

Reexamining the Empirical Relation between Loan Risk and Collateral: The Roles of Collateral Characteristics and Types

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Abstract: This paper offers a possible explanation for the conflicting empirical results in the literature concerning the relation between loan risk and collateral. Specifically, we posit that different economic characteristics or types of collateral pledges may be associated with the empirical dominance of the four different risk-collateral channels implied by economic theory. For our sample, collateral overall is associated with lower loan risk premiums and a higher probability of *ex post* loan nonperformance (delinquency or default). This finding suggests that the dominant reason collateral is pledged is that banks require collateral from observably riskier borrowers (“lender selection” effect), while lower risk premiums arise because secured loans carry lower losses given default (“loss mitigation” effect). We also find that the risk-collateral channels depend on the economic characteristics and types of collateral. The lender selection effect appears to be especially important for outside collateral, the “risk-shifting” or “loss mitigation” effects for liquid collateral, and the “borrower selection” effect for nondivertible collateral. Among collateral types, we find that the lender selection effect is particularly strong for residential real estate collateral and that the risk shifting effect is important for pledged deposits and bank guarantees. Our results suggest that the conflicting results in the extant risk-collateral literature may be because different samples may be dominated by collateralized loans with different economic characteristics or different types of collateral.

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1. Introduction

Collateral is a prominent feature of debt contracts, but the underlying motivation for collateral is not well-understood. Economic theory generally explains collateral as an attempt to reduce agency costs or contracting frictions in the presence of asymmetric information. One strand of theory motivates collateral as part of an optimal debt contract by invoking *ex post* frictions, like moral hazard, and predicts that observably riskier borrowers are more likely to be required to pledge collateral.¹ A second set of theories focuses on *ex ante* private information and suggests that collateral may allow lenders to sort observationally equivalent loan applicants through signaling.² Specifically, lenders offer a menu of contract terms such that observationally equivalent applicants with higher-quality projects choose secured debt with lower risk premiums, while those with lower-quality projects self-select into unsecured debt with higher risk premiums.

To test these theories, a number of studies link measures of loan risk – such as loan risk premiums or *ex post* nonperformance – to whether or not collateral was pledged for a given credit. Some studies report a positive relationship between loan risk premiums (loan rates less the risk-free rate) and collateral pledges (e.g., Berger and Udell, 1990; Blackwell and Winters, 1997; Machauer and Weber, 1998; John, Lynch, and Puri, 2003; Brick and Palia, 2007; Godlewski and Weill 2010), while others find a negative relationship (e.g., Degryse and Van Cayseele, 2000; Lehmann and Neuberger, 2001; Agarwal

¹ See Boot, Thakor, and Udell (1991), Boot and Thakor (1994), Aghion and Bolton (1997), and Holmstrom and Tirole (1997) for examples of models with moral hazard. Other *ex post* frictions identified in the literature include difficulties in enforcing contracts (e.g., Banerjee and Newman, 1993; Albuquerque and Hopenhayn, 2004; Cooley, Marimon, and Quadrini, 2004) and costly state verification (e.g., Townsend, 1979; Gale and Hellwig, 1985; Williamson, 1986; Boyd and Smith, 1994).

² For examples of these theoretical models, see Bester (1985, 1987), Besanko and Thakor (1987a, 1987b), Chan and Thakor (1987), and Boot, Thakor, and Udell (1991).

and Hauswald, 2010; Berger, Frame, and Ioannidou, 2011).³ In addition, two studies find that *ex post* nonperformance of loans (delinquency or default) is positively related to collateral pledges (Jimenez and Saurina, 2004; Berger, Frame, and Ioannidou, 2011).

To our knowledge, there are no attempts to explain this puzzle in the literature – why the empirical relation between loan risk and collateral is sometimes positive and other times negative. This paper provides a potential solution to this puzzle by examining the relations between risk and the economic characteristics and types of collateral – each of which may be associated with the empirical dominance of different risk-collateral channels implied by economic theory (outlined below). This suggests that the prior literature may have conflicting results because the different samples may be dominated by collateral with different economic characteristics or different collateral types.

Ex post theories of collateral imply the existence of three individual channels with different predictions for the empirical relation between loan risk and collateral: the “lender selection” effect under which observably riskier borrowers are required to pledge collateral; the “risk shifting” effect that encourages borrowers to shift into safer investment projects when collateral is pledged; and the “loss mitigation” effect in which collateral reduces losses in the event of borrower default. By contrast, *ex ante* private information theories of collateral predict an unambiguous negative relationship between loan risk and collateral. This is due to the “borrower selection” effect – in which unobservably safer borrowers tend to pledge collateral more often – as well as the aforementioned “risk shifting” and “loss mitigation” effects. In our empirical analysis below, we attempt to isolate the four individual effects of collateral on loan risk to the extent possible.

The degree to which information-based contracting frictions are mitigated by collateral should depend on the economic characteristics and types of the collateral. All else equal, we hypothesize that all four of the effects of collateral on loan risk should be stronger when the economic characteristics and

³ Agarwal and Hauswald (2010) specifically report a negative relation between commercial loan rates and the incidence of collateral. The result is presumably consistent with a negative relation between loan rate premiums and collateral, given that risk-free rates were unlikely to have varied much over the short time horizon of the sample (15 months).

types of collateral are more desirable. For example, the “borrower selection” effect should be stronger when the collateral is more desirable because the unobservably safest borrowers are expected to choose the lowest loan rates and pledge the most desired type of collateral. As well, the “lender selection” effect should be stronger when the collateral is more desirable as the lender is likely to insist on such collateral from the riskiest borrowers. The “risk shifting” and “loss mitigation” effects are similarly stronger when collateral is more desirable. We argue that liquidity, nondivertibility, and outside ownership status (discussed further below) are desirable collateral characteristics.

Some prior research exists that analyzes some important individual economic characteristics of collateral and collateral types, although none look at a variety of collateral characteristics and types concurrently.⁴ Puri, John, and Lynch (2003) study U.S. corporate debt and find that non-mortgage collateral pledges are associated with higher interest rates than mortgage collateral pledges and unsecured loans – a result that is stronger for longer-term loans and loans to riskier firms. Voordeckers and Steijvers (2006) report that the pledging of outside collateral is more likely for informationally opaque credits – i.e., loans made to younger and family firms and small loans. Berger and Black (2011) find that large banks are more likely than small banks to use leases rather than pledges of fixed-asset collateral when lending to small businesses. Benmelech, Garmaise, and Moskowitz (2005) find that the terms of commercial real estate loans are affected by the zoning regulations associated with the underlying properties, which the authors use as a measure of redeployability. We consider “redeployability” as being synonymous with “liquidity.” The study finds that more redeployable (liquid) assets receive larger loans with longer maturities and lower interest rates. Three other papers empirically demonstrate that airline financing conditions are positively related to the redeployability (liquidity) of the firm’s fleet. First, Benmelech and Bergman (2008) find that airlines are better able to renegotiate their airplane leases when their financial condition is sufficiently poor and when the liquidation value of their fleet is low. Second, Benmelech and Bergman (2009) find that the pricing of collateralized debt obligations financing airplanes

⁴ However, one paper does relate the incidence of some individual collateral types to a measure of the expected default risk of individual borrowers (Liberti 2011).

depends on the aircraft model as bonds backed by more redeployable (liquid) airplanes carry lower interest rates. Finally, Benmelech and Bergman (2011) show that airline bankruptcies produce a negative externality for other firms in an industry by increasing the available supply of airplanes. The authors identify this “collateral channel” using prices for collateralized debt obligations – finding that the effect is stronger for less redeployable (liquid) models, less senior tranches, and higher loan-to-value ratios.

This paper significantly extends the empirical literature by studying the relations between loan risk and collateral characteristics and types using detailed commercial loan data provided by a national credit registry. Specifically, we relate two different measures of loan risk (loan risk premiums and *ex post* loan nonperformance) to a simple indicator of collateral being pledged, three key economic characteristics of collateral, and nine different collateral types. The first collateral characteristic is “liquidity,” or the ease, cost, and time with which the secured assets can be converted to cash at fair market value in the event of default. Bank deposits and securities are examples of liquid collateral. The second collateral characteristic studied is “divertibility,” or the ability of the firm to divert an asset (e.g., equipment) to alternative uses or reduce maintenance, which can result in lower recovery values. The third collateral characteristic is an indication of ownership status – i.e., whether the pledged asset would otherwise be legally attachable in the event of default. As discussed by Chan and Kanatas (1985), the economic theories of collateral described above generally assume that the asset being pledged actually comes from outside of the firm. This “outside collateral,” such as an owner’s home in the case of limited liability firms, should act like additional equity in the firm.

By way of preview, we find that overall the incidence of collateral is associated with lower loan risk premiums and a higher probability of *ex post* loan nonperformance (delinquency or default). Taken together, these findings suggest that the dominant reason why collateral is pledged is because banks require collateral from observably riskier borrowers (“lender selection” effect), while the main reason for lower risk premiums is because secured loans carry lower losses given default (“loss mitigation” effect). However, the risk-collateral channels appear to depend on the characteristics and types of collateral. The “lender selection” effect appears to be especially important for outside collateral, the “risk-shifting” and

“loss mitigation” effects for liquid collateral, and the “borrower selection” effect for nondivertible collateral. We also find support for the “lender selection” effect for residential real estate collateral and the “risk shifting” effect for two types of collateral – pledged deposits and bank guarantees. Hence, our results suggest a role for all four risk-collateral channels depending on the economic characteristics and types of collateral. This suggests a possible solution to the puzzle in the empirical literature.

The remainder of the paper is structured as follows. Section II describes the credit registry data we use. Section III outlines our empirical tests and Section IV presents our results. Section V concludes.

II. Data

The data used in this paper come from the *Central de Información de Riesgos Crediticios (CIRC)*, the public credit registry of Bolivia, provided by the Bolivian Superintendent of Banks and Financial Entities (SBEF). Since CIRC’s creation in 1989, the SBEF requires all formal (licensed and regulated) financial institutions operating in Bolivia to report detailed information on all loans. Our sample covers the entire credit registry for the period between January 1998 and December 2003. For each loan, we have information on origination and maturity dates, credit type, interest rate, collateral type, and *ex post* nonperformance through the sample period (delinquencies and defaults). For each borrower, we have information about their industry, physical location, legal structure, banking relationships, and whether they have been delinquent or defaulted on another loan in the recent past.

The data include loans from both commercial banks and nonbank financial institutions (e.g., private financial funds, credit unions, mutual societies, and general deposit warehouses). To keep the set of lenders homogenous in terms of financial structure and regulation, we focus exclusively on loans granted by commercial banks between March 1999 and December 2003.⁵ There are 13 commercial banks

⁵ Although we have data as of January 1998, we start our sample in March 1999 since prior to this date the data do not allow us to distinguish between commercial and consumer loans. However, we use the prior information from January 1998 through February 1999 to help fill in the history of bank-firm relationships as well as the firm’s credit history as of March 1999.

active in Bolivia during the sample period. For the purposes of our analysis, we focus only on commercial loans. Commercial loans represent an important segment of the credit markets for which collateral is a negotiated loan term that is only sometimes present and where a wide variety of assets with different economic characteristics is pledged.

There are several types of commercial credit contracts in the data, including credit cards, overdrafts, installment loans, discount loans, and lines of credit. We focus exclusively on installment loans and discount loans, which together account for 92 percent of the total value of commercial loans during the sample period. Of these contracts, 98 percent are denominated in U.S. dollars and we use only these loans in our analysis. We also only study new loans originated during the sample period. A loan is defined by a unique identification code and a date of origination. The data set includes new loans to new or existing customers and also renegotiations of previous loans. Banks, however, are required to indicate whether a new loan is a renegotiation of a previous (performing or nonperforming) loan and we use this information to exclude renegotiations.⁶ We also do not include loans drawn on pre-existing lines of credit as new loans.⁷ Our sample encompasses 28,252 loans to 2,462 different firms.

Table 1 provides variable names, definitions, and summary statistics for all loans in the sample.⁸ Most of the sample firms are limited liability corporations (48.8 percent), while joint stock corporations (22.2 percent), limited partnerships (13.6 percent), sole proprietorships (12.6 percent), and general partnerships (0.8 percent) are less common. Only 0.3 percent of the loans were given to borrowers that had defaulted in the prior twelve months (*Prior_Default*). Hence, it seems that borrowers that default rarely get another loan, either because they are credit rationed or cease to exist as a going concern. About

⁶ To the extent that some renegotiations are not recorded (either because of reporting errors or because banks do that intentionally to reduce their loan loss reserves), our sample would include some renegotiations as new loans.

⁷ When a borrower draws on a pre-existing line of credit, a “new loan” appears in the registry with origination date and contract terms as of the date the bank originated the credit line. Since the date the loan first appears in the registry is subsequent to the origination date, we can identify when a “new loan” is a draw on a pre-existing line of credit and exclude it from our sample.

⁸ For relationship length, loan amount, and maturity we report summary statistics for the level of these variables, but our empirical models (below) incorporate the natural logarithm of one plus the level.

21.1 percent of the loans were given to borrowers that had a delinquency with any bank in the previous twelve months (*Prior_NPL*). Some of these past delinquencies are observable to prospective lenders, while others are not and thus provide controls for both the “lender selection” and “borrower selection” effects respectively (see Berger, Frame, and Ioannidou, 2011). The estimated average length of a banking relationship is almost 23 months. This is defined as the number of months since the first loan in the data for the bank-borrower pair as of January 1998.

Turning to the loan characteristics, almost one-half of the sample is composed of installment loans and the average loan maturity is almost 11 months. The average loan carries an interest rate of 13.5 percent, with an average spread of 9.5 percentage points over U.S. Treasury securities of comparable maturities. About 18 percent of the loans in our data are secured. With respect to *ex post* performance of the 25,918 loans that matured before the end of the sample period, 5.9 percent had *ex post* delinquencies or defaults.

A wide variety of assets are pledged as collateral. Nine percent of collateralized loans are secured by deposits in the same or another financial institution, almost four percent are secured by bank guarantees (e.g., letters of credit), and about two percent with securities (stocks or bonds). Movable firm assets (such as accounts receivable, inventory, crops, properties, tools, machines and equipment) are frequently pledged as collateral and are distinguished as either creditor- or debtor-held. Creditor-held movable assets are typically stored in a warehouse on the behalf of the creditor to limit the debtor’s access to the assets and make sure that the appropriate maintenance is done.⁹ Debtor-held movable assets are not subject to such restrictions. For our sample, almost 16 percent of collateralized loans are secured by creditor-held movable collateral, while almost 25 percent are secured by debtor-held movable collateral. Real estate is also a frequent form of collateral, as 20 percent of collateralized loans are secured by residential real estate and almost nine percent by commercial real estate. Finally, almost 14 percent of

⁹ Depending on the type of the asset and its importance for the operations of the firm, a warehouse can also be set up at the firm’s premises to control access to the asset and at the same time allow the firm to continue using the asset.

collateralized loans are secured with endorsements from deposit warehouses backed by the deposit of commodities (known as “Bonos de Prenda” or “Collateral Bonds”) and two percent by vehicles.

Next, we categorize these collateral types along three key economic dimensions: (1) liquidity, (2) divertability, and (3) ownership status. Table 2 provides a mapping from collateral types to these economic characteristics. An asset is considered liquid if it can be converted into cash quickly without substantial discount on its price. *Liquid* is an indicator variable that takes a value of one for collateral identified as either: *Pledged Deposits*, *Bank Guarantees*, or *Securities*.

Asset divertibility is another important collateral characteristic. Since nondivertible assets are less susceptible to borrower agency problems, they are better able to mitigate moral hazard incentives. The variable *Nondivertible* takes a value of one for loans secured by the three liquid assets defined above as well as for loans secured by *Creditor-Held Movable Assets* (i.e., movable firm assets that are in the control of the bank during the term of the loan) and *Collateral Bonds*.

Turning to ownership status, most of the assets observed in the data are expected to be owned by the firm and attachable in the event of default. However, assets or other forms of collateral pledged from outside of the firm may act to effectively increase equity in the firm. *Outside* is an indicator that takes a value of one for loans collateralized by either *Bank Guarantees* or *Residential Real Estate* pledged by limited liability firms (limited liability corporations and limited partnerships). Residential real estate loans are assumed to be backed by real property owned by the firm’s principal shareholder and, in the case of limited liability firms, such assets would not otherwise be attachable in the event of bankruptcy.

As shown in the last row of Table 2, 14.3 percent, 44.2 percent, and 14.7 percent of secured loans employ liquid, nondivertible, and outside collateral, respectively. All else equal, liquidity, nondivertibility, and outside ownership status are considered desirable economic characteristics. As noted above, it is generally expected that all four of the risk-collateral channels should be stronger when the collateral characteristics are more desirable.

III. Empirical Analysis

We examine the relation between loan risk and collateral by conducting two sets of empirical tests – each delineated by the risk measure studied – loan risk premiums and *ex post* nonperformance. Each set of tests explores the relation between the risk measure and the overall incidence of collateral, collateral characteristics, and collateral types. Regressions include several control variables, including firm, relationship, and loan variables and fixed effects for region, bank, industry, and time (and sometimes interactions of firm, bank, and time fixed effects).

Our loan risk premium regressions, each of which is estimated using OLS, can be summarized as:

$$Risk_Premium_{ijkt} = a(Collateral_{ijkt}, Firm_j, Relationship_{jkb}, Loan_{ijk}, Bank_k, Industry_b, Region_m, Time_t) \quad (1)$$

$$Risk_Premium_{ijkt} = b(Collateral_{ijkt}, Collateral\ Characteristics_{ijkt}, Firm_j, Relationship_{jkb}, Loan_{ijk}, Bank_k, Industry_b, Region_m, Time_t) \quad (2)$$

$$Risk_Premium_{ijkt} = c(Collateral\ Types_{ijkt}, Firm_j, Relationship_{jkb}, Loan_{ijk}, Bank_k, Industry_b, Region_m, Time_t) \quad (3)$$

where i, j, k, l, m and t index loans, firms, banks, industries, regions, and time, respectively.

In equations (1) – (3), $Risk_Premium_{ijkt}$ is defined as the loan interest rate minus the rate on U.S. Treasury securities of comparable maturity at the time of loan origination. The key explanatory variables are those reflecting collateral pledges. Consistent with the extant literature, we first relate loan risk premiums to a simple indicator of whether the loan was collateralized – $Collateral_{ijkt}$ (equation 1). We then repeat the experiment using $Collateral_{ijkt}$ plus our three derived economic characteristics of collateral: $Collateral\ Characteristics_{ijkt} = Liquid, Nondivertible,$ and $Outside$ (equation 2). We include the simple collateral indicator along with the economic characteristics because some types of collateral have none of these characteristics (i.e., they are illiquid, divertible, and inside). Finally, we replace the indicators for collateral in general and the three collateral characteristics with a vector of collateral types (described above): $Collateral\ Types_{ijkt} = Pledged\ Deposits, Bank\ Guarantees, Securities, Creditor-Held\ Movable\ Assets, Debtor-Held\ Movable\ Assets, Residential\ Real\ Estate, Commercial\ Real\ Estate, Collateral\ Bonds,$ and $Vehicles$ (equation 3).

The vector $Firm_{jt}$ accounts for differences in firm characteristics, particularly legal structure and past loan performance problems. We use a set of dummy variables indicating the legal structure of the firm: *General Partnership*, *Limited Partnership*, *Joint Stock Company*, and *Limited Liability Corporation* (*Sole Proprietorship* is the omitted group). *Prior_Default* indicates whether the borrowing firm had defaulted on a loan with any lender in the previous 12 months. *Prior_NPL* indicates whether the borrowing firm missed a payment on a loan with any lender in the previous 12 months. We also include a set of firm-related dummy variables – denoted *Industry* – for 19 industry classifications (similar to the SIC or NAICS codes).¹⁰

Our empirical specification also includes a relationship characteristic and a loan characteristic. *Relationship Length* indicates the length of a bank-firm relationship and it is equal to the natural logarithm of one plus the number of months we observe the bank and borrower in a credit relationship. *Installment* is a dummy variable equal to one if the contract is an installment loan rather than a discount loan. We also include *Region*, a set of dummy variables that indicate the location from which the loan was originated. This includes nine regions in Bolivia as well as Argentina, Paraguay, Panama, and the United States.

Bank and time (month-year) fixed effects are also included in the model, represented by $Bank_k$ and $Time_t$, respectively. Bank fixed effects should capture any systematic differences across banks in the pricing of their commercial loans. The time fixed effects are intended to account for temporal differences in loan risk premiums related to the business, interest rate, or credit cycles.

Additional specifications include firm fixed effects interacted with bank and time fixed effects (i.e., $Firm_j * Bank_k * Time_t$ fixed effects). Time-invariant firm and industry variables are omitted from these specifications. The identification of parameters in this most conservative case is obtained from the

¹⁰ The 19 industry categories are: Agriculture and cattle; Farming; Forestry and fishery; Extraction of oil and gas; Minerals; Manufacturing; Electricity, gas, and water; Construction; Wholesale and retail trade; Hotels and restaurants; Transport, storage, and communications; Financial Intermediation; Real estate activities; Public administration defense, and compulsory social security; Education; Communal and personal social services; Activities of households as employees of domestic personnel; Activities of extraterritorial organizations and bodies; and Other.

subsample of firms with more than one loan from the same bank in the same month. The addition of the interacted firm fixed effects help us to better identify the “risk shifting” and “loss mitigation” effects by virtually eliminating the “borrower selection” and “lender selection” effects as well as any other firm and bank heterogeneity that might be correlated with our collateral variables.¹¹

Our second set of empirical regressions use $Ex_Post_Nonperformance_{ijt}$ as a dependent variable. This variable indicates whether the loan eventually becomes delinquent or defaults, but does not measure the size of any losses. As above, this measure is separately regressed on a dummy variable indicating that collateral was pledged, the set of collateral characteristics as well as the collateral dummy, the set of collateral types, plus all other explanatory variables used in the risk premium regressions:

$$Ex_Post_Nonperformance_{ijt} = d(Collateral_{ijk}, Firm_j, Relationship_{jkl}, Loan_{ijk}, Bank_k, Industry_l, Region_m, Time_t) \quad (4)$$

$$Ex_Post_Nonperformance_{ijt} = e(Collateral_{ijk}, Collateral\ Characteristics_{ijk}, Firm_j, Relationship_{jkl}, Loan_{ijk}, Bank_k, Industry_l, Region_m, Time_t) \quad (5)$$

$$Ex_Post_Nonperformance_{ijt} = f(Collateral\ Types_{ijk}, Firm_j, Relationship_{jkl}, Loan_{ijk}, Bank_k, Industry_l, Region_m, Time_t) \quad (6)$$

where i, j, k, l, m and t again index loans, firms, banks, industries, regions, and time, respectively.

Importantly, in these specifications, only the “borrower selection,” “lender selection,” and “risk shifting” effects are present. Consequently, these results – coupled with those for loan risk premiums – may allow us to better identify the singular importance of the “loss mitigation” effect of collateral. For this analysis, we drop all loans that do not mature before the end of the sample (December 2003); thereby leaving 26,033 bank loans. Since this has the effect of reducing the average loan maturity in our sample, we also eliminate all loans originated during the last six months of the sample (July – December 2003) – further reducing the sample to 25,391 loans.

¹¹ For example, a firm’s observed collateral pledge may reflect a constraint on their available assets that is potentially correlated with firm risk characteristics not controlled for in our experiments. This would typically result in biased estimates. The inclusion of $Firm*Bank*Time$ fixed effects essentially eliminates this problem.

A limitation of this analysis relative to the loan risk premium analysis is that we cannot include firm fixed effects to control for unobserved borrower heterogeneity that may be correlated with collateral pledges. The reason is that we have very few nonperformance observations that are repeated for individual borrowers.

IV. Results

Table 3 presents the results for the loan risk premium regressions for which all four risk-collateral channels are in force. Columns I-III include only the collateral variables (collateral overall, collateral characteristics, and collateral types) along with the region, bank, and time fixed effects as well as a dummy variable indicating whether the loan is an installment (as opposed to a discount loan). Columns IV-VI then offer results for regressions that further include measures of firm ownership structure and risk, the length of the bank-firm relationship, and industry fixed effects. Columns VII-IX incorporate firm-bank-time fixed effects, while removing all time-invariant firm characteristics as well as the individual bank and time fixed effects. These latter regressions are structured to virtually eliminate the “lender selection” and “borrower selection” effects of collateral, as parameters are identified based on firms that obtain more than one loan from the same bank in the same month.

Table 4 then provides the results for the *ex post* nonperformance regressions. Note that these regressions encompass only three of the risk-collateral channels since the “loss mitigation” effect is not active. Columns I-III in each table present results including only the collateral variables along with the region, bank, and time fixed effects as well as a dummy variable indicating whether the loan is an installment (as opposed to a discount loan). Columns IV-VI then offers results for regressions that further include measures of firm ownership structure and risk, the length of the bank-firm relationship, and industry fixed effects. There is no analog for Columns VII-IX of Table 3 because we cannot include firm fixed effects owing to too few nonperformance observations that are repeated for individual borrowers, as mentioned above.

A. Collateral Overall.

In Table 3, we find a negative overall relationship between the loan risk premiums and the incidence of collateral. The results in Column I suggest that collateral overall is associated with a 60 basis point discount. Given that the “lender selection” effect is the only channel that implies a positive risk-collateral relation, the results are consistent with the net empirical domination of the combination of the “borrower selection,” “risk shifting,” and “loss mitigation” effects. Moving from Column I to Column IV, we control for several firm characteristics, which reduces the “lender selection” and “borrower selection” effects; and in Column VII these effects are virtually eliminated. Looking across these columns, the negative overall relation between loan risk premiums and collateral is robust and quantitatively stable. This implies that the measured negative effect in Column I is mainly driven by the “risk shifting” and/or “loss mitigation” effects; and not by the “borrower selection” effect.

Table 4 presents the marginal effects of a Probit model for $ExPost_Nonperformance_{ijt}$. In Column I, the overall risk-collateral relation is positive – suggesting the net empirical dominance of the “lender selection” effect over the “borrower selection” and “risk shifting” effects. (Recall that the “loss mitigation” effect is not reflected in the *ex post* nonperformance variable.) This suggests that the lower average risk premium found in Table 3 for *Collateral* is primarily driven by a “loss mitigation” effect. In other words, the lower risk premiums of secured loans are mainly due to the “loss mitigation” effect, while the main reason for which collateral is pledged is “lender selection” effect.

B. Collateral Characteristics.

The estimated relation between loan risk premiums and the economic characteristics of collateral are displayed in Columns II, V, and VIII of Table 3. In each of these regressions, we find that the incidence of collateral in general is associated with lower loan risk premiums of roughly 40 basis points. In columns II and V, we find that liquid and nondivertible collateral are each associated with further loan risk premium discounts, while firms that pledge outside collateral pay a higher loan risk premium (relative to both other secured loans and unsecured loans). Each of the three economic characteristics of collateral, are statistically significant in these regressions, consistent with our separate treatment.

The consistent negative and statistically significant coefficient for *Liquid* collateral in all three specifications is consistent with substantial “risk shifting” and/or “loss mitigation” effects for liquid collateral. The finding that the coefficient for *Nondivertible* is negative in Columns II and V and statistically indistinguishable from zero in Column VIII is consistent with a “borrower selection” effect for this collateral characteristic. The positive overall effect of *Outside* collateral is consistent with a strong “lender selection” effect, suggesting that the riskiest firms pledge outside collateral. This is confirmed by the results in Column VIII, where the “lender selection” and “borrower selection” effects are virtually eliminated and the estimated coefficient on *Outside* is statistically indistinguishable from zero.

Next, we turn to the estimated relation between *ex post* nonperformance and our three economic characteristics of collateral in Columns II and VI of Table 4. Here again, the statistical significance of the economic characteristics justifies their inclusion. Individually, *Liquid* and *Nondivertible* collateral are each negatively and statistically significantly related to *ex post* nonperformance, although the joint significance of these variables with *Collateral* suggests a positive net effect relative to unsecured loans. The coefficient on *Outside* is marginally positively economically and statistically related to *ex post* nonperformance. The positive coefficient on collateral as a whole and the joint positive effects of *Liquid*, *Nondivertible*, and *Outside* collateral (with collateral overall) suggest the presence of a “lender selection” effect for all kinds of collateral.

C. Collateral Types.

We further explore the risk-collateral relation by examining the nine collateral types present in the data. The results for the attendant loan risk premium regressions are presented in Columns III, VI, and IX of Table 3. We find that desirable collateral types that are liquid and/or nondivertible, such as *Pledged Deposits*, *Bank Guarantees*, *Creditor-Held Movable Assets*, and *Collateral Bonds*, are negative and statistically significant in all three regressions. (The only exception is *Securities*, which is not statistically significant in our most conservative specification.) These results are consistent with the empirical dominance of the “loss mitigation” and/or “risk shifting” effects for these types of collateral.

Less desirable collateral types, such as *Debtor-Held Movable Assets* and *Commercial Real Estate* are each negatively and statistically significantly related to loan risk premiums in the first two regressions (Columns III and VI), but not in the final regression that virtually eliminates the two selection effects (Column IX). This suggests that pledges of *Debtor-Held Movable Assets* and *Commercial Real Estate* are consistent with “borrower selection.” *Residential Real Estate* is positively and statistically significantly related to loan risk premiums in the first two regressions but not the third. This pattern is consistent with a relatively stronger “lender selection” effect for this type of collateral and/or a higher incidence of such collateral among riskier firms. This is consistent with our results for *Outside* collateral above.

Next, we turn to the relation between *ex post* nonperformance and collateral types in Table 4. When looking at the individual types, we observe that the overall positive relation between collateral and *ex post* nonperformance is mainly driven by collateral types that are neither liquid nor nondivertible, such as *Debtor-Held Movable Assets*, *Residential Real Estate*, *Commercial Real Estate*, and *Vehicles*. In Columns III and VI, these types of collateral are found to be positively related to *ex post* nonperformance, consistent with a dominant “lender selection” effect. More attractive collateral types that are both liquid and nondivertible, such as *Pledged Deposits* and *Bank Guarantees*, are negatively related to *ex post* nonperformance. The prior support for the empirical dominance of the “risk shifting” and/or “loss mitigation” effects in Table 3 – plus the fact that the “loss mitigation” effect is not present here – suggests the importance of the “risk shifting” effect for these types of collateral. None of the other types of collateral are found to have a statistically significant relationship to *ex post* nonperformance.

Turning to the other explanatory variables, we see that each of the firm risk characteristics are generally positively related to loan risk premiums and *ex post* nonperformance. One exception is *Prior_Default* which is statistically insignificant in the *ex post* nonperformance regressions – perhaps owing to the small number of loans to firms that had recently defaulted, received new credit, and defaulted again. Relative to sole proprietorships, each of the other ownership structures are associated with lower loan risk premiums. However, this finding is unlikely to be related to default risk as limited

liability firms (limited liability companies and limited partnerships) are more likely to have *ex post* nonperformance problems. Longer banking relationships appear to be associated with higher loan risk premiums and lower rates of *ex post* nonperformance (although the latter is not statistically significant) – consistent with lock-in effects. Riskier firms are more likely to have installment loans – as they are associated with higher loan risk premiums (before controlling for firm risk) and higher rates of *ex post* nonperformance.

V. Conclusions

A puzzle in the empirical literature is that loan risk and collateral are found to sometimes be positively related and sometimes negatively related. One potential explanation for these findings is that prior studies treat collateral as generic – and hence ignore the fact that certain collateral types or characteristics are more desirable because they can better mitigate informational frictions. Some prior research exists that analyzes some important individual economic characteristics of collateral and collateral types, although none look at a variety of collateral characteristics and types concurrently or otherwise attempted to address this puzzle.

This paper offers a potential solution to this puzzle by showing that different risk-collateral channels are effective to different degrees for collateral with different economic characteristics and different collateral types. Thus the puzzle may be explained by the possibility that different studies use data samples with different mixes of collateral characteristics and types.

We find evidence supporting the economic importance of each of the four risk-collateral channels that we identify. For our sample, collateral overall is associated with reduced loan risk premiums and higher rates of *ex post* nonperformance. This suggests that the dominant reason why collateral is pledged is the “lender selection” effect, while the primary reason that collateralized loans carry lower risk premiums is the “loss mitigation” effect. Furthermore, the risk-collateral channels appear to depend upon the economic characteristics and types of collateral. The “lender selection” effect appears to be especially important for outside collateral, the “risk-shifting” and “loss mitigation” effects for liquid collateral, and

the “borrower selection” effect for nondivertible collateral. Among collateral types, our findings suggest that the “lender selection” is important for residential real estate, and that the “risk shifting” effect is important for at least two types of collateral – pledged deposits and bank guarantees.

Collateral does not appear to be homogeneous in its economic effects and hence future research should include information about the economic characteristics and/or types of collateral whenever possible. We also suggest that future research should further investigate the four risk-collateral channels identified here.

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Table 1
Variables and Summary Statistics

The table reports the notation and definitions of variables used in the analysis, and summary statistics for all loans in the sample. The summary statistics for *Ex Post Nonperformance* use the number of loans that matured before the end of the sample period.

Variables	Description	Obs	Mean	St. Dev.
Past Nonperformance				
<i>Prior_Default</i>	Equals one if the borrower had defaulted on a loan anytime in the previous 12 months with any lender, and is zero otherwise	28,252	0.003	0.052
<i>Prior_NPL</i>	Equals one if the borrower had overdue payments of at least 30 days with any bank anytime in the previous 12 months, and is zero otherwise	28,252	0.211	0.408
Firm Characteristics				
<i>Sole Proprietorship</i>	Equals one if the firm is a sole proprietorship, and is zero otherwise	28,252	0.126	0.332
<i>General Partnership</i>	Equals one if the firm is a general partnership (i.e., all partners have unlimited liability and ownership is not transferable), and is zero otherwise	28,252	0.008	0.091
<i>Limited Partnership</i>	Equals one if the firms is a limited partnership (i.e., some partners have limited liability and their ownership rights are transferable), and is zero otherwise	28,252	0.136	0.343
<i>Joint Stock Company</i>	Equals one if the firm is a joint stock company (i.e., all partners have unlimited liability and their ownership rights are transferable), and is zero otherwise	28,252	0.222	0.415
<i>Limited Liability Company</i>	Equals one if the firm is a limited liability company (i.e., all partners have limited liability and transferable ownership rights), and is zero otherwise	28,252	0.488	0.500
Relationship Characteristic				
<i>Rel_Length</i>	Length of bank-firm relationship in months	28,252	22.704	15.769
Loan Characteristics				
<i>Installment</i>	Equals one if an installment loan and zero if a discount loan	28,252	0.456	0.498
<i>Loan Amount</i>	Loan amount at loan origination in US dollars	28,252	148,902	436,026
<i>Maturity</i>	Number of months between loan origination and maturity	28,252	10.757	12.833
<i>Interest Rate</i>	Annual contractual interest rate at loan origination	28,252	13.538	2.848
<i>Risk Premium</i>	Loan interest rate minus U.S. Treasury rate of comparable maturity at origination	28,252	9.507	2.557
<i>Collateral</i>	Equals one if collateral was pledged at loan origination, and is zero otherwise	28,252	0.177	0.381
Types of Collateral				
<i>Pledged Deposits</i>	Equals one if deposits were pledged, and is zero otherwise	4,989	0.091	0.287
<i>Bank Guarantees</i>	Equals one if bank guarantees or letters of credit were pledged, and is zero otherwise	4,989	0.037	0.188
<i>Securities</i>	Equals one if bonds or stocks were pledged, and is zero otherwise	4,989	0.022	0.146
<i>Creditor-Held Movable Assets</i>	Equals one if there is a possessory security on the firm's movable assets (e.g., inventory, crops, properties, tools, and equipment), and is zero otherwise	4,989	0.158	0.364
<i>Debtor-Held Movable Assets</i>	Equals one if there is a non-possessory security on the firm's movable assets (e.g., a/cs receivable, inventory, crops, properties, tools, and equipment), and is zero otherwise	4,989	0.248	0.432
<i>Residential Real Estate</i>	Equals one if a residential real estate is pledged, and is zero otherwise	4,989	0.199	0.399
<i>Commercial Real Estate</i>	Equals one if a commercial real estate is pledged, and is zero otherwise	4,989	0.088	0.283
<i>Collateral Bonds</i>	Equals one if a loan is secured with endorsements from deposit warehouses backed by the deposit of commodities ("Bonos de Prenda").	4,989	0.135	0.342
<i>Vehicles</i>	Equals one if vehicles were pledged, and is zero otherwise	4,989	0.023	0.149
Ex Post Loan Performance				
<i>Ex_Post_Nonperformance</i>	Equals one if a loan is 30+ days overdue anytime after origination or if it is downgraded to the default status (a rating of 5) and zero otherwise	25,918	0.059	0.237

Table 2
Mapping from Collateral Types to Economic Characteristics

Types of Collateral	Economic Characteristics		
	Liquid	Nondivertible	Outside
<i>Pledged Deposits</i>	1	1	0
<i>Bank Guarantees</i>	1	1	1
<i>Securities</i>	1	1	0
<i>Creditor-Held Movable Assets</i>	0	1	0
<i>Debtor-Held Movable Assets</i>	0	0	0
<i>Residential Real Estate_Limited Liability Companies</i>	0	0	1
<i>Residential Real Estate_Non Limited Liability Companies</i>	0	0	0
<i>Commercial Real Estate</i>	0	0	0
<i>Collateral Bonds</i>	0	1	0
<i>Vehicles</i>	0	0	0
<i>Percentage of Secured Loans</i>	14.3%	44.2%	14.7%

Table 3
Determinants of Loan Risk Premiums

This table reports OLS regressions for $Risk_Premium_{ijt}$, which is defined as the loan interest rate at loan origination minus the rate of U.S. Treasury bill with comparable maturities. Standard errors are corrected for heteroskedasticity and reported between brackets. ***, **, and * indicate significance at the 1%, 5%, and 10%, respectively.

	Baseline			(+ Firm Characteristics			Firm*Bank*Time FE		
	I	II	III	IV	V	VI	VII	VIII	IX
Collateral									
<i>Collateral</i>	-0.600*** [0.044]	-0.413*** [0.059]		-0.580*** [0.043]	-0.431*** [0.056]		-0.636*** [0.096]	-0.466*** [0.171]	
Collateral Characteristics									
<i>Liquid</i>		-1.197*** [0.127]			-1.199*** [0.130]			-0.517** [0.255]	
<i>Nondivertible</i>		-0.242*** [0.084]			-0.165** [0.081]			-0.16 [0.188]	
<i>Outside</i>		1.073*** [0.111]			1.075*** [0.109]			-0.086 [0.244]	
Collateral Types									
<i>Pledged Deposits</i>			-1.692*** [0.123]			-1.773*** [0.126]			-1.168*** [0.272]
<i>Bank Guarantees</i>			-1.185*** [0.221]			-0.763*** [0.221]			-1.142*** [0.322]
<i>Securities</i>			-0.718*** [0.183]			-0.820*** [0.184]			-0.403 [0.486]
<i>Creditor-Held Movable Assets</i>			-0.965*** [0.097]			-0.822*** [0.096]			-0.823*** [0.140]
<i>Debtor-Held Movable Assets</i>			-0.820*** [0.089]			-0.657*** [0.081]			-0.597 [0.355]
<i>Residential Real Estate</i>			0.742*** [0.086]			0.558*** [0.084]			-0.156 [0.161]
<i>Commercial Real Estate</i>			-0.368*** [0.120]			-0.496*** [0.119]			-0.406 [0.302]
<i>Collateral Bonds</i>			-0.343*** [0.082]			-0.332*** [0.083]			-0.382*** [0.121]
<i>Vehicles</i>			-0.157 [0.157]			-0.311* [0.165]			-0.353 [0.312]
Past Nonperformance									
<i>Prior_Default</i>				0.739*** [0.242]	0.700*** [0.242]	0.582** [0.236]			
<i>Prior_NPL</i>				0.468*** [0.029]	0.466*** [0.029]	0.471*** [0.029]			
Firm Characteristics									
<i>General Partnership</i>				-0.403*** [0.137]	-0.441*** [0.137]	-0.431*** [0.137]			
<i>Limited Partnership</i>				-0.345*** [0.048]	-0.349*** [0.048]	-0.319*** [0.048]			
<i>Joint Stock Company</i>				-1.269*** [0.044]	-1.270*** [0.043]	-1.213*** [0.043]			
<i>Limited Liability Company</i>				-0.397*** [0.036]	-0.439*** [0.036]	-0.366*** [0.036]			
Relation Characteristic									
<i>Rel_Length</i>				0.037** [0.016]	0.045*** [0.016]	0.045*** [0.016]			
Loan Characteristic									
<i>Installment</i>	0.077*** [0.027]	0.04 [0.027]	0.024 [0.027]	0.047* [0.026]	0.016 [0.026]	0.007 [0.026]	0.066 [0.049]	0.051 [0.049]	0.046 [0.049]
Constant	11.117*** [0.099]	11.174*** [0.098]	11.063*** [0.095]	10.793*** [0.127]	10.836*** [0.126]	10.711*** [0.124]	9.247*** [0.025]	9.250*** [0.025]	9.248*** [0.025]
Fixed Effects									
<i>Industry</i>				Included	Included	Included			
<i>Region</i>	Included	Included	Included	Included	Included	Included			
<i>Bank</i>	Included	Included	Included	Included	Included	Included			
<i>Time (Month-Year)</i>	Included	Included	Included	Included	Included	Included			
<i>Firm *Bank*Time</i>							Included	Included	Included
(Adjusted) R-squared	0.35	0.36	0.36	0.41	0.42	0.42	0.87	0.87	0.87
Observations	28,252	28,252	28,252	28,252	28,252	28,252	13,274	13,274	13,274

Table 4
Determinants of Ex Post Nonperformance

This table reports the marginal effects of Probit regressions for *Ex Post Nonperformance*, a dummy variable that equals one if a loan is 30+ days overdue anytime after its origination or if it is downgraded to the default status (i.e., given a rating of 5). For continuous variables we report the effect for an infinitesimal change in each independent variable and for dummy variables we report the estimated effect of a change from 0 to 1. P0 is the predicted probability of *ex post* nonperformance, evaluated at the mean of all independent variables. ***, **, and * indicate significance at the 1%, 5%, and 10%, respectively. The standard errors are corrected for heteroskedasticity.

	Baseline			(+ Firm Characteristics		
	I	II	III	IV	V	VI
Collateral						
<i>Collateral</i>	0.035***	0.056***		0.028***	0.049***	
	[0.005]	[0.007]		[0.005]	[0.007]	
Collateral Characteristics						
<i>Liquid</i>		-0.033***			-0.024***	
		[0.005]			[0.006]	
<i>Nondivertible</i>		-0.023***			-0.025***	
		[0.004]			[0.003]	
<i>Outside</i>		0.020*			0.019*	
		[0.011]			[0.011]	
Collateral Types						
<i>Pledged Deposits</i>			-0.023***			-0.017**
			[0.008]			[0.008]
<i>Bank Guarantees</i>			-0.023**			-0.020**
			[0.011]			[0.010]
<i>Securities</i>			0.016			0.009
			[0.025]			[0.022]
<i>Creditor-Held Movable Assets</i>			0.015			0.003
			[0.009]			[0.008]
<i>Debtor-Held Movable Assets</i>			0.080***			0.062***
			[0.012]			[0.010]
<i>Residential Real Estate</i>			0.051***			0.050***
			[0.013]			[0.013]
<i>Commercial Real Estate</i>			0.073***			0.077***
			[0.018]			[0.018]
<i>Collateral Bonds</i>			0.016			0.005
			[0.010]			[0.008]
<i>Vehicles</i>			0.058*			0.071**
			[0.033]			[0.036]
Past Nonperformance						
<i>Prior_Default</i>				0.02	0.02	0.02
				[0.025]	[0.025]	[0.025]
<i>Prior_NPL</i>				0.061***	0.061***	0.061***
				[0.004]	[0.004]	[0.004]
Firm Characteristics						
<i>General Partnership</i>				-0.012	-0.012	-0.012
				[0.010]	[0.010]	[0.010]
<i>Limited Partnership</i>				0.016***	0.014**	0.013**
				[0.006]	[0.006]	[0.006]
<i>Joint Stock Company</i>				-0.006	-0.005	-0.005
				[0.004]	[0.004]	[0.004]
<i>Limited Liability Company</i>				0.008**	0.007*	0.008**
				[0.004]	[0.004]	[0.004]
Relation Characteristic						
<i>Rel_Length</i>				-0.001	-0.001	-0.001
				[0.002]	[0.002]	[0.002]
Loan Characteristic						
<i>Installment</i>	0.024***	0.021***	0.022***	0.022***	0.020***	0.020***
	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]
Fixed Effects						
<i>Industry</i>				Included	Included	Included
<i>Region</i>	Included	Included	Included	Included	Included	Included
<i>Bank</i>	Included	Included	Included	Included	Included	Included
<i>Time (Month-Year)</i>	Included	Included	Included	Included	Included	Included
Pseudo R-Square	0.094	0.1	0.1	0.154	0.159	0.159
P0	0.045	0.044	0.044	0.038	0.037	0.037
Observations	25,391	25,391	25,391	25,380	25,380	25,380