JOURNAL OF FINANCIAL INTERMEDIATION 3, 355–378 (1994)

Information Revelation, Lock-In, and Bank Loan Commitments*

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Received October 4, 1993

This paper considers the extent to which loan commitments mitigate the problems of information monopolies that arise when the firm contracts with a private lender. Loan commitments in conjunction with short-term debt often provide the firm with superior investment incentives by influencing both the states in which bargaining occurs as well as the outcomes from bargaining. Commitment contracts are particularly valuable when there is a high likelihood that information about the firm will be publicly revealed *ex post*. We also identify circumstances under which the firm foregoes commitment financing, relying on short-term debt instead. *Journal of Economic Literature* Classification Numbers G21, G32, D82. © 1994 Academic Press, Inc.

1. INTRODUCTION

Borrowing from a financial intermediary may be a two-edged sword. Intermediaries acquire information about their borrowers (see, for example, Diamond (1984), Fama (1985), and Allen (1990)), which allows for more efficienct renegotiation as the borrower's circumstances change over time (see Gertner and Scharfstein (1991) and Lang and Nakamura (1989)). However, as demonstrated in recent work by Rajan (1992), the possession of private information also enables lenders to extract rents from successful firms by threatening to withhold further funding. The creation of such *ex post* information monopolies reduces the efficiency of subsequent bargaining between the two parties and has a negative influ-

* We thank Mark Flannery, Chris James, and Bob Mooradian for their helpful comments. We also acknowledge the helpful suggestions of the two anonymous referees and the journal editors. All remaining errors are our own.

1042-9573/94 $6.00

ence on the *ex ante* decisions of the borrower.[1] In fact, the costs of such lock-in problems might even prompt the borrower to forego intermediary financing altogether.

This raises the question as to whether private debt contracts can be structured to reduce the costs arising from the creation of information monopolies. We will show that the problems arising from information monopolies can be mitigated with the use of contingent contracts resembling loan commitments. The presence of commitments influences both the states in which bargaining occurs and the outcomes of the bargaining process.

By providing a prearranged source of funds, loan commitments limit the lender's ability to extract rents from successful projects. However, commitments may also weaken incentives since they can be used to continue unsuccessful projects. This trade-of suggests that there are circumstances under which borrowers would prefer to rely solely on spot market contracts and forego commitment financing.

Our analysis also provides insights into how the structure of private debt contracts is affected by the likelihood of information revelation regarding the borrower's quality. Since the lender's information monopoly is broken when such revelation occurs, the likelihood of the project's quality being revealed can also be viewed as a measure of *ex post* competition among lenders.[2] We demonstrate that commitment contracts are more likely to be selected when the project's quality is likely to be publicly revealed. Therefore loan commitments are likely to be used by young firms anticipating public ownership. Another interpretation is that loan commitments are more valuable the greater the level of *ex post* competition among lenders.

The existing literature views loan commitments as insurance contracts to risk-averse borrowers, hedging vehicles for lenders, devices to mitigate underinvestment and/or suboptimal liquidations, or as signaling devices (see Boot *et al.* (1987), Thakor and Udell (1987), Greenbaum *et al.* (1991), Berkovitch and Greenbaum (1991), Campbell (1978), Kanatas (1987), Houston and Venkataraman (1994), and Thakor (1989)). This paper suggests an alternate explanation for loan commitments, based on their abil-

[1] This point has been made in other contexts. For example, Farrell and Shapiro (1989) consider "lock-in" arrangements between buyers and sellers of goods and services, and James (1992) considers the effects that lock-in has on the underwriting process. Sharpe (1990) makes a similar point in the context of customer relationships in banking.

[2] Two contrasting views of this *ex post* competition can be found in the literature. Diamond (1991) assumes that private information is revealed to the entire banking sector, leading to perfect competition. On the other hand, Rajan (1992) examines the case where none of the private information is revealed, leading to a monopoly relationship between the firm and the bank.

ity to address problems arising from information monopolies. This interpretation of commitments is consistent with Farrell and Shapiro's (1989) observation that lock-in problems elicit corrective contractual and/or institutional arrangements.[3]

The paper proceeds as follows. Section 2 describes the model and the first-best outcome without debt financing. Section 3 considers the effects of short-term debt financing. The various forms of loan commitment financing are described in Section 4, and Section 5 examines the optimal contract. Section 6 concludes.

2. THE MODEL

Consider a three-date ($t = 0, 1, 2$) model, where a risk-neutral entrepreneur has access to a risky project that requires a fixed investment of I_0 dollars at $t = 0$. At $t = 2$, a good project yields a certain cash flow of X, while a bad project yields a cash flow of X with probability p_b, and zero otherwise. The entrepreneur's choice of effort, q, made at $t = 0$, determines the *ex ante* probability that the project is good. Without loss of generality, we assume that this probability is also equal to q, and that the risk-free rate is zero over each of the two periods. The cost of expending effort in the project is given by

$$C(q) = Kq^2, \tag{1}$$

where K is an exogenously specified positive constant.[4] After the original investment and choice of effort, the project's quality is revealed to the entrepreneur at $t = 1$. If the project is good, there is a probability ϕ that this will be known to the public as well. Otherwise, the quality of the project remains unknown to outsiders.[5] In addition to observing the project quality, the entrepreneur also learns the firm's liquidation value

[3] In a recent paper, Berlin *et al.* (1993) examine the implications of allowing banks to hold equity in the firms that they lend to and argue that this improves the credibility of renegotiations in financial distress. In a different context, Berlin and Mester (1992) examine the trade-off between the *ex ante* use of covenants to control agency problems and their impact on *ex post* renegotiation.

[4] We will later restrict K to ensure that q is between 0 and 1. While the assumption of a quadratic cost function simplifies the exposition considerably, the results are applicable for any cost function with $C'(q) > 0$ and $C''(q) > 0$.

[5] We could also assume that when a project is bad, there is some probability that outsiders discover this. However, once it is revealed that a project is bad, outsiders will choose not to compete with the bank at $t = 1$. As a result, such information will not affect the bargaining game between the bank and the entrepreneur. To simplify notation we therefore assume that there is a zero probability that the quality of a bad project is revealed to outsiders.

which is a function of project quality. A good project implies a liquidation value of L dollars, whereas a bad project yields either zero or L with probabilities λ and $(1 - \lambda)$, respectively. Therefore, at $t = 1$, the information revealed could consist of one of four possibilities:

1. The project is good, and this information is revealed to the public (state GR).
2. The project is good, but this information is not revealed to the public (state GNR).
3. The project is bad, and the liquidation value is high (state BH).
4. The project is bad, and the liquidation value is low (state BL).

a. *First Best*

Consider first the optimal decisions of the entrepreneur who manages his own firm without external financing. Based on the observed project quality and liquidation value at $t = 1$, the entrepreneur decides whether to continue operations. We assume that $X > I_0 > L > p_b X$, which ensures that a good project will be continued and that a bad project will be liquidated whenever the liquidation value is high (State BH). The *ex ante* choice of effort, q, influences the probability of obtaining these payoffs. The optimization problem faced by the entrepreneur is

$$\max_q \; qX + [1 - q][\lambda p_b X + (1 - \lambda)L] - I_0 - Kq^2. \tag{2}$$

Note that this problem is independent of ϕ, the probability that project type is revealed to the public. The optimal level of effort, q^*, is

$$q^* = [X - [\lambda p_b X + (1 - \lambda)L]]/2K. \tag{3}$$

The entrepreneur trades off the marginal benefit of increased effort against the marginal cost of determining the optimal effort to expend.[6] It also follows from (3) that the optimal effort of the entrepreneur is increasing in X and λ, and decreasing in L, p_b, and K.

Our model is similar to that of Rajan (1992). There are two key differences, however. First, we allow for the possibility that the firm's quality is publicly revealed (i.e., $\phi > 0$), breaking the bank's information monopoly. Also in our model, a bad project outcome does not always imply liquidation since the liquidation value could be lower than the value of continued operations (i.e., $\lambda > 0$). This establishes incentives to restructure debt claims to ensure that operations are continued.

[6] To ensure that $q < 1$, we assume that $K > \{X - [\lambda p_b X + (1 - \lambda)L]\}/2$, which is nonnegative. Moreover, from (3) and the fact that $p_b X < L < I_0 < X$, it follows that $q > 0$.

3. SHORT-TERM DEBT FINANCING

Suppose the entrepreneur requires I_0 dollars of external funds in order to proceed. Moreover, suppose the firm issues debt to fund the project.[7] Lenders know that the entrepreneur maximizes the value of equity. This creates a moral hazard problem both with the liquidation/continuation decision at $t = 1$ and with the effort decision at $t = 0$.

Since public lenders are unaware of project quality and of liquidation value in states GNR, BH, and BL, public debt contracts lead to inefficient liquidation at $t = 1$. We therefore assume that these funds are obtained through an intermediary ("the bank") that can verify both the project quality and the liquidation value of the firm at $t = 1$, but not the original effort decision of the entrepreneur.[8] In this section, we assume that the bank debt is short-term, since this creates the most obvious incentives for monitoring at $t = 1$ (long-term financing is considered in Section 4). To ensure that the bank will monitor the firm at $t = 1$ to determine project quality and liquidation value, we assume that verification costs are zero.

The *ex ante* competitive bank, which is also assumed to be risk neutral, lends I_0 at $t = 0$ and prices the debt to break even. The face value of the debt F_1 is assumed to be greater than L.[9] We assume that at $t = 1$, either the firm or the bank can propose that the two parties bargain. If bargaining fails, the party in control makes the decision that they would have made absent bargaining. Since there is symmetric information between the firm and the bank when they bargain, the continuation/liquidation policy is efficient. We assume that the outcome of the bargaining game is such that the gains from the efficient policy are shared by the two parties. The fraction that is captured by each party is a function of its bargaining

[7] Following Diamond (1984), Rajan (1992), and earlier work by Townsend (1979) and Gale and Hellwig (1985), the unobservability of terminal cash flows can be used to explain the firm's reliance on external debt financing. Our formulation also allows for the use of contracts other than just short- or long-term debt. We consider this possibility explicitly in the next section.

[8] As pointed out by Rajan (1992), problems associated with being locked in to a relationship with an intermediary might convince a firm to use public debt instead. Since our focus is primarily on the extent to which contractual features mitigate problems associated with informational monopolies, we ignore the possibility of the firm using public debt.

[9] This condition will occur over the entire range of bargaining strengths μ_e as long as ϕ is set high enough. It can be established (by totally differentiating the rational pricing constraint) that $dF_1/d\mu_e > 0$. Consequently, it is sufficient to verify that $F_1 > L$ for the case where $\mu_e = 0$. In this special case, the rents extracted by the bank in the state GNR force it to accept a lower promised payment F_1 *ex ante*. Consequently, F_1 is more likely to exceed L if the probability of rent extraction is low, i.e., ϕ is high. It can be shown that a sufficient condition for F_1 to exceed L is $\phi > \{X - [\lambda p_b X + (1 - \lambda)L]\}/(X - L)$. (Details on the proof are available from the authors upon request.)

strength, denoted by μ_e for the owners of the firm and $(1 - \mu_e)$ for the bank.[10]

If the project is good, and this is revealed to the public (state GR), the firm will be able to repay the bank. In any of the other states, however, the bank has more information about the firm than the public, which is assumed to be unwilling to provide financing.[11] If the state is BH, the bank will liquidate the firm. In the GNR and BL states, the firm and the bank will seek to ensure that operations are continued. If the public knew that the true state was GNR, they would have refinanced the debt. Since they are not aware of this, however, the bank can extract rents from the firm by threatening to withhold refinancing.[12] In state BL, it is optimal to continue operations, even though the project is bad. In this state, the two parties once again find it beneficial to restructure the debt, and the firm has the incentive to continue operations.

Suppose the firm promises to pay the bank F_1 dollars at $t = 1$. As long as $F_1 > L$, the bank can obtain $L + (1 - \mu_e)(X - L)$ by threatening to withhold funds in state GNR.[13,14] Similarly in BL, bargaining provides the bank with $(1 - \mu_e)p_b X$. Since the firm anticipates these state-contingent outcomes, it's effort choice is the solution to

$$\max_q q[\phi(X - F_1) + (1 - \phi)\mu_e(X - L)] + [1 - q][(1 - \lambda)0 + \lambda\mu_e p_b X] - Kq^2. \tag{4}$$

The first-order condition leads to

$$q_{st} = q^* - [\Omega_{st}/2K], \tag{5}$$

[10] This bargaining game is similar to that utilized in Rajan (1992) and can be justified based on the alternating offer model of Rubinstein (1982). For simplicity, bargaining strength has been assumed to be state independent.

[11] If state GR does not occur, the firm could still attempt to pay the bank through an issue of new debt. These "new" bondholders will compare the amount that the firm wishes to refinance, F_1, with the perceived "quality" of the assets, when deciding whether or not to provide the requisite funding. A sufficient condition for ensuring that such funding is unavailable is $[q^*(1 - \phi)X + (1 - q^*)p_b X]/[q^*(1 - \phi) + (1 - q^*)] < L$.

[12] This is similar to the lock-on effect described by Rajan (1992). Diamond (1991) assumes that any information obtained by the firm's bank is also revealed to the "banking industry." Under these circumstances, of course, the original bank cannot extract rents by threatening to withhold financing.

[13] The interpretation of the bargaining game as leading to rent extraction by the bank makes intuitive sense as long as $L + (1 - \mu_e)(X - L) \geq F_1$. If not, a more plausible view is that of the firm extracting rents from the bank.

[14] The assumption that $F_1 > L$ is always satisfied as long as ϕ is large enough. As the firm's bargaining power (μ_e) decreases, the rents that can be extracted by the bank in GNR force it to lower F_1 in order to break even. It is therefore possible that at sufficiently low μ_e values, $F_1 < L$. The possibility is incorporated into the numerical examples. Details for this case are available from the authors upon request.

where

$$\Omega_{st} = [\phi F_1 + (1 - \phi)(L + (1 - \mu_e)(X - L))] - [\lambda(1 - \mu_e)p_b X + (1 - \lambda)L] \tag{6}$$

represents the difference between the bank's expected payoff in the good and bad states. When debt is risky, the bank must receive higher payments in the good states to compensate for it receiving less than I_0 in the bad states, i.e., $\Omega_{st} > 0$. This asymmetry in expected payoffs to bondholders across the good and the bad states reduces the entrepreneur's incentive to expend effort since his payoff in the good state is reduced by a larger amount then his payoff in the bad states. Short-term lenders recognize that the presence of debt distorts the entrepreneur's incentives to expend effort and price the debt accordingly. The promised payment F_1 also has to satisfy the rational pricing constraint[15]

$$q[\phi F_1 + (1-\phi)(L + (1-\mu_e)(X-L))] + [1-q][\lambda(1-\mu_e)p_b X + (1-\lambda)L] = I_0. \tag{7}$$

The solution under short-term debt can now be characterized.

PROPOSITION 1. *The entrepreneur will always underinvest in effort when short-term debt is utilized, i.e., $q_{st} < q^*$. The effort expended with short-term financing decreases in μ_e and is independent of ϕ.*

Proof. See Appendix.

The interim revelation of project type to the public allows the firm to escape the bank's information monopoly and thereby recontract under better conditions. Consequently, one might expect the effort choice with short-term debt to depend on the likelihood of such revelation. Surprisingly, the likelihood of the project's quality being revealed has no effect on firm value if the project is financed with short-term debt. This is because an increase in ϕ has no effect on the expected payment received by bondholders in the bad state. To satisfy rational pricing, therefore, the expected payment in the good state has to remain unchanged as well. Thus, the impact on expected payments to bondholders in the good and bad states is such that an increase in ϕ is exactly offset by a decrease in F_1. Since it is the difference in the expected payments across the good and bad states that skews the entrepreneur's incentives, it follows that

[15] It can be demonstrated that effort incentives diminish as the promised payment, F_1, increases. This suggests that the rational pricing constraint is binding, and therefore it will not pay to "overfinance" a project. This contrasts with Rajan (1992) where *ex ante* competition among banks leads firms to over finance projects at $t = 0$.

changes in ϕ, which have no impact on this difference, do not affect the outcome.[16]

An examination of the impact of the bargaining strength of equity on the solution reveals that as long as the probability that debt needs to be restructured in the bad states, λ, is positive, an increase in the bargaining strength of equity, μ_e, reduces the amount of effort that is exerted by the entrepreneur. An increase in μ_e reduces the payments to bondholders in states GNR and BL. Since the payment in BH cannot be changed, the only choice that the lender has is to increase the promised payment F_1 that they receive in state GR. Since expected payments to the lender increase in the good states (GR and GNR) and decrease in the bad states (BH and BL), this motivates the entrepreneur to expend less effort.

With the short-term debt contract the bank controls liquidation policy at $t = 1$. For example, the bank is able to unilaterally shut down the firm in state BH. Similarly, in states GNR and BL, the bank is able to initiate a bargaining game with the borrower. In the next section, we analyze a set of alternative contracts which limit the bank's control over the firm.

4. LOAN COMMITMENT FINANCING

Consider a contract with parameters $(\hat{F}_1, \hat{F}_2)$ that provides the firm with an option on how to pay off its obligation to the bank. One alternative is to pay the bank $\hat{F}_1$ at $t = 1$. If such a payment is made, the firm is not liable for any additional payments to the bank. If the firm decides not to pay the $\hat{F}_1$ dollars at $t = 1$, it has two alternatives. It can either promise the bank $\hat{F}_2$ at $t = 2$ and continue operations or it could liquidate the firm. This contract can be viewed as short-term debt, coupled with a loan commitment (that allows the firm to borrow $\hat{F}_1$ at $t = 1$, for a promised payment of $\hat{F}_2$ at $t = 2$).[17]

With the loan commitment in place, the bank no longer can threaten the firm by refusing to provide financing, i.e., the threat that led to bargaining in the presence of short-term debt alone since the firm can then simply

[16] This is true as along as $F_1 > L$. When $F_1 < L$, the states in which bargaining occur change. It can be shown that the resulting solution is strictly worse than that computed above (details available from the authors upon request). Moreover, the inclusion of this additional complication does not change the nature of the results. While we explicitly incorporate this possibility in the numerical example, we assume for analytical ease of exposition that $F_1 > L$.

[17] We assume that the bank is able to make credible commitments. If not, this contract is no different from short-term debt. Kanatas (1987) considers cases where banks may choose not to honor commitments. Boot *et al.* (1991) examine situations where the credibility of commitments is endogenously determined.

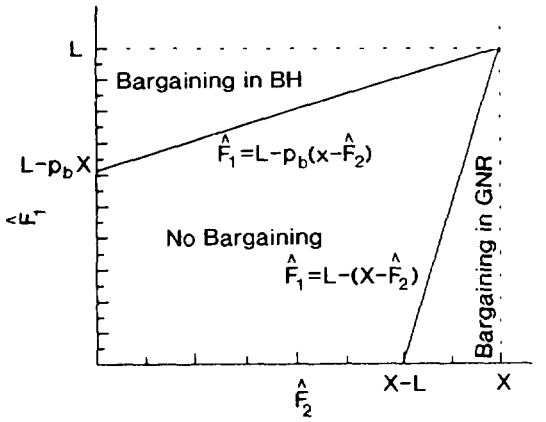

FIG. 1. Bargaining at $t = 1$ when the borrower has a loan commitment.

take down the loan commitment.[18] Two complications are of note. First, the firm could threaten to liquidate inefficiently by refusing to exercise the commitment. If such a threat is credible, the bank and the firm will bargain to ensure that operations are continued. Such threats can never occur in BL (since the liquidation value is zero), but they are credible in GNR. Second, the firm could threaten to continue operations by exercising the commitment, even when it is optimal to liquidate the firm. Once again, if such a threat is credible, it would lead to bargaining between the firm and the bank to ensure liquidation. The location of these credible regions, as a function of $\hat{F}_1$ and $\hat{F}_2$, are plotted in Fig. 1. These regions highlight the fact that there are many combinations of $(\hat{F}_1, \hat{F}_2)$, where the threats of the firm are not credible. Hence, bargaining between the firm and the bank may not ensue because there is nothing that the firm can do that would bring the bank to the bargaining table (i.e., $p_b(X - \hat{F}_2) < L - \hat{F}_1 < X - \hat{F}_2$). We refer to the three games induced by the appropriate selection of $(\hat{F}_1, \hat{F}_2)$ as the BH, GNR, and the NB game, respectively. The states in which bargaining occurs at $t = 1$, as a function of the relationship between $\hat{F}_1$ and $\hat{F}_2$, are formalized next.

PROPOSITION 2. *The contract* $(\hat{F}_1, \hat{F}_2)$ *can lead to one of three bargaining outcomes between the firm and the bank.*

[18] A recent paper by Gorton and Kahn (1992) argues that long-term lending arrangements, coupled with "covenants" that allow the bank to call in the loan at its discretion, provide similar benefits to those examined in this paper. Boot *et al.* (1993) show that reputational considerations may lead banks to honor commitments that are not legally binding.

TABLE I
BARGAINING IN BH: PAYOFFS TO EQUITY AND DEBT
(Restriction: $\hat{F}_1 \geq L - p_b(X - \hat{F}_2)$)

State	Probability	Equity	Debt
GR	$q\phi$	$X - \hat{F}_1$	$\hat{F}_1$
GNR	$q(1 - \phi)$	$X - \hat{F}_2$	$\hat{F}_2$
BH	$(1 - q)(1 - \lambda)$	$p_b(X - \hat{F}_2) + \mu_e(L - p_b X)$	$p_b\hat{F}_2 + (1 - \mu_e)(L - p_b X)$
BL	$(1 - q)\lambda$	$p_b(X - \hat{F}_2)$	$p_b\hat{F}_2$

If $\hat{F}_1 \geq L - p_b(X - \hat{F}_2)$, *bargaining occurs in state BH.*

If $L - (X - \hat{F}_2) < \hat{F}_1 < L - p_b(X - \hat{F}_2)$, *bargaining does not occur in any of the states.*

If $\hat{F}_1 \leq L - (X - \hat{F}_2)$, *the two parties bargain in state GNR.*

Proof. See Appendix.

The payoffs to debt and equity under these three games are summarized in Tables I–III. These tables assume that $\hat{F}_1 < \hat{F}_2$. If $\hat{F}_1 \geq \hat{F}_2$, the firm is unable to benefit from refinancing based on the public revelation of its quality at $t = 1$. Moreover, while the firm would always prefer to continue operations until $t = 2$, the bank will provide concessions in state BH at $t = 1$ to encourage the firm to liquidate. Such a continuation policy is similar to what would be observed if the firm used long-term debt. In the special case where $\hat{F}_1 = \hat{F}_2 = F_2$, where F_2 is the face value of rationally priced long-term debt, the firm's actions and payoffs under commitment financing are identical to what would be observed under long-term debt.

a. *Designing the Optimal Loan Commitment*

Within each bargaining region, the contract $(\hat{F}_1, \hat{F}_2)$ which provides the best incentives *ex ante* is chosen by the firm from among the set of feasible commitments. Note that the bank's rational pricing constraint implies that $\hat{F}_1$ and $\hat{F}_2$ are not independent.

TABLE II
BARGAINING IN GNR: PAYOFFS TO EQUITY AND DEBT
(Restriction: $\hat{F}_1 \leq L - (X - \hat{F}_2)$)

State	Probability	Equity	Debt
GR	$q\phi$	$X - \hat{F}_1$	$\hat{F}_1$
GNR	$q(1 - \phi)$	$(L - \hat{F}_1) + \mu_e(X - L)$	$\hat{F}_1 + (1 - \mu_e)(X - L)$
BH	$(1 - q)(1 - \lambda)$	$L - \hat{F}_1$	$\hat{F}_1$
BL	$(1 - q)\lambda$	$p_b(X - \hat{F}_2)$	$p_b\hat{F}_2$

TABLE III
NO BARGAINING: PAYOFFS TO EQUITY AND DEBT
(Restriction: $L - (X - \hat{F}_2) < \hat{F}_1 < L - p_b(X - \hat{F}_2)$)

State	Probability	Equity	Debt
GR	$q\phi$	$X - \hat{F}_1$	$\hat{F}_1$
GNR	$q(1 - \phi)$	$X - \hat{F}_2$	$\hat{F}_2$
BH	$(1 - q)(1 - \lambda)$	$L - \hat{F}_1$	$\hat{F}_1$
BL	$(1 - q)\lambda$	$p_b(X - \hat{F}_2)$	$p_b\hat{F}_2$

The following proposition characterizes the optimal commitment contract within each bargaining region.

PROPOSITION 3. *Conditional on being in a particular bargaining solution, the optimal commitment has the following characteristics:*[19]

Bargaining in BH only:

$$[\hat{F}_1 = L - p_b(X - \hat{F}_2),\ \hat{F}_1 \leq L,\ \hat{F}_2 \leq X] \quad \text{or} \quad [\hat{F}_1 > L,\ \hat{F}_2 = X]$$

Bargaining in GNR only:

$$[\hat{F}_1 < L,\ \hat{F}_2 = X]$$

No bargaining (NB):

$$[\hat{F}_1 = L - p_b(X - \hat{F}_2)] \quad \text{when } \phi < \phi^* = \frac{1 - \lambda}{(1 - \lambda) + \lambda p_b}$$

and

$$[\hat{F}_1 = L - (X - \hat{F}_2)] \quad \text{when } \phi \geq \phi^* = \frac{1 - \lambda}{(1 - \lambda) + \lambda p_b}.$$

Proof. See Appendix.

Q.E.D.

Proposition 3 indicates that within the regions where bargaining occurs (i.e., the BH solution and the GNR solution), effort incentives are maximized by maximizing $\hat{F}_2/\hat{F}_1$. For these contracts, increasing $\hat{F}_2$ relative to $\hat{F}_1$ increases the entrepreneur's expected payoff in the good states relative

[19] When the firm is indifferent between exercising the commitment and bargaining, we allow for both of these possibilities in the analysis. This ensures that the solution is not dependent on *ad hoc* tie-breaking rules.

to the expected payoff in the bad states and thereby improves effort incentives. In the region where bargaining does not occur, two possibilities emerge. If $\phi < \phi^*$, it is optimal to minimize $\hat{F}_2/\hat{F}_1$, and if $\phi > \phi^*$ it is optimal to maximize $\hat{F}_2/\hat{F}_1$.

For subsequent analysis, we assume that the BH solution characterized in the previous proposition always lies in the interior, i.e., $\hat{F}_2 < X$.[20] As shown next, such a solution is dominated by the no-bargaining (NB) contract.

PROPOSITION 4. *For any feasible BH solution satisfying* $\hat{F}_1 = L - p_b(X - \hat{F}_2)$, *there also exists a feasible NB solution, such that the BH solution is dominated.*

Proof. See Appendix.

Proposition 4 demonstrates that a loan commitment contract which necessitates paying the firm to liquidate (i.e., which led to bargaining in BH) would be avoided. By paying the firm to liquidate, the bank increases the firm's expected payoff if the project is bad and thereby reduces incentives to expend effort. By choosing an NB contract that is "close" to this BH contract, such liquidation is done voluntarily.

Recall, from the discussion following Proposition 2, that long-term debt contracts can be viewed as a special case of the loan commitment contract, where $\hat{F}_1 = \hat{F}_2 = F_2$, where F_2 is the face value of long-term debt. Proposition 4 therefore implies that long-term debt contracts (without contingent features attached) are never optimal. This result appears consistent with observed practice. Long-term bank contracts are rarely observed without a commitment or contingent feature of some sort.[21,22]

5. THE OPTIMAL CONTRACT

The results of Proposition 3 indicate that the optimal loan commitment contract will either lead to bargaining in GNR or will not involve any bargaining at all. It is also possible, however, that short-term debt provides a superior solution to commitment financing. The choice of financ-

[20] While this restriction eliminates some technologies from the analysis, it does not change the nature of the results.

[21] See James (1987) and Billett *et al.* (1993) for a description of the characteristics of bank loans.

[22] A sufficient condition for there to be a trade-off between short- and long-term debt is that $(L - p_b X - \lambda L) > 0$. Since long-term debt is only a special case of the more general commitment contract, however, we do not specifically consider the trade-off between these two contracts.

ing depends critically on two parameters: the firm's bargaining strength, μ_e, and the probability of public revelation of quality, ϕ.

In characterizing the optimal contract we first consider the effect these parameters have on contract feasibility. We then consider how changes in these parameters affect the choice among the set of feasible contracts.

a. *Contract Feasibility*

Even when the short-term debt and NB commitment contracts are feasible over the entire range of bargaining strengths (μ_e), the same need not be true of the GNR commitment. Specifically, the GNR contract becomes infeasible whenever $\hat{F}_1$ exceeds L, in which case the firm can no longer credibly commit to not bargaining in BH. In particular, the GNR contract is less likely to be feasible at high levels of μ_e and/or ϕ. As the bargaining strength of the firm (μ_e) increases, bargaining in GNR provides larger cash flows to the firm and therefore smaller cash flows to the bank. By the same logic, an increase in ϕ reduces the bank's expected cash flows since it is less likely to realize an information monopoly at $t = 1$. In both circumstances, the bank must increase $\hat{F}_1$ (since $\hat{F}_2$ is already optimally set at X and cannot be raised any further) in order to earn the same expected return. The contract remains feasible as long as $\hat{F}_1$ remains less than L. Once $\hat{F}_1$ exceeds L, the firm can no longer credibly commit to not bargaining in BH, and the GNR contract is no longer feasible.

b. *The Optimal Contract When All Contracts Are Feasible*

We can now characterize the optimal contract when all contracts are feasible. The following proposition demonstrates that commitment financing is always preferred to short-term borrowing whenever the GNR contract is feasible.

PROPOSITION 5. *When it is feasible, the GNR bargaining contract always dominates short-term debt financing.*

Proof. See Appendix.

Unlike short-term borrowing, the loan commitment (with bargaining in GNR) enables the entrepreneur to profit from the possibility that its true quality will be publicly revealed.[23] If project quality is revealed, the firm is able to avoid the informational monopoly. The bank responds by charging a higher contract rate, which in the case of the commitment reduces the firm's expected payoff from unsuccessful projects. This in turn improves effort incentives. Therefore, commitment contracts with bargaining in

[23] Recall, from Proposition 1, that the value of the firm, under short-term borrowing, is independent of ϕ.

GNR are preferable to short-term debt because they improve effort incentives by altering the rents due to *ex post* information monopolies.

We next show that as long as there is a sufficiently high probability that good projects become publicly revealed, commitments with bargaining in GNR also dominate commitments that lead to no bargaining.

PROPOSITION 6. *A sufficient condition for the GNR bargaining contract to dominate the NB contract over the range where it is feasible is*

$$\phi > \phi^{**} = \frac{1 - \lambda - p_b}{(1 - \lambda)(1 - p_b)}. \tag{8}$$

Moreover, $\phi^{**} < \phi^*$.

Proof. See Appendix.

Proposition 6 indicates that the more likely it is that the project's quality is revealed, the more likely the GNR contract will be selected. Since $\phi^{**} < \phi^*$, it also follows that when the GNR contract is feasible, the firm would never select the no-bargaining contract where $\hat{F}_1 = L - (X - \hat{F}_2)$. Also, the GNR contract is less likely to be selected at low levels of λ. Finally, since the value of the GNR contract is increasing in μ_e while the NB contract is invariant to μ_e, it follows that the GNR contract is more likely to be selected if the firm's bargaining power is relatively low.

In choosing between the two commitment contracts, the firm is choosing between contracts that are structured differently. One contract maximizes $\hat{F}_2/\hat{F}_1$ (i.e., has a relatively high commitment rate and a relatively low $\hat{F}_1$), which provides incentives for bargaining in state GNR. By contrast, the no-bargaining contract minimizes $\hat{F}_2/\hat{F}_1$ (i.e., has a relatively low commitment rate and a relatively high $\hat{F}_1$). This lower $\hat{F}_1$ for the GNR contract explains in part why the attractiveness of this contract increases with the probability of project quality revelation.

The results in Propositions 5 and 6 taken together suggest that as long as the contracts remain feasible, loan commitment contracts dominate short-term borrowing. We next consider the optimal contract over the range of bargaining powers where the loan commitment contract which leads to bargaining in GNR is no longer feasible.

c. *The Optimal Contract when the GNR Contract Is No Longer Feasible*

Recall that at high levels of firm bargaining power, the commitment contract that leads to bargaining in GNR is no longer feasible. For levels of firm bargaining power where this is the case, the firm must choose between short-term borrowing and commitment contracts that produce no subsequent bargaining.

First, note that if $\phi < \phi^{**}$, the commitment contract with no bargaining always dominates short-term borrowing. This follows immediately from Propositions 5 and 6. However, if $\phi < \phi^{**}$, short-term borrowing may dominate commitment financing if the firm's bargaining power is high enough that the GNR commitment contract is infeasible. This is less likely to occur if the firm has great bargaining power, because bargaining power reduces the value of short-term debt borrowing, while having no effect on the value of the commitment that precludes bargaining. Similarly, short-term borrowing is less likely to be selected at high levels of ϕ, since increases in ϕ increase the value of the commitment contract, and have no effect on the value of short-term borrowing.

Two interesting implications follow immediately. First, commitment contracts do not always dominate short-term borrowing.[24] Second, an increase in the Firm's bargaining power does not always increase firm value. Once bargaining power is great enough such that the GNR contract becomes infeasible, firm value may be declining in bargaining power.

The following example highlights the contract choice over the range of bargaining powers.

Numerical Example. Suppose that the original investment required by the firm I_0, is 1 unit. The other parameters characterizing the technology are

$$X = 5; \qquad p_b = 0.09, \qquad L = 0.65; \qquad \lambda = 0.50.$$

We consider three different possibilities for ϕ, the probability of public revelation. Specifically, $\phi = 0.50$, 0.60, and 0.70. The first-best value, given this technology, is independent of ϕ. The optimal amount of effort, q_{fb}, is 0.74167. The value of V_{fb}, given this effort level, is 1.20021. The comparable values, under short-term debt and the optimal loan commitment, are summarized in Table IV.

An examination of the solution also illustrates that the value of the firm under the optimal contract need not be monotonic in the firm's bargaining strength μ_e. As long as the GNR contract is feasible (at $\mu_e = 0.65$ and 0.70), effort and therefore firm value are increasing in μ_e. Once the GNR contract is infeasible, firm value is either decreasing in μ_e (if the short-term debt contract is being selected) or unaffected by μ_e (if the no-bargaining contract is being selected).[25]

[24] This provides a potential explanation for why some small firms voluntarily decide to forego commitment financing (Morgan, 1993).

[25] The solution under public debt financing was also computed for this set of parameters. Short-term public debt is infeasible for this set of parameter values. The solution under long-term public debt financing is independent of ϕ. The effort exerted by the firm is $q = 0.4603$, and the corresponding value of the firm is $V = 0.9087$. Details on the analytical and numerical solutions under public debt financing are available from the authors upon request.

TABLE IV
THE OPTIMAL CONTRACT—A NUMERICAL EXAMPLE

Parameters		Short-term debt				Optimal loan commitment						Optimal contract
		q_{st}	F_1	E(G)	E(B)	Type	q_{lc}	$\hat{F}_1$	$\hat{F}_2$	E(G)	E(B)	
$\phi = 0.5$	$\mu_1 = 0.65$	0.5661	0.7414	1.4570	0.4038	GNR	0.6056	0.5609	5	1.3222	0.5055	GNR commitment
	$\mu_2 = 0.70$	0.5613	0.9947	1.4672	0.3925	GNR	0.6178	0.6316	5	1.2841	0.5408	GNR commitment
	$\mu_3 = 0.80$	0.5512	1.5061	1.5131	0.3700	NB (BH)	0.5377	0.4420	2.6892	1.5656	0.3420	Short-term debt
	$\mu_4 = 0.95$	0.5348	2.2871	1.5773	0.3363	NB (BH)	0.5377	0.4420	2.6892	1.5656	0.3420	NB commitment
$\phi = 0.6$	$\mu_1 = 0.60$	0.5709	0.8062	1.4394	0.4150	GNR	0.6129	0.6030	5	1.2990	0.5265	GNR commitment
	$\mu_2 = 0.70$	0.5613	1.1548	1.4749	0.3925	NB (BH)	0.5533	0.4746	3.0507	1.5050	0.3746	Short-term debt
	$\mu_3 = 0.85$	0.5459	1.6874	1.5335	0.3588	NB (BH)	0.5533	0.4746	3.0507	1.5050	0.3746	NB commitment
$\phi = 0.7$	$\mu_1 = 0.50$	0.5800	0.7997	1.4073	0.4375	GNR	0.6178	0.6316	5	1.2841	0.5408	GNR commitment
	$\mu_2 = 0.575$	0.5732	0.9720	1.4314	0.4206	NB (BH)	0.5731	0.5203	3.5589	1.4319	0.4203	Short-term debt
	$\mu_3 = 0.70$	0.5613	1.2691	1.4749	0.3925	NB (BH)	0.5731	0.5203	3.5589	1.4319	0.4203	NB commitment

At low values of μ_e, the GNR commitment contract is feasible and is selected over both short-term debt and the NB contract. At intermediate values of μ_e, the GNR solution is no longer feasible. The firm now selects short-term debt over the NB commitment contract. Finally, at high values of μ_e, the NB contract is superior to short-term debt. The benefit of commitment financing arises from its ability to structure the expected payments to the bank so that a larger amount (relative to short-term debt) is paid in the bad state, thus providing for superior incentives.

These results suggest that firms with intermediate levels of bargaining power prefer short-term borrowing, while those with extreme (low or high) bargaining powers prefer loan commitments. Moreover, commitment financing is more effective in improving the firm's effort incentives as the probability of public revelation (ϕ) increases. This is more likely to be the case for larger, well-established firms, which are typically also in better bargaining positions relative to lenders. This finding provides a possible explanation for the observation (Morgan, 1993) that while most existing models of loan commitment financing predict that the "...smallest, least-known firms in the economy would benefit most from a commitment,... in fact, such firms are less likely to have a commitment than medium sized firms." [26]

6. CONCLUSION

This paper examines the consequences of information monopolies that may arise when a firm contracts with a private lender. Such monopolies permit the lender to extract rents *ex post*, which distorts the *ex ante* (effort) incentives of the firm. Loan commitments emerge in this setting, because they influence

i. the states in which bargaining occurs, and

ii. the payoffs to the firm and the bank that occur as a consequence of bargaining.

Through their impact on *ex post* bargaining, commitments also influence *ex ante* incentives. Commitments improve effort incentives by providing borrowers with a means of escaping information monopolies. However, they also weaken incentives by providing funds to borrowers with unsuc-

[26] This finding is also consistent with Berger *et al.* (1992) who find that among firms that borrow from financial institutions, safer then average firms are more likely to utilize lines of credit. Moreover, firms with fewer years of experience are also more likely to utilize commitment financing. Their sample is restricted, however, to firms with fewer than 500 employees.

cessful projects. This trade-off explains why some firms choose to avoid commitment financing altogether.

The role of commitment financing developed in this paper is quite different from what has been advanced in the literature. Since they reduce the cost of developing a relationship, the widespread use of commitments in private lending is illuminated.

Finally, our analysis suggests the types of firms that are most likely to benefit from commitment financing. Firms with extreme bargaining power (either too high or too low), a low probability of public revelation of firm quality, and with liquid assets are more likely to use loan commitments.

APPENDIX

We first present a result that is used regularly in the proofs of the various propositions.

LEMMA 1. *Suppose the equation characterizing the choice of effort, q, is given by*

$$Aq^2 + Bq + C = 0, \tag{A1}$$

where $A > 0$. The solution of interest is the highest possible level of q. This implies that the optimal level of effort satisfies $q > (-B/A)$.

Proof of Lemma 1. Follows from the solution for the roots to the quadratic.

Proof of Proposition 1. Substituting for F_1 from the rational pricing constraint (7) into the incentive compatibility condition (5) and simplifying, we get

$$2Kq^2 - \Omega_{fb}q + [I_0 - [\lambda(1 - \mu_e)p_b X + (1 - \lambda)L]] = 0,$$
$$\text{where } \Omega_{fb} = X - [\lambda p_b X + (1 - \lambda)L]. \tag{A2}$$

Note that the solution to (A2) is independent of ϕ. Once again, from Lemma 1, we know that

$$q > \frac{\Omega_{fb}}{4K}. \tag{A3}$$

Differentiating the quadratic with respect to μ_e yields

$$\frac{dq}{d\mu_e} = \frac{-\lambda p_b X}{4Kq - \Omega_{fb}}, \tag{A4}$$

which is negative. Q.E.D.

Proof of Proposition 2

Note that under the commitment contract, the firm will voluntarily continue operations in states GR and BL. In GNR, the firm gets $\max[L - \hat{F}_1, 0]$ if it liquidates and $X - \hat{F}_2$ if it continues operations. The efficient decision is to continue operations. Consequently the threat of liquidation that will bring the bank to the bargaining table is credible only when

$$\max[L - \hat{F}_1, 0] \geq X - \hat{F}_2, \tag{A5}$$

leading to the condition identified for GNR. Similarly in state BH, liquidation gives the firm $\max[L - \hat{F}_1, 0]$, while continuing operations yield $p_b(X - \hat{F}_2)$. The efficient decision here is to continue operations. Consequently, the firm can credibly threaten to continue operations and therefore induce bargaining if

$$\max[L - \hat{F}_1, 0] \leq p_b(X - \hat{F}_2), \tag{A6}$$

leading to the condition identified. Finally, there is a range $L - (X - \hat{F}_2) < \hat{F}_1 < L - p_b(X - \hat{F}_2)$, where neither of these conditions is satisfied. Consequently, for these parameter values no bargaining occurs.

Q.E.D.

Proof of Proposition 3

The proof for each region proceeds in two steps. We first substitute for $\hat{F}_1$ from the rational pricing constraint into the incentive constraint. We solve for the optimal level of q, conditional on a given level of $\hat{F}_2$. Totally differentiating leads to the result of interest.

Region BH. In this region the incentive compatibility and rational pricing expressions are given by

$$\Omega_{fb} - \Omega_{bh} = 2Kq_{bh} \tag{A7}$$

$$q[\phi\hat{F}_1 + (1 - \phi)\hat{F}_2] + (1 - q)[p_b\hat{F}_2 + (1 - \lambda)(1 - \mu_e)(L - p_bX)] = I_0, \tag{A8}$$

where

$$\Omega_{bh} = [\phi\hat{F}_1 + (1 - \phi)\hat{F}_2] - [p_b\hat{F}_2 + (1 - \lambda)(1 - \mu_e)(L - p_bX)]. \tag{A9}$$

Appropriate substitution and simplification leads to

$$2Kq^2 - \Omega_{fb}q + [I_0 - (p_b\hat{F}_2 + (1 - \lambda)(1 - \mu_e)(L - p_bX))] = 0. \tag{A10}$$

From Lemma 1 this implies that $4Kq > \Omega_{fb}$. Totally differentiating (7) with respect to $\hat{F}_2$ and simplifying gives

$$\frac{dq}{d\hat{F}_2} = \frac{p_b}{4Kq - \Omega_{fb}} > 0. \tag{A11}$$

Region GNR. The incentive compatibility and rational pricing constraints in this region are given by

$$\Omega_{fb} - \Omega_{gnr} = 2Kq \tag{A12}$$

$$q[\hat{F}_1 + (1 - \phi)(1 - \mu_e)(X - L)] + (1 - q)[\lambda p_b \hat{F}_2 + (1 - \lambda)\hat{F}_1] = I_0, \tag{A13}$$

where

$$\Omega_{gnr} = [\hat{F}_1 + (1 - \phi)(1 - \mu_e)(X - L)] - [\lambda p_b \hat{F}_2 + (1 - \lambda)\hat{F}_1]. \tag{A14}$$

Once again, the elimination of $\hat{F}_1$ from the (IC) condition and appropriate simplification leads to

$$\begin{aligned} 2K\lambda q^2 + [2K(1 - \lambda) - \Omega_{fb}]q + [\lambda I_0 - \lambda p_b \hat{F}_2 \\ + (1 - \phi)(1 - \mu_e)(1 - \lambda)(X - L)] - (1 - \lambda)\Omega_{fb} = 0. \end{aligned} \tag{A15}$$

From Lemma 1,

$$4K\lambda q > \Omega_{fb}\lambda - 2K(1 - \lambda). \tag{A16}$$

Totally differentiating the quadratic with respect to $\hat{F}_2$ and solving for the derivative of interest,

$$\frac{dq}{d\hat{F}_2} = \frac{\lambda p_b}{4Kq\lambda - [\Omega_{fb}\lambda - 2K(1 - \lambda)]} > 0. \tag{A17}$$

Region NB. The incentive compatibility and rational pricing constraints in this region are

$$\Omega_{fb} - \Omega_{nb} = 2Kq \tag{A18}$$

$$q[\phi\hat{F}_1 + (1 - \phi)\hat{F}_2] + (1 - q)[\lambda p_b \hat{F}_2 + (1 - \lambda)\hat{F}_1] = I_0, \tag{A19}$$

where

$$\Omega_{nb} = [\phi\hat{F}_1 + (1 - \phi)\hat{F}_2] - [\lambda p_b \hat{F}_2 + (1 - \lambda)\hat{F}_1]. \tag{A20}$$

Substituting for $\hat{F}_1$ and simplifying gives

$$2Kq^2 + [2K(1 - \lambda) - \Omega_{fb}\lambda]q + [I_0(\phi - (1 - \lambda)) + \hat{F}_2((1 - \lambda)(1 - \phi) - \phi\lambda p_b)] - (1 - \lambda)\Omega_{fb} = 0. \tag{A21}$$

From Lemma 1, we get

$$4K\lambda q > \Omega_{fb}\lambda - 2K(1 - \lambda). \tag{A22}$$

Totally differentiating the quadratic with respect to $\hat{F}_2$, and rearranging

$$\frac{dq}{d\hat{F}_2} = \frac{\lambda\phi p_b - (1 - \lambda)(1 - \phi)}{4K\lambda q - [\Omega_{fb}\lambda - 2K(1 - \lambda)]} \tag{A23}$$

while the denominator of this expression is positive, the numerator is positive iff

$$\phi > \frac{(1 - \lambda)}{(1 - \lambda) + \lambda p_b}, \tag{A24}$$

being negative otherwise. This completes the proof.

Q.E.D.

Proof of Proposition 4

Consider the BH contract $(\hat{F}_1, \hat{F}_2)$ that is just on the boundary with the no-bargaining region. (Note that technically we would have to explicitly appeal to a tie-breaking rule here. For expositional ease, we assume that one could actually pick between the two contracts.) A comparison of the payoffs to the bank in the good and the bad states reveals that the bank gets the same payments in the good states and makes more in the bad states. Thus the bank would prefer moving into the NB region. The firm now has an incentive to exert more effort. To make sure that the bank only breaks even, the firm can reduce $\hat{F}_1$ appropriately. Note that this also leads to an improvement in effort incentives. Thus, the firm has sufficient flexibility in the NB region to satisfy rational pricing while ensuring that a higher level of effort is implemented.

Proof of Proposition 5

We begin by establishing the following properties of the GNR bargaining contract.

1. The effort level, q, is increasing in μ_e over the range where it is feasible.

2. The GNR contract need not be feasible over the entire range of μ_e.

Recall, that in the GNR region, the firm would like to set $\hat{F}_2 = X$. $\hat{F}_1$ and q are then determined from the incentive compatibility and rational pricing constraints. Substituting out for $\hat{F}_1$ from the rational pricing condition into the incentive compatibility condition, and simplifying, we get

$$2K\lambda q^2 + [2K(1-\lambda) - \lambda\Omega_{fb}]q + [\lambda I_0 - (1-\lambda)\Omega_{fb} + (1-\lambda)(1-\phi)(1-\mu_e)(X-L) - \lambda p_b X] = 0. \tag{A25}$$

From Lemma 1

$$q > \frac{\lambda\Omega_{fb} - 2K(1-\lambda)}{4K\lambda}. \tag{A26}$$

Differentiating the quadratic with respect to μ_e yields

$$\frac{dq}{d\mu_e} = \frac{(1-\lambda)(1-\phi)(X-L)}{4K\lambda q - [\lambda\Omega_{fb} - 2K(1-\lambda)]}, \tag{A27}$$

which is positive. The fact that the GNR solution is not necessarily feasible over the entire range of bargaining strengths can be seen in the numerical example of Section 5.

Now consider the short-term debt and GNR solutions, given by $(\hat{F}_1, \hat{F}_2)$ and $(\hat{G}_1, \hat{G}_2)$, respectively. Substituting for $\hat{G}_2 = X$ in $\Omega_{gnr} - \Omega_{st}$, and simplifying, we get

$$\Omega_{gnr} - \Omega_{st} = -\phi(\hat{F}_1 - L) - \lambda(L - \hat{G}_1) + \mu_e p_b X, \tag{A28}$$

which is unambiguously negative at $\mu_e = 0$, since $\hat{F}_1 > L$ and $\hat{G}_1 < L$. If this result holds at $\mu_e = 0$, it has to hold at all levels of μ_e where the GNR solution is feasible, since the GNR solution is increasing in μ_e and the short-term debt solution is decreasing in μ_e (Proposition 1).

Q.E.D.

Proof of Proposition 6

The proof requires a comparison of the NB commitment contract on the BH line and the GNR commitment. Suppose we characterize the NB contract by $(\hat{F}_1, \hat{F}_2)$. We now look for conditions under which we can find a GNR contract $(\hat{G}_1, \hat{G}_2)$ that provides the same incentives as the NB contract and (weakly) satisfies the rational pricing constraint. Let $\hat{G}_2 = X$. Furthermore, note that for the GNR contract to dominate over the range of bargaining strengths where it is feasible, it is necessary and sufficient that it dominate at $\mu_e = 0$. It is easy to show that the GNR commitment

that provides the same incentives as the NB commitment also has to satisfy

$$\hat{G}_1 = L - \frac{(1-\phi)}{\lambda}[(1-p_b)(X-\hat{F}_2)]. \tag{A29}$$

Satisfying rational pricing now requires that

$$\lambda p_b X + (1-\lambda)\hat{G}_1 \geq \lambda p_b \hat{F}_2 + (1-\lambda)\hat{F}_1. \tag{A30}$$

Substituting for $\hat{G}_1$ and simplifying,

$$\lambda p_b(X-\hat{F}_2) > (1-\lambda)(1-\phi)(1-p_b)(X-\hat{F}_2), \tag{A31}$$

which, upon simplification, provides the final result.

Q.E.D.

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