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Abstract

This paper investigates the relationship between credit market competition and the availability of bank credit for firms of unobserved credit quality when firms pledge collateral to secure the loans. Loan data from the Spanish Credit Register shows that the average credit quality of borrowers that get loans in a provincial market decreases with market concentration (which is shown to be positively correlated with market power) and with the availability of collateral, although the marginal effect of each variable decreases for higher values of the other. We also find that credit lines' interest rates increase with the availability of collateral, but the increase is lower for banks operating in more concentrated credit markets. Therefore market power in credit markets and collateral appear as substitutes to increase the availability of bank finance under asymmetric information.

JEL classification: G21.

Keywords: collateral; competition; asymmetric information; relationship banking.

1 Introduction

Are collateral and credit market competition complements or substitutes when it comes to facilitate bank credit to firms of different quality? Petersen and Rajan (1995) show that under information asymmetries between borrowers and lenders young and opaque firms will have more credit available and at lower cost in credit markets where banks have market power than in perfectly competitive credit markets. This welfare enhancing effect of market power of banks challenges the most conventional view that market power causes a social dead weight loss. However, little is known about how credit market competition and use of collateral interact in determining the availability and cost of credit, even though to pledge collateral is a well-documented common practice in loan contracts[1]. If we find that collateral is an alternative to market power in increasing credit availability to firms, then fostering competition in credit markets at the pace at which more collateral is available will increase both static and dynamic efficiency of credit markets. This paper provides empirical evidence supporting this conclusion. The literature that focuses on the role played by financial markets in economic growth[2] largely ignores collateral availability. The results presented here call for a more careful scrutiny of the role played by collateral in determining the relationship between financial development and economic growth.

Townsend (1982) shows that multi period contracting is more efficient than single period contracting in dealing with adverse selection and moral hazard. Credit availability to firms will increase when lending banks have market power, compared with credit availability when they do not, because market power makes more difficult for borrowing firms to renegotiate the contract *ex post* and consequently multiperiod contracting becomes more feasible [Petersen and Rajan (1995)]. On the other hand, Bester (1985), and Besanko and Thakor (1987a and b), among others, show that to pledge collateral can mitigate adverse selection and moral hazard problems in credit markets. Therefore, collateral can be an alternative to market power of banks to increase availability of bank finance for firms.

In this paper we evaluate the substitution between market power and collateral by extending the Petersen and Rajan model on multiperiod contracting. This will allow banks to ask for collateral as a condition for granting a loan. Petersen and Rajan show that market power lowers the lower bound of credit quality of new borrowers that get finance, since it increases the pay off of the bank in future periods. The extended model shows that collateral also lowers the average quality of borrowers that get bank finance in a given credit market. The reason is that with collateral banks can ask for higher interest rates in the first period without violating the moral hazard constraint that forces borrowers to choose the good project. Consequently, the acceptable probability that the borrower is of good quality, from the break-even condition of the bank, can be lower. Thus, our extension shows that the effect of higher market power in credit availability is lower in markets with collateral than in markets without collateral. In other words, collateral and market power are substitutes when it comes to increase credit availability.

In addition, the paper investigates the consequences of the interaction between collateral and market power in determining the loan interest rate. First period interest rate is

1. See Berger and Udell (1990); Harhof and Körting (1998); Jiménez, Salas and Saurina (2006), and John, Lynch and Puri (2003).

2. See King and Levine (1993), Levine and Zervos (1998) or Rajan and Zingales (1998).

an increasing function of the lower bound in borrowers' credit quality in the particular market. Variables that affect the lower bound such as market power and collateral will affect the interest rate. The prediction from the model is that the average interest rate in bank loans to borrowers of unobserved credit quality will increase for banks lending in markets where lower credit quality borrowers get loans, but the increase will be lower in markets where banks have more market power. The result is expected to hold when credit quality is substituted by availability of collateral.

Empirical predictions are tested using extensive data from two different Spanish datasets. On the one hand, the Spanish Credit Register (CIR), which collects all bank loans granted to non-financial firms between 1985 and 2002. From these database we construct measures of credit risk of borrowers that get bank loans, credit market concentration and use of collateral, in each of the 50 geographic markets (Spanish provinces) at the end of the year. On the other hand, we also collect data from files of interest rates reported by banks on new credit lines granted to non financial companies every year from 1988 to 2002. Bank loans are the main source of external finance for Spanish non-financial firms. The long period of time covered by the analysis includes a full business cycle and a period of nominal convergence in the Spanish economy before joining the EMU area. In this process nominal and real interest rates, together with interest rate spreads, have fallen significantly while financial institutions upgraded their policies towards credit risk. Therefore, the Spanish case offers a natural experiment to evaluate the relationship between credit market competition, use of collateral and credit availability.

Using the province level data we find that the average credit quality of borrowers in a province decreases with availability of collateral and with credit market concentration in that province. We also observe that the cross effect of the two explanatory variables is positive, so the net effect of each variable is higher at low values of the other. The empirical relationship between interest rates of bank loan, collateral and market concentration is consistent with the results obtained with province data. A positive effect of market concentration in the availability of credit to borrowers of lower quality is also documented in Petersen and Rajan (1995) with US data on loans to small and medium size firms. But the interaction between credit market concentration and availability of collateral as joint determinants of the availability of credit for low quality borrowers is new in the empirical literature.

Market power is a key variable in theoretical models but difficult to observe and measure in empirical analysis. In this paper, as in Petersen and Rajan original paper, banks' market power is assumed to increase with credit market concentration (Herfindahl index) of the respective province. Although the use of the Herfindahl index as a proxy for market power of banks in papers that investigate the relationship between market power and credit availability is very common[3], there is also a controversy on whether the concentration index do in fact measure market power, specially in deregulated markets with free entry, Claessens and Laeven (2003)[4]. Our paper provides direct evidence that a bank in more concentrated credit markets charges a higher mark up in loans, supporting the use of the Herfindahl index

3. See Cetorelli and Gambera (2001); Cetorelli (2004); Bonaccorsi di Patti and Dell'Ariccia (2005); Jayaratne and Strahan (1998), and Black and Strahan (2002).

4. These authors find that in a cross country analysis the Panzar-Rose measure of market power is more correlated with barriers to entry than with market concentration, and from this result they question the use of concentration as a measure of market power. However, they do not account for differences in credit risk premium in the calculation of mark ups.

as a measure of the banks' market power. To test this we have used the Lerner index, relative profit margin in credit lines of banks, as a measure of market power, where interest rates are actual rates charged by banks for this particular loan product and the marginal cost of the loan is calculated using data on the estimated credit risk of the bank. The unique dataset used to test the relationship between market power and concentration, together with the generalized use of market concentration in empirical studies on the effects of market power of banks in credit availability and the debate around it, makes this analysis of interest in itself.

The results of the paper have an important implication for competition policies and for the workings of credit markets. Besides Petersen and Rajan's (1994 and 1995) initial results showing the welfare enhancing effects of market power of banks in terms of helping young firms to get bank finance, other papers find mixed evidences and raise some caveats [see Cetorelli (2004) for a review]. Moreover, Cetorelli and Gambera (2001) find that credit market concentration has a net negative effect (when considering young and incumbent firms) on total credit availability. Our results suggest that as countries become wealthier and more collateral is available, there is room for increasing market competition and gain in static efficiency without endangering dynamic efficiency in terms of entry and growth of new firms, since to pledge collateral can substitute market power in solving moral hazard and adverse selection problems.

The remaining of the paper is divided as follows. Section 2 contains the model while the database and the empirical hypotheses to be tested appear in Section 3. We show the results of the estimation in Section 4 and finally, Section 5 contains a discussion and the main conclusions.

2 A model of moral hazard in lending with collateral

The model presented in this section is an extension of Petersen and Rajan (1995). In the first stage, banks face an adverse selection problem since entrepreneurs can be of good or bad quality (with a known proportion of each class in the whole population), but the credit quality of a particular borrower is unknown for the lender. If the loan is granted, in period two (second stage) there is a moral hazard situation since good entrepreneurs can choose between a safe and a too risky investment project. Banks are the only source of external finance, they can only hold debt claims and contracts cannot be made contingent on the project taken. Our main contribution is to introduce the possibility that borrowers pledge collateral in the loan they receive. The use of collateral allows lenders to charge higher interest rates in the early time periods of the relation without creating moral hazard problems in the decision about the project choice (safe or risky project). For this reason, collateral lowers the quality of the marginal borrower that gets finance.

The model assumes a market with borrowers of two types, good or bad. There are three periods. At t=0 borrowing entrepreneurs can invest I_0 either in a safe or in a risky project. If the investment is made by a good entrepreneur, the safe project pays S_1 in t=1. When the project concludes there will be a new investment opportunity in a safe project of size I_{1S}, that returns S_2 in t=2. If the good entrepreneur invests in the risky project in t=1 obtains R_1 with probability p and 0 with probability 1-p. If the project succeeds, there is a new risky investment opportunity at t=1, I_{1R}, that pays R_2 with probability p in t=2. Investments by bad entrepreneurs get nothing in t=1, regardless of the project.

Safe projects have positive net present value ($S_2 + S_1 - I_{1s} - I_0 > 0$), while the expected NPV of the risky ones is negative [$p\,(R_2 + R_1 - I_{1R}) - I_0 < 0$]. Future projects with positive NPV started in t=1, have all the same expected returns and investment requirements, regardless of the project chosen in t=0 ($pR_2 = S_2 > pI_{1R} = I_{1S}$). Finally, the entrepreneurs need bank finance in t=1 to continue investing since the revenues from the projects invested in t=0 are insufficient to finance investments in t=1 ($I_{1S} > R_1 > S_1$).

At t=0 banks only know that a fraction θ of the entrepreneurs that demand finance are good, but each entrepreneur knows her quality. Banks learn about entrepreneur's type over the course of the relationship, so it is assumed that at t=1 the bank knows the kind of agent it is dealing with. At t=0, when the information asymmetries exist, the lender has some discretion in how much interest to charge for the loan. But at t=1, under full information, it will charge a rate such that the return in loans is M, where M is a measure of the market power of the bank (M=1 in a competitive market, while M>1 indicates that the bank has market power). The risk free interest rate is supposed to be zero.

In the Petersen and Rajan model entrepreneurs go to the bank and ask for a loan of a given amount and maturity. The bank responds by asking an interest rate with expected return less or equal to M. If no interest rate gives the bank an expected return larger than or equal to the opportunity cost (equal to one), it turns down the loan.

Our extension of the model incorporates the use of collateral through its amount C, where $0 \leq C < I_0$, at t=0 to secure the loan. We first solve the model assuming that banks quote the corresponding interest rate and ask for collateral.

Being aware that they can take advantage of the full information situation at t=1, good entrepreneurs will borrow the lowest possible amount at t=0, I_0. If D_1 is the amount that a good entrepreneur repays in t=1, the amount of funds to borrow in t=1 to invest in the safe project will be $I_{1s} – (S_1 – D_1)$. Given the outcome of the safe project in period 2, S_2, and the risk-free full-information rate M the entrepreneur pays for the borrowed funds, the net-profits in period 1 from choosing the safe project at t=0 will be:

$$\text{Max } \{S_2 – M[I_{1s} – (S_1 – D_1)], 0\}. \quad (1)$$

Similarly, the expected profit from choosing the risky project having pledged collateral is:

$$\text{Max } \{p (R_2 – M [I_{1r} – (R_1 – D_1)]) – (1 – p) C, 0\}. \quad (2)$$

Good entrepreneurs will choose the safe project if the expected profits are at least as high as the profits from the risky one. From the assumptions of the model, safe projects will be chosen if the repayment at t=1 satisfies,

$$[S_1 – p R_1] / (1 – p) + C / M \geq D_1. \quad (3)$$

A second condition for financing the investment is that the bank expects to recover the finance provided in t=0, I_0. Since the entrepreneur asking for a loan can be good or bad, the bank will get a positive return in the first case and zero in the second one. Charging M to the amount borrowed at t=1, the return for the bank in case the entrepreneur is good will be $D_1 + (M – 1) [I_{1S} – (S_1 – D_1)]$. The bank estimates in θ the probability that an entrepreneur is good, so the expected return from lending is $\theta [D_1 + (M – 1) (I_{1S} – (S_1 – D_1))]$. This value has to be greater or equal to the amount lend at t=0, I_0. Solving for the value of D_1 that satisfies this condition,

$$D_1 \geq I_0 / (M\theta) – [(M – 1) / M] (I_{1s} – S_1). \quad (4)$$

Combining (3) and (4), the minimum value of the proportion of good borrowers in the market θ that can get finance is given by $\theta_m (M,C)$ such that,

$$\theta_m (M, C) = I_0 (1 – p) / [M (S_1 – pR_1) + (M – 1) (I_{1s} – S_1) (1 – p) + C (1 – p)]. \quad (5)$$

Equation (5) is an extension of equation (6) in Petersen and Rajan for the case when borrowers are asked to pledge collateral[5], i.e., if C=0, then $\theta_m (M, 0)$ is the same as $\theta(M)$ in PR.

Result 1:

a) The use of collateral decreases the threshold value on the minimum proportion of good entrepreneurs in the market that get bank finance, compared with the threshold with no collateral, $\theta_m (M, C) < \theta_m (M, 0)$. Therefore, with collateral, borrowers of lower credit quality obtain bank finance.

5. That is, $\theta_m (M) = I_0 (1 – p) / [M (S_1 – pR_1) + (M – 1) (I_{1s} – S_1) (1 – p)]$.

b) As the market power M of the lender increases, the threshold value of the proportion of good borrowers that gets finance decreases. Therefore, firms of lower credit quality will get finance. This result holds with and without collateral and is Result 1 of Petersen and Rajan[6].

c) The rate at which θ_m (M, C) decreases with the use of collateral (market power) is lower in markets with more market power M (collateral), than in markets with less market power (collateral). This means that market power and use of collateral are substitutes when it comes to facilitate access to credit to borrowers of lower quality[7].

With collateral, the lender can charge a higher initial interest rate without violating the moral hazard constraint (3) than when there is no collateral, which implies that the non-negative expected profit condition of the bank can be satisfied with a lower fraction of high quality borrowers in the market. On the other hand, higher market power means that the lender can charge higher interest rates in the future and, thus, it can extract more rents from the borrower. In exchange, it can charge a lower initial interest rate D_1, which in turn implies that the lender has higher incentives to choose the safe project. Alternatively, for a given repayment, banks can find profitable to grant loans with a lower fraction of good borrowers in the market. Result c) comes from equation (5) where market power and the use of collateral enter in a non-additive way and the presence of one of them moderates the contribution of the other to increase credit availability to borrowers of lower quality[8].

2.1 Loan interest rates

The model can be extended to predictions about the interest rate of loans. In period t=1 interest rate is equal to M but in period t=0 the interest charged is limited by the upper bound of the moral hazard constraint (3) and by the lower bound of the participation constraint (4). Both constraints are binding for the lower credit quality to get finance, θ_m (M, C). For a given credit quality θ, equation (4) implies that the lower limit of D_1 decreases with M, and the initial interest rate charged to the lowest quality borrower that gets finance is lower in markets where banks have higher market power [this is Result 2 of Petersen and Rajan (1995)]. In our extended model, use of collateral raises the upper and the lower bound in initial interest rate. The raise in upper bound is immediate from equation (3) and the raise in the lower bound comes from equation (4) and equation (5); collateral lowers the minimum credit quality that gets finance and since θ decreases, the lower bound in initial interest rate increases. Therefore, collateral raises the initial interest rate to low credit quality borrowers. Equations (3) and (4) also show that the absolute slope of the relationship between initial interest rate and market power is lower in markets with more collateral.

Data on interest rate of loans for firms of different age in a particular market are not available. For this reason, predictions on interest rates of loans to young firms as a function of collateral and market power cannot be directly tested. What we have is data on average monthly quoted interest rates of new loans granted by bank j; loans can be to firms in different provinces and to firms of different age, old and new, but these variables are not

6. As in Petersen and Rajan, we draw the implication that a lower threshold for the proportion of good entrepreneurs in order to grant a loan implies a lower minimum credit quality of borrowers that get loans. This implication is justified if we assume that banks estimate the probability of a good borrower conditional to the information available at the time of the first loan, and they grant the loan as long as this credit quality is below the threshold.

7. That is, the cross derivative of θ_m in (5) with respect to collateral C and market power M is positive.

8. Inderst and Mueller (2005) postulate a model that also predicts a positive association between use of collateral in loans and credit market competition. Their explanation is based upon the finding that collateral allows lenders to extract higher surplus in competitive credit markets than otherwise and less projects with positive NPV are rejected.

observable during year t, where bank j can grant loans in several geographic credit markets (provinces) and to firms of different age. Interest rate of loans granted by a bank in a given period of time includes both, initial interest rates for loans that start in t=0, D_1 in the model, and second period, t=1, interest rates for loans to good borrowers equal to M_j , where M_j represents the market power in the representative market of bank j. Interest rate of bank j will be affected by market power in a positive and in a negative way: higher market power will rise the interest of loans to good quality borrowers but will also lower the initial interest rate to low quality borrowers [equation (4)], so the net effect is undetermined. But we still expect that market power moderates the positive effect of availability of collateral in higher interest rates from the negative effect of collateral in average quality of borrowers that get a loan from a particular bank. Therefore, the effect on interest rates can be summarized in the next result:

Result 2:

Interest rates of loans to firms will increase with the availability of collateral in the credit market, but the increment will be lower in credit markets with higher market power for banks.

3 Data, empirical models and predictions

3.1 Database

To test the predictions of the model, the main sources of information are the Credit Register database of Banco de España and data on interest rates charged in new loans to firms granted by each Spanish bank. The CIR provides data on all *new* loans granted to firms by all Spanish banks and other intermediaries during a given year and their status over time. That is, any loan granted by any Spanish bank over a minimum threshold of 6,000 euros must be registered in the CIR. Given the small threshold, almost all loans to firms (i.e. business loans) are included. For each loan, information is available about amount, type of instrument, currency, collateral, maturity, identification of the borrower, industry, region, identity of the lender and if the loan is in default or not at the end of the year. Banks have access to the total exposure of the borrower in the Spanish banking system at the time the loan is granted. They also know if the firm is in default in any of its existing loans. However, the CIR does not inform about historical data of borrower's previous defaults[9].

The time period covered in the analysis goes from 1985 to 2002. We identify 50 different geographic markets, one for each of the fifty Spanish provinces. To test Result 1, in each province we measure market power, availability of collateral and credit quality of borrowers that get loans in the province. No direct measure of banks' market power in the province is available because banks operate in multiple provinces and the interest rates in each province market are unknown. As Petersen and Rajan (1995), we assume that market power is higher in provinces with higher bank credit concentration, measured by the Herfindahl index of the province, equal to the sum of squared market shares of all business loans granted by banks in the province at the end of each year.

Information about interest rates is available at the bank level. Spanish banks report monthly to Banco de España the average interest rate of loans granted during the past 30 days. We focus on interest rates for credit lines since it is the more representative loan to firms in Spain. The interest rate in credit lines of bank *j* in year *t*, r_{jt}, is equal to the average of interest rates reported by the bank each of the twelve months of the year. We estimate the marginal cost of loans granted by a particular bank as follows. Let *PD* be the estimated probability of default for a loan granted by the bank, let *LGD* be the loss given default of the loan and let *i* be the risk free interest rate of loans of equal maturity. The marginal cost of the loan for the bank in period *t* is the risk adjusted rate i_l that solves the equation,

$$(1+i_l)(1-PD)+PD(1-LGD)(1+i_l)=1+i \qquad (6)$$

Solving for i_l,

$$i_l=\frac{i+PD\cdot LGD}{1-PD\cdot LGD}. \qquad (7)$$

The *PD* values are obtained for each bank using the CIR database and they are equal to credit lines in default of the bank *j* in period *t+1* divided by total credit lines in year t. We assume banks have perfect foresight and at the time the loan is granted they anticipate

9. A more detailed description of the CIR content can be found in Jiménez, Salas and Saurina (2006).

the observed rate of default in the next period. The *LGD* of each individual bank are not available and we assume, following BCBS (2004) recommendations, a common value of 45% for all banks. The risk free interest rate is set equal to the one year interbank rate.

3.2 Empirical models

The empirical analysis will focus on the predictions from Result 1 and from Result 2. Result 1 refers to the quality of borrowers that will get bank finance in credit markets with more or less availability of collateral and with different banks' market power (market concentration). Equation (5) and Result 1 are translated into the following empirical predictions:

i) Average quality of borrowers obtaining finance will be lower in provinces with higher credit market concentration (higher market power) and in provinces where borrowers pledge more collateral.

ii) The difference in the average quality of borrowers in the province with less collateral, with respect to the quality in the province with more collateral, is higher in less concentrated provinces.

Credit Quality of borrowers that get bank finance in each province is measured, in an inverse way, by the amount of business loans in default (i.e. 90 days past due) or doubtful loans over the total amount of outstanding bank loans to firms in province *i* at the end of year *t*, $PRBADLO_{it}$. A higher value of the non-performing loan ratio will indicate that the quality of borrowers that get loans in the province is lower than in other provinces where the ratio is lower. The availability of collateral in each province is measured in terms of volume of pledged collateral, that is, amount of loans with collateral over total amount lend to firms, $COLL_{it}$. Market power of banks will be assumed to be proportional to the concentration of the credit market in the province, $HERFINDAHL_{it}$.

The empirical model is then formulated as follows:

$$\begin{aligned} PRBADLO_{it} &= \beta_0 PRBADLO_{it-1} + \beta_1 HERFINDAHL_{it} + \beta_2 COLL_{it} + \beta_3 \\ & HERFINDAHL_{it} x COLL_{it} + \eta_i + d_t + \varepsilon_{it}, \end{aligned} \qquad \text{(Eq.1)}$$

where η_i is a dummy variable that takes the value of 1 for province *i* and 0 otherwise, d_t is a time dummy variable and ε_{it} is the error term. The province (η_i) and time (d_t) dummy variables control for unobserved fixed effects.

Taking into account that the dependent variable is an inverse measure of the credit quality of the borrowers in each market, the theory predicts (Result 1) that the estimated coefficients will satisfy $\beta_1 > 0$, $\beta_2 > 0$ and $\beta_3 < 0$.

The observed proportion of loans with collateral in a market will be a function of the amount of collateral borrowers can pledge and a function of the decision of banks to ask for collateral as a condition to grant the loan. We assume that potential borrowers have more collateral available to be pledged in richer than in poorer provinces. Wealth of provinces is measured by the house price index of the province in year t, $HOUSING_{it}$. On the other hand, the model in section 2 implies a lower minimum threshold for the quality of borrowers that can get a loan with no collateral, θ_m, in markets with higher market power of banks. For a given quality and personal wealth of borrowers, the proportion of loans (and volume lend) with collateral will be higher in markets with low threshold value than in markets with high threshold. In conclusion, less observed collateral can then be expected in provinces with higher market power of banks. Therefore, the variable collateral can be written as a function of wealth and market concentration,

$$COLL_{it} = \gamma_0 + \gamma_1 \, Ln\,(HOUSING_{it}) + \gamma_2 \, HERFINDAHL_{it} \tag{8}$$

where γ_1 is expected to be positive and γ_2 negative. Substituting (8) in (*Eq 1)*, we obtain the alternative empirical formulation of the model,

$$\begin{aligned} PRBADLO_{it} &= \varphi_0 PRBADLO_{it-1} + \varphi_1 HERFINDAHL_{it} + \varphi_2 Ln(HOUSING_{it}) + \\ &\varphi_3 Ln(HOUSING_{it}) HERFINDAHL_{it} + \varphi_4 HERFINDAHL^2_{it} + \eta_i + d_t + \varepsilon_{it} \end{aligned} \qquad \text{(Eq.1')}$$

where taking into account the values and signs of the original parameters, $\varphi_1 = (\beta_1\gamma_2 + \beta_2)$ can be positive or negative since the two terms of the sum have opposite signs; $\varphi_2 = \beta_1\gamma_2 > 0$*;* $\varphi_3 = \beta_3\gamma_1 < 0$; *and* $\varphi_4 = \beta_3\gamma_2 > 0$.

The estimation method is the GMM for dynamic models with panel data [Arellano and Bond (1991)]. Firstly, this method takes first differences in (Eq. 1) to get rid off the province fixed effects. Then suitable lags of the levels of the right-hand-side (RHS) variables are used as instruments to build orthogonal moments in the GMM estimation. The validity of the instruments will be assessed with the Hansen's test; Arellano-Bond's test for autocorrelation will also be reported. An AR(1) process for the residuals is expected in first differences, because $\Delta\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{it-1}$ should be correlated with $\Delta\varepsilon_{it-1} = \varepsilon_{it-1} - \varepsilon_{it-2}$, since they share the ε_{it-1} term.

Result 2, on the other hand, refers to predictions about the relationship between observed average interest rates in business loans charged by banks and market power and availability of collateral. Market power in the representative market of bank *j* is measured by the variable $BHERFINDAHL_{jt}$, calculated as the weighted sum of the Herfindahl index of all the provinces where the bank has granted a loan in period *t*, using as weights the proportion of business loans of the bank in province *i* over total business loans of the bank. Availability of collateral in the representative credit market of bank *j,* $BCOLL_{jt}$, and credit quality of borrowers that obtain a loan in such market, $BPRBADLO_{jt}$ are calculated in a similar way as the weighted sum of the $COLL_{it}$ and $PRBADLO_{it}$ defined above, respectively.

The empirical prediction about determinants of differences in interest rates of credit lines across banks is formulated as follows:

iii) Interest rates of banks' credit lines increase with the availability of collateral in the representative provinces of the banks, but the marginal effect of availability of collateral in interest rates decreases with credit market concentration in the representative province.

The empirical model is formulated as follows,

$$\begin{aligned} Ln(1+r_{jt}) &= \alpha_1 Ln(1+i_t) + \alpha_2 Ln(1-BCOLL_{jt}) + \alpha_3 BHERFINDAHL_{jt}\,x Ln(1-BCOLL_{jt}) \\ &+ \alpha_4 LnGDPC_{jt} + \eta_j + \varepsilon_{jt} \end{aligned} \qquad \textit{(Eq 2)}$$

where i_t is the one year interbank interest rate which accounts for time varying changes in the risk free interest rate, $GDPC_{jt}$ is the gross domestic product per capita of representative market of bank *j* in period *t* which is introduced for control purposes, and η_j are bank fixed effects. The specification of the model takes into account that from (7), perfect competition implies $(1 + r_{jt}) = (1 + i_t) / (1 - PD_{jt}\, LGD)$. Taking logs to both sides of the equation we have the interest rate $Ln\,(1 + r_{jt})$ as a function of the risk free interest rate $Ln\,(1 + i_t)$ and of the term $Ln\,(1 - PD_{jt}\, LGD)$ that is the quality of borrowers of bank *j*. From section 2 we predict that quality of the borrowers that get a loan from a particular bank will be a function of the amount of collateral and of the level of concentration in the representative market of the bank. The predictions summarized in iii) imply a negative sign for α_2 and positive for α_1 and α_3.

4 Results

4.1 Descriptive statistics

The amount of loans in default represents, in average for all provinces and years, 5.41% of the total loans, Table I (Panel A). The dispersion is fairly high as it goes from 0.37% to 28.34% with a standard deviation of 4.32. The period under study includes the deep recession of the early nineties that affected severely the most industrialized provinces of Spain. That is why average non-performing loan ratios increase significantly for the period 1991-1996, in sharp contrast with the final years of the sample.

The average Herfindahl index across provinces and years is 7.57%, which implies an equivalent to around 14 banks of equal size in the province. Again, differences in concentration are rather high (minimum value of 2.52% and maximum of 42.48%, Table I, Panel A), and the numbers have to be interpreted under the intense merger activity that has taken place during the time period of the study, in both commercial and savings banks, and the expansion of savings banks outside their traditional territories[10]. The average Herfindahl index shows an increasing trend along time. Therefore, the consolidation trends dominate over the dispersion effect of entry of new banks.

Finally, collateral pledged in loans represents, on average, 25.5% of the face value of total loans, although in some provinces and time periods collateral represented up to 58.7% of the total loans granted. The proportion of the *number* of loans with collateral (not reported) is 11.4%, lower than the proportion of volume, thus, the use of collateral is more likely as the size of the loan increases.

Bank level variables include interest rates in credit lines, estimated marginal costs of these loans and characteristic of the representative market of each bank, such as availability of collateral, average quality of borrowers, concentration and GDPC. Panel B of Table I provide descriptive statistics for these variables in logs. We observe the decline in interest rates of loans over time from approximately 15% average in 1985-1990 to 6% ten years later. The decline goes parallel to that of the interbank rate that goes from 13 % to 4%. The Lerner index, $L_{jt} = (r_{jt} - i_{ljt})/r_{jt}$ shows a negative average value for all banks and years, but we must keep in mind that the index is computed over credit risk adjusted marginal cost of the credit line and that the Spanish economy was in a serious recession during several years of the whole period.

10. Average Herfindahl index for Spanish provinces is around half the average value of the Herfindahl index reported in US local markets (Metropolitan Statistical Area, MSA) and used in most empirical studies. For example, Black and Strahan (2002) report an average deposit Herfindahl index of 19.1 across MSAs in state (standard deviation of 6.7). The reason is that the province is a larger territory than the MSA. The coefficient of variation in our provinces, 0.5=3.5/7.6, is similar to the date reported by Black and Strahan, 0.4=6.7/19.1.

Table I. Descriptive statistics

Panel A: Province level data

Average, minimum, maximum and standard deviation values of the variables in the period from 1985 to 2002. $PRBADLO_{it}$ is the non-performing loan ratio in province *i* at year *t*. $HERFINDAHL_{it}$ is the index of credit market concentration equal to the sum of banks squared market shares in loans made in each one of the fifty Spanish provinces in year *t*. $COLL_{it}$ is the proportion of the amount of collateral over the total amount of business loans in province *i* at the end of year *t*.

	1985-1990	1991-1996	1997-2002	1985-2002			
		Average		Average	Min	Max	SD
$PRBADLO_{it}$ (%)	5.56	8.48	2.20	5.41	0.37	28.34	4.32
$HERFINDAHL_{it}$ (%)	6.85	7.09	8.77	7.57	2.52	42.48	3.47
$COLL_{it}$ (%)	20.10	27.09	29.30	25.50	6.29	58.67	8.07

Panel B: Bank level data

Average, minimum, maximum and standard deviation values of the variables in the period from 1985 to 2002. R_{jt} is the average interest rate of credit lines of bank *j* in year *t*. i_t is the interbank interest rate in year *t*. $BPRBADLO_{jt}$ is the proportion of bad loans in representative province market of bank *j* in year *t*. Equal to the weighted average of $PRBADLO_{it}$, with weights equal to the proportion of total loans of the bank in the province in year *t*. In the same way we define and calculate bank level variables $BCOLL_{jt}$, $BHERFINDAHL_{jt}$ and $BGDPC_{jt}$ from $COLL_{it}$, $HERFINDAHL_{it}$ and $GDPC_{jt}$, respectively. PD_{jt} is the probability of default for credit lines of bank *j* in year *t* compiled directly from bank data. *LGD* is the loss given default assumed constant and equal to 45%. L_{jt} is the Lerner index of bank *j* in year *t,* defined as $L_{jt} = (R_{jt} - i_{ljt}) / R_j$, where i_{ljt} is the credit risk adjusted marginal cost of credit lines of bank *j* granted in year *t*

	1985-1990	1991-1996	1997-2002	1985-2002			
		Average		Average	Min	Max	SD
$Log(1+R_{jt})$	0.15	0.12	0.06	0.11	0.04	0.19	0.04
$Log(1+i_t)$	0.13	0.10	0.04	0.08	0.03	0.14	0.04
$Log(1-BPRBADLO_{jt})$	-0.04	-0.07	-0.02	-0.04	-0.19	-0.01	0.03
$Log(1-BCOLL_{jt})$	-0.19	-0.26	-0.28	-0.25	-0.68	-0.11	0.07
$Log(1-PD_{jt}*LGD)$	-0.04	-0.05	-0.02	-0.04	-0.60	0.02	0.04
$BHERFINDAHL_{jt}$ (%)	5.16	6.18	8.08	6.59	3.37	15.14	1.80
$Log(BGDPC_{jt})$	2.37	2.47	2.64	2.50	1.85	2.90	0.17
L_{jt}	-0.11	-0.22	0.02	-0.11	-7.19	0.62	0.50

4.2 Herfindahl index as a measure of market power

Cournot type competition in markets with homogeneous products predicts that, in equilibrium, the average relative profit margin (i.e. the Lerner index), of the firms in the market is proportional to the Herfindahl index of market concentration. It is also shown that collusion and monopoly solutions are easier to sustain in more concentrated markets than in less concentrated ones [Tirole (1988), chapters 5 and 6)]. These results justify the use of the Herfindahl index as a measure of market power. There is however mixed empirical evidence on whether the Herfindahl index is a good proxy of market power [Claessens and Laeven, (2003)]. For this reason we provide our own evidence in this respect.

We test for a positive association between concentration and market power estimating the empirical model,

$$L_{jt} = \alpha L_{jt-1} + \beta BHERFINDAHL_{jt} + d_t + \eta_j + u_{jt}$$

where L_{jt} is the Lerner index, d_t is a time dummy variable and η_j is a bank fixed effect. We expect β to be positive. The first lag of the dependant variable in the right hand side controls for the great persistence of the variable over time. The Arellano-Bond (1991) dynamic panel data estimation of the model gives an estimate of parameter β equal to 0.179, standard error of 0.093 and p-value of 0.055[11]. Therefore, the hypothesis that higher levels of the Herfindahl index are associated with higher levels of market power is not rejected with our data.

4.3 Access to credit in province markets

The results of estimating equation (Eq. 1) are shown in Table II. The dependent variable is transformed so the domain of the new variable goes from minus to plus infinite: $PBD_{it} = \text{Log}\,[PRBADLO_{it} / (100–PRBADLO_{it})]$.

Model 1 in Table II excludes cross effects between concentration and use of collateral for comparative purposes, while in Model 2 cross effects are included. Both models include as an explanatory variable the lagged dependent variable to account for persistent effects of bad loans over time.

All specification tests (Hansen and autocorrelation) are verified. In Model 1 the two main explanatory variables have positive coefficients as predicted from the theory (although only the coefficient on collateral is significant) and, therefore, more collateral implies lower average quality of borrowers that get loans in province markets (i.e. empirical prediction *i).*

In Model 2 the coefficients of the two variables continue to be positive but now are both significant and their values are twice those in Model 1, while the cross-effect variable has a negative and significant coefficient, as expected. This evidence is consistent with the theoretical prediction that credit availability for low credit quality borrower increases with collateral (market power) but the slope of the relationship is lower in markets with higher market power (collateral). Thus, empirical prediction ii) cannot be rejected.

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11. Time period 1985-2002. Equation estimated in first differences using Arellano and Bond (1991) GMM estimator. Instruments used up to lag t-2 for the lagged dependent variable and lags t-2 and t-3 for $BHERFINDAHL_{jt}$ Hansen's test gives p-value of 0.29 and the tests for first-order (m1) and second-order (m2) serial correlation of the residuals (in differences) give respectively p-values of 0.06 and 0.21, respectively. Robustness tests include estimation with market concentration treated as exogenous and with $BGDPC_{jt}$ in place of time dummies. In all cases the null hypothesis of no association between Lerner index and market concentration is rejected at p values of <10%. If we assume that the relationship between the Lerner index and the Herfindahl index comes from a Cournot competition model the inverse of the estimated beta is equal to the short term elasticity of demand of credit lines, while its long term value is $\beta/(1-\alpha)$. Since the estimated value of α is 0.631, then the implicit long term elasticity is 0.485.

Table II

Results of the estimation of the model:

$$PBD_{it} = \beta_0 PBD_{it-1} + \beta_1 HERFINDAHL_{it} + \beta_2 COLL_{it} + \beta_3 HERFINDAHL_{it} xCOLL_{it} + \eta_i + d_t + \varepsilon_{it}$$

on the determinants of average credit quality of borrowers that get bank loans in the different geographic markets (Spanish provinces). Time period 1985-2002. Equation (Eq. 1) estimated in first differences (to eliminate province fixes effects η_i) using Arellano and Bond (1991) one step GMM estimator. Dependant variable, *PBD_{it},* is the logistic transformation of the non-performing loan ratio in province *i* in year *t* (*$PRBADLO_{it}$*) in order to have a non bounded dependant variable: *$PBD_{it} = Ln[PRBADLO_{it} / (100–PRBADLO_{it})]$*. The lagged dependent variable is introduced as an explanatory variable to account for persistence effects over time. *$HERFINDAHL_{it}$* is the index of credit market concentration, equal to the sum of squared market shares of banks in all business loans granted in province *i* in year *t*. *$COLL_{it}$* is the proportion of the amount of collateral over the total amount of business loans at the end of year *t*. Model 3 uses the log of Price index of housing (*$HOUSING_{it}$*) as a measure of availability of collateral in province *i* and year *t*. All the variables are treated as endogenous, using up to lag t-2. The tables show Hansen's test as well as test for first-order (m1) and second-order (m2) serial correlation of the residuals (in differences). Standard errors (SE) of estimated coefficients consistent to any pattern of heteroskedasticity within banks. Year dummies, d_t, included. ***, **, *, mean statistically significant at 1%, 5% and 10%, respectively.

Variable	**Model 1**		**Model 2**		**Model 3**	
Dependent Variable	PBD_{it}		PBD_{it}		PBD_{it}	
Estimation	Arellano-Bond		Arellano-Bond		Arellano-Bond	
	Coefficient	*SE*	*Coefficient*	*SE*	*Coefficient*	*SE*
PBD_{it-1}	0.634	0.036 ***	0.610	0.032 ***	0.616	0.050
$HERFINDAHL_{it}$	0.013	0.012	0.049	0.012 ***	0.193	0.100
$COLL_{it}$	0.014	0.004 ***	0.034	0.006 ***	--	--
$COLL_{it}$ * $HERFINDAHL_{it}$	--	--	-0.002	0.000 ***	--	--
Log($HOUSING_{it}$)	--	--	--	--	0.599	0.205
Log$(HOUSING)_{it}$ * $HERFINDAHL_{it}$	--	--	--	--	-0.037	0.015
$HERFINDAHL^2_{it}$	--	--	--	--	0.002	0.001
No. Observations	800		800		712	
Hansen test (p-value)	1.00		1.00		1.00	
Test 1^{rst} order serial correlation (m1) /p-value	-4.90	0.00	-4.97	0.00	-4.67	0.00
Test 2nd order serial correlation (m2) /p-value	-1.12	0.26	-1.11	0.27	-1.60	0.11

The short-term difference in the proportion of bad loans in two markets i and k with levels of collateral $COLL_{it}$ and $COLL_{kt}$, is given by $(PBD_{it}–PBD_{kt}) = (0.034–0.002 \times HERFINDAHL_t) (COLL_{it}–COLL_{kt})$, or $(PBD_{it}–PBD_{kt}) = 0.02(COLL_{it}–COLL_{kt})$ for the sample mean of the Herfindahl index equal to 7.57 (Table I, Panel A). The sample average of COLL is 25.5% and the standard deviation is 8.11% (Table I). Therefore, provinces with a proportion of loans with collateral one standard deviation above the sample mean will have an odds ratio of bad loans 34% higher than a market with proportion of collateral one standard deviation below the mean: $Log [PRBADLO_{it} / (100–PRBADLO_{it})] – Log [PRBADL_{kt} / (100–PRBADLO_{kt})] = 0.02x16.2 = 0.50.$

If we do the same calculation in two province markets with Herfindahl index one standard deviation below (above) the sample mean, *HERFINDAHL* = 4 (11), the relative increase in the log-odds ratio is 44.2% (20.4%). The results have economic and as well as statistical significance: In credit markets with "high" concentration of banks the marginal effect of availability of collateral in reducing the credit quality of borrowers that get a loan can be half the marginal increase observed in markets with "low" concentration. The complementary evidence provided above indicates that concentration is positively related with market power and therefore the evidence confirms the substitutability between market power and collateral in solving moral hazard and adverse selection problems that affect credit availability for new firms.

Model 3 present the results of the estimation when collateral is replaced by a function of housing prices and market concentration, (Eq 1'). All the estimated coefficients are significantly different from zero and have the expected signs, including the coefficient of the Herfindahl index. The amount of loans with collateral in a market is function of supply (wealth in real assets of the market) and demand conditions (the threshold value of credit quality below which no loans without collateral are granted which in turn depends on market concentration) and when observed collateral is substituted by the function that is expected to determine it, the empirical results are exactly those expected, for example a quadratic relationship between proportion of bad loans in the province and concentration of banks in the province credit market. Robustness test, for example substituting proportion of volume of loans collateralized by the proportion in the number of loans with collateral as explanatory variable, keep all the conclusions unchanged.

Therefore, the evidence confirms that wealth conditions, availability of collateral, and market concentration (market power) are substitutes in increasing supply of bank credit to lower credit quality borrowers, in the sense that at high values of one of the two variables the marginal effect of increasing the other is relatively low.

4.4 Collateral and interest rates

We now test empirical prediction iii) estimating (Eq. 2), Table III. In Models 1, and 2 all the explanatory variables are considered exogenous since the interest rate (the dependent variable) is a bank level variable while the explanatory variables are province level variables. In Model 3 explanatory variables are also bank level variables and they are treated as endogenous and instrumented using the Arellano and Bond one step GMM estimation system. In this model the effect of the interbank interest rate is captured with the first lag of the dependant variable since the model specification test improve with this substitution. Model 1 is the one that directly tests the relationship between interest rates collateral and market concentration. In Model 2 collateral is replaced by the average quality of borrowers that get bank loans in the representative province of the bank.

Interbank interest rate is the variable with higher explanatory power for the interest rates in credit lines. Banks in provinces with higher proportion of loans with collateral and in provinces with higher proportion of bad loans charge higher interest rates in loans but in both cases the marginal effect of the explanatory variable is lower in markets with higher market power (higher concentration)[12]. For example, the elasticity of interest rates of credit lines with respect to the proportion of loans with collateral in the representative province of the bank is 6.8% if the Herfindahl index of the province is 3, one standard deviation below the mean, and 3,3% if the concentration index is 10, one standard deviation above the mean.

Results of Table III, column 1, have been subject to several robustness tests. Model 3 replaces the province level variables of models 1, and 2 by the bank level variable proportion of bad loans of the bank itself, PD. As indicated above the variable is treated as endogenous and properly instrumented. The results are consistent with those of Model 2 where bad loans represent average values for all banks in the representative province. Second, we estimate the model excluding those banks that concentrate the mayor part of their banking activity in one province, in particular banks whose representative Herfindhal index is above the percentile 75 (we also exclude those above the percentile 50). The results are practically unchanged compared with those of column 1 even in the case where the sample size falls down to one half. In another robustness check we add the Herfindahl index as an additional explanatory variable of the interest rates. The estimated coefficient of the market concentration variable is not statistically significant and the rest of coefficients slightly increase in absolute values[13].

12. Berger and Udell (1990) also find a positive association between interest rate and use of collateral in individual loans granted by US banks to small and medium size firms, but they do not explore the effect of market competition in use of collateral and implications for interest rates.

13. Since the dependent variable includes interest rates of credit lines to old and new firms the effect of market concentration in interest rate is ambiguous.

Table III

Results of the estimation of the model:

$$Ln(1+r_{jt}) = \alpha_1 Ln(1+i_t) + \alpha_2 Ln(1-BCOLL_{jt}) + \alpha_3 BHERFINDAHL_{jt} x Ln(1-BCOLL_{jt}) + \alpha_4 LnBGDPC_{jt} + \eta_j + \varepsilon_{jt}$$

Time period 1985-2002. Models 1 and 2 estimated in OLS and Model 3 using the Arellano and Bond (1991) one step GMM estimator. The dependant variable, $Ln(1+r_{jt})$, is the log of 1 plus the interest rate of credit lines of bank *j* granted in year *t,* and i_t is the interbank interest rate in year *t*; $BHERFINDAHLJ_{jt}$, $BCOLL_j$, $BGDPC_{jt}$, $PRBADLOA_j$ are bank level variables obtained as weighted averages of the respective province level variables using as weights the proportion of business loans of the bank in the respective province. PD_{jt} and *LGD* are the probability of default and the loss given default of bank *j*; and η_j are the bank fixed effects. For Model 3 instruments used with $Ln(1+r_{jt-1})$, $Ln(1\text{-}PD_{jt}{*}LGD)$ and $Log(1\text{-}PD_{jt}{*}LGD){*}HERFINDAHL_{jt}$ up to lag t-2. The Table shows for Model 3 Hansen's test as well as test for first-order (m1) and second-order (m2) serial correlation of the residuals (in differences). Standard errors (SE) of estimated coefficients are consistent to any pattern of heteroskedasticity within panels. ***, **, *, mean statistically significant at 1%, 5% and 10%, respectively.

	Model 1		Model 2		Model 3	
Estimation	OLS		OLS		Arellano-Bond	
Dependant variable	$Log(1+r_{jt})$		$Log(1+r_{jt})$		$Log(1+r_{jt})$	
	Coefficient	*S.E.*	*Coefficient*	*S.E.*	*Coefficient*	*S.E.*
$Log(1+i_t)$	0.857	0.013 ***	0.853	0.013 ***	--	--
$Log(1+r_{jt-1})$	--	--	--	--	0.695	0.024 ***
$Log(1\text{-}COLL_{jt})$	-0.083	0.011 ***	--	--	--	--
$Log(1\text{-}COLL_{jt}){*}HERFINDAHL_{jt}$	0.005	0.001 ***	--	--	--	--
$Log(1\text{-}PRBADLO_{jt})$	--	--	-0.207	0.044 ***	--	--
$Log(1\text{-}PRBADLO_{jt}){*}HERFINDAHL_{jt}$	--	--	0.014	0.006 **	--	--
$Log(1\text{-}PD_{jt}{*}LGD)$	--	--	--	--	-0.180	0.092 *
$Log(1\text{-}PD_{jt}{*}LGD){*}HERFINDAHL_{jt}$	--	--	--	--	0.035	0.014 **
$Log(GDPC_{jt})$	-0.031	0.006 ***	-0.012	0.005 **	-0.084	0.009 ***
No. Observations	1,782		1,782		1,240	
F test (p-value)	0.00		0.00		0.00	
Hansen test (p-value)	--		--		1.00	
Test 1rst order serial correlation (m1) /p-value	--		--		-8.17	0.00
Test 2nd order serial correlation (m2) /p-value	--		--		-1.20	0.23

5 Conclusion

The important insight of Petersen and Rajan (1994 and 1995) that competition in credit markets can affect the marginal credit quality of borrowers that get finance ignores the possibility of pledging collateral. This paper extends the original model and shows that collateral lowers the marginal credit quality of borrowers that get finance but it does so in a more pronounced way in markets where banks have less market power. Alternatively, market power increases the availability of credit for riskier firms but at lower marginal effects as the availability of collateral in the market increases. That is, lack of competition and availability of collateral are substitutes in determining access of firms to bank finance. The implication of this result is that as borrowers increase their wealth and have more assets to use as collateral, parallel increases in credit market competition will not lower the access to credit since lenders can substitute market power by the use of collateral.

We also extend the predictions from the model to explain differences in average interest rate of credit lines. According to the model, credit risk of borrowers, market power of banks and availability of collateral in the province interact in a complex non-linear way in determining the average interest rate of bank loans. The main conclusion is that market power also moderates the expected positive association between availability of collateral in markets where a bank grants loans and average interest rates charged by the bank. The empirical evidence confirms that interest rate in credit lines among Spanish banks increases with the availability of collateral in the representative market of banks but the marginal effect of availability of collateral in interest rates is moderated by concentration in the credit market. The results are robust to other model specifications where collateral is replaced by direct measures of credit quality of firms that get finance.

Market power and availability of collateral appear as close substitutes in determining the availability and terms of loans granted to young firms and the result opens new directions in the research on development of financial markets, business investment and economic growth. Models that link development of financial markets with economic growth of the nations, King and Levine (1993), Levine and Zervos (1998), Rajan and Zingales (1998), ignore the effect of cross-country differences in availability of collateral in such a link. The same is true for papers that investigate the reasons why financial development causes higher rates of growth. Papers addressing this topic, referenced in the introduction of the paper, find conflicting evidence on whether market concentration is positive or negative for credit availability, investment and growth. Our results suggest that static and dynamic efficiency brought about by competition in credit markets are possible if the increase in competition goes in parallel with the process of wealth accumulation.

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