Collateralization, Bank Loan Rates and Monitoring: Evidence from a Natural Experiment

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Abstract

Collateral is one of the most important features of a debt contract. A substantial theoretical literature motivates the use of collateral as a means to alleviate ex-ante and ex-post information asymmetries between borrowers and lenders and the incidence of credit rationing. Through its seniority effect, collateral may also affect banks' incentives to monitor borrowers. There is little empirical evidence, however, on the precise workings of collateral, its interaction with other contract terms, and its impact on banks' monitoring incentives.

We study a change in the Swedish law that exogenously reduced the value of all outstanding company mortgages, i.e., a type of collateral that is comparable to the floating lien. We explore this natural experiment to identify how collateral determines borrower quality, loan terms, access to credit and bank monitoring of business term loans. Using a differences-in-differences approach, we find that following the change in the law and the loss in collateral value borrowers pay a higher interest rate on their loans, receive a worse quality assessment by their bank, and experience a substantial reduction in the supply of credit by their bank. Consistent with theories that consider collateral and monitoring to be complements, the reduction in collateral precedes a decrease in bank monitoring intensity and frequency of both collateral and borrower.

Keywords: Collateral, credit rationing, differences-in-differences, floating lien, loan contracts, monitoring, natural experiment.

JEL Classification: D82, G21

1. Introduction

Collateral is one of the most important features of many debt contracts. An extensive theoretical literature motivates the use of collateral to ameliorate information asymmetries between borrowers and lenders. Specifically, collateral is perceived to be a costly, yet effective loan-contracting tool aimed at alleviating *ex ante* adverse selection and *ex post* moral hazard problems (Bester (1985); Chan and Thakor (1987); Boot *et al.* (1991); Boot and Thakor (1994)). Consequently, posting collateral can relax credit constraints.

From the lender's perspective, collateral (that is internal) generally grants a higher position on the seniority ladder and therefore reduces the lender's expected losses given default. Recent research shows that collateral may thereby affect the incentives of banks to seek information about their prospective and current borrowers (Berglöf and von Thadden (1994); Rajan and Winton (1995); Repullo and Suarez (1998); Longhofer and Santos (2000); Manove *et al.* (2001); Gorton and Kahn (2000)). The ability of banks to produce information about borrowers forms the centerpiece in modern theory of financial intermediation (Diamond (1984)). To the extent that both monitoring and collateral serve the purpose of reducing the information gap between borrower and lender, it is also important to understand their interplay.

Despite the abundance in theoretical modeling, the precise workings of collateral, such as its interaction with other contract terms and its impact on a bank's monitoring incentives and credit availability, have yet to be identified empirically in a convincing way. Many of the difficulties faced by existing empirical studies reside in the limitations of the available data and the resulting econometric challenges. Accurate information on collateral value and monitoring activity is typically not available to researchers. Moreover, the joint determination of collateral with other contract terms

(Dennis *et al.* (2000); Brick and Palia (2007); Bharath *et al.* (2007)) and with bank monitoring effort (Ono and Uesugi (2009)) requires that several strong and potentially questionable assumptions need to be made in order to identify the effects of collateral.

In this paper, we aim to take a step forward in identifying the role that collateral plays in debt contracts and its impact on credit availability and bank monitoring. For this purpose, we exploit a change in law implemented in Sweden on January 1st, 2004 that reduced the value of company mortgages, a special collateral right commonly used in Sweden. Company mortgage refers to a claim on a floating pool of assets that, in many aspects, resembles the also widely observed floating lien in the U.S., the floating charge in the U.K., and the chattel mortgage in Australia. This unique natural experiment enables us to isolate unambiguously the impact that collateral has on the loan rate, the borrower-specific credit supply, the bank's internal measure of borrower risk, and its monitoring behavior.

Our empirical strategy combines two key ingredients that enable us to overcome the econometric difficulties faced in the extant literature. The first ingredient is a unique experimental setting that exogenously reduced the value of a special and widely used type of collateral. The second ingredient is a rich dataset from a major Swedish bank that contains all the records it keeps on file about its entire portfolio of business term-loan contracts, including the loan rate, lending limit, a bank-internal borrower rating, monitoring activity, and regularly updated estimates of the value of the assets pledged to secure each loan.

We study the effects of the change in law using a differences-in-differences method. Specifically, we assign the 3,537 loans, that are observed during 108,368 loan-months in our sample, to an affected, i.e., treated, and a non-treated group. Treated loans are those for which the borrower pledged the bank a company mortgage that is still

outstanding around the change in the law. Importantly for our purposes, we are able to identify the causal relationship from collateral to interest rates because all business term loans carry a quarterly adjustable interest rate while all other contract terms are fixed.

We establish four main findings, which we obtain comparing the same treated loans and borrowers before and after the change in law. First, following the change in the law, the bank reduces the assessed value of the outstanding collateral. For example, the collateral coverage ratio recorded by the bank drops by 4 percentage points on average following the change in the law. Second, the bank reduces its internal credit limit to borrowers with collateralized business loans by 13 percent and downgrades these borrowers by almost 2 notches on a 21-grade scale. Third, the bank increases the interest rate on the same treated loan by 24 basis points. Even after controlling for the reassessment of borrower quality by the bank, the increase in the loan rate is approximately 20 basis points (which, recall from the first finding, corresponds to a 4 percentage point decline in the collateral coverage ratio). Fourth, following the change in the law, the bank significantly reduces the intensity and frequency of its monitoring of the condition of both the collateral and the borrower.

Taken together, these results suggest that collateral is important for the bank and valuable for the borrower. Following a loss in collateral value, the bank charges a higher interest rate on the loan, decreases the availability of credit, worsens its quality assessment of the borrower, and reduces its monitoring efforts of collateral as well as of the borrower. Overall, our findings are consistent with Berger *et al.* (2010), who – even though they do not study the effect of collateral on loan pricing and credit availability − document that collateral serves primarily as a contractual device to solve moral hazard problems. Our evidence also suggests collateral may complement monitoring. This

finding is in line with Rajan and Winton (1995), who claim that collateral can improve lenders' incentives to monitor when the value of the assets pledged is risky.

The remainder of this paper is organized as follows. Section 2 relates our paper further to the literature. Section 3 describes the change in the company mortgage law. Section 4 details the data, variables, and empirical methodology. Section 5 discusses the impact of the change in the law on collateralization, loan rate, borrower limit and internal rating, and bank monitoring effort. Section 6 concludes.

2. Literature Review

a. Collateral and Loan Contracting

An extensive theoretical literature emphasizes the role of collateral as an effective loan-contracting tool aimed at ameliorating information asymmetries in the credit market.[1] Collateral may compensate either for *ex ante* adverse selection (e.g., Bester (1985); Chan and Thakor (1987); Boot *et al.* (1991)) or for *ex post* moral hazard problems (Boot and Thakor (1994)). The two sets of theories offer opposite predictions regarding the relation between the incidence of collateral and the observable quality of the borrower. While *ex post* theories predict that riskier borrowers are more likely to be required to pledge collateral, *ex ante* theories postulate that unobservably safer borrowers pledge collateral. Not surprisingly, the empirical evidence is equally mixed with this respect. Overall, the available evidence seems to suggest that riskier borrowers are more likely to pledge collateral (e.g., Berger and Udell (1990); Berger and Udell (1995); Harhoff and Körting (1998); Berger *et al.* (2010)).

[1] Freixas and Rochet (2008) and Degryse *et al.* (2009) review the theory and the empirical evidence on collateral and bank-firm relationships. Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) model the role of collateral for macro-economic credit cycles. Liberti and Mian (2010) document the importance of collateral for economic development.

A related empirical question that has received much attention recently is the relation between collateral and loan rates. This is a challenging empirical question, since loan contract terms may be determined simultaneously (as was already recognized by Melnik and Plaut (1986) for example). Some studies have attempted to address this concern by estimating models of simultaneous equations (Dennis *et al.* (2000); Brick and Palia (2007); Bharath *et al.* (2007)). Specifically, these studies employ an instrumental variables approach to estimate the effect on the loan rate of a binary measure of collateral, assuming that the relationship between the two variables is unidirectional. Although they employ different U.S. datasets, all three studies find a positive and statistically significant effect of the collateral dummy on the loan rate, which they interpret in light of *ex ante* collateral theories.

b. Collateral and Bank Monitoring

While collateral is often regarded as a contractual device to mitigate a borrower's adverse incentives, a recent literature deals with the agency problems on the lender's side. From the lender's perspective, collateral grants a higher position on the seniority ladder and therefore reduces the lender's expected losses given a borrower's default.

A substantial literature demonstrates that seniority improves a lender's incentives to monitor the firm and liquidate the firm if it gets in financial distress (e.g., Berglöf and von Thadden (1994); Repullo and Suarez (1998); Gorton and Kahn (2000); Park (2000)). Longhofer and Santos (2000) for example show that seniority encourages the formation of banking relationships and thereby improves the banks' incentives to monitor. The intuition for their result is that in bad states the investment in monitoring yields higher returns when the lender is senior. In Park (2000), seniority ensures that the lender appropriates the full return from monitoring when the borrower's moral hazard problem is severe. Rajan and Winton (1995), on the other hand, argue that in the

presence of other claimants monitoring is valuable because it allows the lender to demand additional collateral if the firm is in distress. As a result, collateral should improve a bank's monitoring incentives.[2]

To the best of our knowledge, Ono and Uesugi (2009) is the only other empirical study that attempts to test the relation between collateral and monitoring. Using a survey dataset of Japanese small and medium enterprises, Ono and Uesugi (2009) find that firms that more frequently submit documents to their main bank are less likely to pledge collateral.[3]

We aim to take a step forward in identifying the value of collateralization and its impact on borrower quality and bank monitoring. To this end, we exploit a change in the law affecting the value of collateral as a unique natural experiment and employ a differences-in-differences approach to analyze a dataset containing all business term loans granted by a major Swedish bank. Our empirical analysis in this way combines a unique experimental setting and a comprehensive dataset to overcome the fundamental econometric identification challenge that existing studies have partly left unaddressed.

3. The Swedish Company Mortgage

The company mortgage is a special type of collateral commonly used in Sweden that in many aspects resembles the floating lien in the United States, the floating charge in the U.K., and the chattel mortgage in Australia.[4] Many other jurisdictions recognize

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[2] Manove *et al.* (2001) argue that collateral can weaken the bank's incentive to evaluate the profitability of a planned investment project. We note that while their model focuses on screening incentives, the focus of our empirical investigation is bank monitoring.

[3] Ono and Uesugi (2009) measure the incidence of collateral with an indicator variable. About 72 percent of the firms in their sample responded that they pledged collateral to their main bank. They measure monitoring with an ordinal variable that ranges from one (documents submitted to the borrower once every 1-2 months) to four (documents submitted on an annual basis). In a related study, Argentiero (2009) employs data from Italy to analyze the relation between collateral value and firm screening, measured as the number of bank employees in the lending branch scaled by the loan amount.

[4] In the United States, a lien typically refers to so called non-possessory collateral interests. In many other common-law countries, liens tend to refer to possessory collateral. A chattel pledge typically refers

comparable collateral concepts. Company mortgages and their equivalents in other jurisdictions have been popular as collateral for two main reasons. First, chargees create collateral that covers not only current but also future assets in a pre-defined range. Second, chargors can, to the extent possible, extract contractual benefits from their lenders with the pledged assets while maintaining their freedom to use the assets in the normal course of their business and thus avoiding the inconvenience of requiring permission from their lenders to engage in transactions. Floating charges provide creditors with seniority, but rank behind holders of fixed collateral and claims by some classes of preferential creditors however.

Swedish company mortgages enable businesses to pledge particular categories of personal assets as collateral, with the exception of assets that can be mortgaged otherwise such as real estate and financial assets, i.e., cash, bank deposits, stocks, and bonds. Each mortgage is recorded in an official register maintained by the Swedish Companies Registration Office. The holder of a company mortgage can voluntarily list himself in the register. Registering a company mortgage does not guarantee that nominally sufficient collateral is present in the business. For example, the registration office does not have any responsibility to verify coverage. If a business has registered multiple company mortgages, these mortgages have relative seniority ordering depending on the calendar date of their registration. Businesses pay a one percent annual register fee over the outstanding amount of the company mortgage plus a nominal fee upfront.

Before 2004, company mortgages were *special priority rights* claims that could be invoked by its holder not only in case of a bankruptcy – as is the case with any normal,

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to a security concept where the chattel is brought under the control of the creditor, for example through an approved third-party warehouse. Berger and Udell (2006) report that in 2003 the stock of total asset-based loans in the U.S. was about $300 billion, compared to a stock of commercial and industrial loans of about $900 billion (inclusive of bank asset-based loans).

not legally prioritized claim, as well as with many senior debt claims – but also in the case of distraint, i.e., the seizure of assets by a third party. This special priority right raised the value of the company mortgage versus claims that had: (1) *Normal priority rights*, and hence are ranked below special priority rights, such as costs incurred in bankruptcy or reconstruction procedures, taxes and most of the wage claims by employees (a limited part has special priority rights); or (2) *no priority rights*.

On January 1st, 2004, the Law on Company Mortgages that regulates the company mortgage (henceforth, "the Law") was changed.[5] The special priority rights of the company mortgage converted into normal priority rights and consequently the security interest obtained by means of a company mortgage could only be invoked in the case of bankruptcy. While the group of assets that could be pooled into a company mortgage now also included cash, bank deposits, financial assets, and real estate, the share of total eligible assets was reduced from 100% to 55%.[6] As a result, the company mortgage lost in value in most cases. In fact, the official records of the Parliamentary Committee on Civil Law mention that collateral of lower quality will provide better incentives to banks to assess the profitability of firms rather than the availability of collateral.

Yet, lawmakers did not expect the change in law to result in higher collateralization requirements because these requirements were supposedly at their maximum already.[7] The Swedish Banking Association, however, commented on the proposed change in the law that it expected collateralization requirements to increase, given the key role played

[5] The "Lag (2003:528) om företagsinteckning" replaced the "Lag (1984:649) om företagshypotek".

[6] Other elements of the change in the law were an abolishment of the normal priority rights of the taxes (to give government institutions incentives to cooperate in bankruptcies and reconstructions) and a quantitative reduction of the normal priority rights of wage claims. To compensate for the latter reduction, the government increased the wage amount it guaranteed with public funds.

[7] Lawmakers also did not expect any detrimental effects of the change in the law on start-up firms because primarily more mature businesses in their expansionary phase employ the company mortgage (Source: *Official Documents of the Parliamentary Committee on Civil Law* dealing with the change in the law, Sveriges Riksdag, Lagutskottets betänkande 2002/03:LU17).

by collateral for Basel II capital requirements. The Association also expected interest rate margins to increase.

In principle, the change in the law mainly aimed at improving the possibilities for temporally troubled but essentially solvent and viable businesses to avoid inefficient liquidation by timely reorganization, and at weakening the lenders' incentives to secure collateral rather than to spend effort screening and monitoring the borrowers. However, while abolishing the special priority rights of the company mortgage meant that changes in the composition of assets (during borrower distress for example) would matter less for lenders (by abating the borrowers' incentives to game the assets and assuring lenders their collateral value), any lenders' collateral claim would now require the borrower's actual bankruptcy.[8]

Given the nearly experimental setting this change in the law provides, involving an exogenous and rather sudden loss in the value of all company mortgages, we study its impact on all outstanding loans and a bank's collateralization requirements, loan rates and monitoring intensity.

[8] The 2004 change in the law was mostly "reversed" on January 1st, 2009. Currently lacking the required data, we leave the study of this reversal for future research. Among the economic arguments put forward by the government for this reversal were anecdotic reports that companies found it more difficult to obtain credit, and that credit had become more expensive, especially in the less densely populated areas of Sweden. Many governmental agencies, industry lobbies and legal specialists on the other hand in their solicited written comments on the proposed reversal argued in vain that too little time had passed for a serious evaluation of the 2004 change in the law. The government pushed the reversal arguing that businesses would have more assets available as collateral and thus better access to credit. Worse incentives for lenders to monitor and for borrowers during bankruptcy received only short shrift this time. In fact, the government explicitly expected bankruptcy to become more likely and reorganization less likely. The 2009 change in the law did not only involve a reversal of the 2004 change as it also totally abolished the government's normal priority rights for paid-out guarantees on wage claims. A budget proposal to cover the expected reduction in government revenues in bankruptcy procedures, amounting to 298 million Swedish kroner (about 38 million U.S. dollars in 2009) per year therefore accompanied the change in the law.

4. Data, Variables, and Empirical Methodology

a. Data

For our analysis, we use a unique and comprehensive database containing all corporate accounts of a major Swedish commercial bank (henceforth, "the bank"). The database contains all loan files the bank maintains for each borrower at a monthly frequency between 2003:01 and 2006:12. From this database, we extract all business term loans, i.e., loans with a pre-determined quarterly repayment schedule. Important for our purposes, business term loans can be either secured or unsecured by a company mortgage. Company mortgages can only be pledged to secure this particular type of loan.[9] The loans carry a floating reference interest rate with a mark-up that is adjustable on a quarterly basis. For our purposes, it is important that no other contract feature than the interest rate paid on the loan can be altered in response to a change in collateral values.

We supplement the bank's data with information from the Swedish Companies Registration Office. The Office maintains registered information on all company mortgages pledged in Sweden. The dataset we have access to tracks all company mortgages registered between 2000 and 2008. For each company mortgage, we obtain the date of registration and the amount. The identity of the holder of the mortgage letter is not always known because this information is not required by the Office. However, the holder often provides his identity voluntarily when filing the company mortgage, because it allows for notification when collateral becomes callable.

[9] The internal classification of loans by the bank is such that loans with a variety of fixed collateral make up a range of separate loan categories. Similarly, unsecured credit is also identified separately.

b. Variables

Table 1 describes the dependent variables used in this study and presents some descriptive statistics for each variable: The mean, standard deviation, and number of observations. We analyze three sets of variables. First, we analyze some terms specified in each individual loan contract: The collateral value, the collateral coverage ratio, and the loan rate. The collateral value is the bank's own estimate of the assets pledged to secure that particular loan. The collateral value is updated occasionally as a result of the bank's revaluation of the assets pledged. On average, businesses pledge € 49,950 worth of assets through a company mortgage. The collateral coverage ratio is defined as the collateral value scaled by the exposure (i.e., the outstanding balance) of the loan and equals 46.6 percent on average. The coverage ratio is an important determinant of the lender's recovery rate upon a loan default (Khieu and Mullineaux (2009); Altman and Kalotay (2010)). The average loan rate, computed as the annualized interest rate of the loan, equals 6.57 percent.

Second, we employ two measures of the bank's own assessment of the borrower's creditworthiness. The first is the internal credit rating of the borrower, which ranges from 0 (highest risk category) to 20 (lowest risk category), with a mean of 9.28. Only borrowers with exposure levels above a certain threshold are assigned an internal rating.[10] To circumvent the problem that these ratings are missing for almost 40% of the borrowers in our sample, we first analyze the borrower's internal credit limit, i.e., the maximum exposure the bank is willing to have vis-à-vis each client. As with the internal ratings, this internal limit is reviewed periodically and is generally not directly observable by the borrower. In most cases, the borrower's total exposure is a fraction of

[10] For confidentiality reasons, we cannot disclose what the threshold is. Clients with an exposure below this threshold are assigned a so-called "behavioral rating" which is based on account behavior. We do not have access to the behavioral ratings. Evidence on the importance of indications from account activity for loan pricing is provided by Norden and Weber (2010).

this internal limit. However, in some cases the internal limit equals the borrower's current exposure. Borrowers have an average internal credit limit of € 499,000.

Third, we propose a number of measures of bank monitoring activity. We separate these measures into collateral-based and borrower-based measures. Collateral-based monitoring relates to the revaluation of the assets pledged as collateral, while borrower-based monitoring pertains to the review by the bank of the borrower's condition. In the context of collateral-based monitoring, we further distinguish between monitoring intensity and monitoring frequency. We measure monitoring intensity as the absolute value of the percentage change in the collateral value between two consecutive months. The mean annualized change in collateral value equals 6.05 percent. We presume that larger asset revaluations require more time spent by loan officers in evaluating the assets pledged as collateral. While some infrequent additions or subtractions of collateral could also result in large changes in collateral value, we note that they may also be the consequence of loan officer monitoring and actions.

We also analyze the magnitude of changes in the collateral coverage ratio as an alternative measure of collateral monitoring intensity. If the bank's monitoring incentives of a particular loan are tied to its risk exposure, then monitoring incentives should be tied to the coverage ratio, rather than to the absolute collateral value. The mean change in the collateral coverage ratio is 2.9 percent.

Besides considering the magnitude of the revaluations of the assets pledged as collateral, we also analyze the frequency with which loan officers undertake such revaluations. To this end, we calculate the number of collateral revaluations made per year. As before, we compute this measure for both the collateral value and the collateral coverage ratio. The average number of revaluations ranges between 2 and 2.3, depending on the measure chosen.

Finally, we compute a measure of borrower monitoring based on the frequency with which the bank revises the client's situation. Specifically, we calculate the time to the next review as the number of months until the next planned review date. The time to the next revision is slightly above 10 months but varies widely across firms. The revision outcome may be a change in the collateral value, the loan rate, the internal limit, and/or the internal rating. The revision of the client's situation requires that the loan officer collects and processes new information about the customer. This leads us to hypothesize that more frequent revisions are consistent with a more intensive monitoring effort.

c. Empirical Methodology

We examine the effects of the change in the law using a differences-in-differences approach. This methodology compares the effect of the change in the law on two groups: A group that is affected by the event, which we will call "the treated group", and a group that is unaffected by the event, which is the control group or non-treated group. The differences-in-differences approach then relies on measuring the differential effect of the change in the law across the two groups.

Our identification strategy exploits the change in the law in 2004 that decreased the value of company mortgages. We define the treated group as all borrowers that pledged a company mortgage to the bank before 2004.[11] Since the change in law focused only on this particular type of collateral, we presume that borrowers that never registered a company mortgage during our sample period should not have been directly affected by the new law. Therefore, we assign these borrowers to the non-treated group. We further require that the non-treated borrowers have loans outstanding that originate prior to the change in the law and mature thereafter (relaxing this requirement by including all loans

[11] Recall that the company mortgages dataset we obtain from the Swedish Companies Registration Office starts in 2000.

that are outstanding during the sample period does not alter results). Borrowers that pledged a company mortgage either to any other identified entity or to an unidentified entity were dropped.

To evaluate the effect of the change in law, we estimate the following regression model:

$$y_{it} = \alpha_i + \lambda_t + \beta Treated_i \times After_t + u_{it}, \quad (1)$$

where i indexes loans or borrowers (depending on the specification),[12] and t indexes time, i.e., year*month. The dependent variable is y_{it} and the error term is u_{it}.

The main explanatory variable of interest, $Treated_i \times After_t$, results from the interaction of two terms.[13] The first, $Treated_i$, defines the treated group (as opposed to the non-treated group). Specifically, this dummy indicates whether the firm had a company mortgage pledged to our bank before the new law became effective on January 1st, 2004. This variable captures differences between the treated and non-treated groups before the change in the law.

The second term, $After_t$, equals one for the periods following the change in the law (i.e., 2004:01 to 2006:12), and equals zero otherwise (2003:01 to 2003:12). This variable captures differences for the non-treated group before and after the change in law. To the extent that the change was anticipated, and loan contracts and bank assessments were adjusted prior the effective implementation date, we are likely to underestimate the impact of the change in the law. Nevertheless, in unreported robustness checks we confirm this to be only marginally the case.

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[12] Some firms have more than one loan at the bank so we can use the loan as a cross-sectional unit. We then cluster the standard errors at the borrower level to address the potential correlation between loans belonging to the same borrower (Bertrand *et al.* (2004)).

[13] We cannot include the two variables separately in the specification, because *Treated* is spanned by the individual fixed effects, while *After* is spanned by the time fixed effects.

The variable resulting from interacting the two terms, $Treated_i \times After_t$, measures the differences-in-differences effect. Specifically, it measures the differential effect of the change in the law across firms that had pledged and firms that had not pledged company mortgages.

The model includes both individual fixed effects (α_i) and time fixed effects (λ_t). The inclusion of these fixed effects is crucial to absorb sources of heterogeneity. On the one hand, the individual fixed effects control for time-invariant differences between the treated and non-treated groups. This ensures that our estimates are not plagued by bias due to nonrandom selection into treatment (i.e., a firm's decision to pledge a company mortgage on a particular loan). On the other hand, the time fixed effects control for aggregate fluctuations at the singular bank level.

5. The Impact of the Change in the Law

a. Collateralization, Loan Rate, Borrower Limit and Internal Rating

We start by documenting the effect of the change in law on the borrowers' credit terms. Specifically, we analyze how the exogenous decrease in collateral value following the 2004 change in the law affects the loans' collateral value and coverage ratios, interest rate, as well as the borrowers' internal limits and ratings. Table 2 displays the averages for the non-treated and treated groups, before and after the change in law, for the five aforementioned variables. The table also provides differences of means tests and differences-in-differences estimates. We note that the estimates of these differences can also be obtained by estimating the pooled version of equation (1), where the individual effects (α_i) and time effects (λ_t) are replaced by the $Treated_i$ and $After_t$ variables, respectively. Therefore, when interpreting the differences-in-differences

estimates displayed in Table 2, one should keep in mind that they do not account for unobserved heterogeneity across loans, firms, and time.

Before the change in the law, borrowers that had pledged company mortgages had credit terms that were virtually identical to those of borrowers in the non-treated group. We note that the only difference between the two groups is that the treated borrowers had significantly lower internal ratings.

The differences in means before and after the change in law are difficult to interpret because they are probably capturing economy or bank wide changes that affect both groups. Most interesting is the finding that the 2004 change in the law brought about a significant wedge between the two groups. Specifically, borrowers with outstanding pledged company mortgages experienced a sharp decrease in collateral value, a significant increase in the loan rate, and deterioration in their internal limits.

To further assess the significance of the change in law, we rely on the differences-in-differences estimates shown in Table 3. These estimates are obtained from the model in equation (1), which includes sets of fixed effects for both the cross-sectional (i.e., loans or borrowers) and time (i.e., year*month) units. The results indicate that the value of the assets pledged as collateral by the treated group decreased by 75% on average. Part of this effect is due to a larger reduction in outstanding loan amount for the treated group. However, the decrease in collateral value is sharper than the decrease in the individual loan exposure for the treated group, which translates into a decline in their collateral coverage ratio of more than four percentage points after 2004. Hence, and not unexpectedly, the change in the law is perceived by the bank to result in a loss of collateral value.

The decrease in the coverage ratio caused by the reduction in the value of outstanding collateral increases the bank's expected losses. Consistent with this view,

the treated group also experienced an average 24 basis points increase in their loan rate, a reduction in their internal credit limit by 13 percent and a downgrade in their internal rating by almost 2 levels on a 21-level scale, vis-à-vis the untreated group.

Following the change in the law, we observe a contemporaneous decline in the collateral coverage ratio of about 4 percentage points and an increase in the loan rate by 24 basis points, for the same loan and borrower. However, the change in the value of the company mortgage also affects the borrower limit and the rating. In Table 4 we introduce these internal bank measures of borrower risk as additional control variables in specifications for the 3,491 and 2,083 loans, respectively, for which we have these measures. Controlling for the deterioration in borrower quality ― as assessed by the bank ― slightly lowers the increase in the loan rate after the change in the law, but the impact remains statistically significant and economically relevant (the estimated coefficients on $Treated_i \times After_t$ "drop" from 19 to 18 and from 39 to 33 basis points, respectively).

These estimates suggest that for the same loan contract (and accounting for changes in borrower quality following the change in the law) the bank "charges" the borrower on average around 6 basis points for each percentage point decrease in collateral coverage ratio. This finding is consistent with the observation that collateralization (and the degree of subordination) is a key determinant of recovery on defaulted debt (e.g., Khieu and Mullineaux (2009); Altman and Kalotay (2010)). Consequently, our results suggest that posting collateral may substantially reduce the loan rate at the individual loan contract level.

b. Unaffected Leasing Contracts

In order to test the robustness of our identification strategy, we propose a simple "placebo" test. Specifically, we investigate whether the change in the law has an impact

on other loans in our sample that should not have been directly affected. We select all borrowers in our sample that have leasing contracts outstanding in 2004. Leasing contracts should not be affected by the change in the law, since a leased asset, and not a company mortgage, serves as its security. As a result, the change in the law should not have a differential effect on the loan rates charged to the leasing contracts of the non-treated control and the treated groups.

We estimate this premise using the differences-in-differences model presented in equation (1), which includes both loan and year*month fixed effects. The estimates (not reported) corroborate our empirical strategy, as the differences-in-differences estimate is statistically insignificant and economically negligible.[14]

c. Bank Monitoring

We analyze how the change in a law, which weakened the value of company mortgages, affected the bank's monitoring activities. We analyze the effect of the change in law on the frequency and intensity of the loan officer's revaluation of the assets pledged as collateral and on the frequency of review of the borrower's condition.

Table 5 provides the comparison of the means for the non-treated control and treated groups, before and after the 2004 change in the law, for our monitoring variables. As before, we prefer to assess the economic effect of the change in the law from a specification that controls simultaneously for individual- and time- heterogeneity. Table 6 displays the results of the full model.

The estimates in Table 6 show that following the 2004 change in the law that reduced the collateral value of company mortgages, the bank monitored this collateral

[14] We do find, however, a differential increase in the exposure of these lease contracts for the treated group following the change in law. The decrease in the value of the company mortgages may have pushed some firms to obtain financing through lease agreements. This result corroborates the view that a lease contract is often considered to be a potential substitute for a secured loan (Eisfeldt and Rampini (2009)).

less actively than other types of collateral. This conclusion holds for the two measures of monitoring proposed – frequency and intensity, and regardless of whether we look at collateral value or at the collateral coverage ratio.[15] On the one hand, the change in the law led to a stronger reduction in the intensity of the revaluation of collateral for the treated group than for the control group. The estimated differences-in-differences effect suggests that the change in the law decreased the magnitude of collateral revaluations by 2.5 percentage points.

On the other hand, we observe that the change in the law was followed by a significant decrease in the frequency of the revaluation of the assets pledged as collateral. Moreover, the estimated differential decrease in the frequency of 0.64 revaluations per year is economically meaningful, since the average number of collateral revaluations per year in our sample is 2.02 (Table 1).

Next, we turn to the effect of the change in law on the bank's monitoring frequency of the borrower's condition. The relevant model estimates are shown in the last column of Table 6. After the change in the law, the bank revised less frequently the condition of clients that had pledged company mortgages before 2004 than of clients who had not. On average, the bank revises a client's condition approximately every ten months (Table 1). Our differences-in-differences estimates indicate that after 2004 the bank increased the revision interval by about three weeks for the treated group, as opposed to the control group. This finding confirms a reduction in the bank's monitoring effort following an exogenous decrease in the value of the collateral.

In sum, the intensity and frequency of the bank's monitoring of the condition of the collateral and borrower is reduced as the value of the company mortgage drops. This

[15] To the extent that the amortization schedule of our loan contracts is pre-determined, the decrease in loan exposure over time is mechanical. Moreover, we do not observe changes in amortization plans for the group of loans used in our analysis. Therefore the differential effects we obtain for the collateral coverage ratio cannot be attributed to differential changes in loan exposure across the two groups.

result suggests that a part of a bank's monitoring activities may be collateral-related and that collateral posting not necessarily makes a bank "lazy."

6. Conclusion

Collateral is an important feature of many debt contracts and a feature that has received much attention in the academic literature. However, the intricate nature of collateral such as its joint determination with other contract terms and its impact on borrower and bank behavior imposes steep empirical identification challenges. Moreover, accurate data on collateral values, for example, that would enable researchers to start to address these challenges is typically not available.

Our empirical strategy combines two key ingredients that enable us to make progress in empirically assessing the value of collateral. First, we study the impact of a sudden change in a law in Sweden that exogenously reduced the value of company mortgages. The company mortgage is a commonly used means of collateral to secure credit in Sweden, which is similar to the floating lien in the US, the floating charge in the UK, and the chattel mortgage in Australia. The change in the Law on Company Mortgages was implemented on January 1st, 2004. Second, we have access to a comprehensive dataset from a major Swedish bank that contains detailed information about the loan contracts, including the regularly updated estimates of the value of the assets pledged to secure each loan.

We study the impact of the change in the law on the bank's business loan portfolio using a differences-in-differences approach. Following the change in the law, we find that the bank reduces the assessed value of collateral and contemporaneously increases the interest rate. The bank lowers its internal credit limit to the borrower, and formally downgrades the borrower. However, the intensity and frequency of the bank's monitoring of the condition of the collateral and borrower is significantly reduced.

Our results indicate that collateral is valuable for the borrower and important for the bank. While pledging high-quality collateral enables borrowers to pay lower loan rates and benefit from increased credit availability, our results also suggest that lenders preserve their incentives to monitor the borrower. As a result, collateral enhances the lenders' role as delegated monitors.

Table 1 – Variable definitions and descriptive statistics

The table defines the variables used in the analysis and displays the summary statistics, i.e., the mean, standard deviation (Std. Dev.) and number of observations (Obs.).

Variable	Definition	Mean	Std. Dev.	Obs.
Loan contract				
Collateral value (€000)	Estimated value of assets pledged to secure the loan	49.95	184.15	108,368
Coverage ratio (%)	Collateral value / Loan exposure	46.60	46.54	108,368
Loan rate (%)	Annual interest rate of the loan	6.57	1.51	108,368
Borrower				
Internal rating	Internal rating assigned by the bank to the borrower (0-20)	9.29	3.23	56,696
Internal limit (€000)	Maximum exposure towards the borrower	499.09	2616.09	99,635
Monitoring intensity of collateral				
Change in collateral value (%)	Annualized absolute value of the monthly change in collateral value	6.05	19.83	107,372
Change in coverage ratio (%)	Annualized absolute value of the monthly change in coverage ratio	2.90	13.02	107,372
Monitoring frequency of collateral				
Nr. changes in collateral value	Number of yearly changes in collateral value	2.02	3.04	108,368
Nr. changes in coverage ratio	Number of yearly changes in coverage ratio	2.35	3.97	108,368
Monitoring of borrower				
Time to next review (months)	Number of months to next review of the borrower's situation	10.42	3.20	94,704

Table 2 – Change in law and credit terms: Comparison of means

For each dependent variable, the table displays the averages for the *non-treated* and *treated* loans and for borrowers before and after the change in company mortgage law on January 1st, 2004. *Non-treated* refers to borrowers that never registered a company mortgage in the period 2000-2006. *Treated* indicates that the borrower had a company mortgage outstanding on January 1st, 2004. *After* refers to the period 2004-2006 and *Before* refers to the year 2003. Standard errors (clustered at the firm level) are provided in parentheses. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Before	After	Difference
Ln(1 + Collateral value)			
Non-treated loans	5.96	5.52	-0.44***
	(5.25)	(5.25)	
Treated loans	6.29	5.05	-1.24***
	(4.95)	(4.94)	
Difference	0.33	-0.47	-0.80**
Coverage ratio (%)			
Non-treated loans	48.34	45.71	-2.63***
	(46.2)	(46.7)	
Treated loans	51.22	43.99	-7.23**
	(45.17)	(46.78)	
Difference	2.88	-1.72	-4.61
Interest rate (%)			
Non-treated loans	6.94	6.35	-0.59***
	(1.35)	(1.58)	
Treated loans	7.04	6.79	-0.25***
	(0.97)	(1.06)	
Difference	0.10	0.44***	0.34***
Ln(1 + Internal limit)			
Non-treated borrowers	11.74	11.71	-0.03
	(1.51)	(1.55)	
Treated borrowers	11.73	11.45	-0.28***
	(1.19)	(1.4)	
Difference	-0.01	-0.26**	-0.25***
Internal Rating			
Non-treated borrowers	9.67	9.41	-0.26***
	(2.71)	(3.15)	
Treated borrowers	7.08	6.08	-1.00**
	(4.14)	(4.58)	
Difference	-2.59***	-3.33***	-0.73

Table 3 – Change in law and credit terms: Panel analysis

The table reports the results for regressions of the form: $y_{it} = \alpha_i + \lambda_t + \beta Treated_i \times After_t + u_{it}$, where i indexes loans or borrowers, t indexes year*month, and β is the differences-in-differences estimate of the coefficient on the interaction term of *Treated* and *After*. The dependent variables are defined in Table 1. Robust t-statistics (standard errors are clustered at the borrower level) are provided in parentheses. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Loan			Borrower	
Dependent Variable	Ln(Collateral)	Coverage ratio	Loan rate	Ln(Internal limit)	Internal rating
Treated x After	-0.75***	-4.15***	0.24***	-0.13***	-1.84***
	(-11.39)	(-6.73)	(18.37)	(-12.12)	(-32.28)
Loan fixed effects	Yes	Yes	Yes	No	No
Borrower fixed effects	No	No	No	Yes	Yes
Year*month fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.03	0.01	0.25	0.06	0.05
Number of loans	3,537	3,537	3,537	3,515	2,155
Number of observations	108,368	108,368	108,368	99,635	56,696

Table 4 – Change in law and loan rate controlling for borrower risk: Panel analysis

The table reports the results for regressions of the form: $y_{it} = \alpha_i + \lambda_t + \beta Treated_i \times After_t + u_{it}$, where i indexes loans or borrowers, t indexes year*month, and β is the differences-in-differences estimate of the coefficient on the interaction term of *Treated* and *After*. The dependent variables are defined in Table 1. Robust t-statistics (standard errors are clustered at the borrower level) are provided in parentheses. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable	Loan rate			
Borrower Risk	Ln(Internal limit)		Internal rating	
Independent Variables	(I)	(II)	(I)	(II)
Treated×After	0.19***	0.18***	0.39***	0.33***
	(12.42)	(11.68)	(20.76)	(17.66)
Borrower Risk		-0.09***		-0.03***
		(-19.26)		(-21.87)
Loan fixed effects	Yes	Yes	Yes	Yes
Year*month fixed effects	Yes	Yes	Yes	Yes
R-squared (%)	0.24	0.24	0.33	0.34
Number of loans	3,491	3,491	2,083	2,083
Number of observations	99,635	99,635	56,696	56,696

Table 5 – Change in law and monitoring: Comparison of means

For each dependent variable, the table displays the averages for the *non-treated* and *treated* borrowers before and after the change in company mortgage law on January 1st, 2004. *Non-treated* refers to borrowers that never registered a company mortgage in the period 2000-2006. *Treated* indicates that the borrower had a company mortgage outstanding on January 1st, 2004. *After* refers to the period 2004-2006 and *Before* refers to the year 2003. Standard errors (clustered at the firm level) are provided in parentheses. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Before	After	Difference
Absolute change in collateral value (%)			
Non-treated borrowers	5.58	5.98	0.40*
	(18.81)	(19.79)	
Treated borrowers	9.90	8.50	-1.40
	(25.39)	(23.73)	
Difference	4.32***	2.52***	-1.80
Absolute change in collateral coverage (%)			
Non-treated borrowers	2.65	2.87	0.22*
	(11.68)	(13.31)	
Treated borrowers	4.79	4.28	-0.51
	(15.31)	(16.22)	
Difference	2.14***	1.41***	-0.73
Number of changes in collateral value			
Non-treated borrowers	2.02	1.98	-0.04
	(3.05)	(3.03)	
Treated borrowers	2.68	2.27	-0.41
	(3.10)	(3.15)	
Difference	0.66***	0.29	-0.37
Number of changes in collateral coverage			
Non-treated borrowers	2.52	2.25	-0.27***
	(4.09)	(3.92)	
Treated borrowers	3.09	2.15	-0.94***
	(4.10)	(3.58)	
Difference	0.57**	-0.10	-0.67**
Time to next review			
Non-treated borrowers	11.05	10.22	-0.83***
	(2.71)	(3.30)	
Treated borrowers	9.26	9.61	0.35
	(4.03)	(3.61)	
Difference	-1.79***	-0.61***	1.18***

Table 6 – Change in law and monitoring: Panel analysis

The table reports the results for regressions of the form: $y_{it} = \alpha_i + \lambda_t + \beta Treated_i \times After_t + u_{it}$, where i indexes loans or borrowers, t indexes year*months, and β is the differences-in-differences estimate of the coefficient on the interaction term of *Treated* and *After*. The dependent variables are defined in Table 1. Robust t-statistics (standard errors are clustered at the borrower level) are provided in parentheses. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Monitoring of collateral				Monitoring of borrower
	Change in value		Number of changes		Time to next review
Dependent variable	Ln(Collateral)	Coverage ratio	Ln(Collateral)	Coverage ratio	
Treated x After	-2.52***	-1.22***	-0.64***	-0.84***	0.62***
	(-5.04)	(-3.50)	(-13.75)	(-15.14)	(6.48)
Loan fixed effects	Yes	Yes	Yes	Yes	No
Borrower fixed effects	No	No	No	No	Yes
Year*month fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.001	0.001	0.01	0.04	0.08
Number of loans	3,537	3,537	3,537	3,537	3,406
Number of observations	107,372	107,372	108,368	108,368	94,704

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