Debt Renegotiation, Monitoring and Financial Intermediation

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ABSTRACT: *This paper investigates the importance of monitoring when there is opportunity of renegotiation. It follows the theory of finance intermediation based on information production to show how the advantage of a financial intermediary on acquiring information determines the lender's willingness to renegotiate a debt contract without mitigating the borrower's incentives to pay. We show that renegotiation is valuable and that lenders with high ability of gathering information before renegotiation may avoid voluntary default. As the lender's advantage on monitoring is relevant to reduce the successful borrower's incentive to default, we can differentiate intermediaries conform their monitoring ability.*

KEYWORDS:
Debt Contract; Renegotiation; Financial Intermediation; Monitoring.

1. Introduction

This paper investigates the importance of monitoring when there is opportunity of renegotiation. It follows the theory of financial intermediation based on information production to explore the financial intermediary advantage on gathering information. This approach suggests that once the asymmetry of information between lenders and borrowers demands monitoring to resolve incentive

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problems, an intermediary is delegated the task of costly monitoring and enforcing loan contracts written with firms who borrow from it[2]. One implication is that banks may play a unique role in the alleviation of informational asymmetries because of its superior ability to select alternative projects and to monitor the use of funds. This point is verified empirically by James (1987) Lummer and McConnell (1989), Slovin, Johnson and Glascock (1992) and Best and Zhang (1993). They study the information content of bank loan through market valorization of firms.

We examine the relevance of an intermediary producing information before the bankruptcy decision. We allow the lender to gather information without bankruptcy and before taking the decision of renegotiating the original contract. Renegotiation is necessary to mitigate the dead-weight loss of liquidating unsuccessful borrowers. Bester (1994), Kahn and Huberman (1988b), Krasa and Villamil (1994) and Jorge-Neto (1997a, 1997b) have examined the role of renegotiation of debt contract to mitigate the dead-weight loss of bankruptcy. If intermediaries use debt contract as the optimal enforcement mechanism, all intermediaries would be able to avoid default by the successful borrower. A debt contract gives the lender the right to take over the borrower's asset in case of default[3], inducing the complete separation between successful and unsuccessful borrowers. The successful borrower pays back her debt and the unsuccessful borrower enters bankruptcy. Once the mere use of a debt contract enforces the separation between successful and unsuccessful borrowers[4], intermediaries can not be differentiated conform their enforcement abilities. As a consequence, the intermediary function as information producer demands further explanation. This paper shows that an intermediary with good monitoring ability is useful to counterweight the lack of credibility of the bankruptcy threat that weakens the lender's enforcement power. As the attribute of

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[2] As Diamond (1984) shows, a financial intermediary exists because it minimizes cost production of information useful for resolving the incentive problems.

[3] Towsend (1974), Diamond (1984) and Williamson (1987) derive debt contract as the optimal contract to bind the lending process. Other important result is in Gale and Hellwig (1985).

[4] Kahn and Huberman (1988a) and Kahn and Yavas (19894) make further investigation about debt contract and the lender's right of foreclosure.

monitoring plays a fundamental role to improve incentives when renegotiation is possible, we can associate the lender's ability of monitoring to the signaling relevance of a bank loan concession. Considering a bank as a financial intermediary that has great advantage on gathering information, we can show that a bank loan may play a unique role because it can avoid the successful borrower's opportunistic behavior with renegotiation.

The first part of this paper investigates how a renegotiation proposal mitigates the dead-weight loss of the debt contract arrangement. When the lender opens the opportunity to renegotiate the initial contract, the successful borrower will not always pay. The gains with renegotiation are counterweighted with weaker incentives. Nonetheless, there is room for the lender to have some power over the borrower ex post because, while there is no credible threat to impose bankruptcy, there is a credible threat to make the terms of the renegotiation more or less onerous. That is, instead of being uncertain about the occurrence of renegotiation the borrower is uncertain about the renegotiation outcome. In the process we examine the situation when such a randomization of the renegotiation terms plays a useful role. The possibility of renegotiation does not allow the lender to induce the separating equilibrium. The feasible equilibrium is the partially pooling equilibrium, in which a successful borrower may masquerade as insolvent. This result ignores the financial intermediary ability of getting relevant information without bankruptcy.

The second part of this paper incorporates the lender's ability of gathering information. Lenders gather information about the borrower's situation without imposing bankruptcy. In fact renegotiation will typically occur at some future date. In the interim, i.e., after the contract has been signed, there is ample opportunity for the lender to gather information useful in the renegotiation. This is exactly the most fundamental role of a financial intermediary. Intermediaries with more ability to learn the borrower project realization should have the power of reducing the successful borrower willingness of defaulting. The intermediary gathers information without bankruptcy but uses a verification technology whose signal about the project realization is not perfectly correlated with the true realization. The verification technology identifies with positive probability when the borrower can pay the face value of debt. To understand the lender's willingness to acquire the verification technology we then analyze the optimal renegotiation mechanism designed by a potentially informed lender. The lender has now two incentive devices: the randomization among renegotiation offers and the information revelation. The possibility of identifying the borrower's type with high degree of certainty before the renegotiation stage induces the full revelation equilibrium. The successful borrower does not masquerade as unsuccessful borrower since there is a high risk of being caught. The separating equilibrium illustrates the existence of an equilibrium that supports the optimal case where the liquidation cost is not incurred, that is, there is no costly bankruptcy. When the verification technology has low degree of accuracy, part of the successful borrower masquerade as unsuccessful. The lender needs to use the randomization device for incentive reasons. We show when it is optimal to acquire the verification technology.

The importance of a financial intermediary to mitigate the moral hazard problem of the lending activity depends on the possibility of inducing the separating equilibrium with renegotiation. Lenders, however, differ in their capacity of gathering information. Not all intermediaries have the same verification technology, implying that intermediaries have distinct relevance depending on the quality of the information produced. We can then classify financial intermediaries in two classes, matching their monitoring ability. A financial intermediary that is a good monitor can avoid the successful borrower's opportunistic behavior. Once the verification technology has a degree of accuracy that allows the lender to avoid the successful borrower´s default, the use of a more accurate verification technology does not produce further useful information or increases the lender's return. A financial intermediary that is a bad monitor can not eliminate the successful borrower's opportunistic behavior. It can, however, benefit from the information gathered to severely punish defaulters identified as solvent. This suggests that the lender´s return increases with the degree of accuracy of the verification technology up to a threshold value. Above the cut off level, the lender´s return is constant.

The lender, however, does not get the maximum possible return at each level of the verification accuracy because there is an incompatibility between feasibility and optimality. With bad verification technology, the borrower has low incentives to truthfully reveal the project outcome because the payment of the debt value is higher than the expected loss with renegotiation. This means that the lender would be better off with the separating equilibrium since the payment of the debt value is higher than what the lender expects to gain from the successful borrower with renegotiation. As separation is not feasible in this case, the lender must accept the lower return with positive rate of default. With good verification technology, the borrower has high incentives to truthfully reveal the project outcome because the payment of the debt value is lower than the expected loss with renegotiation. In this case the separating equilibrium is induced. As the lender's return increases with the degree of accuracy of the verification technology, this means that the lender would be better off with the pooling equilibrium since the payment of the debt value is lower than what the lender expects to gain from the successful borrower with renegotiating.

Following this introduction, the second section describes the renegotiation game, derives the equilibrium and analyzes the efficiency aspect of renegotiation. The third section describes the renegotiation game with information gathering, derives the equilibrium, analyzes the efficiency aspect of renegotiation with partially informed lender and the advantage of gathering information. The fourth section concludes.

2. Debt Renegotiation

A debt contract gives the lender the right to take over the borrower's asset in case of default, inducing the complete separation between successful and unsuccessful borrowers. Many authors such as Bester (1994), Kahn and Huberman (1988), Krasa and Villamil (1994) and Jorge-Neto (1997) have examined the role of renegotiation to mitigate the dead-weight loss of bankruptcy.

Renegotiation is necessary to mitigate the dead-weight loss of liquidating unsuccessful borrowers.

Krasa and Villamil (1994) characterize a debt contract with the chance of renegotiation. Kahn and Huberman (1988) argue that under a symmetric information environment, a secured loan contract with renegotiation achieves efficient outcomes. This contract means that the borrower either pays the specified payment of the loan or gives up the security to the lender. The lender uses the threat of foreclosure to induce total payment, but he will always renegotiate because he is much more inefficient managing the security than the borrower. On the renegotiation process, each part receives half of the difference between the social value of leaving the asset in the borrower's hands and the social value of the unrenegotiated loan.

Bester (1994) analyses a renegotiation process seeking an efficient outcome when the lender does not observe the project realization. He analyses the importance of a secured debt contract when there is no precommitment to avoid renegotiation. The idea is to reduce the dead-weight loss from project liquidation through renegotiation. Collateral has the role of increasing the lender's willingness to renegotiate, reducing this type of inefficiency. The maximum loss due to bad shock is eliminated if the new value of debt is the value of the low realization. However, there is still a loss whenever bankruptcy is imposed. Bankruptcy threat is necessary to induce the fulfillment of the contract terms by the successful borrower. Bester implicitly assumes that the lender commits to a single offer and that such an offer does not consider the possibility of a new contract with a value higher than the unsuccessful realization. His approach assumes that borrowers always appropriate all the benefit of the renegotiation when they have received a good shock and renegotiation is proposed. We analyze a renegotiation game in which, contrary to Bester (1994), the new contract proposed is determined in accordance to the specific renegotiation procedure. Next section presents the renegotiation game.

2.1 The Renegotiation Game

The lender is a financial intermediary that deals with a representative borrower. He provides capital (I) to the borrower using the mechanism of a debt contract.[5] The lender and the borrower are risk-neutral. The borrower has an investment project but does not have the liquid capital to invest; he possesses a wealth w in the form of illiquid capital. The project realization, that is a function of the state θ, where $\theta \in \Theta = \{L,H\}$, determines the borrower's type *ex post* B^{θ}. The production technology transforms one unit of capital in y_θ units in next period, where $y_H > y_L$. Consider q as the probability that y_H occurs.

In the contracting period, the lender offers a debt contract to the borrower. C_1 states the face value of the debt R, where $R > I$, and that the lender will foreclose the project if R is not paid. It is assumed that $R \geq y_L$ and that the lender can not recover I in case of project failure, that is, $I > y_L$.

The realization of the project is private knowledge to the entrepreneur. The lender learns the project realization by imposing bankruptcy. The borrower pays R or defaults. B^L always defaults and B^H can default or pay. The lender can impose bankruptcy or propose a renegotiation in case of default. The bankruptcy procedure is exogenous. In bankruptcy the debt value R is forgiven in return for a seizure of the investment project. Bankruptcy is costly but credible. When the lender imposes bankruptcy, he incurs in a cost of $(1-\delta)y_\theta$ to take over the project.[6] The bankruptcy loss is avoided by renegotiating. If the lender decides to renegotiate he offers a new contract C_2 that expresses the terms of the renegotiated value of debt. Letting $\Re$ be the set of the new contracts that can be offered at renegotiation, define $\Delta(\Re)$ as the set of probability distribution over

[5] The relevant assumption that makes debt contract optimal is used. Krasa and Villamil (1995) using a renegotiation game, what they call settlement game, similar to the one analyzed here are able to show that debt contract is optimal. The notion of debt contract secured by a collateral is not used. If we assume that the loss of taking over the collateral can be completely avoided, then we can show that the amount of collateral used is the maximum available. That is, the borrower's total wealth is used as collateral.

[6] This is equivalent to the Bester (1994) and Kahn and Huberman (1988) model as well as to the costly state verification approach.

$\Re$. C_2 is then a particular probability distribution of the renegotiated debt value picked from $\Delta(\Re)$. $\bar{R}$ represents the new debt value and $\pi(\bar{R})$ is the probability of offering $\bar{R}$. In case of success, any excess available is captured by the new debt value.

We consider a renegotiation regime in which the lender can not commit to any particular contract for the renegotiation stage. It is assumed, as in Bester (1994), that the expected foreclosure value of the project exceeds the investment cost and the creditor's expected profit from making a loan can be made positive simply by allowing him to foreclose on the project in the event of default:

<u>A1.</u> $$\delta[qy_H + (1-q)y_L] > 1$$

The borrower chooses how often to default when she is solvent and the probability of accepting the lender's offer in the renegotiation stage. Her strategy set is $s_B=(\sigma_L,\sigma_H,d)$, where B^H and B^L accept the new contract with probability σ_H and σ_L, respectively, and d is the rate of default. The lender's strategy is to offer C_1 and to choose the frequency of renegotiation. Let b be the probability of renegotiation not be offered. The lender's strategy is expressed by $s_L=(R,C_2,b)$. The set of strategy is described as a function of the contract terms, where $s=(R;\sigma_L,\sigma_H,b,d;C_2)$.

We consider renegotiation as the proposal of a menu of offers that reflects an incomplete contract and whose terms are determined as a result of ex-post agreement. Next we will describe and characterize the renegotiation procedure.

2.2 Equilibrium

A renegotiation procedure with multiple offers consists of a second contract C_2 stating a menu of renegotiation offers. C_2 determines the terms of the renegotiated contract and is expressed as a particular probability distribution of renegotiated debt value picked from $\Delta(\Re)$.

In the initial period, the lender offers a contract C_1 with debt value R and C_2 with the menu of renegotiation offers in case of default. The borrower has the option of paying back R or defaulting.

If she defaults the lender will select a renegotiation offer from C_2 or impose bankruptcy. The borrower then has the option of accepting the offer and paying the prescribed amount or defaulting. If she defaults she receives 0 and the lender receives the realization times δ. The solvent borrower always accepts any offer and the insolvent borrower only accepts the offer of y_L.

Figure 1 represents the renegotiation game:

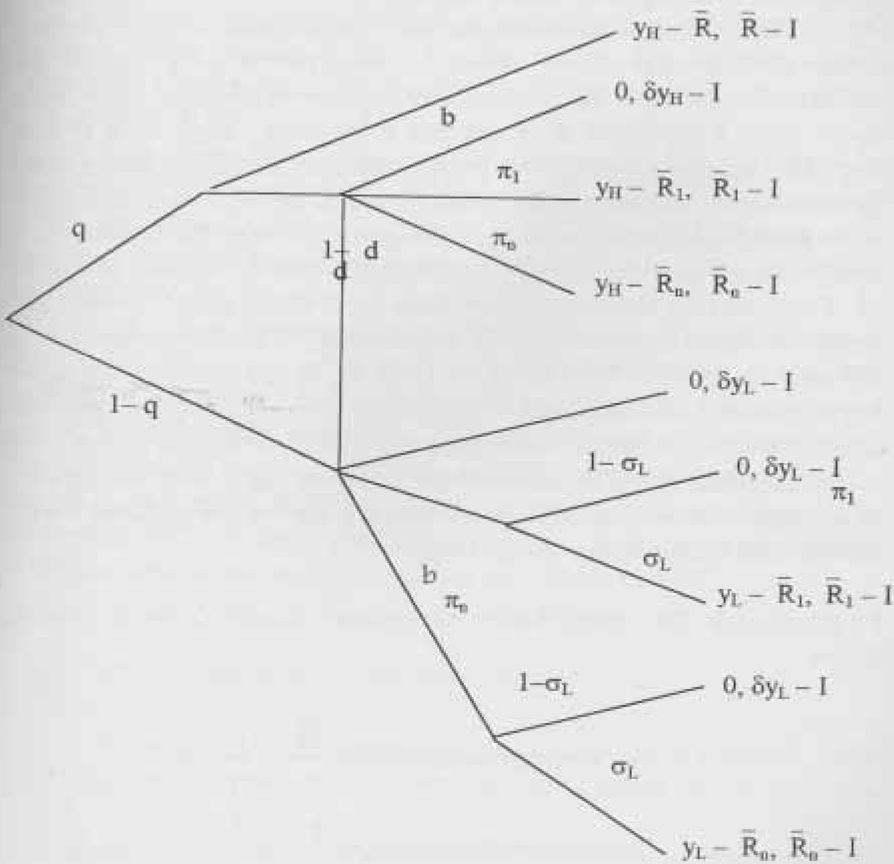

Figure 1

The lender offers a contract with debt value R and does not commit to make any specific renegotiation offer in case of default. The borrower has the option to pay back R or default. If she defaults the lender will randomly select a renegotiation offer or impose bankruptcy. The borrower then has the option of accepting the offer and paying the prescribed amount or defaulting. If she defaults she receives 0 and the lender receives the realization times δ. The solvent borrower always accepts any offer and the insolvent only accepts an offer equal or lower than of y_L.

The rationale to determine the renegotiation offer is that the lender should offer $\bar{R}=y_H$ when he does not recover any of the liquidation cost with the unsuccessful borrower, that is, when he is up to offer $\bar{R}>y_L$. Once B^L is not able to pay any $\bar{R}>y_L$, only B^H can pay this $\bar{R}$, implying that the lender can set $\bar{R}$ slightly lower than y_H and extract all the surplus from B^H. Such an offer does not allow the lender to share the benefit of renegotiation with the borrower, it works like an incentive device to obligate B^H not to default. The offer of $\bar{R}=y_H$, in fact slightly smaller than y_H to make $\sigma_H=1$, should not always be done because there is a probability q that the borrower is not able to pay R. So, $\bar{R}=y_L$ is valid to be proposed with some frequency to avoid the dead-weight loss, $(1-\delta)y_L$, of taking over the asset of B^L. This is a kind of forgiveness that gives a gain of $(y_H - y_L)$ to B^H. This rent is the benefit that the borrower gets with the chance of a renegotiation proposal. Proposition 1 shows the optimal menu that is used on the renegotiation stage.

<u>Proposition 1</u>: The renegotiation procedure consists of the following menu:

$$y_H \text{ with probability } \pi_H' = \frac{R - y_L}{y_H - y_L}\text{; and}$$

$$y_L \text{ with probability } \pi_L' = \frac{y_H - R}{y_H - y_L}.$$

With this menu, the borrower always defaults when insolvent and defaults with probability d=d' when solvent, where $d' = \frac{(1-q)(1-\delta)y_L}{q(y_H - y_L)}$. The solvent borrower always accepts any offer and the insolvent only accepts the offer lower or equal to y_L. Bankruptcy only occurs when an offer is not accepted. These results are proved in the appendix.

Given the take-it-or-leave-it feature of the lending process, the face value of debt is $R = y_H - r/q$, where r is the borrower's outside expected return. The lender's expected return is $LER = q(1 - d')R + qd'y_H + (1-q)\delta y_L - I$.

The menu is also time consistent because after the borrower has defaulted with probability d' the lender keeps the same expected return by setting $\pi_H=0$ or $\pi_L=0$, or both. It is not, however, with certainty that this equilibrium is feasible. The constraint about R>I demands that $r<q(y_H-y_L)$.

The renegotiation opportunity mitigates the dead-weight loss of liquidating insolvent borrowers as will be shown in the next section. It, however, reduces the solvent borrower incentives of paying back the debt. The lender is not able to induce the separating equilibrium, he must accept the partially pooling equilibrium in which a successful borrower may masquerade as insolvent. The occurrence of a partially pooling equilibrium with the renegotiation is comparable to the result of Laffont and Tirole (1990).

2.3 Advantage of Renegotiation

Proposition 2 expresses the advantage of a contract with renegotiation over one in which renegotiation is not allowed.

Proposition 2: Inducing renegotiation in contract is valuable.

The following arguments demonstrate this proposition. Under the non-renegotiation scheme, the lender takes over the borrower's asset whenever default occurs, i.e., b=1 if the payment is

y_L and b=0 if the payment is R. In this case, the lender's expected return is equal to $LER_n = qR_n + (1-q)\delta y_L - I$, where R_n=R.

The multiple proposal renegotiation process is more efficient than the case where there is precommitment not to renegotiate at all. The face value of debt is the same for the procedure under commitment and under non-commitment. The advantage of renegotiation occurs because the menu allows the lender to reduce the cost of bankruptcying insolvent borrower and, at the same time, allows him to appropriate part of the solvent borrower surplus. This implies that, independently of the renegotiation procedure, a lending-borrowing process where the lender commits *ex-ante* not to renegotiate is a non-credible promise. Moreover, since $LER - LER_n = (y_H - R)d$ and d increases with the liquidation cost, the improvement from renegotiation also increases with the liquidation cost. This shows that the gains with renegotiation counterweights with weaker incentives.

This result ignores the financial intermediary ability of getting relevant information without bankruptcy. Next section analyzes the renegotiation game the lender gathers information before the renegotiation stage about the borrower's condition to pay.

3. Debt Renegotiation With Monitoring

The theory of financial intermediation based on information production needs a further investigation when the commitment not to renegotiate is not credible. A financial intermediary may still have the advantage of low cost to carry bankruptcy, but such advantage is not enough to keep the power of enforcing contracts. Renegotiation weakens the intermediary power to mitigate the borrower's opportunistic behavior. However, intermediaries may gather information without bankruptcy. Intermediaries can then be qualified as their ability of gathering the right information. We investigate now the renegotiation game when the lender uses a verification technology to gather information about the borrower's payment condition.

This section points out that a menu is optimal only when the lender does not acquire information about the project before proposing renegotiation. The monitoring cost is essential to explain when randomization is optimal. We investigate how the presence of the information gathered before renegotiation affects the subsequent renegotiation and the type of contract chosen. This work therefore contrasts with a costly state verification appeal which assumes that the lender learns the project realization only by taking over the debtor's project. It also illustrates the role of a financial intermediary as the most relevant producer of information.

3.1 The Renegotiation Game

The contracting and the renegotiation game have the same structure as the one without information gathering. The production technology is the same. The borrower has the option to pay back R or default. If she defaults, the lender selects a renegotiation offer or imposes bankruptcy. The borrower then has the option to accept the offer and pay the prescribed amount or refuse the offer and enters bankruptcy. In case of bankruptcy, the borrower receives 0 and the lender receives the realization times δ. Figure 2 represents the renegotiation game.

The new game assumes the existence of an imperfect verification technology that is purchased before the contract is offered; such a technology has a cost c. It is assumed that the borrower knows if the lender is gathering information and the degree of accuracy of the verification technology. The lender obtains the signal about the project realization after the shock is realized but before the borrower makes the decision about default.

In the contracting period, the lender offers the contract C'_1 to the borrower. C'_1 stipulates the possibility of bankruptcy be imposed when default occurs, the debt value R', and the type of the verification technology to be used. C'_1 may include the terms of the new contract in case of renegotiation. Assume that $R'>I+c$ and $I>y_L$.

α represents the correlation between the true realization and the signal that the lender receives. The value of α is determined before the contract is offered. The verification technology is now characterized. Let $\tilde{\theta} \in \tilde{\Theta} = \{H,L\}$ be the signal observed by the lender and consider it as having the following properties:

$$P(\tilde{\theta} = L/\theta = L) = 1$$

and

$$P(\tilde{\theta} = L/\theta = H) = 1 - \alpha$$

The indirect verification technology does not distinguish the situation where the borrower is insolvent with certainty from other in which he is solvent. Only a proportion α of non-defaulters is identified with certainty while the proportion $(1-\alpha)$ is pooled with the totality of insolvent. The value of α is ultimately determined by the efficiency of the verification technology and is assumed to be fixed and known to the lender and to the borrower. The borrower does not know, however, which signal was received by the lender. She asserts a belief γ that $\tilde{\theta} = H$. After observing a bad signal the lender believes that the true state is $\theta = H$ with probability

$$\mu'_0 = \frac{(1-\alpha)q}{(1-\alpha)q + 1 - q}.$$

The renegotiated contract $C'_{2\tilde{\theta}}$ depends on the signal that the lender observes. The lender chooses a menu according to the signal. Letting $\Re$ be the set of new contracts that can be offered at renegotiation, define $\Delta(\Re)$ as the set of probability distribution over $\Re$. $C'_{2\tilde{\theta}}$ is then a particular probability distribution of renegotiated debt value picked from $\Delta(\Re)$.

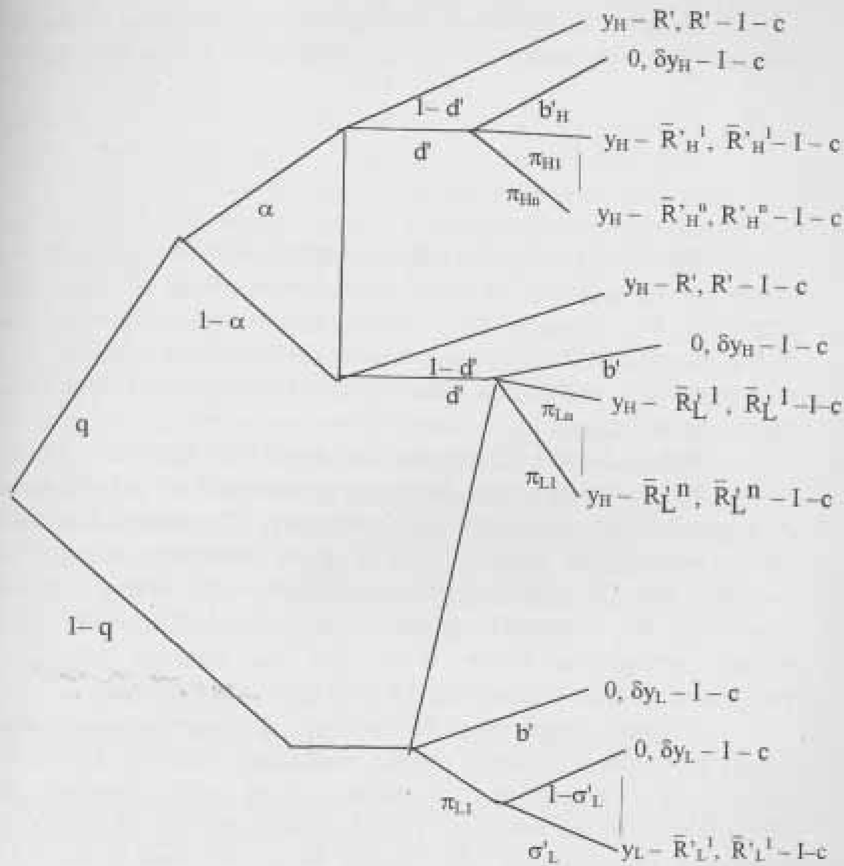

Figure 2

It is assumed that the expected foreclosure value of the project exceeds the investment cost and the cost c of the verification technology. After receiving a bad signal the creditor's expected profit from making a loan can be made positive simply by allowing him to foreclose on the project in the event of default:

<u>AI'</u> $$\delta[q(1-\alpha)y_H + (1-q)y_L] > I + c$$

The payoff structure is the same as the one used in the last section. There are, however, different values when $\tilde{\theta}$ is observed.

3.2 Equilibrium

The lender offers an initial contract with debt value R' and opens the opportunity to renegotiate with a menu of offers. The terms of the renegotiated contract is expressed by $C'_{2\tilde{\theta}}$ for $\tilde{\theta} = \{L,H\}$, which is offered conditional on the signal received. $C'_{2\tilde{\theta}}$ is a particular probability distribution of renegotiated debt value picked from $\Delta(\Re)$.

When default occurs and the signal $\tilde{\theta} = \{H,L\}$ is obtained, the lender has the option to offer a new contract $C'_{2\tilde{\theta}}$, that consists of a menu of offers, or impose bankruptcy. The solvent borrower always accepts any offer and the insolvent borrower only accepts the offer of y_L. The lender always renegotiates by taking over the totality of the borrower's project when $\tilde{\theta}$ =H. The lender also always renegotiate when $\tilde{\theta}$ =L, but his strategy toward a renegotiation offer depends on the information accuracy α.

A good verification technology, that produces accurate signal about the borrower's project realization, gives the lender the chance of charging high penalties more often through the identification of the borrower that is misrepresenting. If the risk of proposing renegotiation with penalty to an insolvent borrower is low, the lender does not need to renegotiate with a menu. The lender can base the renegotiation procedure on forgiveness when the signal reveals insolvency and penalty when the signal reveals insolvency. Such a procedure is optimal when the value of α is such that the solvent borrower has all incentives to truthfully reveal her project outcome. This occurs because the payment of the debt value is lower than the expected loss with renegotiation.

Proposition 3.1: When $\alpha \geq \alpha' = \dfrac{R' - y_L}{y_H - y_L}$, the renegotiation procedure consists of the offer of y_H when a good signal is received and y_L when a bad signal is received.

The lender always renegotiates in case of default using these renegotiation proposals, the solvent borrower does not default and bankruptcy only occurs when an offer is not accepted. This result is proved in the appendix. The face value of debt is $R' = y_H - r/q$ and the lender's expected return is $LER'_1 = qR' + (1-q)y_L - I - c$.

With bad verification technology, the borrower has low incentives to truthfully reveal the project outcome. The value of α with the renegotiation procedure stated in proposition 3.1 doe not work in this case because the solvent borrower's expected loss with renegotiation is lower than the payment of the debt value. This demands further mechanisms to minimize the borrower's willingness to default. Such a devise is the introduction of the possibility of penalty when a bad signal is obtained. This result is stated in Proposition 3.1.

Proposition 3.2: When $\alpha < \alpha' = \dfrac{R' - y_L}{y_H - y_L}$, the renegotiation procedure consists of the offer of y_H when a good signal is received; and randomizing between y_H with probability

$$\pi_{LH} = \frac{R' - (\alpha y_H + (1-\alpha) y_L)}{(1-\alpha)(y_H - y_L)}$$ and y_L with probability

$$\pi_{LL} = \frac{y_H - R'}{(1-\alpha)(y_H - y_L)}$$ when a bad signal is received.

The lender always renegotiates in case of default using these renegotiation proposals. The borrower always defaults when insolvent and defaults with probability $d'' = \frac{(1-q)(1-\delta)y_L}{q(1-\alpha)(y_H - y_L)}$ when solvent. Bankruptcy only occurs when an offer is not accepted. This means that some insolvent borrower enters bankruptcy since the solvent borrower always accepts any offer and the insolvent only accepts the offer lower or equal to y_L. This result is proved in the appendix. The face value of debt is $R'=y_H - r/q$ and the lender's expected return is $LER'_2 = q(1 - d'')R' + qd''y_H + (1 - q)\delta y_L - I - c$.

These 2 propositions show the relevance of monitoring as an incentive device. A lender that renegotiates can not avoid some degree of default only when the monitoring activity does not produce good signal. The next section explores the advantage that a financial intermediary gets on gathering information and determines when it is optimal to monitor through an imperfect verification technology.

3.3 Financial Intermediation and Advantage on Gathering Information

The lender's return increases with his monitoring ability. It increases with α until the cut off level α' that induces the separating equilibrium. Above α', the lender's return is independent of the monitoring efficiency. The lender's return increases with α because the lender gets the value of the penalty more frequently. However, the lender does not get the maximum possible return at each level of α, exhibiting an incompatibility between feasibility and optimality[7]. With bad verification technology, the borrower has low incentives to truthfully reveal the project outcome because the payment of the debt value is higher than the expected loss with renegotiation ($R'>\alpha y_H + (1-\alpha)y_L$). This means that the lender would be better off with the separating equilibrium since the payment of the debt value is higher than what the lender expects to gain from the successful borrower with renegotiation. That is, LER_1-

[7] The incompatibility between pareto optimal result and game theory result is also stated in Gale and Hellwig, (1989).

$$LER_2 = \frac{(1-q)(1-\delta)y_L}{q(1-\alpha)(y_H - y_L)}(R' - (\alpha y_H + (1-\alpha)y_L)) > 0.$$

As separation is not feasible in this case, $\alpha < \alpha'$, the lender must accept the lower return with positive rate of default. This shows that the impossibility of avoiding the borrower's opportunistic behavior is harmful to the lender.

With good verification technology, the borrower has high incentives to truthfully reveal the project outcome because the payment of the debt value is lower than the expected loss with renegotiation ($R' < \alpha y_H + (1-\alpha)y_L$). In this case the separating equilibrium is induced, $\alpha > \alpha'$. As the lender's return increases with α, this means that the lender would be better off with the pooling equilibrium since the payment of the debt value is lower than what the lender expects to gain from the successful borrower with renegotiating, $LER_1 - LER_2 < 0$. The possibility of avoiding the borrower's opportunistic behavior demands that the lender pay the incentive cost $\alpha y_H + (1-\alpha)y_L - R'$ as an extra revenue from the monitoring activity that is not received. This occurs because the successful borrower sets $d'=0$ in this case, limiting the lender's potential gain with monitoring[8].

A financial intermediary is indifferent to any $\alpha > \alpha'$ and worse off with any $\alpha < \alpha'$. It acquires the verification technology when the mitigation of the dead-weight loss of bankruptcy compensates the cost of the verification technology. The gain of avoiding default, however, may be lower than the cost of the verification technology. As the information gathered bases the lender's decision to reduce the bankruptcy rate, when the signal has high correlation with the true realization, the lender's strategy of offering y_H when a good signal is received is able to avoid default.

[8] With a verification technology the lender can monitor the borrower's project outcome and enforce payment. With monitoring, the lender identifies the payment condition of part of defaulters but the pool of defaulters not correctly identified does not alter. This occurs because the frequency of default increases with monitoring. Even with higher rate of default, the lender can be made better off with monitoring because he receives the value of high penalty more frequently. This value may compensate the loss with lower expected payment of debt.

This allows the lender to charge y_L when a bad signal is received. This totally eliminates the bankruptcy cost $(1-q)(1-\delta)y_L$. When the signal has low correlation with the true realization, the threat of being caught and being charged y_L is not enough to reduce the borrower's gain with default. Some rate of default occurs and the lender must offer a menu $\{y_H, y_L\}$ to reduce the liquidation cost. The usefulness of the verification technology for this case is to increase the probability of offering y_L and reduce the liquidation cost.

Proposition 4: When $\alpha \geq \alpha'$, information is gathered if $c \leq c' = \alpha'(1-q)(1-\delta)y_L$; when $\alpha < \alpha'$, information is gathered if $c < c'' = c'\alpha(1-\alpha')/(\alpha'(1-\alpha))$.

For $\alpha \geq \alpha'$ we have that $c'' > c'$ and for $\alpha < \alpha'$ we have that $c'' < c'$. As the lender gets the highest return with the separating equilibrium induced by $\alpha > \alpha'$, it is never profitable to use the verification technology when $c > c'$. Once $c < c'$, the verification technology is acquired when $\alpha > \alpha'$ or $\alpha < \alpha'$ and $c < c'' < c'$ and is not acquired when $\alpha < \alpha'$ and $c'' < c < c'$. The last case expresses the situation in which the verification technology could be acquired if the equilibrium were the separating equilibrium. When $\alpha < \alpha'$, the threshold value c'' increases with α, implying that there is a value for α above α' that generates surplus to acquire the verification technology. Let such a value be α''. Assuming that $c \leq c'$, we have that intermediaries with extremely bad monitoring ability $(\alpha < \alpha'')$ does not produce any useful information; intermediaries with bad monitoring ability $(\alpha'' < \alpha < \alpha')$ produces useful information but does not avoid the borrower's opportunistic behavior; and intermediaries with good monitoring ability $(\alpha' < \alpha)$ produces useful information that avoids the borrower's opportunistic behavior.

Assuming that it is feasible to acquire the verification technology, $c < c'$, we have by definition that $LER_1 > LER$. So, the lender gets LER when $\alpha < \alpha''$, LER_2 when $\alpha'' < \alpha < \alpha'$ and LER_1 when $\alpha > \alpha'$. This shows that intermediaries with extremely bad monitoring ability $(\alpha < \alpha'')$ gets low constant return; intermediaries with bad monitoring ability $(\alpha'' < \alpha < \alpha')$ gets increasing returns as a function of α; and intermediaries with good monitoring ability $(\alpha' < \alpha)$ gets the highest return that is independent of α

Once the monitoring cost is not very high, we can classify each intermediary i in accordance to its particular monitoring ability α_i. Each intermediary pays the same fixed cost to get the opportunity of gathering information before bankruptcy but differs on the ability of verifying the correct signal. Banks can then be identified as the most efficient financial intermediary to produce information. They can be so efficient that their monitoring ability can avoid the borrower's opportunistic behavior even under renegotiation. These intermediaries get the maximum feasible return and are indifferent about improving their monitoring ability. The second class of intermediaries does not avoid the borrower's opportunistic behavior with the renegotiation possibility and benefit from improvements on the monitoring ability. The third class of intermediaries does not avoid the borrower's opportunistic behavior with the renegotiation possibility and gets the lowest return. These intermediaries do not exert any monitoring activity, not conveying useful information to the market.

This result can be related to the literature that empirically verifies the relevance of a bank on credit concession. James (1987) verifies the positive stock market reaction to the announcement of a line of credit. Lummer and McConnell (1989) show that the new loan is not so important. Banks enter new credit agreement with no information advantage relative to other investor. The authors show that the most important is the signal issued with loan revision. Slovin, Johnson and Glascock (1992) show that bank loan has importance on revealing information when it is related to small firms. Best and Zhang (1993) argue that the market does not react in the same way to the announcement of bank loans made to firms whose expected performance has been recently revised upward by financial analysts. The informational content of bank loan is most significant when both the analysts' forecast error is high and the most recent forecast revision is unchanged or negative. Under our approach, the information content of bank loan relies on the fact that a bank monitoring activity is so efficient that the successful borrower is induced to truthfully reveal her outcome even with the renegotiation opportunity.

3.4 Advantage of Renegotiation

Information has no value when there is commitment not to renegotiate. The lender does not benefit from the signal received to reduce the chance to bankrupt the insolvent borrower and extract surplus from the solvent borrower. The lender's return is the same as LER_n. As $LER>LER_n$ and the use of the verification technology depends on the relation between LER_1 and LER and the relation between LER_2 and LER, it is expected that these are the same relations that determines the optimality of the renegotiation scheme over the scheme that does not allow renegotiation. Proposition 5 states this result:

Proposition 5: When it is optimal to gather information, the renegotiation procedure with information gathering is superior to the scheme in which the lender commits not to renegotiate.

To see this result note that the lender prefers the separating equilibrium when information is gathered over the equilibrium without renegotiation ($LER_1>LER$) if $c<(1-q)(1-\delta)y_L$. This is verified since the condition to acquire the verification technology when $\alpha>\alpha'$ demands that $c<\alpha'(1-q)(1-\delta)y_L$. The lender prefers the partially pooling equilibrium when information is gathered over the equilibrium without renegotiation if $c<qd''(y_H-R)$. This is verified since the condition to acquire the verification technology when $\alpha<\alpha'$ demands that $c<q\alpha d''(y_H-R)$

This result does not imply that the lender prefers commits not to renegotiate when the verification technology is very costly. We showed that the renegotiation equilibrium is superior to the scheme that does not allow renegotiation when the lender does not gather information. Once this is true, the lender prefers not commit not to renegotiate when the technology cost is high.

4. Conclusion

A promise not to renegotiate a debt contract is not credible. The reason for the renegotiation is the possibility of minimization of the dead-weight loss with inefficient liquidation. One drawback of renegotiation is that some degree of voluntary default must be admitted. With a verification technology the lender can monitor the borrower's project outcome and enforce payment. The usefulness of the information gathering process is to affect the lender's bankruptcy decision by the imposition of one more restriction in the borrower's willingness to default. We use a stylized debt renegotiation game to show that the lender's advantage on monitoring is relevant to reduce the successful borrower's incentive to default. We conclude that the possibility of identifying the borrower's type with high degree of certainty before the renegotiation stage induces the full revelation equilibrium. With low degree of certainty, the use of the verification technology induces the pooling equilibrium in which part of the successful borrower defaults. The separating equilibrium illustrates the existence of an equilibrium that supports the optimal case where the liquidation cost is not incurred, that is, there is no costly bankruptcy.

Once the monitoring cost is not very high, we can classify each intermediary in accordance to its particular monitoring ability. Banks could be identified as the most efficient financial intermediary to produce information. They can be so efficient that their monitoring ability can avoid the borrower's opportunistic behavior even under renegotiation. The second class of intermediaries also uses the verification technology to monitor but does not avoid the borrower's opportunistic behavior with the renegotiation possibility. The third class of intermediaries does not exert any monitoring activity, not conveying useful information to the market, and does not avoid the borrower's opportunistic behavior with the renegotiation possibility. Under our approach, the information content of bank loan relies on the fact that a bank monitoring activity is so efficient that the successful borrower is induced to truthfully reveal her outcome even with the renegotiation opportunity. This result sheds some light on the empirical literature about the uniqueness of bank loan.

Appendix

1) Equilibrium of the renegotiation game

To derive the equilibrium we first derive the credible renegotiation offer in the first step. Then, in the second step we show that the equilibrium must be in completely mixed strategy.

First step: derive the credible renegotiation offer.

We show that $\{y_H, y_L\}$ is the menu that maximize the lender's expected return given any borrower's action.
When faced with an renegotiation offer a borrower has a simple strategy. A solvent borrower accepts any offer lower than y_H, rejects any offer greater than y_H and is indifferent with an offer equal to y_H. An insolvent borrower accepts any offer lower than y_L, rejects any offer greater than y_L and is indifferent with an offer equal to y_L. For the time being, assume that the borrower accepts when indifferent. (Later we will show that there is no equilibrium when the borrower randomizes over accepting or not when she is indifferent) Clearly the lender will not offer $\bar{R}>y_H$, since such an offer will always be rejected and it is dominated by $\bar{R}=y_H$. For $\bar{R}\leq y_H$, the lender's expected outcome of an offer is:

$$F(\bar{R},d) = \mu \bar{R} + (1-\mu)(\delta y_L + (\bar{R} - \delta y_L)\sigma_L)$$

where $\sigma_L=0$ if $\bar{R}>y_L$, $\sigma_L=1$ otherwise; and μ is the lender's belief that the borrower is solvent, $\mu=\dfrac{qd}{qd+(1-q)}$ Bankruptcy is equivalent to the offer $\bar{R}=\delta y_H$ and to appropriation of borrower's outcome. It is, however, strictly dominated by $\bar{R}=y_H$.

Given the lender's response strategy and the probability of default by each type of borrower, the offers that are not dominated are y_H and y_L. Any offer between y_L and y_H is accepted with the same probability thus the lender may as well offer y_H. Any offer less than y_L is always accepted, therefore the lender may as well offer y_L. Which of these two is best depends on the relative likelihood of the borrower being of each of the two types:

$$\bar{R}=y_L \text{ if } 0\leq d\leq d^*$$
$$\bar{R}=y_H \text{ if } 1\geq d\geq d^*.$$

In other words, y_H is the best offer if it is likely that the lender is of type H, y_L is the best offer if it is likely that the lender is of type L. If $d=d^*$, the lenders is indifferent between the two offers: $F(y_L,d^*)=F(y_H,d^*)$.

So far we have treated the default decision as exogenous, we next consider which frequency of default can occur in equilibrium. We will show that d is the only possibility.

Second step: show that the equilibrium is in mixed strategy.

Consider any possible offer $\bar{R}^i\in[0,y_H]$ and let π_i be the probability of such an offer. The solvent borrower decides to pay if the expected renegotiation gain $\sum\pi_i(y_H-\bar{R}^i)$ is lower than the outcome with payment y_H-R. By the analysis above, we can restrict the lender's renegotiation proposal to y_H with probability π_H and y_L with probability π_L. Given the borrower's best response consider that:

a) $(y_H-y_H)\pi_H+(y_H-y_L)\pi_L>y_H-R$.

This implies that d=1 and it can be achieved with $\pi_L>\dfrac{y_H-R}{y_H-y_L}$.

However, this can not be equilibrium because d=1 implies $\pi_L=0$ since $F(y_H,d=1)>F(y_L,d=1)$.

b) $(y_H-y_H)\pi_H+(y_H-y_L)\pi_L<y_H-R$.

This implies that d=0 and it can be achieved with $\pi_L<\dfrac{y_H-R}{y_H-y_L}$.

However, this can not be equilibrium because d= 0 implies $\pi_L=1$ since $F(y_H,d=0)<F(y_L,d=0)$.

c) $(y_H - y_H)\pi_H + (y_H - y_L)\pi_L = y_H - R$.

This implies that $d=d^*$ and that the lender's best reaction is to randomize over y_H and y_L.

Note that any d different from d^*, 1 and 0 is not possible in equilibrium because: $0<d<d^*$ implies $\pi_L=1$, with $\bar{R}=y_L$ for sure, but then the borrower would choose d=1;
$1>d>d^*$ implies $\pi_H=1$, with $\bar{R}=y_H$ for sure, but then the borrower would choose d=0.

This conclusion certifies that the lender does not choose to randomize over more than two renegotiation offers and that the unique equilibrium is in mixed strategy.

There is no equilibrium with the borrower defaulting when indifferent. Consider any candidate for such equilibrium. The lender will find it advantageous to cut the charge by ε, increasing his profits.

The value of R derives from the borrower's incentive compatible constraint with the optimum stratrgies.

2) Equilibrium of the renegotiation game with information gathering

First step: derive the credible renegotiation offer

We show that the lender's best response is restricted to the menu $\{y_H, y_L\}$ or one of these values.

When the lender receives the signal that the borrower is solvent he proposes renegotiation by offering y_H. Any offer between y_L and y_H is accepted with the same probability thus the lender may as well offer y_H. When he receives the signal that the borrower is not solvent he must consider the probability that the borrower accepts an offer in order to structure the renegotiation.

When faced with an renegotiation offer a borrower has a simple strategy. A solvent borrower accepts any offer lower than y_H, rejects any offer greater than y_H and is indifferent with an offer equal to y_H. An insolvent borrower accepts any offer lower or equal to y_L, rejects any offer greater than y_L. Clearly the lender will not offer $\bar{R}^s > y_H$, since such an offer will always be rejected and it is dominated by $\bar{R}^s = y_H$. For $\bar{R}^s \leq y_H$, the lender's expected outcome of an offer is:

$$F(\bar{R}^s, d') = \mu' \bar{R}^s + (1-\mu')(\delta y_L + (\bar{R}^s - \delta y_L)\sigma'_{LL})$$

where $\sigma'_{LL}=0$ if $\bar{R}^s > y_L$, $\sigma'_{LL}=1$ otherwise; and μ' is the lender's belief that the borrower is solvent, $\mu' = \dfrac{qd'(1-\alpha)}{qd'(1-\alpha)+(1-q)}$. Bankruptcy is equivalent to the offer $\bar{R}^s = \delta y_H$ and to appropriation of borrower's outcome. It is, however, strictly dominated by $\bar{R}^s = y_H$.

The only offers that are not dominated are y_H and y_L. Any offer between y_L and y_H is accepted with the same probability thus the lender may as well offer y_H. Any offer less than y_L is always accepted therefore the lender may as well offer y_L. Which of these two is best depends on the relative likelihood of the borrower being of each of the two types:

$$\bar{R}^s = y_L \text{ if } 0 \leq d' \leq d^*$$
$$\bar{R}^s = y_H \text{ if } 1 \geq d' \geq d^*.$$

In other words, y_H is the best offer if it is likely that the lender is of type H, y_L is the best offer if it is likely that the lender is of type L. If $d' = d^*$, the lenders is indifferent between the two offers: $F(y_L, d^*) = F(y_H, d^*)$.

So far we have treated the default decision as exogenous, we next consider which frequency of default can occur in equilibrium. We will show that there are two possibilities: $d'=0$ and $d'=d^*$.

Second step: Show that the equilibrium is in mixed strategy. Considering that the solvent borrower gets nothing when a good signal occurs, he decides to pay if the expected renegotiation gain $(1-\alpha)\sum \pi_{LL}(y_H - \bar{R}^s)$ is lower than the outcome with payment $y_H - \bar{R}^*$. By the analysis above, we can restrict the lender's renegotiation proposal to $\bar{R}^{H}=y_H$ with probability π_{LH} and $\bar{R}^{L}=y_L$ with probability π_{LL}. Given the borrower's best response consider that:

a) $(1-\alpha)(y_H-y_L)\pi'_{LL} > y_H - R'$.
This implies that $d'=1$, but this can not be equilibrium because $d'=1$ implies $\pi_L=0$ since $F'(y_H,d'=1)>F'(y_L,d'=1)$.

b) $(1-\alpha)(y_H-y_L)\pi'_{LL} < y_H - R'$ This implies that $d'=0$. Such an equilibrium can be achieved with $\pi_{LL} < \dfrac{y_H - R'}{(1-\alpha)(y_H - y_L)}$ or with $\pi_{LL}=1$ and $\alpha>\alpha'$. The first can not be equilibrium because $d'=0$ implies $\pi'_{LL}=1$ since $F'(y_H,d'=0)<F'(y_L,d'=0)$. It lasts the second as a feasible equilibrium.

c) $(1-\alpha)(y_H-y_L)\pi'_{LL} = y_H - R'$.

This implies that $d'=d^*$ and that the lender's best reaction is to randomize over y_H and y_L. $\alpha\leq\alpha'$ is required to satisfy the condition $\pi_{LL}\leq 1$.

Note that the same reasoning above applies to eliminate any d different from d^*, 1 and 0. This conclusion certifies that the lender does not choose to randomize over more than two renegotiation offers.

The value of R' derives from the borrower's incentive compatible constraint with the optimum stratrgies.

3) Proof of Proposition 4:

The lender is better off with the non-default equilibrium when information is gathered if $c<qd'(R-y_L) = \alpha'(1-q)(1-\delta)y_L>c$.

The lender is better off with the default equilibrium when information is gathered if $c<q[d^*-d'](y_H - R) = \alpha(1-q)(1-\delta)y_L(1-\alpha')/(1-\alpha)$.

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