

Financial Predation by the “Weak”

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Abstract

We consider a Stackelberg game, where a financially constrained leader competes with a “deep pocket” follower, and analyze the trade-off between a financial and a strategic advantage for both the design of financial contracts and market structure.

Key words: predation; financial contracts; Stackelberg game

JEL classification: G32; G43

1. Introduction

There is plenty of research suggesting that financially constrained firms might be vulnerable to predation by cash rich competitors. Early work on the “deep pocket” theory of predation, as this area of research is known, offers useful insights. However, it treats financial constraints as exogenous; see, for example, Telser (1966) and Benoit (1984). This is recognized by Bolton and Scharfstein (1990), who develop a model where financial constraints emerge endogenously and then proceed to derive the optimal anti-predation contract. Faure-Grimauld (2000) builds on their approach by explicitly allowing for Cournot competition in the product market. In this paper, we follow these steps but make one significant change in the framework. The financially constrained incumbent in our model is also a Stackelberg leader in the product market. Therefore, in our setup, the incumbent has a strategic advantage and the potential entrant has a financial advantage. We explore the consequences of this trade-off for the design of financial contracts and market structure.

As in Bolton and Scharfstein (1990) and Faure-Grimauld (2000), the source of agency problem in our model is the lack of revenue verifiability. This implies that short-term contracts are not feasible since the borrower has always an incentive to default. However, in a multi-period setting, the threat of premature asset liquidation

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by the lender might provide incentives to the firm to meet its financial obligations. As long as the benefits of continuation are sufficiently high, the firm will do so. However, the entrant targets exactly this incentive mechanism. The predation strategy amounts to sacrificing some short-term profits by producing a level of output that pushes the price sufficiently low so that the incumbent's incentive constraint is violated and thus it strategically defaults. Anticipating the reaction of the entrant, we then consider the optimal anti-predation contract. The intuition here is that the incumbent produces an output that is sufficiently low so that the entrant does not find predation profitable. Using a numerical example, we also demonstrate that the incumbent, despite being a leader in the market, might produce a lower quantity than the entrant. This suggests that by observing only the output choices of firms without any knowledge of their financial position might be not sufficient for deducing the competitive structure of the industry to which they belong.

Our results might also be relevant for the debate on whether or not a predator must be larger than its prey. While common sense suggests that larger firms have deeper pockets, this view was challenged by Hilke and Nelson (1988), who develop a theoretical model that predicts that large diversified firms are more likely to exit in the face of predation than small firms unable to diversify. Their work is motivated by the legal case of the US Federal Trade Commission versus General Foods, in which the Federal Trade Commission argued that it is impossible for a smaller firm to induce the exit of a larger firm by following a predatory strategy. The intuition behind their claim was that a large and diversified firm has already sunk search costs related to entry into new markets. Therefore, withdrawing from one market and moving to another costs a large firm very little compared to a smaller and less diversified firm that faces a higher marginal cost of exit. In contrast, Levy (1989) puts forward the opposite argument. Because a diversified firm has the flexibility of transferring assets internally, it can improve its marginal efficiency. Then these assets play the same role as excess capacity that can deter a potential entrant.

Although we do not explicitly allow for differences in firm size, our model offers an alternative explanation for how larger firms can be victims of predatory behavior by smaller firms. As long as the incumbent firm is financially constrained, it will be vulnerable to a smaller firm with deep pockets. Nevertheless, our results also suggest that, despite the entrant's predatory behavior, the lender can ensure that the incumbent survives by designing a financial contract that takes the threat into account.

Our paper is related to the extensive literature that examines the interaction between market structure and financial markets. A large body of work in this area focuses on the relationship between the choice of capital structure (debt to equity ratio) and output decisions in imperfectly competitive markets; see, for example, Brander and Lewis (1984), Maksimovic (1988), Glazer (1991), Jain et al. (2003), Lambrecht (2001), McAndrews and Nakamura (1992), Snowalter (1995), and Wanzenried (2003). While the cases of Cournot and Bertrand competition have been studied extensively, to our knowledge we are the first to consider the Stackelberg game. Our work is also related to a group of papers that examine how a variety of

information and agency issues affect the design of financial contracts, output choices, and the decisions to enter and exit the market. These include the signaling models of Gertner et al. (1988), Jain et al. (2002), and Poitevin (1989, 1990), the managerial moral hazard models of Kanatas and Qi (2001) and Cestone and White (2003), and the signal jamming model of Jain et al. (2004).

In the next section, we restrict our attention to the financial side of the model by considering the monopoly case. In Section 3, we introduce a rival financially unconstrained firm and analyze the Stackelberg game. In Section 4, we examine whether predation by the financially unconstrained follower is profitable. Given that predatory behavior is viable when the incumbent acts as a leader, in Section 5 we design a financial contract that can deter predation. Finally, in Section 6 we present a numerical example that demonstrates how the threat of predation can wipe out the leader's strategic advantage.

2. Single Seller

We first solve the monopoly case before we introduce a second producer that will allow us to consider strategic interactions. By doing so, we can concentrate on the financial contract design problem. We refer to this monopolist as the incumbent (firm i). There are two production periods ($t=1,2$). In each period, the cost of producing one unit of output is $c > 0$. There is demand uncertainty in the product market and to keep things simple we assume that there are two states of the world. In the high demand state, realized with probability θ , the incumbent faces the inverse demand curve $p_i(q_{it}) = \alpha - q_{it}$, where q_{it} denotes output produced in period t by the incumbent and α is a positive constant. In the low demand state, realized with probability $1-\theta$, we assume that demand vanishes. The incumbent chooses output to maximize expected profits prior to the revelation of the true demand state. We assume that states are independently distributed across periods.

There is asymmetric information in the product market. The demand state is revealed only to the incumbent. All other parameters are public knowledge that can also be observed by lenders and any third party.

On the financial side of the model, that follows closely Tirole (2006, pp. 141-142), the incumbent needs to raise external funds to finance production costs. We assume that the incumbent has no initial wealth but owns assets with end-of-first-period value equal to K . The assets completely depreciate by the end of the second period. External funds can be raised in the capital market, which consists of a large number of risk-neutral investors. We assume that the capital market is perfectly competitive and without loss of generality set the opportunity cost of funds to zero.

Given that investors cannot observe the state of demand, the terms of the loan contract between an investor and the incumbent cannot be contingent on profits. When the incumbent cannot meet obligations specified in the contract, the investor can liquidate the firm and obtain the assets K .

Let q_i^* denote the level of output that maximizes expected profit, p^* the corresponding price, and V^* revenues in the high demand state (notice that the corresponding revenues in the low demand state are equal to zero). Then:

$$q_i^* = \frac{\alpha - c/\theta}{2}, \quad (1)$$

$$p^* = \frac{\alpha + c/\theta}{2}, \quad (2)$$

and

$$V^* = (\alpha - q_i^*)q_i^* = \frac{\alpha^2 - (c/\theta)^2}{4}. \quad (3)$$

Next, we consider the financial contract between the incumbent and an investor. We assume that:

$$K < V^*, \quad (4)$$

which implies that liquidation is inefficient, and that:

$$K < cq_i^*, \quad (5)$$

which implies that if investment is at the first-best level, the loan will be risky.

The size of funds that the incumbent needs each period is cq_i^* . Given that revenues are not verifiable, the investor will always liquidate the firm if the incumbent denies repaying the loan. We also need to ensure that the threat of liquidation gives the incentive to the incumbent to make a high repayment when the demand is high. The incumbent borrows cq_i^* at the beginning of the first period. The repayment Z is set so that it satisfies the following zero-profit condition for the investor:

$$\theta Z + (1 - \theta)K = cq_i^*, \quad (6)$$

or

$$Z = \frac{cq_i^* - (1 - \theta)K}{\theta}. \quad (7)$$

The incentive compatibility constraint for the incumbent is given by:

$$Z + cq_i^* \leq \theta V_i^*. \quad (8)$$

The left-hand side of (8) represents the cost of revealing the true state, which is equal to the repayment plus the cost of second period output (see below). The right-hand side captures the corresponding benefits, which are equal to expected revenues.

Given that the incumbent will not make any loan repayments at the end of the second period (there is no liquidation threat), the second-period investment can only be financed with first-period revenues. Thus, we further assume that:

$$V_i^* > Z + cq_i^* = \frac{(1+\theta)cq_i^* - (1-\theta)K}{\theta}. \quad (9)$$

This inequality implies that revenues in the high demand state are sufficiently high that it is possible for the incumbent, at the end of period 1, to repay the loan received to finance that period's investment and also to cover the cost of the investment in period 2. Notice that if the incentive compatibility constraint (8) is satisfied, the re-investment constraint is also satisfied. Both constraints are satisfied for high values of K , α , and θ . The intuition is that high values of α and θ boost revenues and thus the incumbent has more funds available for re-investment and a higher opportunity cost of liquidation, and a high value of K implies that the repayment can be set low.

In the above analysis, we implicitly assume that the incumbent is protected by limited liability. Carr and Mathewson (1988) and Lawarrée and Van Audenrode (1996) consider the case of unlimited liability.

3. Introducing Competition

In this section, we introduce a second firm into the model. Now the incumbent firm faces a potential entrant. We investigate the effect of entry on the contractual relationship between the investor and the incumbent. In general, an incumbent might be able to deter the threat of entry by expanding its output capacity or by following an aggressive output strategy. Here we assume that the incumbent is not in the position to deter entry. Investment in capacity expansion is an irreversible sunk cost. Aggressive output strategies reduce the incumbent's short-term profits. Both of these strategies require a significant amount of financial resources, and the incumbent in our model is financially constrained. The incumbent lacks the funds necessary to pursue such expensive entry deterrence policies.

Outside investors might also be reluctant to finance such strategies. To see this, consider what happens when potential entry takes place in the second period. The above strategies imply that the incumbent will have to borrow more from the investor in the first period. To successfully block entry, the size of the first-period loan would have to increase, which implies a higher first-period repayment. However, this could violate the incentive compatibility constraint, and in that case the contractual relationship between the investor and the incumbent would break down.

We therefore consider the situation where the incumbent accommodates the entrant. We assume that the entrant is a financially unconstrained Stackelberg follower. Therefore, the entrant has a financial advantage, but the incumbent has a strategic advantage. We explore the implications of this trade-off for both market

structure and the relationship between outside investors and the incumbent. We assume that entry takes place in the first period after the incumbent signs the financial contract. In this section, we derive the market equilibrium for each period and the financial contract between the incumbent and the investor, restricting our attention to strategic considerations only in the output market. In this case, the two competitors are involved in a Stackelberg game during the first period. When the demand is low, the incumbent will exit the market at the end of period 1 and the entrant will become a monopolist in period 2. In the following section, we consider the case where the entrant can use a predation strategy in period 1 that exploits the financial relationship between the incumbent and the investor in order to establish a monopoly. More specifically, we establish necessary conditions for predation, which amount to showing that predation is the optimal response to the original contract. Next, assuming that the necessary conditions are satisfied, we examine whether the incumbent and the investor can design an anti-predation contract that will allow the former to survive in the market.

We use the subscript e to denote the entrant. With two competitors, the market (inverse) demand in the high state is $p_i(Q_i) = \alpha - Q_i$, where $Q_i = q_{ii} + q_{ei}$. In period 1, the incumbent and the entrant play a leader-follower quantity game. The incumbent learns about the threat of entry prior to signing the financial contract. To derive a complete solution of the model, we first derive the entrant's optimal reaction. In period 1, the entrant acts as a Stackelberg follower, choosing the level of output q_{e1} given the incumbent's choice q_{i1} . In period 2, the entrant becomes a monopolist with probability $1 - \theta$. If the market demand is low in period 1, the incumbent will fail to meet its contractual agreement with the lender, who in turn will liquidate the firm. However, when the first-period demand is high, the incumbent will be able to re-invest in the second period. In this situation, the entrant remains a Stackelberg follower. This will happen with probability θ . Let Π_i and Π_e denote the total expected profit of the incumbent and the entrant.

The entrant solves the following problem:

$$\begin{aligned} \underset{(q_{i1}, q_{e2}, q_m)}{\text{Max}} \Pi_e = & \theta(\alpha - Q_1)q_{e1} - cq_{e1} + \theta^2(\alpha - Q_2)q_{e2} - \theta cq_{e2} \\ & + (1 - \theta)\theta(\alpha - q_m)q_m - (1 - \theta)cq_m \end{aligned} \quad (10)$$

where q_m denotes the level of output produced by a monopolist. The entrant's reaction functions for each of the two periods and its optimal quantity as a monopolist are given by:

$$q_{ei}(q_{ii}) = \frac{\alpha - q_{ii} - c/\theta}{2} \quad \forall t \quad (11)$$

$$q_m = \frac{\alpha - c/\theta}{2}. \quad (12)$$

Now consider the incumbent's output selection problem. Its profit maximization problem can be written as:

$$\max_{\{q_{i1}, q_{i2}\}} \Pi_i = \theta(\alpha - q_{i1} - q_{e1}(q_{i1})q_{i1} - Z - cq_{i2}) + \theta^2(\alpha - q_{i2} - q_{e2}(q_{i2})q_{i2}). \quad (13)$$

The repayment Z must satisfy:

$$\theta Z + (1 - \theta)K = cq_{i1}. \quad (14)$$

Substituting the above expression in the incumbent's problem and solving the system of first-order conditions, we obtain the following solution:

$$q_{it} = q_i^* = \frac{\alpha - c/\theta}{2} \quad \forall t. \quad (15)$$

Substituting the above solution into the entrant's reaction function, we obtain the optimal response:

$$q_{et} = q_e^* = \frac{\alpha - c/\theta}{4} \quad \forall t. \quad (16)$$

The incumbent's revenues are given by:

$$V_i^{ss} = \frac{\alpha^2 + (2\alpha c)/\theta - 3(c/\theta)^2}{8} < V_i^s, \quad (17)$$

where the superscript S indicates that this is a Stackelberg value. We assume that the above solution satisfies the incentive compatibility and re-investment constraints obtained from (8) and (9), respectively, after substituting the new quantity and revenue values. Notice that these constraints are now tighter. While the incumbent produces the same quantities, revenues are lower because of the fall in price.

Next, we derive and compare expected profits. Substituting the equilibrium quantities into the objective functions, we obtain:

$$\Pi_i = \frac{1}{8}\theta(1 + \theta)\left(\alpha - \frac{c}{\theta}\right)^2 + (1 - \theta)K \quad (18)$$

and

$$\Pi_e = \frac{1}{16}\theta(1 + \theta)\left(\alpha - \frac{c}{\theta}\right)^2 + \frac{1}{4}\theta(1 - \theta)\left(\alpha - \frac{c}{\theta}\right)^2. \quad (19)$$

Notice that the incumbent earns Stackelberg leader (expected) profits with certainty in the first period and with probability θ in the second period. In contrast, the entrant in each of these cases earns Stackelberg follower profits but also earns monopoly profits with probability $1 - \theta$ in the second period. Hence, if the probability of the high demand state is low, the expected profit of the entrant can be higher than the incumbent's because there is a good chance that the incumbent will

be out of the market in period 2 and the entrant will enjoy monopoly profits. As the probability of the high demand state increases, it is more likely that the incumbent will obtain new funds in period 2 and hence less likely that the entrant will become a monopolist.

To summarize, at the beginning of the first period, the lender offers the incumbent a contract demanding a repayment Z in exchange for a loan cq_1^* . If at the end of the first period the repayment is not made, the lender will liquidate the firm. In contrast, if the repayment is made, the incumbent will re-invest. Observe that the relationship between the lender and the incumbent that is specified in the contract signed prior to production in the first period depends on the entrant's anticipated action. Up to this point, the entrant's output decision affects the incumbent's output and profit only because of strategic considerations in the product market that influence the first-period repayment and thus the incentives of the incumbent to repay the loan. In the next section, we show how the entrant can directly influence the contractual relationship between the incumbent and the lender.

4. Predation

We noted above that the entrant might be able to exercise some influence over the loan contract between the lender and the incumbent by following a predation strategy. The idea behind this strategy is that a firm sacrifices its short-term profit in order to drive out its rivals and take control of the product market in the long run. The goal of predation is to allow the firm to enjoy a monopoly profit in the future by eliminating competitors from the market. Actually, if such strategy is viable, the incumbent (and its investor) will anticipate it and will be forced to stay out of the market even in the first period.

In our setup, the incumbent is fully leveraged while the entrant is self-financed. Before we consider the incumbent's optimal response to the threat of predation, we need to establish that the predation strategy is profitable. The objective of predation is to force the incumbent to strategically default at the end of the first period by targeting the incentive compatibility constraint. The entrant can accomplish this by choosing a first-period output that is sufficiently high that, due to the ensuing fall in the high-demand-state price and thus revenues, the incumbent prefers to default rather than re-invest. Thus, in this section, we assume that the incumbent acts as a leader in a Stackelberg game and compare the entrant's payoff from following the predation strategy to its payoff from behaving as a follower.

In this section we examine under what conditions predation is viable, while in the next section we investigate whether, given that predation is viable, the incumbent and the investor can design a contract that would allow the incumbent to survive. Note that the incumbent's financial constraint does not affect its level of output. Therefore, the entrant does not learn anything from the incumbent's choice of output. Here we assume that the incumbent's wealth is public knowledge. Thus, the entrant, by observing the incumbent's level of production, can deduce the terms of the contract.

Consider a second-period output level for the incumbent, q_{i2}^* , that solves:

$$Z + cq_{i2}^* = \theta V_i'(q_{i2}^*) = \theta(\alpha - q_{i2}^* - q_{e2}(q_{i2}^*))q_{i2}^*, \quad (20)$$

where Z is given by (14) assuming that the incumbent's first-period output is equal to q_i^* and the entrant's second-period output is an optimal response given by the reaction function (11). In words, if the incumbent's second period output is equal to q_{i2}^* and the entrant's output choice is an optimal response, the incumbent's expected revenues in the second period will equal the repayment plus the cost of second-period output—i.e., the incentive compatibility constraint (20) just binds.

Next, consider a first-period level of output for the entrant, q_{e1}^* , that solves:

$$(\alpha - q_i^* - q_{e1}^*)q_i^* - Z = cq_{i2}^*. \quad (21)$$

Assuming that the incumbent acts as a leader in the first period and the entrant's first-period output is q_{e1}^* , the incumbent's first-period net revenues (revenues minus loan repayment) just suffices to cover the cost of producing a level of second-period output equal to q_{i2}^* . We can now prove the following result.

Proposition 1: (Predation strategy) Suppose that the incumbent acts as a leader in period 1. Then, if the entrant's output in period 1 is above q_{e1}^* , the incumbent will default with certainty at the end of period 1.

Proof: Suppose that $q_{e1} > q_{e1}^*$. Then (21) implies that the incumbent's net revenues in period 1 will be less than cq_{i2}^* . Since the incumbent's profits are decreasing in its own output (given that the entrant responds optimally), (20) implies that the incentive compatibility constraint will be violated in the high-demand state.

Let Π_e^* denote the entrant's overall profits when it engages in a predation strategy—i.e., the output choices of the two competitors are $q_{i1} = q_i^*$, $q_{i2} = 0$, $q_{e1} = q_{e1}^* + \varepsilon$ (ε small), and $q_{e2} = q_m$. Thus, we obtain:

$$\Pi_e^* = \theta(\alpha - q_i^* - (q_{e1}^* + \varepsilon))(q_{e1}^* + \varepsilon) - c(q_{e1}^* + \varepsilon) + \theta(\alpha - q_m)q_m - cq_m. \quad (22)$$

Proposition 2: If the incumbent acts as a leader, it is optimal for the entrant to follow a predation strategy if and only if $\Pi_e^* > \Pi_e$.

Proof: First suppose that the entrant's first-period output choice is equal to $q_{e1}^* + \varepsilon$. Then, the incumbent's first-period net revenues will be less than cq_{i2}^* , which implies that second-period expected revenues will be less than Z , and hence the incumbent will default at the end of the first period. The overall profits of the entrant will be $\Pi_e^* - f(\varepsilon)$, which will be greater than Π_e for sufficiently small ε . For the reverse direction, note that if the inequality does not hold, the incumbent's optimal strategy is to act as a leader.

In the example below, we calculate the critical value for q_{e1}^* such that the incentive compatibility constraint just binds.

Example 1: Let $\theta = 0.5$, $\alpha = 20$, $c = 1$, and $K = 2$. Then $Z = 16$, $q_i^* = 9$, $q_{i2}^* = 4.87689$, $q_{e1}^* = 8.68035$, $q_{e2}(q_{i2}^*) = 6.56155$, $q_m = 9$, $\Pi_e = 35.44$, and $\Pi_e^* = 41.89$.

To summarize, if the inequality in the statement of the proposition is satisfied, then, should the incumbent decide to act as a leader in the first period, the entrant will follow the predation strategy. It is clear that in equilibrium the incumbent and the investor will anticipate the entrant's behavior and the former will not act as a leader. Put differently, if the inequality is satisfied, then acting as a leader in the first period cannot be a perfect equilibrium strategy.

5. Anti-Predation Contract

When predation is profitable, the contract between the incumbent and the investor, which is designed under the assumption that the former will be a leader in the product market, is not predation-proof. When the financial position of the incumbent is common knowledge, rival firms can exploit this weakness by pursuing a strategy such that the incumbent is forced out of competition. The predation strategy that we derive above does not target directly the incumbent's product market decision. What the entrant's predation output choice does is to adversely affect the financial relationship between the incumbent and its financier by tampering with the incentive mechanism of the financial contract.

The intuition behind an anti-predation contract is that the lower the output that the incumbent produces, the more unprofitable the entrant's predation strategy becomes. Thus, the leader's financial weakness jeopardizes its ability to fully commit and requires that it and its financier anticipate the entrant's behavior. Assuming that if the entrant is indifferent between behaving as a follower and engaging in predation, it will choose the former, we can show the following.

Proposition 3: In equilibrium the incumbent will produce a strictly positive level of output in the first period such that the entrant will be indifferent between engaging in predation and being a follower.

Proof: Consider what happens as the incumbent's output vanishes. If the entrant decides to act as a follower, its first-period profits will be approximately equal to monopoly profits, while if it decides to engage in predation, its first-period profits will be much lower. In either case, its second-period profits will be approximately equal to monopoly profits.

Given that when the entrant acts as a follower the incumbent's profits increase with its production, in order to solve for the optimal anti-predation contract we need to find the highest output that the incumbent can produce such that the entrant is

indifferent between being acting as a follower and engaging in predation. Let q_{i1}^* and q_{i2}^* denote the incumbent's optimal output in periods 1 and 2, respectively. Then the following system of equations solves for the anti-predation equilibrium:

$$\begin{aligned} & \theta(\alpha - q_{i1}^* - (q_{e1}^*))q_{e1}^* - c(q_{e1}^*) + \theta(\alpha - q_m)q_m - cq_m \\ & = \theta(\alpha - q_{i2}^* - q_{e1}(q_{i1}^*))q_{e1}(q_{i1}^*) + \theta^2(\alpha - q_{i2}^* - q_{e2}(q_{i2}^*))q_{e2}(q_{i2}^*) \\ & \quad + \theta(1 - \theta)(\alpha - q_m)q_m - cq_m, \end{aligned} \quad (23)$$

$$Z^{**} + cq_{i2}^* = \theta(\alpha - q_{i2}^* - q_{e2}(q_{i2}^*))q_{i2}^*, \quad (24)$$

$$(\alpha - q_{i1}^* - q_{e1}^*)q_{i1}^* - Z^{**} = cq_{i2}^*, \quad (25)$$

$$(\alpha - q_{i1}^* - q_{e1}(q_{i1}^*))q_{i1}^* - Z^{**} = cq_{i2}^*, \quad (26)$$

$$q_{i2}^* = \min\{q_m, q_{i2}^*\}. \quad (27)$$

The left-hand side of (23) shows the overall profits of the entrant when it engages in predation, and the right-hand side shows the overall profits when it acts as a follower. In order to find the optimal quantity that the entrant must produce in the first period when it engages in predation, we follow the same steps as above and solve the incentive compatibility and re-investment constraints (24) and (25) respectively, as equalities, where $Z^{**} = (cq_{i1}^* - (1 - \theta)K) / \theta$ denotes the repayment. We also need to find the incumbent's optimal output assuming that the entrant acts as a follower. Equations (26) and (27) state that it is optimal for the incumbent to act as a leader unless it is constrained by the re-investment constraint.

We demonstrate the solution using the example of the previous section.

Example 2: Let $\theta = 0.5$, $\alpha = 20$, $c = 1$, and $K = 2$. Then $Z = 9.98304$, $q_{i1}^* = 5.99152$, $q_{i2}^* = 9$, $q_{i2}^* = 2.59158$, $q_{e1}^* = 11.9097$, $q_{e1}(q_{i1}^*) = 6.00424$, and $q_{e2}(q_{i2}^*) = 4.5$.

In this particular example, the incumbent's financial disadvantage wipes out its strategic advantage in period 1 but not in period 2. The intuition behind this example is as follows. Suppose that the incumbent produces in period 1 a level of output equal to 5.99152 units and consider the entrant's optimal response. The entrant can behave as a follower responding with a period-1 output equal to 6.00424 units. In this case, if the demand is high in period 1, the incumbent will have sufficient funds in period 2 to behave as a leader and produce. In contrast, suppose that the entrant decides to engage in predation. The expected benefit from predation is that, with probability 0.5, instead of being a follower it will become a monopolist (whether it engages in predation or not it will be a monopolist with probability 0.5). The cost of predation is that, in order to force the incumbent to default, the entrant's first-period output must be 11.9097 (plus ε) units, which implies a loss in first-period revenues equal to the expected benefit of predation. When the entrant engages in predation, the incumbent's revenues are also low and the amount left for re-investment is 2.59158 units, in which case the incentive compatibility constraint just binds.

At this point it is worth considering how the leader's balance sheet affects its vulnerability. In our model, the key financial variables are θ , an inverse measure of risk, and K , the value of liquidation. The benefits of predation decrease with risk because, when the incumbent fails, the entrant becomes a monopolist even without predation. This also suggests that if we allow the returns across periods to be correlated, the likelihood of predation would increase with the degree of correlation. This is because predation confers benefits only if the demand in period 1 is high, and in that case a positive correlation would imply that the probability of success is higher in period 2 also. Finally, the higher the value of liquidation, the less likely is predation. This is because an increase in the value of collateral implies a decrease in the repayment, which relaxes the incentive compatibility constraint.

6. Conclusion

The central theme of this paper is that a financial disadvantage may wipe out any strategic advantage in the product market. The reason is that financial vulnerability offers incentives to rival firms to follow predatory behavior. As in Bolton and Scharfstein (1990) the goal of predation is not to convince competitors that it is unprofitable to stay in the market but to target their relationship with their financiers and push them towards bankruptcy.

The predatory behavior of the entrant involves a high output level that sufficiently reduces the price and hence revenues, so that it induces the incumbent to strategically default on its financial obligations. An appropriately designed financial contract can deter predation. The incumbent, by lowering its own output, decreases the profitability of the predation strategy. From the incumbent's point of view, given that predation is viable when it behaves as a Stackelberg leader, choosing the predation deterrence contract is the only way to survive. Given the incumbent's action, the strategy that gives the entrant the highest return is to be a Stackelberg follower. An interesting consequence is that, although the outcome of the game is a Stackelberg-Nash equilibrium, the incumbent, as the quantity leader, might produce less than the entrant. The result contrasts with the usual outcome of the Stackelberg game in which the financial position of firms is not taken into account.

Agency problems play an important role in formulating business strategies. Leveraged firms find it easy to be targeted by deep-pocket rivals. Our model suggests that even large firms might become victims of predation if they are financially constrained. In order to survive in the market, the incumbent has to be "soft" in the product market so that it does not provoke an aggressive output strategy from its competitors.

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