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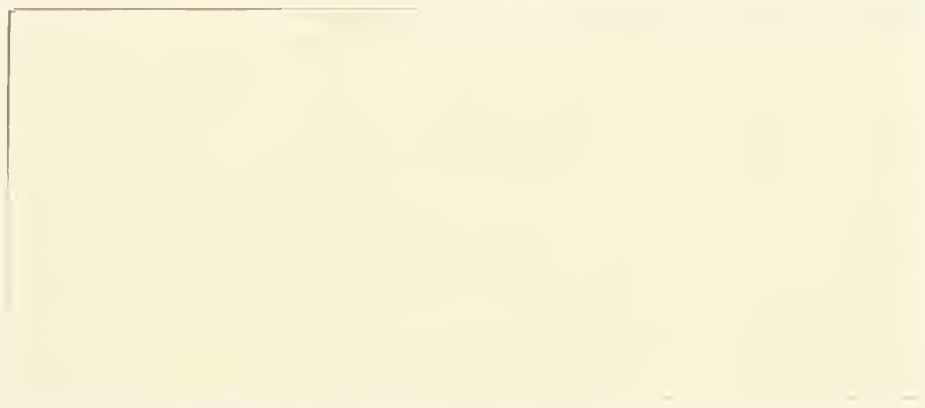
Agency Problems, Financial Contracting,  
and Predation

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### Abstract

We present a theory of predation and competition based on agency problems in financial contracting. To mitigate incentive problems, investors will threaten not to provide further financing if the firm's performance is poor. This encourages competitors to ensure that their rivals' performance is indeed poor. Thus, an optimal contract balances the conflicting goals of deterring predation and providing incentives; predation may or may not occur in equilibrium. Our theory of rational predation differs from existing theories which view predation as an attempt to convince rivals that remaining in the industry is unprofitable; in our model, it is common knowledge that production in each period is profitable. The analysis suggests that studying the interaction between the capital and product markets can provide useful insights into both industrial organization and corporate finance.



## 1. Introduction

In this paper, we present a theory of predation based on agency problems in financial contracting. Our work is closest in spirit to the "long-purse" (or "deep-pockets") theory of predation, in which cash-rich firms drive their financially constrained competitors out of business by reducing their rivals' current cash flow.<sup>1</sup> Although the existing theory is suggestive, it begs important questions. Why are firms financially constrained? And, even if firms are financially constrained, why aren't these constraints lifted under the threat of predation?<sup>2</sup>

We attempt to answer these questions. In Section 2, we present a model (which is of independent interest) in which financial constraints emerge endogenously as a way of mitigating incentive problems. We argue that the commitment to terminate funding if the firm's performance is poor ensures that the firm will not divert resources to itself at the expense of investors.<sup>3</sup> This termination threat, however, is costly in the presence of competition. Rivals now have an incentive to ensure that the firm's performance is poor. This increases the likelihood that the firm's contract is terminated and induces premature exit.

Section 3 analyzes the optimal contract when this cost is taken into account. In general, the optimal response to predation is to lower the sensitivity of the refinancing decision to the performance of the firm. There are two ways of doing this. One way is to increase the likelihood that the firm is refinanced if its performance is poor; the other is to lower the likelihood that the firm remains even if its performance is good. Both strategies reduce the benefit of predation by lowering the effect of predation on the likelihood of exit. We identify conditions under which each of these strategies is optimal.

There is a tradeoff between deterring predation and mitigating incentive problems; reducing the sensitivity of the refinancing decision discourages predation, but exacerbates the incentive problem. Depending on the importance of the incentive problem relative to the predation threat, the equilibrium optimal contract may or may not deter predation.

We conclude these introductory remarks by contrasting our paper to three related literatures. The first is the recent game-theoretic work on predation.<sup>4</sup> This literature shares with ours the feature that predation is rational. It differs, however, in that predation is viewed as an attempt to convince rivals that it would be unprofitable to remain in the industry; predation changes rivals' beliefs about industry demand or the predator's costs. In our paper, there is common knowledge that production in each period is a positive net present value investment.<sup>5</sup> Thus, predation does not work by changing rivals' beliefs. Rather, predation adversely affects the agency relationship between the firm and its creditors.

A second related literature (although not explicitly about predation) is the work on the interaction between product-market competition and the capital market. Brander and Lewis [1986] and Maksimovic [1986] are among the earliest papers. They point out that the objective function of equity holders depends on the degree of leverage because equity holders receive only the residual above the fixed debt obligation. If managers maximize the value of equity, their marginal production incentives will then depend on the debt-to-equity ratio. Capital structure can therefore be used to induce managers to compete more aggressively and so affects product-market equilibrium.<sup>6</sup> The drawback of their work is that they restrict attention to a subset of feasible financial instruments. If the space of feasible contracts were expanded product-market equilibrium would, in general, be

very different. Our paper, in contrast, derives the set of feasible contracts from first principles and analyzes optimal contracts within that set. Furthermore, in these papers, financial structure plays no role other than through its effect on product-market strategy, whereas here, financial policy also affects moral hazard problems within the firm.

Finally, our basic framework bears some resemblance to Katz [1987] which considers a contract-design problem between a principal and an agent in which the agent's performance both influences and is influenced by a third party. Although Katz's main application is to bargaining between an agent and a third party, his framework seems well-suited to analyze the interaction between product-market competition and the capital market.

## 2. Contracting without Predation

There are two firms labelled A and B, who compete in periods 1 and 2. At the beginning of each period, both firms incur a fixed cost,  $F$ . The firms differ with respect to how they finance this cost. Firm A has a "deep pocket"; it has internally generated funds which it can use to finance this cost. Firm B has a "shallow pocket"; it has no working capital and must raise all funds from the capital market.

The first step in our analysis is to characterize the contractual relationship between firm B and its sources of capital. We assume that there is one investor who makes a contract offer to firm B at the initial date 0, and that firm B accepts if the contract provides non-negative expected value. The assumption that the investor has all the bargaining power may be unrealistic for a firm issuing public debt or equity in a well-functioning capital market with many competing investors. However, young companies requiring venture-capital financing or older ones placing private debt or equity are likely to engage in explicit bargaining with

investors. In reality neither side has all the bargaining power; our assumption simply sharpens our results without affecting their essential character.

Firm B's profit in each period is either  $\pi_1$  or  $\pi_2$ , where  $\pi_1 < \pi_2$ . At the beginning of each period, all players have common priors that  $\pi = \pi_1$  with probability  $\theta$ . For simplicity, the discount rate is zero. We assume that the investment has positive net present value:

$$\bar{\pi} = \theta\pi_1 + (1-\theta)\pi_2 > F.$$

Later, we discuss the different implications of the model when  $\pi_1 < F$  and when  $\pi_1 > F$ .

We consider one particular form of agency problem, although our results generalize to other types of agency problems. We have chosen to analyze this problem for its simplicity and the crispness of the results. Our discussion below details the applicability of our results to a wide variety of multi-period contracting problems.

The agency problem we analyze stems from the impossibility of making the financing contract explicitly contingent on profit. There are two alternative interpretations underlying this assumption. One is that at the end of each period, profit is privately observed by the firm. The other is that while both the firm and creditor observe profit, it cannot be verified by the courts.<sup>7</sup>

In a one period model, the investor would not invest in the firm, whenever  $\pi_1 < F$ . To see this, let  $R_i$  be the transfer from the firm to the investor at date 1 if the manager reports that profit is  $\pi_i$ ,  $i = 1, 2$ . Assuming the firm is protected by limited liability,  $R_i$  can be no greater than  $\pi_i$ . Clearly, the firm will report the profit level which minimizes the



payments to the investor. Since  $R_i \leq \pi_i$ , the most the investor can hope to receive at date 1 is  $\pi_1 < F$ .

If instead the relationship lasts for two periods, the investor can control whether the firm receives financing in the second period. The threat of not refinancing the firm in the second period if it defaults in the first, can be used to induce the firm to pay more than  $\pi_1$  in the first period.

Formally, we analyze the contract-design problem as a direct revelation game. The terms of the contract are based on the firm's report of its profit. By the Revelation Principle, such a contract is perfectly general.

Suppose the investor gives the firm  $F$  dollars at date 0 to finance first-period production. As in the above one-period model, let  $R_i$  be the transfer at date 1 if the firm reports profits of  $\pi_i$  in the first period. Let  $\beta_i$  be the probability that the investor gives the firm  $F$  dollars at date 1 to finance second-period production. We assume that without this second-round financing the firm has insufficient funds to operate in the second period. Below we show that this amounts to assuming that  $\pi_2 - \pi_1 < F$ . Finally, let  $R_{ij}$  be the transfer from the firm to the investor at date 2 if the first-period report is  $\pi_i$  and the second-period report is  $\pi_j$ .

It is clear from the argument for the one-period model that  $R_{i1} = R_{i2}$ ; the investor cannot make the second-period transfer depend on second-period profit because the firm would always report the profit level corresponding to the lower transfer. Thus, let  $R^i$  be the second-period transfer if the first-period reported profit is  $\pi_i$ . Limited liability implies  $R^i \leq \pi_i - R_i + \pi_1$ ; the second-period transfer can be no more than the surplus cash from

the first period,  $\pi_i - R_i$ , plus the minimum profit in the second period,  $\pi_1$ .

The optimal contract maximizes the expected profits of the investor subject to the following constraints: (i) the firm truthfully reveals its profit at dates 1 and 2 (incentive compatibility); (ii) the contract does not violate limited liability; (iii) the firm opts to sign the contract at date 0 (individual rationality). Formally, the problem is the following:

$$(1) \quad \text{maximize} \quad -F + \theta[R_1 + \beta_1(R^1 - F)] + (1-\theta)[R_2 + \beta_2(R^2 - F)],$$

$$(\beta_i, R_i, R^i)$$

subject to

$$(IC) \quad \pi_2 - R_2 + \beta_2(\bar{\pi} - R^2) \geq \pi_2 - R_1 + \beta_1(\bar{\pi} - R^1);$$

$$(LL) \quad \pi_i \geq R_i,$$

$$\pi_i - R_i + \pi_1 \geq R^i, \quad i = 1, 2;$$

$$(IR) \quad \theta[\pi_1 - R_1 + \beta_1(\bar{\pi} - R^1)] + (1-\theta)[\pi_2 - R_2 + \beta_2(\bar{\pi} - R^2)] \geq 0.$$

The incentive-compatibility constraint (IC) ensures that when profit is high the firm does not report that profit is low. If profit is  $\pi_2$ , the firm receives some surplus in the first period if it reports  $\pi_1$  since  $R_1 \leq \pi_1 < \pi_2$ ; however, by setting  $\beta_1 < \beta_2$  the investor makes it costly for the firm to report  $\pi_1$ , since the firm generally receives surplus in the second period.

Omitted from this formulation is the incentive-compatibility constraint ensuring that the firm reports  $\pi_1$  rather than  $\pi_2$ . It is demonstrated later that this constraint is not binding. This follows because at an optimum,  $R_2 > \pi_1$ , and hence the firm could never meet its

first-period obligation. Note also that the firm truthfully reveals profit in the second period because  $R_{i1} = R_{i2}$ . Finally, observe that the limited-liability constraints (LL) imply that the individual-rationality constraint (IR) is not binding.

The remainder of this section is devoted to establishing that investors will use the refinancing decision as part of an optimal incentive scheme. Analysis of the optimal contract is simplified by the following two lemmas.

Lemma 1: Constraint (IC) is binding.

Lemma 2: An optimal contract sets both second-period transfers,  $R^1$  and  $R^2$ , equal to  $\pi_1$ .

Lemma 1, which we prove in the Appendix, is a standard feature of contracting problems. Lemma 2, which we also prove in the Appendix, establishes that since there is no refinancing threat in the second period, the most the investor can receive from the firm at that time is the minimum profit level,  $\pi_1$ .

Making use of these two observations, the maximization problem simplifies to:

$$(2) \text{ maximize } -F + R_1 + \beta_2(1-\theta)(\bar{\pi}-F) - \beta_1[\theta F + (1-\theta)\bar{\pi} - \pi_1],$$

subject to the limited-liability constraint,  $\pi_i \geq R_i$ ,  $i = 1, 2$ .

Let  $(R_1^*, \beta_1^*, R_2^*, \beta_2^*)$  denote the optimal contract. It follows immediately that  $R_1^* = \pi_1$  and  $\beta_2^* = 1$ . The values of  $\beta_1^*$  and  $R_2^*$  depend on the sign of  $\theta F + (1-\theta)\bar{\pi} - \pi_1$ . If

$$(*) \quad \theta F + (1-\theta)\bar{\pi} - \pi_1 > 0,$$

$\beta_1^* = 0$  and from (IC),  $R_2^* = \bar{\pi}$ ; if the inequality (\*) is reversed,  $\beta_1^* = 1$ , and from (IC),  $R_2^* = \pi_1$ . It is straightforward to establish that these contracts also satisfy the limited-liability constraints and the omitted incentive constraint.<sup>8</sup>

The basic idea underlying this result is as follows. Given  $R_1^* = \pi_1$ , and  $\beta_2^* = 1$ , (IC) implies

$$R_2^* = \pi_1 + (1-\beta_1)(\bar{\pi}-\pi_1).$$

The expression,  $\bar{\pi}-\pi_1$ , is the firm's expected surplus in the second period given that the firm is refinanced. By reporting  $\pi_1$  rather than  $\pi_2$  in the first period, the firm reduces by  $(1-\beta_1)$  the probability that it receives this surplus. A marginal reduction in  $\beta_1$  therefore lowers by  $\bar{\pi}-\pi_1$  the expected value of reporting  $\pi_1$ . Hence, it increases by  $\bar{\pi}-\pi_1$  the amount the investor can require the firm to pay when it reports profit of  $\pi_2$  in the first period. Since first-period profit is  $\pi_2$  with probability  $1-\theta$ , the increase in expected profit to the investor from reducing  $\beta_1$  is  $(1-\theta)(\bar{\pi}-\pi_1)$ . The cost (or perhaps benefit) of reducing  $\beta_1$  is the foregone expected profit (or loss) to the investor of  $\theta(\pi_1-F)$  when the firm is forced to exit if first-period profit is  $\pi_1$ .

It follows that  $\beta_1^* = 1$  (resp. 0) if  $(1-\theta)(\bar{\pi}-\pi_1)$  is greater (resp. less) than  $\theta(\pi_1-F)$ . Alternatively, the pair  $(\beta_1^*, R_2^*)$  is given by

$$(\beta_1^*, R_2^*) = \begin{cases} (1, \pi_1) & \text{if } F < [\pi_1 - (1-\theta)\bar{\pi}]/\theta \\ (0, \bar{\pi}) & \text{if } F > [\pi_1 - (1-\theta)\bar{\pi}]/\theta \end{cases}$$

Both of these conditions are identical to the conditions implied by (\*).

If  $\pi_1 < F$ , the investor actually benefits by not refinancing the firm: in the second period, the investor only receives  $\pi_1$  and puts up  $F$ . Thus,

reducing  $\beta_1$  unambiguously increases investor profit. If  $\pi_1$  is sufficiently greater than  $F$ , however, the cost to the investor of foregoing expected second-period profit of  $\theta(\pi_1 - F)$ , will outweigh the benefit of increased expected first-period profit of  $(1-\theta)(\bar{\pi} - \pi_1)$ . In this case,  $\beta_1^* = 1$ . But note that if  $\pi_1$  is not substantially greater than  $F$ , condition (\*) will be met and the investor will set  $\beta_1^* = 0$ ; although the investor foregoes second-period profit of  $\pi_1 - F$ , this is offset by the greater first-period profit.

Finally, we must determine the conditions under which the investor earns non-negative profit. Clearly, if  $\pi_1 > F$ , the investor earns positive profit; a transfer of  $\pi_1$  in each period is feasible (although perhaps not optimal) and earns positive profit. If  $\pi_1 < F$ ,  $\beta_1^* = 0$ ,  $R_2^* = \bar{\pi}$  and the investor's expected profit is  $\pi_1 - F + (1-\theta)(\bar{\pi} - F)$ . Thus,  $F$  must be no greater than  $[\pi_1 + (1-\theta)\bar{\pi}]/(2-\theta)$  for the investor to invest at date 0. One can verify that  $[\pi_1 + (1-\theta)\bar{\pi}]/(2-\theta) > [\pi_1 - (1-\theta)\bar{\pi}]/\theta$ , so there is a range of  $F$  such that the firm operates in the first period but exits if first-period profit is  $\pi_1$ . (This establishes that (\*) and the non-negative profit condition can be met simultaneously.)

The above results are summarized in the following proposition.

**Proposition 1:** The investor invests at date 0, if and only if  $F < (\pi_1 + (1-\theta)\bar{\pi})/(2-\theta)$ . Under this condition,  $R_1^* = \pi_1$ ,  $\beta_2^* = 1$ . Furthermore,

$$(i) \quad \beta_1^* = 1, R_2^* = \pi_1 \text{ if } F < (\pi_1 - (1-\theta)\bar{\pi})/\theta;$$

$$(ii) \quad \beta_1^* = 0, R_2^* = \bar{\pi} \text{ if } (\pi_1 - (1-\theta)\bar{\pi})/\theta < F < (\pi_1 + (1-\theta)\bar{\pi})/(2-\theta).$$

## 2.1 Interpretation

The focus of this paper is on the contract described in case (ii) of Proposition 1. In that case, the investor uses the threat of not refinancing the firm as a way of mitigating incentive problems. In this model, not only are payments contingent on performance, but the firm's access to future capital is also explicitly contingent on performance.

We believe that this contract captures an important feature of corporate-financing arrangements. In venture-capital financing, the venture capitalist almost never provides the entrepreneur with enough capital up front to see a new product from its early test-marketing stage to full-scale production. (See Sahlman [1986].) Instead, typical venture-financing arrangements take the form of "staged capital commitment". Initially, the venture capitalist provides enough money to finance the firm's start-up needs like research and product development. Conditional on the firm's performance in this early stage, the venture capitalist may provide further financing to fund test-marketing, and then full-scale production.

There are at least two reasons why such contracts are used. First, they are a means of limiting the financier's exposure should the venture turn out to be an unprofitable one. Entrepreneurs who have confidence in the venture will be more willing to accept contracts of this form. Therefore, staged financing minimizes problems of adverse selection. Second, staged financing arrangements enable the venture capitalist to mitigate incentive problems that inevitably arise between entrepreneurs and financiers. The requirement that the firm return to the venture capitalist for further funding limits the extent to which management will pursue its own interests at the expense of the venture capitalist. Our model formalizes this idea.

The model applies to more than just venture capital. More generally, debt contracts requiring fixed repayments at fixed dates bear many of the same features of the contract described in case (ii) of the proposition. If repayments are met, creditors will generally renew or extend existing credit lines; otherwise, the debtor is denied access to further financing and the creditor receives all or part of the firm's assets.

We can interpret  $\bar{\pi}$  as the face value of debt. If the firm meets its debt obligation, it is refinanced. If not, the creditor receives the entire value of the firm,  $\pi_1$ , and the debtor is denied access to further financing. This is a standard debt contract. Indeed, our model bears some resemblance to Gale and Hellwig [1985], who show that a standard debt contract can be justified as an optimal contract. In their one-period model, profit is privately observed by the firm, but can be observed at a cost by the investor. An optimal contract specifies that if the firm reports low profit, the investor monitors the firm and confiscates all the assets; otherwise, the firm pays a fixed amount and is not monitored. In their model, the cost of reporting low profit is the threat of being monitored and having all assets confiscated; in our model, it is the cost of not being refinanced. Our result is also similar to Stiglitz and Weiss who that the termination threat can be used to improve first-period incentives. Their paper differs from our in two respects: they do not consider fully optimal contracts and they consider a different incentive problem, namely the choice of project riskiness.

## 2.2 Extensions

Other Agency Problems. The above model focuses on a particular agency problem. It is not the only type of agency problem, but it makes our point in the simplest possible way. We believe that the refinancing threat is a

useful incentive device for a wide variety of agency problems. The following example exhibits how this basic idea extends to the familiar effort-elicitation model of agency.

Suppose there are two periods of production and in each period the manager can "work hard" or "shirk". If the manager works hard, he increases the probability that profit is  $\pi_2$  rather than  $\pi_1$ . Working hard reduces the manager's utility by some fixed amount. Managers are risk neutral and protected by limited liability. The limited-liability constraint makes it infeasible to sell the entire firm to the manager (which is otherwise the optimal solution to the moral-hazard problem when the manager is risk neutral).

To prevent the manager from shirking the manager must be rewarded for good performance and will be compensated in excess of his reservation utility. Therefore the manager bears a utility cost if the firm is not refinanced. Moreover, if the creditor threatens not to refinance the firm when profit is low, the effect of this threat will be greater on the manager who shirks than one who does not since the probability of low profit is greater in the former case. Thus the threat of not refinancing the firm makes shirking more costly. By using the refinancing threat, the investor is able to induce greater effort at lower cost. The optimal contract resembles equity with the feature that if performance is poor the investor has the right to shut down the firm. In this sense the financing is very similar to preferred stock in which the holder of preferred stock is given control rights if certain dividend requirements are not met.

Correlation in Profits. In this model, unlike many multi-period agency models, the principal (investor) does not learn about the agent's (firm's) profitability (ability) over time. Here gross profits are



identically and independently distributed. The model can be extended to the case where profits are serially correlated; in fact, our results are strengthened in this case. Let  $E(\pi|\pi_1)$  be expected second-period profits conditional on first-period profits,  $\pi_1$ . If there is positive serial correlation,  $E(\pi|\pi_2) > \bar{\pi}$  and  $E(\pi|\pi_2) > E(\pi|\pi_1)$ . It is straightforward to establish that if  $\theta F + (1-\theta)E(\pi|\pi_2) - \pi_1 > 0$ , the optimal contract is such that  $\beta_1^* = 0$ ,  $\beta_2^* = 1$ ,  $R_1^* = \pi_1$ , and  $R_2^* = E(\pi|\pi_2)$ . Other things being equal, it is more profitable for the investor to invest in the firm. The firm's second-period surplus in period 2 is now greater when first-period profit is  $\pi_2$ . Accordingly, it has more to lose if it is not refinanced. This reduces its incentive to underreport profits and the investor can extract more rent from the firm in period 1.<sup>9</sup>

Renegotiation. In this model, if  $\beta_1^* = 0$ , there is an ex-post inefficiency; the firm exits when first-period profit is  $\pi_1$  even though it is efficient to continue operation. It is natural to ask whether, at date 1, after first-period profit of  $\pi_1$  is realized, the two parties have an incentive to tear up the original contract and renegotiate a mutually beneficial arrangement.

Note that although it is efficient to produce because  $\bar{\pi} > F$ , the most the investor can receive from the firm is  $\pi_1$ . Thus, if  $\pi_1 < F$ , it will not be possible to negotiate around the contractually specified inefficiency. In contrast, if  $\pi_1 > F$ , the investor and the firm will negotiate to share the surplus of  $\bar{\pi} - F$  that is created when the firm operates. Therefore, a contract that originally specifies  $\beta_1^* = 0$ , cannot be implemented ex-post. This implies that the most the investor can induce the firm to pay in each period is  $\pi_1$  since the threat of not refinancing the firm is not credible. One might, however, argue that if the investor is long-lived with many

similar financial arrangements it may have an incentive to develop a reputation for not renegotiating contracts.

Internal Finance. The analysis so far ignores the possibility that the firm may be able to finance second-period production with internally generated funds. If the firm reports profit of  $\pi_1$ , when in fact profit is  $\pi_2$ , in the second period the firm will be able to invest the difference between its earnings and its first-period payment,  $\pi_2 - \pi_1$ . Thus, if  $\pi_2 - \pi_1 > F$ , it may not be possible to prevent the firm from producing in the second period. This implies that the most the investor can require the firm to pay in the first period is  $\pi_1$ . If  $\pi_1 < F$ , the firm will not be able to raise any capital; the inability to discipline the firm ex post freezes the firm out of the capital market.

This illustrates quite dramatically the effects of incentive problems created by "free-cash flows" inside the firm. It has been argued by Jensen [1986] among others that there may be substantial benefits to reducing the amount of internal financing by firms. Our model provides a simple example and formalization of this idea.

Bargaining Power. In the model, the firm has all the bargaining power. Above, we discuss the circumstances under which this is reasonable. It is straightforward to show that if  $\pi_1 < F$ , assigning all the bargaining power to the firm does not change the results substantially. In this case,  $\beta_1^* \in (0, 1)$ ; that is, the firm will exit with positive probability if its first-period profit is  $\pi_1$ . In contrast, if  $\pi_1 > F$  and the firm has all the bargaining power, then  $\beta_1^* = \beta_2^* = 1$  and  $R_i^* = R^{i*} = F$ ,  $i = 1, 2$ . When neither the firm nor the investor has all the bargaining power, in general  $\beta_1^* < 1$  even though  $\pi_1 > F$ . The basic character of our results is not sensitive to our assumptions on the bargaining game.

Capacity Expansion. We have so far interpreted  $\beta_1$  as the probability of refinancing. An alternative interpretation is that  $\beta_1$  is a capacity-expansion parameter. That is, the investor commits to a staged capital-expansion plan contingent on the firm's first-period performance. If profits are  $\pi_1$ , then the firm is given funds to increase capacity by an amount  $\beta_1 F$ . In addition, expected profits increase by  $\beta_1 \bar{\pi}$ . Under this interpretation there is no longer the constraint  $\beta_1 \in [0, 1]$ , but  $\beta_1$  can be assumed to lie in some interval  $[\underline{\beta}, \bar{\beta}]$ . An optimal contract in this framework will also set  $\beta_1 < \beta_2$  as a way of inducing the firm to reveal profits truthfully.

### 3. Predation and the Optimal Contract

In this section we model explicitly the interaction between the firm's financial policy and product-market competition. As discussed above, we assume that firm A is financed with internally generated funds and that firm B must raise funds from the capital market.

To begin, suppose the investor and firm B do not take into account the existence of firm A when designing an optimal financial contract. That is, they take the stochastic structure of profits as exogenous to the contracting process. In this case, the financial contract will be as described in Section 2. Consider the case where firm B is forced to shut down when its first-period profit is low. (This is case (ii) of Proposition 1.) This opens up the possibility of predation by firm A. If firm A can take actions (such as reducing its price or increasing its advertising expenditure) that lower firm B's expected first-period profit, then it can increase the probability that firm B exits. Firm A will engage in predatory behavior if the costs of taking such actions are outweighed by the expected benefits of acquiring a monopoly position.

We model predation as follows: for a cost  $c > 0$ , firm A can increase from  $\theta$  to  $\mu$  the probability that firm B earns low profit,  $\pi_1$ , in period 1. If firm B exits, firm A becomes a monopolist and its second-period expected profits are  $\pi^m$ . If instead firm B remains in the market, firm A's expected profits are  $\pi^d$ . Thus, given the contract  $\beta_1 = 0$ ,  $\beta_2 = 1$ , the expected benefits of predation are  $(\mu - \theta)(\pi^m - \pi^d)$ . It will choose to prey provided  $(\mu - \theta)(\pi^m - \pi^d) > c$ , or defining  $\Delta \equiv c / (\mu - \theta)(\pi^m - \pi^d)$ , if  $\Delta < 1$ .

More generally, for any financial contract of firm B,  $(\beta_1, R_1, \beta_2, R_2)$ , firm A will prey if  $(\beta_2 - \beta_1)(\mu - \theta)(\pi^m - \pi^d) > c$  or  $(\beta_2 - \beta_1) > \Delta$ . Here, the benefits of predation depend on firm B's financial contract. Note that when the investors of firm B ignore the possibility of predation, they maximize the benefit of predation to firm A, since  $\beta_2 - \beta_1$  is largest when  $\beta_2 = 1$  and  $\beta_1 = 0$ . The contract that minimizes agency problems also maximizes the incentive to prey. To make the analysis interesting, we assume for the remainder of the paper that the parameters are such that if  $\beta_2 = 1$  and  $\beta_1 = 0$ , it is optimal to prey, i.e.  $\Delta < 1$ .

To analyze the effect of the financial contract on product-market equilibrium we need to make two further informational assumptions. First, we assume that the predatory action by firm A is not observable by a court. This is a reasonable assumption in view of the difficulties legal scholars and economists have encountered in defining predation.<sup>10</sup> Given that predation is not verifiable by a court, the contract between firm B and its creditors cannot be made contingent on the predatory action of firm A. Notice that we do allow for the possibility that firm B and its investors can observe firm A's predatory actions. This distinguishes our model from explanations of predation which rely on signaling (Milgrom and Roberts [1982]) or signal jamming (Fudenberg and Tirole [1986]).

Our second informational assumption concerns the observability by firm A of the contract between firm B and its investors. If the predator can observe the contract, then the investor can use the contract to influence firm A's actions. By reducing the sensitivity of the refinancing decision to first-period profit, i.e., reducing the difference between  $\beta_2$  and  $\beta_1$ , the investor reduces the gains from predation. For small enough values of  $(\beta_2 - \beta_1)$  predation is deterred. In the extreme, predation is deterred by setting  $\beta_2 = \beta_1 = 1$ ; the investor gives firm B a "deep pocket", i.e. a commitment of resources from which to finance investment. The assumption that the contract is observable implies that the contracting parties cannot secretly renegotiate their contract. The Securities and Exchange Commission requires that all publicly-held firms disclose information on their financial structure. In privately-held companies, however, there is no disclosure requirement. For such firms, it may be more reasonable to assume that financial contracts cannot be observed. We therefore consider the two cases of observable and unobservable contracts.<sup>11</sup>

### 3.1 Observable Contracts

If contracts are observable, the investor can ensure that predation will not take place by writing a contract that satisfies the following "no-predation constraint":

$$(\beta_2 - \beta_1)(\mu - \theta)(\pi^m - \pi^d) \leq c, \text{ or}$$

$$(\beta_2 - \beta_1) \leq \Delta.$$

That is, the investor can deter predation by making the contract less sensitive to firm B's performance. As discussed earlier, one way of doing this is to give firm B a deep pocket;  $\beta_2 = \beta_1 = 1$ . Although this solution has often been suggested as a rational response to predation, we argue

below that it ignores an important cost of such a policy, namely the effect of guaranteed financing on the firm's incentives.

To determine the efficient contractual response to predation, we first analyze the optimal contract that deters predation. We then compare this contract to the optimal contract given predation. The investor chooses the contract with the higher payoff, provided it earns non-negative profit.

The optimal predation-detering contract solves the following program:

$$\max_{(\beta_1, R_1)} -F + \theta[R_1 + \beta_1(\pi_1 - F)] + (1-\theta)[R_2 + \beta_2(\pi_1 - F)],$$

subject to

$$(IC) \quad \pi_2 - R_2 + \beta_2(\bar{\pi} - \pi_1) \geq \pi_2 - R_1 + \beta_1(\bar{\pi} - \pi_1),$$

$$(LL) \quad \pi_i \geq R_i \quad , \quad i=1,2,$$

$$(NPC) \quad (\beta_2 - \beta_1) \leq \Delta.$$

This maximization problem is identical to the problem analyzed in Section 2 except for the constraint (NPC) which ensures that no predation occurs in the first period. Note that predation would never occur in the second period, since it is the last period.

As shown in Proposition 1, if  $\theta F + (1-\theta)\bar{\pi} < \pi_1 < 0$ ,  $\beta_2^* = \beta_1^* = 1$ . This contract will also be the optimal predation-detering contract because firm A will not prey under these circumstances. The interesting case is when  $\theta F + (1-\theta)\bar{\pi} > \pi_1 > 0$ . If the (NPC) constraint is ignored, the optimal solution is  $\beta_2 = 1$ ,  $\beta_1 = 0$ . Firm A will prey and the (NPC) constraint is violated. This implies that at an optimum the constraint must be binding:  $\beta_2 - \beta_1 = \Delta$ . The remainder of the analysis focuses on this case. Using the fact that  $\beta_2 - \beta_1 = \Delta$  and the observation that  $R_1 = \pi_1$ , the binding

(IC) constraint becomes  $R_2 = \Delta\bar{\pi} + (1-\Delta)\pi_1$ . Substituting these equalities into the objective function, the maximization problem becomes:

$$\max -F + \beta_1(\pi_1 - F) + \Delta(1-\theta)(\bar{\pi} - F),$$

where the restrictions that  $\beta_2 - \beta_1 = \Delta$ ,  $\beta_2 \leq 1$ , and  $\beta_1 \leq 1$  imply  $\beta_1 \leq 1 - \Delta$ . The following proposition now follows easily.

**Proposition 2:** If it is optimal to sign a predation-detering contract, and if inequality (\*) holds,  $R_1^* = \pi_1$ ,  $R_2^* = \Delta\bar{\pi} + (1-\Delta)\pi_1 < \bar{\pi}$ .

(i) If  $\pi_1 > F$ , then  $\beta_1^* = 1 - \Delta$  and  $\beta_2^* = 1$ . The investor's expected profits are  $2(\pi_1 - F) + \Delta[\theta F + (1-\theta)\bar{\pi} - \pi_1]$ .

(ii) If  $\pi_1 < F$ , then  $\beta_1^* = 0$  and  $\beta_2^* = \Delta$ . The investor's expected profits are  $\pi_1 - F + (1-\theta)\Delta(\bar{\pi} - F)$ .

The two cases discussed in Proposition 2 differ fundamentally. In the first case (when  $\pi_1 > F$ ), the optimal predation-detering strategy is to give the firm a (partial) deep pocket. By committing (with positive probability) to continue operation, even when profit is low, the investor reduces the incentive for firm A to prey. This comes at a cost to the investor; rather than receiving  $\bar{\pi}$  when first period profit is high, the investor now receives only  $\Delta\bar{\pi} + (1-\Delta)\pi_1 < \bar{\pi}$ .

In the second case (when  $\pi_1 < F$ ), the optimal contract is to give the firm a "shallow pocket", the opposite of a deep pocket. Rather than committing not to exit when first-period profit is low, it is optimal to commit to leave (with positive probability) if profit is high. This reduces the benefit of predation because there is now a greater probability that the firm will exit even if firm A does not prey.

These different responses to predation can be understood as follows. A marginal reduction in  $\beta_2$  and increase in  $\beta_1$  have the same effect on the (NPC) constraint and the same effect on the (IC) constraint. But raising or reducing the likelihood of refinancing implies that the investor is more or less likely to get  $\pi_1 - F$  in the second period. Thus, if  $\pi_1 > F$ , the investor increases  $\beta_1$ ; if  $\pi_1 < F$ , the investor decreases  $\beta_2$ .

In Section 2 we argued that we can interpret  $\beta_i$  as a capacity-expansion parameter; it is a commitment to a scale of operation in the second period. The implication of Proposition 2 under this interpretation is that if  $\pi_1 < F$  it is optimal to deter predation by committing to expand less when first-period profit is high. If  $\pi_1 > F$ , the optimal predation-detering strategy is to commit to more aggressive expansion even if the firm does poorly in the first period.

It remains an open question whether it is optimal to sign predation-detering contracts. The benefit of deterring predation is that the probability of low profit is  $\theta < \mu$ . The cost is that  $\beta_2 - \beta_1$  is equal to  $\Delta < 1$  so that the investor can extract less surplus from the firm. Whether the benefits of deterring predation outweigh the costs depends on a number of factors; there is no crisp characterization of when it is optimal to deter predation.

Inspection of the investor's payoffs reveals that it will be optimal to deter predation provided

$$(i) \quad (1-\theta)\Delta > 1-\mu \quad \text{if } \pi_1 < F;$$

$$(ii) \quad \Delta(\theta F + (1-\theta)\bar{\pi} - \pi_1) > (\mu F + (1-\mu)\bar{\pi} - \pi_1) \quad \text{if } \pi_1 > F,$$

where recall that  $\Delta = c/(\pi^m - \pi^d)(\mu - \theta)$  is itself a function of  $\mu$  and  $\theta$ .

A number of comparative statics follow easily.



(i) An increase in the cost of predation,  $c$ , and a decrease in the benefit of predation,  $\pi^m - \pi^d$ , make predation deterrence more attractive. This is because the costs of predation deterrence decline;  $\beta_2 - \beta_1$  need not be reduced by as much to deter predation.

(ii) In the extreme case where  $c = 0$ , it never pays to deter predation, since this would require setting  $\beta_2 = \beta_1$  which has extreme negative incentive effects.

(iii) If  $\mu = 1$ , it always pays to deter predation, since otherwise the firm would always earn low profit.

To complete the analysis, if the firm is to produce at all, the more profitable of the two contracts must earn non-negative profit. Regardless of whether the optimal contract deters predation or not, both contracts will yield lower expected profit for the investor. If  $\pi_1 < F$ , this reduction in profit may be large enough to prevent entry altogether. Thus, it is possible that the threat of predation upon entry can prevent the firm from entering in the first place, even if ex-post the optimal contract between firm B and its investor is such that predation is deterred.

### 3.2 Unobservable Contracts

The assumption that contracts are observable may be inappropriate in some circumstances. There are no financial disclosure requirements for privately held firms, so it may be impossible for outsiders to actually observe a firm's contractual relationship with its creditors.<sup>12</sup> Thus, we also investigate the case in which firm A cannot observe the contract signed by firm B and the investor. Instead, firm A must make a rational conjecture about the contract chosen in equilibrium.

When contracts are unobservable, it is as if the investor and the predator play a simultaneous move game. (We can ignore firm B because its

actions follow trivially from the contract chosen by the investor.) Firm A's strategy set is composed of two pure strategies: "prey," which we denote by P, and "do not prey," which we denote by NP. The investor's strategy set is essentially a choice of a pair  $(\beta_1, \beta_2) \in [0,1]^2$ . (We can ignore  $R_1$  and  $R_2$  since firm A is only concerned with the probabilities of refinancing,  $\beta_1$  and  $\beta_2$ .)

To characterize the Nash equilibria of the game, we identify three cases:

$$(i) \mu F + (1-\mu)\bar{\pi} > \pi_1;$$

$$(ii) \mu F + (1-\mu)\bar{\pi} < \pi_1 < \theta F + (1-\theta)\bar{\pi};$$

$$(iii) \mu F + (1-\mu)\bar{\pi} < \theta F + (1-\theta)\bar{\pi} < \pi_1.$$

Case (i): If  $\mu F + (1-\mu)\bar{\pi} > \pi_1$ ,  $(0,1)$  is a dominant strategy for the investor; given any strategy by firm A, contract  $(0,1)$  is optimal. Firm A's best response to contract  $(0,1)$  is to choose P. Thus, in this case, contract  $(0,1)$  and predation form a unique Nash equilibrium.

Case (ii): If  $\mu F + (1-\mu)\bar{\pi} < \pi_1 < \theta F + (1-\theta)\bar{\pi}$ , there is no Nash equilibrium in pure strategies. To see this, suppose firm A chooses P, then the investor's best response is  $(1,1)$ . But firm A's best response to contract  $(1,1)$  is NP. Finally, if firm A chooses NP, the investor's best response is contract  $(0,1)$  since  $\theta F + (1-\theta)\bar{\pi} > \pi_1$ .

We can, however, construct an equilibrium in which firm A plays a mixed strategy. If firm A plays a mixed strategy, it must be indifferent between P and NP. Thus,  $\beta_2 - \beta_1 = \Delta$ .

Recall that if  $\alpha$  is the probability that first period profit is  $\pi_1$ , then if  $\alpha F + (1-\alpha)\bar{\pi} > \pi_1$ , the investor chooses contract  $(0,1)$ , and if  $\alpha F +$

$(1-\alpha)\bar{\pi} < \pi_1$ , the investor chooses contract (1,1). Thus, a contract in which  $\beta_2 - \beta_1 = \Delta$  is optimal only if  $\alpha F + (1-\alpha)\bar{\pi} = \pi_1$ .

If firm A preys with probability  $\gamma$ ,  $\alpha = \gamma\mu + (1-\gamma)\theta$ . Thus,  $\gamma$  must satisfy

$$(**) \quad [\gamma\mu + (1-\gamma)\theta]F + [1 - \gamma\mu - (1-\gamma)\theta]\bar{\pi} = \pi_1$$

To determine the particular values of  $\beta_1$  and  $\beta_2$ , observe that  $\mu F + (1-\mu)\bar{\pi} < \pi_1$  implies  $\pi_1 < F$ . It then follows from Proposition 2 that in this case  $\beta_1 = 1 - \Delta$  and  $\beta_2 = 1$ .<sup>13</sup>

Case (iii): If  $\mu F + (1-\mu)\bar{\pi} < \theta F + (1-\theta)\bar{\pi} < \pi_1$ , the investor's dominant strategy is to choose contract (1,1). Firm A's best response is NP. Thus, (1,1) and NP form the unique Nash equilibrium in this case.

We summarize these results in Proposition 3.

Proposition 3: In equilibrium, firm A preys with positive probability if  $\theta F + (1-\theta)\bar{\pi} > \pi_1$ . In particular,

(i) If  $\mu F + (1-\mu)\bar{\pi} > \pi_1$ , firm A preys with probability one and the equilibrium contract is  $(\beta_1, \beta_2) = (0,1)$ ;

(ii) If  $\mu F + (1-\mu)\bar{\pi} < \pi_1$ , firm A preys with probability  $\gamma$  (where  $\gamma$  solves (\*\*)) and the equilibrium contract is  $(\beta_1, \beta_2) = (1-\Delta, 1)$ .

Finally, if  $\theta F + (1-\theta)\bar{\pi} < \pi_1$ , firm A does not prey and the equilibrium contract is  $(\beta_1, \beta_2) = (1,1)$ .

In case (i) of the proposition, (0,1) is a dominant strategy for the investor. With unobservable contracts, there is nothing the investor can do to deter predation. The predator rationally conjectures that the investor will always choose contract (0,1). Therefore, in equilibrium firm A preys.

In case (ii), contract (0,1) is no longer a dominant strategy for the investor. If firm A preys, contract (1,1) will be chosen; if firm A does not prey contract (0,1) will be chosen. Thus, no pure strategy equilibrium exists. In equilibrium, firm A preys with probability  $\gamma \in (0,1)$  so predation is partially deterred even though contracts are not observable.

#### 4. Concluding Remarks

The central idea of this paper is that agency problems in financial contracting can give rise to predation. The financial contract that minimizes agency problems also maximizes rivals' incentives to prey. As a result, there is a tradeoff between deterring predation and mitigating incentive problems: reducing the sensitivity of the refinancing decision to the performance of the firm discourages predation but exacerbates the incentive problem. In equilibrium, whether financial contracts deter predation depends on the relative importance these two effects.

Our theory of predation departs from the existing literature which views predation as an attempt to convince rivals that it would be unprofitable to remain in the industry. In our model, it is common knowledge that it is profitable for the rivals to remain in the industry. Predation induces exit because it adversely affects the agency relationship between the rivals' investors and its manager and not because it changes rivals' perceptions about their profitability.

Although our model narrowly focuses on predation, we believe that the model provides a useful starting point for analyzing a broader set of issues concerning competitive interaction among firms with agency problems and financial constraints. One issue that can be addressed with our type of model is the effect of product-market competition on the incentive problem within the firm. The conventional wisdom is that increased competitive

pressure reduces managerial slack. This idea has been formalized by Oliver Hart [1983], but as Scharfstein [1988] shows, the results depend crucially on the specification of managerial preferences; for reasonable assumptions about managerial preferences, competition actually exacerbates the incentive problem.

In this model, the results are even stronger: competition has unambiguously negative incentive effects. In response to the threat of predation, investors make the refinancing decision less sensitive to performance and hence the manager is able to extract greater rent from the investors. The welfare effects of increased competition, however, are ambiguous. If  $\pi_1 < F$  and contracts are observable, it is optimal to reduce  $\beta_2$  in response to the predation threat. Thus, there is greater exit due to competition and welfare is lower.<sup>14</sup> In contrast, if  $\pi_1 > F$ , the optimal response is to increase  $\beta_1$ , there is less exit, and welfare is higher.

There are obviously important effects that are omitted in this analysis. First, within any period there is no production decision made by the firm and thus no productive inefficiency; the only inefficiency arises between periods in the exit decision. Second, the competitive interaction is modelled in reduced form, and hence it is difficult to consider how efficiency changes as competition becomes more or less aggressive. A model that maintained the dynamic features of our model and incorporated these other features would be an important step towards understanding the incentive effects of competition.

A second general issue raised by our analysis concerns the nature of dynamic competition when firms face capital-market constraints. In the early generation of models of dynamic competition the only relevant consideration is the total capital stock acquired by firms and not the way

in which it was acquired.<sup>15</sup> In contrast, in our framework, firms' competitive behavior depends crucially on whether capital was acquired through internally-generated funds or through external financing. This suggests that an important determinant of product-market success is the ability of firms to finance investment from internal funds. As Donaldson's [1984] study shows, this belief appears to be widely-held even among corporate managers of large industrial companies. We believe that this observation may have important implications for understanding both product-market competition and corporate financing decisions.

## Appendix

Lemma 1: Constraint (IC) is binding.

Proof: Suppose to the contrary that (IC) is slack and that the only constraints are (LL). We establish that the optimal solution to this relaxed program violates (IC).

First note that the maximization problem can be written:

$$\begin{aligned} & \text{maximize } R_i + \beta_i R^i - \beta_i F \\ & (\beta_i, R_i, R^i) \end{aligned}$$

subject to

$$(A.1) \quad R_i \leq \pi_i$$

$$(A.2) \quad R_i + R^i \leq \pi_i + \pi_1.$$

At an optimum to this program,  $R_i = \pi_i$  and  $R^i = \pi_1$ . This is true in the case where  $\beta_i < 1$  because given the constraint on the total payments (A.2), it is optimal to shift more of the payment to the first period when it will be received with certainty. If  $\beta_i = 1$ , any division of payments satisfying  $R_i + R^i = \pi_i + \pi_1$  is optimal and we may as well set  $R_i = \pi_i$  and  $R^i = \pi_1$ . (Note that given  $\beta_i = 1$  the division of payments between  $R_i$  and  $R^i$  has no effect on the incentive-compatibility constraint.)

The (IC) constraint therefore simplifies to

$$\beta_2(\bar{\pi} - \pi_1) \geq \pi_2 - \pi_1 + \beta_1(\bar{\pi} - \pi_1).$$

It is easily seen that for all values of  $\beta_1$  and  $\beta_2$  the inequality cannot be satisfied. Thus the (IC) constraint is violated at the optimum of the relaxed program, establishing the contradiction.

Lemma 2:  $R^1 = R^2 = \pi_1$  is a part of an optimal contract.

Proof: Substituting the (IC) constraint into the objective function yields the new objective function,

$$-F + R_1 + \beta_1[R^1 - \theta F - (1-\theta)\bar{\pi}] + (1-\theta)\beta_2(\bar{\pi} - F).$$

It follows that  $\beta_2 = 1$ . Hence only the sum,  $R^2 + R_2$ , and not the individual values  $R^2$  and  $R_2$  affects the objective function and the (IC) constraint. Thus we can set  $R^2 = \pi_1$ . If  $\beta_1 = 1$  the same can be said for  $R_1$  and  $R^1$ . If  $\beta_1 < 1$ ,  $R_1$  and  $R^1$  will be chosen to maximize  $R_1 + \beta_1 R^1$  since it simultaneously maximizes the objective function and relaxes the (IC) constraint. This expression is maximized subject to (LL) by setting  $R_1 = R^1 = \pi_1$ . This completes the proof.



### Endnotes

1. See, for example, Telser [1966], Benoit [1984], Fudenberg and Tirole [1986] and Tirole [1988].

2. Fudenberg and Tirole [1986] endogenize the financial constraints facing the firm; however, they do not address the question of how these financial constraints might change under the threat of predation.

3. Stiglitz and Weiss [1983] also show that the termination threat can be an optimal incentive scheme for reasons similar to those considered here; however, they analyze a different incentive problem.

4. See for example, Salop and Shapiro [1982], Scharfstein [1984], and Saloner [1987]. These papers draw much from the early work of Milgrom and Roberts [1982] on rational limit-pricing.

5. Saloner's paper differs from ours in that he uses a signaling model to analyze predation. It is, however, similar in that the predation mechanism operates through the capital market: predation lowers the price at which the prey can be acquired.

6. This is similar to Fershtman and Judd [1986] on the effect of managerial employment contracts on product-market competition.

7. In many situations, the latter interpretation is more plausible; an investor is often closely involved in the firm's operations, whereas the courts are not. Irregular accounting practices can make it difficult for outside parties to know the firm's true profitability.

8. Note that in each case, the firm weakly prefers to announce the true profit, when first-period profit is  $\pi_1$ . When  $\beta_1^* = 0$  and  $R_2^* = \bar{\pi}$ , if the firm reports  $\pi_2$ , it will not be able to meet its first-period payment obligation and so it will be in default. In this case, the investor is paid  $\pi_1$  and does not refinance the firm. The firm is then indifferent

between the possible reports of  $\pi$ . We assume that it reports the true profit. In the case when  $\beta_1^* = 1$  and  $R_2^* = \pi_1$ , the firm is always indifferent between the two profit reports. Again we assume profit is reported truthfully.

9. Obviously, if the firm's profits are negatively correlated over time, it loses less if it is not refinanced and it is more difficult for the creditor to extract rent from the firm. However, situations in which profits are negatively correlated over time seem rather implausible.

10. See, for example, Joskow and Klevorick [1979] for one attempt at defining predation and a discussion of the difficulties in doing so.

11. For more discussion of the different implications of contract observability, we refer the reader to Katz [1987].

12. It may be argued that although it is costly for outsiders to observe the contract, it is in the investor's interest to reveal its contract to firm A. But, as Katz [1987] points out in a related context, if the observed contract is not efficient, the two parties will have an incentive to annul the advertised contract by writing a hidden contract.

13. We have identified an equilibrium in which the investor plays a pure strategy. However, this strategy is equivalent to mixing between contract (0,1) and (1,1) where the investor plays the former contract with probability  $\Delta$  and the latter with probability  $1 - \Delta$ .

14. This assumes that the welfare loss from less competition in the second period outweighs the potential gains from increased competition in the first period.

15. See Fudenberg and Tirole [1986b] for a discussion of the importance of this assumption in dynamic oligopoly models.

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