Collateral, Type of Lender and Relationship Banking as Determinants of Credit Risk[*♥]

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Abstract

This paper analyses the determinants of the probability of default (PD) of bank loans. We focus the discussion on the role of a limited set of variables (collateral, type of lender and bank-borrower relationship) while controlling for the other explanatory variables. The study uses information on the more than three million loans entered into by Spanish credit institutions over a complete business cycle (1988 to 2000) collected by the Bank of Spain's Credit Register (*Central de Información de Riesgos*). We find that collateralised loans have a higher PD, loans granted by savings banks are riskier and, finally, that a close bank-borrower relationship increases the willingness to take more risk.

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Key words: credit risk, probability of default, collateral, relationship banking, credit register

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1. Introduction

This paper analyses the determinants of the probability of default (PD) of bank loans. We focus the discussion on a limited set of determinants (collateral, type of lender and bank-borrower relationship) while controlling for the other explanatory variables such as the macroeconomic environment, characteristics of the borrower (industry and region) and of the loan (instrument, currency, maturity and size). We try to discern if riskier borrowers are asked to pledge more collateral or if, on the other hand, low risk borrowers are those who have collateralised loans[1]. Banks managed by conservative managers (maybe those of savings banks) might be less prone to take on credit risk than those where shareholders have more control over bank risk-taking decisions[2]. Finally, a close borrower-lender relationship might increase the incentives that banks have to lend to riskier firms, in particular, if the competition in the banking system is not too high[3].

The main contributions of the paper are based on the large dataset on loan operations for which data on *ex post* risk are available. The study uses information on the more than three million loans entered into by Spanish credit institutions over a complete business cycle collected by the Bank of Spain's Credit Register (*Central de Información de Riesgos*, CIR). With very few exceptions (such as Berger and Udell (1990)), much of the existing empirical literature on credit risk relies on data from surveys of a limited number of borrowers or lenders, usually referring to only one date or, at best, to a short time period. Many times, the datasets used are biased towards big firms or large operations. On the contrary, our dataset covers an entire economic cycle (from 1988 to 2000), and contains the whole population of bank loans (above a minimum threshold of 24,000 euros) to non-financial firms entered by any bank in Spain the last fifteen years.

The Credit Register information used here is based exclusively at the transaction or loan level, not at the level of borrowers. A given borrower may enter into several loans with the same bank or with different banks. As some characteristics of the loans cannot readily be

[1] A discussion of the relationship between collateral and borrower's risk profile can be found in Boot et al (1991).

[2] Carey et al (1998) find differences among types of lenders regarding willingness to lend to riskier borrowers.

[3] See Petersen and Rajan (1995). A thorough revision of the literature on relationship banking can be found in Boot (2000).

aggregated for a given borrower (collateral, maturity, type of instrument), in order to distinguish their impact it is essential to perform the analysis at the level of each loan. If all of a borrower's loans with various different banks are grouped together it also becomes impossible to distinguish differences in behaviour between groups of institutions (i.e. commercial banks *versus* savings banks). Several papers have found that the ownership of the banks affects their risk taking behaviour and credit policies. As well as being problematic, aggregation of loan characteristics of a single borrower might distort the conclusions. All in all, this leads us to the view that it is necessary to determine the influence of these variables at the level of the individual loan in order to obtain a point of reference for any subsequent aggregate analysis undertaken[4].

We focus our analysis on a measure of *ex post* credit risk (i.e. we look for variables that explain the default of a bank loan). The relationship between credit risk, the use of collateral in loan operations and the intensity of relationship banking, to our knowledge, has only been studied so far using measures of risk premium (i.e. Berger and Udell (1990, 1992, 1995), Booth (1992), Angbazo et al (1998), Degryse and Van Cayseele (2000)). Berger and Udell (1990) point out the advantage of having data on *ex post* credit risk to evaluate the relation between the use of collateral and credit risk (for instance, the *ex post* risk is not affected by the monitoring cost of collateral). On the other hand, the analysis of the relation between *ex post* credit risk and relational banking, controlling for the use of collateral in the loan operation, provides a direct test of the hypothesis that banks with close relations with their customers tend to be willing to take more credit risk than banks with looser relations.

The empirical literature has largely focused on the US case[5]. It is therefore of interest to examine whether the results obtained also apply to Spain, a country whose financial system is dominated by credit institutions, where retail banking predominates and savings banks play an important and increasing role.

[4] Note that we are not arguing that an analysis of the probability of default by borrower would not be significant. On the contrary, the use of information about borrower characteristics can help improve the predictive capacity of the models. However, a borrower focus prevents the direct impact of some of the characteristics of credit contracts from being seen. Alternatively, it is possible to consider that some of the variables used (collateral, size of the loan and maturity), to a certain point, are proxies of borrowers' characteristics.

[5] Berger and Udell (1998) review many of the papers.

This paper is structured as follows: section 2 reviews the main hypotheses regarding the impact of the variables on PD determinants. Section 3 describes the database used and the econometric specifications, while the main results are shown in section 4. Finally, section 5 contains the main conclusions of the study.

2. Hypotheses to be tested

The impact of collateral on credit risk is a subject that has raised a good deal of debate. From a theoretical perspective, there are two alternative interpretations that lead to different empirical predictions. On the one hand, the collateral pledged by borrowers may help attenuate the problem of adverse selection faced by the bank when lending (Stiglitz and Weiss (1981), Bester (1985), Chan and Kanatas (1985), Besanko and Thakor (1987a, b) and Chan and Thakor (1987)). Lower risk borrowers are willing to pledge more and better collateral, given that their lower risk means they are less likely to lose it. Thus, collateral acts as a signal enabling the bank to mitigate or eliminate the adverse selection problem caused by the existence of information asymmetries between the bank and the borrower at the time of the loan decision. In a context of asymmetric information between the bank and the borrower, banks design loan contracts in order to sort out types of borrowers: high risk borrowers choose high interest rates and no collateral, whereas low risk ones pledge collateral and get lower interest rates.

Even if there is symmetry *ex ante* between borrower and lender (i.e. the bank knows the credit quality of the borrower), the collateral helps to alleviate moral hazard problems once the loan has been granted. In this sense, the collateral pledged helps align the interests of both lenders and borrowers, avoiding a situation in which the borrower makes less effort to ensure the success of the project for which finance was given. Thus, collateral makes it possible to limit the problem of the moral hazard faced by all banks when they lend money. Collateral can therefore be seen as an instrument ensuring good behaviour on the part of borrowers, given the existence of a credible threat (Aghion and Bolton (1992) and La Porta et al (1998)).

On the basis of the two arguments outlined above, on the empirical level one would expect to see a negative relationship between collateral and loan default, consistent with the assumption that collateral is a signal of high quality borrowers.

Nevertheless, the situation described above seems to be contrary to the general perception among bankers, who tend to associate the requirement of collateral with greater credit risk. There are also theoretical arguments (Manove and Padilla (1999, 2001)) supporting the possibility that more collateral implies more non-performing loans (*ex post* credit risk) or greater PD. Firstly, if banks are protected by a high level of collateral they have less incentive to undertake adequate screening of potential borrowers and loans at the time of the decision. Secondly, there are optimistic businesspersons who underestimate their chances of going bankrupt and who are willing to provide all the collateral they are asked for in order to obtain finance for their projects.

If the lender knows the quality of the borrower who applies for a loan, then Boot et al (1991) show that the loan contract will establish that high risk borrowers will pledge collateral and low risk will not. They show that in a situation of hidden action (moral hazard) but not hidden information, the lender may ask the borrower to pledge collateral just as a way to put more effort on the project financed by the bank[6]. The symmetry between lender and borrower might be the result of a long relationship with the bank (as in Boot and Thakor (1994)) or the result of improvements in the screening technology (i.e. available databases on defaulted borrowers and their characteristics plus scoring or rating models more and more accurate). Rajan and Winton (1995) predict that the amount of collateral pledged is directly proportional to the borrower's difficulties with repayment. In this sense, one might interpret the collateral as a variable that proxies the risk profile of the borrower as it is estimated by the lender. More importantly, none of them investigates the relationship between collateral and PD as we do in this paper. This is important since Boot et al (1991) make clear that the relevant measure of risk to be used in the analysis is the probability of default estimated by the lender at the time of the decision. We implicitly assume that the observed probability *ex post* is a good proxy of the *ex ante* estimated probability of default.

The empirical evidence shows collateralised loans to be subject to greater risk in the sense that they are rated as loans with high probability of default (Orgler (1970), Hester (1979), Scott and Smith (1986)), or they have a higher risk premium (Berger and Udell (1990, 1992),

[6] In case of moral hazard and private information (i.e. the bank does not know the quality of the borrower), good borrowers might also pledge collateral.

Booth (1992), Booth and Chua (1996), Angbazo et al (1998)). However, all these studies were limited to the US loan market.

What role is played by different types of institution in the credit risk incurred by borrowers? Carey et al. (1998) find that specialist finance firms are more willing than banks to lend to riskier borrowers. There is considerable literature on the incentives of savings banks to adopt credit policies that differ from those commercial banks in terms of levels of risk. In general, what has been found is that institutions controlled by shareholders have greater incentives to take on more risk than those controlled by managers, due to the fact that the latter have invested specific human capital or that they can appropriate private profits (Saunders et al (1990), Esty (1997) and Leonard and Biswas (1998); Gorton and Rosen (1995) being an exception). The information available allows us to disentangle the differences in credit risk in loans made by commercial banks, savings banks, which we can assimilate to institutions in which managers have full control, credit cooperatives, which are closer in structure to mutual societies, and finally, credit finance establishments, which provide special-purpose credit (i.e. car purchase finance, consumer credit, leasing, factoring, etc.) but do not take deposits from the public.

Finally, another issue, which has aroused a considerable amount of interest in the literature, is the role of the bank-customer relationship in credit risk. Non-financial companies can benefit from close relationships with banks through easier access to credit, in terms of both the amount of credit they can obtain and how much it costs them, the protection they have during recession and even an implicit insurance of the cost of finance (Petersen and Rajan (1994)). The close bank-customer relationship may produce informational rents for the bank (Sharpe (1990) and Rajan (1992)) enabling it to exercise a certain degree of market power in the future, provided the environment is not excessively competitive (Petersen and Rajan (1995)) or depending of the source of competition (Boot and Thakor (2000)). In this context, banks may be prepared to finance riskier borrowers and/or projects (with higher default rates *ex post*) if they can subsequently offset this higher default rate by applying higher interest rates to the surviving companies and/or because they save costs of explicit monitoring for each new loan operation. Boot (2000) argues that relationship lending contributes to alleviate adverse selection and moral hazard problems raised by *de novo* borrowers.

Empirically, one might expect that the more a bank develops its relationship lending strategy, the greater the rate of default on its lending to firms. The closer the relationship between the bank and the borrower, the greater the likelihood of default. By contrast, when a firm has a relationship with several banks, none of them can monopolize their information on the borrower's quality, and so they cannot extract rents, thus considerably diminishing the incentives to finance higher-risk borrowers[7]. The strength of the customer-bank relationship can be approximated by the number of institutions providing finance for the borrower, the percentage of the borrower's finance that each institution provides, or the duration of the relationship. Given that we have loan by loan information, it can be argued that a close bank-borrower relationship might be associated with a lower level of screening on each individual loan. This would also contribute to a positive impact of closeness of relationship on *ex post* credit risk.

It is possible that there are interactions between several characteristics of loans in determining the PD. To know that the loan is backed by collateral provides information about the quality of the borrower at the time of the decision, depending upon the information asymmetry between the borrower and the lender (Boot et al (1991)), and/or it provides information about the possible trade-off between the use of collateral and time invested in evaluating the risk of the operation for the lender (Manove and Padilla (1999 and 2001)). It can be expected that lenders will offer a choice between a loan without collateral and higher interest rate and a loan with collateral and lower interest rate, in those situations where the problem of hidden information about the borrower's risk profile is more severe. On the other hand, one part of the theory predicts that loans without collateral are evaluated more thoroughly at the time of the decision than loans with collateral. The intensity of relationship banking conditions the cost of evaluating the loan operation for the lender (Boot and Thakor (1994) and Boot (2000)) and therefore relationship banking may have different impact on the probability of default in loans without collateral than in loans with collateral.

Similarly, it might be possible that the relation between collateral and the probability of default was different depending on the type of lender. During the time period studied, savings banks have expanded their activities outside their traditional geographic markets and

[7] However, in the case of Italy, Foglia et al. (1998) find that relationships with multiple banks is associated with greater borrower risk (measured as the *ex ante* probability of default).

therefore it can be expected that they face a more severe adverse selection problem than banks which have grown mostly within their traditional markets. If this was the case among savings banks, collateral might be used to solve the problem raised by the hidden information situation.

The loan maturity and the size of the loan, which in most cases is directly related to the size of the borrower, can also be indicators of credit risk and devices that provide a solution to information problems and allow the lender to impose greater discipline on the borrower. However, in this paper we consider them as control variables, together with currency of the loan and type of instrument, the industry and the region of the borrower as well as the macro environment, since we want to focus the discussion on collateral, type on lender and relationship banking.

3. Database and econometric specifications

As stated above, the database used for this study is the Credit Register of the Bank of Spain (CIR). This database records monthly information on all loans granted by credit institutions (banks, savings banks, cooperatives and credit finance establishments) in Spain for a value of over 6,000 euros. The CIR's data distinguishes between companies and individuals. Among the latter it is possible to identify those undertaking business activities (individual businesspersons). There is a clear separation between the characteristics of loans to companies (mainly in terms of the size of the loan, maturity, collateral, and default rates) and those loans to individuals, making it appropriate to treat each of the two groups separately.

The CIR includes information on the characteristics of each loan (instrument, currency, maturity, collateral, default and amount drawn or available) and of each borrower (province and industry or economic sector in which they operate their businesses). An important difference of the present paper with the existing literature lies in the fact that most studies rely on an often small and biased (towards large borrowers) sample of loans, whereas we have used data on *all* loan transactions carried out by Spanish credit institutions on the dates studied. In order to encompass an entire economic cycle, we have used data from the month of December in five years, namely 1987, 1990, 1993, 1997 and 2000.

The data used have been subjected to various filters: The analysis has been limited to companies; loans with an amount of less than 24,000 euros have been ignored as prior to 1996 there was no obligation to declare them, although many institutions did[8]; only loans with Spanish residents in the private sector have been included (hence loans with non-residents and the public sector have been excluded). The information on loan characteristics is numerical (size of the loan) or alphabetical (instrument, currency, collateral, etc.). We have opted to discretize all the alphabetical ones by constructing dummy variables.

Default on payment (i.e. the event we wish to model) is considered to have occurred when, three months after the date of maturity, the debt balance remains unpaid or when there are reasonable doubts as to its repayment. A filter has been established in order to avoid distortion of the analysis by insignificant non-payment. Specifically, if the unpaid amount is less than 5% of the total credit drawn down, it is not considered to be unpaid.

3.1. Descriptive analysis of the population

As can be seen in Table 1, the number of observations available is large and has grown continuously throughout the period studied. Overall, there are data on over 3 million loans for the five dates analysed. This number of observations ensures the efficiency of the econometric estimates presented in the following section.

The majority of companies' loans are not secured by collateral, or in other words, have only a personal guarantee. Thus, on average, almost 85% of loans have no collateral. Loans that do have collateral have doubled their relative weight over the time horizon analysed. Collateral in the form of real property usually provides full or 100% coverage of the loan. This type of collateral may take the form of public bonds, cash deposits, property or shipping mortgages, listed shares, merchandise or receipts of deposit of merchandise. More detailed information is not available on these types of guarantee, which may have differing degrees of effectiveness and also have different costs of realization. Moreover, there are partial guarantees that do not reach 100% of the value of the loan, but which cover more than 50%. Obviously, these are less effective guarantees, although their relative weight is almost negligible. Finally, we

[8] Nevertheless, the threshold seems low enough for loans to companies.

consider all other types of guarantee: public sector, CESCE (a government-owned export insurer) or credit institutions; that, again, account for a relatively small proportion of loans.

Commercial and savings banks are responsible for providing around 90% of the loans. However, this situation has evolved significantly over time. Commercial banks have gone from controlling four fifths of total loans to close to a half. This loss of market share in the business finance market is the result of the market penetration of the savings banks, which have practically doubled their relative weight over the period under analysis. Financial credit establishments also have a significant market share (almost 10%).

In terms of type of instrument, financial credit dominates, followed at some distance by commercial credit (financing purchases or the provision of services). This latter type of finance has come to account for a smaller share of credit transactions involving companies. Around 10% are leasing operations, with other items (fixed income, factoring and documentary credit) representing only a small share. In terms of the currencies used, the majority of the loans are denominated in pesetas (or euros). The maturity structure is fairly balanced. In general, a shift may be observed from shorter terms to longer ones over the period studied. This shift is related, in part, with the loss of relative weight of commercial credit, and probably, with the increase in loans secured by collateral. Regarding loan size, around 90% of the total number of loans are concentrated in loans from 24,000 to 150,000 euros, although, clearly the percentage is smaller in terms of values lent. This is the only numerical variable in the row data. It enters the regression in absolute terms. It covers almost the whole range of loans, from those providing finance to very small companies, to SMEs of various sizes as well as to major corporations. In terms of industry, loans to companies in manufacturing, commerce and construction (including property developers) stand out. The regional distribution is in line with the relative weights of the economies of the regions in the national economy as a whole[9].

Finally, around half of all borrowers have relationships with only one bank (i.e. 100% exclusivity) although in terms of volume of exposure they only account for around 10% of the total. Almost 20% of borrowers have two bank relationships and 10% have three.

[9] Industry and region distributions are not shown in Table 1 in order to alleviate the presentation of the descriptive analysis.

3.2. Econometric specification

The econometric approach relies on a binomial logit model[10]. The endogenous variable, y_{it}, is dichotomous, where $y_{it} = 1$ if the loan is doubtful and 0 otherwise. To the extent that this variable is related to another latent non-observable random variable, y^*_{it}, which takes the form:

$$y^*_{it} = \alpha + x'_{it}\,\beta + z'_t\,\gamma + \varepsilon_{it} \qquad (1)$$

where $-\varepsilon_{it}$ conditional upon (x_{it}, z_t) follows a logistic distribution, i.e., $F(a) = 1/(1+exp(-a))$, and if also, the relationship is of the type: $y_{it} = 1$ if $y^*_{it} > 0$, and zero otherwise; we obtain:

$$\text{Prob}(y_{it} = 1 / (x_{it}, z_t)) = \text{Prob}(y^*_{it} > 0 / (x_{it}, z_t)) = F(\alpha + x'_{it}\,\beta + z'_t\,\gamma). \qquad (2)$$

where, therefore, $Prob(y_{it} = 1 / (x_i, z_t))$ is the probability of default (PD) of the loan i.

The variable y^*_{it} can be understood as a function of the company's losses, such that if this function is greater than zero (or if the losses exceed a given threshold) the company defaults. Along the same lines, default could also arise out of a company's assessment of the various options it faces, thus turning it into a business decision. Thus, another way of understanding y^*_{it} is to see it as the expected difference between the utility of defaulting on the loan and that of not defaulting, given a series of variables in the context of the information on the company and other macroeconomic factors. From this point of view, a company will default if the utility it obtains thereby is greater than that which it would obtain if it did not, in terms of its expectations. In other words, the company will default if $y^*_{it} > 0$.

As shown in (2), the PD is considered to be a function of the type of instrument, currency, maturity, collateral, amount lent, business sector, region, type of financing institution, all of which are variables that can vary between loans and over time (x_{it}). In order to control macroeconomic elements common to all borrowers and all loans, but which vary over time, a dummy variable for the year has been included (z_t). The estimates of the parameters have been obtained by maximizing the log-likelihood function of y_{it}. For the purposes of our study

[10] A comprehensive analysis of discrete choice models (including the logit model we use) can be found in Amemiya (1981), McFadden (1984) or Maddala (1983).

this analysis has been performed using a pool of five dates (a total of 3,167,326 observations).

4. The determinants of loan's PD

The first column of Table 2 (Model 1) shows the results of the maximum likelihood estimate of the logistic model applied to the pool of data from over the five year period studied. The model includes a constant forcing a variable to be left out of each block of characteristics to avoid perfect multicollinearity from occurring. The constant determines the PD of the excluded loans[11]. The characteristics of the excluded loan are: financial credit, in euros, long term (over five years), without collateral, 1993, construction sector and lent by a bank in a certain region. The interpretation of the sign of the remaining parameters estimated in the model is in relation to the omitted variables. The explanatory power of the model is high, with a percentage of concordant observations of 68.2%[12] while the majority of the parameters are statistically significant at the 1% significance level.

As regards collateral, the pledging of collateral increases the PD when compared with unsecured lending. Within secured loans, the PD of those that are 100% secured is lower than that of those secured to a value of over 50% but not to a full 100%, although the latter account for only a small percentage of the sample. Finally, loans guaranteed by a credit institution or the public sector have a lower likelihood of default, less even than in the case of unsecured loans. Note that this latter class of loan is subject to a double evaluation, i.e. by the bank giving credit and by the bank or public body guaranteeing it.

The foregoing finding makes a significant contribution to clarifying the debate surrounding the role of collateral as a borrower's risk signalling mechanism. In the case of loans to companies in Spain, it may be concluded that banks demand collateral in the case of those

[11] A logistic transformation of that constant gives the PD of a loan with the same characteristics as those of the excluded loan.

[12] The goodness of fit measure is based on the association of predicted probabilities and observed responses. This measures how many pairs of observations have a concordant response, i.e. how many pairs with different observed responses have predicted probabilities that rank accordingly. We use this measure instead of a frequency table of observed and predicted responses because the latter would be highly dependent on the cut off probability point selected.

loans that show greater *ex post* risk of default[13]. This empirical evidence strengthens the arguments of Manove and Padilla (1999 and 2001) that the existence of collateral can weaken the adequate selection of borrowers and/or supports the idea of a more symmetric lender-borrower contracting environment (Boot et al (1991) and Boot and Thakor (1994)). The results are also in line with Rajan and Winton (1995).

Default rates among financial credit establishments are significantly higher than among banks. This result coincides with that obtained by Carey et al (1998) for the US case, although the credit establishments considered here also include those that are subsidiaries of banking institutions. What seems clear is that certain types of finance (consumer durables in particular) and certain types of borrower (those without access to bank credit) are riskier. The fact that credit establishments specialize in a small number of operations could deprive their credit portfolios of the benefits of greater product risk diversification. In fact, a decrease over time in the credit establishments that are bank subsidiaries has been observed, suggesting that banks have decided not to manage loans of this kind separately.

Loans granted to companies by savings banks are riskier than those granted by commercial banks. Given that the institutional characteristics of savings banks in Spain are such that they can be considered companies in which the managers have a broad field of manoeuvre, this result seems to contradict the US empirical evidence, mentioned in section 2, that show that the presence of shareholders makes institutions riskier. The explanation for this difference in the case of Spain could lie in the lesser historical specialization of the savings banks in providing loans to companies and their aggressive entry into this market in the late eighties and early nineties.

From Table 1, it can be seen that between 1988 and 2000, savings banks almost doubled the market share (in terms of number of loans to corporations) at the expense of that of commercial banks. The lack of knowledge of the business segment and the desire to increase market share quickly provided fertile ground for adverse selection. Moreover, many savings banks, which had previously been concentrated in regional or even local markets, implemented ambitious geographical expansion plans outside of the area they traditionally

[13] Note that since we use an *ex post* measure of credit risk we can properly test the asymmetric and sort out paradigm. We do not exclude that riskier borrowers might have higher interest rates. We do reject that riskier

knew well and in which they had always operated. Shaffer (1998) demonstrates that adverse selection has a powerful and lasting impact on new entrants. Although the subject requires investigation in greater depth, on account of both its implications for corporate governance and for credit risk supervision, it seems to be clear that the substantial and significantly higher default rates of the savings banks in the case of loans to firms is the result of adverse selection. Once this factor has been neutralized, it might be possible that the empirical evidence will be more like that obtained in the US case.

Credit cooperatives, which do not have shareholders but do have owner/partners, are somewhat riskier in their credit operations than banks, but much lower risk than savings banks and credit finance establishments. In general, these organizations are highly localized and tend to be concentrated in rural areas. The lack of geographic diversification of their credit portfolio could also explain their difference from banks, which are much larger and more diversified. Moreover, the proximity of the banks to the average PD of their operations is consistent with the greater similarity of their structure of ownership and corporate governance, making the case of Spanish savings banks more interesting still.

Finally, we briefly examine the impact on PD of the remaining loan characteristics. By type of instrument, credit finance is the highest risk, followed by commercial credit. Commercial credit tends to be short term (less than one year) and is closely linked to company turnover and is basically used to provide working capital. By contrast, financial credit tends to be used for longer term investments whose results take longer to materialize. The PD of loans in foreign currencies is substantially and significantly lower than that of loans in the national currency. It should be borne in mind that such loans account for a very small proportion of the total and that, given their characteristics, they are probably scrutinized more closely by the financial institutions involved.

As regards maturity, the longer the time horizon of the loan, the lower the PD. Short term loans (under one year plus those of indeterminate maturity, the latter mainly current account overdrafts and excess borrowing on credit accounts) are the highest risk. The low PD for long term loans (i.e. those over 5 years), probably points towards the importance of screening. Given the time horizon of the loan, the bank examines the application with greater care given

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borrowers do not post collateral.

that the borrower's financial health could change significantly over such a long period. This finding goes in the opposite direction of the signalling hypothesis of Flannery (1986) (i.e. good risks would prefer to rise short term funds).

The results in Table 2 show that there is a decreasing relationship between the size of the loan and the probability of default. The screening argument can again be used here. Institutions study loans implying a larger amount of money progressively more carefully. As the absolute amount of the loan increases, the authority to delegate responsibility for it is more limited and the decision is made further up the management hierarchy of the bank. The involvement of a larger number of individuals and their greater experience in the granting of credit might also be a factor in this result. At the same time, this finding also reflects the fact that large exposures correspond to large companies with a much lower default rate[14].

As expected, significant differences exist between industry and regions[15]. The construction industry (omitted variable) appears to be the riskiest, after the hotel and restaurants sector (which is both seasonal and cyclical). This industry also includes the property development business, whether first or second homes, and also the construction of rental property and commercial premises. This result is consistent with the evidence seen in other countries and with the interest of banking supervisors in monitoring the construction cycle. The lowest risk sector is that of the production and distribution of electricity, gas and water, which is a sector dominated by large companies, many of which have high credit ratings. Significant differences also exist between regions. As mentioned before, both the industry variable and the region variable should be considered here to be control variables, that allow us to obtain unbiased estimations of the parameters associated with the rest of the explanatory variables.

The temporal dummy variables play a similar role as control variables. Note that the parameters of these variables faithfully reflect the cyclical profile of the Spanish economy over the period 1988 to 2000, with a deep recession in 1993. Note the large difference between the PD associated with 2000 compared with the other years, in particular 1988. In

[14] The maturity and size variables probably deserve a more careful scrutiny. Unfortunately, these would lead us beyond the scope and the length of the present paper.

[15] Although the specific values of the parameters are not shown in Table 2, all the estimates include the dummies for industry and region, as omitting them could bias the results. These variables are statistically significant.

both years the Spanish economy underwent rapid rates of annual growth (around 4-5% of real GDP) but the average PD is almost half in 2000. In addition to the structural changes undergone by the Spanish economy between these dates, part of the explanation could be an improvement in credit risk management by financial institutions, resulting from better measurement and management of risk. The high value of the temporal dummy parameters reveals the markedly cyclical nature of credit risk.

In short, the empirical evidence for the case of Spain shows that collateral pledged to secure companies' loans is associated with greater credit risk, that savings banks, which have no shareholders or owners, have higher levels of credit risk than banks, contrary to most empirical evidence, but very probably explained by adverse selection; and that credit institutions that do not take deposits are the riskiest, in line with the evidence from other countries. This study shows the importance for credit institutions of an adequate policy for granting credit (i.e. screening) in order to obtain a healthy loan portfolio. The estimated parameters show that, on average, institutions appear to have adopted a cautious policy towards long term, unsecured and large amount loans.

The model estimated allows us to calculate the PD of any loan, given a set of characteristics. For instance, the probability of default of a loan granted by a bank in 1997, in pesetas, long term (more than five years), without collateral, to the property sector in a certain region, instrumented as credit finance and of an amount of 50,000 euros is 4.81%[16]. It is possible to calculate the marginal impact on the PD of a change in a variable. For instance, if the same loan was collateralised, the PD will increase to 6.57% (i.e. the probability increases around one third). Therefore, the impact of collateral on *ex post* credit risk is substantial in economic terms. The same happens if the loan is granted by a lender different from a commercial bank. The PD increases to 5.28%, 5.80% and 5.88% depending on whether the lender is a credit cooperative, a savings bank or a credit finance establishment, respectively. Apart from the statistical relevance of Model 1, the information might be useful to bank managers as well as to supervisors that closely track the quality of banks' credit portfolios.

[16] That PD is obtained substituting the value of the variables (x) in the logistic function: $PD = F(x'\widehat{\beta})$ using the parameters β previously estimated. Changes in the value of the variables result in different PD estimations.

We have performed some changes to Model 1 in order to test the stability of parameters estimated[17]. First of all, we have substituted the temporal control variables with the growth of real GDP contemporary and lagged one period. As one would expect, the slowing of the economy translates into a higher PD, although the greatest impact is not on the contemporary PD but in that which is lagged one year. More importantly, there are very few changes in the remainder of the parameters. The explanatory power of the model is somewhat reduced with respect to Model 1 (lower concordant ratio). Secondly, if we eliminate the temporal dummy variables without replacing them with any macroeconomic variables, there is a substantial fall in the explanatory power of the model. Moreover, the parameters associated with the sectoral variables change substantially, most probably showing that the cyclical behaviour of the sectors is not the same. Clearly, the macroeconomic conditions must be controlled in order to obtain a proper estimation of the PD.

A further analysis was performed to estimate the five dates separately. In general, the explanatory power decreases. This decrease in the ratio of concordants is greater in those years, such as 2000, where the ratio of default is very low. The main results remain, in particular those relating to collateral and the type of institution, which do not show any noteworthy exceptions from Model 1 in any of the years. The remainder of the characteristics (maturity, size, instrument, currency and region) do not show significant variations with respect to Model 1, while there is a certain degree of instability in the industry parameters.

The role of relationship banking

This section focuses on the potential impact on the PD of the closeness of the bank-borrower relationship. Model 2 (second column of Table 2) contains a measure of relationship banking: the number of banks with which each borrower relates. Obviously, given that our study focuses on a loan-by-loan analysis, the value of the variable will be the same for all the loans of a borrower. Additionally, since that variable will be larger for bigger borrowers, we control for the size of the borrower including the total size of the borrower, net of the size of the loan considered.

[17] Not included in the paper but available upon authors' request.

It can be seen that the more widespread multiple lending is, the lower the PD. In other words, when a borrower's loans are spread across several or many institutions there is less of an incentive to finance riskier borrowers and/or the screening process is more thorough. Note that the size of the borrower is negative and significant, large borrowers are far less risky than smaller ones[18]. However, the sign of the size of the loan has changed, the larger the loan analysed the higher the PD, once the remaining size of the borrower is taken into account. In other words, for a given size of the borrower, the larger the loan exposure the higher the PD. Comparing the absolute value of both parameters, it seems that what really matters in bank-borrower relationships is, as one would expect, the customer dimension more than the transaction or operation dimension[19]. The rest of the parameters do not change in a significant way and goodness of fit improves substantially[20].

From Model 2, one might conclude that credit institutions are willing to finance higher risk loans if they have a close relationship with the borrower, because they provide a large percentage of the borrower's finance, or even they are the only bank that finance the firm. It would seem obvious that banks are willing to finance operations that are, on average, riskier in the case of customers with which there is a greater degree of commitment if, in return, they can recoup the greater expected losses by charging their other surviving exclusive or nearly exclusive customers higher interest rates. Therefore, the results of Model 2 indirectly support the existence of informational rents for the bank by developing a close relationship with the customer (Sharpe (1990), Rajan (1992) and Boot (2000)). The company obtains finance despite the fact that its risk profile is worse. This advantage of relationship lending is in addition to those already found by Petersen and Rajan (1994) regarding the greater availability of funds at lower cost.

A more detailed analysis of the role of collateral

In this subsection the model is estimated allowing for differences in the effects of type of lender and number of banks relationships in the probability of default within loans that have

[18] As found by Berger and Udell (1995).

[19] The advantages in terms of access to finance for riskier borrowers would seem to be offsetting the drawbacks indicated in Detragiache et al. (2000).

[20] The likelihood ratio test confirms that Model 2 is an improvement over Model 1 since the value of the χ^2 is 15.983, which is larger than the critical value of 5.99 with 2 degrees of freedom.

collateral and loans without it. We focus on collateral covering 100% of the loan, as these constitute the majority of secured loans (92% on average).

According to Table 3 results, for those loans that have collateral, the probability of default decreases with the number of banks relationships at a lower rate than it does within the loans without collateral (the coefficient of the variable, collateral times number of banks' relationships, is positive). This means that even though loans with collateral are always riskier, the difference in the risk with those without collateral is larger when there is no relationship banking (i.e. the number of banks with which the borrower interacts is large), than when relationship banking is present. It is likely that when relationship banking is absent, if the bank gives a loan without collateral the screening process of the risk of the operation will be very intense and therefore the *ex post* probability of default is likely to be lower. After all, the lender will not be able to recover the credit risk with more interest and/or more volume of operations into the future as it is the case when relational banking is present.

The coefficient of the variable, collateral times savings bank, is negative. This means that among collateralised loans the probability of default of a loan given by a savings bank is lower than the probability of default when the loan is not collateralised. For savings banks, collateral seem to be an effective device for decreasing borrower risk. Probably this relates to the importance that adverse selection has had in those lenders since the liberalization at the end of the eighties. Savings banks expanded their credit portfolios into business loans (from mainly mortgages to individuals) and, moreover, entered into new geographical regions when freedom to open branches was granted at the end of 1988. Lack of expertise posed a problem of adverse selection that savings banks tried to soften through offering loan contracts that contain collateral requirements that would be more attractive for borrowers of higher quality. Something similar happens in the case of financial credit establishments. Perhaps for certain consumer finance loans the pledging of collateral is an efficient mechanism of selection and ensuring borrower discipline. However, for credit cooperatives, collateralised loans imply additional risk, reinforcing the general conclusion that the greater the borrower's risk, the greater the collateral demanded[21].

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[21] Again, we have performed the likelihood ratio test with the result of Model 3 being an improvement over Model 2 (the χ^2 is 493, which is larger than the critical value of 9.49 with 4 degrees of freedom).

5. Conclusions

This paper has analysed the impact that certain characteristics of loans have on credit risk. We have focused on collateral, type of lender institution and the relationship between the bank and the company it is financing, trying to discern among the various conflicting hypotheses that explain the impact of such variables on the probability of default of a loan.

Unlike many of the existing empirical literature, we use a huge dataset from the Spanish Credit Register (*Central de Información de Riesgos* or CIR), owned and managed by Banco de España, the Spanish central bank and banking regulation and supervision authority. We focus on a loan by loan basis, analysing more than 3 million loans made during an entire economic cycle (from 1988 till 2000). The database does not refer to a sample of banks or borrowers. Instead, it covers all the banks operating in Spain during the time period analysed. We focus on *ex post* credit risk (i.e. if the loan has defaulted or not) which allows for a direct test of the relationship between the explanatory variables and credit risk. Many of the previous literature has focus on risk premiums. As Berger and Udell (1990) point out, the latter has the drawback that it is affected by the monitoring cost of the collateral. Given the exhaustive coverage of the dataset used, we can focus on differences among several types of lenders (commercial banks, savings banks, credit cooperatives and specialist finance firms). Finally, it is important to point out that the vast majority of the empirical literature on these issues has focused on the US loan market. The use of the CIR might contribute to enrich the analysis.

We have applied a logit model to the pool of data, focusing on loans to companies above a threshold of 24,000 euros. Given the size of the database, the estimation of the parameters is highly efficient. Moreover, changes in the explanatory variables do not have a significant impact on the results.

We have tried to discern whether collateral is pledged by low risk borrowers, as one strand of the theoretical literature argues: if the lender does not know the quality of the borrower, it can use the collateral as a device to sort borrowers' quality. However, as Boot et al (1991) argue, if there is symmetry between the bank and the borrower, collateral will be demanded from

riskier borrowers. Manove and Padilla (1999 and 2001) argue that collateral might decrease screening efforts by banks at the time the loan is granted. We have found strong support for the symmetry and/or screening theories. Collateral increases the *ex post* probability of default of a loan.

Secondly, we have found significant differences among the credit risk taken by various lenders. Savings banks' loans are riskier than commercial banks' loans. Given that we can consider Spanish savings banks as institutions mainly controlled by their managers, this result is at odds with the findings that banks controlled by shareholders are riskier than those where risk taking decisions depend on (conservative) managers (Saunders et al. (1990) and Esty (1997)). The differences are possibly related to an intense adverse selection process that savings banks suffered in Spain after deregulation and liberalization in the late eighties allowed them to enter into new regions and products (for instance, loans to companies). Regarding specialist finance firms, our results are similar to those of Carey et al (1998), i.e. that this type of lender is riskier than commercial banks.

Regarding relationship banking, we have tried to discern whether a close bank-borrower relationship increases the willingness to take more risk. The existence of informational rents (Sharpe (1990) and Rajan (1992)) and the environment in which banks compete to each other (Petersen and Rajan (1995) or with the capital market (Boot and Thakor (2000)) would be the main forces leading to that result. We do find that the more widespread multiple lending is, the lower the level of *ex post* credit risk. When many banks lend to the same borrower, there is a higher incentive for each of them to undertake a thorough screening process before they grant the loan since informational rents will be much more diluted.

Finally, we have looked into the interaction between collateral and type of lender and relationship banking. Although collateralised loans are always riskier, the difference in the risk to those without collateral is larger where the closeness of bank to borrower is low. This result reinforces previous ones that have stressed the importance of the screening process. Similarly, among collateralised loans, those given by savings banks are less riskier. This result shows that if the asymmetry between the bank and the borrower is high (for instance, if adverse selection is significant), a loan contract with collateral might help to sort out borrowers by credit quality.

It is worth mentioning that the results of our paper may be used to measure the probability of default (PD) on each loan contained in the Credit Register. Therefore, it is possible to isolate the marginal contribution of each characteristic to the default rate. The model obtained permits the simulation of PD for any change in the characteristics of the loan. In addition to the academic interest of this study, the results are of use to supervisors who wish to monitor the quality of financial institutions' loan portfolios.

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Table 1. Time distribution of the sample. Loans, above 24,000 €, to companies

	1987		1990		1993		1997		2000		Pool	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
. observations	334,384	10.56	608,379	19.21	582,706	18.40	746,344	23.56	895,513	28.27	3,167,326	100
faults	11,271	3.37	23,335	3.84	59,936	10.29	33,497	4.49	14,704	1.64	142,743	4.51
% guarantees (collateral)	24,232	7.25	49,213	8.09	67,419	11.57	100,299	13.44	134,232	14.99	375,395	11.85
artial guarantees (>50%)	1,721	0.51	1,968	0.32	1,919	0.33	2,174	0.29	4,074	0.45	11,856	0.37
ther guarantees	1,742	0.52	5,637	0.93	5,796	0.99	3,533	0.47	4,699	0.52	21,408	0.68
secured	306,689	91.72	551,561	90.66	507,572	87.11	640,338	85.80	752,509	84.03	2,758,667	87.10
anks	268,041	80.16	401,051	65.92	370,475	63.58	442,232	59.25	483,103	53.95	1,964,903	62.04
aving banks	58,973	17.64	114,624	18.84	149,498	25.66	213,576	28.62	295,389	32.99	832,060	26.27
t cooperatives	7,370	2.20	12,057	1.98	17,041	2.92	30,816	4.13	45,228	5.05	112,512	3.55
t finance establishments	0	0.00	80,647	13.26	45,692	7.84	59,720	8.00	71,792	8.02	257,851	8.14
mmercial credit	141,824	42.41	195,100	32.07	171,567	29.44	198,226	26.56	202,936	22.66	909,652	28.72
ancial credit	185,374	55.44	332,875	54.72	359,335	61.67	463,519	62.11	574,677	64.17	1,915,779	60.49
cumentary credit	5,030	1.50	6,698	1.10	5,074	0.87	7,635	1.02	6,938	0.77	31,376	0.99
ed income	2,156	0.64	1,278	0.21	785	0.13	507	0.07	516	0.06	5,242	0.17
sing	0	0.00	71,790	11.80	45,031	7.73	73,280	9.82	96,394	10.76	286,495	9.05
toring	0	0.00	638	0.10	914	0.16	2,947	0.39	6,929	0.77	11,428	0.36
ns or cred. transf. to a third party	0	0.00	0	0.00	0	0.00	230	0.03	7,124	0.80	7,354	0.23
rency: pesetas or euros	325,114	97.23	590,017	96.98	564,720	96.91	725,642	97.23	873,080	97.50	3,078,573	97.20
ther currencies	9,270	2.77	18,362	3.02	17,986	3.09	20,702	2.77	22,433	2.51	88,753	2.80
aturity <1 year	255,198	76.32	409,589	67.32	380,686	65.33	435,054	58.29	452,493	50.53	1,933,020	61.03
aturity 1 year-5 years	58,746	17.57	147,169	24.19	130,816	22.45	204,125	27.35	278,629	31.11	819,485	25.87
aturity >5 years	20,440	6.11	51,620	8.48	71,204	12.22	107,165	14.36	164,391	18.36	414,821	13.10

Table 2. Estimation of the PD equations using pooled cross-sections (1987, 1990, 1993, 1997 and 2000)

	Model 1		Model 2	
Variables	Coefficient	S.D.	Coefficient	S.D.
Constant	-2.165 ***	(0.015)	-1.949 ***	(0.015)
100% guarantees (collateral)	0.330 ***	(0.011)	0.282 ***	(0.011)
Partial guarantees (>50%)	0.425 ***	(0.042)	0.417 ***	(0.042)
Other guarantees	-0.098 ***	(0.037)	0.002	(0.037)
Saving banks	0.197 ***	(0.007)	0.149 ***	(0.007)
Credit cooperatives	0.096 ***	(0.017)	0.014	(0.017)
Credit finance establishments	0.212 ***	(0.016)	0.185 ***	(0.016)
Commercial credit	-0.166 ***	(0.007)	-0.162 ***	(0.007)
Documentary credit	-0.979 ***	(0.073)	-1.031 ***	(0.074)
Fixed income	-0.904 ***	(0.121)	1.595 ***	(0.131)
Leasing	-0.207 ***	(0.017)	-0.224 ***	(0.017)
Factoring	-1.304 ***	(0.097)	-0.831 ***	(0.098)
Loans or cred. transf. to a third party	-0.756 ***	(0.133)	-0.776 ***	(0.134)
Currency different from euros	-1.257 ***	(0.036)	-0.816 ***	(0.036)
Maturity <1 year	0.230 ***	(0.012)	0.260 ***	(0.012)
Maturity 1 year-5 years	0.055 ***	(0.012)	0.069 ***	(0.012)
1987	-1.104 ***	(0.011)	-1.088 ***	(0.011)
1990	-1.037 ***	(0.009)	-1.021 ***	(0.009)
1997	-0.819 ***	(0.007)	-0.818 ***	(0.007)
2000	-1.899 ***	(0.010)	-1.876 ***	(0.010)
Size of the loan	-0.0001 ***	(2E-5)	0.00003 ***	(5E-6)
Size of the borrower - Size of the loan			-0.00053 ***	(1E-5)
No. of borrower's banking relationships			-0.03040 ***	(6E-4)
Chi-square / (p-value)	59,450 /	(0.0001)	75,433 /	(0.0001)
-2*Log-likelihood	1,006,295		990,312	
No. observations / Defaults	3,167,326 /	4.51%	3,167,326 /	4.51%
Association of predicted probabilities and observed responses				
Concordant	68.2%		71.1%	
Tied	2.2%		1.7%	

Notes: 1. The constant term will determine the probability of default for the reference group, which has the following characteristics: credit finance, in pesetas (euros), over more than five years, without collateral, property sector borrower, granted by a bank in certain region, in 1993. Each regression includes 10 industry dummies and 17 regional dummies.

2. Standard deviations of the coefficients (S.D.) in brackets. *** variable significant at the 1%, ** at the 5%, and * at the 10%.

Table 3. The role of collateral. Estimation of the PD equations using pooled cross-sections (1987, 1990, 1993, 1997 and 2000)

	Model 3		
Variables	Coefficient		S.D.
Constant	-1.911	***	(0.015)
100% guarantees (collateral)	0.178	***	(0.016)
Partial guarantees (>50%)	0.406	***	(0.042)
Other guarantees	0.003		(0.037)
Saving banks	0.171	***	(0.008)
Credit cooperatives	-0.011		(0.018)
Credit finance establishments	0.203	***	(0.018)
Commercial credit	-0.158	***	(0.007)
Documentary credit	-1.032	***	(0.074)
Fixed income	1.525	***	(0.131)
Leasing	-0.231	***	(0.018)
Factoring	-0.832	***	(0.098)
Loans or cred. transf. to a third party	-0.761	***	(0.134)
Currency different from euros	-0.800	***	(0.036)
Maturity <1 year	0.237	***	(0.012)
Maturity 1 year-5 years	0.043	***	(0.012)
1987	-1.086	***	(0.011)
1990	-1.019	***	(0.009)
1997	-0.816	***	(0.007)
2000	-1.873	***	(0.010)
Size of the loan	0.000	***	(5E-6)
Size of the borrower - Size of the loan	-0.001	***	(1E-4)
No. of borrower's banking relationships	-0.034	***	(0.001)
No. of borrower's banking relationships *100% Guarantees	0.031	***	(0.001)
Saving banks* 100% Guarantees	-0.119	***	(0.017)
Credit cooperatives* 100% Guarantees	0.101	**	(0.041)
Credit f. esta.* 100% Guarantees	-0.128	***	(0.042)
Chi-square / (p-value)	75,927	/	(0.0001)
-2*Log-likelihood	989,818		
No. observations / Defaults	3,167,326	/	4.51%
Association of predicted probabilities and observed responses			
Concordant	71.2%		
Tied	1.7%		

Notes: 1. The constant term will determine the probability of default for the reference group, which has the following characteristics: credit finance, in pesetas (euros), over more than five years, without collateral, property sector borrower, granted by a bank in a certain region, in 1993. Each regression includes 10 industry dummies and 17 regional dummies.

2. Standard deviations of the coefficients (S.D.) in brackets. *** variable significant at the 1%, ** at the 5%, and * at the 10%.