NEGOTIATION AND RENEGOTIATION OF OPTIMAL
FINANCIAL CONTRACTS UNDER THE THREAT OF
PREDATION*

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The paper examines the effect of renegotiation on the ability of financial contracts between a lender and entrant to deter an incumbent's predation. In the presence of renegotiation, it is more difficult for the entrant to obtain financing and more difficult for the contract to deter predation. Contracts successfully deter predation in some cases, however, even if renegotiation occurs at a stage with symmetric information between the entrant and lender. Giving the entrant (constrained by limited liability) stronger bargaining power vis-à-vis the lender improves the efficiency of the optimal contract, but the results concerning renegotiation are unchanged.

1. INTRODUCTION

The LONG-PURSE theory of predation, originally proposed by Telser [1966], states that an incumbent firm with extensive internal financing may prey upon a rival with limited resources until these resources are exhausted, the rival exits the market, and the incumbent is left to earn monopoly profits. Early theoretical work demonstrated that long-purse predation may be rational for the incumbent if capital markets are imperfect.1 Recent work has explored the strategic role of financial contracts as predation deterrents. For example, the entrant and a lender may pursue a "deep-pocket" strategy, agreeing to finance continued production by the entrant even if the incumbent's predation drastically reduces the entrant's revenue (Tirole [1988]). Alternatively, they may pursue a "shallow-pocket" strategy, reducing the probability that continued production is financed (making the entrant likely to exit the market in any event), thereby reducing the incumbent's incentives to prey (Bolton and Scharfstein [1990]). The literature typically invokes subgame perfection, constraining the incumbent to pursue only credible strategies.

* I would like to thank Oliver Hart, Richard Schmalensee, Lars Stole, and Jean Tirole for valuable insights. The paper benefitted considerably from the suggestions of the editor, Lawrence White, and two anonymous referees. Financial support from the National Science Foundation is gratefully acknowledged.

1 Benoît [1984] shows that long-purse predation can be successful in equilibrium if the entrant is prevented from borrowing on the capital market for exogenous reasons. Fudenberg and Tirole [1985] demonstrate the possibility of predation in a model with an endogenous financial constraint, employing a model of costly state verification due to Gale and Hellwig [1985].

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In a complete theory, financial contracts should likewise be constrained to be credible. A threat by the entrant and lender to “finance production no matter what” may be as empty as a threat by the incumbent to “prey no matter what”: If the incumbent preys in spite of the financial contract between the entrant and lender, the entrant and lender may be inclined to renegotiate the financial contract, removing whatever deterrence provisions it contained. Anticipating this renegotiation, the incumbent’s initial decision to prey may constitute a rational strategy to drive the entrant from the market.

Using the model of Bolton and Scharfstein [1990], this paper examines how renegotiation affects the ability of long-term financial contracts to deter predation. Renegotiation is shown to erode the commitment value of financial contracts in two ways. First, under renegotiation there are fewer cases in which the entrant receives sufficient funding to enter the market. Second, conditional on the entrant’s receiving financing, there are fewer cases in which the optimal contract deters predation. Though renegotiation erodes the commitment value of contracts, there are still cases in which long-term financial contracts can successfully deter predation in spite of renegotiation, which is contrary to Tirole’s [1988] suggestion that renegotiation may destroy the commitment value of predation-deterring contracts entirely.

If a predation-deterring contract does exist, a surprising result is that renegotiation makes the entrant a stronger competitor: under renegotiation the entrant is refinanced in later periods with higher probability and obtains a higher expected surplus than under no renegotiation. Even more surprising, under renegotiation the entrant may prefer to compete with a potential predator rather than with a non-predatory incumbent. These last two results are due to the fact that contracts implementing the “deep-pocket” strategy—but not those implementing the “shallow-pocket” strategy—may be renegotiation-proof. The probability that the entrant is refinanced, as well as the size of the entrant’s expected surplus, may both be higher when the “deep-pocket” strategy is pursued than when the “shallow-pocket” strategy is pursued or when the incumbent cannot engage in predation.

The present paper is part of a growing literature examining the impact of renegotiation on the commitment value of contracts signed with third parties. Tirole [1988] and Katz [1991] note that frictionless renegotiation may destroy the commitment power of contracts. Beaudry and Poitevin [1994] show that contracts may have little commitment value if production takes place over time and renegotiation occurs at frequent stages during the production process. The existence of a discrete sunk investment is an essential element of the model of predation considered here, so their

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2 See Bolton [1990] for a summary.

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negotiation of financial contracts under predation

notion of dynamic renegotiation does not fit our model directly. Dewatripont [1988] and Caillaud, Jullien and Picard [1995] show that asymmetric information between the contracting parties may prevent efficient renegotiation, in which case contracts may retain some commitment power. In the present paper, the contract may retain commitment power even though information is symmetric at the time of renegotiation. A similar idea is developed in Bensaid and Gary-Bobo [1993]: if utility is not freely-transferable between contracting parties, renegotiation may be limited. In the model considered here, the fact that utility is not freely-transferable is a natural result of the capital-market imperfections.

II. CONTRACTING WITHOUT RENEGOTIATION

As a benchmark, we review the model and results of Bolton and Scharfstein [1990], supposing that renegotiation is ruled out for exogenous reasons. Two firms—an incumbent and an entrant—compete on the product market. The incumbent has unlimited access to internal financing. The entrant has no retained earnings and so must rely on financing from an external investor, called a lender. Assume that the market interest rate (determining the lender's cost of funds) is zero.

The timing of the model is given in Figure 1. There are three periods. Period 0 is a contracting stage during which the lender and entrant may sign a long-term financial contract. An important assumption maintained throughout is that the contract is observable to the incumbent and thus has some potential commitment value. The first and second periods are production stages. In each of these periods, a firm must expend sunk cost \( F \) in order to produce. Next, profits are realized; and then the terms of any financial contracts are enforced. We will suppose that production is a

\[ F \text{ invested} \]

\[ F \text{ invested} \]

\[ \]
positive net present value investment for the incumbent whether or not the entrant remains in the market. Since it has unlimited access to internal financing, the incumbent always invests. Its only decision is whether or not to prey on the entrant, a decision that is made after the sunk investment has been expended in the first period.4

II(i). *Predation Is Not Possible*

Suppose for now that the incumbent cannot prey on the entrant. If the entrant invests in a given production period, it earns a random level of profit depending on demand and cost conditions. Profits can be low, \( \pi_L \), with probability \( \theta \) or high, \( \pi_H \), with probability \( 1 - \theta \). Profits are independently distributed across periods. Assume that the investment loses money with positive probability, \( \pi_L < F \), but that the net present value of investment is positive; i.e., \( \pi > F \) where \( \pi \equiv \theta \pi_L + (1 - \theta) \pi_H \). Under these assumptions, if the entrant could finance itself using internal funds, it would invest each period. The entrant is assumed to have no internal funds, however, so it must borrow \( F \) from the lender. Any returns in excess of \( \pi_L \) are "consumed" by the entrant—i.e., diverted to other projects or to non-pecuniary benefits. A capital-market imperfection is generated by assuming that the amount consumed is private information for the entrant, not subject to verification by the lender or courts.5 Any profits not consumed are verifiable.6 It should be emphasized that \( \pi_L \) can always be extracted from the firm; only the residual \( \pi_H - \pi_L \) is consumed by the entrant (and that only in high-profit states).

Given our assumptions about the capital market, it is clear that the lender would never finance the entrant’s investment in a one-period model. The entrant would claim that its profits were low, repaying the lender at most \( \pi_L \) and consuming any remainder. The repayment would be less than the amount lent initially, and so the lender would lose money. Long-term

4 In the model, there is no reason for the entrant to prey since the incumbent always remains in the market. There is also no strategic reason for the incumbent to prey in the last period.

5 Another way of stating the assumption is that auditing costs are infinite. Snyder [1994] analyzes a costly-state-verification model allowing for finite auditing costs.

6 These assumptions differ slightly from the original Bolton–Scharfstein model. There the authors do not consider the idea of consumption by the entrant; they simply suppose that the entire residual \( \pi_H - \pi_L \) cannot be verified. I am grateful to a referee for pointing out a possible problem that would arise under those assumptions. After earning \( \pi_H \), the entrant could under-report profit and use the residual \( \pi_H - \pi_L \) to fund investment partially, borrowing the remainder \( F - (\pi_H - \pi_L) \) from an outside lender. As long as the entrant can sign contracts with outside lenders (or make renegotiation offers to the original lender), such a strategy would be a profitable deviation from truth-telling in Bolton and Scharfstein. Such a strategy would be impossible under the assumptions considered in the present paper, however; here the residual \( \pi_H - \pi_L \) must be consumed by the entrant or else be subject to confiscation by the lender; in either case the residual cannot be used to fund second-period investment. In all other respects the two models are the same and produce the same results.

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(here, two-period) financial contracts are feasible in this model; intuitively, the entrant is induced to repay its first-period loan fully in order to be refinanced in the second period.

Formally, a contract is a direct-revelation mechanism specifying parameters \( r_i, \beta_i \) and \( R_{ij} \). The lender funds the entrant’s initial investment \( F \). After profit \( \pi_i \) (\( i = L, H \)) is realized, the entrant announces this level to the lender. Parameter \( r_i \) is the first-period payment from the entrant to the lender conditional on announcement \( \pi_i \). Conditional on the announcement of first-period profit, \( \beta_i \in [0, 1] \) is the probability that the lender finances the entrant’s second-period production, giving the firm \( F \) dollars at the beginning of the period. \(^7\) We suppose that the lender has access to a public randomizing device to allow for refinancing probabilities strictly within the unit interval. \( R_{ij} \) is the repayment from the entrant to the lender at the end of the second period conditional on the announcement of \( \pi_i \) for first-period profit and \( \pi_i \) for second-period profit. It is immediately obvious that \( R_{ij} \) cannot vary with the second-period announcement or else the entrant would state the profit giving the lowest repayment level. Hence we can write the second-period repayment level as \( R_i \), depending on the first-period profit announcement only.

Bolton and Scharfstein assume that the lender makes a take-it-or-leave-it offer to the entrant at the contracting stage. For the sake of comparison, we continue this assumption here; Section IV works out the case in which the entrant has all the bargaining power at the contracting stage. The optimal contract for the lender solves the following program, called MAX1:

\[
\max_{\pi_i, r_i, R_i} \left[ \theta [r_L + \beta_L (R_L - F)] + (1 - \theta) [r_H + \beta_H (R_H - F)] - F \right]
\]

subject to

\[
\pi_H - r_H + \beta_H (\bar{\pi} - R_H) \geq \pi_H - r_L + \beta_L (\bar{\pi} - R_L)
\]

(3) \( \pi_i \geq r_i \quad i = L, H \)

(4) \( \pi_i - r_i + \pi_L \geq R_i \quad i = L, H \)

(5) \( \theta [\pi_L - r_L + \beta_L (\bar{\pi} - R_L)] + (1 - \theta) [\pi_H - r_H + \beta_H (\bar{\pi} - R_H)] \geq 0 \)

Condition (2) is an incentive-compatibility constraint, ensuring the entrant announces truthfully if its first-period profit is \( \pi_H \). \(^8\) The entrant cannot be forced to pay more than its earnings, so conditions (3) and (4) are imposed

\(^7\)It is assumed that the entrant requires financing in the second period regardless of first-period profit. Bolton and Scharfstein show this assumption is equivalent to \( \pi_H - \pi_L < F \).

\(^8\)The incentive-compatibility constraint ensuring the entrant announces truthfully if its first-period profit is \( \pi_i \) has been omitted from MAX1. Since \( r_H > \pi_L \) in the optimal contracts derived below, this constraint is always trivially satisfied.

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as limited-liability constraints. The final condition is an individual-rationality constraint for the entrant. We have the following proposition:

**Proposition A.** Suppose predation is infeasible. The lender and entrant sign a financial contract and the entrant invests in the first period if and only if

\[ \pi_L - F + (1 - \theta)(\bar{\pi} - F) > 0. \]

An optimal contract in this case specifies \( r_L^* = \pi_L, \beta_L^* = 0, r_H = \bar{\pi}, \beta_H^* = 1 \) and \( R_H^* = \pi_L. \)

**Proof.** Bolton and Scharfstein [1990], Lemma 2 and Proposition 1.\(^9\)

The capital-market imperfection in the model leads to several inefficiencies. From condition (6), there exist parameter values such that the entrant cannot obtain financing from a lender. Even if the entrant obtains financing in the first period, it is not refinanced if profits are low in the first period.

The intuition for the proof is straightforward. Reducing \( \beta_L \) to zero has two benefits. It saves the lender from refinancing the entrant (recall the highest second-period repayment from entrant to the lender is \( \pi_L \), less than the cost of investment \( F \)), and it relaxes the entrant’s incentive-compatibility constraint (2). Increasing \( \beta_H \) to 1 also relaxes (2). It requires the lender to refinance the entrant with certainty; but since investment has a positive net present value, this cost can be more than offset by an increase in \( r_H \). Condition (6) can be easily derived: it simply requires the lender to earn non-negative profit under the optimal contract.

II(ii). **Predation Is Possible**

Proposition A suggests a motivation for predation by the incumbent. The entrant’s continued existence in the second-period market depends on its first-period profits. If the incumbent can reduce this profit through predation, it may induce the entrant to exit the market, leaving the incumbent as a monopolist.

\(^9\) That the lender always loses money in the second period (true since \( R_H^* = \pi_L < F \)) is not an essential feature of the model. It is an artifact of the assumption, made for simplicity, that profits are identically distributed in the first and second periods. Consider an extension of the model in which second-period profits are \( x \pi_L \) and \( x \pi_H \), where the scaling factor \( x \in (0, \infty) \) is a random variable which has mean \( \bar{x} \) and which is realized after second-period investment \( F \) is sunk. In this setting, general contracts can specify a second-period repayment that is a function of \( x \), i.e., \( R_i(x) (i = L, H) \). It can be shown that, as long as \( \bar{x} \) lies in a certain interval around 1, the propositions of the present paper extend naturally to this new variant. In particular, the optimal contract sets \( R_L^*(x) = R_L^*(x) = x \pi_L \). If \( x \) is high enough (namely, \( x > F/\pi_L \)), the lender can earn a positive profit in the second period.
Let the incumbent's expected profit as a monopolist be $\pi^m$ and as a duopolist be $\pi^d$. Predation is modeled in a fairly general way: at a cost of $c$, the incumbent can increase the probability that the entrant's profits are low, from $\theta$ to $\mu$. Given parameters $(\beta_L, \beta_H)$ specified by a general financial contract, the incumbent's benefit from predation is $(\beta_H - \beta_L) (\mu - \theta) (\pi^m - \pi^d)$. The incumbent preys on the entrant if and only if the benefit exceeds the cost $c$. Thus, defining $\Delta = c/[(\mu - \theta) (\pi^m - \pi^d)]$, the incumbent preys if and only if $(\beta_H - \beta_L) > \Delta$.

Notice that the financial contract can deter predation if the difference between $\beta_H$ and $\beta_L$ is sufficiently small. Unfortunately for the lender, the optimal contract in the absence of predation specifies the maximum possible value of $\beta_H - \beta_L$, namely $\beta_H - \beta_L = 1$. In the words of Bolton and Scharfstein, "the contract that minimizes agency problems, maximizes the rival's incentive to prey."

To make the problem interesting, assume that $\Delta < 1$ so that the optimal contract when predation is not possible does not trivially deter predation. Suppose first that it is not optimal for the lender and entrant to deter predation with their financial contract. In this case, the program giving the optimal contract is the same as MAX1 except that $\theta$ is replaced everywhere by $\mu$. Thus the optimal contract is identical to that in Proposition A replacing $\theta$ with $\mu$; in particular, $(\beta_L^*, \beta_H^*) = (0, 1)$.

Suppose that the lender and entrant wish to deter predation with their financial contract. In this case, the program giving the optimal contract is the same as MAX1 with the addition of a "no-predation" constraint:

$\beta_H - \beta_L \leq \Delta$.  

Since $\Delta < 1$, condition (7) binds at the optimum. It is a simple matter to solve the resulting program for the optimal contract. The remaining step is to compare the profit from this contract to the profit from the optimal contract involving no deterrence. It can be shown that deterrence is preferred if and only if $\Delta(1 - \theta) \geq 1 - \mu$. We then have

**Proposition B.** Suppose that renegotiation is infeasible. The lender and entrant sign a financial contract and the entrant invests in the first period if and only if

$\pi_L - F + \max \{\Delta(1 - \theta), 1 - \mu\} (\bar{\pi} - F) \geq 0$.  

If the entrant invests and $\Delta(1 - \theta) \geq 1 - \mu$, the optimal contract specifies $r^*_L = \pi_L$, $\beta^*_L = 0$, $r^*_H = \Delta \bar{\pi} + (1 - \Delta) \pi_L$, $\beta^*_H = \Delta$, $R^*_L = \pi_L$; and it deter predation. If the entrant invests and $\Delta(1 - \theta) < 1 - \mu$, the optimal contract specifies $r^*_L = \pi_L$, $\beta^*_L = 0$, $r^*_H = \bar{\pi}$, $\beta^*_H = 1$, $R^*_H = \pi_L$; and it does not deter predation.

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Interestingly, in the absence of renegotiation, the optimal predation-deterring contract reduces the probability that second-period production is refinanced. The optimal contract that deters predation specifies \( \beta_H = \Delta < 1 \); the optimal contract that does not deter predation specifies \( \beta_H = 1 \). Rather than an aggressive strategy committing the entrant and lender to finance the project even in unfavorable states, the parties pursue a "shallow-pocket" strategy. We will see in the next section that this result is not robust once renegotiation is considered.

III. CONTRACTING WITH RENEWAL

We next examine a model identical to that in Section II with the addition of a renegotiation stage. There are many alternative formulations of renegotiation. For purposes of exposition, we will focus on the case in which the lender makes a take-it-or-leave-it renegotiation offer after the incumbent makes its predation decision but before the entrant learns the value of first-period profit. This case maintains the assumption that the lender has all the bargaining power throughout the course of the game. The results are robust to alternative formulations of renegotiation.\(^\text{11}\)

Clearly, renegotiation plays no role if, as in Section II(i), the incumbent cannot engage in predation for exogenous reasons, for then the lender offers the entrant the most efficient contract possible conditional on period-0 information at the outset. The same can be said of the case in which the optimal contract does not deter predation [i.e., the case in which \( \Delta(1 - \theta) < 1 - \mu \)]. Renegotiation only matters if the incumbent can prey on the entrant and if the optimal contract is designed to deter predation. In this case, the extra constraint (7) is added to the program to affect the actions of the incumbent. But extra constraints are expensive: once the incumbent's actions are sunk, the lender and entrant may wish to design a more profitable contract, removing (7).

Indeed, the predation-deterring contract from Proposition B would be renegotiated. The lender could offer a contract that increases \( \beta_H \) and also

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\(^{10}\) Although the results in Bolton and Scharfstein are correct, the proofs appear to omit some steps. In particular, their Lemma 2, proved for the case without predation, is taken to apply directly to the predation case as well. It is not immediate that the lemma holds in the predation case since the maximization program giving the optimal contract differs depending on the existence of predation. Indeed, an intermediate step in the proof of Lemma 2 requires \( \beta_H = 1 \), contradicted by the result in their Proposition 2 that \( \beta_H = \Delta < 1 \). See the proof of Proposition C in the Appendix for a complete proof.

\(^{11}\) The results are identical if the lender makes the renegotiation offer after the entrant realizes its first-period profits. The results are also identical if the entrant rather than the lender makes the renegotiation offer. Derivations associated with these and other formulations of renegotiation are provided in Snyder [1995].

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increases $r_H$ in a neighborhood of their original values such that the entrant is indifferent between the new contract and the contract from Proposition B. Since $\beta_H^* < 1$ at the optimum, there is room to increase $\beta_H$. The change in the entrant’s expected surplus from the new contract is $dU_E = (1 - \theta)[-dr_H + d\beta_H(\bar{\pi} - \pi_L)]$. Setting $dU_E = 0$ implies $dr_H = d\beta_H(\bar{\pi} - \pi_L)$. The change in the lender’s surplus from the new contract is $dU_L = (1 - \theta)[dr_H + d\beta_H(\pi_L - F)]$. Substituting for $dr_H$ implies $dU_L = d\beta_H(1 - \theta)(\bar{\pi} - F)$. But then $dU_L > 0$, since $d\beta_H > 0$ and since we have assumed $\bar{\pi} > F$. This new contract is a feasible direct-revelation mechanism since, as can easily be verified, it continues to satisfy constraints (2)–(5) of MAX1.

Therefore, if the period-0 contract is given by Proposition B, we have shown that the lender would benefit from offering a new contract in the renegotiation stage. Intuitively, raising $\beta_H$ increases the joint surplus of the entrant and lender: joint surplus is given by the sum of (1) and (5), which simple calculations show is proportional to

$$\theta \beta_L + (1 - \theta)\beta_H.$$  

(9)  

As long as surplus is freely transferable from the entrant to the lender, the lender will wish to raise the refinancing probabilities as high as possible. Following a high-profit realization, the limited-liability constraint (4) is slack since the high type earns more than it needs to repay the lender; i.e., $\pi_H > r_H$. Thus surplus is freely transferable in this case, and so the lender would raise $\beta_H$ and $r_H$ in a renegotiation offer. The same argument does not apply to $\beta_L$. Following a low-profit realization, the entrant’s limited-liability constraint binds; and so utility is not freely transferable from the entrant to the lender. If the lender raises $\beta_L$, it cannot increase $r_L$ to compensate, since $r_L = \pi_L$ already and no more than $\pi_L$ can be extracted from the entrant in the second period.\footnote{Certainly the lender would not lower $\beta_L$ in the renegotiation offer. To see this, note a successful renegotiation offer must Pareto dominate the original contract. Lowering $\beta_L$ would reduce joint surplus [see expression (9)]; so such a renegotiation offer cannot Pareto dominate the original contract.}

The reasoning from the preceding paragraph can be extended to show that any contract specifying $\beta_H < 1$ would be renegotiated, so the resulting contract after renegotiation must specify refinancing with certainty if first-period profit is $\pi_H$.\footnote{In Maskin and Tirole’s [1992] terms, we have shown that $\beta_H = 1$ is a necessary condition for \textit{weak interim efficiency}. Maskin and Tirole show that weak interim efficiency is a necessary condition for renegotiation-proofness.} But then the “shallow-pocket” strategy of predation-deterrence cannot be credible: the incumbent would have an incentive to increase the probability that first-period profit is low, for only in this event can it become a monopoly. Formally, we have the following proposition:}

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Proposition C. Suppose that renegotiation is feasible. The lender and entrant sign a financial contract and the entrant invests in the first period if and only if

$$\pi_L - F + \max \{ \Delta (1 - \theta) - \rho, 1 - \mu \} (\bar{\pi} - F) \geq 0$$

where

$$\rho \equiv (1 - \Delta) \left( \frac{F - \pi_L}{\bar{\pi} - F} \right).$$

If the entrant invests and $\Delta (1 - \theta) - \rho \geq 1 - \mu$, the optimal renegotiation-proof contract specifies $r^*_L = \pi_L$, $\beta^*_L = 1 - \Delta$, $r^*_H = \Delta \bar{\pi} + (1 - \Delta) \pi_L$, $\beta^*_H = 1$, $R^*_L = R^*_H = \pi_L$, and it deters predation. If the entrant invests and $\Delta (1 - \theta) - \rho < 1 - \mu$, the optimal renegotiation-proof contract does not deter predation; and it has the same form as in Proposition B.

(The proofs of Proposition C and of all subsequent propositions are contained in the appendix.)

Proposition C is identical to Proposition B except for the presence of $\rho$, which we will call the "renegotiation parameter." The parametric assumptions made so far place a bound on $\rho$, namely $\rho \in (0, 1)$. Therefore, it is a straightforward exercise in comparative statics to determine the effect of renegotiation on the optimal financial contract.

Proposition D. It is more difficult for the entrant to obtain first-period financing under renegotiation in the following sense: the parameter values for which the entrant obtains first-period financing are a strict subset of the corresponding parameter values in the absence of renegotiation. In the same sense, it is more difficult to deter predation under renegotiation. Conditional on the entrant’s being in the market in the first-period, renegotiation increases the likelihood that the entrant remains in the market in the second period. Renegotiation reduces the lender’s expected surplus. Renegotiation may reduce or increase the entrant’s expected surplus.

The main result contained in Propositions C and D is that long-term financial contracts can still deter predation in spite of the existence of renegotiation. Renegotiation does, however, erode the commitment value of contracts: in the presence of renegotiation there is less first-period investment, lower lender profit, and more predation than in the absence of renegotiation.

It is obvious that lender profit falls in the presence of renegotiation since renegotiation is equivalent to adding the constraint $\beta_H = 1$ to the lender’s maximization program. In contrast, the joint surplus of the entrant and lender may be higher in the presence of renegotiation than in the absence. To be more precise, suppose
implying that the entrant and lender sign a predation-deterring contract when predation is a possibility. Then the entrant and lender’s joint surplus is given by (9); i.e., joint surplus is determined solely by the probability of refinancing. But the probability of refinancing is higher in the regime with possible predation and renegotiation (the regime associated with Proposition C) than in either the regime with possible predation and no renegotiation (the regime associated with Proposition B) or the regime with no predation (the regime associated with Proposition A). Thus, as long as (11) holds, the potential for predation and renegotiation can increase expected joint surplus. By subtracting the lender’s surplus from the joint surplus, it follows that renegotiation and possible predation can increase the entrant’s surplus as well.

The surprising result that possible predation and renegotiation may increase the entrant’s surplus and the joint surplus of the entrant and the lender is due to the fact that utility is not freely transferable from the entrant to the lender. Utility is not freely transferable in the sense that the capital-market imperfections prevent the lender from extracting all the entrant’s surplus. Specifically, the limited-liability constraint prevents the lender from extracting any more than \( \pi_L \) following a low-profit realization in the second period; the informational asymmetry prevents the lender from extracting any more than \( \pi_L \) following a high-profit realization in the second period. Since the lender cannot extract all of the entrant’s surplus, the entrant’s surplus represents an externality in the lender’s maximization program. Hence, the lender’s optimum may not maximize joint surplus; any constraints that are imposed on the lender’s optimization program may move the solution in the direction of increasing the entrant’s surplus and joint surplus. Indeed, if (11) holds, predation and renegotiation effectively impose lower bounds on the refinancing probabilities \( \beta_L \geq \beta_H - \Delta \) and \( \beta_H \geq 1 \), respectively); in view of (9), the resulting rise in the refinancing probabilities increases joint surplus.

IV. ENTRANT BARGAINING POWER

Thus far, we have supposed that the lender makes a take-it-or-leave-it offer of a financial contract in the period-0 contracting stage to the entrant, in

\[
(11) \quad \Delta(1 - \theta) \geq \max \left\{ 1 - \mu + \rho, \left( \frac{2 - \Delta}{1 - \Delta} \right) \rho \right\},
\]

\(^{14}\) It is quite possible that a similar result holds regarding social welfare as well. The probability that the entrant continues in the market—the probability that the industry remains a duopoly rather than becoming a monopoly—is highest in the regime with renegotiation and predation. Under many standard models of competition, social welfare is higher in a duopoly than in a monopoly. Hence, the presence of predation and renegotiation may actually increase social welfare.

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effect giving all of the bargaining power to the lender. In this section, we examine the robustness of the results under the alternative assumption that the entrant has all the bargaining power. The assumption that the entrant makes a take-it-or-leave-it offer to the lender in the period-0 contracting stage is consistent with the existence of a competitive lending sector: competition would drive the lenders to offer a contract that maximizes the entrant's surplus subject to a break-even constraint for the lender.\footnote{For continuity with the previous section, we will continue to suppose that the lender has the bargaining power at the renegotiation stage. As argued in the previous section, the results would be identical if the entrant had the power at the renegotiation stage.}

Label the new program giving the optimal contract MAX2:

\[
\max_{\beta_r, r_L, \bar{R}_L} \theta[\pi_L - r_L + \beta_L(\bar{R}_L - R_L)] + (1 - \theta)[\pi_H - r_H + \beta_H(\bar{R}_H - R_H)]
\]

subject to (2), (3), (4) and

\[
\theta[r_L + \beta_L(R_L - F)] + (1 - \theta)[r_H + \beta_H(R_H - F)] - F \geq 0.
\]

MAX2 is identical to MAX1 except that the objective function and the individual-rationality constraints have been transposed: (12) is the entrant's objective function, and (13) is the lender's individual-rationality constraint. The construction of the optimal contract in this case follows along the lines of the proofs of Propositions A through C. The appendix contains derivations of the optimal contract under alternative assumptions about predation and renegotiation.

It is instructive to compare the results from the previous sections to the results assuming that the entrant makes the contract offer. The differences in the two sets of results stem from the fact that the lender has no liquidity constraint, so it can transfer utility freely to the entrant, implying that the lender's individual-rationality constraint can be made to bind when the entrant makes the contract offer. Therefore, the entrant's objective function fully internalizes joint surplus; the contract that maximizes entrant surplus maximizes the joint surplus of the entrant and lender as well.

An immediate result is that joint surplus is higher when the entrant has the bargaining power. Calculations similar to those accompanying expression (9) show that joint surplus is proportional to the probability of refinancing. Hence, a second result is that the probability of refinancing is higher when the entrant makes the contract offer. This second result can be combined with the fact, proved in the appendix, that there is the same amount of first-period investment whether the lender or the entrant makes the contract offer. Taken together, we see that there is more total investment when the entrant makes the contract offer. A fourth result is that joint surplus and the entrant's surplus no longer rise with the existence
of predation and renegotiation, contrasting the finding in Proposition D. The conclusion from Proposition D—that the potential for predation and renegotiation may increase joint surplus and the entrant's surplus—must therefore depend on the assumption that the lender makes the initial contract offer.

The effects of renegotiation on the contracting process are summarized in the following proposition:

**Proposition E.** Suppose the entrant makes the contract offer in period 0. It is more difficult for the entrant to obtain first-period financing under renegotiation in the following sense: the parameter values for which the entrant obtains first-period financing are a strict subset of the corresponding parameter values in the absence of renegotiation. In the same sense, it is more difficult to deter predation under renegotiation. Conditional on the entrant's being in the market in the first-period, renegotiation may increase the likelihood that the entrant remains in the market in the second period. Renegotiation reduces the expected surplus of the entrant and the joint surplus of the entrant and lender. The lender always earns zero expected surplus.

The first two statements of Proposition D are identical to those in Proposition E. The facts that renegotiation impairs the commitment power of financial contracts, but that some commitment power remains in spite of renegotiation, are robust to changes in the identity of the party making the initial contract offer.

V. CONCLUSION

Four main conclusions should be highlighted. First, long-term financial contracts can function as credible predation defenses in spite of renegotiation; however, renegotiation impairs the commitment value of contracts. This result is robust to changes in how the capital-market imperfections are modeled: Snyder [1994] shows that it emerges from an analysis of a costly-state-verification model. Second, the strategy implied by the optimal contract has intuitive appeal that may have been lacking from the existing theory. Renegotiation forces the entrant and lender to pursue a "deep-pocket" strategy, committing the lender to increase the probability that the entrant is refinanced in the face of predation. By contrast, the optimum in Bolton and Scharfstein [1990] involves a "shallow-pocket" strategy, a reduction in the probability of refinancing in the face of predation. Third, we have the striking result that the presence of predation may increase the entrant's surplus and the joint surplus of the lender and entrant. This result depends on the parameters of the model and on the assumption that the lender has bargaining power at the...
contracting stage. If the concentration of the credit market is a measure of the bargaining power of the lender, the result would be a characteristic of concentrated rather than competitive credit markets. Fourth, the entrant’s surplus, joint surplus, and the probability of refinancing are all higher when the entrant—the party faced with a limited-liability constraint—makes the initial contract offer than when the lender does.16

The paper contributes to the literature on contract renegotiation by demonstrating a model in which renegotiation between symmetrically-informed parties does not destroy the commitment value of contracts. In other models (see Dewatripont [1988] and the discussion in Bolton [1990]), asymmetric information at the time of renegotiation is required for commitment power to survive renegotiation. Contracts retain their commitment value in the present model because capital-market imperfections prevent the free transfer of utility from the entrant to the lender. The fact that utility is not freely-transferable implies that the set of constrained Pareto optima (essentially characterized by $\beta_H = 1$) is a continuum rather than a point. The set of constrained Pareto optima contains the contract that maximizes lender surplus (the contract with $\beta_H = 1$ and $\beta_L = 0$); however, the set also contains contracts that have $\beta_H - \beta_L < \Delta$. The latter contracts deter predation and, since they are constrained Pareto optima, are immune to renegotiation.

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APPENDIX

Proof of Proposition C

In the text, we showed that a renegotiation-proof contract must specify $\beta^*_H = 1$. A financial contract can be designed either to deter predation or not to deter predation. We treat the two designs in turn. First, consider the optimal contract that does not deter predation. It was argued above that this contract would not be renegotiated, so its form is given by Proposition B.

16 Petersen and Rajan [1995] provide some empirical verification of these results in their study of 3,000 small US businesses. Young firms in unconcentrated credit markets (markets in which these firms presumably have bargaining power as borrowers) are found to have significantly higher gross-profit ratios than those in concentrated markets. The proportion of firms with financing from outside lenders grows faster with age in unconcentrated credit markets. One finding not captured in the model is that the proportion of young firms receiving financing from outside lenders is lower in unconcentrated markets—the model would predict no significant difference—providing evidence of the adverse-selection effects outlined by Petersen and Rajan.
Consider, then, the optimal predation-deterring contract. First, it is obvious that (7) must bind; so \( \beta_H^* = 1 \) and \( \beta_L^* = 1 - \Delta \). Second, it is a simple matter to verify that Lemma 1 from Bolton and Scharfstein carries over to this case, implying that the incentive-compatibility constraint (2) binds. Third, we show that the individual-rationality constraint (5) does not bind for \( \beta_L^* = 1 - \Delta \) and \( \beta_H^* = 1 \). In that case, (5) becomes

\[
(A1) \quad \theta[\pi_L - r_L + (1 - \Delta)(\bar{\pi} - R_L)] + (1 - \theta)[\pi_H - r_H + \bar{\pi} - R_H] \geq 0.
\]

The first term of (A1) is strictly positive since

\[
\pi_L - r_L + (1 - \Delta)(\bar{\pi} - R_L) > \pi_L - r_L + (1 - \Delta)(r_L - \pi_L)
\]

\[
\geq 0.
\]

To see the first line, note that condition (4) implies \( \pi_L - R_L \geq r_L - \pi_L \); and so \( \bar{\pi} - R_L > r_L - \pi_L \). The last line follows by simplifying and applying (3). The second term of (A1) is strictly positive by (4).

Fourth, we solve for \( r_L \) and \( R_L \). Treating (2) as an equality, solving for \( r_H + R_H \), substituting into the objective function and removing inessential constants reduces the objective function to \( \max_{r_L, R_L} \{r_L + (1 - \Delta)R_L\} \). [Note that maximizing this function relaxes (2), so we are safe in ignoring (2) as a constraint for the moment.] The remaining constraints are (3) and (4). Both bind at the optimum, so \( r_L^* = R_L^* = \pi_L \).

Last, we can substitute these values into (2) to show

\[
(A2) \quad r_H + R_H = \Delta \bar{\pi} + (2 - \Delta)\pi_L.
\]

Setting \( R_H^* = \pi_L \) and \( r_H^* = \Delta \bar{\pi} + (1 - \Delta)\pi_L \) gives a solution that satisfies (A2) as well as the limited-liability constraints (3) and (4).

Given the optimal predation-deterring contract found above, the lender’s expected surplus can be calculated. Proposition B gives the lender’s expected surplus if predation is not deterred. Comparing these two values, we see that the lender earns more when predation is deterred if and only if \( \Delta(1 - \theta) - \rho \geq 1 - \mu \). The lender’s expected surplus is non-negative if and only if condition (10) holds.

Proof of Proposition D

There are three cases to consider, depending on the value of \( 1 - \mu \).

Case 1: \( 1 - \mu > \Delta(1 - \theta) \). By Propositions B and C, regardless of the existence of renegotiation the optimal contract does not deter predation. The form of the optimal contract is independent of the existence of renegotiation as well.

Case 2: \( \Delta(1 - \theta) - \rho < 1 - \mu \leq \Delta(1 - \theta) \). In this case, the optimal contract in the absence of renegotiation deters predation; but the optimal contract in its presence does not. By Proposition B, in the absence of renegotiation the entrant invests in the first period if and only if

\[
(A3) \quad \Delta(1 - \theta) \geq \frac{F - \pi_L}{\bar{\pi} - F}.
\]

By Proposition C, in the presence of renegotiation the entrant invests if and only if

\[
(A4) \quad 1 - \mu \geq \frac{F - \pi_L}{\bar{\pi} - F}.
\]
Since $1 - \mu \leq \Delta(1 - \theta)$, condition (A4) is stronger than (A3); so there is less first-period investment under renegotiation.

Conditional on first-period investment, the entrant is more likely to be refinanced in the presence of renegotiation, since the optimal contract involves a higher value of $\beta^*_L$ under renegotiation. The lender’s expected surplus in the absence of renegotiation is $\pi_L - F + \Delta(1 - \theta)(\bar{\pi} - F)$, greater than its surplus in the presence of renegotiation, $\pi_L + (1 - \mu)(\bar{\pi} - F)$, since $1 - \mu \leq \Delta(1 - \theta)$. The entrant’s expected surplus in the absence of renegotiation is $(1 - \theta)[\pi_H - \pi_L + (1 - \Delta)(\bar{\pi} - \bar{\pi}_L)]$, greater than its surplus in the presence of renegotiation, $(1 - \mu)(\pi_H - \pi_L)$.

Case 3: $1 - \mu \leq \Delta(1 - \theta) - \rho$. In this case, the optimal contract deters predation regardless of the existence of renegotiation. As shown above, in the absence of renegotiation the entrant invests in the first period if and only if (A3) holds. By Proposition C, in the presence of renegotiation the entrant invests if and only if

$$\Delta(1 - \theta) \geq (2 - \Delta) \left(\frac{F - \pi_L}{\bar{\pi} - F}\right),$$

clearly a stronger condition than (A3). Hence there is less first-period investment under renegotiation.

Conditional on the entrant’s investing in the first period, the entrant is more likely to be refinanced in the presence of renegotiation since both $\beta^*_L$ and $\beta^*_H$ are higher than is the case in the absence of renegotiation. The lender’s expected surplus in the absence of renegotiation is $\pi_L - F + \Delta(1 - \theta)(\bar{\pi} - F)$, greater than its surplus in the presence of renegotiation, $\pi_L + [\Delta(1 - \theta) - \rho](\bar{\pi} - F)$, since $\rho > 0$. The entrant’s expected surplus in the absence of renegotiation is $(1 - \theta)[\pi_H - \pi_L + (1 - \Delta)(\bar{\pi} - \bar{\pi}_L)]$, less than its surplus in the presence of renegotiation, $\theta(1 - \Delta)(\bar{\pi} - \pi_L) + (1 - \theta)[\pi_H - \pi_L + (1 - \Delta)(\bar{\pi} - \bar{\pi}_L)]$.

Proposition D summarizes the relevant findings from the three cases.

**Contracts When the Entrant Makes the Period-0 Offer**

As a preliminary step, we show that the individual-rationality constraint (13) binds in all the subsequent cases. Suppose for the sake of contradiction that it does not bind at the optimum. Then $r_H$ can be lowered slightly without violating (13). This relaxes the rest of the constraints and increases the entrant’s surplus, a contradiction to the optimality of the original contract.

**Case 1: Predation Is Not Possible.** Substituting (13) into the objective function and removing inessential constants, the objective function reduces to

$$\max_{\beta_L, \beta_H} (\theta \beta_L + (1 - \theta) \beta_H).$$

Clearly, then, (3) and (4) bind for $i = L$, implying

$$r^*_L = R^*_L = \pi_L.$$

Next, we show incentive-compatibility constraint (2) binds. Suppose for the sake of contradiction that it does not. Then (4) must bind for $i = H$. If (4) did not bind for $i = H$, the optimum would involve $\beta_L = \beta_H = 1$. But then (13) and (2) would be inconsistent. To see this, substitute $r^*_L = R^*_L = \pi_L$ and $\beta_L = \beta_H = 1$ into (13) and rearrange:

$$(A5) \quad r_H + R_H \geq \frac{2}{1 - \theta} (F - \theta \pi_L).$$

Similarly for (2):

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(A6) \[ r_H + R_H \leq 2\pi_L. \]

Combining (A5) and (A6) implies \( F \leq \pi_L \), a contradiction.

Thus, if (2) does not bind, (4) must. But then the optimum involves \( r_H = \pi_H \) and \( R_H = \pi_L \). Substituting these values into (2) implies \( \beta_H > 1 \), a contradiction. Hence (2) must bind.

Solving (13) and (2), which hold as equalities, simultaneously yields

\[
\beta_L = \frac{\beta_H (1 - \theta) (\bar{\pi} - F) - (F - \pi_L)}{(1 - \theta) (\bar{\pi} - F) + (F - \pi_L)}.
\]

The optimum thus involves \( \beta_H^* = 1 \) and

(A7) \[ \beta_L^* = \frac{(1 - \theta) (\bar{\pi} - F) - (F - \pi_L)}{(1 - \theta) (\bar{\pi} - F) + (F - \pi_L)}. \]

Substituting these values back into (2), we see that one possible solution to MAX2 has \( r_H^* = \bar{\pi} - \beta_L^* (\pi_L - \pi_L) \) and \( R_H^* = \pi_L \).

Finally, note that this solution is only feasible if both the entrant’s expected surplus and the variable \( \beta_L^* \) are non-negative. The constraint \( \beta_L^* \geq 0 \) is the stronger of the two. It is equivalent to (6).

Case 2: Possible Predation; No Renegotiation. If \( 1 - \beta_L^* \leq \Delta \), where \( \beta_L^* \) is given by (A7), the optimal contract in the absence of predation found above trivially deters predation. Suppose, then, that \( 1 - \beta_L^* > \Delta \); i.e., suppose

(A8) \[ \pi_L - F + [\Delta (1 - \theta) - \rho] (\bar{\pi} - F) < 0. \]

Clearly, the predation constraint (7) must bind so that \( \beta_H - \beta_L = \Delta \). Substituting this expression for \( \beta_L \) in the objective function and removing inessential constants, the objective function reduces to maximizing \( \beta_H \).

We next show that (2) binds at the optimum. Suppose for the sake of contradiction that it does not. Then the optimum would have \( \beta_H^* = 1 \). Setting \( r_H = \pi_H \) and \( R_H = \pi_L \), so that (3) and (4) are satisfied, we see that this solution satisfies (13) as well if

\[ F - \theta [\pi_L + (1 - \Delta) (\pi_L - F)] + (1 - \theta) F \leq (1 - \theta) (\pi_L + \pi_H). \]

The above condition holds if \( F - \pi_L \leq \bar{\pi} - F \), an inequality that must hold for the optimal contract to exist even in the absence of predation (see the last paragraph of Case 1 above). Thus, if (2) does not bind, \( \beta_L^* = 1 - \Delta \) and \( \beta_H^* = 1 \) at the optimum. But then (2) implies

\[ r_H + R_H \leq 2\pi_L + \Delta (\bar{\pi} - \pi_L). \]

Substituting into (13) and rearranging implies

\[ \pi_L - F + [\Delta (1 - \theta) - \rho] (\bar{\pi} - F) \geq 0, \]

a contradiction to (A8) above. Hence (2) must bind.

Treating (2), (13), and (7) as equalities and solving simultaneously yields

\[ \beta_H^* = [\Delta (1 - \theta) - \rho] \left( \frac{\bar{\pi} - F}{F - \pi_L} \right) \]

and \( \beta_L^* = \beta_H^* - \Delta \). This contract exists if and only if \( \beta_L^* \geq 0 \); i.e., if and only if

(A9) \[ \Delta [\pi_L - F] + [\Delta (1 - \theta) - \rho] (\bar{\pi} - F) \geq 0. \]

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The entrant may elect to accommodate predation with the optimal contract. Then, the optimal contract would be as in Case 1, with \( \mu \) substituted for \( \theta \). This form of contract exists as long as \( \beta^L_H \geq 0 \); i.e., as long as \( \pi_L - F + (1 - \mu) (\bar{\pi} - F) \geq 0 \). The expected surplus for the entrant can be computed and compared to that from the solution above to determine which strategy, accommodation or deterrence, is pursued at an optimum. The condition guaranteeing the entrant receives financing in the first period reduces to (8).

**Case 3: Possible Predation; Renegotiation.** As argued in the proof of Proposition C, any contract with \( \beta_H < 1 \) would be renegotiated, replaced by a contract with \( \beta_H = 1 \). To deter predation, then, a renegotiation-proof contract would need to specify \( \beta_H = 1 \) and \( \beta_L \geq 1 - \Delta \). As shown in Case 2 above, such a contract also satisfies the rest of the constraints if and only if (A8) is violated. If (A8) does not hold, we showed that the optimal contract is identical to that found in Case 1; in particular, it deters predation.

If (A8) holds, there exists no predation-deterring contract. The optimal contract that accommodates predation is given in the last paragraph of Case 2. Finally, note that the entrant receives financing in the first period if and only if (10) holds.

**Proof of Proposition E**

This proposition is a corollary of the construction above. By Case 2, the entrant enters the first-period market in the absence of renegotiation if and only if (8) holds. By Case 3 the entrant enters the market in the presence of renegotiation if and only if (10) holds. But (10) is a stronger condition than (8), so renegotiation makes entry more difficult.

For predation-deterrence in the presence of renegotiation, (A8) must be violated. This is not a necessary condition for predation-deterrence in the absence of renegotiation. Thus it is more difficult to deter predation under renegotiation.

Next, we demonstrate a case in which the probability of refinancing is greater under renegotiation. Suppose the parameters are such that the entrant is just indifferent between deterring and accommodating predation in Case 2. Let the superscript \( d \) refer to the optimum in the deterrence case and \( a \) refer to the optimum in the accommodation case. As shown above, (13) binds; substituting (13) into the entrant’s objective gives a simple expression for entrant profit. Using this simple expression for profit, we can write the entrant’s indifference condition as

\[
\bar{\pi} - F + [\theta \beta^L_L + (1 - \theta) \beta^H_H] (\bar{\pi} - F) = \mu \pi_L + (1 - \mu) \pi_H - F + [\mu \beta^L_L + (1 - \mu) \beta^H_H] (\bar{\pi} - F).
\]

But since \( \bar{\pi} > \mu \pi_L + (1 - \mu) \pi_H \), it follows that

\[
(A10) \quad \theta \beta^L_L + (1 - \theta) \beta^H_H < \mu \beta^L_L + (1 - \mu) \beta^H_H.
\]

By continuity, there exist parameter values such that the entrant strictly prefers deterrence, but (A10) still holds. Suppose in addition that (A8) holds. Then under no renegotiation (Case 2), the entrant strictly prefers deterrence; while under renegotiation (Case 3), the entrant accommodates. By (A10) the probability of refinancing is greater under renegotiation than under no renegotiation.

It is obvious that renegotiation reduces the entrant’s expected surplus. Renegotiation is equivalent to adding a constraint to the entrant’s program MAX2. Since (13) binds, the lender makes zero profit. The entrant and lender’s joint expected surplus thus equals the entrant’s expected surplus. It follows that renegotiation reduces joint surplus as well.
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