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Abstract

The present text is focused on the evaluation of the influence that determinants of loan contracts' design may have on loan renegotiation. This general purpose is faced with the possible simultaneity of determination of some such factors (namely the use of collaterals and loan interest rate) and the likelihood of contract renegotiation. Naturally, this simultaneity corresponds to an issue of endogeneity of these factors within econometric models of the conditional probability of renegotiation. If neglected, covariates' endogeneity causes model misspecification, translating into unreliable empirical assessments of the marginal effects of all renegotiation determinants on the probability of loan redesign. Building on the theory of incomplete contracts, suggesting that the possibility of contract renegotiation is already anticipated at the contracting date, the empirical findings of the paper, based on a dataset provided by a Brazilian bank, provide strong indication that this can indeed be the case. Accordingly, the empirical assessment of the marginal contributions of important variables to the likelihood of renegotiation is revisited, thereby enabling a deeper understanding of renegotiation processes.

Keywords: Loan renegotiation; Contracting costs; Incomplete contracts; Asymmetric information; Endogeneity.

JEL classification : G21, G32, D82, C25, C26.

1 Introduction

In contract theory, one frequent and substantive concern regards the possibility of contract renegotiation. To a considerable extent, this concern is due to an apparent paradox involved in the signing of contracts.⁽¹⁾ On the one hand, when two parties sign a contract, they commit to follow a set of rules. If these rules are changed after the contracting date and before the end of the agreement, the initial commitment loses its meaning. After all, if the possibility of changing the initial contract were allowed for, what would be the financial rationality of signing those initial terms in the first place? Indeed, in this sense, renegotiation is like changing the rules of the game halfway through the match: it simply should not happen. On the other hand, nonetheless, renegotiation is a frequent element that enters debt arrangements and debt relationships, a fact that suggests its practical utility (Roberts, 2015).

In view of this apparent paradox, it is somehow surprising that the empirical literature on renegotiation in private debt contracts is still at an early stage.⁽²⁾ The few studies that attempt to explain the frequency with which these contracts are renegotiated have emphasized *ex post* changes in the firm or in market conditions, as key drivers of renegotiation (*e.g.*, Roberts, 2015; Roberts and Sufi, 2009). One notable exception is provided by Nikolaev's (2017) study, which focuses on *ex ante* determinants and finds that the demand for monitoring due to agency costs and asymmetric information problems plays an important role in explaining renegotiation. The present study, in line with Nikolaev (2017), also examines the *ex ante* determinants of renegotiation of private debt contracts; however, diversely from this study, it is argued here that some of the attributes that somehow cause renegotiation are also determined by the latter's prospect, which, in itself, influences the initial contract design. In other words, a simultaneity issue, amongst the likelihood of renegotiation and some of its associated covariates, should be allowed for in the study of the determinants of debt renegotiation.

⁽¹⁾ See, *e.g.*, Bolton and Dewatripont (2005) for a comprehensive exposition of contract theory.

⁽²⁾ Conversely, the theoretical literature examining the renegotiation process is abundant. See, *e.g.*, Huberman and Kahn (1988a, 1988b), Hart and Moore (1988, 1998, 1999), Bolton (1990), Dewatripont and Maskin (1990), Fudenberg and Tirole (1990), Hermalin and Katz (1991), Aghion and Bolton (1992), Aghion *et al.* (1994), Bester (1994), Maskin and Moore (1999), Gorton and Kahn (2000), Gârleanu and Zwiebel (2009), and Strulovici (2017).

In theory, renegotiation is triggered by changes in the existing environment at the time of signing the contract. It would be the result of Pareto improvements motivated by inefficient *ex post* results, not foreseen at the contracting date (Maskin and Moore, 1999). In this sense, its determinants would be spotted at some point after the initial deal. However, agency conflicts, asymmetric information and holdup problems generate frictions that are present at the time of signing the contract and directly impact its design. For instance, in a debt contract, the borrower, usually better informed than the lender, tends to yield control rights to the lender (Dessein, 2005). As this information asymmetry decreases over time, there is a tendency for these control rights to migrate back to the borrower, through the relaxation of covenants and other control mechanisms, rigidly and purposefully established in the contract (Gârleanu and Zwiebel, 2009). Thus, certain characteristics of the initial contract (in this example, tighter covenants) arise as determinants of a future process of renegotiation of this very agreement. According to this interpretation, the uncertainty that motivates renegotiation is not exogenously determined, and sub-optimal agreements are intentionally signed so that their future renegotiation is inexorable and anticipated by both parties (Huberman and Kahn, 1988a, 1988b).

Recent empirical evidence has confirmed the importance of initial characteristics of the contract, such as interest rate (*e.g.*, Roberts, 2015), collateral (*e.g.*, Nikolaev, 2017) and covenants (*e.g.*, Carrizosa and Ryan, 2017; Wang, 2017), in explaining the high frequency with which debt contracts are renegotiated.⁽³⁾ However, the possibility that some of these attributes are also influenced by the prospect of renegotiation seems to be lacking in these studies. For example, in the model proposed by Gorton and Kahn (2000), the initial rate of the loan is defined considering subsequent costs of the renegotiation process. Decision rights, in turn, are so rigidly defined initially only because they will be renegotiated and relaxed later (Gârleanu and Zwiebel, 2009). In addition, the inclusion of a collateral in debt contracts – another contractual mechanism related to control rights – makes it more likely that a contract is renegotiated (Bester, 1994). Since the contract interest rate spread is jointly set with collateral (Brick and Palia, 2007; Godlewski and Weill,

⁽³⁾ As a matter of fact, Roberts (2015) estimates the impact of the spread – the difference between the contract interest rate and the lender's opportunity cost – on the number of renegotiation rounds of a contract.

2011; Duarte *et al.*, 2016) its inclusion must also be influenced by the renegotiation process.

In view of the above remarks, it seems clear that, in the present study dedicated to the assessment of renegotiation's determinants, particular attention should be devoted to the possibility that either the interest rate spread or collateral requirements (or both) are endogenous explanatory variables in the context of regression models for the probability of renegotiation. If one's major purpose is to assess the impact of the renegotiation's determinants on its probability, then the relevance of such a concern seems clearly warranted by the foregoing considerations.

In so doing, the present study aims at contributing to the extant literature on contract renegotiation in various respects. Firstly, to the best of the present authors' knowledge, this is the first text to consider the influence of the possibility of renegotiation on the initial contract design. This issue is important because, as mentioned, the initial contract can actually be designed with its own subsequent renegotiation in perspective. If a higher probability of renegotiation influences the level of some attributes included in contracts, and this aspect is overlooked in an empirical study, estimates of the latter's impact on the probability of renegotiation can be biased.⁽⁴⁾ As a consequence, substantive conclusions about the relationship between the contract design and the renegotiation process can prove misleading.

Secondly, also to the best of the authors' knowledge, this is the first empirical study on renegotiation that focuses on companies without access to capital markets, as represented by stock exchanges. Previous studies have restricted their attention to publicly listed companies (*e.g.*, Carrizosa and Ryan, 2017; Denis and Wang, 2014; Godlewski, 2015; Nikolaev, 2017; Roberts, 2015; Roberts and Sufi, 2009; Wang, 2017) due to the unavailability of data related to debt contracts of privately held companies. The present study, in turn, accessed a proprietary database (from a Brazilian bank) with information on smaller borrowers, theoretically riskier and with less access to financing options, and, thus, with less bargaining power than larger companies with easy access to stock markets. This aspect seems relevant

⁽⁴⁾ This issue is discussed in the study by Roberts and Sufi (2009), who found no statistical significance for most of the initial attributes of the contract. The Authors claim that this result can be due to the possible simultaneity between the renegotiation process and the initial contract design.

because the process of renegotiation is fundamentally related to the bargaining power of the contracting parties.⁽⁵⁾

Finally, it seems worth noting that the present study examines the renegotiation process of debt contracts outside the U.S. and European business environments – whereas previous studies on renegotiation determinants have used information on these two markets alone (*e.g.*, Carrizosa and Ryan, 2017; Denis and Wang, 2014; Godlewski, 2015; Nikolaev, 2017; Roberts, 2015; Roberts and Sufi, 2009; Wang, 2017). This aspect seems relevant due to the fact that the literature associates renegotiation with the access to alternative sources of financing, which may vary substantially across markets.⁽⁶⁾ For instance, according to the World Bank, in 2015, in Brazil, domestic credit to the private sector amounted to 67.9% of GDP, whereas in the Euro and U.S. areas it reached 88% and 188.8%, respectively.⁽⁷⁾ Since the Brazilian market provides less financing options than the U.S. and European markets, the bargaining power of Brazilian borrowers is possibly lower than that of their American and European counterparts. By focusing on the Brazilian market, the present study sheds light on how the process of renegotiation takes place in a less developed financial market.

The remainder of the paper is organized as follows: the next section surveys the theoretical and empirical literature on the determinants of debt contracts' renegotiation. Section 3 describes the variables, data, and econometric model employed in the study. Section 4 reports and comments on empirical results. Section 5 concludes the paper with some implications and hints for subsequent research.

⁽⁵⁾ One example of how bargaining power influences the outcome of renegotiation lies in the lender's threat to seize the borrower's assets in the event of non-compliance with certain contractual clauses. Although this seizure rarely occurs, the threat ultimately determines the upshot of the negotiation and the course of the managerial actions of the borrower (Huberman and Kahn, 1988a).

⁽⁶⁾ The link between renegotiation and financial sources availability is given by Hart and Moore (1998). In a high cash flow scenario for a financed project, the borrower may be able to renegotiate down the restrictive terms of the contract. But for this improvement to spur and influence renegotiation, the borrower must have alternative options of financing, otherwise the threat to leave the current lender will not be credible (Rajan, 1992).

⁽⁷⁾ World Bank, Global Financial Development, available on <https://data.worldbank.org/data-catalog/global-financial-development> (access date: October 2018).

2 Theoretical Motivation

The literature on the role of renegotiation in the efficiency of contracts can be classified into one of two lines of thought: one first current sees renegotiation as a phenomenon that destroys contractual efficiency; a second line of thought argues that the renegotiation process increases the efficiency of the agreements.

More specifically, the first line of thought claims that renegotiation can only harm the parties involved in a contractual relationship, since it destroys the incentives to fulfill the clauses initially established (Bolton, 1990; Maskin and Moore, 1999). Indeed, if there is any possibility that the contract, and occasional penalties for deviations therefrom, are modified over the relationship, why bother to comply with the original terms? In general, this stream of the literature considers that both parties have unbounded rationality, that is, they are able to foresee all future contingencies that may impact the interests involved and to describe them in detail in the original contract (Hart and Moore, 1988). If, hypothetically, contracts are potentially complete, then any modification in the original clauses can never benefit the agents involved in the relationship – for if the renegotiation outcome were of any use it would simply be written in the initial agreement (Dewatripont and Maskin, 1990). Therefore, a contract will only be efficient if it is renegotiation-proof.

One early study that discards renegotiation when deriving the optimal contract, or that seeks to derive renegotiation-proof contracts, is the article by Bolton and Scharfstein (1990). These Authors propose an optimal financial contract in a context where an investor controls the managerial actions of a borrower by threatening to cut funding in case of poor business performance. In this situation, the renegotiation option is impracticable, since it implies weakening the investor's threat, and thus the incentives for the borrower to maintain a good business management. More recently, Herweg and Schmidt (2015) show that loss aversion makes renegotiation inefficient. In their model, a buyer and a seller specify *ex ante* the quality and price of a commodity to be traded. Thus, any subsequent change will generate a sense of loss for at least one of the parties, who previously developed an expectation that did not materialize because of renegotiation. Strulovici (2017), in turn, proposes a model in which the participants have countless opportunities to

refine a sales contract through exhaustive – and theoretically costless – negotiation rounds. In this context, renegotiation has little to offer in equilibrium, since the main frictions resulting from future contingencies were foreseen and resolved at the negotiation rounds that preceded the initial contract format.

The fact remains that, in spite of the above claim that no renegotiation should occur, renegotiations are frequent in practice (Bolton, 1990; Roberts, 2015; Roberts and Sufi, 2009). Understandably, one alternative line of thought – the ‘incomplete contracts’ theory – has emerged, with the aim of providing a rationale for this seemingly undisputed fact. According to this literature, specifying the precise actions each party must take in every alternative future event involves a prohibitive cost, especially when one considers that the writing of such a large number of contingencies would have to be intelligible to an outside legal authority capable of enforcing the agreement (Hart and Moore, 1988). In other words, even if the parties have unbounded rationality and conceive all possible contingencies, their detailed specification is very expensive, making it economically advantageous to have a mechanism that allows for the modification of the initial terms (as both parties receive information about costs and benefits). The upshot of this reasoning is that contracts are naturally incomplete and that renegotiation helps increase their efficiency by completing the initial agreement (Tirole, 1999).

The present empirical study falls within the second strand of the literature. Incidentally, one should note that the latter is not to be confused with the (close but distinct) ‘implementation theory’, under which renegotiation is largely an out-of-equilibrium phenomenon.⁽⁸⁾ According to this, when two parties sign a contract, they are presumably interested in ensuring Pareto optimal solutions. Thus, an equilibrium outcome of the negotiation will be efficient in the sense that there will be no room for renegotiation (Maskin and Moore, 1999). However, as future contingencies arise, the renegotiation possibility naturally opens up – parties can always discard the original agreement and write a new one, realizing any Pareto improvement (Bolton, 1990). Thus, the determinants of renegotiation would take place at some point after the signature of the agreement. Quite differently, by taking

⁽⁸⁾ Implementation theory is a research area of game theory concerned with finding dominant solutions (in equilibrium) regarding social welfare, within a finite set of possible alternatives (see, *e.g.*, Maskin and Sjöström, 2002).

the renegotiation process as essential to the efficiency of contracts – and therefore envisaged from the outset – the theory of incomplete contracts (*e.g.*, Hart and Moore, 1988, 1999; Tirole, 1999) suggests that the initial design of the agreement indirectly influences its future modifications (*e.g.*, Bester, 1994). In line with this general approach Aghion *et al.* (1994), for instance, propose a contract model already considering, among its initial terms, the way the future renegotiation process will be conducted.⁽⁹⁾ Also, in Huberman and Kahn's (1988a) model renegotiation always occurs and is anticipated by both parties at the contracting date.⁽¹⁰⁾

If one accepts that renegotiation contributes to the efficiency of contracts and, consequently, is already foreseen when the contract is drawn up, two considerations are jointly plausible: i. the original design of the contract impacts the likelihood of renegotiation; ii. the prospect of renegotiation also influences the design of the original contract. In other words, and as a general corollary to the theory of incomplete contracts, one can expect that the likelihood of renegotiation and its attributes are, to some extent, simultaneously determined.

The foregoing considerations naturally suggest the convenience of ascertaining which attributes of the initial contract are more likely to be influenced by the prospect of renegotiation. Using debt contracts as a background, Gârleanu and Zwiebel (2009) suggest that one consequence of this prospect lies in the inclusion of contract clauses that specify the allocation of control rights. Several debt contracts include covenants that impose restrictions upon the borrower and thus effectively transfer control rights to the investor in certain situations (for instance, the firm may be prohibited from issuing new debt if its financial leverage is above a

⁽⁹⁾ Aghion *et al.* (1994) show that the renegotiation design can be quite powerful. The Authors consider a commercial relationship with observable (by the two contracting parties) but not verifiable (by third parties) investments. Efficient investments and risk sharing can be achieved in a variety of situations, assuming that the initial agreement can: i. specify a default option if renegotiation fails or is unnecessary, and ii. assign all bargaining power to either party.

⁽¹⁰⁾ The Authors argue that renegotiation has a strategic role: sub-optimal contracts are initially put in place to protect one party against unwanted actions from another and are renegotiated as soon as the danger has passed. Bank loans offer one example of contracts where some clauses are included not because they will be met but because the threat of imposing them has a strategic function. It is stipulated that assets will be seized by the bank in the event of default but this threat is never accomplished because both parties know that banks are generally less efficient as asset managers than borrowers. Thus, the only purpose of the threat is to prevent the borrower from engaging in opportunistic behavior.

certain level, otherwise the outstanding debt can be called off by investors). The Authors attribute the high renegotiation rate of such contracts to a purposefully excessive rigidity: covenants are only so tight at first because they will inexorably be relaxed later. The reason for this rigidity lies in an information asymmetry issue: better informed than investors about the investment project, entrepreneurs grant control rights to the former in the initial contract, expecting a future reversal. As the information asymmetry decreases over time, these clauses are renegotiated and the same rights are reversed in the direction of entrepreneurs.

In general, the above reasoning suggests that the tighter the covenants the more likely they are to be renegotiated. Actually, the impact of tighter covenants on the likelihood of renegotiation has been empirically verified in previous studies (*e.g.*, Denis and Wang, 2014; Wang, 2017). Nonetheless, by considering that parties know in advance that tighter covenants will necessarily be renegotiated, Gârleanu and Zwiebel's (2009) model suggests that the parties act accordingly, that is, both agree on the inclusion of tight covenants in a contract only if they expect it to be renegotiated. In other words, the greater asymmetry of information leading to a greater number of renegotiations (*e.g.*, Carrizosa and Ryan, 2017) would also induce greater rigidity of covenants.⁽¹¹⁾

Covenants are not the only contractual mechanism available to lenders and borrowers for dealing with information asymmetry. Collateral requirements, for example, play a similar role in the allocation of control rights (Inderst and Mueller, 2007). In a model of loan contracts with information asymmetry between borrower and lender (where the borrower is better informed than the lender about the actual situation and future perspectives of the financed project), Bester (1994) studies the relationship between collateral requirements and the likelihood of renegotiation. This Author argues that renegotiation will occur whenever the relationship reaches a point, stipulated by the initial contract, that is *ex post* inefficient. Since the lender is usually a less efficient business manager than the borrower, the occasional default by the borrower will not always lead to a bankruptcy imposition by the creditor

⁽¹¹⁾ In a similar study, Demerjian (2017) argues that the lack of *ex ante* information (that he calls "uncertainty") motivates the use of financial covenants in private loan contracts. They suggest that these covenants, by transferring *ex post* control rights, provide a trigger for creditor-initiated renegotiation when the borrower proves to be of poor credit quality.

(given that renegotiation will then be a preferred alternative), and both parties are aware of this. In order to prevent the borrower from taking advantage of this weakness of the creditor by means of a strategic default (a situation in which the borrower would decide to stop making payments on a debt, despite having the financial ability to do so), an external collateral will be required. The stronger the collateral the more inclined the lender will be to believe that default is due to real problems with the project, and the more willing to renegotiate. The general conclusion is that collateral requirements make it more likely for loans to be renegotiated. Recent empirical evidence seems to confirm this positive relationship (*e.g.*, Nikolaev, 2017).

In a different model, with symmetric information (the actual performance of the project is known not only to the borrower but also to the creditor), Bester (1994) suggests that the prospect of renegotiation has an impact on the initial contract design. However, this is not related to the frequency of collateral requirements, but to the quality of the collateral pledged.⁽¹²⁾ Taken together, Gârleanu and Zwiebel's (2009) study and Bester's (1994) models, with either symmetric or asymmetric information, suggest, to some degree, the simultaneous determination of collateral requirements in the initial contract and its renegotiation likelihood. Given that future renegotiation is anticipated at the contracting date, a lender should require more collateral to finance those projects he knows less about, later relaxing the terms insofar as further information is disclosed. As a corollary, it is suggested that not only collateral induces renegotiation, but those contracts that are more likely to be renegotiated (due to greater information asymmetry) also induce stronger collateral requirements – a simultaneity effect that does not seem to have been considered in the empirical literature.

In bank loans, the interest rate constitutes one additional attribute that can be influenced by the likelihood of renegotiation. Gorton and Kahn (2000) present a theoretical model of bank loan renegotiation that suggests this hypothesis. Under these Authors' approach, renegotiation is motivated by new information that may

⁽¹²⁾ In the model with symmetric information, Bester (1994) concludes that a collateral is more likely to be used for financing high-risk investments. Following this reasoning, he argues that the renegotiation prospect may seriously undermine the role of collateral as a screening device, given that, if collateralization becomes attractive also for high-risk entrepreneurs, low-risk entrepreneurs can no longer distinguish themselves by posting collateral.

lead the borrower to add inefficient risk to the project, in the absence of changes in the terms of the loan. For example, the financed project sales may be below expectations. In this scenario, if loan conditions are not changed, the borrower may be tempted to replace the assets he initially invested in by other assets with higher expected returns – though riskier ones. Additionally, there is a potential moral hazard on the part of the bank that can hold-up the borrower by threatening to liquidate the project if the assets are replaced – and thus extract a higher interest rate. Here again, both borrower and lender know in advance that there will be renegotiation if new information impacts the project. The result, in the model, is that the initial contract interest rate is the one that minimizes the expected asset substitution after renegotiation rounds. The resulting interest rate should be high enough to satisfy the bank, but not so high as to encourage the replacement of assets by the borrower.

By theoretically relating renegotiation and the initial contract interest rate, Gorton and Kahn (2000) show that the former impacts the latter. However, the relationship between the interest rate and the probability of renegotiation is not evident in the model because the Authors assume that all debt contracts are renegotiated. This assumption is difficult to confirm in practice – although renegotiation is a commonly seen process in debt relationships, it does not occur in all debt agreements. In the case of loans to firms with lower bargaining power, there may even be a limited number of renegotiated contracts. If one considers that renegotiation is not taken for granted, and that – as the Authors assume – the interest rate influences the renegotiation outcome, it makes sense to hypothesize that there is a simultaneity issue between the likelihood of renegotiating a contract and its interest rate. Nonetheless, the sign of this relationship is trickier to predict. Gorton and Kahn (2000) argue that the initial loan rate is set not to price the risk of default – in which case, there would probably be a positive relationship between loan pricing and renegotiation likelihood (assuming that default is a main *ex post* trigger for renegotiation). However, these Authors show that the initial loan rate is set so as to minimize the costs associated with moral hazard and renegotiation. In other words, the higher the interest rate the higher the costs associated with renegotiating a contract. Higher costs could, in turn, reduce the bank's willingness to renegotiate the debt.

3 Variables and Data. Econometric Model.

3.1 Variables and Data

The proprietary database used in the present study, provided by a Brazilian bank, contains information on whether each particular loan has been renegotiated or was amortized under the terms originally established in the contract. The dependent variable of interest in the study follows the classification issued by the bank, taking a value of one if a contract was renegotiated and zero otherwise. In what regards explanatory variables, these are listed in Table 1, which also displays a brief description of each covariate's computation.

Two important variables in the present study are *Spread* and *Collateral*. *Spread* is computed as the difference between the interest rate originally defined in the agreement and the Brazilian interbank market interest rate traded at the contracting date. *Spread* is considered a better measure of the loan pricing than the interest rate itself because the interbank market interest rate constitutes the lower bound below which no loan is granted, and over which banks have no control. This choice follows the recent empirical literature on renegotiation (*e.g.*, Carrizosa and Ryan, 2017; Roberts, 2015). *Collateral*, in turn, denotes a binary variable equal to one if the loan has an associated collateral and zero otherwise.

Besides *Spread* and *Collateral*, two other important attributes of the contract, also controlled for, are the loan maturity (covariate *Maturity*) and the loan value weighted by the borrower's total assets (denoted as *Loantosize*). The natural logarithm of *Maturity* is used due to a requirement of the estimation method, as described in Section 3.2; the loan amount is weighted by the borrower's total assets so as to avoid the expected correlation with the size of the firm (represented by the covariate *Size*).⁽¹³⁾

In addition to the main attributes of the initial contract, the study also uses, as control variables, proxies for some factors that supposedly influence the probability of future renegotiation at the contracting date. These factors are: i. the

⁽¹³⁾ This approach is in accordance with previous empirical studies regarding renegotiation determinants (*e.g.*, Roberts, 2015; Roberts and Sufi, 2009).

firm's financial health; ii. differences in the firms' life cycle; and iii. the borrower's degree of uncertainty.

Table 1
Definition of Explanatory Variables

Variable	Description
<i>Spread</i>	Loan interest rate – Brazilian market interest rate
<i>Collateral</i>	= 1, if the loan has collateral attached, 0 otherwise
<i>Maturity</i>	Natural logarithm of the number of days between origination and stated maturity date
<i>Loantosize</i>	Loan amount/Borrower's total assets
<i>Debttoassets</i>	Total debt/Total assets
<i>Liquidity</i>	Cash and equivalents/Total assets
<i>Size</i>	Bank's internal classification: 1. Micro and small firms; 2. Medium firms; 3. Large firms
<i>Yearsold</i>	Number of years between creation of the firm and contracting year
<i>ROA</i>	Net income/Total assets
<i>Score</i>	Firm's credit score attributed by the bank
<i>BRLtosize</i>	Maximum borrowable amount/Total assets
<i>Restriction</i>	= 1 if there is some restriction about the firm, 0 otherwise
<i>Loss</i>	= 1 if the firm reported a negative profit previously to the loan year, 0 otherwise
<i>GDPgrowth</i>	Real economic growth forecast about the firm's sector for the contracting year

Except for the case of strategic default, the fulfillment of a loan agreement fundamentally depends on the borrower's financial health, that is, its ability to honor repayment of the loan. This concern is evinced in the covenants that establish minimum liquidity and maximum financial leverage thresholds (see, *e.g.*, Gârleanu and Zwiebel, 2009). Thus, the borrower's financial health at the contracting date may be related to the probability of future renegotiation insofar as it allows for future occasional financial stress problems. Financial health measures are employed to assess the firm's ability to honor loan repayments. To this effect, two variables are used: *Debttoassets*, as a proxy of the financial leverage, and *Liquidity*, which captures the firm's short-term liquidity.

Differences in the firms' life cycle, in turn, indirectly capture the borrower's bargaining power, another attribute intrinsically related to the renegotiation process (Huberman and Kahn, 1988a). *Ceteris paribus*, more mature firms have *a priori* more bargaining power (Hart and Moore, 1999). The differences in the firms' life cycle are represented by three covariates. The variable *Size* controls for differences in the firm's size according to the bank's internal classification (small, medium, and large firms). Although nothing prevents firms from starting off large – or to stay small through time – they can reasonably be expected to grow over time. The covariate *Yearsold* denotes the firm's age, which serves as an indication of its operational resilience and reputation. It is assumed that the older a firm the more advanced it is in its life cycle. In view of the usual observation that a stable and more modest return on assets is usually observed in firms at a more advanced lifecycle stage, the return on assets (*ROA*) is also considered to proxy firms' life cycle stage – in accordance with, *e.g.*, Nikolaev (2017). Although the use of the covariates *Size* and *Yearsold* is novel in the empirical literature on renegotiation, they are considered here because both are plausible proxies for a firm's life cycle stage.

The relationship between the borrower's degree of uncertainty and renegotiation is suggested by the incomplete contracts theory. As noted in Section 2, according to this theory, specifying the actions to be taken in each alternative future scenario is economically prohibitive; hence the renegotiation is a natural mechanism for completing the contract. Thus, the degree of uncertainty related to the borrower's future alternative scenarios at the contracting date may influence the probability of renegotiating the loan. Previous studies have used, as *proxies* for uncertainty, measures of the stock market like stock volatility and price-to-book ratio (*e.g.*, Nikolaev, 2017; Roberts, 2015). Given that the present study deals with small and medium sized unlisted firms, it is impracticable to replicate these same measures. Five variables are employed instead, so as to capture the uncertainty surrounding borrowers. *Score* denotes the credit risk score assigned to the firm by the bank. As such, it captures the expectation of future renegotiations triggered by firms' default probability, as gauged by the bank. The ratio between the maximum amount the firm can borrow from the bank (the so-called "broad risk limit", or BRL) and its total assets is referred to by the variable *BRLto size*, one other measure of the firm's default risk. The higher this variable, the stronger the bank's confidence on

the borrower's future results. The dummy variable *Restriction* informs whether the firm has some type of restriction recorded in the bank's systems at the contracting date – in this sense, it is a red flag warning. The dummy variable *Loss* indicates whether the firm has reported a negative profit in the year preceding the contracting date. Finally, the variable *GDPgrowth* denotes the forecast, at the contracting date, of the real economic growth of the firm's sector for the contracting year (agriculture, industry, or commerce and services). The lower the expected economic growth, the higher the uncertainty for the firm operating in the respective sector.

The dataset used in the present study was made available under a confidentiality condition on the financial institution and clients' identity. Loan agreements funded by government subsidies were dropped from the sample (in these loans the interest rates and collateral requirements are not defined by the bank but by government agencies). Given the purpose of the present study the restriction of the sample to loans funded with depositors' money seems more appropriate. Indeed, these are the sole kinds of loans on which the bank fully exerts its decision-making power regarding the initial contract design. As a result, the sample comprises 11,491 loan agreements with 4,360 firms, signed and settled between January 2007 and December 2016.

Table 2 displays descriptive statistics for all variables. The GDP growth forecast by economic sector (*GDPgrowth*) data were accessed at the Brazilian Central Bank website.⁽¹⁴⁾ The remaining variables were only computed with bank data. The sample percentage of loans that were renegotiated equals 13%. This percentage is inferior to that verified in previous empirical studies focusing on large companies, a fact that may suggest that smaller firms have less bargaining power.⁽¹⁵⁾ Although the range between maximum and minimum interest rate spreads in the sample is considerable, 93% of the loans have spreads within one standard deviation from the mean (between 4.4% and 18.2%). The average interest rate spread of 11.3% may seem high when compared to international standards but, actually, it can be considered modest in the Brazilian context. This means that, in general, the bank

⁽¹⁴⁾ Data available at <https://www.bcb.gov.br/?SERIESTEMP> (Accessed May 2018).

⁽¹⁵⁾ For example, in Roberts and Sufi's (2009) sample, 75% of contracts are renegotiated. However, their study comprises only loans to publicly listed companies.

considers the firms' credit risk to be low – which agrees with the average score of 9.23 attributed to the firms (on a 0–10 scale). In the sample, 29% of the loans have some associated collateral, while the remaining 71% have only personal guarantees. This is a result of the bank's credit policy, requiring collateral only in the case of riskier borrowers. The average stated loan maturity is 633 days. The average loan value is R\$ 422,000, which represents about 5% of the firms' average total assets. The value of the credit limit granted by the bank to borrowers is more substantial, corresponding to 29% of the firms' total assets.

Table 2
Descriptive Statistics

Variable	Mean	Median	Std. Dev.	Min.	Max.
<i>Reneg</i>	.13	.00	.34	.00	1.00
<i>Spread (%)</i>	11.30	10.06	6.89	.47	142.16
<i>Collateral</i>	.29	.00	.45	.00	1.00
<i>Maturity</i>	6.33	6.59	.55	3.00	7.68
<i>Loantosize</i>	.05	.03	.36	.00	35.26
<i>Debtt/assets</i>	.50	.48	.44	.00	31.35
<i>Liquidity</i>	.14	.06	.19	.00	1.00
<i>Size</i>	1.71	2.00	.51	1.00	3.00
<i>Yearsold</i>	13.60	12.00	11.45	-10.00	114.00
<i>ROA</i>	.19	.12	.48	-32.35	8.98
<i>Score</i>	9.23	9.23	.73	.00	10.00
<i>BRLtosize</i>	.29	.21	.68	.00	49.43
<i>Restriction</i>	.64	1.00	.48	.00	1.00
<i>Loss</i>	.07	.00	.26	.00	1.00
<i>GDPgrowth</i>	2.46	2.40	2.61	-6.21	11.00

In general, firms in the sample have at least half of their capital structure financed by equity, which confirms the overall low risk credit profile. Of total assets, 14% are held as cash or cash equivalents. According to the bank's internal classification, most of the firms in the sample are micro- and small-sized (47%) as well as medium-sized (52%). Firms considered large by the bank account for less

than 2% of the total. On average, the firms are 13.6 years old. The *ROA* averages 19%, and only 7% of the sampled firms exhibit a negative profit in the year prior to the contracting date. This, in spite of the fact that 64% of the firms present some type of restriction at the contracting date.⁽¹⁶⁾ Expectations related to economic growth in the firm's sector vary substantially over the sample period, from severe downturn (up to expected 6.2% negative growth) to euphoria (expected 11% positive growth).

3.2 Econometric Model

The starting point of the present empirical enquiry consists on the adoption of a binary-choice regression model, formalizing the decision of whether or not to renegotiate a loan contract, as a function of covariates. Write this model as

$$Reneg_i = \mathbf{1}(X_i\beta + u_i \geq 0), \quad (1)$$

where *Reneg* represents a binary variable equal to 1 if the loan was renegotiated prior to stated maturity, and 0 otherwise, *X* denotes the vector of covariates, as described in Table 1, β represents an unknown parameter vector, *u* denotes an unobserved error term, and $\mathbf{1}(\cdot)$ is an indicator function equal to 1(0) if the inner condition, $X_i\beta + u_i \geq 0$, is true (false). The observational index *i* refers to each individual loan contract. The error, *u*, is assumed to follow a normal conditional distribution, which, as is well known, yields a Probit model for the conditional probability of renegotiation. Formally,

$$\Pr(Reneg_i = 1|X_i) = \Phi(X_i\beta), \quad (2)$$

where $\Phi(\cdot)$ denotes the standard normal distribution.

As mentioned before, theory suggests that the design of the contract can be influenced by the prospect of its future renegotiation. If this is the case, then one is faced with an issue of simultaneity of the occurrence of renegotiation and some of its determinants, such as *Collateral* and *Spread* – under which, estimation of the Probit model by conventional methods (neglecting covariates' endogeneity) yields biased estimates of its parameters. Hence, in order to account for this possibility and

⁽¹⁶⁾ These restrictions vary greatly about their potential impact on renegotiation probability. It may be a flaw in the financial statements presented by the firm or simply a lack of phone number in the registration form. There was not a refinement in this respect because of a lack of information about how the bank differentiates the various types of restrictions.

obtain consistent estimates of the covariates' marginal effects on the probability of renegotiation, an instrumental variables-type (IV) method is required.

In binary choice models with endogenous regressors, IV estimation of linear probability models, control functions (CF) and maximum likelihood (ML) estimators are traditionally employed (see, *e.g.*, Wooldridge, 2010, Sec. 15.7) – but they all have drawbacks. A common problem with the linear probability model is that, in spite of its simplicity, it can easily yield unacceptable predictions, like negative or greater than one probabilities of the occurrence of the event of interest. In addition, estimates of partial effects can have incorrect signs. CF estimators, in turn, are usually consistent only if the endogenous covariates are continuous (*e.g.*, Lewbel *et al.*, 2012) – since *Collateral*, possibly endogenous in model (1), is a binary regressor, CF should be avoided. The ML estimator can be fully efficient, allowing for endogenous covariates to be discrete. However, ML requires a complete parametric specification of how each endogenous covariate depends on instrumental variables and on errors, a voluminous amount of information that is difficult to be correctly specified.

In view of the above, the present study utilizes the Special Regressor (SR) estimation method, originally proposed by Lewbel (2000) and with a step-by-step procedure described in Dong and Lewbel (2015). The simplified version of the SR estimator arguably overcomes the above drawbacks associated with alternative methods. It provides consistent estimators of the model's parameters without requiring endogenous covariates' distributions to be specified, or even continuous, and it does not suffer from computational difficulties. In addition, SR allows for heteroscedasticity of unknown form (Dong and Lewbel, 2015). The only prerequisite of the SR method is the inclusion in the set of covariates of an exogenous regressor, termed “special regressor”, conditionally independent of u and continuously distributed with large support. In the present study, one such regressor – denote this as V – can be found in loan maturity (*Maturity*), arguably exogenous and continuous. Since a special regressor with thick tails (greater than Normal kurtosis) is more useful (Baum, 2012), the logarithm of Maturity is used, so as to produce such a covariate. The SR estimator proposed by Dong and Lewbel (2015) is easily implemented with the econometric software Stata (Baum, 2012).

The endogeneity of *Spread* and *Collateral* in model (1) can be tested through a Hausman-type test. The null hypothesis associated with this test is consistency of both the ML estimator of the Probit assuming covariates' exogeneity (henceforth referred to as Probit-ML) and the SR estimator (consistent under exogenous and endogenous regressors alike). As is well known, standard implementation of the Hausman test requires estimation of the variance the difference between both estimators; in the present study, the bootstrap is used to this effect (see, *e.g.*, Cameron and Trivedi, 2009, section 13.4). Rejection of the null hypothesis suggests that either *Spread* or *Collateral*, or both, are endogenous, in which case Probit-ML is not reliable and the SR estimator should be preferred.

Naturally, at this point, one should mention which variables are employed as instruments for *Spread* and *Collateral*, in SR estimation. These instrumental variables are, respectively, the Brazilian interbank market interest rate (*Selic*) and the natural logarithm of firm's total assets (*Assets*). The choice of the former evinces the fact that the Brazilian monetary policy affects the price of credit (*e.g.*, Koyama and Nakane, 2002) but it is not supposed to affect directly the probability of renegotiation. The interbank market interest rate was also used in previous empirical studies instrumenting loan interest rate spreads (*e.g.*, Duarte *et al.*, 2016). Following Roberts and Sufi (2009), the choice of instrument for *Collateral* is based upon the assumption that book assets capture the firm's ability to secure or collateralize its debt without directly affecting the renegotiation prospect.

Section 4 presents the results of appropriate Hausman tests, as well as the empirical estimates of the partial effects of renegotiation determinants on the probability of renegotiation. The differences found in this regard, statistically supported by the results of the Hausman tests, can be taken as a strong hint that the possible endogeneity of *Spread* and/or *Collateral* in models of renegotiation should not be neglected when one wants to correctly assess the marginal effects of these, and other, covariates on the probability of renegotiation.

4 Empirical Results and Discussion

Table 3 summarizes the results of the Hausman tests. Each of the corresponding null hypotheses, that each of the covariates *Spread* and *Collateral* is exogenous, is

rejected at the 1% significance level. These findings suggest that these variables are endogenous covariates in the renegotiation probability model, so the Probit-ML estimator does not appear to be reliable.

Table 3
Hausman test – Probit-ML vs. Special Regressor

Variable	Test statistic	Bootstrap <i>p</i> -value
<i>Spread</i>	10.35	.001***
<i>Collateral</i>	21.25	≈ .000***

***: statistical significance at 1%.

Table 4 displays estimated average partial effects (APEs) under several variants of the model, produced by both SR and Probit-ML estimation. Following the usual practice, the SR (or Probit-ML) estimated APE of each covariate on renegotiation probability is computed as the average, across all sample contracts, of the partial derivative of (2) (with respect to the covariate in question), evaluated at each individual contract's regressor vector and SR (or Probit-ML) β estimates. Four model specifications are considered in this table: the first set of results (model *A*) refers only to initial contractual attributes as explanatory variables; the second specification (*B*) controls for financial health measures of the firms in the sample; the third specification (*C*) also includes differences in firms' life cycle stage; finally, the fourth specification (*D*) is the most complete, controlling also for borrowers' uncertainty.

The contents of Table 4 evince several differences in the results produced by the two estimation approaches. One striking difference regards the relationship between *Collateral* and the probability of renegotiation. Under SR estimation, the corresponding estimated marginal effect is negative (and statistically significant) across all four specifications considered. This means that, *ceteris paribus*, the presence of collateral requirements in the initial contract lowers the probability of its subsequent renegotiation – a result that disagrees with the prediction from Bester's (1994) model with asymmetric information, under which the presence of collaterals increases the likelihood of renegotiation (see Section 2). One should stress, at this point, that this Author's conclusions do not explicitly consider the potential simultaneity of collateral requirements in the initial contract and the

likelihood of its renegotiation. Incidentally, and somehow expectably, under P-ML estimation (neglecting this simultaneity), this relationship is estimated to be positive (as in previous empirical studies – *e.g.*, Nikolaev, 2017 – who, as well, does not take into account the possible renegotiation-collateral simultaneity). Naturally, this contrast between the SR and P-ML estimates is in accordance with the outcome of the Hausman test (Table 3), indicating the likely endogeneity of *Collateral* in model (1).

Table 4
Average Partial Effects of Renegotiation Determinants

Estimation Methods: Special Regressor (SR) and Probit-ML with Exogenous Covariates (P-ML)

Model <i>Covariate</i>	<i>A</i>		<i>B</i>		<i>C</i>		<i>D</i>	
	SR	P-ML	SR	P-ML	SR	P-ML	SR	P-ML
<i>Spread</i>	-.017***	-.002***	-.018***	-.001***	-.016***	-.002***	-.014***	-.001**
<i>Collateral</i>	-.220***	.025***	-.256***	.020***	-.224***	.026***	-.184***	.023***
<i>Maturity</i>	.094***	.149***	.081***	.150***	.071**	.145***	.051**	.135***
<i>Loantosize</i>	-.146***	-.013	-.143**	-.031***	-.138**	-.024	-.162**	.034**
<i>Debttoassets</i>			.022***	.036***	.014**	.049***	.011*	.051***
<i>Liquidity</i>			-.043***	-.067***	-.040***	-.071***	-.013**	-.067***
<i>Size</i>					.003*	-.028***	-.006	-.022***
<i>Yearsold</i>					-.000***	.002***	-.000	.001***
<i>ROA</i>					-.009	.026***	-.009*	.029***
<i>Score</i>							-.034***	-.005
<i>BRLtosize</i>							.029**	-.046***
<i>Restriction</i>							.001	.087***
<i>Loss</i>							-.015**	-.020*
<i>GDPgrowth</i>							-.003***	-.012***

*/**/***: Statistical significance at 10%/5%/1%, respectively. Bootstrapped standard errors computed for the SR estimator.

A negative relationship between collateral requirements and probability of renegotiation can be explained by a traditional strand of the literature that describes collateral requirements as an incentive or screening device (*e.g.*, Besanko and Thakor, 1987; Bester, 1985). According to this line of thought, collateral requirements enhance the punishment due to default, leading to a negative relation between the collateral pledged and the default risk (the higher the amount of

collateral, the lower the default risk). Following this rationale, if one considers default as a main *ex post* trigger for renegotiation, then, likely, *Collateral* can indeed reduce the *ex ante* probability of renegotiation.

In what regards the covariate *Spread*, its marginal effect on renegotiation probability is estimated to be negative across all four specifications in Table 4, under both SR and Probit-ML estimation. Nonetheless, in spite of a common negative sign of the various estimates, their magnitude differs under each estimator: estimates are considerable under SR estimation but close to zero under P-ML. A close to zero marginal effect of *Spread* on renegotiation probability is in line with previous empirical studies that have found no relationship whatsoever between the two variables (*e.g.*, Roberts and Sufi, 2009). However, again it should be noted that these studies do not take into consideration the possible simultaneity between renegotiation probability and some characteristics of the initial contract. Arguably, if such simultaneity occurs, Probit-ML estimates of marginal effects are not reliable. The finding of a negative estimated marginal effect of *Spread* can be considered in accordance with Gorton and Kahn's (2000) model, who show that the contractual loan rate is set, not to price the risk of default, but to minimize the costs associated with renegotiation. These costs are related to a risk of asset substitution: the borrower may feel tempted to replace the original financed assets by riskier ones (though more profitable, from a borrower's point of view) in the renegotiation. A higher interest rate could prevent this behavior and thus reduce the likelihood of renegotiation.

The sign of the marginal effect of *Maturity* does not seem to be affected by the consideration, or not, of endogenous covariates. In line with previous empirical evidence (*e.g.*, Godlewski, 2015; Roberts, 2015), it is estimated to be significant and positive under both estimation approaches. A positive sign for *Maturity's* marginal effect seems natural because the longer the loan maturity the more frequent the opportunities for questioning the terms of the contract. The sign of the estimated marginal effect of *Loantosize*, in turn, is consistently negative only when endogeneity is taken into account (SR estimator). Given that this covariate is a ratio between loan value and the firm's total assets, it captures the firm's credit risk (low-risk firms get larger loan amounts relative to their size) – which helps explain the finding of a negative relationship. This result is at odds with Roberts' (2015) study,

who obtains a positive sign for this variable's marginal effect. Nonetheless, the Roberts' (2015) result should again be viewed with caution because of possible endogeneity neglect. With P-ML estimation, *Loantosize* is statistically irrelevant under specifications *A* and *C*, negatively related to renegotiation probability in model *B* and positively related in *D*. Again, these differences in the estimated effect of one of the main contractual attributes can be additional indication of the suspected unreliability of the P-ML estimator.

The estimated marginal effects of financial health measures (*Debttoassets* and *Liquidity*) are similar across the four specifications, regardless of the estimation method. The marginal effect of financial leverage (*Debttoassets*) is estimated to be positive, in line with the result obtained by Roberts (2015). Short-term liquidity (*Liquidity*) exhibits a negative relationship with the renegotiation probability, in line with Nikolaev's (2017) findings. Taken together, the marginal effects of these two proxies confirm the expected negative relationship between a firm's financial health and the probability of renegotiating its loan.

Substantial differences between the two sets of estimates are again found with respect to measures capturing firms' life cycle stage. Under specification *C*, allowing for *Collateral* and *Spread* endogeneity (SR estimation), *Size* has a positive significant estimated marginal effect but this relationship turns to negative if all the variables in the model are taken as exogenous (Probit-ML). When controlling for borrower uncertainty (specification *D*), the marginal effect of this variable loses significance in the SR case, contrarily to a significant negative estimate under Probit-ML. The covariate *Yearsold* also loses significance under SR estimation (as opposed to Probit-ML positive significant estimates under models *C* and *D*). *ROA* has a positive and significant estimated marginal effect under models *C* and *D* and Probit-ML, but it is not significant with SR estimation under model *C*, and negative under model *D*. A negative estimate is in line with Nikolaev's (2017) results.

Estimates of marginal effects of the variables related to uncertainty involving borrowers also exhibit substantial differences, when one considers *Collateral* and *Spread* as endogenous or exogenous attributes. For instance, *Score* is estimated to have a negative significant marginal effect under SR estimation, whereas, under Probit-ML, this variable is estimated marginally irrelevant. A negative sign for this variable's effect is explained by default risk: the higher the *Score* the lower the

default risk and, also, the renegotiation probability. The marginal effect of *BRLtosize* is estimated to be positive when endogeneity is considered and negative otherwise. The positive sign of the SR estimates is easier to justify because this variable is another measure of borrower's risk (see Section 3.1). The estimated marginal effect of *Restriction*, in turn, also varies with the estimator, irrelevant under SR but significant and positive under Probit-ML.

The last two proxies for borrower's uncertainty, *Loss* and *GDPgrowth*, exhibit the same significant and negative relationship with renegotiation probability under both estimation methods. A negative sign for *Loss* is at odds with Nikolaev's (2017) results for the same variable, however. This result can be explained by an incentive perspective: a negative profit constitutes a red flag that may encourage the firm to improve its later performance and thereby reduce the likelihood of renegotiating the loan. Finally, the negative relationship between the economic growth forecast for the firm's sector (*GDPgrowth*) and renegotiation probability is naturally explained by the association between economic optimism and a lower level of uncertainty concerning the borrower's investments, which in turn leads to lower probability of loan renegotiation.

5 Concluding Remarks

The renegotiation of debt contracts has been widely scrutinized by contract theory but the empirical verification of some of this literature's predictions has somewhat lagged behind. In particular, one insight that indirectly stems from this theoretical literature seems to have been ignored by empirical studies: that not only the likelihood of renegotiating a loan contract is influenced by the latter's initial characteristics but, also, that the very possibility of contract renegotiation impacts its initial design. The present paper tries to fill this gap in the empirical literature, by assessing the impact of the determinants of debt renegotiation in a context of possible simultaneity of determination of a contract's features and its own renegotiation likelihood.

Building on the theory of incomplete contracts – which suggests that the possibility of renegotiating a debt contract is already anticipated at the contracting date – the empirical findings of the present paper provide strong indication that this

can indeed be the case. In particular, judging from the obtained results of SR and Probit-ML estimators (and corresponding outcomes of Hausman tests), one tends to suspect that the interest rate spread and collateral requirements of loan agreements, as well as their renegotiation likelihood, are, quite possibly, simultaneously determined. As is well known, under linear and nonlinear models alike, this simultaneity issue needs to be appropriately accounted for, in order to consistently estimate marginal effects of all the covariates on the dependent variable of interest. For instance, as suggested by present results, the relationship between the use of collaterals and the probability of contract renegotiation appears to be negative – contrarily to the results obtained in previous studies which neglect the simultaneity issue.

By explicitly accounting for the above issue, the present text contributes to the extant literature on loan renegotiation, offering a seemingly reliable assessment of the impact of contracts' characteristics on the probability of renegotiation. Presumably, the access to more comprehensive databases, involving also listed companies, usually larger and with a greater bargaining power than the ones used in the present sample, may produce more compelling conclusions about these important measurements. In any event, to the extent that it deals with substantive questions regarding the determination of the renegotiation probability and some of its drivers, the present enquiry offers a renewed perspective on this subject, presumably useful for subsequent studies on contracts' redesign.

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