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COLLATERAL IN BANK LENDING DURING FINANCIAL CRISES: A BORROWER AND A LENDER STORY

by Massimiliano Affinito[♠], Fabiana Sabatini[♠] and Massimiliano Stacchini[♠]

Abstract

We analyse whether and to what extent both firm- and bank- soundness are associated with the use of collateral in bank lending, and whether the relations change during the global financial and the euro-area sovereign debt crises. By using a large dataset of 2 million of bank-firm level observations covering the years 2007-13, we find that the degree of collateralization is higher at financially stressed and lowly capitalized firms and that it increases further for these borrowers during downturns. In addition, we find that collateral policies are tighter at sounder banks, that is, at banks that are more capitalized and have a lower burden of bad loans. This result is consistent with the existence of a negative link between bank soundness and risk-taking in bank lending.

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Contents

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1. Introduction[1]

Collateral is a crucial component of loan contracts and a key topic of a large amount of the banking literature. Collateral policies are expected to attenuate opportunistic behaviours of debtors and facilitate screening activities of lenders. This paper investigates whether and to what extent soundness of both borrowing firms and lending banks are associated with the use of collateral in bank lending and whether their role changes during economic downturns. In particular, we first investigate the association between the degree of collateralization and the economic and financial strength of borrowers. Then we focus on the link between the use of collateral and bank balance-sheet health, as measured by banks capitalization and the incidence of bad loans over assets.

By means of a firm-bank matched dataset built by the Italian Credit Register (CR) and the Company Account Database (CAD), we exploit the development in collateralized lending in Italy during the period 2007-13, a horizon comprising the global financial and the euro-area sovereign debt crises. The Italian credit market is an ideal environment to our purposes as Italy is a bank-based economy and most firms' are bank dependent; moreover, the two crises significantly affect the Italian credit market, making it a suitable setting to investigate how the use of collateral changes during downturns.[2] Moreover, Italy allows us to take advantage of a unique home-made 2 billion observations dataset that merges information from the Italian credit register with bank and firm level data.

The empirical strategy relies on the incidence of loans secured by real collateral over total loans at the bank-firm level (degree of collateralization) as a comprehensive measure of the use of collateral in corporate lending. The ratio measures the share of credit losses protected by collateral in the case of a firm default. It captures synthetically the tightness, even evolving over time, of collateral policies. Indeed it is not relevant to our purposes if a given collateral policy is obtained at bank-firm level by decreasing the exposure or increasing the collateral requested, but what matters is exactly the incidence of collateral on total exposure and its development over time. The granularity at firm-

[1] The authors would like to thank for their comments, without implicating them in responsibility, two anonymous referees, Giorgio Albareto, Andrea Brandolini, Riccardo De Bonis, Antonio De Socio, Matteo Piazza, Alfonso Rosolia, the participants at the Bank of Italy's 4th Banking Research Network Workshop and at the internal seminars of our Directorates. All remaining errors are the authors' responsibility only. The views expressed are those of the authors alone and do not represent necessarily those of the Bank of Italy.

[2] The financial crises induce a very deep and long recession in Italy, which leaves a cumulative drop in GDP of almost 10%; this causes a very large increase in non-performing loans (from 5.8% of outstanding bank loans in December 2006 to 16% in December 2013) and a prolonged contraction in bank credit (Angelini et al., 2017; Angelini, 2018). Moreover, unlike other Eurozone countries, Italy does not inject public funds to recapitalize the banking system nor it creates a bad bank to absorb the non-performing loans. As a result, on the borrower side, the double dip recession pushes several firms out of business and stresses many of those who are able to survive; on the lender side, Italian banks remain saddled with a large fraction of bad loans, and several banks struggle to meet the stricter capital requirements imposed by regulators in the aftermath of the crisis.

bank level of our data allows us to run models that absorb all factors that might potentially confound the relationships under investigation, in the spirit of empirical works *à la* Khwaja and Mian (2008), Paravisini (2008), Amiti and Weinstein (2018). In particular, to insulate lender-side features, we consider models that absorb all firm heterogeneity in the use of collateral through time-varying firm fixed effects. Symmetrically, to insulate borrower side features, we control for all bank heterogeneity through time-varying bank fixed effects and firm time-invariant heterogeneity through firm dummies. We also take into account the potential endogeneity issue arising for some variables – bad loans in banks' balance sheets – and run the exercise again by using instrumental variable estimations.

Our results document that, as for the borrower side, the incidence of collateral over the amount of loan is higher at financially stressed and less capitalized firms. We also find a tightening of collateral policies affecting these firms after the deflagration of the financial crises. As for the lender side, we find that collateral policies are tighter at sounder banks, that is, at banks that are more capitalized or that have a lower incidence of bad loans.

The paper contributes to the literature in four ways. First, our paper extends the literature on the relationship between the use of collateral and bank characteristics and conditions. Despite of the large attention to the collateral, scholars largely overlook the lender-side dimension of the story and study the ratio of collateral to loans mainly in association with borrower opacity. Instead, it may well vary according to risk aversion of lenders or as a result of shocks hitting bank ability to provide credit. The literature has already largely shown that during the financial crises tensions are at least partly passed on to the real economy through a tightening of loan availability and cost; to the best of our knowledge, we are the first to show that collateralization is a further channel for the propagation of shocks.

Second, by including the years of the global financial and sovereign crisis, we also investigate how the correlation between collateral policies and firm characteristics change during periods of financial strains. Although borrowers' characteristics are at the core of the literature on moral hazard and adverse selection, conclusions are anything but unanimous even in finding a relationship between collateral and firm riskiness, that is, the firm side of our investigation. The omission of bank-side features, which instead we include, may contribute to explain the different results found so far by the literature.

Third, the paper advances the empirical literature by controlling for and testing the effect of personal guarantees on the use of real collateral. The distinction between real and personal guarantees is notable. Real guarantees provide creditors with legal claims on a debtor's well-defined asset, which is explicitly referred to in the debt contract; for that reason, real guarantees are perceived as powerful to mitigate debtors' opportunistic behaviours. Personal guarantees instead enlarge debtors' resources

by binding third persons to repay loans in case of default, but do not provide creditors with the control over a specific asset. The empirical literature on loan collateralization largely focuses on real guarantees and we follow the same approach in the baseline analysis so to get a benchmark for our results. However, our study also comprises personal collateral. The omission of personal guarantees in fact might imply a bias in the estimates if, in spite of their specificities, real and personal guarantees own some degree of substitutability. For example, if a debtor lacking of internal asset to post as a real collateral might ask to a third party to guarantee the repayment, the use of real collateral would appear lower in the data only because of the presence of a personal guarantee in the loan contract. We verify whether our findings hold both when this distinction is introduced and when we analyse loan guarantees as a whole including real and personal collateral. Indeed, we find that real and personal guarantees present a substitutability role and interestingly identical drivers.

Fourth, our study also contributes to the literature on the link between banks' soundness and risk-taking behaviour (e.g., Delis and Kouretas, 2011; Hilscher and Raviv, 2014). In fact, since our results show that sound (and presumably more risk averse) banks adopt a higher degree of prudency in collateral policies, we hypothesize that a channel through which loan collateralization operates is the banks' risk-taking in lending. To verify whether the channel is really at work, we analyse whether loan conditions to identical borrowers are heterogeneous across banks, in terms of capitalization and quality of assets, and we find that loans granted by sounder banks are characterized by lower rates and tighter collateral policies, which is consistent with the hypothesis about a risk-taking channel of collateralization.

The rest of the paper is organised as follows. Section 2 reviews the main literature on collateral in bank lending. Section 3 presents the data. Section 4 describes our empirical strategy. Section 5 summarizes the baseline results. Section 6 deepens the role of personal guarantees. Section 7 explores the role of banks' risk-taking attitude in the request of collateral. Section 8 illustrates other extensions of our analysis. Section 9 presents some robustness checks. Section 10 concludes.

2. Literature review

A large literature investigates the use of collateral in loan contracts. Collateral is typically expected to mitigate informational asymmetries responsible for moral hazard and adverse selection problems in debt markets. For exposition purposes, it is useful to distinguish three areas of the literature.

The traditional literature analyses the use of collateral focusing on borrowers' characteristics and gives rise to two main views. The first view highlights that the use of collateral is positively

correlated with borrowers' riskiness (sorting-by-observed-risk paradigm) as the presence of collateral has the role of mitigating frictions and increasing ex-post incentives to repay loans. The second view stresses that the use of collateral negatively correlates with observable riskiness (sorting-by-private-information paradigm) because safer borrowers are willing to pledge more collateral to signal their soundness and ability to repay loans.[3] Empirical investigations, pioneered by Berger and Udell (1990), tend to conclude that collateral policies are more severe when borrowers are observationally riskier, in terms of balance sheet characteristics, public ratings, Altman z-score indicator and loan performance.[4]

Another traditional strand relates the use of collateral to the type of relationship between lenders and borrowers. Also in this case there are two views. On the one hand, relationship lenders might apply more favourable collateral policies to clients because they have an informational advantage due to the use of soft information; on the other hand, they could apply tighter collateral policies if some lock-in effect is at work.[5]

A third, more recent and so far limited strand of research relates the use of collateral to lenders' characteristics. At the best of our knowledge, this stream of research only focuses on organizational features of lending activity. Inderst and Mueller (2007) show that, when competition from distant (transactional) lenders increases, also as a consequence of a technological shock, local lenders might rise the request of collateral to increase the payoffs of the projects that, otherwise, would be inefficiently rejected. Jiménez et al. (2009) also find that loans granted by local lenders are, on average, more secured than loans pledged by distant lenders. Peltoniemi and Vieru (2013) find that the use of personal guarantees is positively correlated with transaction based lending. Stroebel (2015) shows that better informed mortgage lenders, whose business is integrated with that of property developers, use informational advantages to lend more against higher quality collateral.[6]

[3] The first theoretical strand (sorting-by-observed-risk paradigm) counts Boot, Thakor, and Udell (1991), Boot and Thakor (1994), Aghion and Bolton (1997), Holmstrom and Tirole (1997). The second theoretical strand (sorting-by-private-information paradigm) counts Bester (1985), Besanko and Thakor (1987), Chan and Thakor (1987), Boot, Thakor, and Udell (1991).

[4] The empirical works include Harhoff and Korting (1998), Pozzolo (2004), Gonas, Highfield and Mullineaux (2004), Chakraborty and Hu (2006), Jiménez et al (2004), Bonaccorsi di Patti (2007), Brick and Palia (2007), Calcagnini et al. (2012).

[5] See Berger and Udell (1995), Harhoff and Korting (1998), Chakraborty and Hu (2006), Brick and Palia (2007), Machauer and Weber (1998), Elsas and Krahnen (2000), Lehmann and Neuberger (2001), Ono and Uesegi (2009), Degryse and Van Cayseele (2000), Jiménez et al. (2004). Menkhoff, Neuberger, and Suwanaporn (2006), Voordeckers and Steijvers (2006), Berger, Espinosa-Vega, Frame, and Miller (2011), Berger, Frame and Ioannidou (2011).

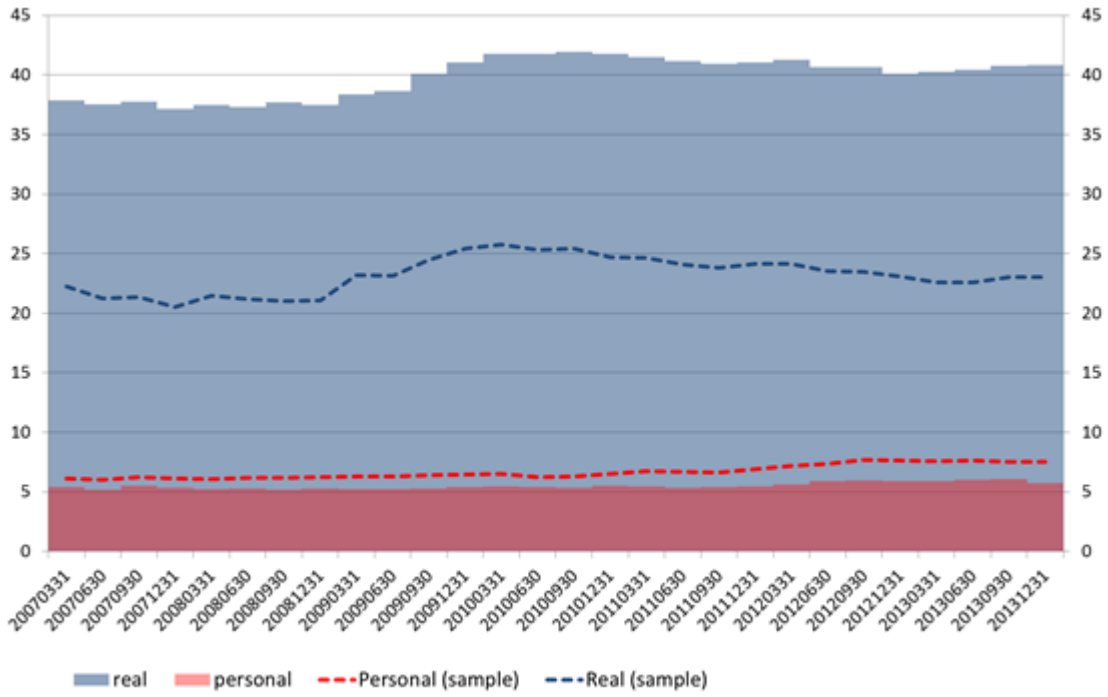
[6] The most recent literature on collateral has also explored new areas of research analysing the role of collateral in association with regulation and firm outcomes. For example, Banerjee and Blickle (2016) shows that effects of changing house prices on both borrowing and investment are higher at more opaque firms. Cerqueiro et al. (2016) show that legal reforms affecting the values of collateral might influence credit limits set by lenders. Calomiris et al. (2017) highlight the link between collateral laws and the use of immovable or movable collateral.

3. Data and variable description

Figure 1 shows the development of the ratios of real and personal guarantees to total loans between 2007 and 2013 for all firms operating in Italy (blue and red area) and for firms included in our sample (blue and red dashed lines). Two stylized facts are noteworthy. First, the use of real guarantees increases remarkably after the failure of Lehman Brother and remains high until the end of 2013. Second, while real collateralization is the predominant type of guarantee in bank lending, personal guarantees are sizable too. With regard to our sample, the development of the use of collateral broadly resembles that of the universe of firms operating in Italy. However, while the incidence of personal guarantees is broadly similar across the two domains, our sample is characterized by a lower incidence of real guarantees, likely due to the relative larger size of firms belonging to the sample. We deepen the point later on in the paper.

Figure 1 – Loans to non-financial corporations: collateral as a share of lending

(percentage points)



Sources: Central Credit Register (CR) of Bank of Italy. *Real* and *Personal* refer to the amount of loans secured by real collateral or, respectively, personal guarantees, as a share of total loans. Bad loans are excluded from the calculus. The data are not influenced by the break in the coverage of the Credit Register occurred in 2009, as the ratios are computed by applying the same CR threshold throughout the sample period (75,000 euros).

The patterns of Figure 1 are equilibrium outcomes and are therefore impacted by both bank and firm characteristics associated with loan collateralization. In particular, during economic downturns borrowers' riskiness increases and this can in turn impact on banks' risk tolerance, causing a tightening in terms and conditions of loans. To disentangle bank and firm level factors, we perform an econometric analysis on a dataset containing variables on firm, bank, and relationship features and covering every loan above 75.000 euros granted by banks operating in Italy to a large sample of non-financial firms belonging to the Company Account Database. The dataset includes around 2 billion of quarterly observations from 2007Q1 to 2013Q4, a period that covers both the global financial and the euro-area sovereign debt crises. The dataset is obtained by merging the three following archives.

i) The Italian Central Credit Register (CR). This dataset is managed by the Bank of Italy and contains information on loans granted to Italian firms by all banks operating in the Italian territory. The database contains the universe of exposures above a certain threshold; specifically, the threshold was equal to 75.000 euros up to 2009 and decreased to 30,000 euros since then; we however include loans above 75.000 for all the period studied to prevent statistical discontinuity in the sample. We use information at firm-bank level on the amount of real (and personal) collateral posted on loans (the numerator of our dependent variable) and the amount of outstanding loans (the denominator of our dependent variable).[7] We use CR data also to build variables on the strength of relationship lending, measured as the share of loans granted by each banking group over the total amount of the firm's debt.

ii) The Company Account Database (CAD) owned by Cerved SPA. This archive contains balance sheet information on around 32,000 firms, including variables such as total assets, leverage, total earnings, sales. Observations come with annual frequency.

iii) Bank of Italy Supervisory Reports. This archive contains data on bank balance sheets submitted by banks to the national authority. Data are aggregated at the bank group-level; we also amend data to take into account of mergers and acquisitions (that is, we consider banks A and B as a sole entity for the whole period if bank A acquires bank B during the period we analyse).

Table 1 reports the list of variables and how they are computed.[8] In baseline estimations, the dependent variable is our measure of the degree of collateralization, *Coll-to-loans*, computed as the

[7] Bad loans, i.e. exposures to insolvent clients, are excluded from our dependent variable (both to the numerator and denominator). This allows us to seize the genuine changing effect of collateral policies over time, that is, to track the use of collateral resulting from lending policies related to exposures whose credit risk's assessment is underway. The exposures we consider include deteriorated lending (different from bad loans) that however have chances of recovery. Instead, bad loans refer to clients that present no or negligible chances to recover and their amount in banks' assets (or their ratio with collateral) does not reflect a lender or a borrower choice, but the ongoing legal procedures for liquidation that in Italy historically take long time to resolve (Visco, 2015).

[8] Standard truncation at the 1 per cent probability level is applied to the original dataset to avoid the effects of outliers.

amount of loans secured by real collateral over total loans at the lender-borrower level.[9] Table 2 illustrates its distribution both before and during the financial crises. On average, *Coll-to loan* equals 7 per cent; figures over the subintervals are broadly in line. Table 2 shows that *Coll-to-loan* equals 0 in a (not negligible) number of cases. This can be explained as the sample that we use for the empirical analysis comprises two types of credit for corporate lending: (i) term loans, which are generally used to finance firm investments, have a predefined maturity and are typically covered by collateral; and (ii) overdrafts, which are instead an instrument largely used as a liquidity buffer, revocable at bank's discretion and usually not backed by collateral. In Section 8 we run a robustness check to control for the changing use of collateral depending on the type of credit.

Our firm-side variables measure firm economic and financial strength and credit risk: *Firm capital* (which measures firm soundness through the capital endowment); *Firm doubtful loans* (which measures firm vulnerability through the share of past due loans); *Firm tangible assets* (which also is a measure of firm riskiness because firms with more enforceable assets are typically perceived as less risky); *Firm sales* and *ROA* (higher sales and profits typically signal a lower risk). *Firm size* and *Firm age* complete the picture as standard control variables. Table 3 reports descriptive statistics on our sampled firms. With regard to capital, average equity as a share of assets equals to 2.1 percent. Average natural logarithm of asset tangibility equals to 1.33. The age of the average firm is 25 years. The difference between means and medians of distributions, together with the size of standard errors, indicate that cross-sectional heterogeneities are relevant. Table 3 also illustrates the worsening of firms conditions during the financial crises. Since we follow Khwaya and Mian (2008), the sample used to perform the analysis comprises only those firms borrowing by more than a bank. However, cross-country studies indicate that multiple banking is more common in Italy than in other countries (Ongena and Smith, 2000; Degryse et al., 2019), and moreover Table 3 shows that the sample statistics of the two types of firms are broadly equal.Overall, the final sample includes around 30,000 firms.

As for banks, indicators of soundness include *Bank capital ratio*, the total burden of *Bank bad loans* and *Bank ROA*. The list of bank-side characteristics also include *Bank liquidity ratio*, *Foreign interbank borrowing*, *Retail funding* and *Bank Size*. Table 4 reports the descriptive statistics on bank characteristics.

Estimations also include two variables defined at lender-borrower level, which proxy features at the bank-firm level. The first variable (*Relationship strength – share*) measures the intensity of the

[9] A given incidence of loan collateralization can be associated to infinite pairs of collateral and loan amounts; similarly, time or cross sectional variations in the incidence might reflect infinite variations at either one or both the components. Moreover, Italy does not experience during the financial crises a real estate bubble (e.g., Nobili and Zollino, 2012), therefore changes in the amounts of collateral over time are unlikely to reflect particular developments of collateral value.

relationship and is equal to the ratio between the amount of credit to firm *i* by bank *j* over the total amount of credit obtained by firm *i*. The second variable (*Bind*) is a dummy equal to 1 if the credit drawn is equal to the credit granted and zero otherwise: when *Bind* is equal to 0, it indicates that a firm can still use its current lending position without necessarily asking for a new loan, while firms displaying *Bind* equal to 1 might potentially be financially constrained.

4. Empirical strategy

A typical concern in the bank-firm level analysis is that firms and banks may be not randomly matched – for instance, riskier firms could be indebted with weaker lenders. If this were the case, the importance of firm characteristics could be confounded by that of bank soundness indicators. To tackle the issue, we analyse firm characteristics by including time-varying fixed effects for each bank so that all time-varying bank heterogeneity is absorbed. We also add firm fixed effects to control for unobservable time-invariant heterogeneity at the borrower level. Thus, the residual variation in the data on loan collateralization is a function of several time-varying covariates capturing firm opacity and riskiness.[10] Symmetrically, investigating the bank side features related to the use of collateral, we include time-varying fixed effects for each borrower to absorb all time-varying firm heterogeneity, and bank fixed effects to capture time-invariant heterogeneity at the lender level. In this case, the residual variation in the incidence of collateral is modelled as a function of time-varying bank indicators proxying bank soundness.[11]

To control for the lender-borrower relationship, we also include the two bank-firm pair specific variables capturing the intensity of the relationship (*Relationship strength - share*) and the possibility that borrowers are financially constrained (*Bind*).

a) Firm-side features of collateral

In formal terms, we investigate the firm side characteristics associated with the use of collateral through the following equation:

[10] Therefore, as it is standard in this kind of analysis, we assume that time-varying firm level factors influencing borrower opacity and riskiness, potentially (and unavoidably) omitted in the empirical model (such as for example firm investment opportunities), are correlated either with the vector of time-varying variables on economic and financial strength of the firm or with the firm level estimated fixed effects.

[11] Similarly to before, we assume time-varying bank factors influencing lenders' strength, potentially omitted in the empirical model, are correlated either with the vector of time-varying bank covariates or with the bank level estimated fixed effects.

$$coll_{ijt} = F_{it-1}\,\beta + R_{ijt-1}\,\gamma + b_{jt} + f_i + e_{ijt} \quad (1)$$

where $coll_{ijt}$ is the collateral-to-loans ratio, that is, the ratio of the amount of collateral outstanding to total loans by bank *j* to firm *i* in quarter *t;* F_{it-1} is a vector of lagged time-varying firm characteristics; R_{ijt-1} is a vector of lagged variables defined at *ijt* level; the variables contained in F_{it-1} and R_{ijt-1} are listed in Table 1; b_{jt} is a vector of (time-varying) bank fixed effects; f_i is a vector of (time-invariant) firm fixed effects; e_{ijt} are idiosyncratic errors ~ i.i.d.

b) Bank-side features of collateral

Symmetrically, to investigate the bank side characteristics associated to the degree of collateralization we estimate the following equation:

$$coll_{ijt} = B_{jt-1}\,\delta + R_{ijt-1}\theta + f_{it} + b_j + u_{ijt} \quad (2)$$

where $coll_{ijt}$ and R_{ijt-1} are defined as before; B_{jt-1} is a vector of (lagged) time-varying bank characteristics; b_j and f_{it} are vectors of, respectively, (time invariant) bank and (time-varying) firm fixed effects; u_{ijt} are idiosyncratic errors ~ i.i.d.[12]

To analyse the effects of the financial crises, we estimate equations (1) and (2) again and allow the slope coefficients to differ over time; we obtain the results within a single empirical estimation rather than through a simple sample splitting to simplify the comparison of coefficients.[13]

In addition, in order to address the potential endogeneity issues related to specific bank-side characteristics, we also employ instrumental variable (IV) estimations of equation 2 and enrich the baseline equation by including specific instruments.

[12] The different use of time invariant and time-varying bank and firm fixed effects in two equations explains the different number of observations in the results of the two models.

[13] In the basic regressions the turning date is the collapse of Lehman. However, we also experiment with other dates as a check (which shows that the choice of the turning date is irrelevant for our outcomes).

5. Baseline results

Table 5 and Table 6 report the results for equation (1) and (2), respectively.

5.1 Firm-side features of the use of collateral

Column A of Table 5 is obtained by estimating the baseline specification on the entire period under investigation; columns B and C (obtained through a single empirical model) report the results for the period preceding and the one starting with the financial crisis.[14]

Broadly speaking, estimates indicate that higher collateral ratios are always associated with riskier and more vulnerable firms. Specifically, a higher degree of collateralization is associated with firms that are less capitalized (*Firm capital ratio*); have a higher past due loans ratio (*Firm doubtful loans*); are financially constrained (*Bind*); have a lower asset tangibility (*Firm tangible assets*) and lower sales (*Firm sales*). Economic magnitudes are not negligible. A sizable magnitude is estimated for *Bind*: a shift from a sound to a stressed condition implies an increase in the collateral ratio of 0.023, a value representing around 10 per cent of the average ratio, equals to 0.22. Turning to the other variables, a one standard deviation increase in *Firm capital ratio* is associated with a reduction in the degree of collateralization by 0.006 (=-0.15*0.04), i.e. around a 3 per cent decrease of the average ratio. As about *Firm doubtful loans*, a one standard deviation increase is associated with a rise in collateralization by 0.002 [=0.024*0.085], i.e. around 1 per cent of the average collateral ratio.

With regard to the size, we find that the use of collateral is lower at smaller firms: such a result might seem puzzling as larger firms are normally considered safer and benefit of more favourable terms and conditions (as shown by Figure 1). However, this finding is consistent with Berger and Udell (1995) and Chakraborty and Hu (2006), who show that larger firms are willing to increase the collateral-to-loans ratio in order to benefit of better conditions on credit.[15] We turn to the point analysing the non-linearity of firm size for collateralization in Section 8.

A comparison of the outcomes of columns B with those of column C indicates that, while the sensitivity of collateral policies to *Firm sales* does not change significantly after the onset of the crisis, the coefficients of *Doubtful loans* and *Tangible assets* gain significance and the economic magnitude of *Firm capital* raises. These variations point to an increase in the lenders' risk aversion;

[14] We do not include in these estimations the variable *Firm z-score* along with the other covariates because the variable strongly correlates with the rest of firm-level balance sheet characteristics, which indeed it is inferred on. Indeed, we run (unreported but available upon request) regressions, where the coefficient of the variable *Firm z-score* is significantly negative if included in the model alone, while its significance attenuates when it is added as an additional variable.

[15] This argument is consistent with the lower interest rates charged on bank loans larger than 1 euro million in Italy. See Bank of Italy, Supplements to the Statistical Bulletin, Money and Banking, July 2015, Table 3.1 https://www.bancaditalia.it/pubblicazioni/moneta-banche/2015-moneta/en_suppl_35_15.pdf?language_id=1

this is potentially associated to the worsening of the economic outlook and poor loan performance occurred during the crisis.

5.2 Bank-side features of the use of collateral

Column A of Table 6 reports the estimates on bank characteristics for the whole period, while columns B and C display, respectively, the estimations referred to the period before and during the financial crises (again obtained through a single empirical model). Results show that bank soundness matters in the collateralization of lending. Collateral ratios are significantly higher at more capitalized banks and at lenders with lower bad loan-to-loan ratios. Specifically, both a one standard deviation increase in bank capitalization and a one standard deviation reduction in bad loan-to-loan are associated with an increase of loan collateralization of around 0.01; this value can be compared with the average collateral ratio that equals to 0.22. These results are suggestive of a negative relation between bank soundness, measured both as capitalization and assets quality, and risk-taking behaviour. The issue will be further explored in Section 7.

Turning to the other covariates, we find banks more reliant on foreign interbank market to adopt stricter collateral policies. This outcome may be a confirmation of tighter collateral policies at sounder banks. In fact, in particular just during the financial crises, interbank funding is obtained by sounder banks thanks to an incentive scheme through interbank peer monitoring (Rochet and Tirole, 1996; Distinguin et al., 2013).

Columns B and C show that *Bank capital ratio* and *Bank bad loans* are significantly associated with higher collateral-to-loans ratio, both before and after the aftermath of the financial crises. Instead, with regard to foreign interbank deposits, estimates show a relevant role for such a variable only after the occurrence of the liquidity shock generated by the collapse of Lehman, which confirms our interpretation.

We are aware that reverse causality may be a concern for the bank-side features of the use of collateral. Although we interpret all our outcomes as only indicative of a relationship, the direction on the negative relation between the incidence of bad loans and the collateralization of credit might go the other way round: that is, higher collateral-to-loan ratios may precede the lower incidence of bad loans and simply lagging one period bank characteristics may be not enough. As mentioned, in order to verify whether the results hold, we run again equation (2) by instrumenting the potentially endogenous variable, while still including the same large sets of time-invariant and time-varying fixed effects.

We instrument the variable *Bank bad loans* of each given bank by taking advantage of multiple lending and the effects of information sharing among banks. Specifically, we exploit the

evaluations made, on each firm borrowing from multiple banks, by all creditors drawing from the CR the classification of status (performing, bad loan or non-performing other than bad loan) assigned to each firm by each bank and track the cases in which each given bank attributes to each borrower a less conservative status.[16] Then, for each bank in each period, we instrument the bad loan ratio through the (aggregate) value of such tracked cases, weighted for the share of loans. In formal terms, the bad loans ratio for bank *j* in time *t* is instrumented through the following variable:

$$Instr\_bad\_loans_{jt} = \frac{\sum_{i=1}^{n_{jit}} loan_{less\ conservative;\ j,i,t}}{\sum_{i=1}^{n_{ijt}} loan_{j,i,t}}$$

where $loan_{j,i,t}$ is the total stock of loans in quarter *t* to firm *i* by bank *j*; $loan_{less\ conservative\ j,i,t}$ is the stock of loans, in quarter *t* to firm *i* by bank *j*, which are less conservatively classified than loans outstanding in the balance sheets of other banks *h* (with $h \neq j$) extended to the same *i*-th firm. For instance, if the *i*-th firm has (at least) a non performing loan with a bank, all performing loans granted to that firm by other lenders (if any) are reclassified as "less conservative".

The instrument is expected to correlate with the bank bad loan ratio as a typical effect of information sharing systems should be the attenuation of cross-banks heterogeneities in credit risk assessments. Banks in fact are not forced to classify their clients in the same way of the other creditors, yet it is generally a good idea to do so, in particular if the classification of the status by other banks is more conservative. Similar to us, Angelini et al. (2017) exploit the different promptness in the classification of each borrower across banks and use the percentage of bad loans not yet classified by a bank as such as a proxy of the (lack of) quality in the bank internal control system. Further, the inclusion of credit risk assessments conducted by other lenders – which determines the relevance of less conservative loan positions – attenuates reverse causality potentially shaping the link between loan quality and loan collateralization at a specific lender and limits the concerns about the correlation between the instrument and the error terms of the loan collateralization regressions which include *firm*×*time* (multiplicative) and *bank* (additive) dummies.

The results are presented in columns D-E of Table 6. The first stage regression shows that the instrument is positively and significantly correlated with the bad loan ratio (the instrumented variable). The identification *F* test statistic, equal to 16.4, comforts our choices. The second stage

[16] Although the classification across loan quality categories has to be consistent with the rules set-up by regulators, large room for discretion remains on the part of banks, especially as far as the distinction between non-performing loans to insolvent borrowers ("bad loans") and other non-performing loans to temporary illiquid borrowers who however have a chance to recover. On the issue see Affinito and Meucci (2021). While we remove bad loans from the aggregate of loans when we measure loan collateralization, we take into account these exposures when we compute the amounts of the 'less conservative' positions in the banks' balance sheets.

regression confirms that the coefficient of the bad loan ratio is negative and statistically significant; the results of all the other variables are confirmed as well. A comparison between OLS and IV shows an overlap of the estimates[17]: the 95 per cent confidence band for the OLS parameter is (-0.481; -0.261), which 'lives' within the band for the IV coefficient (-1.629; -0.184). Due to the overlapping in the statistical distribution of OLS and IV parameters, we focus on the OLS approach in subsequent analysis (see Schiantarelli et al., 2019).[18]

6. Taking into account the role of personal guarantees

Our baseline analysis focuses on real guarantees because this type of collateral generally provides (with respect to personal collateral) a higher level of creditors' protection thanks to claims it gives on a well-defined asset owned by the debtor. Furthermore, the reference empirical literature on banking usually analyses that type of guarantee. Nevertheless, the omission of personal guarantees in the analysis might imply a bias in the estimates as real and personal guarantees might be regarded, at least to some extent, as substitute. For example, a debtor that lacks of internal asset to post as a real collateral might ask to a third party to guarantee the repayment. If this were the case, not controlling for the presence of personal guarantees in the loan contract might result in an apparent lower recourse to real collateral. In order to control for this possible cross-subsidization, we carry out two further exercises.

First, we verify whether our results on firm and bank-level characteristics associated to real collateralization survive when personal guarantees, as a share of total loans, are included in the model as a further covariate. Tables 7 and 8 reports the estimates of equations (1) and (2) by adding personal guarantees among controls. As before, column A reports the estimates for the entire period, while columns B and C disentangle for the periods before and during the financial crises. With regard to the firm-side, results of Table 7 are in line with those of Table 5 as both indicate that borrower risk is positively correlated with loan collateralization. Interestingly, in all specifications, we find a negative link between personal guarantees and real collateral, corroborating the hypothesis about the substitutability between the two types of guarantee: therefore, it seems that the presence of a personal guarantee lowers the riskiness of a loan, all being equal, and somewhat compensates the decrease in the intensity of real collateralization. Table 8 shows that also bank-side results remain broadly

[17] See the columns A and D. More specifically, the intervals illustrated in the text are obtained by considering the 95 percent confidence bands associated to the *t*-statistics of each estimates (reported in brackets in Table 6).
[18] Additional robustness tests on the issue of endogeneity are described in Section 9.

unchanged (sounder banks, in terms of capital and ex-post loan quality, are associated with a higher degree of collateralization) and confirm a negative relationship between real and personal guarantees.

Second, we build a new dependent variable, which encompasses at the numerator both real and personal guarantees (obtained by summing-up for each bank-firm pair the amount of loans covered by any real and personal type of collateral) and at the denominator the total lending. We employ the new dependent variable in the previous models studying again the firm- and bank-side characteristics associated to loan collateralization (Tables 9 and 10, respectively). Results confirm the importance of firm riskiness and bank soundness as key factors associated with the use of collateral, both before and after the deflagration of the financial crises. Also the signs, the significance as well as the magnitude of coefficients reply the picture already outlined referring to the real guarantees suggesting that, while real and personal guarantees are substitute, the characteristics more associated to their use tend to coincide.

7. A look at the link between bank soundness, risk-taking and the cost of lending

Our evidence indicates that bank soundness plays a role in bank loan collateralization. Specifically, we find that conditions on collateralization are tighter for those banks that are sounder in terms of capitalization and quality of assets. In other terms, sounder banks appear more likely to mitigate risks (that is, to adopt more prudent collateral policies), all being equal. As a complementary evidence, one may figure out that returns expected on lending by sounder (more adverse to risk) lenders are lower than those expected by riskier (more prone to risk) banks.[19] To further understand the relationship between bank soundness and risk-taking we include in the analysis the cost of lending, a variable that might reasonably proxy the expected returns on lending, in order to verify whether tighter collateral policies by sounder banks are also associated to different pricing of loans. Tighter policies on loan collateralization are likely to reduce the riskiness of loans as mitigate opportunistic behaviours of the borrower, and the reduced riskiness of loans might in turn lower the cost of lending for borrowers.

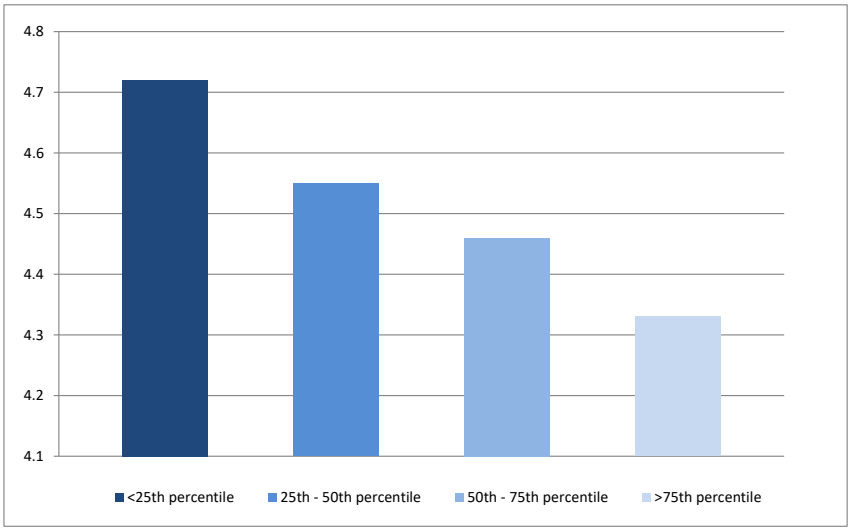
Figure 2 plots the interest rates on loans to non-financial corporations on the distribution of bank capital and shows that rates applied by sounder banks are lower than those applied by less capitalized institutions. The rate charged by banks in the fourth quartile is around 40 basis points

[19] On the link between bank capital and risk, conclusions of the literature are contrasting. A negative association between capital and risk is posited by the scholars who interpret capital as a buffer accumulated to prevent unexpected losses and by the scholars who study the effects of insurance deposit scheme on asset risk. Conversely, a positive link is established by the authors who interpret capital as a relatively costly – with respect to debt – source of funds, to be rewarded through riskier investments. See Kim and Santomero (1988); Gennotte and Pyle (1991); Rochet (1992); Helmann et al. (2000).

lower than that charged by banks in the first quartile. To verify whether this graphical result is driven by a poorer composition of borrowers for less capitalized banks, Table 11 reports the distributions of the z-score indicators of the borrowers, evaluated separately at sounder and weaker banks, and shows that indeed there are no divergences on this account.[20]

Figure 2 – Interest rates on new loans and bank capital (1)

(percentage values)



Source: Supervisory reports and Taxia data.
Notes: Mean of interest rates for term loans to non-financial corporations during the period. Percentiles of the distribution of banks' capital ratio. Data on loan interest rates are reported in Italy (Taxia database) by around 200 banks accounting for over 90% of total outstanding loans.

Moreover, in order to further test if the result holds controlling for confounding and sorting effects, we regress the interest rate applied to each borrower on a set of bank-level variables including time-varying firm fixed effects (*firm* × *quarter* fixed effects) to absorb all time varying firm heterogeneity. Table 12 reports the results. Consistently with Figure 2, results show that, for the same borrower, sounder banks (in terms of capitalization) and safer banks (in terms of assets quality) apply on average lower rates than riskier lenders. Therefore, for the same borrower, loan collateralization is tighter and interest rates are lower at safer banks than at riskier banks.[21] Taken together, these

[20] The statistical equivalence of the loan portfolios at sounder and weaker banks in terms of borrowers' riskiness also corroborates the robustness of our econometric analysis on the use of collateral because it excludes systematic patterns all (including borrower risk) being equal.
[21] Being based on the within-borrower variation (i.e., on the loans extended to a given firm by different banks), the interest rates under investigation refer to the same level of borrower risk; therefore, they reasonably proxy the differences between the returns, expected by sounder (and requiring more collateral) banks and weaker (and requiring less collateral) banks, on exposures that are identical in terms of borrower riskiness. It is also to notice that our results are confirmed controlling

results confirm that sounder banks (in terms of capitalization and relative amount of bad loans) use collateral policy to mitigate risk.

8. Other extensions

a) Controlling for the size of loans

It is possible that the use of collateral presents confounding effects with the size of the exposure. For instance, higher collateral/loan ratios might be required by sounder banks just because exposures associated to those loans are more sizable. To address the issue, we include the size of loans among our covariates in both equations 1 and 2. However, the inclusion of the amount of loan among regressors rises again a potential issue of endogeneity with the dependent variable (the use of collateral), which is likely to be jointly determined with the decision on the amount. In this light, we instrument the (individual level) variable loan collateralization through the variable put forward by Jiménez et al. (2004): the Product market risk. That is, an (aggregate) variable that captures the amount of impaired loans as a share of total loans in the sector where the firm operates (lagged one period). This variable is likely to be taken into account by financiers as it (inversely) proxies investment opportunities in the borrower's economic sector. In sectors where firms have fewer difficulties repaying the loans, lenders are expected to be more willing to finance large projects. The exclusion restriction requires to assume (as in Jiménez et al., 2004) that the (aggregate) variable *Product market risk* does not affect the (individual) collateral policy directly, but only through the channel of the decision about loan availability (i.e., whether and to what extent the credit is granted by the lender to the firm). Our results are based on this assumption.

Table 13 reports the results of this exercise for the bank-side characteristics. We report the results of our baseline regression (column A), the model augmented with loan size (column B), and the two stages of our IV estimation (columns C- D). The first stage shows a negative association between *Loan size* and our instrument, in line with Jiménez et al. (2004). The weak identification *F* test is equal to 12.5. The second stage confirms the positive link between bank soundness and the degree of collateralization. Turning to loan size, we find that higher amount of loans are characterized by higher collateral-to-loan ratios. The outcome is in line with the literature that shows that the use of collateral, by reducing asymmetric information, implies an equilibrium characterized by less

for the size of the exposures (columns B and D of Table 12), which address the concern of potential confoundedness associated to heterogeneities of loan size across sounder and weaker banks.

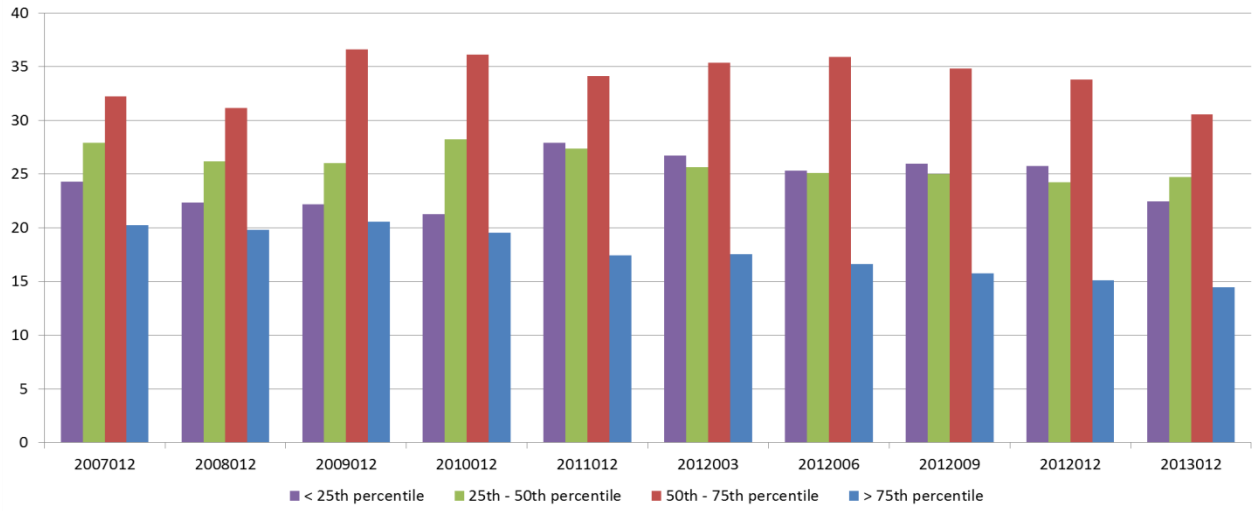
adverse selection and less credit rationing.[22] The result also tallies with the evidence that we previously showed on the more extensive use of collateral in lending to larger firms.

b) Collateral and firm size

Figure 1 shows that smaller firms post on average higher collateral-to-loan ratios; on the contrary, the econometric exercises show that *Firm size* is positively associated with the degree of collateralization. To deepen the puzzle, we extend the analysis in two ways.

Figure 3 – Ratio of real collateral to credit drawn by firm size quartiles

(percentages)



Sources: Central Credit Register of Bank of Italy.

First, we plot in Figure 3 the collateral-to-loan ratios across our sample period for the four quartiles of the distribution of the variable *Firm size*. Figure 3 shows that for firms in the three lower quartiles the collateral-to-loan ratio increases in size (as in our econometric exercise); for those belonging to the top quartile (i.e., the largest firms), however, the level of guarantees over total loans is remarkably lower, suggesting the existence of a non-linear relationship between firm size and the use of collateral.

Second, and accordingly, we augment our baseline model by including the quadratic term of the variable *Firm size*. Table 14 reports the results. The exercise corroborates an inverted U shaped

[22] See for instance the seminal paper by Stiglitz and Weiss (1981).

relation between firm size and collateral (while not significant, the coefficient of the quadratic term of *Firm size* is negative).

c) Loan types

As already mentioned in Section 3, the dataset that we use for the econometric analysis comprises two types of bank lending: term loans and overdrafts. Term loans are generally used to finance firm investments, while overdrafts are typically used to address firm liquidity needs. Importantly, collateral are mainly posted on term loans whereas overdrafts are mostly uncollateralized. We therefore estimate equation (1) and (2) for term loans only. Tables 15 and 16 show that the results are in line with the baseline findings.

9. Robustness checks

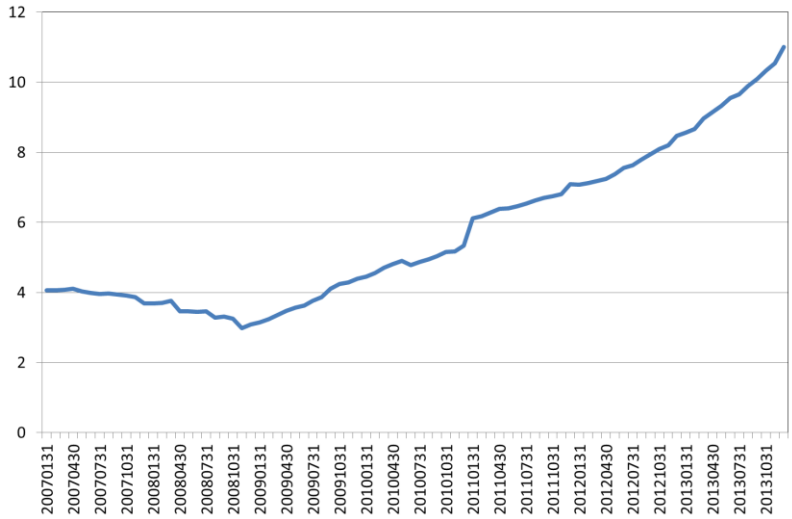
a) Again on the endogeneity of bank-side characteristics

As argued, our analysis on bank-side characteristics may rise concerns on the direction of the relationship between the incidence of bank bad loans (and capitalization) and the degree of collateralization of loans. In addition to the IV exercise described above, in order to further test the robustness of our results, we run additional exercises.

First, we readdress the endogeneity issue on bad loans by exploiting the abrupt increase in bank bad loans occurred in Italy starting in December 2008. Figure 4 shows the reversal in the development of loan quality occurred in December 2008, which is likely to reflect a deterioration of the borrowers' ability to repay loans arising from the deepening of the economic recession. This development may be regarded as less endogenously associated to the degree of loan collateralization. We therefore run again the estimation by focusing only on the period interested by the shock, regressing the collateral ratio between December 2008 and March 2009 over *Bank bad loans* for the same period. Table 17 reports the results. The link between the two variables is confirmed to be negative and statistically significant.

Figure 4 – Loans to the private sector in Italy: bad loans as a share of total loans

(percentages)



Source: Supervisory reports.

As a second exercise we carry out a new IV regression, where *Bank bad loans* are now instrumented by exploiting the effects exerted on the classification of impaired assets by the Assessment Quality Review (AQR) exercise, conducted at the end of 2014 by the ECB towards a large number of European banks in order to verify whether the allocation of bank loans was consistent with the expected value of the assets. Banks going under the AQR are likely to have the incentive to better assess their positions and, as a consequence, to experience an increases in the positions classified as bad loans. This may have represented a (less endogenous) source of variation for the stock of bad loans (Accornero et al., 2017; EBA, 2021). Table 18 compares the results of the baseline OLS estimation (column A, which corresponds to the results of Table 6) with the new IV results (column B). Results confirm that a larger stock of bad loans at bank level is negatively associated with the use of collateral. The statistical diagnostics on the power of the instrument is also passed.

Likewise the AQR might also influence the bank capital ratios. Against this background, we apply the same instrument also to verify possible endogeneity concerns that could regard banks' capital. We run two new IV estimations, alternatively instrumenting either the variable *Bank capital ratio* alone or the Texas ratio (that is, the ratio between bank bad loans and capital), excluding in this case the single components as separate covariates. Results of IV estimations (columns C and E)

always confirm the OLS results (reported in column A, for the capital ratio, and in column D, for the Texas ratio). The statistical diagnostics on the power of the instrument are passed in all cases.[23]

b) Removing fixed effects to assess generalizability of results

Our estimation strategy makes use of a large number of dummy variables. These dummies are aimed to fully control for the effects potentially confounding the identification of firm- and bank-side characteristics associated to the use of collateral. This strategy *à la* Khwaja and Mian (2008) has the pros of increasing the internal validity of results and the cons of reducing its generalizability, as it implies a further reduction of sampling size (for instance, the identification strategy in the firm side restricts the sample only to firms having more than one lender, which however are very typical in Italy).

To verify whether our results can be extended to a broader sample of loans, for instance to those firms having one lender only, we also analyse a less severe specification that includes additive (bank and firm) dummies that do not vary over the period, along with a complete set of non-interacted time dummies. Moreover, this model allows us to estimate the effects of bank and firm characteristics in a single model. Results are reported in Table 19. We run models both with and without the inclusion of loan size among the covariates (see previous Section, point *a*). The results show that basically all our variables are significant and maintain the signs exhibited in the previous (more severe) specifications.

c) Sorting effects

As mentioned, the firm- and bank-level characteristics associated with the use of collateral might be also influenced by factors which are specific for the lender-borrower pair. On this account, we already control for the possible effect through three variables: the strength of the lending relationship (*Relationship strength*); a dummy variable identifying (large) unauthorized withdrawals (*Bind*); and the size of the loan. Notwithstanding the inclusion of these variables, one might be still concerned that unobservable characteristics at the firm-level might correlate with both the dependent variable and banks/firms characteristics.

To address the issue, we run our models by including specific dummies for each lender-borrower pair. Such an estimation demeans the dependent variable by the average collateral ratios, calculated for each lender-borrower pair, so that the (time invariant) elements that characterize

[23] In all three cases, in the first stage the effect of our instrumental dummy is significant: its effect is positive when it is used to instrument *Bank bad loans*; it is negative as for *Bank capital ratio*, and it is positive for the Texas ratio. The *F* statistic is equal to 19.0 for the variable *Bank bad loans*, to 36.48 for the variable *Bank capital ratio* and to 15.01 for the Texas ratio.

relationships are fully controlled for. The results, displayed in Tables 20 and 21, confirm our previous evidence about both firm- and bank-level characteristics.

d) The sovereign debt crisis

The European sovereign debt crisis is arguably more systemic for Italy than the external shock that follows the Lehman default as it represents a systemic shock to both the Italian economy and the banking system and threatens the very survival of many banks. To verify this possibility, we exclude as a check all quarters after June 2011 (when Italy is involved in the sovereign crisis) in equation 2 and in the dummy c_t. The results, not presented here but available on request, remain broadly unchanged, indicating that the effects of the financial crises are already present in the global crisis.

Conclusions

We show that the use of collateral in bank lending is significantly associated with both firm- and bank-side characteristics. In particular, tighter collateral policies are adopted toward observationally riskier firms, that is, borrowers that are lowly capitalized, financially stressed and with larger amounts of doubtful loans. The relationship between firm capital (and delinquency) and loan collateralization becomes even stronger during the financial crises, signalling that the prudence and the attention on firms' characteristics intensify in downturns.

As far as we know, we are the first to document that bank balance sheet conditions are associated with the use of collateral and that collateralization is an additional channel for the propagation of shocks. Specifically, banks more capitalized and accumulating lower stocks of impaired assets tend to be characterized by a higher degree of collateralization. The result may be rationalized in terms of heterogeneities in risk taking attitude in lending by sounder and weaker banks. Sounder banks might adopt more prudent collateral policies as their risk aversion is relatively higher. Consistent with such an interpretation, our results show that returns on lending expected by sounder banks are lower relative to those expected by weaker banks. Finally, our analysis also documents the existence of a substitutability relationship between real and personal guarantees in credit risk management.

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Tables

Table 1 – List and description of variables

Variable	Description
Bank-firm variables	
Coll-to-loan ratio	Amount of loans secured by real collateral as a share of total loans to firm *i* from bank *j* (degree of collaterlazation).
Loan size	Natural logarithm of total loans to firm *i* from bank *j* (revolving and term-loans).
Bind	Dummy variable equal to one if the firm has drawn an amount equal or higher (unauthorized, the so called "sconfinamenti") than the amount granted by the bank; zero otherwise. Thus, the value is equal to one when the firm is financially stressed ("cash" constrained).
Relationship strength (share)	Share of loans granted by the bank *j* over the total amount of the *i*-th firm's debt.
Firm variables	
Firm size	Natural logarithm of total assets.
Firm capital ratio	Capital and reserves over total assets.
Firm doubtful loans	Loans are doubtful when payments of interest and principal are past due by 90 days or when payments are less than 90 days overdue but loan repayment is uncertain. The variable is built as the share of doubtful loans over total loans.
Firm sales	Sales as a share of total assets (also referred to as Asset Turnover ratio).
Firm age	Number of years.
Firm z-score	Altman indicator of riskiness: it ranges from 1 ("low risk") to 9 ("high risk").
Firm ROA	Profits as a share of total assets.
Firm tangible assets	Natural logarithm of firm tangible assets.
Bank variables	
Bank size	Natural logarithm of total assets.
Bank capital ratio	Capital and reserves over total assets.
Bank liquidity ratio	Euro-area sovereign bonds and cash over total assets.
Bank bad loans	Bad loans over the total loans.
Foreign interbank borrowing	Foreign interbank borrowing over total assets.
Bank retail funding	Deposits from households and bank bonds held by households over total assets.
Bank ROA	Profits as a share of total assets.

Table 2 – Collateral-to-loan ratio (bank-firm level data)

Mean	Median	Std.Dev.	Obs.
Before the financial crises			
7.0	0.0	25.2	741,339
During the financial crises			
7.5	0.0	26,0	2,717,602

Table 3 - Firm characteristics (firm-level data)

Before the financial crisis

	Panel 3A Whole sample				Panel 3B firms borrowing from 2 banks or more			
Variable	**Mean**	**Median**	**Std.Dev.**	**Obs**	**Mean**	**Median**	**Std. Dev.**	**Obs**
Firm size (1)	9.88	9.71	1.10	38,444	9.89	9.72	1.09	30,919
Firm capital ratio (2)	2.11	1.39	3.99	38,444	1.92	1.38	3.14	30,919
Firm doubtful loans to total loans(2)	1.57	0.00	8.49	38,444	1.62	0.00	8.56	30,919
Firm sales (2)	126.41	112.31	77.64	38,444	125.66	111.63	76.87	30,919
Firm age (3)	24.67	22.00	15.50	38,444	24.75	23.00	15.45	30,919
Firm ROA (2)	7.54	6.31	14.51	38,444	7.20	6.22	14.00	30,919
Firm tangible assets (1)	1.33	0.00	2.57	38,444	1.36	0.00	2.59	30,919

During the financial crisis

	Panel 3C Whole sample				Panel 3D firms borrowing from 2 banks or more			
Variable	**Mean**	**Median**	**Std.Dev.**	**Obs**	**Mean**	**Median**	**Std. Dev.**	**Obs**
Firm size (1)	9.92	9.76	1.08	38,744	9.93	9.76	1.08	31,611
Firm capital ratio (2)	2.28	1.5	4.13	38,744	2.12	1.49	3.38	31,611
Firm doubtful loans (2)	4.69	0	17.23	38,744	4.83	0	17.44	31,611
Firm sales (2)	115.8	100.81	77.85	38,744	115.11	100.22	77.14	31,611
Firm age (3)	26.01	24	15.71	38,744	26.08	24	15.67	31,611
Firm ROA (2)	5.20	3.70	12.97	38,744	4.94	3.67	12.50	31,611
Firm tangible assets (1)	1.04	0.00	2.34	38,744	1.06	0.00	2.36	31,611

(1) Log of total quantity. (2) Percentage points. (3) Number of years.

Table 4 – Bank characteristics (bank-level data)

Before the financial crisis

Variable	Mean	Median	Std.Dev.	Obs.
Bank size (1)	24.98	25.7	2.148	528
Bank capital ratio (2)	8.49	8.59	2.20	528
Bank liquidity ratio(2)	4.02	2.60	4.19	528
Bank bad loans (2)	2.62	2.55	1.2	528
Foreign interbank borrowing (2)	6.5	3.8	9.4	528
Bank retail funding (2)	50.03	47.51	15.54	528
Bank profitability (2)	0.82	0.90	0.34	528
Relationship strength (share) (2)	26.02	16.51	26.60	741,339
Bind (4)	18.50	0.00	38.80	741,339

During the financial crisis

Variable	Mean	Median	Std.Dev.	Obs.
Bank size (1)	25.01	25.41	2.10	538
Bank capital ratio (2)	9.6	9.6	2.3	538
Bank liquidity ratio(2)	6.3	5.2	4.5	538
Bank bad loans (2)	6.1	5.7	3.4	538
Foreign interbank borrowing (2)	5.9	3.4	9.5	538
Bank retail funding (2)	47.62	42.91	15.18	538
Bank profitability (2)	0.3	0.3	0.3	538
Relationship strength (share) (2)	25.5	15.6	26.9	2,717,602
Bind (4)	0.25	0.00	0.44	2,717,602

Table 5 - The firm side features of the use of collateral (2007Q1 - 2013Q4)

	Coll-to-loan ratio	Coll-to-loan ratio (before crisis)	Coll-to-loan ratio (crisis)
	(A)	(B)	(C)
Firm size	0.0286***	0.0251***	0.0304***
	(9.886)	(7.523)	(10.70)
Firm capital ratio	-0.149***	-0.0753***	-0.155***
	(-5.821)	(-2.832)	(-5.728)
Firm doubtful loans	0.0235***	-0.0124	0.0236***
	(3.403)	(-0.828)	(3.292)
Firm sales	-0.00592***	-0.00745***	-0.00590***
	(-3.233)	(-3.657)	(-3.258)
Firm age	-0.00109	-0.00145	-0.00159
	(-0.521)	(-0.646)	(-0.704)
Relationship strength (share)	0.380***	0.375***	0.381***
	(12.19)	(11.90)	(12.13)
Bind	0.0228***	0.0241***	0.0225***
	(8.615)	(5.218)	(8.328)
Firm ROA	-0.00421	0.0186**	-0.0105**
	(-0.993)	(2.445)	(-2.579)
Firm tangible assets	-0.000720***	-0.000312	-0.000774***
	(-3.009)	(-0.688)	(-3.509)
Observations	1,880,431	1,880,431	
Bank*quarter fixed effects	yes	yes	
Firm fixed effects	yes	yes	

Table 6 - The bank side features of the use of collateral (2007Q1 - 2013Q4)

	Coll-to-loan ratio	Coll-to-loan ratio (before crisis)	Coll-to-loan ratio (crisis)	Coll-to-loan ratio	IV Regression First stage
	(A) - OLS	(B) - OLS	(C) - OLS	(D) – IV (Bad loans instrumented)	(E)
Bank size	0.0221	0.0244	0.0226	0.017	-0.006
	(1.224')	(1.607 ')	(1.504')	(0.709)	(-0.33)
Bank capital ratio	0.237**	0.241*	0.250**	0.571**	0.528**
	(2.24 ')	(1.74')	(2.572')	(2.07')	(2.16)
Bank liquidity ratio	0.0181	-0.127**	0.0582	0.0974	0.115**
	(0.473')	(2.423')	(1.516')	(1.085')	(2.10)
Bank bad loans	-0.317***	-0.430***	-0.317***	-0.907**	
	(-5.721)	(-2.775)	(-6.077)	(-2.474)	
Foreign interbank borrowing	0.0771***	0.0884	0.0501**	0.0699**	-0.0175
	(2.909')	(1.361')	(2.361')	(2.115')	(-0.32)
Bank retail funding	0.0261	0.0789	0.0274	0.0416	0.0317
	(0.445')	(1.607')	(0.527')	(0.655')	(0.52)
Bank ROA	-0.671*	-0.46	-0.922**	-0.0386	1.245
	(-1.811)	(-0.536)	(-2.534)	(-0.0527)	(1.44)
Relationship strength (share)	0.425***	0.392***	0.433***	0.422***	-0.0004*
	(12.94')	(12.23')	(13.08')	(12.68')	(-1.75)
Bind	0.0306***	0.0330***	0.0302***	0.0286***	0.0002***
	(11.78')	(4.921')	(11.42')	(12.02')	(2.91)
Instr_bad_loans					0.397**
					(2.16)
Observations	2,585,884	2,585,884		2,367,867	2,367,867
Firm*quarter fixed effects	yes	yes		yes	yes
Bank fixed effects	yes	yes		yes	yes

Notes: Independent variables are lagged with respect to dependent variable.
Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level. With regard to IV (column E), the weak identification F-test is equal to 16.38.

Table 7 - The firm side features of the use of collateral: personal guarantees among regressors (2007Q1 - 2013Q4)

	Coll-to-loan ratio (A)	Coll-to-loan ratio (before crisis) (B)	Coll-to-loan ratio (crisis) (C)
Firm size	0.0285***	0.0251***	0.0302***
	(9.872)	(7.498)	(10.70)
Firm capital ratio	-0.149***	-0.0748***	-0.155***
	(-5.787)	(-2.801)	(-5.699)
Firm doubtful loans	0.0233***	-0.0124	0.0234***
	(3.376)	(-0.829)	(3.262)
Firm sales	-0.00598***	-0.00756***	-0.00594***
	(-3.272)	(-3.691)	(-3.297)
Firm age	-0.00111	-0.00146	-0.00160
	(-0.530)	(-0.648)	(-0.708)
Relationship strength (share)	0.380***	0.374***	0.381***
	(12.18)	(11.89)	(12.12)
Bind	0.0227***	0.0240***	0.0224***
	(8.577)	(5.211)	(8.286)
Personal guar to loans	-0.0213***	-0.0245***	-0.0205***
	(-5.630)	(-4.782)	(-5.416)
Firm ROA	-0.00419	0.0188**	-0.0105***
	(-0.990)	(2.475)	(-2.589)
Firm tangible assets	-0.000717***	-0.000310	-0.000772***
	(-3.002)	(-0.688)	(-3.494)
Observations	1,880,431	1,880,431	
Bank*quarter fixed effects	yes	yes	
Firm fixed effects	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level. *Personal guar to loan* is the amount of loans secured by personal guarantees as a share of total loans at bank-firm level.

Table 8 - The bank side features of the use of collateral: personal guarantees among regressors (2007Q1 - 2013Q4)

	Coll-to-loan ratio (A)	Coll-to-loan ratio (before crisis) (B)	Coll-to-loan ratio (crisis) (C)
Bank size	0.0224	0.0246	0.0228
	(1.234)	(-1.618)	(-1.515)
Bank capital ratio	0.237**	0.242*	0.251**
	(2.236)	(-1.744)	(-2.569)
Bank liquidity ratio	0.0183	-0.128**	0.0586
	(0.477)	(-2.439)	(-1.525)
Bank bad loans	-0.318***	-0.429***	-0.317***
	(-5.705)	(-2.774)	(-6.061)
Foreign interbank borrowing	0.0769***	0.0881	0.0500**
	(2.896)	(-1.356)	(-2.352)
Bank retail funding	0.0261	0.0792	0.0275
	(0.445)	(-1.615)	(-0.528)
Bank ROA	-0.663*	-0.448	-0.915**
	(-1.787)	(-0.522)	(-2.513)
Relationship strength (share)	0.425***	0.392***	0.433***
	(12.91)	(-12.2)	(-13.05)
Bind	0.0305***	0.0329***	0.0301***
	(11.73)	(-4.919)	(-11.35)
Personal guar to loans	-0.0213***	-0.0239***	-0.0209***
	(-4.379)	(-3.537)	(-4.343)
Observations	2,585,884	2,585,884	
Firm*quarter fixed effects	yes	yes	
Bank fixed effects	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level. *Personal guar to loan* is the amount of loans secured by personal guarantees as a share of total loans at bank-firm level.

Table 9 - The firm side features of the use of collateral: an aggregated indicator for real and personal collateralization (2007Q1 - 2013Q4)

	Real and Personal Coll-to-loan ratio (A)	Real and Personal Coll-to-loan ratio (before crisis) (B)	Real and Personal Coll-to-loan ratio (crisis) (C)
Firm size	0.0233***	0.0214***	0.0251***
	(8.782)	(6.401)	(9.718)
Firm capital ratio	-0.136***	-0.0503	-0.143***
	(-4.756)	(-1.452)	(-4.866)
Firm doubtful loans	0.0111	-0.0185	0.0119
	(1.525)	(-1.308)	(1.522)
Firm sales	-0.00783***	-0.0105***	-0.00722***
	(-4.525)	(-5.026)	(-4.159)
Firm age	-0.00171	-0.00178	-0.00205
	(-0.777)	(-0.757)	(-0.872)
Relationship strength (share)	0.373***	0.366***	0.374***
	(11.96)	(11.93)	(11.87)
Bind	0.0188***	0.0211***	0.0184***
	(7.408)	(4.808)	(7.059)
Firm ROA	-0.00126	0.0246***	-0.00847**
	(-0.342)	(3.181)	(-2.419)
Firm tangible assets	-0.000586**	-9.15e-05	-0.000676***
	(-2.434)	(-0.214)	(-2.697)
Observations	1,880,431	1,880,431	
Bank*quarter fixed effects	yes	yes	
Firm fixed effects	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level. *Real and Personal Coll-to-loan ratio* is the amount of loans secured by real and personal guarantees as a share of total loans at bank-firm level.

Table 10 - The bank side features of the use of collateral: an aggregated indicator for real and personal collateralization (2007Q1 - 2013Q4)

	Real and personal Coll-to-loan ratio (A)	Real and personal Coll-to-loan ratio (before crisis) (B)	Real and personal Coll-to-loan ratio (crisis) (C)
Bank size	0.0269	0.0289*	0.0274*
	(-1.514)	(-1.951)	(-1.848)
Bank capital ratio	0.256**	0.320**	0.269***
	(-2.328)	(-2.175)	(-2.704)
Bank liquidity ratio	0.0208	-0.171***	0.0679*
	(0.507)	(-3.030)	(-1.724)
Bank bad loans	-0.358***	-0.423***	-0.368***
	(-6.627)	(-3.000)	(-7.239)
Foreign interbank borrowing	0.0726**	0.0843	0.0413*
	(-2.499)	(-1.329)	(-1.963)
Bank retail funding	0.00880	0.079	0.0145
	(0.153)	(-1.611)	(-0.286)
Bank ROA	-0.829**	-0.416	-1.253***
	(-2.154)	(-0.491)	(-3.516)
Relationship strength (share)	0.410***	0.375***	0.418***
	(12.68)	(-12.1)	(-12.79)
Bind	0.0242***	0.0283***	0.0236***
	(-9.629)	(-4.485)	(-9.038)
Observations	2,585,884	2,585,884	
Firm*quarter fixed effects	yes	yes	
Bank fixed effects	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level. *Real and Personal Coll-to-loan ratio* is the amount of loans secured by real and personal guarantees as a share of total loans at bank-firm level.

Table 11 – The composition of borrowers at sounder and weaker lenders

Capital to total assets		Z-Score of borrowers of banks in the Quartile of the bank Capital distribution	Z-Score of borrowers of banks in the Quartile of the bank Bad loans distribution
1st quartile	mean	5,17	5,22
	25th pct	4	4
	50th pct	5	5
	75th pct	7	7
2nd quartile	mean	5,22	5,20
	25th pct	4	4
	50th pct	5	5
	75th pct	7	7
3rd quartile	mean	5,19	5,18
	25th pct	4	4
	50th pct	5	5
	75th pct	7	7
4th quartile	mean	5,17	5,15
	25th pct	4	4
	50th pct	5	5
	75th pct	7	7

Table 12 – Bank characteristics associated with interest rates on new loans

	Interest rate	Interest rate	Interest rate	Interest rate
	(A)	(B)	(C)	(D)
Bank size	-2.722***	-2.843***	0.0380	0.0980
	(-4.032)	(-3.915)	(0.104)	(0.257)
Bank capital ratio	-13.21***	-15.32***	-6.252**	-7.457**
	(-3.877)	(-4.492)	(-2.339)	(-2.621)
Bank bad loans	13.67***	14.99***	6.600***	7.956***
	(5.187)	(5.464)	(3.210)	(3.546)
Bank liquidity ratio	1.163	1.128	0.142	-0.0310
	(0.252)	(0.238)	(0.190)	(-0.0453)
Foreign interbank borrowing	4.989	5.850	-1.550**	-1.314*
	(1.424)	(1.585)	(-2.579)	(-1.951)
Bank retail funding	-10.60***	-10.94***	-0.0184	0.0768
	(-4.294)	(-4.205)	(-0.0193)	(0.0795)
Bank ROA	118.0***	107.1***	8.609	5.899
	(6.030)	(5.190)	(1.303)	(0.860)
Relationship strength (share)		-0.113		0.0685
		(-0.700)		(1.428)
Bind		0.645***		0.0242
		(9.789)		(0.832)
Loan size		-0.267***		-0.0351***
		(-11.84)		(-3.421)
Observations	308,705	265,860	217,828	181,192
Bank fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	-	-
Firm*quarter fixed effects	no	no	yes	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses.*** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level. Data on loan interest rates are reported by around 200 banks accounting for over 90% of total outstanding loans.

Table 13 - The bank side features of the use of collateral controlling for loan size: an IV approach based (2007Q1 -2008Q2)

	Coll-to-loan ratio	Coll-to-loan ratio	Coll-to-loan ratio (IV)	IV Regression First stage
	(A)	(B)	(C)	(D)
Bank size	0.0221	0.0163	-0.00415	0.132
	(1.224)	(0.919)	(-0.181)	(1.433)
Bank capital ratio	0.237**	0.250**	0.277**	-0.220
	(2.240)	(2.569)	(2.393)	(-0.355)
Bank liquidity ratio	0.0181	0.0399	0.0754	-0.430
	(0.473)	(0.995)	(1.176)	(-1.090)
Bank bad loans	-0.317***	-0.282***	-0.214**	-1.099**
	(-5.721)	(-5.579)	(-2.557)	(-2.236)
Foreign interbank borrowing	0.0771***	0.0436*	-0.0232	0.686**
	(2.909)	(1.781)	(-0.518)	(2.328)
Bank retail funding	0.0261	0.0394	0.0251	-0.273*
	(0.445)	(0.649)	(0.340)	(-1.746)
Bank ROA	-0.671*	-1.075***	-1.554***	5.640*
	(-1.811)	(-2.807)	(-3.264)	(1.738)
Bind	0.0306***	0.0306***	0.0299***	0.00430
	(11.78)	(10.23)	(8.362)	(0.217)
Relationship strength (share)	0.425***	0.256***	-0.171	4.957***
	(12.94)	(6.387)	(-0.895)	(22.58)
Loan size		0.0362***	0.122***	
		(7.744)	(3.054)	
Product market risk				-3.018***
				(-3.485)
Observations	2,585,884	2,017,496	2,165,429	2,004,157
Firm*quarter fixed effects	yes	yes	yes	yes
Bank fixed effects	yes	yes	yes	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. The weak identification F statistic referred to the first stage of IV (column D) is equal to 12.5. *** Significant at the 1 percent level.** Significant at the 5 percent level.* Significant at the 10 percent level.

Table 14 - The firm side and the bank side features of the use of collateral (2007Q1 - 2013Q)

	Coll-to-loan ratio
Bank size	0.0372*
	(1.863)
Bank capital ratio	0.278***
	(3.147)
Bank liquidity ratio	0.0361
	(1.055)
Bank bad loans	-0.348***
	(-6.005)
Foreign interbank borrowing	0.0751***
	(3.121)
Bank retail funding	0.0409
	(1.188)
Bank ROA	-0.785***
	(-2.879)
Firm size	0.0390
	(1.567)
Firm size square	-0.000477
	(-0.376)
Firm capital ratio	-0.150***
	(-5.268)
Firm doubtful loans	0.0238***
	(3.392)
Firm sales	-0.00615***
	(-3.363)
Firm age	0.000851
	(0.364)
Bind	0.0229***
	(8.715)
Share of total loans	0.386***
	(11.83)
Firm ROA	-0.00296
	(-0.675)
Firm tangible assets	-0.000711***
	(-2.887)
Observations	1,751,059
Bank fixed effects	yes
Firm fixed effects	yes
Time fixed effects	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 15 – The firm side features of the use of collateral: term loans

	Coll-to-loan ratio (A)	Coll-to-loan ratio (before crisis) (B)	Coll-to-loan ratio (crisis) (C)
Firm size	0.0243***	0.0191***	0.0272***
	(7.025)	(4.814)	(8.053)
Firm capital ratio	-0.187***	-0.0622	-0.194***
	(-5.411)	(-1.397)	(-5.632)
Firm doubtful loans	0.0401***	0.0251	0.0376***
	(3.618)	(1.139)	(3.403)
Firm sales	-0.00833***	-0.00813***	-0.00897***
	(-4.083)	(-3.441)	(-4.752)
Firm age	0.000106	-0.000307	-0.000415
	(0.0432)	(-0.117)	(-0.157)
Relationship strength (share)	0.400***	0.382***	0.404***
	(10.92)	(9.685)	(11.25)
Bind	0.0302***	0.0347***	0.0293***
	(8.769)	(5.833)	(8.705)
Firm ROA	-0.00877*	0.0279***	-0.0189***
	(-1.829)	(3.493)	(-3.831)
Firm tangible assets	-0.000866***	-0.000322	-0.00115***
	(-2.742)	(-0.476)	(-4.157)
Observations	1,316,540	1,316,540	
Bank*quarter fixed effects	yes	yes	
Firm fixed effects	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 16 – The bank side features of the use of collateral: term loans

	Coll-to-loan ratio (A)	Coll-to-loan ratio (before crisis) (B)	Coll-to-loan ratio (crisis) (C)
Bank size	-0.00317	0.0055	0.0039
	(-0.127)	(-0.28)	(-0.199)
Bank capital ratio	0.198	0.2210	0.214*
	(1.533)	(-1.372)	(-1.77)
Bank liquidity ratio	0.102*	-0.0778	0.136**
	(1.828)	(-1.097)	(-2.45)
Bank bad loans	-0.383***	-0.523***	-0.360***
	(-6.095)	(-2.638)	(-5.872)
Foreign interbank borrowing	0.0247	0.0714	0.0057
	(0.931)	(-1.088)	(-0.275)
Bank retail funding	-0.0159	0.0915	-0.0106
	(-0.175)	(-1.18)	(-0.135)
Bank ROA	-1.179**	-0.9120	-1.357***
	(-2.412)	(-0.841)	(-2.961)
Relationship strength (share)	0.456***	0.401***	0.470***
	(10.77)	(-9.694)	(-11.23)
Bind	0.0378***	0.0401***	0.0374***
	(10.53)	(-5.111)	(-10.23)
Observations	1,653,757	1,653,757	
Firm*quarter fixed effects	yes	yes	
Bank fixed effects	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses.*** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 17 – The bank side features of the use of collateral: exploiting the end-2008 reversal in the development of loan quality to attenuate endogeneity of *bank bad loans* (2008Q4-2009Q1)

	Coll-to-loan ratio
Bank size	0.0262
	(1.031)
Bank capital ratio	0.0921
	(0.758)
Bank liquidity ratio	-0.108
	(-1.137)
Bank bad loans	-0.173**
	(-2.486)
Foreign interbank borrowing	-0.0262
	(-0.649)
Bank retail funding	0.0767
	(0.912)
Bank ROA	0.302
	(0.901)
Relationship strength (share)	0.425***
	(13.74)
Bind	0.0264***
	(5.484)
Observations	199,356
Bank fixed effects	yes
Firm*quarter fixed effects	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 18 – The bank side features of the use of collateral: endogeneity of *bank bad loans*

	Coll-to-loan ratio (OLS – Table 6 A) (A)	Coll-to-loan ratio (IV 2 - Bad loans) (B)	Coll-to-loan ratio (IV - Capital ratio) (C)	Coll-to-loan ratio (OLS - Texas) (D)	Coll-to-loan ratio (IV - Texas) (E)
Bank bad loans	-0.317***	-0.876**	-0.542***		
	(-5.721)	(-2.474)	(-3.170)		
Bank size	0.0221	0.0123	0.0401*	0.0226	0.0128
	(1.224)	(0.662)	(1.852)	(1.199)	(0.813)
Bank capital ratio	0.237**	0.529**	1.014**		
	(2.240)	(2.198)	(2.037)		
Bank liquidity ratio	0.0181	0.0757*	0.0672*	0.00104	0.0670
	(0.473)	(1.681)	(1.873)	(0.0267)	(1.635)
Foreign interbank borrowing	0.0771***	0.0988***	0.151***	0.0913***	0.212***
	(2.909)	(2.623)	(2.967)	(2.901)	(2.659)
Bank retail funding	0.0261	0.0337	-0.00193	0.0390	0.0887
	(0.445)	(0.520)	(-0.0259)	(0.714)	(1.453)
Bank ROA	-0.671*	-0.166	-0.777	-0.826**	-0.474
	(-1.811)	(-0.231)	(-1.514)	(-2.378)	(-0.843)
Bind	0.0306***	0.0307***	0.0307***	0.0306***	0.0308***
	(11.78)	(12.86)	(12.77)	(11.75)	(12.81)
Relationship strength (share)	0.425***	0.425***	0.425***	0.426***	0.425***
	(12.94)	(13.07)	(13.06)	(12.93)	(13.05)
Bank Texas ratio				-0.0444***	-0.203**
				(-2.867)	(-2.311)
Observations	2,585,884	2,585,884	2,585,884	2,585,884	2,585,884
Firm*time fixed effects	yes	yes	yes	yes	yes
Bank fixed effects	yes	yes	yes	yes	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. Weak identification F statistics for column A: equal to 16.4; for column C: 19.0; for column D: 36.4; for column F: 15.0. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 19 - Removing fixed effects to assess generalizability of results (only additive dummies; column A), also controlling for loan size (column B) (2007Q1 - 2008Q2)

	Coll-to-loan ratio (A)	Coll-to-loan ratio (B)
Bank size	0.0372*	0.0284
	(1.863)	(1.457)
Bank capital ratio	0.278***	0.258***
	(3.146)	(2.886)
Bank liquidity ratio	0.0361	0.0591
	(1.054)	(1.644)
Bank bad loans	-0.348***	-0.294***
	(-6.007)	(-5.237)
Foreign interbank borrowing	0.0751***	0.0506**
	(3.121)	(2.277)
Bank retail funding	0.0410	0.0429
	(1.188)	(1.225)
Bank ROA	-0.785***	-0.983***
	(-2.881)	(-3.406)
Firm size	0.0295***	0.00452
	(10.03)	(1.123)
Firm capital ratio	-0.150***	-0.00238
	(-5.269)	(-0.0723)
Firm doubtful loans	0.0239***	0.0174**
	(3.382)	(2.387)
Firm sales	-0.00620***	-0.00415**
	(-3.254)	(-2.109)
Firm age	0.000857	0.00129
	(0.376)	(0.495)
Bind	0.0229***	0.0160***
	(8.702)	(5.366)
Relationship strength (share)	0.386***	0.238***
	(11.83)	(6.818)
Firm ROA	-0.00287	0.0195***
	(-0.652)	(3.644)
Firm tangible assets	-0.000714***	-0.000508**
	(-2.897)	(-2.231)
Loan size		0.0317***
		(7.215)
Observations	1,751,059	1,751,059
Bank fixed effects	yes	yes
Firm fixed effects	yes	yes
Time fixed effects	yes	yes

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses.*** Significant at the 1 percent level.** Significant at the 5 percent level.* Significant at the 10 percent level.

Table 20 –The firm side features of the use of collateral controlling for "sorting" effects in banks' selection of borrowers (2007Q1 - 2013Q4)

	Coll-to-loan ratio	Coll-to-loan ratio (before crisis)	Coll-to-loan ratio (crisis)
	(A)	(B)	(C)
Firm size	0.0171***	0.0124***	0.0185***
	(6.971)	(4.847)	(7.607)
Firm capital ratio	-0.0613***	0.0200	-0.0682***
	(-4.678)	(0.852)	(-4.881)
Firm doubtful loans	0.0284***	-0.0113	0.0275***
	(4.425)	(-0.968)	(4.283)
Firm sales	-0.00639***	-0.00646***	-0.00704***
	(-3.796)	(-4.105)	(-4.008)
Firm age	0.00229	0.00211	0.00209
	(0.801)	(0.825)	(0.818)
Relationship strength (share)	0.126***	0.121***	0.127***
	(7.046)	(6.377)	(7.154)
Bind	0.000695	-0.00291*	0.00121
	(0.891)	(-1.796)	(1.593)
Firm ROA	0.00253	0.0190***	-0.00172
	(0.914)	(3.343)	(-0.648)
Firm tangible assets	-0.000624***	-0.000698**	-0.000557***
	(-3.021)	(-2.025)	(-2.669)
Observations	1,871,606	1,871,606	
Bank*quarter fixed effects	yes	yes	
Firm fixed effects	yes	yes	
Bank*firm fixed effect	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable. Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 21 –The bank side features of the use of collateral controlling for "sorting" effect in banks' selection of borrowers (2007Q1 - 2013Q4)

	Coll-to-loan ratio (A)	Coll-to-loan ratio (before crisis) (B)	Coll-to-loan ratio (crisis) (C)
Bank size	0.0467***	0.0434***	0.0426***
	(-5.456)	(-5.712)	(-5.508)
Bank capital ratio	0.190**	0.181**	0.230**
	(-2.218)	(-1.987)	-2.5730
Bank liquidity ratio	-0.0614**	-0.153***	-0.0266
	(-2.227)	(-3.836)	(-0.960)
Bank bad loans	-0.246***	-0.0485	-0.299***
	(-6.538)	(-0.567)	(-9.490)
Foreign interbank borrowing	0.0939***	0.0643**	0.0659***
	(-3.411)	(-2.573)	(-2.913)
Bank retail funding	0.0210	0.0332	0.0161
	(0.667)	(-1.044)	(-0.527)
Bank ROA	-0.542**	0.0239	-0.741**
	(-2.396)	(-0.0614)	(-2.473)
Relationship strength (share)	0.184***	0.170***	0.187***
	(10.02)	(-9.082)	(-10.2)
Bind	3.29e-05	-0.00357	0.000669
	(0.0429)	(-1.564)	(-0.782)
Observations	2,572,414	2,572,414	
Firm*quarter fixed effects	yes	yes	
Bank fixed effects	yes	yes	
Bank*firm fixed effect	yes	yes	

Notes: Independent variables are lagged with respect to dependent variable.
Standard errors are clustered at bank and firm level. T-statistics are reported in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

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