Collateral in Corporate Financing*

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Abstract

This paper presents a control theory of collateral. Collateralization of an asset partly takes away the entrepreneur's control over the asset by preventing its value-enhancing restructuring. Prohibiting restructuring has an ambiguous effect on the value of the lender's claim: it decreases the claim's value by increasing the probability of default but reduces the lender's loss given default. Only assets that have a favorable relation between these two effects are suitable collateral assets. In particular, characteristics that imply a high financing capacity do not necessarily make assets suitable as collateral, because the high financing capacity may be conditional on the asset not being collateralized. Assets of high specificity and those lacking fungibility as well as core assets tend to be ill suited as collateral.

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1 Collateral in Corporate Financing

A significant fraction of the debt issued by corporations is collateralized. For example, studies by Berger and Udell (1990), Harhoff and Körting (1998), and Nguyen and Qian (2012) find that, on average, 70 per cent of the loans from financial institutions are secured. Rauh and Sufi (2010) report that secured debt makes up for 15 per cent of the capital structure of non-financial firms. Collateral creates an interest over certain assets to secure the performance of the debt obligation.

Collateral is often considered as a right that creditors have to an asset in the event of default. If the borrower defaults, rather than having their claims met by the pool of the company's assets, lenders appoint a receiver or foreclose to discharge the liability that the asset secures.[1] For that reason, collateral establishes a definitive priority to specific assets.

However, the extent of the rights included in collateral pledges goes beyond the instance of default, and covers the life of the asset while in possession of the borrower. Typically, the asset cannot be sold to a third party, moved to a different location, used for another purpose, refurbished and transformed without the protection or consent of the lender.[2] These restrictions aim at making the loan secured by protecting the asset from the actions of the borrower. Accordingly, a collateral pledge gives the lender a *de facto* control right over a specific asset, which is – due to its legal status – stronger than commitments inscribed in bond indentures.

The practice of pledging assets to lenders as a facet of corporate financial policy has received modest attention in academic circles. In the empirical literature, the vast majority of studies look at the value of collateral purely from the perspective of the lender if default happens. This focus explains the importance attributed to characteristics such as tangibility, redeployability and general usability (non-specificity).[3] For example, Campello and Giambona (2012) find that tangibility matters to the firm's capital structure for assets that are redeployable, and Berger, Ofek and Swary (1996) associate tangibility with how the book value of physical assets compares to the proceeds from sales when firms discontinue operations.

In this paper, we intend to show that this common view of collateral is imperfect. Specifically, we establish that there is no simple relation between the tangibility, or redeployability or non-specificity of an asset and the firm's propensity to use it as collateral. On the one hand, there are

[1] A secured creditor can seek court permission to get its collateral prior to bankruptcy judgment, in a procedure called ("replevin"), as long as that collateral is not real estate. Otherwise, the debtor has the opportunity to respond within a period to the creditor's lawsuit.

[2] There are limitations when the borrowing firm files for bankruptcy and the judge grants an automatic stay by including the collateralized assets in the bankruptcy estate.

[3] See, for example, Almeida and Campello (2007).

many tangible, redeployable and non-specific assets that are ill-suited for collateral. On the other hand, there are many intangible assets, such as rights to patent and brands that could make excellent collateral, and yet firms are reluctant to pledge them. Even if firms agree to pledge the income received from brands and patents, brands and patents are themselves not collateralized. There are many counter examples to the established view that tangibility, redeployability and non-specificity mean good collateral. Assets vary in their re-usage value outside the firm where they reside. Take, for example, the case of a telecom service provider. It is not evident that, for such operator, investment in building a client database has lower resale value than installing a fiber optic cable in an area populated with competitors. If financial contractibility were solely determined by how much assets fetch in liquidation, one should expect that assets with higher liquidation value should be collateralized first and to a higher degree than assets with a lower liquidation value. Using the estimates in Berger, Ofek and Swary (1996) that a dollar of book value yields, on average, 72 cents in exit value for total receivables, 55 cents for inventory, and 54 cents for fixed assets, one should expect companies to collateralize receivables first.[4] Yet many companies do not follow such pecking order, and also prefer to collateralize only very few of their many assets. Reading the empirical literature, it is far from clear (1) what assets are better collateral? and (2) why is that so?

In this paper we attempt to provide answers to these two questions. We contend that pledging an asset as collateral has important implications related to the control rights of the asset. Collateral transfers ownership rights from the borrower to the lender, namely the ability to freely decide the sale of the asset, its reusage and significant modifications to it.[5]

We build a model of an entrepreneur with a project partly funded by an investor. At some point, it is possible that the project's prospects deteriorate, in which case the asset needs to be restructured. While restructuring improves the expected success of the project, it may reduce the asset's liquidation value. If the asset is collateralized, the entrepreneur is prohibited from restructuring it, because restructuring may impose on the investor a loss in the asset's liquidation value (downside risk). The entrepreneur cannot credibly promise all of the project's payoffs to the investor, and collateralization that forbids the transformation of the asset may be necessary for the investor to break even. Thus, collateralization involves a trade off to the investor: a higher probability of default, from the inability to implement a needed restructuring, versus a higher liquidation value in default from not restructuring. Only assets that have a small increase

[4] Giambona and Schwienbacher (2007) is one of the few papers that distinguishes among the different types of tangible assets and alerts to the problem of conducting analysis using the average firm rather than a subset of firms for which certain collateralizable assets create additional debt capacity.

Benmelech, Garmaise and Moskowitz (2005) provide a link between collateral and liquidation values, but their analysis applies to one particular type of asset in a specific context.

[5] An extreme case of pledging is pawnbroking, where the owner is stripped of all ownership rights during the life of the contract.

in the default probability when restructuring is precluded, compared to the investor's downside protection, are suitable collateral. To the entrepreneur, the cost of collateralization is the impossibility to restructure the asset and improve as a result the odds of success. Consequently, assets with high marketability – tangible, redeployable, non-specific – may not be ideal collateral assets.

We show that collateralization is not just driven by the redeployability of an asset, which is what the investor cares about in the event of liquidation. It also depends on the ability to transform an asset in a restructuring, and how it contributes to the diversity of outcomes associated with both the entrepreneur's and the lender's claims. The paper explains why it is rational for lenders to place restrictions on the use of the asset inside the firm by means of collateral, as well as why it is rational for entrepreneurs to avoid these restrictions when flexibility is valuable. It helps to see that the discussion about the suitability of an asset as collateral based on liquidity alone misses the point.

Our model also examines how the specificity of an asset's determines its appropriateness as collateral. Highly specific assets for the firm have a high correlation between their values inside and outside the firm, both in terms of restructuring, as well as in liquidation. If a project's prospects deteriorate, specific assets used in the project are likely to also have a low value outside the firm. However, assets of low specificity still have a high value, if firms in other industries are able to reuse them productively. Thus, the unfavorable relationship between the increase in the rate of default and the downside protection of specific assets results in their infrequent use as collateral.

An inspection of companies' financial statements reveals that of the many assets in the books, some are collateralized, others are leased, and others are free from liens. In this paper we show that the choice of which assets to collateralize, and which to lease follows a logic supported by property rights. Companies collateralize assets with the highest liquidation values for a given level of loss caused by the restriction to restructure them. Core assets are particularly sensitive to the possibility of being restructured, which is less of a problem for non-core assets, for which outside marketability is the most important feature. By exploring this key feature, the paper proposes a pecking order of collateralization. Firms with strong balance sheets do not need to collateralize any assets and maintain maximum internal discretion over their usage. Firms with medium-strength balance sheets should collateralize only non-core assets, and among the non-core assets, collateralize first the assets that generate most of their values from the core asset; only after that, firms should collateralize non-core assets with values less related to the values of the core assets. Firms with weak balance sheets need to collateralize all assets. Leasing occurs with assets that are non-core and are less firm specific. Since the lessor retains the ownership of the leased asset, in terms of control rights, leasing has similarities to collateralized financing.

We follow the modern legal literature (Merrill and Smith 2001a and 2001b) which makes a

distinction between control rights and contractual rights. In our model, collateral is a control right that the lender has over a specific asset that is good against the current borrower and any third party. This contrasts with contractual rights pledged by the borrower to the lender. One example of such contractual rights are loan covenants, which include certain thresholds on financial ratios and promises to comply with key operational actions. Lenders include covenants with the purpose of protecting loans and assuring repayment. Since lenders ask for collateral to preserve the value of their loans, one might ask why do covenants co-exist with collateral? We show how covenants and collateral differ. To uphold covenants lenders are required to monitor.[6] And while covenants make overall demands on a company's collection of assets, collateral encompasses specific assets.[7] Covenants seem particularly appropriate when the lender is unsure when and whether one of the firm's many assets needs to be restructured. Granting some flexibility to the borrower might therefore be good, and this cannot be achieved if restrictions are placed on the transformation of particular assets. However, when collateralization increases the pledgeable value, it is important that the flexibility enjoyed by not collateralizing does not reduce the value of the assets that can be collateralized. We show that collateral and covenants can play complementary roles in facilitating corporate financing.

A number of other ideas have been presented to show the usefulness of collateral. Many papers specify collateral as the entrepreneur investing her existing wealth as back up for lending in the presence of frictions created by information asymmetries (for example, Stiglitz and Weiss, 1981, Bester, 1985, Chan and Kanatas, 1985, Besanko and Thakor, 1987, Manove, Padilla and Pagano, 2001). Many of the issues in these papers are also valid in our setting. However, we focus on the liquidation values of a firm's asset rather than on the initial contribution of equity used for protection of the lender. Papers that model issues of the leftover values of firms' assets to satisfy lenders are, for example, Boot, Thakor and Udell (1991), Stulz and Johnson (1985), Hart and Moore (1994) and Rampini and Viswanathan (2011). In these papers, collateral is available to all lenders and not pledged in the context of individual debts. None of these models is able to address issues of control related to collateral. Aghion and Bolton (1992) show that pledgeable value can increase if the entrepreneur transfers control rights to the lenders. In their model, lenders induce the entrepreneur to take an inefficient activity, who bears a private cost in doing the activity. In our model, collateralization results in *inefficient inactivity* on the part of the entrepreneur, who then suffers from a higher rate of the project's failure. Eisfeldt and Rampini (2009) study the different characteristics of secured lending and leasing in bankruptcy, and emphasize that the repossession of a leased asset is easier than foreclosure on the collateral

[6] See Rajan and Winton (1995)

[7] Ayotte and Bolton (2011) also develop a model that shows the difference between contractual rights and control rights, when different lenders have competing claims to the cash flows of the borrower and imperfect knowledge about the antecedents of existing loan contracts. In their model control rights are stronger than contractual rights. Interestingly, the authors show that clarity about the control rights of senior lenders can help lending by subordinated lenders.

of a secured loan.[8] The arguments in theirs and in our paper are complementary. While Eisfeldt and Rampini (2009) point out the benefits of strong creditor rights in bankruptcy, our paper highlights the benefits of strong creditor rights prior to bankruptcy.

The rest of the paper will proceed as follows. The formal argument is presented in section 2, a general model of one asset. The optimal contract balances the benefits of flexibility to restructure the asset if the project deteriorates and the risk of loss in liquidation value. In such a setting, we show the role of collateral. In section 3 we show that the ability to enforce the financial contract varies over time and depends on the incentives to monitor. Costly monitoring cannot guarantee that monitoring happens and as a result lenders might decide to collateralize. In section 4, the model of section 2 is extended to multiple assets. The distinction between core and non-core assets is introduced and analyzed. Section 4 also shows the incentive to collateralize specific versus general usable assets. Section 5 sketches several empirical implications of the model and section 6 provides concluding remarks.

2 A Simple Model of Collateralization

2.1 Model Setup

The project

An entrepreneur with a cash endowment of W has the opportunity to invest in a project that lasts for two periods. For convenience, in this section we use interchangeably the words project and asset. Later we analyze projects with multiple assets. Normally W is positive, but it may be zero or, in case of a debt overhang, $W < 0$. The project requires an initial outlay of $I > W$, implying that the entrepreneur needs to approach a lender to implement the project. If the project is successful, it yields a payoff after two periods of $R + B$, where $R > I$ is a monetary return, and $B > 0$ is a private benefit. B may not necessarily be tied to the project, and could be a reputational effect relevant for the entrepreneur's future activities.[9]

After the investment is made, and the passing of one period, the project's prospects either remain intact, with probability $1 - \eta$, or deteriorate, with probability η. If prospects remain intact, the project succeeds with probability 1. If prospects deteriorate and no further action is taken by the entrepreneur, the project fails with probability $1-q \in (0, 1]$. Irrespective of success or failure, the asset has a liquidation value at the end of the second period of $L \in (0, I - W)$.

[8] Prior to bankruptcy, however, a secured lender has the right to dispose of any or all of the collateral upon default [Uniform Commercial Code §9-610].

[9] B can also be a monetary rent of the entrepreneur required to incentivize her to exert the necessary effort before the final date of the project. If B is monetary, it is paid to satisfy the entrepreneur's incentive compatibility constraint, precluding pledgeability of part of what the final project delivers.

Restructuring

The entrepreneur can restructure the project after the first period. This requires a significant modification of the use of the asset or of the asset itself, perhaps the sale of at least part of the asset and possibly the purchase of a different asset. At date 1, the project has a usage value to the firm of γL, and for simplicity we consider that $\gamma \leq 1$. A higher γ means that a project that is worth more. If the project's prospects deteriorate, restructuring generates an increase in the probability of success, $p(\gamma L) \in (0, 1-q)$. Thus a project with higher γL merits and implies that the chances of a successful restructuring are higher, and the success rate of restructuring increases with γL, or $dp(\gamma L)/d(\gamma L) > 0$.[10]

To ensure that the best course of action is to continue the project at date 1, we assume that $qR + L \geq \gamma L$.

Restructuring does not guarantee success and involves risks. When the project fails, despite of the asset's restructuring, the liquidation value is below L at date 2. A low liquidation value is, for example, to be expected if, in the restructuring, equipment is modified in a way that it cannot be used by other firms anymore (i.e. it becomes more firm-specific). Another example is if part of the liquidation value is dissipated to pay for suppliers that provide specific and non-alienable services to the firm. For notational simplicity, we assume that the liquidation value subsequent to a failed restructuring is zero.[11]

Financing and contract

In exchange for financing $I - W$, the lender requires a cash repayment from the entrepreneur and/or from the proceeds of the liquidation of the asset at date 2. We assume an environment whereby contractual enforceability varies over time, because the lender's monitoring incentives vary as well. Below such contracting environment is derived from the analysis of the monitoring incentives. Concretely, we assume that at date $t = 2$ the lender's incentive to monitor is high, and contractual repayments in cash flows and in liquidation value are enforceable. This implies that repayments can be contracted upon R and L, the latter in both success, S, and failure, F. Such repayments are denoted by r_R, r_L^S and r_L^F, respectively. The asset structure giving R in the case of success is different whether success is generated with restructuring or not. Thus, we assume that it is possible to contractually distinguish between project success with and without restructuring.[12] We refer to the repayment in case of success upon restructuring as r_R^o. In case of a zero liquidation value subsequent to a failed restructuring, the entrepreneur has no cash or

[10] It is not necessary for the results that the probability of a successful restructuring is very sensitive to a change in γL.

[11] As will become clear below, assuming that restructuring does not cause a decrease in liquidation value with certainty may constitute an additional disadvantage of collateralization.

[12] As it turns out, this distinction is immaterial.

other asset to distribute and the repayment is zero.

In contrast to the contract enforceability at $t = 2$, at $t = 1$ contractual requirements cannot be enforced because of insufficient monitoring incentives. Specifically, it is impossible to prevent restructuring with a contractual right. However, it is possible to devise a property right, stronger than a contractual right, that gives the lender a right that is good against the entrepreneur, and also against third-parties.[13]. Consequently, enforcing a property right involves less monitoring by the lender.[14] We assume that a property right implemented with a collateral pledge is sufficient to rule out restructuring. In sum, collateralizing the asset precludes its transformation, re-usage to a different end and location, as well as its sale. Therefore, the entrepreneur cannot engage in effective restructuring.[15]

Further assumptions and time line

We assume risk neutrality of all players. We designate the entrepreneur-borrower as "she" and the lender as "he". Also, we assume that the entrepreneur has the entire bargaining power and captures the surplus generated. The interest rate is zero.

[13] See, Hansmann and Kraakman (2002).

[14] See Ayotte and Bolton (2011).

[15] Pledge and security lending agreements stipulate which assets are pledged by the borrower to its creditors, and impose clear restrictions on collateral. Examples include: (i) The borrower will not be allowed to sell, lease or otherwise dispose of the collateral except for dispositions specifically permitted pursuant to the contract; (ii) No piece of equipment or inventory shall at any time be stored at any other location, unless the creditor gives prior written consent, and must be maintained, preserved and kept in good repair and working and saleable condition; (iii) The borrower is not allowed to alter any identifying part, symbol or number on the equipment constituting collateral without the creditor's prior written consent; (iv) The borrower must give the creditor notice of its acquisition of equipment and vehicle with value in excess of a stipulated amount; (v) The borrower cannot file an application for the registration of any patent and trademark with a governmental office or agency without giving the creditor prior written notice; (vi) The security agreement creates a continuing lien and its breach by the borrower of any of the terms or provisions constitutes an event of default. The borrower agrees to indemnify the creditor against liabilities, and damages relating to the manufacture, purchase, acceptance, rejection, ownership, delivery, lease, possession, use, operation, condition, sale, return or other disposition of the collateral.

The time line is as follows:

- $t = 0$. The entrepreneur offers a financial contract that specifies repayments conditional on the project outcome and asset structure. If the lender accepts, investment takes place. The contract may specify a collateral pledge of the asset which prohibits transformation and sale of the asset.
- $t = 1-$. A random variable is realized determining whether prospects deteriorate.
- $t = 1$. If prospects don't deteriorate or the asset is collateralized, there is no additional action. If prospects deteriorate and the asset is not collateralized, the entrepreneur decides whether to restructure.
- $t = 2-$. If restructuring took place, a random variable is realized determining whether the project is successful.
- $t = 2$. The parties are compensated.

2.2 Analysis

First-best actions

If prospects deteriorate, it is socially optimal to restructure if the increased probability of project success, $p(\gamma L)$ outweighs the loss of liquidation value: $p(\gamma L)(R + B) \geq L$. Thus, for $p(\gamma L)(R + B) \geq L$, the maximum expected surplus is

$$S = (1 - \eta)(R + B + L) + \eta(q + p(\gamma L))(R + B) - I. \tag{1}$$

On the other hand, for $p(\gamma L)(R + B) < L$, the surplus-maximizing decision is to refrain from restructuring. Then, the expected surplus is

$$S = (1 - \eta + \eta q)(R + B) + L - I. \tag{2}$$

We assume that the expected surplus is positive in both cases, therefore, it is socially optimal to invest if funding is available.

Situation without collateralization

Given the assumption that the entrepreneur captures the entire surplus, she benefits from offering a financing contract that yields the first-best outcome. However, it is possible that the value pledgeable to the lender is not maximized when the first-best action is implemented. Without collateralization, the specified repayment amounts provide incentives for the entrepreneur to restructure in case prospects deteriorate, or refrain from doing so. We analyze the values that

can be pledged to investors in the two situations: 1) The entrepreneur restructures if prospects deteriorate; and 2) She does not restructure.

Consider first the pledgeable value when the entrepreneur is incentivized to restructure if the project's prospects deteriorate. The pledgeable value satisfies the following maximization problem

$$\max_{r_R, r_R^o, r_L^S, r_L^F} (1-\eta)\left(r_R + r_L^S\right) + \eta\left(q + p\left(\gamma L\right)\right) r_R^o \tag{3}$$

subject to

$$\begin{aligned}
\left(q + p\left(\gamma L\right)\right)\left(R + B - r_R^o\right) &\geq q\left(R + B - r_R + L - r_L^S\right) + (1-q)\left(L - r_L^F\right) && (4)\\
0 &\leq r_R, r_R^o \leq R && (5)\\
0 &\leq r_L^S, r_L^F \leq L && (6)
\end{aligned}$$

Restriction (4) reflects the incentive compatibility constraint. Given that an increase in r_R does not impair incentives, it is straightforward to show that the binding constraints are repayments limited by the amount of verifiable cash flows. Therefore, the optimal values are $r_R = r_R^o = R$, $r_L^S = L$ and for $r_L^F \in [0, L]$, respectively. This yields a pledgeable value of:

$$pv^{nc} := (1-\eta)\left(R + L\right) + \eta\left(q + p\left(\gamma L\right)\right) R. \tag{7}$$

Now, consider the pledgeable value when the entrepreneur is incentivized to not restructure. The maximization problem is

$$\max_{r_R, r_R^o, r_L^S, r_L^F} (1-\eta)\left(r_R + r_L^S\right) + \eta q\left(r_R + r_L^S\right) + \eta\left(1-q\right) r_L^F \tag{8}$$

subject to

$$\begin{aligned}
\left(q + p\left(\gamma L\right)\right)\left(R + B - r_R^o\right) &\leq q\left(R + B - r_R\right) + q\left(L - r_L^S\right) + (1-q)\left(L - r_L^F\right) && (9)\\
0 &\leq r_R, r_R^o \leq R && (10)\\
0 &\leq r_L^S, r_L^F \leq L && (11)
\end{aligned}$$

The incentive compatibility constraint (9) has now the opposite sign from before. A *ceteris paribus* increase in r_R^o, as well as decreases in r_R, r_L^S and r_L^F facilitate satisfying the constraint. The relative loss in pledgeable value is lowest for a reduction in r_L^F. A lower r_L^F renders failure more beneficial for the entrepreneur, which counters her incentive to restructure. At the optimum, the magnitude of r_L^F is limited by the constraint that $r_L^F \leq L - \frac{p(\gamma L)}{1-q} B$. In sum, it holds that $r_R^o = r_R = R$, $r_L^S = L$ and $r_L^F = L - \frac{p(\gamma L)}{1-q} B$. Thus, the pledgeable value in this case is:

$$\left(1 - \eta + \eta q\right)\left(R + L\right) + \eta\left(1-q\right)\left(L - \frac{p\left(\gamma L\right)}{1-q} B\right). \tag{12}$$

Comparing the two pledgeable values reveals the following result:

Lemma 1 *The pledgeable value to the lender when the contract implements restructuring is larger than or equal to the pledgeable value that prevents restructuring, if and only if restructuring maximizes the social surplus,* $p(\gamma L)(R+B) \geq L$.

The result implies that the amounts of relative pledgeable values do not restrict the implementation of the surplus-maximizing action. Whenever restructuring is a positive (negative) NPV decision, the pledgeable value to the lender is larger when the contract implements restructuring (no restructuring). Therefore, there is no inefficiency arising from asset substitution moral hazard activity on the part of the entrepreneur.

While the relative values pledgeable do not create investment distortions, a lack of absolute pledgeable value can make the project impossible to implement. Consider when restructuring is a positive NPV decision: $p(\gamma L)(R+B) \geq L$. A contract that fulfills the lender's participation constraint can be found only if the pledgeable value is at least equal to the loan amount: $pv^{nc} \geq I - W$.

Note that in case the project succeeds, the full return $R+B$ cannot be pledged, only R. The lender's participation constraint is easier to satisfy if the entrepreneur can contribute with more of her own capital ("stronger balance sheet"), W.

If $pv^{nc} \geq I - W$ and R is sufficiently high, the equilibrium contract may specify, for example,

$$r_R^{nc} = r_R^{o,nc} = \frac{I-W}{(1-\eta)+\eta(q+p(\gamma L))}, \; r_L^{S,nc} = 0, \text{ and } r_L^{F,nc} = L,$$

which amounts to a standard debt contract. A similar analysis can be performed for the case when restructuring is a negative NPV decision: $p(\gamma L)(R+B) < L$.

If the lender' participation constraint is fulfilled, there is no role for collateralization, because the first-best outcome is achieved. Thus, the model predicts that firms with good prospects and strong balance sheets, such as high cash flows in case of success, R, and large W, do not need to collateralize. There may be a role for collateralization, however, if the participation constraint is otherwise not met. Obviously, this only makes sense if the pledgeable value to the lender is increased when there is no restructuring.

Situation with collateralization

Collateralization implies not just that, in the event of default, the lender obtains ownership of the assets pledged as collateral. To make the clause effective, the pledged assets cannot be substantially modified, transferred or sold. Therefore, the pledgeable value is $pv^c := (1-\eta+\eta q)(R+L)+\eta(1-q)L$.

Consider first when restructuring yields a negative NPV, $p(\gamma L)(R+B) < L$. Collateralization has a positive effect on the pledgeable value because it eliminates any rents that the lender has to offer the entrepreneur to refrain from restructuring. Then, the pledgeable value under

collateralization is always higher. This implies that an asset is suitable as collateral if its liquidation value, L, is high. This insight is anything but novel, but the argument supporting it is different. Collateralization protects the pledgeable value better than than repayment incentives which ensure that the entrepreneur does not restructuring.[16]

A more interesting situation occurs when restructuring is a positive NPV decision: $p(\gamma L)(R+B) \geq L$. Then, collateralization increases the expected pledgeable value for:

$$(1-\eta+\eta q)(R+L)+\eta(1-q)L > (1-\eta)(R+L)+\eta(q+p(\gamma L))R.$$

This reveals the following result:

Proposition 1 *If restructuring is a positive NPV project, an asset is suitable for collateral iff*

$$L > p(\gamma L)R. \tag{13}$$

The asset has high liquidation value in default, L, and/or low probability of successful restructuring, $p(\gamma L)$.

Note that the pledgeable value may increase with collateralization despite the (suboptimal) inability to restructure an asset that has deteriorated. As before, a high liquidation value, L, at date 2 is important for the lender in the event of default. Moreover, the cost of not restructuring is smaller when the probability of a successful restructuring is lower, $\frac{d(p(\gamma L)R)}{d\gamma L} = \frac{d(p(\gamma L))}{d\gamma L}R > 0$.

Pledgeable value is generated both by high probability of successful restructuring and high liquidation value in case of failure. The collateralization decision trades off these two sources of pledgeable value. Only if the tradeoff favors the liquidation value does collateralization make sense. If the relation (13) is violated, collateralization not only is costly to the entrepreneur, but also detrimental to the lender.

When the entrepreneur cannot raise enough unsecured debt, a loan secured by an asset is attractive when collateralization, by limiting her actions, increases the pledgeable value to the lender. From this it is possible to see that collateralization is an instrument of control for the lender. In Aghion and Bolton (1992) control is used by the investor to force the entrepreneur to engage in an action that has a private cost to her. In our model, control is used to prohibit the entrepreneur from taking a certain action in order to protect the value of the loan.[17]

[16] Given that a property right potentially imposes significant monitoring costs on third parties, the law stipulates the creation of property rights only in a restricted way. See Ayotte and Bolton (2011).

[17] Note that the argument that assets are collateralized if otherwise pledgeable income is not sufficient does not rely on the notion that the lender's liquidation value is lower than that of the entrepreneur. The cost of collateralization arises from the elimination of inside flexibility, which reduces the overall surplus.

What collateralization does is to take away flexibility from the entrepreneur. The parameter that characterizes the entrepreneur's flexibility (*inside flexibility*) is $p(\gamma L)$. $p(\gamma L)$ consists of two parts: γL and $p(\cdot)$. The higher γL, the more valuable is the asset to the entrepreneur's activities, and the higher is the chances of a successful restructuring. Consequently, preventing restructuring by collateralizing the asset reduces the surplus by more when γL is higher. The cost of collateralizing is shared by the entrepreneur and the lender.

Sometimes the probability of a successful restructuring $p(\cdot)$ is driven by the entrepreneur's skills. To parametrize differences in the entrepreneur's restructuring ability, consider that the probability of a successful restructuring is given instead by $\lambda p(\gamma L)$, where λ represents the entrepreneur's ability to restructure the asset. λ affects only the pledgeable income with no restructuring, and the first derivative with respect to λ is positive. Thus, high quality entrepreneurs tend to not secure loans with assets that might need to be restructured. This implies that collateralization of an asset may also critically depend on the entrepreneur's ability to restructure it. An analogous argument holds for the exogenous restructuring characteristics of an asset. An asset that has a high probability of being successfully restructured is unlikely to be used as collateral.

Recall that an asset suitable as collateral must have a high L. Analogous to the situation in date 1, we denote this as *outside flexibility*.

It is often argued that a good characteristic for collateralization is an asset's value preservation in high and low states of the world. At first glance the claim appears obvious: If an asset has a low probability of deterioration, a low η, it is well suited as collateral. However, Proposition 1 clearly shows that this is misleading. A low η increases the pledgeable value, and the firm's financing capacity both under collateralization and non-collateralization. The first derivative of the difference in pledgeable values with and without collateralization with respect to η is

$$\frac{d\left(pv^{c}-pv^{nc}\right)}{d\eta}=-p\left(\gamma L\right)R+L. \tag{14}$$

While the effect of a change in η is typically different from zero, it does not affect the critical relation that determines the suitability of an asset as collateral, (13). This shows that an asset's characteristics that increase the financial capacity do not necessarily make that asset more suitable for collateralization.

In general, if collateralization is necessary there is a multiplicity of optimal contracts. The optimal contract is characterized by $(1-\eta+\eta q)\left(r_R+r_L^S\right)+\eta(1-q)\,r_L^F=I-W$. One of the optimal contracts is the standard debt contract $r_L^{F,c}=L$, $r_L^{S,c}=0$, and consequently $r_R^c=\frac{I-W-\eta(1-q)L}{1-\eta+\eta q}$, as long as $\frac{I-W-\eta(1-q)L}{1-\eta+\eta q}\leq R$.

Figure 1 illustrates the results of the basic model.

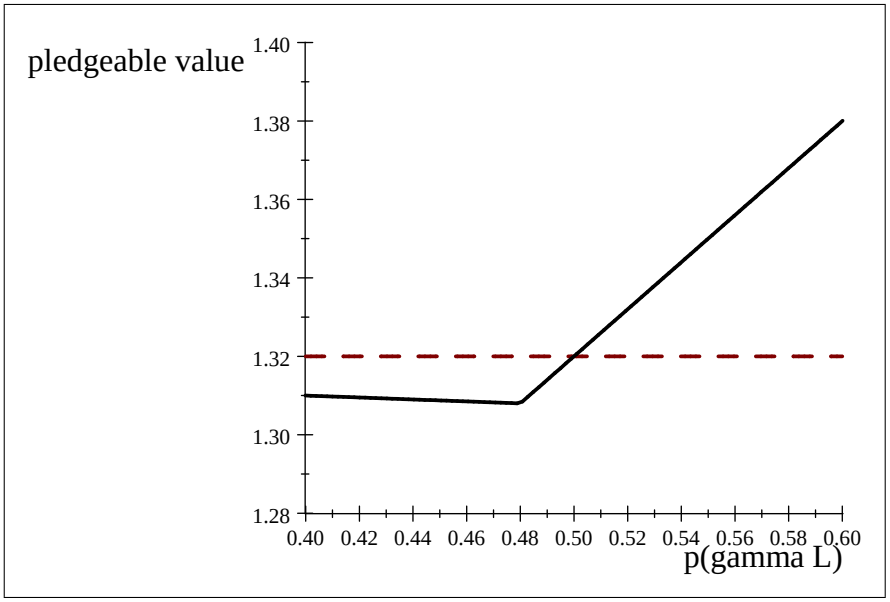

Figure 1: Gross benefit and pledgeable value as a function of the probability of restructuring success, $p(\gamma L)$. Parameter values: $\eta = 0.5$, $R = 1.2$, $B = 0.05$, $L = 0.6$. $p(\gamma L)(R + B) = L$ for $p(\gamma L) = 0.48$.

The solid and dashed lines depict the pledgeable values without and with collateralization for varying levels of $p(\gamma L)$, respectively. Note that without collateralization and $p(\gamma L)(R + B) < L$, the pledgeable value is decreasing in $p(\gamma L)$, because the entrepreneur's rents increase when she refrains from restructuring. If $p(\gamma L)$ exceeds a threshold value, the pledgeable value is higher when the asset is not collateralized.

Given that the results when restructuring is a positive NPV decision encompass those when restructuring is a negative NPV decision, in the remainder of the paper we focus on the situation in which it is socially optimal to restructure:

$$p(\gamma L)(R + B) > L. \tag{15}$$

3 Covenants versus Collateral: Different Rights

In the previous section we have assumed that the ability to enforce the loan contract varies over time. In this section we explain why this is so by analyzing explicitly the incentives to monitor. We show that enforceability of the loan contract is not effective at the interim date 1, and it is impossible to prevent restructuring, unless the lender actively monitors. However, monitoring is costly and cannot be assumed beforehand. As a result, contract clauses are enforced so long as monitoring is advantageous to the lender.

To make the analysis clearer we add a couple of assumptions. First, transfers of cash or assets

by the entrepreneur to third parties are not verifiable in the absence of monitoring. Second, the entrepreneur can divert value when there is no monitoring, in which case the entrepreneur forgoes a fraction, $\mu \in (0,1)$, of the diverted value, to evade being caught. μ is neither too small to be inconsequential, nor too large to rule out diversion:

$$1 - \frac{I}{R} \leq \mu \leq \frac{(q + p(\gamma L))\, B}{\gamma L}$$

The inequality implies that if the entrepreneur diverts she earns the private benefit, but foregoes a fraction of the total payoff in success, which includes her private benefit then.

To deal with the agency costs, lenders attach covenants to the financial contract. Although monitoring prevents actions prohibited by the covenants, including restructuring of the assets, monitoring does not reveal to the lender whether the project's prospects have deteriorated or not. So, if the lender monitors the covenants that forbid restructuring, he will not know before $t = 2$ whether restructuring was necessary or not. On the other hand, if the lender skips monitoring, he learns that the prospects have deteriorated, but only after restructuring occurred at $t = 1$.

The lender decides to monitor period by period. Monitoring imposes per period cost of $\kappa > 0$. This cost is not too large to dissuade monitoring, $\kappa < (1 - \eta)\, I$.

When restructuring is a positive NPV decision, collateral can play a role. To illustrate the impossibility of ruling out restructuring, we also assume that the firm succeeds in obtaining finance only if no restructuring occurs, even when enforcing this requires monitoring, $(1 - \eta + \eta q)\, R + \eta (1 - q)\, L + \kappa \geq I - W$. Consequently, with restructuring (no monitoring), financing is not viable: $(1 - \eta)\, R + \eta (q + p(\gamma L))\, R < I - W$.

To simplify the analysis we assume also that $W = 0$, $r_R = r_R^o$ and $r_L^F = L$. Given that there are many optimal contracts, the last two assumptions make, without loss of generality, the contract payments resemble a standard debt contract.

To highlight the role of collateral, consider that the model abstracts from collateral. The time line of the events is as follows:

- $t = 0$: The contract is signed. Besides the specification of repayments, the contract forbids restructuring.
- $t = 1 - -$: The lender decides on first-period monitoring. Monitoring prohibits restructuring of assets and the diversion of cash flows at date 1.
- $t = 1-$: The random variable determining whether the project deteriorates or not is realized. The entrepreneur observes the realization of the variable, but not the lender.
- $t = 1$: If prospects do not deteriorate and there is no monitoring, the entrepreneur decides whether to do nothing or divert the asset. If prospects deteriorate and there is

no monitoring, the entrepreneur decides whether to restructure, do nothing or divert the asset.

- $t = 2 - -$: The lender decides on second-period monitoring. Monitoring prohibits the diversion of assets at date 2.
- $t = 2-$: A random variable determines whether the project is successful. If there is no monitoring, the entrepreneur decides whether to divert or not.
- $t = 2$: The parties are compensated.

  We analyze the model by proceeding backwards.

$t = 2$ and $t = 2-$: Diversion decision and payoffs to the parties.

If the entrepreneur does not divert, she is compensated according to the contract. If she diverts, she receives the entire financial proceeds less the fraction μ, plus the private benefit.

Consider first that there is monitoring at $t = 2$. If the project is successful, the payoff r_R occurs. If the project fails and a restructuring was not undertaken (undertaken), the repayment is $r_L = L$ ($r_L = 0$).

Lemma 2 *If the lender does not monitor at date* 2*, the entrepreneur diverts in all states in which the project's value is positive. The lender's payoff is zero.*

Proof. If the project succeeds, the borrower diverts if $R - r_R + B < \mu R + B \Leftrightarrow (1-\mu) R < r_R$. From the condition on μ, the borrower diverts. If the project fails and there was no restructuring, the borrower diverts if $L - r_L = 0 < \mu L$, which holds. If the project fails and there was restructuring, the entrepreneur's payoff is 0, irrespective of diversion. Thus, if there is no monitoring, the entrepreneur diverts in all states in which the project has a positive value. ■

$t = 2 - -$: Lender's monitoring decision.

Anticipating diversion, the lender's payoff is zero if he does not monitor. If the lender monitors, repayments are according to what is specified in the contract. Whether the lender decides to monitor or not at date 1, he does not observe whether prospects deteriorate or not. Then, if the entrepreneur decides to restructure, which happens in the absence of monitoring: $(1-\eta)\left(r_R + r_L^S\right) + \eta\left(q + p\left(\gamma L\right)\right) r_R - \kappa$. If the entrepreneur's policy is to not restructure: $(1 - \eta + \eta q)\left(r_R + r_L^S\right) + \eta\left(1 - q\right) L - \kappa$. A necessary condition to satisfy the lender's participation constraint is: $\left(r_R + r_L^S\right) \geq I$. Thus, and using the upper bound for μ, it is optimal that the lender monitors. The incentive to monitor is high, otherwise the lender loses his payoff.

$t = 1$: The entrepreneur's decision.

Consider first that the prospects deteriorate. With monitoring, the entrepreneur cannot restructure. With no monitoring, diverting yields the entrepreneur the payoff $\mu\gamma L$. Not diverting and anticipating monitoring at $t = 2$ implies an entrepreneur's payoff $(q + p(\gamma L))(R - r_R + B)$, if she restructures, and a payoff $L - L = 0$, if she does not restructure. The imposed lower bound on μ ensures that the entrepreneur prefers restructuring more than diverting.

Consider now that prospects do not deteriorate. With no monitoring, the entrepreneur does nothing. The entrepreneur's payoff if she diverts is $\mu\gamma L$, and $R - r_R + B$ if she does not divert. The lower bound on μ implies that $\mu\gamma L < R - r_R + B$.

In sum, the entrepreneur does not divert at date $t = 1$. Diversion at date 1 is unattractive, because diverting eliminates the entrepreneur's payoff when the project is successfully finished. Thus, the payoff at $t = 1$ upon diversion is relatively small, $\mu\gamma L$. If prospects deteriorate and the entrepreneur finds it optimal to do something, she rather restructures than diverts because this increases the probability of receiving the surplus from successfully completing the project.

$t = 1 - -$: Lender's monitoring decision.

The decision to monitor at the beginning effectively prevents the entrepreneur from restructuring the project in case its prospects deteriorate. Monitoring yields a payoff of $(1 - \eta + \eta q)\left(r_R + r_L^S\right) + \eta(1 - q)L - \kappa$. Not monitoring yields a payoff of $(1 - \eta)\left(r_R + r_L^S\right) + \eta(q + p(\gamma L))r_R$. Thus, monitoring is too expensive if $\kappa > \eta\left(qr_L^S + (1 - q)L - p(\gamma L)r_R\right)$.

A sufficient condition for the absence of monitoring at $t = 1 - -$ is $\kappa > \eta(L - p(\gamma L)I)$.[18] The analysis can be summarized as follows:

Proposition 2 *The lender's incentives to monitor are stronger at $t = 2$ than at $t = 1$. At $t = 2$, the lender monitors for all feasible parameters of the monitoring cost κ. At $t = 1$, the lender monitors for sufficiently small values of the monitoring cost κ.*

The analysis illustrates how monitoring is less beneficial to the lender at $t = 1$ than at $t = 2$. The reason is that monitoring is less relevant at $t = 1$. With probability $1 - \eta$ the prospects remain intact at $t = 1$, and monitoring does not alter the entrepreneur's behavior. When the prospects deteriorate, which happens with probability η, the entrepreneur restructures and does not divert, which would be the worst action for the lender. Restructuring yields in expectation a positive payoff to the lender. Note that monitoring is the lender's optimal action ex-ante, but frequently not ex-post. This inability to commit to a specified course of action at the outset makes it impossible to enforce provisions in contracts.

That the incentives to monitor change over time and with the circumstances is somewhat obvious, but the reasons are not. There are some interesting implications that result: (a) The incentives

[18] A less restrictive condition can be found, because r_R is strictly larger than I.

for the lender to monitor contractual arrangements are highest at maturity and thereby render, among other things, the repayment of the principal at maturity enforceable; (b) When restructuring is a positive NPV decision and the surplus is (mostly) captured by the entrepreneur, diverting cash flows is relatively unattractive before maturity. Hence, the incentives to monitor are reduced, and covenants prohibiting restructuring are often not enforceable. No contractual right that requires costly monitoring is able to close the enforceability lapse. One practical way to solve the inability to enforce is by a property right, such as collateral. Collateral achieves the necessary enforceability without imposing high monitoring costs on the lender.

4 Multiple Assets

Until now, we have assumed that the project consists of a single asset. In practice, firms hold a multitude of assets with different characteristics. While studying an individual asset is often a sensible way of describing important facets of collateralization, some issues require considering multiple assets. Doing so helps to understand how collateralization is influenced by how different assets relate to one another.

4.1 Inside flexibility and complementarity

Consider a firm with two assets, M and N, with identical liquidation values at date 2, $\frac{1}{2}L$, but worthy different amounts to the firm at date 1, $\gamma_j L$ for asset j for $j = M, N$, with $1 > \gamma_{_M} = \frac{1}{2}\gamma(1+\phi) > \frac{1}{2}\gamma(1-\phi) = \gamma_N > 0$. Recall that $p(\gamma L)$ measures inside flexibility. For reasons of tractability, we assume that the random variables that govern the assets' deterioration of prospects are perfectly correlated. Thus, the prospects of both assets deteriorate, with probability η, or do not deteriorate. Below, we discuss the case of imperfect correlation.

The two assets have varying degrees of substitutability/complementarity. With assets that are perfect substitutes, restructuring successfully one of the two assets suffices to make the project successful. With assets that are perfect complements, both assets have to successfully restructured to make the project successful. The degree of substitutability is measured by $\alpha \in [0,1]$. A high α means high degree of substitutability. Specifically, the probability of a successful project upon deterioration is given by:

$$q + \alpha \cdot p(\gamma_{_M} L) + \alpha \cdot p(\gamma_{_N} L) + 4 \cdot (1-\alpha) \cdot p(\gamma_{_M} L) \cdot p(\gamma_{_N} L). \tag{16}$$

The specific functional form allows us to keep the surplus amount comparable to the single-asset case. For notational simplicity, we assume that $q = 0$.

If $\alpha = 1$, the third term in (16) disappears, and we have perfect substitutes assets (the successful restructuring of one asset is sufficient for the project to be successful). If $\alpha = 0$, only the third

term is relevant and we have assets that are perfect complements (the restructuring of both assets has to be successful for the project to be successful).

Suppose that the assets' prospects have deteriorated. Then:

Situation without collateralization

If neither of the assets is collateralized, the entrepreneur has complete discretion to restructure. If restructuring takes place, the surplus is:

$$(1-\eta)(R+B+L)+\eta[\alpha\cdot p(\gamma_{M}L)+\alpha\cdot p(\gamma_{N}L)+4\cdot(1-\alpha)\cdot p(\gamma_{M}L)\cdot p(\gamma_{N}L)](R+B)-I. \quad (17)$$

The pledgeable value to the lender is $(1-\eta)(R+L)+\eta[\alpha\cdot p(\gamma_{M}L)+\alpha\cdot p(\gamma_{N}L)+4\cdot(1-\alpha)\cdot p(\gamma_{M}L)\cdot p(\gamma_{N}L)]R$.

Situation with collateralization of both assets

If both assets are collateralized, the surplus is, as before, $(1-\eta)(R+B+L)+\eta L-I$. The pledgeable value to the lender is $(1-\eta)(R+L)+\eta L$.

Situation with collateralization of one asset

If only asset j is collateralized, it can neither be restructured or sold. If restructuring of the non-collateralized asset takes place, the surplus is:

$$(1-\eta)(R+B+L)+\eta L\left[\alpha p(\gamma_{-j}L)(R+B)+\frac{1}{2}L\right]-I$$

and the pledgeable value to the lender is $(1-\eta)(R+L)+\eta L\left[\alpha p(\gamma_{-j}L)R+\frac{1}{2}L\right]$.

The analysis allows us to state the following:

Proposition 3 *If only one asset is collateralized, it is optimal to collateralize asset N, the asset with the lower inside flexibility. A higher degree of complementarity, i.e., a smaller α, makes the collateralization of one asset less attractive.*

Proof. If asset N is collateralized and prospects deteriorate, asset M is restructured and implies a higher probability of success than if asset M is collateralized and N restructured. This also generates a higher surplus and therefore a higher expected surplus to the entrepreneur. Also, as $\alpha p(\gamma_M L)R+\frac{1}{2}L>\alpha p(\gamma_N L)R+\frac{1}{2}L$, collateralizing asset N generates a higher pledgeable value to the lender than collateralizing asset M.

If one asset is collateralized, both the surplus and the pledgeable value increase in α. If no asset is collateralized or both assets are collateralized, complementarity does not affect the surplus and pledgeable value. Thus, the second statement of the proposition holds. ■

The proposition shows that when a firm has several assets and considers using them as collateral, *ceteris paribus* the firm chooses the assets with the lowest inside flexibilities.

Also, an asset that is more complementary to another tends not to be used as collateral. More formally, collateralizing only asset N reduces the pledgeable value vis-a-vis no collateralization, for $\alpha < \frac{1}{p(\gamma_N L)} \frac{1}{p(\gamma_N L)[1-4\cdot p(\gamma_M L)]} \left(\frac{1}{2}\frac{L}{R} - 4 \cdot p(\gamma_M L)\right)$. If the inequality holds, it is never optimal to collateralize one asset. Then, sufficiently complementary assets are better bundled together as collateral or not pledged at all as collateral.

Different liquidation values

Next we generalize the setting to allow for different liquidation values at date 2. To do this, we assume that in the absence of restructuring, asset M's liquidation value is $\frac{1}{2}(1+\phi)L$ and asset N's liquidation value $\frac{1}{2}(1-\phi)L$. Hence, the asset with the higher inside flexibility, asset M, has also a larger liquidation value. Collateralizing only asset N implies a higher pledgeable value than collateralizing only asset M for

$$\begin{aligned} \alpha p(\gamma(1+\phi)L)R + \frac{1}{2}(1-\phi)L &> \alpha p(\gamma(1-\phi)L)R + \frac{1}{2}(1+\phi)L \Leftrightarrow \\ \alpha\left[p(\gamma(1+\phi)L) - p(\gamma(1-\phi)L)\right]R &> \phi L. \end{aligned}$$

Whether this relationship holds depends on parameter values. Collateralizing only asset N and allowing M to be restructured, implies a higher loss of liquidation value at date 2 than the other way round (only collateralize asset M). This means that the entrepreneur may be forced to collateralize asset M despite its higher internal flexibility.

This generalized setting allows also to look again at the use of covenants versus collateral in corporate financing.

So far we have assumed that the lender's monitoring incentives at date 1 are insufficient to prohibit restructuring and, therefore, covenants are ineffective to impede restructuring. With multiple assets, the incentives to monitor at date 1 are more complex. While it may be relatively costly to monitor individual assets and thereby prevent their restructuring, this may be not so at a more aggregate level: Audited financial reports give a relatively cost effective assessment of actual aggregate values by categories of assets. In that sense, covenants have a role in limiting restructuring.

Using a simple description, suppose that monitoring each of the two individual asset is quite costly. Then, financial reporting allows the lender to costlessly monitor whether at least one of the assets is still in place at $t = 1$. By including a respective clause in the loan contract and choosing to monitor financial reports at date $t = 1--$, the lender can prevent the entrepreneur from restructuring both assets. However, due to imperfections in financial reporting, the lender is not able to keep the entrepreneur from restructuring one of the two assets just by monitoring the firm's financial reports.

To illustrate the different roles of covenants and collateralization, consider that the pledgeable value is sufficient to cover the loan amount if asset M is never restructured. Asset M has a relatively high liquidation value at date 2 and, therefore, provides protection to the lender's claim. As a contractual right, a covenant is sufficient to ensure the lender's participation if the lender is able to prevent the restructuring of asset M. While a covenant is able to prevent that both assets are restructured, it cannot prevent that one of the two assets is restructured. If it is in the interest of the entrepreneur to restructure asset N rather than asset M, there are no issues. Consider that the repayment amount on the loan is the maximum possible amount R. Then, the entrepreneur prefers to restructure M over restructuring N if $\alpha p(\gamma\,(1+\phi)\,L)B > \alpha p(\gamma\,(1-\phi)\,L)B$, which is always true, since the entrepreneur strictly prefers to restructure the asset yielding a higher probability of project success. Then, a covenant is insufficient to does not provide the lender with sufficient pledgeable value.

However, there are situations when the interests of the entrepreneur and the lender are aligned as to which asset to restructure. For example, in the case of identical liquidation levels described above, both the entrepreneur and the lender prefer asset N to be restructured. Then, a covenant may be sufficient to ensure the participation of the lender. Furthermore, when the prospects of deterioration of the assets are imperfectly correlated, covenants may be even strictly better than collateralization, because covenants provide flexibility to restructure the asset whose prospects have deteriorated.

Covenants and collateral in corporate borrowing are quite different and also frequently complementary. A security interest such as collateral is attached to individually specified assets or clearly defined groups of assets, and limits the restructuring of such assets. Part of the monitoring costs are transferred to parties outside the actual contractual relationship.[19] On the other hand, specific restrictions imposed by collateralization can turn out to be ex post too restrictive. Contractual rights like covenants are different: They apply to the firm rather than to assets. With covenants lenders can keep the costs of monitoring at a reasonable level by simply resorting to audited financial reports of the firm. Only when monitoring costs are sufficiently low, covenants provide protection to the lender, while giving the entrepreneur greater flexibility to restructure.

4.2 Core versus non-core assets

In the previous section, we analyzed a setting where the benefits of successful restructuring were symmetric across assets. In this section, we focus on the relative relevance of the different assets. Consider again a firm with two assets. One that is unique to the firm's value proposition, its main source of value added from positive rents in the product market. We refer to this asset

[19] See Ayotte and Bolton (2011).

as the *core asset*. The other asset is not crucial to the firm's success, but provides a profitable contribution when used in conjunction with the core asset. This second asset is called the *non-core asset*. It is plausible to assume that the non-core asset derives part of its usefulness inside the firm from the core asset. A core asset is key to the firm, so if it needs to be restructured, the success in restructuring will have a positive effect on the non-core asset; if restructuring of the core asset fails, then no matter how much money is spend in restructuring the non-core asset, it is not going to do well.

To motivate the analysis, consider an American Football franchise or an English Premier League Football club. The core asset is the team. Merchandizing, media and the stadium are examples of non-core assets. If the team does not win, it becomes critical to restructure it, so that merchandizing, media rights and matchday earnings improve; on the other hand, no matter how much the club spends on improving merchandizing and modernizing the stadium, if the team does not perform, ticket and merchandizing sales inevitably sag.

In terms of our model, this can be represented in the following way: The successful project's payoff can be split into the core asset, $c \cdot (R + B)$, and the non-core asset, $n \cdot (R + B)$, with $c + n = 1$. The values of the core asset and non-core asset at dates 1 and 2 are given by γcL and γnL at date 1, and cL and nL at date 2.

Again, the random variables that govern the assets' deterioration of prospects are assumed to be perfectly correlated. We relax this assumption below.

If the core asset is restructured, the probability of success is $q + p_C(c\gamma L)$. The fundamental difference between the core asset and the non-core asset is that the success of the project, in case of a deterioration of its prospects, depends crucially on the successful restructuring of the core asset. If the prospects of the core asset deteriorate, it is important to give priority to its restructuring, because without its successful restructuring, the non-core asset will also fail. Therefore, the non-core asset can only be successful if the restructuring of the core asset works. Then, the probability of a successful restructuring of the non-core asset is $q + p_N(n\gamma L)$. For notational simplicity, we assume again that $q = 0$. Note that the debt capacity of the non-core asset benefits from the externality of the successful restructuring of the core asset. From $\gamma cL + \gamma nL = \gamma L$, if both assets are restructured, the success probability of the non-core asset is therefore $p_C(c\gamma L) \cdot p_N(n\gamma L)$.

First-best actions

If both assets are restructured, the surplus is given by

$$S = (1 - \eta)(R + B + L) + \eta p_C(c\gamma L)\left[c(R + B) + p_N(n\gamma L)\, n(R + B)\right] - I.$$

Where, as before, restructuring is a positive NPV decision.

Situation without collateralization

Contracting is more complicated, given that there are three possible outcomes: both assets are successfully restructured, only the core asset is successfully restructured, or none of the two assets is successfully restructured. As before, we assume that of $c \cdot (R + B)$ and $n \cdot (R + B)$, but only cR and nR is pledgeable to the lender, respectively. The result derived in Lemma 1 continues to hold:

Lemma 3 *Suppose the project consists of a core asset and a non-core asset. Then, the pledgeable value to the lender when the contract implements restructuring is larger than or equal to that preventing restructuring, if and only if restructuring maximizes social surplus.*

Proof. Follows the steps in deriving Lemma 1. ■

As before, no collateralization does not lead to underinvestment in restructuring if a debt contract is signed. Contractually incentivizing the entrepreneur to refrain from restructuring limits the amount the lender can get in default, and the corresponding pledgeable income.

The lender agrees to financing if its participation constraint is satisfied:

$$(1 - \eta)(R + L) + \eta p_C (c\gamma L)[c + p_N (n\gamma L) n] R \geq I - W. \tag{18}$$

In this situation there is no need for collateralization, and the first-best outcome is achieved. There is potentially a role for collateralization when the participation constraint of the lender is not met.

Situation with collateralization of both assets

Consider first the case of collateralizing both the core and the non-core asset. With both assets collateralized, a restructuring cannot be undertaken. The expected pledgeable value is $(1 - \eta)(R + L) + \eta L$. Collateralization of both assets increases the expected pledgeable value to the lender when compared to the situation without collateralization, for

$$\begin{aligned} (1 - \eta)(R + L) + \eta L &> (1 - \eta)(R + L) + \eta p_C (c\gamma L)[c + p_N (n\gamma L) n] R \\ &\Leftrightarrow \quad L > p_C (c\gamma L)[c + p_N (n\gamma L) n] R. \end{aligned} \tag{19}$$

Situation with collateralization of only the core asset

Next, suppose that only the core asset is collateralized. Then the core asset cannot be restructured, but the non-core asset can. However, from the assumption that the success of the project in case of a deterioration critically depends on a successful restructuring of the core asset, the restructuring effort of the non-core asset alone is futile. Thus, there is no reason to contractually incentivize the entrepreneur to restructure. In the absence of such an explicit incentive,

the entrepreneur decides to not restructure the non-core asset. The pledgeable value is equal to that in the situation with collateralization of both assets: $(1-\eta)(R+L)+\eta L$.

Situation with collateralization of only the non-core asset

Consider the case of collateralizing only the non-core asset. Then, the core asset can be restructured while the non-core asset cannot. The pledgeable value if only the core asset is restructured is:

$$(1-\eta)(R+L)+\eta\left[p_C(c\gamma L)cR+nL\right]. \tag{20}$$

Note that if only the core asset is restructured, the non-core asset fails if its prospects deteriorate, but its liquidation value nL is pledgeable.

Comparing the collateral pledge of the non-core asset with the pledgeable value of both assets as collateral gives:

$$(1-\eta)(R+L)+\eta\left[p_C(c\gamma L)cR+nL\right]\leq(1-\eta)(R+L)+\eta L\Leftrightarrow p_C(c\gamma L)R\leq L.$$

Comparing the collateral pledge of the non-core asset versus no collateralization gives:

$$(1-\eta)(R+L)+\eta\left[p_C(c\gamma L)cR+nL\right]\geq(1-\eta)(R+L)+\eta p_C(c\gamma L)\left[c+p_N(n\gamma L)n\right]R.$$

The pledgeable value using the non-core asset as collateral is higher for

$$L\geq p_C(c\gamma L)p_N(n\gamma L)R. \tag{21}$$

On can immediately see that while it may be attractive for the entrepreneur to collateralize only the non-core asset, the entrepreneur cannot improve the situation by collateralizing only the core asset. To see whether the entrepreneur finds it optimal to use only the non-core asset as collateral rather than both assets, we compare the entrepreneur's surplus in both instances. If both assets are collateralized, the entrepreneur receives the surplus of $(1-\eta)(R+B+L)+\eta L-I$. If only the non-core asset is collateralized, the entrepreneur obtains $(1-\eta)(R+B+L)+\eta p_C(c\gamma L)c(R+B)+\eta nL-I$. The surplus is higher when only the non-core asset is collateralized for:

$$cL<p_C(c\gamma L)c(R+B). \tag{22}$$

This is precisely the condition for the socially optimal restructuring of the core asset. In a surplus-increasing restructuring, the entrepreneur prefers to collateralize only the non-core asset, instead of both assets. If doing so allows the entrepreneur to pledge a payoff sufficient to meet the lender's participation constraint, the entrepreneur does not collateralize both assets, but only the non-core asset. Hence, we find a pecking order of collateralization decisions, as a function of the entrepreneur's wealth, W:

Proposition 4 *Consider the situation in which restructuring of the core asset and of both assets are positive NPV projects. Suppose also the collateralization increases pledgeable value, and the collateralization of both assets maximizes pledgeable value. Then, all else equal, an entrepreneur with a large enough wealth, W, does not collateralize any of the assets. An entrepreneur with an intermediate level of wealth collateralizes only the non-core asset. An entrepreneur with low wealth collateralizes both the non-core and the core asset.*

Core assets are of strategic importance to the firm. A key feature of core assets is that their productivity makes non-core assets more productive. This also implies a high loss of value in case they deteriorate, resulting in the absolute need to preserve the flexibility to restructure them. This implies that the entrepreneur only decides to collateralize the core asset if she absolutely has to. It is well known that secured creditors take precedence and are allowed to seize and sell assets in the event of default. This can have important implications to the viability of a firm as a going concern, and may precipitate the sale of the company on a break-up basis. Our argument is different: collateralizing the core asset reduces the value of the going concern not just in bankruptcy. It also affects the firm before bankruptcy, in a way that is detrimental to both the entrepreneur and the creditor.

The entrepreneur's last option to collateralize the core assets holds, even if such assets generate significantly more pledgeable value if collateralized. In fact core assets may be quite desirable to existing competitors or to new market entrants, making them have a high L. [20]

We close this sub-section by proposing an interesting modification of the existing setup that allows us to analyze, in a simple way, the case of a non-core asset whose value is less related to the core asset. While the probabilities of deterioration are assumed to remain at η, we now assume that the deterioration of the assets is independently distributed. As before, if the core asset fails, the non-core asset cannot be successful. We compare the condition regarding collateralization to that of the above case in which deterioration is perfectly correlated. In doing so, we focus on the condition for which the pledgeable value is increased by pledging the non-core asset relative to refraining from collateralizing any asset.

Maintaining that restructuring is a positive NPV decision note that the change in the joint distribution does affect the first best surplus. The surplus if both assets are restructured is

[20] For example, access to financial institutions' computer code for electronic trading is extremely valuable to outsiders.This has lead to multiple attempts of unlawfully copying such code. A recent example of a court case documenting the copying of proprietary code involves trader Ke Xu and the hedge fund Trenchant. [FT.com: Hedge fund worker jailed for copying code, July 03, 2015]

given by:

$$\begin{aligned} S &= (1-\eta)^2 (R+B+L) + \eta^2 p_C (c\gamma L) [c(R+B) + p_N (n\gamma L) n(R+B)] - I \\ &\quad +\eta(1-\eta) p_C (c\gamma L) [c(R+B) + n(R+B+L)] \\ &\quad +\eta(1-\eta) [c(R+B+L) + p_N (n\gamma L) n(R+B)]. \end{aligned}$$

Perhaps counterintuitively, the surplus is smaller than the surplus when the deterioration probabilities are perfectly correlated. The reason for this is the larger negative impact caused by the deterioration of the core asset. When the core asset deteriorates, its restructuring is not always successful. Such failed restructuring has now a more severe impact on the payoff if the non-core asset is intact than if its prospects also deteriorate. As such a relatively strong externality does not arise if either both or none of the assets deteriorate. Hence, the overall surplus is lower if the likelihood of deterioration is independently distributed across different assets.

The distribution does not only affect the surplus when restructuring takes place, but also in case restructuring is not undertaken because of collateralization. The surplus is then $(1-\eta)^2 (R+B+L) + \left(\eta^2 + \eta(1-\eta)\right) L + \eta(1-\eta) [c(R+B+L) + nL] - I$. Here the externality is even stronger, as only the liquidation value is obtained whenever the core asset deteriorates, even if the non-core asset remains intact.

The larger negative impact caused by the deterioration of the core asset also impacts the benefits to collateralizing the non-core asset relative to refraining from doing so. By not collateralizing the unrelated non-core asset, the firm is also able to avoid the significant loss in surplus in case that only the non-core asset deteriorates. The pledgeable value by collateralizing the non-core asset is increased if

$$L \geq [\eta p_C (c\gamma L) + (1-\eta)] p_N (n\gamma L) R. \tag{23}$$

This condition is stricter than the corresponding one when the assets deteriorate in perfectly correlated fashion. Thus it holds:

Proposition 5 *When a non-core asset's prospects deteriorate independently from the prospects of the core asset, the non-core asset asset is less frequently used as collateral than when both assets' deterioration is perfectly correlated.*

Discussion: asset relevance, debt capacity and leasing

The analysis in this section serves to illustrate that the debt capacity of an asset depends on the role of that asset in the context of the firm's overall pool of assets. Two assets with similar individual characteristics, when seen in isolation, can have very different relations to the other assets of the firm. Suppose that one is a core asset and the other a non-core asset. Then, the two

apparently equivalent assets, have very different pledgeable values, are pledged in very different ways to the lenders and, as a result, generate different debt capacities for the firm. For example, two laboratory settings in pharmaceutical/biotech firms of identical individual characteristics may have different debt capacities if one is a core asset (e.g. a proprietary lab set-up to identify promising compounds), and the other is a non-core asset (e.g. a generic quality control protocol).

It is not uncommon for the status of an asset to change with time and the strategic focus of the firm. An example of this is Tesco's controlling stake of Dunnhumby, the company that operates its Clubcard loyalty scheme: "Dunnhumby was instrumental in Tesco's domination of the British supermarket sector in the late 1990s and early part of this century". More recently, however, "... Dunnhumby has been identified as a non-core asset that could generate substantial value".[21] Our model helps to see that an asset's debt capacity depends on its status (core or non-core asset), and that status is not a static condition, even if the asset's identity and characteristics remain unchanged.

The impact of an asset's status on the debt capacity of the firm comes from the unique externality that core assets create on the value of non-core assets. This means that a firm that decides to allocate the property rights of core assets to its debt holders, it is paying a very cost when it does that. Therefore, the firm must do its utmost to retain the option of inside flexibility to manage its core assets. Non-core assets do not exert an externality, and the firm does not have to manage and may even sell them. Our argument is very different from the view that non-core assets generate debt capacity because they can be sold for cash and supports the firm's leverage. Collateralization prohibits the sale of non-core assets and forces these to remain in the firm.

Corporate financial reports do not distinguish core and non-core assets. Therefore, it is possible that firms with identical balance sheet levels of Property, Plant and Equipment (PPE) have significantly different debt capacities. Ignoring the distinction between core and non-core assets introduces a bias in assessing the firm's capital structure, debt capacity and firm value. This bias would not be serious if an asset's property of being core and non-core was strongly correlated with the asset's presumed characteristics, such as, specificity, tangibility and redeployability, widely used in empirical studies to assess an asset's ability to generate firm debt capacity. But, as we have mentioned before, specific core assets can be highly desirable to competitors. Also, often non-core assets are not easily redeployable. Thus, we conjecture that a strong correlation between an individual asset's characteristic and its status is very unlikely.

The differences we point out to explain collateralization both between core and non-core assets, and different degrees of the assets' complementary apply to leasing. More generally, leasing is just one specific form of asset collateralization. Eisfeldt and Rampini (2009) show that leasing facilitates repossession of the asset when companies get into financial trouble. Lessors have control rights. However, their right to remove assets when the lessee is in financial trouble, can

[21] See FT.com: WPP eyes stake in Tesco Clubcard operator, March 16, 2015.

actually precipitate bankruptcy and upset the reorganization in Chapter 11. Therefore, firms must be very careful when they decide which assets to lease. Companies should not lease a core asset, because when its restructuring is essential for the success of the firm, the firm may find that the lessor does not allow it. This is because, even if restructuring benefits all parties, the lessor bears the risk that restructuring does not succeed or the asset loses value in the secondary market once it is transformed into a less comparable asset. Furthermore, during bankruptcy, realizing the full value L may require restructuring. For that reason, an automatic stay in bankruptcy commonly ring fences assets that serve as collateral for specific debts. However, automatic stays do not incorporate leased assets, which are returned to the lessor. In our model, this means that a firm in default is not able to realize the full value L, if stripped of core assets that have been leased. The cost of leasing is the inability to restructure the asset before and in bankruptcy. We believe that this cost explains why leasing contracts assign property rights to the lessor, as well as why the need to control the core assets explains why leasing markets for core assets do not exist.[22]

5 Empirical Implications and Discussion

The model has a number of empirical implications. Very profitable firms and firms with strong balance sheets do not need to collateralize assets and resort to secure debt, especially when it is important to keep the option of maintaining inside flexibility. Less profitable firms have to use collateral to obtain debt. This is also the case in the models of Rajan and Winton (1995) and Inderst and Müller (2007). It is also consistent with the empirical findings in, for example, Berger and Udell (1995), Dennis, Nadny and Sharpe (2000), and Rauh and Sufi (2010). Collateral protects the value of the loan. However, collateralizing assets put severe limitations on the entrepreneur. Consequently, loans secured by collateralized assets that cannot be restructured, are more likely to default, but offer better protection in default.

An asset with strong value preservation increases a firm's debt capacity, but stability in value does not say much about suitability for collateralization. Assets with a high degree of fungibility or substitutability tend to be more used as collateral. Complementarity among assets reduces the advantage that each asset is individually collateralized. Thus, firms decide to collateralize most or very few of their more complementary assets. However, complementarity is an unlikely primary reason to collateralize an asset. More important, is the asset's specific contribution to the value created by the firm. Firms tend to avoid collateralizing their core assets. They prefer to collateralize only non-core assets. Among the non-core assets, firms collateralize first assets that are less related to the core assets. And if firms must collateralize core assets, then they have very low levels of wealth, in which case they collateralize both non-core and core assets.

[22] For different perspectives on leasing, see Eisfeldt and Rampini (2009) and Rampini and Viswanathan (2010).

Also, firms should avoid leasing core assets in case these are used in activities that need to be restructured.

Many empirical studies that focus on the debt capacity of the firm appear to be biased, since they assume an association between a firm's financial capacity and the characteristics of its assets, such as redeployability, tangibility and non-specificity. The problem arises because corporate accounting does not distinguish between core and non-core assets. Therefore, it is possible that two companies with the same amounts in Property, Plant and Equipment (PPE) can have different debt capacities and as well as quite different amounts of collateralized assets. We conjecture that, a strong correlation between an individual asset characteristic and the contextual property of an asset, being core or non-core, is rather unlikely.

Covenants and collateral have different roles in protecting the rights of lenders. While collateral is a property right attached to a specific asset or groups of assets, covenants are contractual rights that are best applied at a higher level, for example a division or a firm. Covenants that keep the costs of monitoring at a reasonable level, give the entrepreneur the necessary flexibility to restructure. However, when the incentives to monitor are low and the monitoring costs are high, collateralizing assets is the a better alternative.

6 Concluding Remarks

Non-financial firms pledge many assets to their lenders. The empirical literature associates collateral with the characteristics of the assets pledged in the event of default. An asset is a good candidate for collateral if it is tangible, and tangibility is often associated with redeployability, presumably reflecting higher recovery rates in the event of liquidation. Furthermore, tangible assets that are less specific appear to make better collateral. On the other hand, the lack of tangibility drives the cost of borrowing up, as the firm has to tap more expensive sources of capital to fund investments. Because increases in costly finance mitigate the effect of a cash flow shock, the response of investment to cash flow shocks is stronger when the tangibility of the firm's underlying assets is high. Our analysis shows this line of reasoning is not so straightforward. Tangibility of an asset is suitable for collateral insofar as tangible assets strike the right balance between internal redeployability and external redeployability. Intangible assets can be less suited as collateral, because they either have jointly high redeployability in default, as well as internally, or high values both in default and when they need to be restructured. For example, specific intangible assets, such as rights to brand names or patents may have very high values at any date, whereas less concretely defined intangible assets, such as the capability of a firm to develop innovative products, may be associated with a substantial loss in value if they need to be transferred, leading to both low γL and low L.

Collateral imposes restrictions on the borrower to transform/reuse an asset in case of a needed

restructuring. This represents a limitation to the property rights of the owner-borrower, with the purpose of protecting the value of the asset pledged to the lender. Highly profitable firms and firms with strong balance sheets do not give up their freedom to restructure their assets, and therefore are free to choose whether to use collateralized debt or not. Less profitable firms have to use collateral to obtain debt. If collateral is used in debt contracts, our model establishes a pecking order, predicting that predominantly non-core assets with a low degree of specificity are used. Only severely financially constrained firms decide to collateralize core assets. Paradoxically, collateralizing might contribute to increase the likelihood of bankruptcy.

With multiple assets, ownership rights in one asset (specifically, the right to sell it) can be used to restructure a different asset, but this is only possible if both assets are not collateralized. Also, assets with higher degrees of fungibility/substituibility tend to be more frequently used as collateral. The result that fungibility is positively associated with collateralization may be surprising, because fungibility is often associated with the easier diversion of funds.

An extension of the model can show that in environments with stronger institutions, lenders not only need less collateral per unit of loan amount, but also accept collateral with higher specificity. This seems to suggest that lenders understand that the collateralization of certain assets reduces the value of the lenders' claim.

Finally, we show that when there is the risk of losing the full value of an asset in default, an automatic stay must ring-fence some assets that are used as collateral for specific debts. Since leased assets are returned to the lessor in the event of bankruptcy, firms prefer to collateralize than to lease assets that are important to the successful restructuring in Chapter 11. Leasing has a cost that comes from the inability to restructure the asset successfully. Leasing makes more sense for assets that do not display significant complementarities with other assets, so that leasing does not compromise a needed restructure.

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