank NPL ratios.

These measures of market concentration are typically used as a proxy for measures of market (or pricing) power, which are more direct measures of an institution's ability to collect monopoly rents. For the Spanish banking system, we are able to construct market power measures based on Lerner indexes using bank-specific marginal interest rates on a variety of loan and deposit products. Our empirical results show that Lerner measures of loan market power do have a negative relationship with bank risk; that is, as market power increases, bank NPL ratios decrease. This result is direct evidence support of the franchise value paradigm. With respect to Lerner measures of deposit market power, most of them have no relationship with the level of bank risk-taking. Joint loan and deposit Lerner indexes have a negative and very significant impact on banks' non-performing loan ratios. Our results do not support the existence of the risk-shifting effects permitted in the BDN and MMR models.

The contribution of our paper is to perform a limited (i.e., Spanish banking market) but rather precise, test of bank competition versus bank risk in order to provide guidance for banking regulation policies related to competition and financial stability. Our empirical results for the Spanish market provide additional support for the franchise value paradigm. While our study is limited to a single country, the long time period of study and the closeness of the empirical variables to the theoretical constructs should weaken the empirical standing of alternative market power paradigms.

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Figure 1. Time series of the non-performing loan ratio

This figure shows the time evolution of the non-performing loan ratio (%) of the sample of banks used in the study by quartiles (i.e., Q25, Median and Q75). The time period analyzed spans from 1988 to 2003

Figure 2A. Time series of the Lerner index for the whole loan portfolio

This figure shows the time evolution of the Lerner index for the whole loan portfolio of the sample of banks used in the study by quartiles (i.e., Q25, Median and Q75). The time period analyzed spans from 1988 to 2003

Figure 2B. Time series of the Lerner index for all deposits

This figure shows the time evolution of the Lerner index for all deposits of the sample of banks used in the study by quartiles (i.e., Q25, Median and Q75). The time period analyzed spans from 1988 to 2003

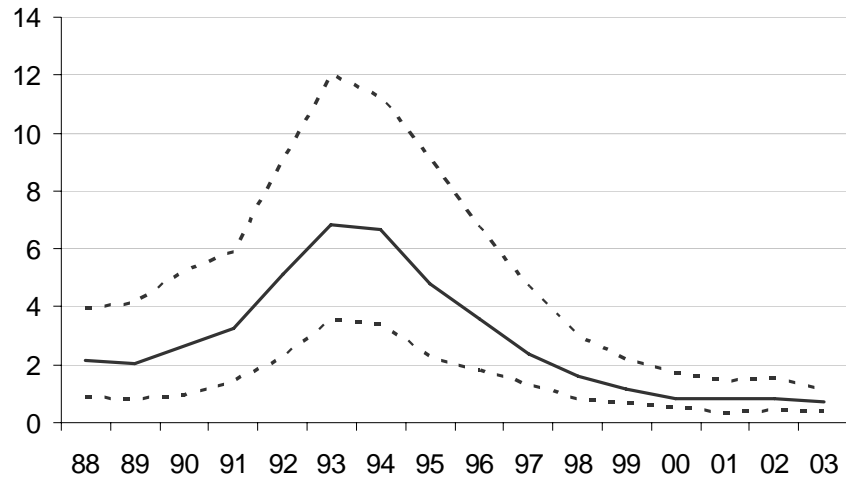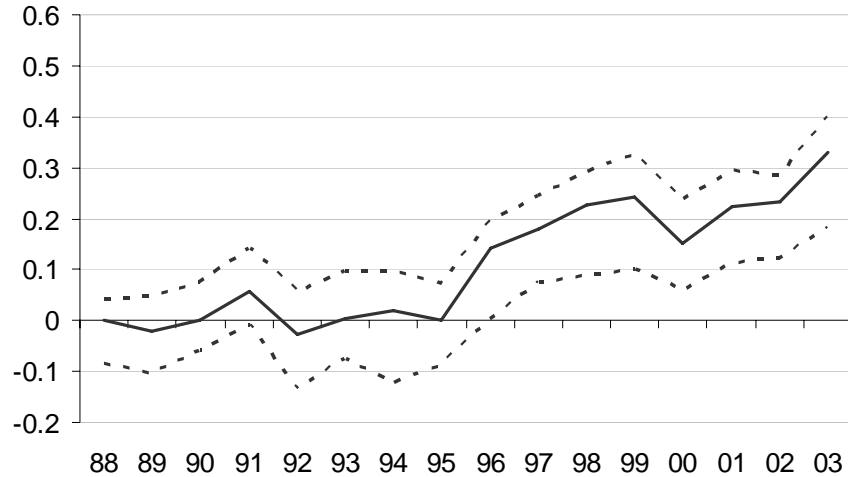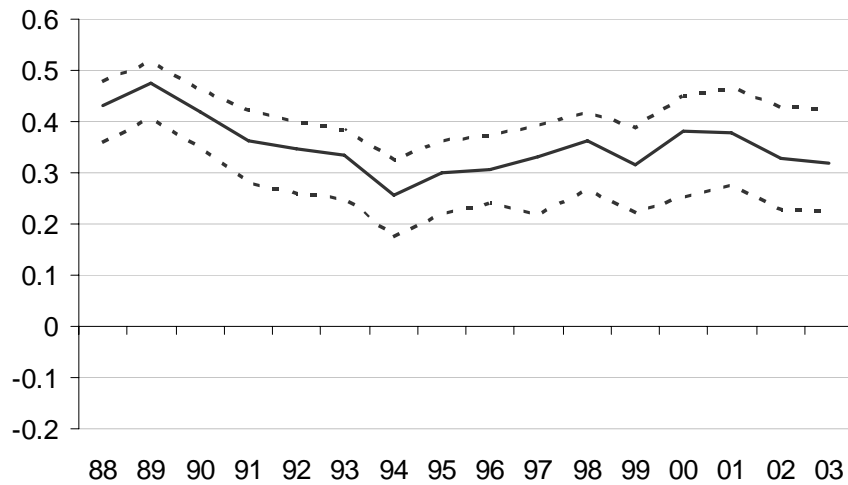# Table 1. Descriptive statistics for bank-year observations

NPL$_{it}$ is the commercial non-performing loan ratio of bank i at time t; *GDPG$_t$* is the real GDP growth rate of the Spanish economy at time t; *INTEREST RATE$_t$* is the one-day real interbank interest rate at time t; *SIZE$_{it}$* is the market share of bank i at time t in terms of total loans; *LOAN RATIO$_{it}$* measures the specialization of firm i at time t in the non-financial sector through the ratio of loans to firm over total assets; *ROA$_{it}$* is the return on assets of bank i at time t; *Number of banks$_{it}$* is the number of banks that has the representative province for bank i at time t, calculated as the weighted average (by total loans) over all the provinces where the bank grants loans (the other concentration and competition measures are obtained in the same way); C5 denotes the share of the 5 largest banks in the representative province for bank i at time t; *Her$_{it}$* is the Herfindahl index of concentration for the representative province of bank i at time t, calculated in each province as the sum of banks' squared market shares in loans granted in the province; *Lerner$_{it}$* is the Lerner index of bank i in year t defined for product l of the asset side as $(R_l - R)/ R_l$, where R is the credit risk adjusted marginal cost of product l for bank j granted in year t, while it is defined as $(R- R_l)/ R$ when the product l is a liability. The time period analyzed spans from 1988 to 2003. We have 1,632 observations from which, after taking first differences and instrumenting remain 1,262 corresponding to 107 unique banks (commercial and savings banks).

Variables	Mean	S.D	Median	Minimum	Maximum
NPL$_{it}$	4.44	4.93	2.66	0.00	38.02
GDPG$_t$	2.92	1.56	2.76	-1.03	5.04
INTEREST RATE$_t$	3.57	2.85	3.56	-0.67	8.12
SIZE$_{it}$	0.70	1.27	0.28	0.00	9.32
LOAN RATIO$_{it}$	25.41	12.55	23.00	0.08	90.14
ROA$_{it}$	0.66	1.19	0.72	-16.19	11.08
Number of banks$_{it}$	75.93	24.77	73.00	22.00	148.00
C5_loans$_{it}$	57.73	6.60	58.44	40.00	74.25
Her_loans_firms$_{it}$	8.22	1.86	8.09	4.14	15.02
Lerner_receivables$_{it}$	0.15	0.39	0.19	-7.96	0.64
Lerner_credit_lines$_{it}$	-0.10	0.50	0.00	-6.09	0.70
Lerner_loans$_{it}$	0.05	0.53	0.11	-12.27	0.52
C5_deposits$_{it}$	68.00	5.61	67.35	53.70	84.64
Her_deposits$_{it}$	16.77	3.67	16.33	7.58	28.57
Lerner_REPO_operations$_{it}$	0.09	0.11	0.07	-1.24	0.67
Lerner_sight_accounts$_{it}$	0.45	0.17	0.43	-0.35	0.77
Lerner_deposits$_{it}$	0.35	0.11	0.36	-0.49	0.68
Lerner_loans+Lerner_deposits$_{it}$	0.40	0.56	0.47	-11.82	1.05

Table 2. Correlation coefficients

NPL_{it} is the commercial non-performing loan ratio of bank i at time t; $GDPG_t$ is the real GDP growth rate of the Spanish economy at time t; $INTEREST\ RATE_t$ is the one-day real interbank interest rate at time t; $SIZE_{it}$ is the market share of bank i at time t in terms of total loans; $LOAN\ RATIO_{it}$ measures the specialization of firm i at time t in the non-financial sector through the ratio of loans to firm over total assets; ROA_{it} is the return on assets of bank i at time t; $Number\ of\ banks_{it}$ is the number of banks that has the representative province for bank i at time t, calculated as the weighted average (by total loans) over all the provinces where the bank grants loans (the other concentration and competition measures are obtained in the same way); C5 denotes the share of the 5 largest banks in the representative province for bank i at time t; Her_{it} is the Herfindahl index of concentration for the representative province of bank i at time t, calculated in each province as the sum of banks' squared market shares in loans granted in the province; $Lerner_{it}$ is the Lerner index of bank i in year t defined for product l of the asset side as $(R_l - R)/R_l$, where R is the credit risk adjusted marginal cost of product l for bank j granted in year t, while it is defined as $(R - R_l)/R$ when the product l is a liability. ***; **; *; significant at the 1%, 5% and 10% levels

Variables																		
NPL_{it}	1																	
$GDPG_t$	-0.458 ***	1																
$INTEREST\ RATE_t$	0.414 ***	-0.544 ***	1															
$SIZE_{it}$	-0.095 ***	-0.010	-0.017	1														
$LOAN\ RATIO_{it}$	-0.377 ***	0.135 ***	-0.263 ***	0.088 ***	1													
ROA_{it}	-0.216 ***	0.090 ***	0.012	-0.025	0.061 **	1												
$Number\ of\ banks_{jt}$	0.040	-0.069 **	0.169 ***	0.179 ***	-0.062 **	-0.355 ***	1											
$C5\_loans_{jt}$	-0.216 ***	0.252 ***	-0.508 ***	-0.095 ***	0.162 ***	0.227 ***	-0.649 ***	1										
$Her\_loans\_firms_{jt}$	-0.106 ***	0.165 ***	-0.392 ***	-0.132 ***	0.115 ***	0.206 ***	-0.630 ***	0.853 ***	1									
$Lerner\_receivables_{jt}$	-0.189 ***	0.033	-0.106 ***	0.018	0.180 ***	0.158 ***	-0.167 ***	0.013	0.046	1								
$Lerner\_credit\_lines_{jt}$	-0.557 ***	0.269 ***	-0.329 ***	-0.033	0.125 ***	0.240 ***	-0.251 ***	0.237 ***	0.189 ***	0.142 ***	1							
$Lerner\_loans_{jt}$	-0.465 ***	0.303 ***	-0.429 ***	-0.019	0.135 ***	0.240 ***	-0.299 ***	0.213 ***	0.186 ***	0.551 ***	0.719 ***	1						
$C5\_deposits_{jt}$	-0.177 ***	0.155 ***	-0.448 ***	-0.167 ***	0.111 ***	0.196 ***	-0.676 ***	0.820 ***	0.773 ***	0.101 ***	0.276 ***	0.288 ***	1					
$Her\_deposits_{jt}$	-0.109 ***	0.082 ***	-0.280 ***	-0.155 ***	0.076 ***	0.128 ***	-0.428 ***	0.537 ***	0.591 ***	0.083 ***	0.199 ***	0.202 ***	0.837 ***	1				
$Lerner\_REPO\_operations_{jt}$	0.034	-0.127 ***	0.487 ***	0.000	0.014	0.138 ***	-0.034	-0.100 ***	-0.127 ***	-0.021	0.001	-0.118 ***	-0.182 ***	-0.187 ***	1			
$Lerner\_sight\_accounts_{jt}$	-0.097 ***	0.133 ***	-0.195 ***	-0.155 ***	-0.105 ***	0.040	-0.155 ***	0.187 ***	0.159 ***	-0.059 **	0.108 ***	0.096 ***	0.216 ***	0.227 ***	-0.075 ***	1		
$Lerner\_deposits_{jt}$	-0.089 ***	0.086 ***	0.047 *	-0.090 ***	-0.181 ***	0.180 ***	-0.185 ***	0.171 ***	0.145 ***	-0.005	0.183 ***	0.123 ***	0.160 ***	0.155 ***	0.312 ***	0.749 ***	1	
$Lerner\_loans+Lerner\_deposits_{jt}$	-0.446 ***	0.301 ***	-0.366 ***	-0.049 *	0.056 **	0.278 ***	-0.333 ***	0.251 ***	0.217 ***	0.490 ***	0.706 ***	0.936 ***	0.314 ***	0.235 ***	0.006	0.352 ***	0.465 ***	1

Table 3. Baseline estimations. Loan market

$$\ln\left(\frac{\text{NPL}_{it}}{100-\text{NPL}_{it}}\right) = \alpha + \beta \ln\left(\frac{\text{NPL}_{it-1}}{100-\text{NPL}_{it-1}}\right) + \delta_1 \text{COMPETE}_{it} + \delta_2 \text{COMPETE}^2 + \gamma_1 \text{GDPG}_t + \gamma_2 \text{GDPG}_{t-1} + \phi_1 \text{ROA}_{it}$$

$$+ \phi_2 \text{SIZE}_{it} + \phi_3 \text{LOAN RATIO}_{it} + \eta_i + \varepsilon_{it},$$

NPL_{it} is the commercial non-performing loan ratio of bank i at time t; $GDPG_t$ is the real GDP growth rate of the Spanish economy at time t; $SIZE_{it}$ is the market share of bank i at time t in terms of total loans; $LOAN\ RATIO_{it}$ measures the specialization of firm i at time t in the non-financial sector through the ratio of loans to firm over total assets; ROA_{it} is the return on assets of bank i at time t; $Number\ of\ banks_{it}$ is the number of banks that has the representative province for bank i at time t, calculated as the weighted average (by total loans) over all the provinces where the bank grants loans (the other concentration and competition measures are obtained in the same way); C5 denotes the share of the 5 largest banks in the representative province for bank i at time t; Her_{it} is the Herfindahl index of concentration for the representative province of bank i at time t, calculated in each province as the sum of banks' squared market shares in loans granted in the province; $Lerner_{it}$ is the Lerner index of bank i in year t defined for product l of the asset side as $(R_l - R)/R_l$, where R is the credit risk adjusted marginal cost of product l for bank j granted in year t, while it is defined as $(R - R_l)/R$ when the product l is a liability. The time period analyzed spans from 1988 to 2003. We have 1,632 observations from which, after taking first differences and instrumenting remain 1,262 corresponding to 107 unique banks. Standard errors (SE) of estimated coefficients consistent to any pattern of heteroskedasticity within banks . ***, **, *, mean statistically significant at 1%, 5% and 10%, respectively.

Dependant variable	Ln(NPL$_{it}$/(100-NPL$_{it}$))		Ln(NPL$_{it}$/(100-NPL$_{it}$))		Ln(NPL$_{it}$/(100-NPL$_{it}$))		Ln(NPL$_{it}$/(100-NPL$_{it}$))		Ln(NPL$_{it}$/(100-NPL$_{it}$))		Ln(NPL$_{it}$/(100-NPL$_{it}$))	
X$_{it}$	Ln(# banks)		C5_loans		Her_loans_firms		Lerner_receivables		Lerner_credit_lines		Lerner_loans	
Estimation method	GMM First Differences		GMM First Differences		GMM First Differences		GMM First Differences		GMM First Differences		GMM First Differences	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Persistence												
Ln(NPL$_{it-1}$/(100-NPL$_{it-1}$))	0.529	7.24 ***	0.516	7.98 ***	0.522	8.04 ***	0.503	9.03 ***	0.436	7.42 ***	0.494	8.72 ***
GDPG$_t$	-0.147	-12.03 ***	-0.155	-12.10 ***	-0.151	-12.03 ***	-0.134	-11.39 ***	-0.118	-10.36 ***	-0.122	-10.58 ***
GDPG$_{t-1}$	-0.035	-1.75	-0.024	-1.54	-0.036	-2.21 **	-0.063	-5.12 ***	-0.041	-3.17 ***	-0.059	-4.66 ***
X$_{it}$	-5.584	-1.11	-0.040	-0.58	-0.215	-1.83 *	-0.694	-4.7 ***	-1.423	-6.43 ***	-0.937	-5.1 ***
X$_{it}^2$	1.645	1.39	0.000	0.41	0.010	1.48	-0.074	-4.15 ***	-0.443	-3.97 ***	-0.079	-4.46 ***
SIZE$_{it}$	-0.711	-3.00 ***	-0.570	-2.85 ***	-0.535	-2.69 ***	-0.451	-2.99 ***	-0.393	-2.80 ***	-0.498	-3.34 ***
LOAN RATIO$_{it}$	-0.028	-4.24 ***	-0.032	-3.97 ***	-0.028	-3.53 ***	-0.023	-2.97 ***	-0.011	-1.65	-0.014	-1.89 *
ROA$_{it}$	-0.028	-0.66	-0.031	-0.69	-0.025	-0.56	-0.072	-0.91	-0.055	-1.06	-0.017	-0.26
No. Observations	1,262		1,262		1,262		1,155		1,155		1,155	
F test (p-value)	0.000		0.000		0.000		0.000		0.000		0.000	
Test 1^{rst} order serial correlatoin (m1) /p-value	-3.90	0.00	-5.23	0.00	-5.26	0.00	-4.48	0.00	-4.36	0.00	-4.36	0.00
Test 2nd order serial correlatoin (m2) /p-value	-1.47	0.14	-1.60	0.11	-1.54	0.12	-1.46	0.14	-1.23	0.22	-1.34	0.18
Hansen test (p-value)	1.00		1.00		1.00		1.00		1.00		1.00	
Bank fixed effects, η_i	yes		yes		yes		yes		yes		yes	

Table 4. Baseline estimations. Deposit market

$$\ln\left(\frac{NPL_{it}}{100-NPL_{it}}\right) = \alpha + \beta \ln\left(\frac{NPL_{it-1}}{100-NPL_{it-1}}\right) + \delta_1 COMPETE_{it} + \delta_2 COMPETE^2 + \gamma_1 GDPG_t + \gamma_2 GDPG_{t-1} + \phi_1 ROA_{it}$$
$$+ \phi_2 SIZE_{it} + \phi_3 LOAN\ RATIO_{it} + \eta_i + \varepsilon_{it},$$

NPL_{it} is the commercial non-performing loan ratio of bank i at time t; $GDPG_t$ is the real GDP growth rate of the Spanish economy at time t; $SIZE_{it}$ is the market share of bank i at time t in terms of total loans; $LOAN\ RATIO_{it}$ measures the specialization of firm i at time t in the non-financial sector through the ratio of loans to firm over total assets; ROA_{it} is the return on assets of bank i at time t; $Number\ of\ banks_{it}$ is the number of banks that has the representative province for bank i at time t, calculated as the weighted average (by total loans) over all the provinces where the bank grants loans (the other concentration and competition measures are obtained in the same way); C5 denotes the share of the 5 largest banks in the representative province for bank i at time t; Her_{it} is the Herfindahl index of concentration for the representative province of bank i at time t, calculated in each province as the sum of banks' squared market shares in loans granted in the province; $Lerner_{it}$ is the Lerner index of bank i in year t defined for product l of the asset side as $(R_l -R)/ R_l$, where R is the credit risk adjusted marginal cost of product l for bank j granted in year t, while it is defined as $(R- R_l)/ R$ when the product l is a liability. The time period analyzed spans from 1988 to 2003. We have 1,632 observations from which, after taking first differences and instrumenting remain 1,262 corresponding to 107 unique banks. Standard errors (SE) of estimated coefficients consistent to any pattern of heteroskedasticity within banks . ***, **, *, mean statistically significant at 1%, 5% and 10%, respectively.

Dependant variable	Ln(NPL$_{it}$/(100-NPL$_{it}$))		Ln(NPL$_{it}$/(100-NPL$_{it}$))		Ln(NPL$_{it}$/(100-NPL$_{it}$))		Ln(NPL$_{it}$/(100-NPL$_{it}$))		Ln(NPL$_{it}$/(100-NPL$_{it}$))		Ln(NPL$_{it}$/(100-NPL$_{it}$))	
X$_{it}$	C5_deposits		Her_deposits		Lerner_REPO_operations		Lerner_sight_accounts		Lerner_deposits		Lerner_loans+Lerner_deposits	
Estimation method	GMM First Differences		GMM First Differences		GMM First Differences		GMM First Differences		GMM First Differences		GMM First Differences	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Persistence												
Ln(NPL$_{it-1}$/(100-NPL$_{it-1}$))	0.505	7.38 ***	0.498	7.30 ***	0.577	10.19 ***	0.541	7.42 ***	0.572	9.14 ***	0.496	8.07 ***
GDPG$_t$	-0.139	-10.06 ***	-0.138	-11.11 ***	-0.147	-14.27 ***	-0.151	-13.47 ***	-0.149	-12.90 ***	-0.126	-10.57 ***
GDPG$_{t-1}$	-0.041	-2.36 **	-0.046	-2.68 ***	-0.048	-4.04 ***	-0.030	-1.74 *	-0.012	-0.75	-0.037	-2.77 ***
X$_{it}$	0.426	2.48 **	0.161	2.43 **	0.191	0.46	0.218	0.31	0.440	0.51	-0.855	-4.88 ***
X$_{it}^2$	-0.004	-2.66 ***	-0.005	-3.15 ***	0.075	0.08	-0.924	-1.340	-1.719	-1.69 *	-0.078	-4.99 ***
SIZE$_{it}$	-0.609	-3.17 ***	-0.531	-2.87 ***	-0.435	-2.60 **	-0.445	-2.98 ***	-0.534	-3.31 ***	-0.534	-3.23 ***
LOAN RATIO$_{it}$	-0.017	-1.98 **	-0.028	-3.86 ***	-0.026	-3.30 ***	-0.033	-3.88 ***	-0.035	-4.49 ***	-0.017	-2.31 **
ROA$_{it}$	-0.035	-0.77	-0.013	-0.32	0.003	0.08	-0.086	-0.90	-0.068	-0.83	-0.013	-0.26
No. Observations	1,262		1,262		1,155		1,155		1,155		1,155	
F test (p-value)	0.000		0.000		0.000		0.000		0.000		0.000	
Test 1^{rst} order serial correlatoin (m1) /p-value	-5.17	0.00	-5.15	0.00	-4.42	0.00	-4.25	0.00	-4.40	0.00	-4.23	0.00
Test 2nd order serial correlatoin (m2) /p-value	-1.26	0.21	-1.43	0.15	-0.68	0.50	-1.31	0.19	-1.13	0.26	-1.22	0.22
Hansen test (p-value)	1.00		1.00		1.00		1.00					
Bank fixed effects, η_i	yes		yes		yes		yes		yes		yes	

Table 5. Baseline including real interest rates

$$\ln\left(\frac{NPL_{it}}{100-NPL_{it}}\right) = \alpha + \beta \ln\left(\frac{NPL_{it-1}}{100-NPL_{it-1}}\right) + \delta_1 COMPETE_{it} + \delta_2 COMPETE^2 + \gamma_1 GDPG_t + \gamma_2 GDPG_{t-1} + \gamma_3 INTERESTt\ RATE_t$$

$$+ \gamma_4 INTEREST\ RATE_{t-1} + \phi_1 ROA_{it} + \phi_2 SIZE_{it} + \phi_3 LOAN\ RATIO_{it} + \eta_i + \varepsilon_{it},$$

NPL_{it} is the commercial non-performing loan ratio of bank i at time t; $GDPG_t$ is the real GDP growth rate of the Spanish economy at time t; $INTEREST\ RATE_t$ is the one-day real interbank interest rate at time t; $SIZE_{it}$ is the market share of bank i at time t in terms of total loans; $LOAN\ RATIO_{it}$ measures the specialization of firm i at time t in the non-financial sector through the ratio of loans to firm over total assets; ROA_{it} is the return on assets of bank i at time t; $Number\ of\ banks_{it}$ is the number of banks that has the representative province for bank i at time t, calculated as the weighted average (by total loans) over all the provinces where the bank grants loans (the other concentration and competition measures are obtained in the same way); C5 denotes the share of the 5 largest banks in the representative province for bank i at time t; Her_{it} is the Herfindahl index of concentration for the representative province of bank i at time t, calculated in each province as the sum of banks' squared market shares in loans granted in the province; $Lerner_{it}$ is the Lerner index of bank i in year t defined for product l of the asset side as $(R_l - R)/R_l$, where R is the credit risk adjusted marginal cost of product l for bank j granted in year t, while it is defined as $(R - R_l)/R$ when the product l is a liability. The time period analyzed spans from 1988 to 2003. We have 1,632 observations from which, after taking first differences and instrumenting remain 1,262 corresponding to 107 unique banks. Standard errors (SE) of estimated coefficients consistent to any pattern of heteroskedasticity within banks . ***, **, *, mean statistically significant at 1%, 5% and 10%, respectively.

Dependant variable	Ln(NPL_it/(100-NPL_it))		Ln(NPL_it/(100-NPL_it))		Ln(NPL_it/(100-NPL_it))		Ln(NPL_it/(100-NPL_it))		Ln(NPL_it/(100-NPL_it))		Ln(NPL_it/(100-NPL_it))	
X_it	Ln(# banks)		C5_loans		Her_loans_firms		Lerner_receivables		Lerner_credit_lines		Lerner_loans	
Estimation method	GMM First Differences		GMM First Differences		GMM First Differences		GMM First Differences		GMM First Differences		GMM First Differences	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Persistence												
Ln(NPL_it-1/(100-NPL_it-1))	0.534	7.88 ***	0.528	7.89 ***	0.496	7.55 ***	0.567	9.91 ***	0.511	7.64 ***	0.547	8.66 ***
GDPG_t	-0.097	-5.50 ***	-0.081	-4.11 ***	-0.078	-4.05 ***	-0.069	-4.25 ***	-0.069	-5.17 ***	-0.071	-4.62 ***
GDPG_t-1	-0.051	-2.49 **	-0.045	-2.21 **	-0.053	-2.76 ***	-0.057	-3.92 ***	-0.032	-2.14 **	-0.052	-3.12 ***
Real interest rate_t	0.035	2.30 **	0.050	2.91 ***	0.053	2.78 ***	0.022	1.54	0.010	0.85	0.012	0.96
Real interest rate_t-1	0.040	2.04 **	0.056	3.02 ***	0.063	3.79 ***	0.072	4.57 ***	0.066	4.99 ***	0.070	4.70 ***
X_it	-5.676	-0.71	0.081	1.27	0.199	1.76 *	-0.544	-4.08 ***	-1.173	-5.82 ***	-0.742	-4.29 ***
X_it^2	1.477	0.78	-0.001	-1.19	-0.007	-1.35	-0.051	-3.06 ***	-0.386	-3.62 ***	-0.066	-4.25 ***
SIZE_it	-0.441	-1.96 *	-0.339	-1.89 *	-0.363	-2.13 **	-0.257	-2.27 **	-0.169	-1.36	-0.309	-2.89 ***
LOAN RATIO_it	-0.007	-0.84	-0.006	-0.69	-0.007	-0.87	0.006	0.58	0.009	1.16	0.009	1.09
ROA_it	-0.046	-0.96	-0.059	-1.12	-0.045	-0.92	-0.181	-1.89 *	-0.132	-2.10 **	-0.101	-1.27
No. Observations	1,262		1,262		1,262		1,155		1,155		1,155	
F test (p-value)	0.000		0.000		0.000		0.000		0.000		0.000	
Test 1rst order serial correlatoin (m1) /p-value	-4.08	0.00	-4.17	0.00	-5.47	0.00	-4.84	0.00	-4.62	0.00	-4.65	0.00
Test 2nd order serial correlatoin (m2) /p-value	-1.50	0.13	-1.45	0.15	-1.59	0.11	-1.20	0.23	1.00	0.32	-1.12	0.26
Hansen test (p-value)	1.00		1.00		1.00		1.00		1.00		1.00	
Bank fixed effects, η_i	yes		yes		yes		yes		yes		yes	