Collateralization of Loans: Testing the Prediction of Theories

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Abstract

What are the determining factors of banks loans collateralization? Our paper answers this question by using the unique internal data of eight Italian banks at 2008 reporting 9,930 bank-firm relationships. We have three main results. First, we provide evidence that observed riskier borrowers are encouraged to give more collateral to banks in order to obtain a loan, while in presence of hidden information are the less risk borrowers to offer collateral in order to signal their quality. Second, we show relationship banking has a direct impact on the use of collateral as well as produces moderating effects on the other determining factors. Finally, unlike lender-based theories we observe distant banks, i.e., banks with more difficulties to collect and transfer soft information, are more likely to pledge collateral than local banks.

Keywords: collateral, distance, relationship lending, competition

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1. Introduction

Collateralization is a widespread feature of the credit acquisition process as documented by several studies (recently, Berger et al. 2011b; Menkhoff et al., 2012) and indicated by descriptive statistics on banking systems in industrialized countries.

The collateralization practice has been investigated across various countries (e.g. Berger and Udell, 1990, 1995; Berger et al., 2011a; Harhoff and Korting, 1998; Jiménez et al., 2009; Ono and Uesugi, 2009 use non-U.S. data) and type of lending (e.g. Chakraborty and Hu, 2006; Jiménez et al., 2009 focus on business lending: Hainz, Dinh, and Kleimeier, 2011; Menkhoff, et al., 2012 analyze both business lending and consumer lending).

Previous research has also analyzed the determining factors of collateral. Various papers (e.g. Besanko and Thakor, 1987a; Ono and Uesugi, 2009; Berger et al., 2011a, b) point out that the probability of pledging collateral is strictly related to observed characteristics of the borrower (i.e., age, size and risk). Other studies link the presence or not of collateral to more or less relationship banking (e.g. Berger and Udell, 1995; Degryse and Van Cayseele, 2000; Chakraborty and Hu, 2006), level of credit market competition (Besanko and Thakor, 1987a; Jiménez et al., 2009), and lenders characteristics (Inderst and Mueller, 2007; Jiménez et al., 2009).

The empirical evidence on reasons of collateralization paints a mixed picture, and the predictions on the relationship between the probability of pledging collateral and the explanatory variables vary across theories. Following the borrower-based theories (Chan and Kanatas, 1985; Besanko and Thakor, 1987a; Boot et al., 1991) some loans are collateralized and others not because of informational advantages of borrowers over lenders; in similar situations, banks ask for collateral in order to solve the problems of adverse selection, caused by ex-ante information gap (hidden information), and/or of moral hazard arising from ex-post information gap (hidden actions). Following the lender-based theories (Inderst and Mueller, 2007; Jiménez et al., 2009) the use of collateral serves to exploit the information advantage of local lenders, relative to distant ones, in evaluating the borrowers risk, when the competition constrains banks choice about the interest rates

loans.

As such, although numerous papers have investigated the collateralization, why some loans are secured and others not has remained partly unresolved.

What are the determining factors of banks loans collateralization? Are there significant differences between secured loans granted to rated and unrated borrowers? Do banks ask for collateral to offset the problems caused by information asymmetry or to exploit their information advantage? Our paper answers these questions by using the unique internal data of eight Italian banks reporting 9,930 bank-firm relationships.

The Italian data are especially useful for three reasons, at least. First, Italian firms are very sensitive to any distortion in credit supply because they are highly dependent on bank credit. Second, the high taxation associated with the weakness of legal systems encourages firms to manipulate accounting data for tax saving goals (Fabbri and Padula, 2004; Bianco et al., 2005) and makes the Italian credit market an ideal setting to test the impact of asymmetric information problems on the use of collateral. Third, the great concentration of banks headquarters in a single area (the north), allows us to observe the existence of difference in the behavior between local lenders and distant ones (Degryse and Ongena, 2005; Alessandrini et al., 2009).

Our main findings can be summarized as follows. According to moral hazard and adverse selection hypotheses, we find that riskier borrowers give more collateral to banks, but in presence of hidden information are the less risk borrowers to offer collateral in order to signal their quality. However, not only collateral is able to solve the asymmetric information problems as we find the stronger the relationship banking the lower is the probability that banks asking for collateral. Furthermore, in sharp contrast with the lender-based theory, we observe distant banks are more likely to pledge collateral than local banks, although we find the duration of relationship banking acts on the lender-borrower distance by reducing the probability that distant banks ask for collateral. Finally, we find that a possible effect of high competition in credit markets is represented by a greater demand for collateral. Overall our results confirms the borrowed-based theories: namely on

one hand we suggest that collateral mainly serves to reduce the informational advantages of borrowers over lenders, especially in high competitive credit markets, the other we display that relationship lending is complementary to collateral.

We believe to enrich the existing literature on collateral in different ways. The major contribution of our paper is the use of a unique and distinctive dataset that allows us to exactly measure the borrower risk observed by bank lender (i.e., internal ratings) and to distinguish between borrowers with observed risk measure and borrowers whose level of risk is not observable from bank lender (i.e., borrowers without internal rating). This is particularly important because, unlike previous studies, that mainly use proxies for the borrowers observed risk and fail to check if bank lender is affected or not by hidden information problems, we are able to better stress the adverse selection and moral hazard hypotheses.

The second contribution is that we find a strong complementarity between relationship banking and the use of collateral. This result is novel to the extent we observe that a strong relationship banking (i.e., old relationship) negatively affects the use of collateral both because it directly reduces the probability of pledging collateral and because it produces moderating effects on those factors that increase the probability of asking collateral (such as the lender-borrower distance).

The third contribution is that unlike the lender-based theories we observe distant banks are more likely to pledge collateral than local banks. This result appears consistent with the idea that distant lenders, i.e., the lenders for which it is more difficult to collect and transfer soft information, *ceteris paribus* are more affected by asymmetric information problems than local lenders, and therefore are more inclined to ask for collateral.

The remainder of the paper is organized into the following sections. Section 2 presents the literature on collateralization and discusses research hypotheses. Sections 3 and 4 describe the data and empirical strategy, respectively. Section 5 explains variables we use in the empirical analysis and Section 6 discusses our main findings. Section 7 concludes.

2. Literature review and research hypotheses

The use of collateral in the credit acquisition process is widespread, such as suggested by numerous studies on bank lending process (e.g. Ono and Uesugi, 2009; Steijvers and Voordeckers, 2009; Berger et al., 2011a, b, Broccardo et al., 2012). Thus, collateralization appears as a robust phenomenon that extends across countries and time periods, even if, it has been shown that the request for collateral is higher in less developed markets (see e.g. Menkhoff et al., 2012) as a consequence of both opaque information and weak enforcement of contracts. Several studies have also observed that the use of collateral in debt contracts arises several problems, for borrowers, lenders and credit markets. Borrowers incur opportunity costs because of more restrictive asset usage, fluctuations in their credit availability due to value changes of their collateralized assets, and increase in costs of default (e.g. Berger et al., 2011). Lenders have to sustain costs of screening and maintenance of the pledged assets, as well as any legal and other administrative expenses in the case of repossession (Igawa and Kanatas, 1990). Coherently, collateral can also have a negative impact on the credit market efficiency, as banks that are highly protected by collateral may perform too little screening of the projects that they finance (Manove et al., 2001). Finally it's worth to note that when collateral requirement is too high, firms could be discouraged to apply a bank loan (Chakravarty and Xiang, 2013).

Since the collateral arises several drawbacks, from the early 1980s, various studies have been done in order to understand why some loans are collateralized and others not. The debate is furthered by Stiglitz and Weiss (1981), who point out that banks are able to screen the wealth of risk-adverse borrowers by using differently collateralized loan contracts. Following Stiglitz and Weiss (1981) pioneering paper, several hypotheses have been developed in attempt to explain the determining factors of collateralization. The first set of theoretical models (the borrower-based theories) explains collateral as arising from information gaps between borrowers and lenders that can lead to an equilibrium characterized by adverse selection, moral hazard and credit rationing problems (e.g. Besanko and Thakor, 1987a; Boot et al., 1991). The second set of theoretical models

(the lender-based theories) argues that collateral serves to the local lenders to exploit their informational advantages over the distant lenders, in contexts where competition constrains the banks' choice about the loan interest rates (e.g. Inderst and Muller, 2007).

The best known argument for the use of collateral is the presence of informational advantages of borrowers over lenders (e.g., Besanko and Thakor, 1987a; Boot et al., 1991). As a result, the borrower-based theories recognise that the use of collateral varies across loans according to the characteristics of borrowers, which in turn affect information asymmetries between both parties with regard to actions taken by the borrower after the loan is extended (moral hazard hypothesis) or about the credit risk of the loan (adverse selection hypothesis).

According to the moral hazard hypothesis, various papers (e.g., Bester 1994; Boot et al., 1991; Jiménez et al., 2009) highlight that collateral potentially helps to mitigate moral hazard problems in contexts where banks are able to distinguish the credit quality across borrowers, but suffer information asymmetries with regard to borrower behaviour after the loan is granted. Thus, contrary to models based on hidden information, those focused on hidden actions predict a positive relationship between the borrower observed-risk and the probability to pledge collateral, because collateral induces more effort by the borrower (Boot et al., 1991) or reduces its incentives of strategic default (Bester, 1994). Consistently, a positive relationship between the existence of collateral and the cost of debt should be expected. In their study, John et al. (2003) suggest that lower quality firms are required to use collateral when issuing debt while higher quality firms issue debt without it. Furthermore, they found (after controlling for credit rating) that the yield differential between secured and unsecured debt is larger for low credit rating and consider perk consumption (or neglect) of the collateralized assets as one of the determinants of this difference.

Following these studies we define the moral hazard hypothesis as follows:

H_1: the likelihood of the use of collateral in bank loans increases with the borrower observed-risk

According to the adverse selection hypothesis, various papers (e.g., Stiglitz and Weiss, 1981; Bester, 1987; Boot et al., 1991; Berger et al., 2011b) point out that collateral acts as a signal allowing the bank to offset the adverse selection and credit rationing problems caused by the ex-ante information gap. The idea is that in presence of hidden information, banks are not able to exactly evaluate the borrowers risk and thus collateral enables lower-risk borrowers to signal their quality in attempt to pay lower risk premiums and/or increase their credit availability. Consequently, the adverse selection theory predicts that riskier borrowers are less likely to pledge collateral. Since the main determining factor of collateralization is related to unobserved risk, from an empirical point of view, recent studies (Jiménez et al., 2006; Berger et al., 2011a) have attempted to analyse the adverse selection hypothesis by using ex post measures of borrower riskiness (i.e., defaults after the loan origination) or by using proxies for private information that lenders did not have when the loan was granted (Berger et al., 2011b). Following previous studies we define the adverse selection hypothesis as follows:

H_2: the likelihood of the use of collateral in bank loans decreases with unobserved (ex-post) risk measure.

Since various studies have explained the use of collateral as an attempt to mitigate both ex-ante and ex-post information disadvantages, a large literature has grown up by testing whether the level of borrower's transparency plays a role in reducing the likelihood to pledge collateral. Thus, several papers (Jiménez et al., 2009; Ono and Uesugi, 2009; Berger et al., 2011a) have discussed size, age, and legal form of the firm as borrower characteristics affecting the use of collateral: large, old and corporate firms should be less opaque than smaller, younger, and unincorporated firms, because potential lenders unable to collect more information on their investment opportunities or managerial skills. Following previous studies we define our third hypothesis as follows:

H_3: *the likelihood of the use of collateral in bank loans decrease with borrower's transparency*

Various papers (Boot and Thakor 1994; Berger and Udell, 1995; Degryse and Van Cayseele, 2000; Chakraborty and Hu, 2006; Brick and Palia, 2007) have pointed out that also the relationship

banking should play an important role in mitigating asymmetric information problems between borrowers and lenders improving the borrower's corporate governance (Dass and Massa, 2011) . The benefits of relationship banking practices is also confirmed during crises time since bank-depositor relationships help mitigate the credit rationing effects explained by a supply-side point of view (Puri et al., 2011).

Banks that have strong relationship with their borrowers are able to capture some of the hidden information concerning the borrowers risk and their ex-post actions, thus reducing the ask for collateral. However, from the empirical standpoint, it is unclear whether the strength of the relationship banking affects the likelihood of collateral being pledged (e.g. Berger and Udell, 1995; Machauer and Weber, 1998; Menkhoff et al., 2006; Brick and Palia, 2007; Ono and Uesugi, 2009). The mixed results probably depends both by the type of variable used to proxy the strength of relationship banking (mainly duration and number of banks the borrower has loans with) and because it is theoretically likely that a solid relationship becomes detrimental to the borrower if it causes hold-up problems (i.e., Rajan, 1992; Sharpe, 1990; Boot, 2000; Degryse and Van Cayseele, 2000). Based on previous studies we define our fourth hypothesis as follows:

H_4: *the likelihood of the use of collateral in bank loans decreases with the duration of relationship banking and increases with the number of bank lenders.*

The distance is another dimension to measure the strength of the relationship and is considered as a proxy for a lender's informational advantage for nearby competitors, because borrower proximity facilitates the collection of soft information (Agarwal and Hauswald, 2010; Dass and Massa, 2011).

An emerging literature (Inderst and Mueller, 2007; Jiménez et al., 2009) suggests the use of collateral is strictly related to borrower observed characteristics and more or less relationship banking, as well as it varies across the characteristics of lenders (i.e. lender-borrower distance) and of credit market (i.e. level of concentration). As such, these studies describe the use of collateral as the way to exploit the information advantage of local lenders over distant ones in estimating a loan

credit risk when competition limits the interest rates that local banks can charge on the loans (lender-based theory). In other words, the opportunity that borrowers have to select between local and distant lenders gives them a reservation profit because the distant lenders are less informed about local credit market conditions and offer loans at favorable conditions for borrowers. In a similar environment, the choice of the loan interest rate by local banks is constrained and they ask for collateral in order to still take advantage of any superior information. Therefore, the lender-based theory predicts that the use of collateral will be higher for loans granted by local lenders. However, unlike this prediction and according to the borrower-based theories, it is also theoretically possible that are the distant lenders, i.e., the lenders for which it is more difficult to collect and transfer soft information, to ask more collateral, because *ceteris paribus* they are more affected by asymmetric information problems. Thus, the formal representation of the fifth hypothesis of this study is as follows:

H_5: *the likelihood of the use of collateral in bank loans increases (decreases) for distant lenders (local lenders).*

Competition represents another main factor capable to explain lending processes in banking industry. Bank competition may affect positively the elasticity of demand for loans, and may alter the role of information in loan approval process affecting the task of loan officers and the use of soft or hard information. Heider and Inderest (2012), argue that in response to more competition, banks reduce lending standards and may choose to prefer the use hard information disregarding soft information in their credit approval.

Furthermore, a relationship between market power and collateral requirements also have been explored by the literature on market power in banking studies.

Over the 1990s the deregulation process is based on the idea that stimulating competition and increasing contestability in banking sector was the way to improve quality of credit and sustainable growth (Besanko and Thakor, 1987a) and to reduce the financing obstacles (Beck et al., 2006). As a consequence, an increase of bank competition should be associated to a reduction of both loan rates

and collateral requirements. However, in sharp contrast with this prediction some papers (e.g. Jiménez et al., 2006, and Jiménez et al., 2009) have found that high competitive credit markets are linked to more use of collateral. The likely explanation of this evidence is that in high competitive credit markets bank lenders use collateral to collect rents from borrowers that have higher reservation profits. Conversely, in more concentrated markets, reservation profits are expected to be lower, and therefore less use of collateral is expected. Hence, the sixth formal hypothesis to address in this study is as follows:

H_6: *the likelihood of the use of collateral decreases (increases) with credit market concentration*

3. Data

We collected credit-file data from eight Italian banks that belong to a large bank group operating across Italy. The banking group is one of a few truly national banks operating in Italy; it lends to borrowers located in 106 out of 110 provinces and operates in 165 industries (six-digit NACE classification).

Our data consist of 9,930 observations containing bank-borrower data[1] (included information on collateral and the bank internal borrower ratings), local banking market concentration and firm-specific variables. We select our sample by using the following criteria. First, we consider firms that are active at the end of 2008 and for which we know if they are still active or not after two years (i.e., 2010). This criteria allow us to collect information on unobserved risk. Second, we consider only firms for which we have notice about the address of the local branch where the borrower established and still holds the relationship. This criteria allow us to construct a measure of bank's organizational distance (i.e., Jiménez et al., 2009) and test the impact of the latter on the probability of pledging collateral. Third, we drop data related to individual customers, as we are interesting in studying the bank-firm relationship. As such, our sample is composed by data of loans granted to 9,930 firms by 31 December 2008. Since one goal of this study is to test both the adverse selection

[1] Data are bank-firm pair: each firm i (i=1..9,930) point is matched to a unique bank j (j=1..8).

hypothesis and the moral hazard hypothesis, we separate our sample in two samples based on rating availability. The first sample consists of 8,205 firms that had an internal rating calculated by lender at the time of the analysis. The second sample consists of 1,725 firms without rating (hidden information) due to lack of borrower's transparency. Table 1 reports the descriptive statistics. It is worthwhile to note that both samples are composed mainly of small and micro firms (about 78% vs. 92%), while the percentage of small firms in Italy in the same period is 95% (ISTAT, 2009).

<Insert here TABLE 1>

4. Empirical Strategy

Following previous studies (e.g., Jiménez et al. 2009; Berger et al., 2011b), we run a cross sectional probit model to explore the determinants of collateral.

Thus, the probability of a loan being secured is given by:

$$Prob(COLLATERAL = 1) = \int_{-\infty}^{\beta' x} \phi(t)\, dt = \Phi(\beta' x) \quad (1)$$

where Φ is the standard normal distribution function, *x* is a vector of explanatory variables, including measures of variables for a firm's creditworthiness, the strength of the bank–firm relationship, market structure and other firm's characteristics, including industry dummies.

As such, we use two different model specifications to test the determinants of collateral for rated firms (*Sample A*) and unrated firms (*Sample B*).

Specifically, to test the H1, H3, H4, H5, and H6 we formulate the following empirical model on the use of collateral for rated firms (*Sample A*):

$$\begin{aligned} Prob(COLLATERAL_{ijklt} = 1) = F(&\beta_0 + \beta_1 Risk_{ij} + \beta_2 Lenders_{ij} + \beta_3 Years_{ij} + \beta_4 HHI_{ij} + \\ &+ \beta_5 Distance_{ij} + \beta_6 Credit_{ij} + \beta_7 Risk * New + \beta_8 Lenders_{ij} * New + \beta_9 HHI_{ij} * New + \\ &\beta_{10} Distance_{ij} * New + \beta_{11} Credit_{ij} * New + \beta_{12} Size + \beta_{13} Control_{ij} + \eta_{ij}) \end{aligned} \quad (2)$$

where where the subscript *i* indicates the borrowing firm (*i=1..9,930*), subscript *j* indicates the

lender (*j=1..8*), while $Collateral_{ij}$ is a binary variable that takes the value of one if the borrower *i* has any kind of collateral with the lender *j*, and 0 otherwise;all other variable are defined in Table 1.

Furthermore, to test the H_2, while controlling for H_3, H_4, H_5, and H_6 we use a second empirical model to explain the use of collateral for unrated firms (*Sample B*) by replacing *Risk* with the other following variables: *Default* (i.e., the borrower's unobserved risk measure) and *Share* (i.e., the percentage of firms served by each bank over the total number of firms active in the province of firm at the end of the year) and their cross-effects with new loans (i.e., *Default*New* and *Share*New*).

Additionally, we run a cross sectional probit model to explore the mitigating effect of relationship on the use of collateral. More specifically, we formulate the following empirical model to test the impact of the relationship measures on the probability of pledging collateral:

$$Prob(COLLATERAL_{ij}=1)=F(\beta_0+\beta_1 Risk_{ij}+\beta_2 Lenders_{ij}+\beta_3 Years_{ij}+\beta_4 HHI_{ij}+ \\ +\beta_5 Distance_{ij}+\beta_6 Credit_{ij}+\beta_7 Years_{ij}*Lenders(1/0)+\beta_8 Size+\beta_9 Control_{ij}+\eta_{ij}) \quad (3)$$

where *YEARS*LENDERS(1/0)* is the cross effect between the duration of relationship and a dummy related to the number of lenders.

Moreover, to disentangle the contribution of relationship variables to determine collateral pledging, we separately add to Eq. (3) other two dummies to measure the moderating effects between the duration of bank-firm relationship with, respectively, market competition and the quality of lenders intended as distant or local bank.

In all specifications, the standard errors are robust to heteroskedasticity. Since we using a firm level variable as dependent, while some key explanatory variables are at the bank and market level, the assumption of independently distributed errors could be not appropriate. Hence, initially we clustering the standard errors at the bank level to correct the variance–covariance matrix. The results are similar to the no-clustering OLS results. However we decided do not use clustering data

at bank-level due to the low number of banks of the sample (eight)[2].

5. Variables

This section describes the variables we use in our analysis. Specifically, we describe our dependent variable (Section 5.1), i.e., the collateral, and the independent variables used into two previous models, i.e., borrower's characteristics in terms of observed-risk, unobserved-risk and transparency variables (Section 5.2), the relationship banking indicators (Section 5.3), the lender's characters and the credit market indicators (Section 5.4), and the control variables (Section 5.5).

5.1. Collateral

Following previous papers (e.g., Chakraborty and Hu, 2006; Ono and Uesugi, 2009; Berger et al., 2011a) and in order to identify the motivations for the use of collateral, we measure our dependent variable ($COLLATERAL_{ij}$) as a dummy variable that takes the value of 1 if loan granted from bank *j* to borrower *i* is collateralized and 0 otherwise[3]. Since we have no information neither on the percentage of collateralized loans and on the type of loan, we cannot extend the analysis of Jimenez et al. (2004) and drawing conclusions about the quality of collateralized loans or the impact of innovative assets used as collateral on the incentive of lenders to finance firms (Giannetti, 2012). Further, our data do not consent to identify the date of loan's collateralization since we use cross sectional data at one point in time (31 December 2008). Consequently, we know whether a loan have or not a collateral, but not when the borrower to pledge it. However, as we will describe below, this lack of information is solved indirectly with the introduction of a dummy variable (NEW_{ij}) that help us to isolate a subsample of loans for which we know the date of loan's collateralization.

[2] As reported in his study, cited also by Petersen (2009), Rogers (1993) argues that as long as the largest cluster size is no more than 5% of the observations, the variance estimator performs reasonably well (based on some experiments). So, one should roughly have at least 20 clusters to avoid statistical bias.

[3] Out of 10,192 observations in our sample, only 8,063 have collateral information. Following Bharath et al. (2011) and Fang et al. (2012), we consider such loans as unsecured. We also ran all our specifications by excluding all observations for which this data was missing. The results (not reported) remain unchanged .

5.2. Borrower's characteristics variables

Various studies have pointed out that asking for collateral is strictly related to the characteristics of the borrower in terms of risk, both observed and unobserved, and transparency (Jiménez et al., 2009; Ono and Uesugi, 2009; Berger et al., 2011b). Therefore in this sub-section we explain how we measure these variables.

Observed-risk measure

The borrower's observed-risk has been traditional measured by using accounting information (Chakraborty and Hu, 2006; Ono and Uesugi, 2009; Berger et al., 2011a) or by analyzing whether the loan is given to a borrower that defaulted with any bank in the previous year (e.g., Jiménez et al., 2009). However, both these indicators may fail to capture the level of risk effectively observed by bank lenders, because the latter before granting a loan have to analyze quantitative and qualitative data, and information on whether the borrower defaulted with any bank in the previous years (more than one). Therefore, in order to overrun this drawback, we use the variable $RATING_{ij}$ that represents a snapshot of the credit risk observed by bank lender *j*. Indeed, this variable contains the borrower's creditworthiness as calculated by the banks' internal borrower rating system, which is composed of 10 risk classes for solvent borrowers (i.e., 1 = the less risky class; 10 = the worst)[4]. Consistent with the moral hazard hypothesis the better the risky class, the lower is the probability of pledging collateral. While the exact calculation of internal rating is a black box, we know that rating are calculated according a mixed approach that considering as main determinants the balance-sheet of firms and the existence (and severity) of past default and current events in the credit history of the borrower both with the single lender and with the bank system. Thus, we can exclude endogeneity problems with the dependent variable, COLLATERAL, that plays a significant role in the loan approval process only at the stage of Loss Given of Default (LGD) calculation.

[4] We normalize to 10 the number of internal rating classes to preserve the privacy disclaimer of our data provider. However, the true number of internal rating classes is not much different from 10.

Unobserved-risk measure

Previous studies have attempted to measure the borrower's unobserved-risk by using ex-post information on credit quality (Jiménez et al., 2006, 2009; Berger et al., 2011a), namely whether or not the borrower ends up in default after the loan has been granted, or by using proxies for private information that lenders did not have when the loan was granted (Berger et al., 2011b). Following the approach of Jiménez et al. (2009), we measure unobserved risk through a dummy variable that takes the value of 1 if the firm receives a distress rating notch from bank because the former experiences a default event after two years ($DEFAULT_{ij}$) from the time of our cross section analysis[5]. However, unlike previous study we use the $DEFAULT_{ij}$ only for borrowers who belong to the "unrated class", and for which we are sure there are hidden information problems. According to adverse selection hypothesis the probability of pledging collateral decreases with the borrowers' default.

Borrower's transparency indicator

Various studies observe that the level of borrower's transparency plays a role in reducing the likelihood to pledge collateral. Thus, following several papers (Jiménez et al., 2009; Ono and Uesugi, 2009; Berger et al., 2011a) we identify the firm's size as the main borrower's transparency variable affecting the use of collateral: larger firms should be less opaque than others, because potential lenders unable to collect more information on their investment opportunities or managerial skills. However, while previous studies (e.g. Ono and Uesugi, 2009) measure the firm's size as the book value of total sales, we use four dummy variables, one for each category of firms (micro, small, medium-sized and large) provided by banks. This four-size classification considers both sales and other variables, such as asset size and number of workers. According to the borrowers-based theory the likelihood of the use of collateral decreases moving from the micro-firms up to large firms.

[5] We consider that one firm experiences a default event if it has (at least) one or more past due loans remaining unpaid three months after the maturity date. In this case, the internal rating systems of the banks put in the 11th class (the default class) the borrower. In this class borrowers are then classified according to the severity of the distress.

5.3 Relationship banking variables

A large part of the existing literature on collateral (Boot and Thakor 1994; Berger and Udell, 1995; Degryse and Van Cayseele, 2000; Chakraborty and Hu, 2006; Brick and Palia, 2007) has pointed out that the relationship banking plays an important role in mitigating asymmetric information problems between borrowers and lenders, and in turn affects the use of collateral. As suggested by these studies we measure the strength of the relationship banking through the following two variables.

The first relationship variable is $LENDERS_i$ that reports the number of banks the borrower *i* has loans with. According to previous research (e.g., Chakraborty and Hu, 2006) the higher the number of borrower's lenders the higher is the probability that its loans will be secured, as the lack of exclusivity may reduce the quality of soft information deriving from the lending relationship.

The second variable is $YEARS_{ij}$, that is the effective duration of the credit relationship, namely the number of years since the bank lender *j* granted the first loan to the borrower *i*[6]. According to other studies (e.g., Berger and Udell, 1995; Harhoff and Korting, 1998; Jiménez et al., 2006; Brick and Palia, 2007), the duration of relationship banking significantly discourages the presence of loan collateralized because a longer relationship is a key to generate "soft" information about a borrower.

5.4. Lender's characteristics and credit market structure variables

Previous research (Inderst and Mueller, 2007; Jiménez et al., 2009) suggests that the use of collateral varies also across the characteristics of lenders and of credit market. Therefore in this sub-section we explain variables used to measure these factors.

Lender distance

[6] In cases where the credit relationship duration is less than one year, this duration is approximated as one year.

Jiménez et al. (2009) observe that the distance between the lender and the borrower affects the use of collateral because it is a proxy of the informational advantage that some banks (local banks) have on the others (distant banks). Following this study we measure the variable $DIST_{ij}$ as the organizational distance (see among others Berger and DeYoung; 2001), i.e., the value of the distance (expressed in kilometres) between the province of the local bank branch that originates the loan and the city where the bank's headquarter is located[7]. However, unlike Jiménez et al. (2009) we predict that *DIST* positive acts on the probability of pledging collateral because the proximity between lender and borrower is expected to facilitate ex ante screening and ex post monitoring and as such, should reduce the informational gap.

Lender's experience indicator

Lenders that grant loans to unrated borrowers (i.e., borrowers with hidden information) should make this decision based on the knowledge of local market conditions accumulated through their experience. As a consequence in the model developed to stress the adverse selection problems we control the results by using a variable that measures the experience of the bank in the province (*SHARE*). Following Jiménez et al. (2009) the variable $SHARE_{ij}$ is equal to the percentage of firms *i* served by each bank *j* over the total number of firms active in the province of firm *i* at the end of the year. However, the expected sign of *SHARE*'s coefficient by itself is ambiguous because the private information revealed through the experience could be favorable or unfavorable.

Market concentration indicator

Several studies find that an increase of bank competition should be associated to a reduction into collateral requirements. Thus and following various studies (among others Black and Strahan, 2002; Jiménez et al., 2009; Fiordelisi et al., 2011), we measure the Herfindahl-Hirschman index (*HHI*) as the sum of banks squared market shares in loans granted in each one of the Italian provinces at the end of the year.

[7] In more formal terms, the following proxy of distance was used: $DIST_{ij}= \ln(1+KM_{ij})$, where KM_{ij} is the distance in kilometers between the province of firm i (in Italy, there are 110 provinces) and the headquarter of bank j (j=1..8).

5.5 Control variables

Various additional factors may influence the probability of pledging collateral. These factors can be at the bank and industry levels and related to the exposure of the bank against the firm. Therefore we put in the models dummy variables to control for industry (165 dummies) and lenders (8 dummies) of firms. Moreover we use $CREDIT_{ij}$ that is an aggregated measure of the credit outstanding; it sums loans, accounts receivable, short-term loans, long-term loans and revolving credit lines[8]. The greater the exposure of a bank against the firm *i* and the higher should be the probability of pledging collateral. Finally, since we have no information about the date of loan's collateralization (data are cross sectional at the end of 2008), we controlling for the age of collateral with the introduction of the binary variable NEW_{ij}. This variable takes the value of one if loans of borrower *i* have been originated no longer than one year from the date of the analysis, and 0 otherwise. The basic idea is that with this variable we can identify a subsample of borrowers (those with NEW=1 and COLLATERAL=1) for which the collateral and loan's origination date are coincident.

6. Results

This section describes our findings. First, we present the results for firms with observed risk (i.e., rated firms) (sample A, Table 2). Second, we discuss our econometric model to investigate the link between collateral and its determinants for firms with hidden information (i.e., unrated firms) (sample B, Table 2).

<Insert here TABLE 2>

Sample A - Rated firms

[8] A credit line is here indented here as a contract that allows a borrower to take advantage of a predetermined "line limit" and repay it at the borrower's discretion with an interest rate periodically set by the bank. Whenever the drawn credit exceeds the line limit, the bank charges a penalty interest rate.

Probit data regression of Eq. (1) on *Sample A* tests if the probability of collateral is linked to variations in borrower characteristics (i.e., *RATING*, and *LARGE*, *MEDIUM*, *SMALL*, and *MICRO*, H1 and H3, respectively), relationship measures (i.e., *YEARS* and *NUMBER OF LENDERS*, H4), lender' characteristics and market structure measures (i.e., *DIST*, and *HHI*, H5 and H6, respectively) and firm-specific measures (i.e., *CREDIT*) controlling for the "age of collateral" (i.e., *NEW*, the date of collateral pledging).

Focusing on the observed risk (Table 2, *Columns (1)* and *(2)*), the positive regression coefficient estimate for *RATING* suggests that a higher probability of default (i.e., coming from 1, the less risky class, to 10, the worst class) increases the probability of collateral pledging supporting the moral hazard hypothesis (H1). Observed risk is associated with 0.71 percentage point increase in the probability of collateral, consistent with previous literature (Berger et al. 2011a, and Menkoff et al., 2006, 2012). Further, while we have no data on loan's interest rates, we find these result consistent with positive relationship between cost of loans and collateral as documented in John et al. (2003). Results for new loans (i.e., loans originated no farther than one year) (*RATING*NEW*) are also in this direction as they are found to be positively linked to the probability of collateral but the significance decreases (at the 10% confidence level). This is consistent with a limited availability of private information with new loans as lenders may have little qualitative data and information about borrower behavior (reliability and project choices).

We also report findings supporting the hypothesis H3 and the idea that micro-sized firms (*e.g.* the most widespread firms in Italy) are more exposed to asymmetric information problem and to collateral pledging. Indeed, *MICRO* is associated with 14.62 percentage point increase in the probability of collateral supporting the previous studies (Berger et al., 2011b, and Ono and Uesugi, 2009). In contrast, *LARGE* and *SMALL* show a negative impact on the dependent variable.

We additionally show that our proxies for bank-firm relationship (i.e., *LENDERS*, and *YEARS*) have a substantial influence on the probability of collateral pledging as predicted by H4. Namely, estimated regression coefficient for *LENDERS* is positive confirming that a higher number of

lenders increases the presence of loan collateralized (Jiménez et al., 2009, and Ono and Uesugi, 2009). At the same time, estimated regression coefficient for *YEARS* is negative supporting the idea that private information accumulation over time decreases the probability of collateral (Elsas, 2005; Harhoff and Korting, 1998). However, the interaction term between number of lenders and new loans (i.e., *LENDERS*NEW*) displays a negative and not statistically significant impact on probability of collateral pledging.

Additionally we find that the probability of collateral pledging is positively influenced by borrower-lender distance, and negatively related to degree of market concentration. As such, focusing on *DIST*, we report findings that are not consistent with the lender-based theories (i.e., Inderst and Mueller, 2007; Jiménez et al., 2009) supporting the idea that distant lenders, i.e., lenders for which it is more difficult to collect and transfer soft information from the branch to the headquarter, require more collateral. Thus, this result is consistent with the borrower-based theories and may be affected by changes in the Italian credit market over the last two decades: most banks have changed from a local decision-making model (i.e., local banks gather soft information and decide to grant a loan) to a distant decision-making model (i.e., local banks gather soft information and transfer it to headquarter) (e.g., Degryse and Ongena, 2005; Alessandrini et al., 2009). However, the coefficient of the cross-effect between the distance and new loans (i.e., *DIST*NEW*) is not statistically significant[9]. Moreover, focusing on *HHI*, we find that the probability of collateral pledging has a (negative) statically significant link with *HHI*. These findings on Italian credit market are in line with the study of Jiménez et al. (2006) that analyzes the Spanish credit market and support the theory according to which the use of collateral is more likely with competition than monopoly (Besanko and Thakor, 1987b, and more recently Inderst and Muller, 2007). Results for new loans are also in this direction as the cross-effect between the market concentration and new

[9] Therefore, we conclude that new loans change the effect that distance has on the likelihood of collateral use, but it is not significant, probably because there are "countervailing forces" when we consider the impact of distance on gather of information about new borrowers.

loans (i.e., *HHI*NEW*) is statistically significant. Considering the marginal effects, we note that if a firm applies for a loan to a lender for the first time in a competitive market, the likelihood of pledging collateral increases by 8.4%.

Finally, controlling for the bank exposure against the borrower, the probability of collateral pledging increases with *CREDIT* according to the theory (i.e., Boot et al., 1991) and the evidence on determinants of collateral (i.e., Jimenez et al., 2006) that predicts an increase of collateral for loans of larger size in the bad states of the world (e.g., credit turmoil). However, the interaction between the credit outstanding and the new loans (i.e., *CREDIT*NEW*) holds the predicted sign but it is not significant.

Sample B - Unrated firms

Probit data regression of Eq. (2) on *Sample B* tests if the probability of collateral is linked to unobserved risk (i.e., *DEFAULT*, H2), transparency (i.e., *LARGE*, *MEDIUM, SMALL*, and *MICRO*, H3), relationship measures (i.e., *YEARS* and *NUMBER OF LENDERS*, H4), lender characteristics and market structure measures (i.e., *DIST*, *HHI*, and *SHARE*, H5 and H6) controlling for the date of collateral pledging (i.e., *NEW*) and various factors at the bank and industry levels.

An in-depth analysis of Table 2 - *Columns (3)* and *(4)* - reveals some interesting findings about firms with initial informational gap.

First, high levels of unobserved risk (i.e., *DEFAULT*) are associated with lower probability of collateralized loans. That is to say, to the extent that this occurs, good borrowers are more likely to pledge collateral according to models of signaling (e.g., Berger et al., 2011a). This finding supporting the adverse selection hypothesis (H2), i.e., the use of collateral is expected to be higher for high quality borrowers in presence of hidden information. However, the interaction between the state of default and new loans (i.e., *DEFAULT*NEW*) is positive but its sign is not statistical significant. This evidence may be affected by the low number (i.e., 160) of new firm defaulted after just two years from the start of relationship with the lender.

Second, we find that if a firm is classified as *LARGE* or *MICRO*, it is more likely to pledge collateral. More specifically, the smallest class of borrower size, captured by the dummy *MICRO*, affects positively the collateralization of the loan. As smallest firms suffering of a serious lack of transparency, this finding is consistent with H3. That is, if a lender grants a loan to micro-sized firm with hidden information problems the probability to pledge collateral increases of 14%.

Third, relationship banking measures are also likely to impact on the probability of collateral for unrated firms. As such, we find that *LENDERS* has a consistent direct impact on the probability of collateral pledging as predicted by H4. Results for *Num*NEW* are also in this direction providing evidence that the lack of exclusivity causes an increase of the likelihood of collateral mainly for new loans. At the same time, we find that *YEARS* shows a consistent direct impact on the collateral pledging. That is to say, also in the presence of hidden information problems, the length of relationship captured by its duration is significantly related to the incidence of collateral (Jiménez et al., 2009; Berger et al., 2011a).

Fourth, the lender's characteristics and market structure measures show an impact on the probability of collateral for unrated firms. The coefficient estimate on *DIST* is positive and significant. At contrast, the degree of concentration proxied by *HHI* does not appear to be relevant to the incidence of collateral. However, consistent with findings on rated firms, the coefficient of the cross-effects between the measure of concentration and new loans is negative and significant (i.e., *HHI*NEW*). Moreover, *Column (3)* of Table 2 includes $SHARE_{ij}$ as additional explanatory variable. Since the relative number of firms served by the lenders in the province is an indirect measure of their knowledge of local market conditions, *SHARE* suggests that the knowledge of the province affects the probability of collateral pledging to unrated firms. This effect is confirmed when controlling for the interaction between this measure and new loans (i.e., *SHARE*NEW*) that shows a positive and significant coefficient.

Finally, the measure of the credit outstanding seems to represent an important predictor of collateral pledging only for new loans (i.e., *CREDIT*NEW*).

6.1 Additional evidences on the role of relationship lending

Our results show that bank-firm relationship affects the probability of collateral pledging to rated and unrated firms, and clearly depict a framework where a strength relationship between borrower and lender discourages the use of collateral. As such, the strength of the relationship is measured according to the most widespread measures suggested by literature (i.e., duration of bank-firm relationship and the number of banks the borrower has loans with). While this effect can be explained by the enhancement of monitoring ability of the lender in those case where the relationship with borrower is strength, we need to clarify which is, between *YEARS* and *LENDERS*, the relationship variable that most plays a disincentive role for collateral use.

There are reasons why this evidence should be further investigated when studying the determinants of collateral. First, when the borrower practices multiple lending relationship, a long relationship with one of the lender could discourage the latter to ask for collateral due to the development of close ties. Second, there may be some interdependencies (i.e., moderating effects) between the variables used to proxy the strength of relationship that may affect the likelihood of collateral being pledged. Third, it is also possible that the partial effect of market structure measures on the collateral depends on the magnitude of the bank-firm relationship.

Thus, this section presents additional evidences on the role of relationship lending when we identify the determinants of the probability of collateral pledging for rated firms (Sample A). First, we investigate the impact of moderating effects between the duration of the relationship and the number of banks on the likelihood of collateral being pledged (columns 3 and 4 of Table 3). Second, we discuss the interdependencies between the market structure measures and the relationship measure and their effect on the probability of collateral pledging (columns 5, 6 7 and 8 of Table 3). Third, we analysis the moderating effect between the duration of relationship and the organizational distance (DIST).

To this scope we create three dummy variables for that take the value of 1 when the variables *LENDERS*, *HHI* and *DIST* assume values ≥ or ≤ their median. Then, we analyze the joint effect between these dummies and the duration of relationship (YEARS) with some interactions.

<Insert here TABLE 3>

We report some interesting additional evidences on the role of relationship lending.

First, we take into account the coefficients of *YEARS*, *LENDERS*, and *YEARS*LENDERS(1/0)* to correctly interpret the effect of the relationship measures on the likelihood of the use of collateral (columns 3 and 4), where *LENDERS(1/0)* is a dummy that takes the value of 1if the number of banks of a firm is equal or major than 3 (the median value of *LENDERS*). The estimated coefficient of the interaction term is negative (0.0082) and highly statistical significant. This finding means that also when the borrower practices multiple lending relationship, a long relationship with one of the lender discourage the latter to ask for collateral. That is, if the value of the investment in borrower-specific information increases over time, an increase in the number of lenders over the median (i.e., *LENDERS(1/0)* takes the value of 1) enhances the impact of duration of relationship on the probability of collateral pledging supporting H4a. Thus, it seems that the duration of relationship is a strong measure of relationship among the ways in which it can be measured (i.e., Steijvers and Voordeckers, 2009).

Second, in model (2) we add the cross effects between the duration of relationship and the index of market concentration (i.e., *Year*HHI*(*1*/0)) where *HHI*(*1/0*) is a binary variable that takes the value of 1 if bank competition is medium-high[10] (columns 5, and 6).

The signs of relationship metrics, *YEARS*, *LENDERS*, and *YEARS*LENDERS*(*1/0*), remain unchanged, while the marginal effect of the interaction term *YEARS*HHI*(*1/0*) does not support $H6_a$. As such, we report that the probability of observing an increase in collateralized loans is

[10] Specifically, *HHI(1/0)* takes the value of 1 if *HHI* is ≤ 652 (the median value of *HHI*).

associated with a decrease in the duration of relationship also when we moderate with the impact of the multiple lending and the degree of competition. We also show that the impact of *HHI* on the probability of collateral pledging is negative, also taking into account the moderating effect of the duration of relationship (i.e., *YEARS*HHI(1/0)*), i.e., lenders respond to greater competition by asking less collateral if there is a long relationship.

Finally, we include in columns 7, and 8 of Table 3 the interaction between the duration of the relationship and the distance, i.e., *YEARS*Dist (1/0)*, where the latter is *binary* variable that assumes the value of 1 if *Dist* is ≥ 38 (the median value).

Once again, the use of collateral is more likely with competition than monopoly even if a long relationship mitigate this effect . The positive regression coefficient of *DIST* suggests that a higher distance increases the likelihood of the use of collateral according to borrower-based theory while the cross-effect between the duration of relationship and the distance (the marginal effect of *YEARS*Dist*(*1/0*) on the probability of pledging collateral is -0.0033, and highly statistical significant) seems to reverse this effect according to lender-based theory (e.g., Jiménez et al., 2009). That is to say, distance reduces the incentives to collect soft information and transfer it along the organization and enhances the probability to ask more collateral, but developing closer relationships with their firms helps local lenders to ask for collateral in order to still take advantage of any superior information.

7. Conclusions

Existing evidence on the determining factors of collateral pledging is mixed and does not adequately control for the moderating effects of the relationship banking on the other determining factors. This paper presents an exhaustive analysis of the determinants of collateral pledging in loans granted to firms by using the unique internal data of a large Italian banking group reporting 9,930 bank-firm relationships. Our empirical exercise builds on a unique and distinctive dataset that allows us to exactly measure the borrower risk observed by bank lender (i.e., internal ratings) and to

distinguish between borrowers with observed risk measure and borrowers whose level of risk is not observable from bank lender (i.e., borrowers without internal rating).

We find that riskier borrowers are encouraged to give more collateral to banks in order to obtain a loan, while in presence of hidden information are the less risk borrowers to offer collateral in order to signal their quality. These results are consistent with the moral hazard and adverse selection hypotheses. However, not only collateral is able to solve the asymmetric information problems as we find the stronger the relationship banking the lower is the probability that banks asking for collateral. Specifically, we report that the duration of relationship is the most effective measure of relationship banking as a long relationship with one of the lender discourage the latter to ask for collateral when the borrower practices multiple lending relationship. Furthermore, unlike the lender-based theory, we observe distant banks are more likely to pledge collateral than local banks, although we find that the duration of relationship banking acts on the lender-borrower distance by reducing the probability that distant banks ask for collateral. Finally, we find that a possible drawback of high competitive credit markets is related to a more ask for collateral. Overall, our results confirms the borrowed-based theories: namely on one hand we suggest that collateral mainly serve to reduce the informational advantages of borrowers over lenders, especially in high competitive credit markets, the other we display that relationship lending is complementary to collateral.

Our empirical evidence addresses new questions related to explaining the impact of relationship measures on the use of collateral with respect to specialization of lenders (i.e., local cooperative banks versus distant commercial banks).

References

Agarwal, S., Hauswald, R. (2010). Distance and Private Information in Lending. The Review of Financial Studies, 23 (7), 2757–2788.

Alessandrini, P., Presbitero, A.F., Zazzaro, A., 2009. Banks, distances and firms' financing constraints. Review of Finance 13, 261–307

Beck, T., Demirgüç-Kunt, A., Maksimovic, V., 2008. Financing patterns around the world: Are small firms different?. Journal of Financial Economics, 89(3), 467–487.

Berger, A.N., Udell, G.F., 1990. Collateral, loan quality, and bank risk. Journal of Monetary Economics 25, 21–24.

Berger, A. N., Udell, G. F., 1995. Relationship lending and lines of credit in small firm finance. Journal of business 68, 351–381.

Berger, A. N., De Young, R., Udell, G. F., 2001. Efficiency barriers to the consolidation of the European financial services industry. European Financial Management, 7(1), 117–130.

Berger, A. N., Espinosa-Vega, M. A., Frame, W. S., Miller, N. H., 2011a. Why do borrowers pledge collateral? New empirical evidence on the role of asymmetric information. Journal of Financial Intermediation 20(1), 55–70.

Berger, A.N., Frame, W.S., Ioannidou, V., 2011b. Tests of ex ante versus ex post theories of collateral using private and public information. Journal of Financial Economics 100, 85–97.

Besanko, D., Thakor, A.V., 1987a. Collateral and rationing: sorting equilibria in monopolistic and competitive credit markets. International Economic Review 28, 671–689.

Besanko, D., Thakor, A. V., 1987b. Competitive equilibrium in the credit market under asymmetric information. Journal of Economic Theory 42(1), 167–182.

Bester, H., 1987. The role of collateral in credit markets with imperfect information. European Economic Review, 31(4), 887–899.

Bester, H., 1994. The role of collateral in a model of debt renegotiation. Journal of money, credit and banking, 26(1), 72–86.

Bharath, S.T., Dahiya, S., Saunders, A., Srinivasan, A., 2011. Lending relationships and loan contract terms. Review of Financial Studies 24, 1141–1203.

Black, S. E., Strahan, P. E., 2002. Entrepreneurship and bank credit availability. The Journal of Finance, 57(6), 2807–2833.

Boot, A. W., Thakor, A. V., Udell, G. F., 1991. Credible commitments, contract enforcement problems and banks: Intermediation as credibility assurance. Journal of Banking and Finance 15(3), 605–632.

Boot, A. W., Thakor, A. V., 1994. Moral hazard and secured lending in an infinitely repeated credit market game. International Economic Review, 899–920.

Boot, A. W., 2000. Relationship banking: What do we know?. Journal of financial intermediation, 9(1), 7–25.

Brick, I. E., Palia, D., 2007. Evidence of jointness in the terms of relationship lending. Journal of Financial Intermediation, 16(3), 452-476.

Bazzana, F., Broccardo E., Hanedar, E., 2012. Collateral Requirements of SMEs: The Evidence from Less–Developed Countries. Cefin Working Paper, 428.

Chakraborty, A., Hu, C.X., 2006. Lending relationships in line-of-credit and non-line of- credit loans: evidence from collateral use in small business. Journal of Financial Intermediation 15, 86–107.

Chakravarty, S., Xiang, M., 2013. The international evidence on discouraged small businesses. Journal of Empirical Finance 20, 63–82.

Chan, Y.S., Kanatas, G., 1985. Asymmetric valuation and the role of collateral in loan agreements. Journal of Money, Credit and Banking 17, 85–95.

Dass, N., Massa, M., 2011. The Impact of a Strong Bank-Firm Relationship on the Borrowing Firm Review of Financial Studies 24 (4), 1204-1260.

Degryse, H., & Van Cayseele, P., 2000. Relationship lending within a bank-based system: Evidence from European small business data. Journal of Financial Intermediation 9(1), 90–109.

Degryse, H., Ongena, S., 2005. Distance, lending relationships, and competition. Journal of Finance 60, 231–266.

Elsas, R., 2005. Empirical determinants of relationship lending. Journal of Financial Intermediation, 14(1), 32–57.

Fabbri, D., Padula, M., 2004. Does poor legal enforcement make households credit-constrained? Journal of Banking and Finance, 28(10), 2369–2397.

Fang, Y., Francis, B., Hasan, I., Wang, H., 2012. Product market relationships and cost of bank loans: Evidence from strategic alliances. Journal of Empirical Finance, 19, 653–674.

Fiordelisi, F., Marques-Ibanez, D., Molyneux, P., 2011. Efficiency and risk in European banking. Journal of Banking & Finance, 35(5), 1315–1326.

Giannetti, C., 2012. Relationship lending and firm innovativeness. Journal of Empirical Finance, 19, 762–781.

Harhoff, D., Körting, R., 1998. Lending relationships in Germany-empirical evidence from survey data. Journal of Banking and Finance 22, 1317–1353.

Hainz, C., Dinh, T., Kleimeier, S., 2011. Collateral and its Determinants: Evidence from Vietnam. Proceedings of the German Development Economics Conference, Berlin 2011 36, Verein für Socialpolitik, Research Committee Development Economics.

Heider, Florian, and Roman Inderst, 2012, Loan Prospecting, *Review of Financial Studies*, 25 (8), 2381–2415.

Igawa, K., Kanatas, G., 1990. Asymmetric information, collateral, and moral hazard. Journal of Financial and Quantitative Analysis 25(4), 469–490.

Inderst, R., Mueller, H.M., 2007. A lender-based theory of collateral. Journal of Financial Economics 84, 826–859.

Jappelli, T., Pagano, M., Bianco, M., 2005. Courts and Banks: Effects of Judicial Enforcement on Credit Markets, Journal of Money, Credit and Banking, 37(2), 223–44.

Jiménez, G., Saurina, J., 2004. Collateral, type of lender and relationship lending as determinant of credit risk. Journal of Banking and Finance 28, 2191–2212.

Jiménez, G., Salas-Fumás, V., Saurina, J., 2006. Determinants of collateral. Journal of Financial Economics 81, 251–281.

Jiménez, G., Salas-Fumás, V., Saurina, J., 2009. Organizational distance and use of collateral for business loans. Journal of Banking and Finance 33, 234–243.

John, K., Lynch, A.W. & Puri, M. (2003). Credit ratings, collateral and loan characteristics: implications for yield. Journal of Business, 76, 371-409

Machauer, A., Weber, M., 1998. Bank behavior based on internal credit ratings of borrowers. Journal of Banking & Finance, 22(10), 1355–1383.

Manove, M., Padilla, A. J., and Pagano M., 2001. Collateral versus Project Screening: A Model of Lazy Banks. Rand Journal of Economics 32(4), 726–744.

Menkhoff, L., Neuberger, D., Suwanaporn, C., 2006. Collateral-based lending in emerging markets: evidence from Thailand. Journal of Banking and Finance 30, 1–21.

Menkhoff, L., Neuberger D., Rungruxsirivorn, O., 2012. Collateral and its substitutes in emerging markets' lending. Journal of Banking and Finance 36(3), 817–834.

Ono, A., Uesugi, I., 2009. The role of collateral and personal guarantees in relationship lending: evidence from Japan's SME loan market. Journal of Money, Credit and Banking 41, 935–960.

Petersen, M., 2009. Estimating Standard Errors in Finance Panel Data Sets: Comparing approaches. Review of Financial Studies 22, 435–480.

Puri, M., J. Rocholl and S. Steffen (2011). Global Retail Lending in the Aftermath of the US Financial Crisis: Distinguishing between Demand and Supply Effects. Journal of Financial Economics, 100(3), 556–578.

Rajan, R. G., 1992. Insiders and outsiders: The choice between informed and arm's- length debt. The Journal of Finance, 47(4), 1367–1400.

Rogers, W.H.,1993. Regression Standard Errors in Clustered Samples. Stata Technical Bulletin 13, 19-23.

Sharpe, S. A., 1990. Asymmetric information, bank lending, and implicit contracts: A stylized model of customer relationships. The Journal of Finance, 45(4), 1069–1087.

Steijvers, T., Voordeckers, W., 2009. Collateral and credit rationing: a review of recent empirical studies as a guide for future research. Journal of Economic Surveys, 23(5), 924–946.

Stiglitz, J. E., Weiss, A., 1981. Credit rationing in markets with imperfect information. The American economic review, 71(3), 393–410.

Table 1 - Description of variables and summary statistics

Variables	Symbol	Description
Borrower's characteristics variables		
Borrower observed risk	RISK	This variable contains the borrower's creditworthiness as calculated by the banks' internal borrower rating system, which is composed of 10 risk classes for solvent borrowers (i.e., 1 = the less risky class; 10 = the worst)
Borrower unobserved risk	DEFAULT	This variable is a dummy that takes the value of 1 if the firm receives a distress rating notch from bank because experiences a default event[11] after two year and 0 otherwise
Transparency	LARGE, MEDIUM, SMALL, MEDIUM	These variables are four dummy variables are provided by banks. They consider both sales and other variables, such as asset size and number of workers
Relationship banking variables		
Number of relationships	LENDERS	This variable reports the number of banks the borrower has loans with.
Duration of relationship	YEARS	This variable report number of years since the bank lender granted the first loan to the borrower[12]
Lender's characteristics and credit market structure variables		
Organizational distance	DIST	This variable accounts for the value of the distance between the province of the local bank branch and the city where the bank's headquarter[13] is located
Lender's experience	SHARE	This variable is equal to the percentage of firms served by each bank over the total number of firms active in the province of firm at the end of the year
Market concentration indicator	HHI	The variable is the sum of banks squared market shares in loans granted in each one of the Italian provinces at the end of the year
Control variable		
Credit outstanding	CREDIT	This is an aggregated measure of the credit outstanding from the bank *j* to firm *i*; it sums loans, accounts receivable, short-term loans, long-term loans and revolving credit lines[14].

[11] We consider that one firm experiences a default event if it has (at least) one or more past due loans remaining unpaid three months after the maturity date. In this case, the internal rating systems of the banks put in the 11th class (the default class) the borrower. In this class borrowers are then classified according to the severity of the distress.

[12] In cases where the credit relationship duration is less than one year, this duration is approximated as one year.

[13] In more formal terms, the following proxy of distance was used: $DIST_{ij}= \ln(1+KM_{ij})$, where KM_{ij} is the distance in kilometers between the province of firm i (in Italy, there are 110 provinces) and the headquarter of bank j (j=1..8).

[14] A credit line is here indented here as a contract that allows a borrower to take advantage of a predetermined "line limit" and repay it at the borrower's discretion with an interest rate periodically set by the bank. Whenever the drawn credit exceeds the line limit, the bank charges a penalty interest rate.

Summary statistics

Name Variable	N (Sample A) [Sample B]	Mean	Median	SD
COLLATERAL (1/0)	(8,205) [1,725]	0.298 0.255	0 0	0.457 0.436
NumLENDERs	(8,205) [1,725]	4.552 3.945	3 3	4.215 3.577
YEARs	(8,205) [1,725]	17.184 17.766	20 20	7.467 7.049
DISTANCE	(8,205) [1,725]	63.722 88.706	38 49	128.796 154.337
HHI	(8,205) [1,725]	1,019.672 1,110.225	652.752 728.557	704.240 755.803
CREDIT	(8,205) [1,725]	683,618.7 313,839.9	135,422 25,347	279.062 183,958
RISK	(8,205) [1,725]	5.922	6	3.028
LARGE (1/0)	(8,205) [1,725]	0.020 0.003	0 0	0.143 0.0570
MEDIUM (1/0)	(8,205) [1,725]	0.199 0.075	0 0	0.399 0.263
SMALL (1/0)	(8,205) [1,725]	0.280 0.263	0 0	0.449 0.206
MICRO (1/0)	(8,205) [1,725]	0.474 0.867	0 1	0.499 0.339
Only for sub-sample B				
Default (1/0)	[1,725]	0.726	1	0.445
SHARE	[1,725]	11.679	12.17505	9.247

Table 2 - Determinants of collateral

	Sample A *Rated Firms*		*Sample B* *Unrated firms*	
	Coefficients	Marginal effects	Coefficients	Marginal effects
RISK	0.0243***	0.0071***		
	(0.0072)			
DEFAULT			-0.9836***	-0.3093***
			(0.1117)	
YEARS	-0.1255***	-0.0368***	-0.1177***	-0.0321***
	(0.0046)		(0.0087)	
LENDERS	0.0556***	0.0163***	0.0448***	0.0122***
	(0.0068)		(0.0132)	
DIST	0.0006***	0.0001***	0.0016***	0.0004***
	(0.0001)		(0.0002)	
HHI	-0.1501**	-0.0440**	-0.0136	-0.0037
	(0.0746)		(0.0838)	
SHARE			0.0123**	0.0033**
			(0.0057)	
CREDIT	4.37e-08***	1.28e-08***	5.34e-08	1.46e-08
	(1.20e-08)		(4.34e-08)	
LARGE	-0.3415**	-0.0868**	1.0898*	0.3941*
	(0.1587)		(0.5926)	
SMALL	-0.3595***	-0.0986***	0.4010	0.1256
	(0.0672)		(0.2541)	
MICRO	0.5005***	0.1462***	0.6748***	0.1441***
	(0.0701)		(0.2106)	
RISK*NEW	0.0342*	0.0100*		
	(0.0206)			
DEFAULT*NEW			0.3620	0.1130
			(0.4392)	
LENDERS*NEW	-0.0106	-0.0031	0.4091***	0.1116***
	(0.0173)		(0.1027)	
DIST*NEW	-0.0001	-0.0000	0.0022*	0.0006*
	(0.0004)		(0.0012)	
HHI*NEW	-0.2853***	-0.0836***	-0.6143***	-0.1675***
	(0.0528)		(0.0803)	
SHARE*NEW			0.1018***	0.0277***
			(0.0313)	
CREDIT*NEW	1.29e-08	3.79e-09	4.02e-07***	1.10e-07***
	(2.55e-08)		(1.43e-07)	
Constant	0.0690		0.5557	
	(0.5780)		(0.6595)	
Dummies Banks	Yes		Yes	
Dummies Industries	Yes		Yes	
N. Obs	8,205		1,725	
Pseudo R^2	0.3967		0.3640	
Wald χ^2	2,064.20		463.40	
Log L	-3,015.30		-618.10	
Prob> χ^2	0.0000		0.0000	

This table reports probit regressions for COLLATERAL, a dummy variable that equals one if borrowing firm has a collateralized loan. See Table 1 for description of the other variables. Under the heading ‘‘Probit coefficients,’’ we report the estimated coefficients of the two probit specifications. Standard errors, corrected for heteroskedasticity, are reported between brackets. Under the heading ‘‘Marginal effects,’’ we report the change in probability of pledging collateral for each one of the independent variables. For continuous variables we report the effect for an infinitesimal change in each independent variable; dummy variables are treated as continuous variables. ***, **, and * indicate significance at the1%, 5%, and10% level, respectively.

Table 3 - Collateral and Relationship: interactions

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficients	Marginal effects	Coefficients	Marginal effects	Coefficients	Marginal effects	Coefficients	Marginal effects
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RISK	0.0344***	0.0100***	0.0350***	0.0102***	0.0342***	0.0099***	0.0326***	0.0102**
	(0.0068)		(0.0068)		(0.0068)		(0.0068)	
YEARS	-0.0955***	-0.0279***	-0.0909***	-0.0265***	-0.0801***	-0.0233***	-0.0688***	-0.0234***
	(0.0038)		(0.0041)		(0.0043)		(0.0049)	
LENDERS	0.0483***	0.0141***	0.0551***	0.0160***	0.05403***	0.0157***	0.0554***	0.0216***
	(0.0064)		(0.0069)		(0.0069)		(0.0070)	
DIST	0.0008***	0.0002***	0.0007***	0.0002***	0.0005***	0.0001***	0.0006***	0.0002***
	(0.0001)		(0.0001)		(0.0001)		(0.0001)	
HHI	-0.1713**	-0.0500**	-0.1692**	-0.0493**	-0.4497***	-0.1311***	-0.6082***	-0.4917***
	(0.0742)		(0.0740)		(0.0859)		(0.0938)	
CREDIT	3.94e-08***	1.15e-08***	3.83e-08***	1.12e-08***	3.98e-08***	1.16e-08***	3.84e-08***	1.42e-08***
	(1.02e-08)		(1.02e-08)		(1.04e-08)		(1.04e-08)	
LARGE	-0.2650*	-0.0694**	-0.3190**	-0.0815**	-0.3344**	-0.0847**	-0.3316**	-0.1062***
	(0.1509)		(0.1553)		(0.1572)		(0.1595)	
SMALL	-0.3554***	-0.0972***	-0.3582***	-0.0978***	-0.3471***	-0.0948***	-0.3555***	-0.1383***
	(0.0621)		(0.0630)		(0.0633)		(0.0636)	
MICRO	0.3644***	0.1063***	0.3238***	0.0943***	0.3449***	0.1003***	0.3430***	0.1578***
	(0.0657)		(0.0672)		(0.0675)		(0.0676)	
YEARS*LENDERS (1/0)			-0.0082***	-0.0024***	-0.0082***	-0.0023***	-0.0078***	-0.0029***
			(0.0024)		(0.0024)		(0.0024)	
YEARS*HHI (1/0)					-0.0177***	-0.0051***	-0.0271***	-0.130***
					(0.0026)		(0.0033)	
YEARS*DIST (1/0)							-0.0130***	-0.0081***
							(0.0027)	
Constant	-0.9250*		-0.9480*		1.0469***		2.1419***	
	(0.5624)		(0.5609)		(0.6370)		(0.6896)	
Dummies Banks	Yes		Yes		Yes		Yes	
Dummies Industries	Yes		Yes		Yes		Yes	
N. Obs	8,205		8,205		8,205		8,205	
Pseudo R^2	0.3705		0.3717		0.3759		0.3783	
Wald χ^2	2,140.24		2,145.95		2,163.98		2,166.04	
Log L	-3,146.07		-3,140.22		-3,119.42		-3,107.38	
Prob> χ^2	0.0000		0.0000		0.0000		0.0000	

This table reports probit regressions for COLLATERAL, a dummy variable that equals one if borrowing firm has a collateralized loan. We test interaction effect of duration or bank-firm relationship (YEARS) with other independent variable. Specifically, YEARSxLENDERS(1/0) is the product between YEARS and a dummy that takes the value of one if the number of banks of a firm is equal or major than 3 (the median value of LENDERS). YEARSxHHI(1/0) is the product between YEARS and a dummy that takes the value of one if HHI is equal or minor than 652 (the median value of HHI). YEARSxDIST(1/0) is the interaction with a dummy that takes the value of one if DIST is equal or major than 38 (the median value of DIST). See Table 1 for description of the other variables. Under the heading ''Probit coefficients,'' we report the estimated coefficients of the three probit specifications. Standard errors, corrected for heteroskedasticity, are reported between brackets. Under the heading ''Marginal effects,'' we report the change in probability of pledging collateral for each one of the independent variables. For continuous variables we report the effect for an infinitesimal change in each independent variable; dummy variables are treated as continuous variables. ***, **, and * indicate significance at the1%, 5%, and10% level, respectively.