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# Outside Collateral, Preserving the Value of Inside Collateral and Sorting**


## Abstract

Within a framework of debt renegotiation and a priori private information, what is the role of outside and inside collateral? The literature shows that unobservability of the project's returns implies that the high-risk borrower is more inclined to pledge outside collateral than is the low-risk borrower. However, this finding does not hold when the bank can observe neither the project's returns nor the borrower's risk class. We show that in this scenario, low-valued outside collateral enables the low-risk entrepreneur to select himself, but high value outside collateral has no sorting potential at all. We also show that a bank's incentive to sort borrowers may induce investment to preserve the value of the inside collateral and to build up restructuring know-how. If self-selection via outside collateral is operating, restructuring know-how reduces the cost of separation. If outside collateral gives rise to pooling, restructuring know-how may restore sorting.


JEL-Classification: D82, G21, G33.

## 1 Introduction

Banks want to sort borrowers according to whether the borrower is high or low-risk. In this paper, we ask if a bank's incentive to sort borrowers is an inducement to invest in restructuring know-how. To answer this question, we explore the role of outside collateral and restructuring know-how within a framework of two-dimensional asymmetric information. We model banks that can neither observe the borrower's type ex ante nor the project's outcome ex post. The debt contract contains a bankruptcy clause that defines the project's assets as the inside collateral of the contract. This clause enables the creditor to seize the firm's assets in the event of default. But, as the bank is a priori the less efficient manager of the firm, the entrepreneur has an incentive to default strategically and renegotiate his debt[1]. To weaken this incentive of repudiation (*Gale/Hellwig* (1989)), the entrepreneur may either be forced to pledge outside collateral or the bank may invest in restructuring know-how upfront. The latter is an investment for protecting the

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1 See *Bester* (1994).

value of the inside collateral. We assume that if the bank has invested it can take over efficiently in the event of default.

Restructuring know-how may be thought of as an intensive, firm-specific, monitoring process that starts immediately after the firm has chosen a restructuring contract. During the process, the bank's loan officer, together with some members of the restructuring department, may collect any relevant information and prepare it for later use. Because collecting private information cannot be done without developing a relationship with the firm and consulting the entrepreneur from time to time, the bank's ability to restructure a firm and to maintain it after taking it over as a going concern is an important feature of relationship lending (*Boot* (2000); *Brunner/Krahnen* (2000)). With information collection as crucial part of the investment in restructuring know-how, it seems natural to assume that the borrower can observe the bank's upfront investment.

Our research makes two points. First, we show that self-selection by the low-risk borrower who pledges private assets as collateral may also exist in a framework of costly verification of the state. This contradicts *Bester*'s (1994) result that unobservability of a project's returns leads to collateralization by the high-risk entrepreneur. In fact, observability of risks is crucial to *Bester*'s conclusion. Building on *Bester*'s framework, and assuming that the borrower's type is unknown, we find that outside collateral acts as a sorting device. Thus, the low-risk borrower is more inclined to secure his debt with additional private assets than is the high-risk borrower. Although this result is in accordance with most of the theoretical research, it is somewhat puzzling when we consider the empirical literature. Most studies find just the opposite to be true (see *Berger/Udell* (1995), *Carey/Post/Sharpe* (1998), or *Elsas/Krahnen* (1998) and *Table 1*).

On the basis of our findings we suggest that this puzzle might be due to the fact that theoretical and empirical research concentrate on different stages of the creditor/debtor relationship. At the start of this relationship, the new borrower's risk class is always somewhat unclear. Banks are therefore obliged to allow for self-selection even if it is extremely expensive to secure debt. However, as the creditor learns more about his clients, the urge for self-selection gradually disappears. The outside collateral's potential to force proper repayment then becomes the dominant motivation for securing debt, and the creditor will demand outside collateral from the high-risk borrower in the first place. By relying implicitly on the *sorting-by-observed-risk paradigm* (*Berger/Udell* (1990)), empirical research presumably captures only the second, more mature, stage of this relationship[2]. This explanation of the disparity between theory and empiricism is supported by an empirical study by *Cressy* (1996). By analyzing the financing of business start-ups, *Cressy* shows that low-risk entrepreneurs do indeed pledge more outside collateral and pay lower interest rates than do high-risk borrowers.

Our second main point refers to the ongoing struggle by banks to establish effective restructuring departments and permanently enhance their efficiency once

2 We should also be aware of the fact that empirical studies usually do not differentiate between outside and inside collateral. This raises additional doubts about the puzzle.

*Table 1: Empirical Evidence*

| Who has to post more collateral? | | |
|---|---|---|
| Author(s) | low risks | high risks |
| **Large firms** | | |
| *Ewert/Schenk/Szczesny* (2000) | x | x |
| *Machauer/Weber* (1998) | | x |
| *Elsas/Krahnen* (1998) | | x |
| *Elsas/Krahnen* (1999) | | x |
| *Carey/Post/Sharpe* (1998) | | x |
| **Small firms** | | |
| *Harhoff/Körting* (1998) | | x |
| *Blackwell/Winters* (1997) | | x |
| *Berger/Udell* (1995) | | x |
| **Very small firms** | | |
| *Degryse/van Cayseele* (2000) | x | |
| *Cressy* (1996) | x | |

these departments are in place. We suggest that the investment in restructuring know-how is not only driven by the increased default risk, but also by the way banks use outside collateral in debt contracts. First, according to our findings, restructuring know-how may economize on the extremely inefficient, but because of self-selection nevertheless inevitable, pledging of outside collateral. Second, if self-selection cannot be achieved using outside collateral, restructuring know-how can function as an alternative sorting mechanism. We want to stress that in most cases of separation a bank only chooses to invest in preserving the value of the inside collateral and in being tough in case of default if it faces a high-risk borrower. Although the low-risk borrower has to pledge outside collateral, he may also obtain debt forgiveness. Interestingly, in some separating equilibria created either by outside collateral only or by restructuring know-how, banks can earn sustainable positive profits even though there is perfect competition (*Bester* (1995))[3].

In preparation for making these main points we develop a benchmark model in which banks know the borrower's risk type a priori, but cannot observe the project returns directly. Since high-risk borrowers are more likely to default strategically than are low-risk borrowers, their motivation to secure the debt with additional private assets is stronger. For the same reason, when dealing with the high-risk borrower, banks have a greater incentive to invest ex ante in restructuring expertise.

3 *Bester* also emphasizes that sustainable positive profits can occur even though there is perfect competition among agents.

The paper reflects earlier studies by *Chan/Thakor* (1987) and *Boot/Thakor/Udell* (1991). These researchers have also studied a problem of two-dimensional information asymmetry. They focus on private information about creditor's type combined with unobservability of action choice. We concentrate on ex ante private information and unobservability of project returns. In addition, both *Chan/Thakor* and *Boot/Thakor/Udell* only consider outside collateral, but we allow for restructuring know-how as a second instrument to weaken borrowers' ex post opportunism. By showing that, with two instruments, unconstrained availability of outside collateral is neither a necessary nor a sufficient condition for a separating equilibrium (*Bester* (1985)) the paper is also related to *Besanko/Thakor* (1987), *Bester* (1987), and *Hellwig* (1988). These authors use the rationing probability as an alternative sorting device. Good borrowers are less likely to receive a credit, since rationing deters bad borrowers from coveting the good borrowers' contracts[4]. In our framework, banks also sort by increasing the high-risk borrower's imitation costs. However, since restructuring know-how reduces the default risk, the sorting is due to the fact that banks offer the bad borrower a more profitable type of contract.

In focusing on the deterrence of inefficient default, we take a different approach from that of *Manove/Padilla/Pagano* (1998). They study the separation of high- and low-risk firms, but assume that a bank can invest upfront in a screening technology and rule out directly all the negative net present value (NPV) projects in advance. By suggesting that banks are lazy, (that is, banks do not invest and screen out the bad projects of low-risk debtors because these types select themselves by posting outside collateral), the authors propose that creditors' rights to repossess outside collateral are weakened. This conclusion depends heavily on the assumption that the debtors post fully liquid outside collateral. Introducing liquidation costs within their framework would give results that are in some way comparable to our findings. That is, banks may use upfront investments to economize on inefficient but inevitable pledging of outside collateral.

The next section describes the model and derives the equilibria with unobservable project returns only. In Section 3 the two dimensional information asymmetry case is analyzed. We first explore the credit market equilibria when outside collateral is the only instrument for restricting borrowers opportunism. We then study the impact of restructuring know-how on the different equilibria. Section 4 concludes. All proofs appear in the Appendix.

## 2 The Model

*Project and entrepreneurs*

I consider a risk-neutral economy. Because they do not have liquid funds, entrepreneurs ask banks to finance profitable but risky projects. However, each entrepreneur has known non-liquid private wealth $W$, which he can use as outside collateral $C \in [0, W]$. The project requires the initial investment $I$ and, since the entre-

4 See *Kürsten* (1997) for critical remarks on the rationing theory.

preneur is in charge, this investment yields the high return $x_h$ if it is successful and $x_l$ otherwise. We do not allow for safe credits, $I > x_l + W$. To simplify the model, we normalize the interest rate to zero. The project's returns are the private information of the entrepreneur. The creditor can only observe the true outcome after transfer of control. Depending on the entrepreneur's type $j \in [g, b]$, the probability that the project succeeds is either $p_g$ or $p_b$, where $1 > p_g > p_b > 0$. Each borrower knows his own type.

*Banks*

Banks are perfectly competitive and face a perfectly elastic supply of funds. The bank cannot distinguish among borrowers. It only knows that a fraction $\mu$ of the entrepreneurs are low-risk types $g$ (good borrowers) and that the rest $(1-\mu)$ are high-risk types $b$ (bad borrowers). Moreover, banks are, a priori, the less efficient managers. Therefore, if the entrepreneur declares default and the bank exercises the right to foreclose, it has to bear a transfer-related loss of $(1-\alpha_i)\, x_i$, where $i \in \{l,h\}$. However, the creditor can get around this takeover cost if he chooses to invest $S$ ex ante and build up restructuring know-how. We assume that the creditor's skill in restructuring is effective only if the declared failure is true. In this case it preserves the value of the inside collateral and lowers the takeover cost to zero. Denoting the creditor's decision by $k \in \{0,S\}$ we define

$$\gamma_k \equiv \begin{cases} 1 & \text{if } k = S \\ \alpha_l & \text{if } k = 0. \end{cases} \tag{1}$$

Assumption (1) reflects economies of specialization. If such economies exist the creditor always concentrates on the restructuring of companies that are truly in default. We assume that an unsuccessful project can never yield higher returns than a successful project, even though the bank has invested $S$,

$$\alpha_h x_h > x_l .$$

The bank may also demand outside collateral. If the entrepreneur has secured the outstanding debt and default occurs, the bank liquidates the outside collateral at a cost of $(1-\beta)C$. At first we examine the bank's situation if it has not invested $S$. Suppose the project turns out to be unsuccessful and default is declared. The bank does not know what the state is. It can either take possession of the entrepreneur's assets or renegotiate and forgive a portion of the outstanding debt. Since takeover would depress the asset's value to $\alpha_l\, x_l$, the creditor's dominant strategy is to reduce the repayment obligation to $x_l$, the maximum amount the entrepreneur pretends to have. However, since the face value $R$ is greater than $I$ and, consequently, also greater than $x_l + C$, the prospect of a smaller repayment obligation creates a strong incentive to default in the good state as well.

Suppose now that the creditor has invested $S$. There is then no takeover-related loss in the bad state. Clearly, debt forgiveness is always inferior. Because it is certain that control of the firm will be transferred to the bank, the entrepreneur's incentive to default strategically vanishes.

*Game*

*Figure 1* illustrates the game. In $t = 0$ the bank's credit policy consists of the credit $I$, the (observable) upfront investment $k$, the face value $R > I$, and the amount of outside collateral $C$. In $t = 1$ the return $x_h$ or $x_l$ is realized. Given $x_l$, the owner must default. However, if his project is successful, the entrepreneur has two options. He can either repay $R$ or pretend failure. In the first case, the entrepreneur receives $x_h - R$ and the creditor's net payoff is $R - I - k$. We allow mixed strategies. So the entrepreneur can take the second option with probability $d_{jk} \in [0,1]$. Given that default has been declared, the owner makes a 'take it or leave it' offer to the bank. The offer proposes that the bank reduces the repayment to $x_l$. If the lender accepts the offer, the owner keeps control over the project and receives $x_h - x_l - C$ in strategic default and $-C$ in liquidity (true) default. The bank's payoff is $x_l + \beta C - I - k$. That is, the whole surplus of avoiding bankruptcy goes to the entrepreneur. This creates a strong incentive to default strategically. If the bank rejects the offer, it imposes bankruptcy. The owner loses both the project and the collateral. The bank's payoff is $\alpha_h x_h + \beta C - I - k$ if the project has succeeded, and $\gamma_k x_l + \beta C - I - k$ otherwise. The probability that the creditor actually imposes bankruptcy is denoted by $t_{jk} \in [0,1]$.

*Renegotiation and takeover strategies*

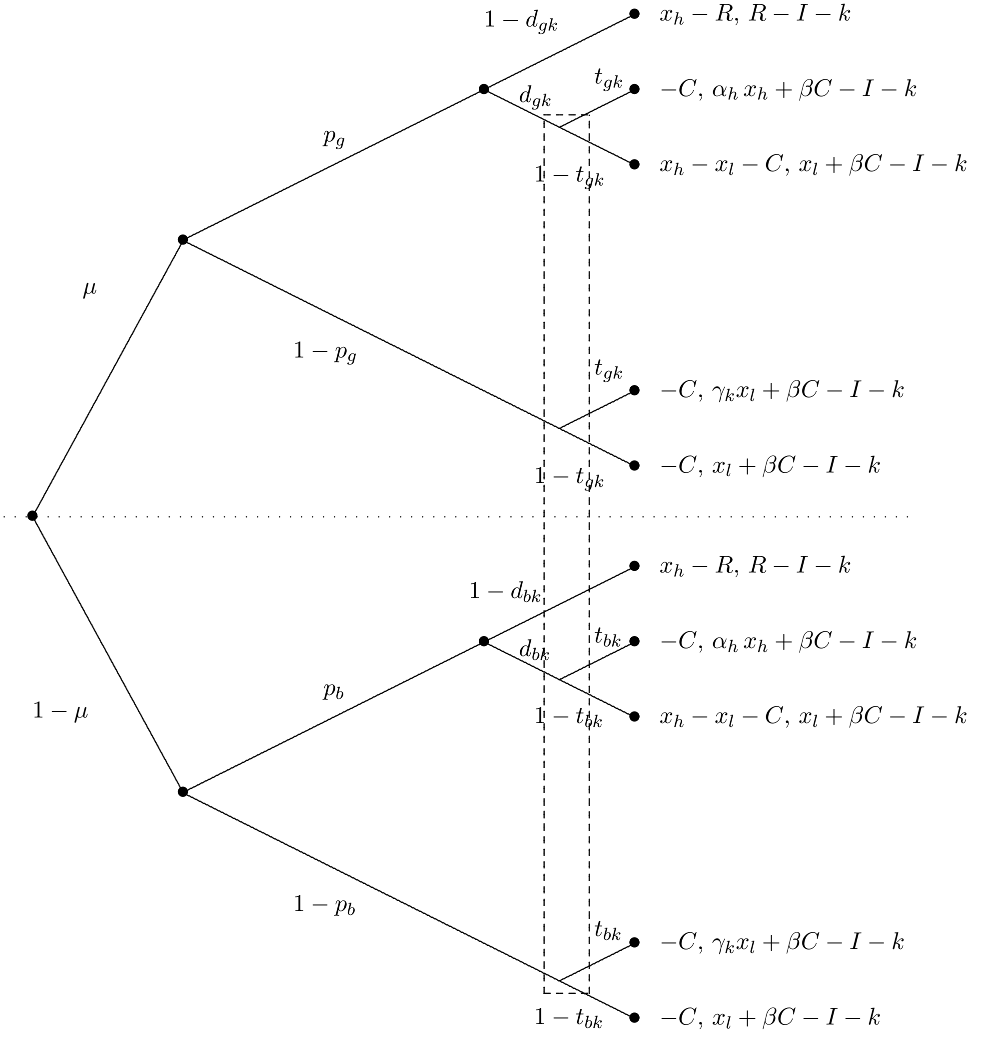
We solve the renegotiation and takeover game by applying the concept of the perfect Bayesian equilibrium (*Bester* (1994)). To begin, we suppose $k = 0$ and the bank knows that the borrower is type $g$. When the borrower declares default, the lender still has no information about the project's outcome. Let the lender expect that the entrepreneur always declares falsely, $d_{g0} = 1$. Since the posterior probability that $x_h$ has been realized is $p_g d_{g0}/(p_g d_{g0} + 1 - p_g)$ the lender's expected payoff from takeover is given by

$$p_g \alpha_h x_h + (1 - p_g)\alpha_l x_l + \beta C > x_l + \beta C. \tag{2}$$

This implies an optimal takeover probability of $t_{g0} = 1$. Given $x_h - R > -C$, the entrepreneur's best response to $t_{g0} = 1$ is $d_{g0} = 0$. However, if the creditor expects that the entrepreneur is telling the truth, he will believe that the project has failed whenever default is declared. As $\alpha_l x_l < x_l$, he reacts to $d_{g0} = 0$ by setting $t_{g0} = 0$. Consequently, $d_{g0} = 1$ and $t_{g0} = 1$ are inconsistent.

Now let the lender believe that default results only from project failure, $d_{g0} = 0$. Given such a belief, the lender will prefer to renegotiate in default, $t_{g0} = 0$. However, this cannot be part of the equilibrium path, because if the entrepreneur expects a final concession, he will optimally default in the good state: $x_h - x_l - C > x_h - R$ and thus $d_{g0} = 1$. As a result, the only strategies consistent with equilibrium behavior are mixed: $0 < d_{g0} < 1$ and, based on analogous arguments, $0 < t_{g0} < 1$. Similar reasoning applies for type $b$. Thus, in equilibrium, the bank is indifferent between takeover and renegotiation,

*Figure 1: The game*




$$\frac{p_j d_{j0}}{p_j d_{j0} + 1 - p_j} \alpha_h x_h \frac{1 - p_j}{p_j d_{j0} + 1 - p_j} \alpha_l x_l = x_l$$

and the entrepreneur is indifferent between repayment and default,

$$x_h - R = (1 - t_{j0})(x_h - C - x_l) + t_{j0}(-C).$$

Solving yields

$$d_{j0} = \frac{(1-p_j)(1-\alpha_l)x_l}{p_j(\alpha_h x_h - x_l)} \quad \text{and} \quad t_{j0} = \frac{R-C-x_l}{x_h - x_l}$$

respectively. We turn now to $k = S$. In the case of default, if $i = l$, the lender is indifferent between bankruptcy and renegotiation. In state $h$, he will strictly prefer a takeover, as $\alpha_h x_h > x_l$. Thus, given restructuring skills, the optimal strategy is takeover with certainty, that is $t_{jS} = 1$. Takeover with certainty implies truth telling, $d_{jS} = 0$. With truth telling, $t_{jS} = 1$ is weakly dominating. Sequential rationality thus leads to consistent beliefs and the equilibrium strategies are $d_{jS} = 0$ and $t_{jS} = 1$. If the project succeeds, the entrepreneur pays back $R$. If the project fails, the lender seizes the assets and the collateral.

### 2.1 Basic Structure and Definition of Equilibrium

We denote a credit contract as $(R,C)$. $(R_{jk}, C_{jk})$, $k \in \{0,S\}$ is the contract signed by type $j$ exclusively. $(R_k, C_k)$ is the pooling contract adopted by both types. If $k = S$, we refer to the contracts as restructuring contracts. We do not allow for random strategies in granting a credit in $t = 0$. To exclude signaling the entrepreneur's type by means of credit size, we assume that the project's initial outlay is identical for each investor[5]. The following timing of moves illustrates the basic structure of the model:

1. lenders propose contracts, $(R_{gk}, C_{gk})$, $(R_{bk}, C_{bk})$ or $(R_k, C_k)$,

2. entrepreneurs choose the type of contract, receive the credit and invest $I$, and depending on the chosen contract, lenders invest the (observable) $S$ or nothing,

3. the project's return is realized,

4. if the project is successful ($i = h$), entrepreneurs decide whether to pay back or default,

5. lenders may either renegotiate or take over.

Suppose the separating contracts $(R_{gk}, C_{gk})$ and $(R_{bk}, C_{bk})$ have been adopted. Given the equilibrium probability of false default $d_{jk}$, the bank's expected profit is

$$G_{jk} = p_j(1-d_{jk})R + (1-p_j+p_j d_{jk})(x_l + \beta C) - I - k. \tag{3}$$

This is the expected return in the non default state, plus the expected return in the case of default, minus the funding costs, and minus the costs of acquiring restructuring know-how. Zero profit for the bank implies

5 See *Milde/Riley* (1988) and *Bester/Hellwig* (1989), who analyze the sorting potential of the initial investment.

$$R_{jk}(C) = \frac{I + k - (1 - p_j + p_j d_{jk})(x_l + \beta C)}{p_j (1 - d_{jk})}. \tag{4}$$

Next, we examine pooling. We denote the equilibrium probability of default in the case of pooling as $\bar{d}_{jk}$. The bank's expected profit in a pooling equilibrium is

$$\begin{aligned}\bar{G}_k = {} & \mu\left(p_g(1 - \bar{d}_{gk})R + (1 - p_g + p_g \bar{d}_{gk})(x_l + \beta C) - I - k\right) \\ & + (1 - \mu)\left(p_b(1 - \bar{d}_{bk})R + (1 - p_b + p_b \bar{d}_{bk})(x_l + \beta C) - I - k\right).\end{aligned}$$

Since the bank's payoffs are identical for both types (see *Figure 1*), pooling is only consistent with $\bar{d}_{bk} = \bar{d}_{gk} \equiv \bar{d}_k$. Given that the pooling contract $(R_0, C_0)$ is calculated on the basis of $\bar{d}_0$, type *j*'s best response is to behave like an average type and fix the equilibrium strategy to $\bar{d}_0 = (1 - \bar{p})(1 - \alpha_l)x_l/(\bar{p}(\alpha_b x_b - x_l))$. Note that $d_{jS} = \bar{d}_S = 0$. Zero profit for the bank yields the face value

$$R_k(C) = \frac{I + k - (1 - \bar{p} + \bar{p}\bar{d}_k)(x_l + \beta C)}{\bar{p}(1 - \bar{d}_k)} \tag{5}$$

where $\bar{p} \equiv \mu p_g + (1 - \mu)p_b$. The calculation of the entrepreneur's profit function gives

$$\Pi_j(R, C) = p_j(x_b - R) - (1 - p_j)C. \tag{6}$$

We consider only feasible projects, that is, $G_{b0} \geq 0$, $\prod_j \geq 0$[6]. By inserting (4) into (6) and differentiating the resulting expression for *C*, after rearranging we arrive at

$$\beta_{jk} \equiv \frac{(1 - p_j)(1 - d_{jk})}{p_j d_{jk} + 1 - p_j}.$$

Using (5) in the same way, we obtain

$$\bar{\beta}_{jk} \equiv \frac{(1 - p_j)}{p_j} \frac{(1 - \bar{d}_k)\bar{p}}{\bar{p}\bar{d}_k + 1 - \bar{p}}. \tag{7}$$

$\beta_{jk}$ and $\bar{\beta}_{jk}$ indicate thresholds that refer to the ex post efficiency of securing debt. If $\beta$ is above the threshold, collateral's benefit which is the prevention of strategic default, is higher than its liquidation cost. Thus, securing debt is ex post efficient: $C = W$. With separated types we have $\beta_{b0} < \beta_{g0}$. The threshold for pledging outside collateral is lower for the bad borrower than for the good one. This is because type *b* is more inclined to deceive the bank. Since outside collateral reduces the incentive to pretend false returns, the borrower who cheats with higher probability

6 This implies $I \leq p_b(1 - d_{b0})x_b + (1 - p_b + p_b d_{b0})x_l$.

should pledge outside collateral in the first place. If the bank has acquired restructuring expertise, $d_{jS} = \bar{d}_S = 0$ imply $\beta_{jS} = \bar{\beta}_{jS} = 1$. This indicates that collateral is not beneficial in terms of preventing strategic default. The reason is that the restructuring know-how completely rules out the entrepreneur's motive to deceive the bank. Since the "job" is already done, collateralization is left with expected cost of $(1 - \beta)W$ but no benefits, so to refrain from it is certainly efficient.

It is easily checked that $\bar{\beta}_{g0} < \beta_{g0}$ and $\bar{\beta}_{b0} > \beta_{b0}$. For simplicity, we assume that the fraction of good borrowers is in a medium range, so that $\bar{\beta}_{g0} < \beta_{b0}$ and $\bar{\beta}_{b0} > \beta_{g0}$. Obviously, the entrepreneur's ex post efficient strategy for collateral will change if he is pooled. Type $g$'s incentive to pledge outside collateral is certainly strengthened. The reason for this is that the bank treats every single borrower as being of average quality. However, type $g$ has a higher success probability than does the average debtor. Thus, if he is pooled, his motivation to default strategically and renegotiate his debt grows instantly. Refusal of payment lowers efficiency and profit, and that makes the restriction of the cheating motive via outside collateral especially beneficial. In contrast, the high-risk borrower faces a different situation. Since his success probability is overestimated in the pool, his motivation to cheat is weakened. Because the pool itself imposes more discipline on the high-risk borrower, the profitability of the disciplinary instrument outside collateral is lowered.

How does ex post efficiency of collateralization affect the equilibrium contracts if the bank has already chosen to offer a pooling variant? Since securing debt increases the profits, the entrepreneur who faces a higher $\beta$ than his threshold $\bar{\beta}_{j0}$ will strictly prefer a fully collateralized variant over any other pooling contract with $C < W$. This strict preference is the ultimate reason for the existence of Nash equilibria even in case of pooling. We analyze this in more detail in Section 3, but at this stage we already want to stress that ex post efficiency is crucial to our analysis of equilibria in the two-dimensional information asymmetry scenario.

With $\beta < \beta_{jk}$ ($\beta < \bar{\beta}_{jk}$), collateralization is ex post inefficient. However, if the bank cannot observe the borrower's type, then outside collateral serves two different purposes, the identification of types and the deterrence of strategic default. Thus, inefficiency in preventing strategic default does not imply that the entrepreneur rejects debt securization. On the contrary, as we will show in the following analysis of a perfectly competitive credit market. We define the equilibrium in this market as follows:

**Definition 1**

*E1* Bank's participation constraint: *Each adopted contract yields nonnegative profits to the bank.*

*E2* No market entry: *Apart from the adopted contracts, there is no other contract that generates positive profits for the banks and nonnegative surplus for the entrepreneurs.*

*E3* Profit maximization: *Each adopted contract maximizes the entrepreneur's surplus.*

### 2.2 The Benchmark: Ex Post Information Asymmetrie only

To create a benchmark, we characterize the competitive equilibria given that the creditors can observe the borrowers' quality. Knowing the entrepreneur's type, the bank offers the good borrower $(R_{gk}, C_{gk})$ but the bad borrower faces $(R_{bk}, C_{bk})$. Where risks are observable, $G_{jk} = 0$ implies that E1 and E2 are satisfied. Recall that $\beta_{b0} < \beta_{g0} < 1$ and $\beta_{jS} = 1$. Set $\lambda = 1$ if $\beta \geq \beta_{j0}$ and $\lambda = 0$ if $\beta < \beta_{j0}$. Let us define

$$S_j(\beta) \equiv (I - x_l)\frac{d_{j0}}{1 - d_{j0}} - W\lambda \frac{(1 - p_j + p_j d_{j0})\beta - (1 - p_j)(1 - d_{j0})}{(1 - d_{j0})} \leq \hat{S}_j$$

as the critical costs of acquiring restructuring know-how. $\hat{S}_j$ represents the maximum of $S_j$.

**Proposition 1** *Because the bank knows the borrower's type ex ante, entrepreneur j selects a restructuring contract if, and only if, $S < S_j$. Since $S_b(\beta) > S_g(\beta)$, the bad borrower is, for all possible values of $\beta$, more inclined to take a restructuring contract than is the good borrower.*

The intuition is as follows: Since the bad borrower faces a higher repayment obligation than does the good borrower, the probability that the bank takes over is higher for type $b$ than for type $g$. Consequently, if the high-risk borrower applies for credit, preparation to avoid the takeover-related losses is especially useful.

## 3 Two-Dimensional Information Asymmetry

We now examine the more realistic scenario, in which the lender can neither observe the borrower's quality nor the project's return. Since parties cannot commit to the equilibrium strategies, we use the modified revelation principle of *Bester/Strausz* (2001), which applies to cases of limited commitment. According to this principle we can restrict our attention to credit policies that are incentive-compatible. That is, sorting of borrowers occurs if, and only if,

$$\Pi_b(R_{bk}, C_{bk}) \geq \Pi_b(R_{gk}, C_{gk}) \tag{8}$$

$$\Pi_g(R_{gk}, C_{gk}) \geq \Pi_g(R_{bk}, C_{bk}) \tag{9}$$

hold, where $(R_{bk}, C_{bk})$ and $(R_{gk}, C_{gk})$ satisfy (3) for $j = b$ and $j = g$ respectively. When we address the problem of what kind of contracts are actually obtained in a competitive equilibrium, we concentrate first on outside collateral only. Thus, in the next section, we assume prohibitively high costs for restructuring expertise ($k = 0$), and focus exclusively on Nash equilibria.

### 3.1 Competitive Equilibrium with outside Collateral

Under ex post asymmetric information (unobservability of project returns), a borrower never pledges outside collateral in equilibrium if $\beta < \beta_{b0}$, because the impact of outside collateral on the probability of inefficient takeover is too small to cover the huge debtor's loss generated by the great disparity between his and the lender's valuation of collateral. However, under two-dimensional information asymmetry, the uncollateralized contracts $(R_{g0},0)$ and $(R_{b0},0)$ cannot represent the bank's optimal credit policy, because the menu is never incentive-compatible. The bad borrower instantly covets any contract $(R_{g0},0)$ that meets the bank's zero-profit condition. In addition, the bank cannot escape from the incentive-compatibility problem by offering a safe credit, since the full insurance level

$$
\begin{aligned}
W_{fI} &\equiv \frac{I - x_l}{\beta} > I - x_l \\
\frac{W_{fI}}{\partial \beta} &< 0
\end{aligned}
\tag{10}
$$

is not feasible, $W < W_{fI}$. However, outside collateral may allow for incentive compatibility if its value is sufficiently low. To see this, we derive the equilibrium isoprofit function of type $b$. Let us denote by $\Pi_b(R_{b0},0)$ type $b$'s profit if $(R_{b0},0)$ is signed. Substituting $\Pi_j$ on the left-hand side of (6) by $\Pi_b(R_{b0},0)$ and solving the resulting expression for $R$ gives

$$
R(C)_{|\overline{\Pi}_b} = \frac{1}{p_b(1-d_b)}\Big(I - (1 - p_b + p_b\, d_b)x_l - C(1-p_b)(1-d_b)\Big). \tag{11}
$$

Any contract $(R(C)_{|\bar{\Pi}_b},C)$ yields $\overline{\Pi}_b$ to the entrepreneur. We denote $R(0)_{|\bar{\Pi}_b}$, as $R^*_{b0}$. By equalizing (11) and $R_{g0}(C)$ from (4) we obtain $C^*_{g0}$ and $R^*_{g0}$. To describe the range for a separating equilibrium, we use $C = W$ in (11), equalize it with $R_{g0}(W)$ from (4), and solve for $\beta$. Let us define the result as $\beta'$. Assumption $W < W_{fI}$ ensures $\beta' < \beta_{b0}$.

**Proposition 2** *If $\beta \le \beta'$, then in an equilibrium under two-dimensional asymmetric information, the bank's optimal credit policy is given by the separating contracts $(R^*_{g0}, C^*_{g0} \le W)$ and $(R^*_{b0},0)$. Only the good borrowers secure their debt. The banks just break even.*

Our result supports the current literature on the sorting of borrowers. With $\beta \le \beta' < \beta_{b0} < \beta_{g0}$, the collateral's liquidation costs are so high that entrepreneurs will never offer collateral when dealing only with strategic default. Therefore, the marginal rates of substitution between outside collateral and repayment have the same structure as in *Bester* (1985) or *Besanko/Thakor* (1987). In addition, for $\beta \le \beta'$ collateralization is so expensive that even small amounts of collateral deter the bad borrower from coveting the good borrower's contract, and the wealth constraint $W$ is not binding. Both features imply that the nature of the separating equilibrium must resemble the one found in *Bester* (1985) and *Besanko/Thakor* (1987)[7]. In the light of this outcome, clearly, one of the main messages in *Bester* (1994), that bad borrowers secure their debt in the first place, is not viable if banks cannot observe the borrower's type. Given a priori private information within a framework of costly verification of state and debt renegotiation, pledging of outside collateral is more attractive for the good borrower than it is for the bad borrower.

Since banks make zero profits, we call the equilibrium described in Proposition 2 an *ordinary* separating equilibrium. Surprisingly there is, for a certain range of $\beta$, a separating equilibrium that yields sustainable positive profits to the bank. To see this, let $\bar{R}_0$ be the face value resulting from (5) for $C = W$. Furthermore, let us denote by $R^+_{g0}$ the face value derived from (11) if we insert $C = W$. Equalizing $R^+_{g0}$ and $\bar{R}_0$ and solving for $\beta$ establishes a second threshold $\beta''$. $W < I - x_l$ and (10) ensure $\beta' < \beta'' < \beta_{b0}$.

**Proposition 3** *In the range of* $\beta \in (\beta', \beta'')$*, the bank's equilibrium credit policy is given by the separating menu* $[(R^*_{b0}, 0), (R^+_{g0}, W)]$*. The good borrower adopts the maximum collateralization contract, but the bad borrower never secures his debt. By signing* $(R^+_{g0}, W)$ *the bank earns positive profits.*

No *ordinary* separating equilibrium is feasible in this medium range of collateral's valuation, because the borrowers' wealth constraint is always binding. Thus, one would expect the bank to offer a uniform contract, but such a contract cannot be an equilibrium either. This is because both contracting parties are better off with a separating menu such that, on the one hand, the bad borrower is indifferent between the separating contracts $(R^*_{b0}, 0)$, and $(R^+_{g0}, W)$ and, on the other hand, $(R^+_{g0}, W)$ guarantees positive profits to the bank. Since both high- and low-risk borrowers will prefer any rival contract that reduces the bank's profits, newcomers, who might offer such a rival contract would end up with a loss-making pooling contract[8].

In the following sections we refer to the menu described in Proposition 3 as a *non ordinary* separating equilibrium. Note that market entry may occur in such an equilibrium, but only with perfect copies of the defined equilibrium contracts. Clearly, in a *non ordinary* separating equilibrium, applicants are never denied credit and rationing can never occur. However, self selection via outside collateral does not always operate. Sorting risks fails if the collateral's value is sufficiently high.

**Proposition 4** *If* $\beta \in [\beta'', 1)$ *risks are pooled in equilibrium and* $(\bar{R}_0, W)$ *is signed. Every single borrower pledges his entire private wealth.*

In a separating equilibrium, the good borrower uses outside collateral to distance himself from the high-risk type. But, for such an equilibrium to emerge, coveting the contract of the good borrower must be sufficiently "expensive" for the bad

7 There is no Nash equilibrium if the fraction of low-risk types in the population is too high. If the menu $[(R^*_{g0}, C^*_{g0}), (R^*_b, 0)]$ of Proposition 2 fails to be a Nash equilibrium, it is a reactive equilibrium (see *Riley* (1979)).

8 The non ordinary separating equilibrium is even a Nash equilibrium if $W$ is not too small. For small $W$, it is at least a reactive equilibrium.

borrower. Highly valued private assets lower the bank's incentive to carry out an inefficient takeover on a large enough scale to make debt securization efficient, or at least almost efficient. Since the bad borrower's imitation costs are (almost) zero, we have $\Pi_b(R^*_{b0},0) < \Pi_b(\bar{R}_0, W)$. Thus, the pooling contract is the only feasible contract here. There is evidence that banks sometimes tend to collateralize their loans to the highest possible degree without checking the borrower's risk class. In the light of Proposition 4, such a behavior might be due to the fact that private assets are sufficiently valuable and an alternative sorting mechanism is not available. However, in any pooling equilibrium the good borrower subsidizes the bad one. This effect certainly provides low-risk entrepreneurs with the highest motivation to escape from such an equilibrium.

### 3.2 Competitive Equilibrum with Restructuring know-how and outside Collateral

Restructuring know-how can prevent the bank from having to bear the costs if it chooses to get tough and take over after default. Thus, restructuring skills eliminate completely strategic default and securing debt becomes more expensive from the entrepreneur's point of view. The bank's marginal rate of substitution between outside collateral $C$ and the face value $R$ is in general, and not only for a specific range of $\beta$ higher than the entrepreneur's rate. As we will see this expanding of the lender/borrower disparity in substitution rates affects the collateral's sorting potential. To develop our argument, we first derive from (6) and (4), $k = S$, the iso-profit line of entrepreneur $b$ as a monotonic function of $S$,

$$R(S,C)_{|\bar{\Pi}_b} = \frac{S + I - (1 - p_b)(x_l + C)}{p_b}, \quad \text{where} \quad \frac{\partial R(S,C)}{\partial S} > 0. \tag{12}$$

Solving (12) for $S$ and inserting the result in $R_{gS}(C)$ from (4) gives, after rearranging,

$$R(\beta,C) \equiv \frac{1 - p_b - \beta(1 - p_g)}{p_g - p_b} C + x_l, \quad \text{where} \quad \frac{\partial R(\beta,C)}{\partial C} > 0. \tag{13}$$

For any given $S$, the function $R(\beta,C)$ reflects the good borrower's restructuring contract that makes (8) with $k = S$ binding and yields zero profits to the bank. That is, for any $S$, the bad borrower is indifferent between the contracts $(R(\beta,C),C)$ and $(R_{bS}(0),0)$. Now let us denote by $R^*_{bS}$ the face value $R(S,0)_{|\bar{\Pi}_b}$ from (12). Furthermore, let $R^*_{gS}$ and $C^*_{gS}$ be the values that satisfy (13).

**Lemma 1** *Suppose both risk types adopt a restructuring contract ($k = S$) and the wealth constraint is not binding. Then, for any $S > 0$, a separating menu*

$$[(R^*_{bS},0)],(R^*_{gS},C^*_{gS} < W)$$

*exists which yields zero profits to the bank. Only the low-risk entrepreneur pledges collateral.*

Since the upfront investment ensures that collateralization is inefficient not only for low values of $\beta$, but also in the whole range $\beta \in (0, 1)$, restructuring know-how strengthens the collateral's potential to sort borrowers. If $k = S$ for both types and private wealth does not impose a constraint on contracts, it must hold, in the entire range of $\beta$, that a pooling contract can never be an equilibrium (*Besanko/Thakor* (1987))[9]. Thus, restructuring contracts adopted by the two types must be distinct. Nevertheless it is still an open question whether, in a credit market equilibrium, both types actually select restructuring contracts. To answer this question, we first identify the cost interval where restructuring know-how has no impact on the equilibrium contracts. Then we analyze the case in which outside collateral sorts borrowers anyway ($\beta < \beta''$). Finally we concentrate on the range ($\beta \geq \beta''$) and derive the impact of restructuring know-how on the pooling equilibria.

**Proposition 5** *Given* $S > \hat{S}_b$, *restructuring contracts are not adopted in equilibrium. The bank's optimal credit policy consists of the menus given in Proposition 2 to 4.*

Any restructuring contract that is rejected by the bad borrower in the case of a one-dimensional information asymmetry ($S > \hat{S}_b$) must be also inferior in a two-dimensional information asymmetry scenario. Thus, there is no distortion-at-the-bottom. Moreover, a contract that is too costly for the high-risk borrower can never be attractive for the low-risk borrower. This fact reflects $\hat{S}_g < \hat{S}_b$ and that the pledging of outside collateral reduces the benefits of restructuring know-how even for the low-risk borrower. With this in mind, we are now able to consider the impact of restructuring know-how on equilibria where the upfront investment may take place.

### *3.2.1 Reduction of Separation costs via Restructuring know-how*

For a given private wealth $W$, borrowers' sorting with outside collateral requires $\beta < \beta'' < \beta_{b0}$. As Proposition 6 states, restructuring know-how affects both sorting equilibria. To prove that, we use Lemma 2. We denote the repayment obligation that satisfies (12) and (4) for $j = g$ and $k = 0$ as $\hat{R}^*_{g0}$. The corresponding outside collateral is $\hat{C}^*_{g0}$. The contract that satisfies (13) and (4) for $j = g$ and $k = 0$ is denoted by $(\tilde{R}_g, \tilde{C}_g)$.

**Lemma 2**

*1. If*

$$S = S_{gW}(\beta) \equiv \frac{W(p_g(1-d_g)(1-p_b)) + (I - x_l)(p_b - (1-d_g)p_g)}{p_g(1-d_g)} - \beta \frac{Wp_b(1-p_g(1-d_g))}{p_g(1-d_g)} \leq \hat{S}_b \;\; \forall \beta \geq \beta'$$

9 In fact, for a fixed $S$, the analysis of the dominant menus described in Lemma 1 shows great resemblance to *Besanko/Thakor* (1987).

*then the bad borrower is indifferent between his own uncollateralized restructuring contract and the fully collateralized non restructuring contract of the good borrower,*

$$\Pi_b(R^*_{bS},0) = \Pi_b(\hat{R}^*_{g0},\hat{C}^*_{g0} = W).$$

*If $S < S_{gW}$, the bad borrower's indifference level $\hat{C}^*_{g0}$ is smaller than the maximum amount W.*

2. *If*

$$\tilde{S}_g(\beta) \equiv \frac{(I-x_l)(1-\beta)p_g d_g(1-p_b)}{\beta(d_g p_g(1-p_b)-p_b(1-p_g))+p_g(1-p_b)(1-d_g)} \leq \hat{S}_g,$$

*the bad borrower is indifferent between three types of contracts: $\Pi_b(R^*_{bS},0) = \Pi_b(R^*_{gS},C^*_{gS}) = \Pi_b(\hat{R}^*_{g0},\hat{C}^*_{g0})$. The good borrower's profit is*

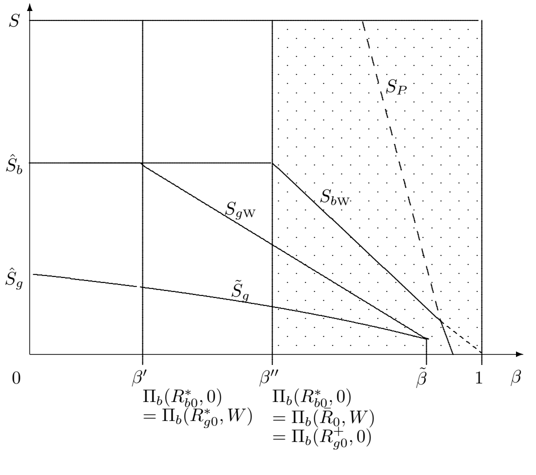
$$\begin{aligned} &\Pi_g(R^*_{gS},C^*_{gS}) \leq \Pi_g(\hat{R}^*_{g0},\hat{C}^*_{g0}) \text{ if } S \geq \tilde{S}_g, \\ &\Pi_g(R^*_{gS},C^*_{gS}) > \Pi_g(\hat{R}^*_{g0},\hat{C}^*_{g0}) \text{ if } S < \tilde{S}_g. \end{aligned} \quad (14)$$

3. *There is a critical value*

$$\tilde{\beta} \equiv \frac{W_{pg}(1-p_b)(1-d_g)-(p_g-p_b)(I-x_l)}{W(p_b(1-p_g)-p_g d_g(1-p_b))} \leq 1$$

*such that $S_{gW}(\bar{\beta}) = \tilde{S}_g(\tilde{\beta}) \geq 0$ and $C^*_{gS} = \hat{C}^*_{g0} \equiv \tilde{C}_g \geq W$ for any $\beta \geq \tilde{\beta}$* [10].

*Figure 2: Restructuring know-how as sorting device*




10 If $\beta \geq \tilde{\beta}$ then $\tilde{C}_g \geq W$. Together with $\beta'' < \beta_{b0} < 1$ and $\partial\tilde{\beta}/\partial W > 0$, this result implies that $\tilde{\beta} > \beta''$ if $W$ is not too small. In what follows, we will concentrate on this case.

*Figure 2* shows the functions $S_{gW}$ and $\tilde{S}_g$[11]. By defining $\hat{R}^+_{g0}$, as the face value that satisfies (12) if $C = W$, we arrive at

**Proposition 6** *If $\beta < \beta''$ and $S < S_{gW}$, restructuring know-how reduces the cost of separation. In the range of $S \in (\tilde{S}_g, S_{gW})$, the bad borrower selects a restructuring contract and the good borrower chooses the non restructuring variant. If $S < \tilde{S}_g$, borrowers sign only restructuring contracts.*

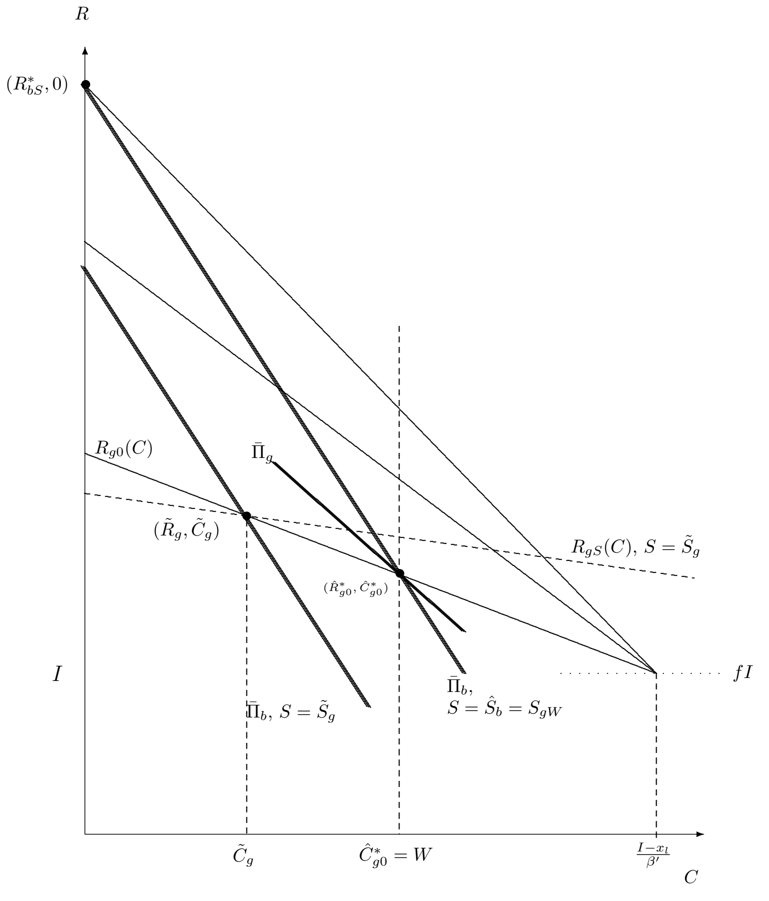
*Figure 3* illustrates the essence of Proposition 6. In the Figure, $\beta = \beta'$ is assumed. Note that the dotted line $fI$ reflects the full insurance contract $(R = I, C = (I - x_l)/\beta)$ for alternating values of $\beta$. The bold lines represent the entrepreneurs' indifference curves $\bar{\Pi}_j$. The solid lines are the bank's isoprofit functions, given that the upfront investment in restructuring skill has not taken place. The solid line closest to the origin belongs to type $g$, the solid line most distant from the origin to type $b$. The dashed line shows the bank's isoprofit curve if $S = \tilde{S}_g$ and type $g$ adopts a restructuring contract. Since $\beta' < \beta_{b0}$, the indifference curves of both entrepreneurs are steeper than each corresponding isoprofit function. Thus, a separating equilibrium emerges anyway. It is easily checked that for $\underline{S} > \hat{S}_b$ only the menu $[(R^*_{g0}, C^*_{g0}), (R^*_{b0}, 0)]$ meets E1–E3. Since the bold curve $\bar{\Pi}_b$ moves nearer to the origin if $S$ is below $\hat{S}_b$, the amount of outside collateral needed for separation reduces if $S$ becomes smaller. With $S = \tilde{S}_g$, the entrepreneurs' indifference curves $\bar{\Pi}_b$ and $\bar{\Pi}_g$ and the bank's zero-profit functions $R_{g0}$ and $R_{gS}$ meet at $\tilde{C}_g$. This result implies that entrepreneur $g$ is indifferent between the two separating contracts $(\hat{R}^*_{g0}, \hat{C}^*_{g0})$ and $(R^*_{gS}, C^*_{gS})$. If $S < \tilde{S}_g$, the zero-profit function $R_{gS}(C)$ is below $R_{g0}(C)$ for all $C < \tilde{C}_g$. This finding indicates that any restructuring contract $(R^*_{gS}, C^*_{gS})$ that leaves the bad borrower indifferent between $(R^*_{gS}, C^*_{gS})$ and $(R^*_{bS}, 0)$ is superior to a separating non restructuring contract $(\hat{R}^*_{g0}, \hat{C}^*_{g0})$.

The intuition for Proposition 6 is that restructuring know-how pays the bad borrower in the first place and enhances his profit even when restructuring costs are high. A restructuring contract saves the high-risk borrower from having to bear transfer-related losses that would be high because bad borrowers face a high repayment obligation, and, consequently, a high probability of control transfer to the bank in the event of default. The contracted repayment of the low-risk borrower is smaller in equilibrium. Also, this borrower pledges collateral. The problem of strategic default and inefficient takeover is therefore less severe and restructuring expertise is less profitable within this risk class. Thus, good borrowers do not sign a restructuring contract in a medium range of $S$. Nevertheless, they benefit from the bank's upfront investment that is dedicated to type $b$. First, in the range of $\beta \in (\beta', \beta'')$ and $S \in (S_{gW}, \hat{S}_b)$ the bank earns positive profits. However, any reduction of the costs of restructuring know-how enables a market entrant to offer a rival contract with maximum collateral but lower face value. Since the probability of inefficient takeover by the bank increases with $R$ the lower face value in the good borrower's contract reduces the cost of separation and enhances his surplus.

Second, in the ranges $\beta \leq \beta'$ or $\beta \in (\beta', \beta'')$ and $S < S_{gW}$, type $b$'s restructuring contract reduces the amount of outside collateral needed for separation. Since pledg-

11 The figure is based on the following parameters:
$I = 450$, $W = 230$, $x_b = 2000$, $x_l = 200$, $\alpha_l = \alpha_b = 0.5$, $\mu = 0.5$, $p_g = 0.6$, $p_b = 0.4$.

*Figure 3: Economizing on inefficient pledging of collateral*




ing of collateral is inefficient for all $\beta \leq \beta''$, this reduction must increase the low-risk borrower's equilibrium profit and simultaneously lower the cost of separation. Because the upfront investment instantly increases the marginal cost of sorting, type $g$ gains from choosing the restructuring contract only if $S$ is at the low level $S \leq \tilde{S}_g$. In an equilibrium in which banks are competing for the loan contracts, the entrepreneurs' profit represents the whole surplus in the economy. Thus, if the upfront investment in restructuring know-how does occur it certainly enhances the overall wealth.

### 3.2.2 Restoring a Separating Equilibrium via Restructuring know-how

Bad borrowers mimic good borrowers and pledge maximum outside collateral if outside collateral is sufficiently valuable ($\beta \geq \beta''$). Thus, without investment in restructuring know-how, the bank's only feasible credit policy consists of a fully collateralized pooling contract. However, pooling may not be viable if banks can invest upfront. To show this, we define $\bar{R}_S$ as the face value that results from (5) if $C = W$, and develop two further cost functions.

**Lemma 3**

1. *Given that* $\beta \geq \beta''$ *and*

$$S_{bw}(\beta) \equiv \frac{W\bar{p}(1-\bar{d})(1-p_b)+(I-x_l)(p_b-1-\bar{d})\bar{p})}{\bar{p}(1-\bar{d})} - \beta \frac{Wp_b(1-\bar{p}(1-\bar{d}))}{\bar{p}(1-\bar{d})} \leq \hat{S}_b$$

*the bad borrower is indifferent between a restructuring contract without collateral and a pooling contract with maximum outside collateral,* $\Pi_b(R^*_{bS},0) = \Pi_b(\bar{R}_0 W)$.

2. *If*

$$S_P(\beta) \equiv \frac{W\bar{p}(1-p_b)-(I-x_l)(\bar{p}-p_b)}{\bar{p}-p_b} - \beta \frac{Wp_b(1-\bar{p})}{\bar{p}-p_b}$$

*the bad borrower is indifferent between a restructuring contract without collateral and a uniform, fully collateralized restructuring contract,* $\Pi_b(R^*_{bS},0) = \Pi_b(\bar{R}_S, W)$.

3. *There is a critical value*

$$\beta_P \equiv \frac{W\bar{p}(1-p_b)(1-\bar{d}_0)-(\bar{p}-p_b)(I-x_l)}{W(p_b(1-\bar{p})-\bar{p}\bar{d}_0(1-p_b))} \quad \textit{with} \quad \beta_P \in (\tilde{\beta},1)$$

*such that* $S_P(\beta_P) = S_{bW}(\beta_P) > 0$ *and*

$$S_P \begin{cases} > S_{bW} \textit{ if } \beta < \beta_P < 1 \\ < S_{bW} \textit{ if } \beta_P < \beta < 1. \end{cases}$$

*If* $\beta = \beta_P$, *both borrowers are indifferent between the two variants of a fully collateralized pooling contract,* $\Pi_j(\bar{R}_0, W) = \Pi_j(\bar{R}_S, W)$, *and therefore* $\Pi_b(R^*_{bS},0) = \Pi_b(\bar{R}_0, W) = \Pi_b(\bar{R}_S, W)$.

Again, *Figure 2* illustrates the defined critical cost functions. As the next Proposition states, the up front investment that protects the value of the inside collateral is an alternative sorting device.

**Proposition 7** *In the interval* $\beta \in (\beta'',1)$ *restructuring know-how restores sorting for all* $S < \min[S_{bW}, S_P]$.

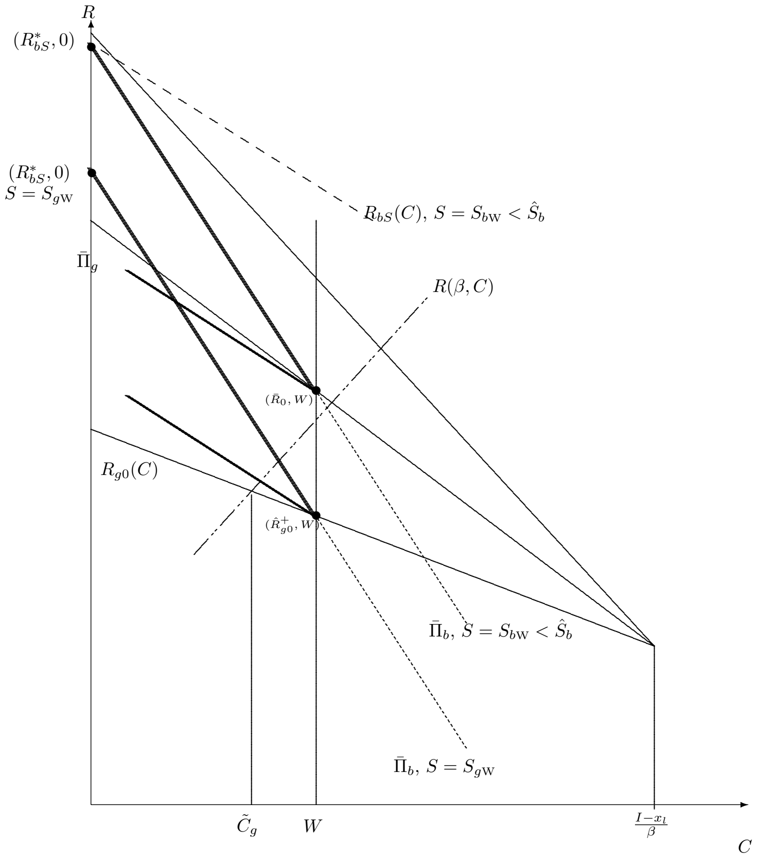
The banks respond to uniform, but expensive, pledging of outside collateral by building up restructuring know-how. Note that the destruction of the pooling equilibria occurs without any additional measures from the entrepreneur's side, such as bringing in a cosigner (*Besanko/Thakor* (1987)). As long as the costs of restructuring know-how are only slightly below $S_{bW}$, banks earn sustainable positive profits from financing the low-risk borrower even though there is perfect competition. The intuition for this observation is that the restructuring contract withdraws the bad borrower from the fully collateralized pooling contract even though the amount $S_{bW}$ needed to preserve the value of the inside collateral is still fairly high. With only the good borrowers remaining, the former pooling contract earns the bank positive profits. Given that there is perfect competition, we would expect such positive profits to be unsustainable. However, for a profit-eroding market entry to occur, the newcomer who offers the rival contract should be able to expect a surplus. But a surplus is not achievable. Each contract with lower outside collateral and/or lower repayment than in the former pooling contract would be preferred by both type *g* and type *b*. So, to avoid losses with certainty, a newcomer can only offer a pooling contract and must make sure that both types accept that contract. However, this kind of offer is impossible, given that the pooling equilibrium in Proposition 4 is a Nash equilibrium. Then type *g* is worse off with any alternative pooling contract $(R_0(C), C < W)$ than with the original contract $(\bar{R}_0, W)$. *Figure 4*, which applies to the interval $\beta'' < \beta < \tilde{\beta}$, illustrates this. Given that $S = S_{bW}$, type *g* prefers the contract $(\bar{R}_0, W)$ to any less collateralized pooling contract.

However, there is a source for driving positive bank profits down to zero. If S goes down, banks have to reduce type *b*'s repayment due to perfect competition. Thus, with more effective banks, type *b*'s incentive compatibility constraint is no longer binding. If banks nevertheless stick to type *g*'s old contract, opportunities to enter the market profitably would instantly arise. Newcomers might offer an alternative contract with a slightly reduced repayment. All good borrowers would choose the new contract, thereby forcing the old contract out of the market. The competition-induced reduction of the repayment only stops when *b*'s incentive compatibility constraint is again binding. Thus, if effectiveness in establishing restructuring know-how grows – that is, *S* decreases – profits shrink. But for profits to erode completely, the costs must be sufficiently small. *Figure 4* shows that, only if *S* is down to $S_{gW}$ does the incentive-compatible menu $[(R^*_{bS}, 0), (\hat{R}^+_{g0}, W)]$ meet the zero-profit condition of both types.

Given that the bank has a high valuation of the entrepreneur's private wealth $(\beta > \tilde{\beta})$, in equilibrium both types choose only restructuring contracts. They will do so because for all possible values of *C*, type *g*'s repayment obligation is lower with a restructuring contract than it is with a non restructuring contract. With $S < S_{bW}$ and $\beta > \tilde{\beta}$, separation will only take place as long as the low-risk borrower finds it more attractive to separate and share profits with the bank than he does to pool with the high-risk borrower (and subsidize that type) in a contract in which both choose the investment in restructuring know-how. If costs are not low enough, $S_P < S < S_{bW}$, the good borrower will prefer the pooling contract with restructuring know-how and maximum collateralization and the bad borrower will follow suit.

Such an equilibrium might seem surprising, since we have argued above that restructuring know-how makes collateralization ex post inefficient in general, and

*Figure 4: Restructuring know how as sorting device*




not only in a specific range of $\beta$. However, this general inefficiency is only true in the case of separation. With pooling, the low-risk borrower is more attracted to securing debt even if there is restructuring know-how. The reason behind this observation is the bank/borrower disparity in the expectation that the collateral is taken. The bank calculates with a higher probability than the low-risk entrepreneur does. Thus, there is a threshold of $\beta$ such that, for any $\beta$ higher than this threshold, the low-risk entrepreneur welcomes the reduction of $R$ following collateralization. In addition, the surplus of separation does not go exclusively to entrepreneur $g$, but must be shared with the bank. Both of these points imply that the pooling contract with restructuring know-how and maximum outside collateral for high values of $\beta$ may be more attractive than the profit-sharing separating contract with that investment. That is, $S_P < S < S_{b\mathrm{W}}$. Only if $S < S_P < S_{b\mathrm{W}}$ does type $g$ select the profit-sharing separating contract with restructuring expertise[12].

12 If $S$ is very small, the bank's profit diminishes and the separating equilibrium created by the upfront investment in restructuring know-how is an *ordinary* separating equilibrium. In such an equilibrium $(R^*_{bS}, 0)$ and $(R^*_{gS}, C^*_{gS} < W)$ are signed, where the latter is defined by (13).

## 4 Conclusion

This paper explains the economic role of outside collateral and restructuring know-how under strategic default and private information. The result that the risk of strategic default leads to pledging of outside collateral primarily by the high-risk borrowers does not appear to be robust. With private information added, our findings confirm a predominant result in the literature dealing with debt securization. The low-risk entrepreneur selects himself by using outside collateral. Therefore low-risk borrowers are more likely to pledge outside collateral than are high-risk borrowers.

Even though the static nature of our model does not allow us to capture the effects of a long-term bank-borrower relationship on informational disadvantage, nevertheless we risk concluding that the ongoing debate in the empirical literature on whether the high- or the low-risk borrower must pledge more outside collateral could be a matter of the maturity of the relationships investigated. Therefore, we believe that the explicit modeling of how the degree of informational asymmetry changes during repeated project financing, and how this learning on the bank's side affects the purpose and the terms of the credit contracts, is a promising field for future research.

We also suggest that uncollateralized credit contracts with implicit restructuring for high-risk borrowers could become major features in the market for new loans. Both features are the bank's best response to the costs of informational disadvantage and the danger of repudiation, regardless of whether outside collateral is valuable or not. If the liquidation values of the entrepreneur's private assets are low, restructuring know-how eases the cost of separation. If liquidation values are high restructuring know-how may enable the bank to identify risk types.

## 5 Appendix

*Proposition 1*

Since $S_j(\beta)$ solves $\Pi_j(R_{j0}, C = \lambda W) = \Pi_j(R_{jS}, C = 0)$ and $\partial \Pi_j(R_{jS}, C = 0)/\partial S < 0$, it is true that $\Pi_j(R_{j0}(C),\ C = \lambda W) < \Pi_j(R_{jS}(0),0) \Leftrightarrow S < S_j$. If $\beta \leq \beta_{j0}$ and $\lambda = 0$, the threshold $S_j$ is constant and at its maximum $\hat{S}_j = (I - x_l)d_{j0}/(1 - d_{j0})$. Note that $\hat{S}_b > \hat{S}_g$ since $d_{g0} < d_{b0}$. In the range $\beta > \beta_{j0}$, the critical cost level depends on the bank's valuation of collateral ($\lambda = 1$). Differentiation of $S_j(\beta)$ with respect to $\beta$ yields $-W(1/(1 - d_{j0}) - p_j)$. Since $d_{g0} < d_{b0}$, this implies that $S_b(\beta) > S_g(\beta)$ for all $\beta < 1$. △

*Proposition 2*

The proof is standard in the literature (see for example *Bester* (1985) and *Besanko/Thakor* (1987)). A separating equilibrium (if it exists) arises in which the good borrower secures his debt and (8) is binding if two conditions are satisfied. First, the marginal rate of substitution between repayment and outside collateral differs in the following way

$$-\frac{\partial R_{|\overline{\Pi}_b}}{\partial C} < -\frac{\partial R_{|\overline{\Pi}_g}}{\partial C} \tag{15}$$

$$-\frac{\partial R_{gk}}{\partial C} > -\frac{\partial R|_{\overline{\Pi}_g}}{\partial C}. \tag{16}$$

Second, the wealth constraint is not binding. Thus, we must show that, in the range $\beta \le \beta'$, (15) and (16) hold and $C^*_{g0} \le W$ is satisfied. From (6) we have $-(1-p_b)/p_b < -(1-p_g)/p_g$. (6) and (4) yield $-\beta(1-p_g+p_g d_{g0})/(p_g(1-d_{g0})) > -(1-p_g)/p_g$ if $\beta < \beta_{b0} < \beta_{g0}$. Finally, (10) guarantees for all $\beta < \beta'$ that the wealth constraint is not binding. Therefore, E1–E3 must be satisfied for all $\beta \le \beta'$ and the equilibrium menu $[(R^*_{g0}, C^*_{g0}), (R^*_{b0}, 0)]$ separates the debtors. △

*Proposition 3*

If $\beta > \beta'$ then (10) implies $C^*_{g0} > W$. Thus, there is never a separating equilibrium with zero profits for the bank. Given that $\beta = \beta''$, type $b$ is indifferent between three contracts, the uncollateralized contract $(R^*_{b0}, 0)$, the fully collateralized pooling contract $(\bar{R}_0, W)$, and the fully collateralized separating contract $(R^+_{g0}, W)$, in which the latter yields positive profits to the bank as $R^+_{g0} = \bar{R}_0 > R_{g0}(\mathrm{W})$. Since (10) implies $R_{g0}(W) < R^+_{g0} < \bar{R}_0$ for all $\beta \in (\beta', \beta'')$ the pooling contract with maximum collateral and zero profits cannot be an equilibrium candidate. Thus, given that a Nash equilibrium exists, the allocation $[(R^*_{b0}, 0), (R^+_{g0}, W)]$ is the only equilibrium candidate[13]. $\beta'' < \beta_{b0}$ ensures (15) and (16), implying that the menu $[(R^*_{b0}, 0), (R^+_{g0}, W)]$ satisfies (8) and (9) for all $\beta \in (\beta', \beta'')$. In addition, the banks' profits are consistent with perfect competition between banks, because no other contract can be found that enables rival banks to profitably enter the market. To see that the no-market-entry condition is met, suppose a rival contract $(R^+_{g0} - \Delta R, W)]$, $\Delta R > 0$ is offered. This contract also attracts the bad borrowers and risks are pooled at the rival contract. However, given that $\beta < \beta''$ and thus $R^+_{g0} < \bar{R}_0$, pooling at $(R^+_{g0} - \Delta R, W)$ must result in negative profits for the newcomer. Such a profit-eroding contract can never be offered in equilibrium, and $[(R^*_{b0}, 0), (R^+_{g0}, W)]$ is also compatible with E2. In combination with (8) and (9), the no-market-entry condition E2 ensures that E3 is fulfilled. Finally, E1 follows from $G_{g0} > 0$ and the fact that $R^*_{b0}$ satisfies the zero-profit condition of the bad borrower. △

*Proposition 4*

If $\beta \ge \beta''$, it follows from (10) that $R^+_{g0} \ge \bar{R}_0$. Both types prefer the pooling allocation $(\bar{R}_0, W)$ to the separating allocation $[(R^*_{b0}, 0), (R^+_{g0}, W)]$. Thus, E2 is only compatible with pooling. Suppose that $W$ is sufficiently large so that in the range of $(\beta', \beta'')$ there is a Nash equilibrium with positive profits for the bank. Then (7) and (10) imply that borrower $g$'s marginal rate of substitution is higher for all $\beta > \beta''$ than the bank's marginal rate of substitution,

$$-\frac{1-p_g}{p_g} > -\frac{1-\bar{p}+\bar{p}\bar{d}_0}{\bar{p}(1-\bar{d}_0)}\beta.$$

13 Because of (15), any contract with $C < W$ can never be a Nash equilibrium for all $\beta > \beta'$.

Define $(\bar{\bar{R}}_0, \bar{\bar{C}} < W)$ as the contract that satisfies equation (5) if $k = 0$. Then for all $\beta > \beta''$, the zero-profit contract $(\bar{\bar{R}}_0, \bar{\bar{C}}_0 < W)$ can attract only bad borrowers. Since E1 is not met, such a contract cannot be an equilibrium candidate. In contrast, the pooling contract with maximum outside collateral $(\bar{R}_0, W)$ is an equilibrium candidate. It meets E1, since it satisfies (5). E2 holds because there is no other pooling contract that withdraws the good borrowers from this contract. For the same reason E3 is met[14]. △

*Lemma 1*

Since $d_{jS} = 0$, we have

$$-\frac{1-p_j}{p_j}\beta > -\frac{1-p_j}{p_j} \quad \forall \quad \beta \in (0,1).$$

Thus, (15) and (16) hold. In addition, the wealth constraint is slack by assumption. Both features imply, that for any given $S$, there must exist a menu that sorts borrowers. For any contract $(R^*_{gS}, C^*_{gS})$ that meets (13), it holds that $\Pi_b(R^*_{bS},0) = \Pi_b(R^*_{gS}, C^*_{gS})$. Thus, (15) and (16) imply that (13) represents the set of type $g$'s separating contracts. The corresponding contracts for type $b$ are obtained by inserting $C = 0$ in (12). △

*Proposition 5*

We start with $\beta < \beta'$ and prove that with $S > \hat{S}_b$ the menu $[(R^*_{g0}, C^*_{g0}),(R^*_{b0},0)]$ is the only equilibrium. (12), $\Pi_b(R^*_{bS},0) = \Pi_b(R^*_{b0},0)$, if $S = \hat{S}_b$, $\partial R_{jS}(C)/\partial S > 0$ and

$$-\frac{1-p_j+p_j d_{j0}}{p_j(1-d_{j0})}\beta < -\frac{1-p_j}{p_j}\beta \tag{17}$$

imply $\Pi_b(R_{bS},(C),\ C \leq W) < \Pi_b(R^*_{b0},0)\ \forall\ S > \hat{S}_b$. Thus, type $b$ strictly prefers the separating non restructuring contract $(R^*_{b0},0)$ to any restructuring contract $(R_{bS}(C),C)$ if $S > \hat{S}_b$. Type $g$ also rejects the restructuring contract if $S > \hat{S}_b$. To see this, let us consider a restructuring contract with pooling. We denote a pooling contract that satisfies (12) if $S = \hat{S}_b$ with $(R_{\hat{S}_b}(C),C)$. Then, because of $R^*_{b0} > R_S(C)$ if $S = \hat{S}_b$, type $b$ will adopt any pooling contract $(R_{\hat{S}_b}(C),C)$ if such a contract is offered. If the good borrower also accepts $(R_{\hat{S}_b}(C),C)$ pooling will occur. Therefore, we must show that type $g$ strictly prefers the separating allocation $[(R^*_{g0}, C^*_{g0}),(R^*_{b0},0)]$ to any pooling allocation if $S > \hat{S}_b$. Inserting $k = S$ and $k = 0$ in

$$\Pi_j = p_j x_b + \frac{(1-\bar{p}+\bar{p}\bar{d}_k)x_l}{1-\bar{d}_k} - \frac{I+k}{1-\bar{d}_k}$$

14 Because I did not allow for random strategies granting a credit in $t = 0$, the pooling contract with maximum outside collateral is a Nash equilibrium.

and equalizing the resulting expressions yields $\bar{S} \equiv \bar{d}_0(I - x_l)/(1 - \bar{d}_0)$, in which $\bar{S} < \hat{S}_b$ since $\bar{d}_0 < d_{b0}$. $S = \bar{S}$ implies

$$\Pi_g(R_0(0),0)) = \Pi_g(R_S(0),0) \tag{18}$$

and type $g$ is indifferent between the two kinds of uncollateralized pooling contracts. However, the Nash equilibrium in Proposition 2 implies

$$\Pi_g(R^*_{b0},0) < \Pi_g(R_0(0),0) < \Pi_g(R^*_{g0},C^*_{g0}). \tag{19}$$

We denote a pooling contract that satisfies (12) if $S = \bar{S}$ with $(R_{\bar{S}}(C),C)$. Then, because of

$$-\frac{1-\bar{p}+\bar{p}\bar{d}_0}{\bar{p}(1-\bar{d}_0)}\beta < -\frac{1-\bar{p}}{\bar{p}}\beta$$

(18) and (19) ensure that

$$\Pi_g(R_{\bar{S}}(C),C) < \Pi_g(R^*_{g0},C^*_{g0}) \tag{20}$$

also holds for $S = \bar{S}$. Since $\hat{S}_b > \bar{S}$, the monotonicity of (5) in $S$ yields

$$\frac{I + \hat{S}_b - (1-\bar{p})(x_l + \beta C)}{\bar{p}} > \frac{I + \bar{S} - (1-\bar{p})(x_l + \beta C)}{\bar{p}} \geq R_0(C).$$

Then (20) guarantees $\Pi_g(R_{\hat{S}_b}(C),C) < \Pi_g(R^*_{g0},C^*_{g0})$ if $S = \hat{S}_b$. The pooling contract $(R_{\hat{S}b}(C),C)$ attracts only bad borrowers and violates E1. Therefore, it is never offered.

Next we consider a separating restructuring contract $((R^*_{gS}, C^*_{gS})$. Suppose the cost of restructuring know-how is $\hat{S}_g = (I - x_l)d_g/(1 - d_g)$[15]. Because of (17) and (15), the incentive-compatible contract $(R^*_{g\hat{S}_g}, C^*_{g\hat{S}_g})$ must be inferior to $(R^*_{g0},C^*_{g0})$. Moreover $\hat{S}_g < \hat{S}_b$, and $\Pi_g(R^*_{gS},C^*_{gS})$ decreases with $S$. These factors imply that in the range of $S \geq \hat{S}_b$ type $g$ does not prefer the separating restructuring contract either. Market entry is not possible with restructuring contracts and, for $S > \hat{S}_b$ and $\beta < \beta'$, Proposition 2 describes the equilibrium.

Suppose now $\beta' < \beta < \beta''$. From $\Pi_b(R^*_{bS},0) = \Pi_b(\bar{R}_0, W) = \Pi_b(R^+_{g0}, W)$ for $S = \hat{S}_b$, the monotonicity of $R_{bS}(C)$ in $S$ and the Nash equilibrium in Proposition 3 it follows that type $b$ rejects the restructuring contract if $S > \hat{S}_b$. With $S = \hat{S}_b$, any pooling restructuring contract is less attractive for type $g$ than any pooling contract without that know-how. Therefore, according to Proposition 3 $\Pi_g(R^+_{g0}, W) \geq \Pi_g(\bar{R}_0, W)$ holds and type $g$ also rejects the restructuring contract if $\beta' < \beta \leq \beta''$ and $S > \hat{S}_b$.

15 Recall that $\hat{S}_g$ makes type $g$ indifferent between the restructuring and non restructuring contract if the bank knows the borrower types and $C = 0$.

For $\beta > \beta''$ the inequality $\Pi_b(R^*_{bS},0) < \Pi_b(\bar{R}_0, W)$ if $S = \hat{S}_b$ follows from (10). Moreover $\bar{R}_0 < R^+_{g0}$ for all $\beta > \beta''$ implies $\Pi_g(R^+_{g0}, W) < \Pi_g(\bar{R}_0, W)$. Thus, for all $S > \hat{S}_b$ there can be no profitable market entry with restructuring contracts. The equilibrium contracts are given by Proposition 2 and 4. △

*Lemma 2*

1. Inserting $C = W$ into $R_{g0}(C)$ from (4) and into (12) gives $S_{gW}$ after equalizing both expressions and rearranging. Inserting $\beta'$ into $S_{gW}$ yields $\hat{S}_b$. $S_{gW} < \hat{S}_b \;\forall\; \beta > \beta'$ follows from $\partial S_{gW}/\partial\beta < 0$ and $\partial\hat{S}_b/\partial\beta = 0$. Since $\Pi_b(R_{bS}(0), 0)$ increases if $S$ decreases, the amount of outside collateral that makes (8) binding decreases with $S$.

2. To derive $\tilde{S}_g(\beta)$ we solve $R_{g0}(C) = R_{gS}(C)$ given by (4) for $C$. We insert the result into (4) again and also into (12). Then after equalizing and rearranging we obtain $\tilde{S}_g(\beta)$ where $\partial\tilde{S}_g/\partial\beta < 0$ and $\tilde{S}_g(\beta) = \hat{S}_g$ if $\beta = 0$ and $\tilde{S}_g(\beta) = 0$ if $\beta = 1$. The cost level $S = \tilde{S}_g$ implies $\hat{R}^*_{go} = R^*_{gS} \equiv \tilde{R}_g, \hat{C}^*_{g0} = C^*_{gS} \equiv \tilde{C}_g$. Furthermore the monotonicity of $R_{jS}(C)$ in $S$ guarantees for a given $\beta$

$$R_{g0}(C)\begin{cases} < R_{gS}(C) & \forall \quad C > \tilde{C}_g \text{ if } S > \tilde{S}_g \\ > R_{gS}(C) & \forall \quad C < \tilde{C}_g \text{ if } S < \tilde{S}_g \,. \end{cases}$$

   Therefore, (14) must hold.

3. Inserting $W$ into (13) and into $R_{g0}(C)$ from (4) and equalizing both yields $\tilde{\beta}$. $W = I - x_l$ gives $\tilde{\beta} = 1$. Inserting $\tilde{\beta}$ into $S_{gW}$ yields $\tilde{S}_g$. The intersection of (13) and $R_{g0}(C)$ from (4) defines

$$\tilde{C}_g = \frac{(I - x_l)(p_g - p_b)}{p_g(1 - p_b) - d_g p_g(1 - p_b)(1 - \beta) - \beta p_b(1 - p_g)}.$$

   Note that

$$z_b \equiv p_b\alpha_b x_b + (1 - p_b)\alpha_l x_l - x_l > 0 \tag{21}$$

   implies $\partial\tilde{C}_g/\partial\beta > 0$. Therefore, $\tilde{C}_g > W$ for all $\beta > \tilde{\beta}$. △

*Proposition 6*

We start with $\beta \le \beta'$. (13) implies $R_{g0}C) < (R_{gS}(C) \;\forall\; C > \tilde{C}_g$ in the range of $S < \tilde{S}_g$. Lemma 1 and the derivatives of (12) and (13) with respect to $C$ guarantee that a pair of incentive-compatible menus,

$$[(\hat{R}^*_{g0}, \hat{C}^*_{g0}), (R^*_{bS}, 0)], [(R^*_{gS}, C^*_{gS}), (R^*_{bS}, 0)], \tag{22}$$

meeting E1–E3 exists in the range of $S \in [\tilde{S}_g, \hat{S}_b]$. Due to (15) and the fact that (8) binds with both menus, the inequality $\Pi_g(R^*_{gS}, C^*_{gS}) < \Pi_g(\hat{R}^*_{g0}, \hat{C}^*_{g0}) \;\forall\; S \in [\tilde{S}_g, \hat{S}_b]$

must hold. Thus, only menu $[(\hat{R}^*_{g0},\hat{C}^*_{g0}),(R^*_{bS},0)]$ also meets E3. Finally, we examine $\beta \in (\beta', \beta'' < \tilde{\beta})$. The inequality $S_{gW} > S_g$ holds within this interval. Since $S_{gW}(\beta') = \hat{S}_b$ and $S_{gW}$ decreases linearly in $\beta$, there must be a range $S_{gW} < S < \hat{S}_b$ such that type $b$ signs $(R^*_{bS},0)$ and type $g$ prefers $(\hat{R}^+_{g0}, W)$ to $(R_0(C),C)$. Since $\hat{R}^+_{g0} > R_{g0}$, the bank earns positive profits for reasons similar to those in Proposition 3. The profits are sustainable. The bad borrower would also adopt any rival contract that reduced the profits and consequently the rival contract would generate losses. Thus, E1–E3 is satisfied for $S_{gW} < S < \hat{S}_b$. In the sense of (22), a pair of incentive-compatible menus exists in the range $\tilde{S}_g < S < S_{gW}$. Thus, only $[(\hat{R}^*_{g0},\hat{C}^*_{g0}),(R^*_{bS},0)]$ also satisfies E3. In the range $S \in (0, \tilde{S}_g]$, the derivation $\partial R_{gS}(C)/\partial S > 0$ implies $R_{g0}(C) > R_{gS}(C)\ \forall\ C < \tilde{C}_g$. Due to (15), for any pair in the sense of (22) the inequality $\Pi_g(R^*_{gS},C^*_{gS}) > \Pi_g(\hat{R}^*_{g0},\hat{C}^*_{g0})$ must hold. Only the menu $[(R^*_{gS},C^*_{gS}),(R^*_{bS},0)]$ also meets E3. △

*Lemma 3*

1. Inserting $W$ in (5), given that $k = 0$, and in (12), equalizing both expressions and solving for $S$ yields $S_{bW}$. Since $R_{g0}(C) < R_0(C)\ \forall\ C < (I - x_l)/\beta$ we have $S_{gW} < S_{bW}$. $\Pi_b(R^*_{bS},0) = \Pi_b(\bar{R}_0, W)$ if $S = S_{bW}$ follows from the definition of (12).

2. We obtain $S_P$ by inserting $C = W$ in (12) and in $R_S(C)$ from (5), equalizing both and solving for $S$. The definition of (12) implies $\Pi_b(R^*_{bS},0) = \Pi_b(\bar{R}_S, W)$.

3. Equalizing $S_P$ and $S_{bW}$ and solving for $\beta$ yields $\beta_P$. $\Pi_b(R^*_{bS},0) = \Pi_b(\bar{R}_0, W) = \Pi_b(\bar{R}_S, W)$ if $\beta = \beta_P$ follows from part 1 and part 2 of that Lemma. Since $\beta_P = \tilde{\beta}$ if $\mu = 1$,

$$\frac{\partial \beta_P}{\partial \mu} = -(1-p_b)\frac{(p_g - p_b)(I - x_l - W)(\alpha_b x_b - x_l)}{(p_b \alpha_b x_b + (1-p_b)\alpha_l x_l - x_l)W(\bar{p}-1)^2} < 0$$

guarantees $\beta_P > \tilde{\beta}$ for all $\bar{p} < p_g$. Note that

$$\frac{\partial S_P}{\partial \beta} = -\infty < \frac{\partial S_{bW}}{\partial \beta} = -W\frac{p_b(1-p_b(1-d_b))}{p_b(1-d_b)} \quad \text{if} \quad \mu = 0.$$

Note also that because of (21)

$$\frac{\partial S_P}{\partial \beta} = -W\frac{p_b(1-p_g)}{p_g - p_b} < \frac{\partial S_{bW}}{\partial \beta} = -W\frac{p_b(1-p_g(1-d_g))}{p_g(1-d_g)} \quad \textit{if} \quad \mu = 1.$$

Then the monotonicity of the derivations in $\mu$ ensures

$$\frac{\partial S_P}{\partial \beta} = -W\frac{p_b(1-\bar{p})}{\bar{p} - p_b} < \frac{\partial S_{bW}}{\partial \beta} = -W\frac{p_b(1-\bar{p}(1-\bar{d}_0))}{\bar{p}(1-\bar{d}_0)} \quad \forall \quad \mu \in [0,1].$$

Therefore $S_P \lesseqgtr S_{bW}$ if $\beta \gtreqless \beta_P$. Because of (21) inserting $\beta_P$ in $S_P$ yields for all $W > I - x_l$

$$S_P = S_{bW} = \frac{\bar{d}_0 \bar{p}(1-p_b)(I-x_l-W)}{p_b - p_b\bar{p} - (1-p_b)\bar{d}_0\bar{p}} > 0. \qquad \triangle$$

*Proposition 7*

We concentrate first on the interval $\beta \in [\beta'', \tilde{\beta}]$ where $S_{bW} > S_{gW} > \tilde{S}_g$. It follows from Lemma 3 part one that (8) binds with three types of contracts $\Pi_b(R^*_{bS},0) = \Pi_b(\bar{R}_0, W) = \Pi_b(\hat{R}^+_{g0}, W)$ if $S = S_{bW}$. The monotonicity of $R_{jS}(C)$ in $S$ ensures then for all $S \leq S_{bW}$: $\Pi_b(R^*_{bS},0) = \Pi_b(\hat{R}^+_{g0}, W) > \Pi_b(\bar{R}_0, W)$. We now show that type g selects the separating renegotiation contract $(\hat{R}^+_{g0}, W)$ but rejects the restructuring contract $(R^*_{gS}, C^*_{gS})$ for all $S_g < S < S_{bW}$. First, $S_{gW} < S < S_{bW}$ implies $R_{g0}(W) < \hat{R}^+_{g0} < \bar{R}_0$ and thus $\Pi_g(\hat{R}^+_{g0}, W) > \Pi_g(\bar{R}_0, W)$. Next, we consider two cases. In the first case, $\beta$ is such that, for any $S \leq S_{bW}$, an incentive-compatible menu in the sense of Lemma 1 is feasible. Then (13) and $-p_b/(1-p_b) < 0$ guarantee that a pair of contracts, $(R^*_{gS}, C^*_{gS})$ and $(\hat{R}^+_{g0}, W)$, exists for which (8) binds,

$$\Pi_b(R^*_{bS}, 0) = \Pi_b(R^*_{gS}, C^*_{gS}) = \Pi_b(\hat{R}^+_{g0}, W). \tag{23}$$

However, (15) and Lemma 2 imply

$$\Pi_g(\hat{R}^+_{g0}, W) > \Pi_g(R^*_{gS}, C^*_{gS}) \tag{24}$$

in the interval $S \in (S_{gW}, S_{bW})$. Therefore separation occurs with $[(R^*_{bS},0),(\hat{R}^+_{g0}, W)]$. We must still show that the separating menu is in line with E1–E3. Since type $b$'s contract satisfies the zero-profit condition, E1 holds. E1 also holds for type $g$, because $S_{bW} > S > S_{gW}$ implies $\hat{R}^+_{g0} > R_{g0}(W)$ and thus $G_{g0} > 0$. Because of (15), any alternative menu preferred by both types would induce a pooling contract. However, Lemma 1 ensures that a uniform pooling contract with restructuring know-how is inferior to the separating menu $[(R^*_{bS},0),(R^*_{gS}, C^*_{gS} < W)]$. Because of (23) and (24), it must be also inferior to $[(R^*_{bS},0),(\hat{R}^+_{g0}, W)]$. In addition, given that the pooling contract $(\bar{R}_0, W)$ is a Nash equilibrium, a pooling contract $(R_0(C), C)$ attracts only high-risk types. Thus, E2 and E3 also holds and $[(R^*_{bS},0),(\hat{R}^+_{g0}, W)]$ is a Nash equilibrium $\forall\, S \in (S_{gW}, S_{bW})$.

In the second case, $\beta$ is such that an incentive-compatible menu in the sense of Lemma 1 is not feasible for some $S \in (S'_{bW}, S_{bW})$, where $S'_{bW} > S_{gW}$. We have $\bar{R}_0 > R(\beta, W) > R_{g0}(W)$ for such a $\beta$ (see *Figure 4*). (15) and $-\beta\,(1-p_g)/p_g > -(1-p_b)/p_b$ imply that any restructuring contract $(R_{gS}(C),\ C \leq W)$, which type $g$ strictly prefers to the renegotiation contract $(\hat{R}^+_{g0}, W)$, $\hat{R}^+_{g0} < \bar{R}_0$, is also preferred by type $b$. Thus, with $S \in (S'_{bW}, S_{bW})$, only a pooling contract with restructuring know-how would satisfy E1. However, from Lemma 3, we know that the inequality $S_P > S_{bW}$, and thus $\bar{R}_S > \bar{R}_0$, must hold for all $\beta \leq \tilde{\beta}$. $\Pi_g(\hat{R}^+_{g0}, W) > \Pi_g(\bar{R}_0, W) > \Pi_g(\bar{R}_S, W)$ follows from $\bar{R}_0 > \hat{R}^+_{g0}$ for all $S_{gW} < S < S_{bW}$. Thus, only $[(R^*_{bS},0),(\hat{R}^+_{g0}, W)]$ satisfies E1–E3.

Now we consider $S \in (S_{g\mathrm{W}}, S'_{b\mathrm{W}})$. A separating equilibrium in the sense of Lemma 1 is feasible in this range. (23)–(24) and the proof for $S \in (S_{g\mathrm{W}}, S_{b\mathrm{W}}]$ apply analogically to $S \in (S_{g\mathrm{W}}, S'_{b\mathrm{W}})$. With $S < S_{g\mathrm{W}}$, the wealth constraint $W$ is never binding and the proof of Proposition 6 applies analogically. Given that $\beta > \tilde{\beta}$, it follows from Lemma 2 part 3 that

$$R_{gS}(C) < R_{g0}(C) \Rightarrow \Pi_g(R_{gS}(C), C) > \Pi_g(R_{g0}(C), C) \quad \forall \quad C \in [0, W]. \tag{25}$$

In the case of separation, borrowers select only restructuring contracts. Thus, we must show that pooling is inferior to any separating menu with both borrowers selecting the restructuring variant. With $S \in (S'_{g\mathrm{W}}, \min[S_{b\mathrm{W}}, S_{\mathrm{P}}])$, where

$$S'_{g\mathrm{W}}(\beta) \equiv W \frac{p_g(1-p_b) - p_b(1-p_g)}{p_g - p_b} - (I - x_l) < S_{g\mathrm{W}} \quad \forall \quad \beta > \tilde{\beta}$$

the isoprofit function (12) implies either $\hat{R}^+_{gS} < \bar{R}_0 < \bar{R}_S$ or $\hat{R}^+_{gS} < \bar{R}_S < \bar{R}_0$. Because of (25) type $g$ strictly prefers the restructuring contract $(\hat{R}^+_{gS}, W)$ to any renegotiation contract. $(\hat{R}^+_{gS}, W)$ makes (8) binding and yields positive profits to the bank. Consequently, $[(R^*_{bS}, 0), (\hat{R}^+_{gS}, W)]$ satisfies E1–E3. Given that $S = S'_{g\mathrm{W}}(\beta)$, we have $\hat{R}^+_{gS} = R(\beta, W)$ and the constraint (8) binds with the restructuring contracts $(R^*_{bS}, 0)$ and $(R^*_{gS}, W)$. Lemma 1 and Lemma 2, parts 2 and 3, thus ensure that for all $S = S'_{g\mathrm{W}}$ an ordinary separating equilibrium exists. △

## 6 References


*Berger, Alan N./Udell, Gregory F.* (1990), Collateral, Loan Quality, and Bank Risk, in: Journal of Monetary Economics, Vol. 25, pp. 21–42.

*Berger, Alan N./Udell, Gregory F.* (1995), Relationship Lending and Lines of Credit in Small Firm Finance, in: Journal of Business, Vol. 68, pp. 351–381.

*Besanko, David/Thakor, Anjan V.* (1987), Collateral and Rationing: Sorting Equilibria in Monopolistic and Competitive Credit Markets, in: International Economic Review, Vol. 28, pp. 671–689.

*Bester, Helmut* (1985), Screening vs. Rationing in Credit Markets with Imperfect Information, in: American Economic Review, Vol. 75, pp. 850–855.

*Bester, Helmut* (1987), The Role of Collateral in Credit Markets with Imperfect Information, in: European Economic Review, Vol. 31, pp. 887–899.

*Bester, Helmut* (1994), The Role of Collateral in a Model of Debt Renegotiation, in: Journal of Money, Credit and Banking, Vol. 26, pp. 72–86.

*Bester, Helmut* (1995), A Bargaining Model of Financial Intermediation, in: European Economic Review, Vol. 39, pp. 211–228.

*Bester, Helmut/Hellwig, Martin* (1989), Moral Hazard and Equilibrium Credit Rationing: An Overview of the Issues, in: *Bamberg, Günter/Spremann, Klaus* (Eds.), Agency Theory, Information, and Incentives, Springer, pp. 135–166.

*Bester, Helmut/Strausz, Roland* (2001),Contracting with Imperfect Commitment and the Revelation Principle: The Single Agent Case, in: Econometrica, Vol. 69, pp. 1077–1089.

*Blackwell, David W./Winters, Drew B.* (1997), Banking Relationship and the Effect of Monotoring on Loan Pricing, in: Journal of Financial Research, Vol. 20, pp. 275–289.

*Boot, Arnoud W.A.* (2000), Relationship Banking – What do we know?, in: Journal of Financial Intermediation, Vol. 9, pp. 7–25.

*Boot, Arnoud W.A./Thakor, Anjan V./Udell, Gregory F.* (1991), Secured Lending and Default Risk: Equilibrium Analysis, Policy Implications and Empirical Results, in: Economic Journal, Vol. 101, pp. 458–472.

*Brunner, Antje/Krahnen, Jan Pieter* (2000), Corporate Debt Restructuring: Evidence on Coordination Risk in Financial Distress, Center of Financial Studies, Frankfurt/M., Working Paper.

*Carey, Mark/Post, Mitch/Sharpe Steven A.* (1998), Does Corporate Lending by Banks and Finance Companies Differ? Evidence on Specialization in Private Debt Contracting, in: Journal of Finance, Vol. 53, pp. 845–878.

*Chan, Yuk-Shee/Thakor, Anjan V.* (1987), Collateral and Competitive Equilibria with Moral Hazard and Private Information, in: Journal of Finance, Vol. 42, pp. 345– 363.

*Cressy, Robert* (1996), Commitment Lending Under Asymmetric Information: Theory and Tests on U.K. Startup Data, in: Small Business Economics, Vol. 8, pp. 397– 408.

*Degryse, Hans/van Cayseele, Patrick* (2000), Relationship Lending within a Bank-Based System: Evidence from European Small Business Data, in: Journal of Financial Intermediation, Vol. 9, pp. 90–109.

*Elsas, Ralf/Krahnen, Jan Pieter* (1998), Is Relationship Lending Special? Evidence from Credit-File Data in Germany, in: Journal of Banking and Finance, Vol. 22, pp. 1283–1316.

*Elsas, Ralf/Krahnen, Jan Pieter* (1999) Collateral, Default Risk, and Relationship Lending: An Empirical Study on Financial Contracting, Center of Financial Studies, Frankfurt/M., Working Paper.

*Ewert, Ralf/Schenk, Gerald/Szczesny, Andrea* (2000), Determinants of Bank-Lending Performance in Germany – Evidence from Credit File Data, in: sbr, Vol. 52, pp. 344–362.

*Gale, Douglas/Hellwig, Martin* (1989), Repudiation and Renegotiation: The Case of Sovereign Debt, in: International Economic Review, Vol. 30, pp. 3–31.

*Harhoff, Dietmar/Körting, Timm* (1998), Lending Relationships in Germany – Empirical Evidence from Survey Data, in: Journal of Banking and Finance, Vol. 22, pp. 1317-1353.

*Hellwig, Martin* (1988), Kreditrationierung und Kreditsicherheiten bei asymmetrischer Information: Der Fall des Monopolmarktes, in: *Rudolph, B./Wilhelm, J.*, Bankpolitik, finanzielle Unternehmensführung und die Theorie der Finanzmärkte, pp. 135–162.

*Kürsten, Wolfgang* (1997) Zur Anreiz-Inkompatibilität von Kreditsicherheiten, oder: Insuffizienz des Stiglitz/Weiss-Modells der Agency-Theorie, in: zfbf, pp. 819–840.

*Machauer, Achim/Weber, Martin* (1998), Bank Behavior Based on Internal Credit Ratings of Borrowers, in: Journal of Banking and Finance, Vol. 22, pp. 1355–1383.

*Manove, Michel/Padilla Jorge A./Pagano Marco* (1998), Collateral vs. Project Screening: A Model of Lazy Banks, Center for Studies in Economics and Finance, Working Paper.

*Milde, Hellmuth/Riley, John G.* (1988), Signalling in Credit Markets, in: Quaterly Journal of Economics, Vol. 103, pp. 101–129.

*Riley, John G.* (1979), Informational Equilibrium, in: Econometrica, Vol. 47, pp. 331–359.