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Author(s): Philippe Aghion and Patrick Bolton

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Contracts as a Barrier to Entry

By PHILIPPE AGHION AND PATRICK BOLTON*

It is shown that an incumbent seller who faces a threat of entry into his or her market will sign long-term contracts that prevent the entry of some lower-cost producers even though they do not preclude entry completely. Moreover, when a seller possesses superior information about the likelihood of entry, it is shown that the length of the contract may act as a signal of the true probability of entry.

Most of the literature on entry prevention deals with the case of two duopolists (the established firm and the potential entrant) who compete with each other to share a market, where one of the duopolists (the incumbent) has a first-move advantage.¹ This basic paradigm has been studied under various assumptions: about the strategy space of the players; the information structure of the game; and the time horizon. Recently, the model has been enlarged to allow for several entrants, several incumbents, several markets, and third parties.²

We propose here to extend the entry-prevention model in one other direction, which to our knowledge has not yet been formalized; namely, we consider whether optimal contracts between buyers and sellers deter entry and whether they are suboptimal from a welfare point of view. It has been pointed out by many economists that contracts between buyers and sellers in intermediate-good industries may have significant entry-prevention effects and that such contracts may be bad from a welfare point of view.³

On the other hand, it is a widespread opinion among antitrust practitioners that contracts between buyers and sellers are socially efficient.⁴ There have been a number of antitrust cases involving exclusive dealing contracts and often the decision reached by the judge has led to considerable controversy. One famous case, *United States v. United Shoe Machinery Corporation* (1922), illustrates quite clearly the nature of the debate: the United Shoe Machinery Corporation controlled 85 percent of the shoe-machinery market and had developed a complex leasing system of its machines to shoe manufacturers, a leasing system against which, it was thought, other machinery manufacturers would have difficulty competing. The judge ruled that these leasing contracts were in violation of the Sherman Act; his decision has been repeatedly criticized by leading antitrust experts (see Richard Posner, 1976, and Robert Bork, 1978). The main argument against the decision has been expressed by Posner: "The point I particularly want to emphasize is that the customers of United would be unlikely to participate in a campaign to strengthen United's monopoly position without insisting on being compensated for the loss of alternative and less costly

*Department of Economics, Harvard University, Cambridge, MA 02138, and University of California, Berkeley, CA 94720, respectively. We are greatly indebted to Jean Tirole for helping us formulate the model. We also thank Jerry Green and Oliver Hart for their useful suggestions and kind encouragement. We have been most fortunate to benefit from many helpful discussions with Dilip Abreu, Richard Caves, Nancy Gallini, Andreu Mas-Colell, and Eric Maskin.

¹See, for example, the seminal contributions by Michael Spence (1977) and Avinash Dixit (1979, 1980).

²For a recent survey, see Drew Fudenberg and Jean Tirole (1986).

³Spence (p. 544), for example, briefly mentioned contracts as a method for impeding entry; see also

Oliver Williamson (1979). Furthermore, there is a literature on barriers to entry and vertical integration that is relevant to our discussion, since most of the time what vertical integration achieves in this literature can also be done through an appropriate contract. (See Roger Blair and David Kaserman, 1983.)

⁴This position has been forcefully defended by Robert Bork (1978), for example.

(because competitive) sources of supply" (p. 203). Exactly the same point is made by Bork (p. 140), who concludes that when we find exclusive dealing contracts in practice, then these contracts could not have been signed for entry-deterrence reasons.

Both Posner and Bork are right in pointing out that the buyer is better off when there is entry and that he (she) will tend to reject exclusive dealing contracts that reduce the likelihood of entry unless the seller compensates him (her) by offering an advantageous deal. Nevertheless, we show that contracts between buyers and sellers will be signed for entry-prevention purposes.

When the buyer and the seller sign a contract, they have a monopoly power over the entrant. They can jointly determine what fee the entrant must pay in order to be able to trade with the buyer; that is to say, if the buyer signs an exclusive contract with the seller and then trades with the entrant, he must pay damages to the seller. Thus he will only trade with the entrant if the latter charges a price which is lower than the seller's price minus the damages he pays to the seller. These damages, which are determined in the original contract (liquidated damages), act as an entry fee the entrant must pay to the seller. We show that the buyer and the seller set this entry fee in the same way that a monopoly would set its price, when it cannot observe the willingness to pay of its customers. Thus, the main reason for signing exclusive contracts, in our model, is to extract some of the surplus an entrant would get if he entered the seller's market.

These contracts introduce a social cost, for they sometimes block the entry of firms that may be more efficient than the incumbent seller. Entry is blocked because the contract imposes an entry cost on potential competitors. This cost takes two different forms: an entrant must either wait until contracts expire, or induce the customers to break their contract with the incumbent by paying their liquidated damages.

The waiting cost is larger, other things being equal, the longer the contract. We are thus led to study the question of the optimal length of the contract. It is a well-known principle in economics that if agents engage

in mutually advantageous trade, it is in their best interest to sign the longest possible contract. A long-term contract can always replicate what a sequence of short-term contracts achieves.

This principle, however, sharply contrasts empirical evidence: In practice most contracts are of an explicit finite duration. Many economists have been puzzled by this obvious discrepancy between the theory and empirical evidence, and several authors have attempted to provide an explanation for why contracts are of a finite duration; most notably Oliver Williamson (1975, 1979) and Milton Harris and Bengt Holmström (1983).

We argue here that looking only at the length of a contract is misleading. What is important is to what extent a contract of a given length locks the parties into a relationship. Thus we are led to make the distinction between the *nominal length* of the contract (the length that is specified in the contract) and the *effective length* of the contract (the actual length that the parties expect the relationship to last at the time of signing). Liquidated damages constitute an implicit measure of the effective length of the contract.

The paper is organized as follows: Section I looks at optimal contracts between a single buyer and the incumbent seller, when both parties have the same information about the likelihood of entry. Section II analyzes optimal contracts when there is asymmetric information about the probability of entry. Section III deals with optimal contracts when there are several buyers. Finally, Section IV offers some concluding comments.

I. Optimal Contracts Between One Buyer and the Incumbent Seller

We consider a two-period model, where a single producer supplies one unit to a buyer. The latter has a reservation price, $P = 1$, and buys at most one unit. The seller faces a threat of entry, which is modeled as follows: At the time of contracting the seller's unit cost is $c = \frac{1}{2}$, while the entrant's cost of producing the same homogenous good is not known. For simplicity we assume that the entrant's cost, c_e , is uniformly distributed in

$[0, 1]$.⁵ Furthermore, if entry occurs and no contract has been signed between the incumbent and the buyer, both suppliers compete in prices, so that the Bertrand equilibrium price is given by $P = \max\{\frac{1}{2}, c_e\}$. When there is no entry, the potential entrant makes zero profits. Thus entry will only occur if $c_e \leq \frac{1}{2}$ and the probability of entry is given by

$$(1) \quad \phi = \Pr(c_e \leq \tfrac{1}{2}) = \tfrac{1}{2}.$$

We attempt here to model in the simplest way the view of the world where there are many investors at each period of time who try to invest their funds in the markets where they hope to get the highest returns. The distribution of profits across markets, however, changes stochastically over time. Therefore entry into a given market may also be stochastic. In this story it is implicitly assumed that investors do not have an unlimited access to funds and/or that there are diminishing returns to managing more investment projects. If neither of these assumptions hold, then investment will take place until the marginal return on the last investment project is equal to the interest rate. Many good reasons have been given for why investors only have a limited access to funds (see for example, Joseph Stiglitz and Andrew Weiss, 1981, or Williamson, 1971).

The timing of the game is as follows: At date 1 the incumbent seller and the buyer negotiate a contract, then entry either takes place or does not. Finally at date 2, there is production and trade.⁶ We assume that the

entrant's cost, c_e , is *not observable* but the parties to the contract know the distribution function of c_e . Therefore, contracts contingent on c_e cannot be written.⁷

If no contract is signed at date 1, the buyer's expected payoff is given by

$$(2) \quad (1 - \phi) \cdot 0 + \phi \cdot \tfrac{1}{2} = \tfrac{1}{2} \cdot \tfrac{1}{2} = \tfrac{1}{4}.$$

That is, with probability $(1 - \phi)$ there is no entry and the seller sets the price equal to one. Hence, the buyer gets no surplus. With probability ϕ , entry occurs and Bertrand competition drives the price down to the incumbent's unit cost $c = \frac{1}{2}$. Now, Posner's point simply was that any contract that is acceptable to the buyer must give him an expected surplus of at least $\frac{1}{4}$ (assuming that the buyer is risk neutral). We shall show that even though the seller faces this constraint, there are gains to signing long-term contracts and in preventing entry.

The buyer and the incumbent seller could conceivably sign very complicated contracts even in this simple setting. For example, the price specified in the contract may be contingent on the event of entry or even contingent on the entrant's offer.⁸ We shall, however, restrict ourselves to simple contracts of the form $c = \{P, P_0\}$ and show that there is no loss of generality in considering only this type of contract. Here P is the price of the good when the buyer trades with the incumbent and P_0 is the price the buyer must

⁵The choice of a uniform distribution is entirely for the sake of computational simplicity. In our 1985 paper, we show that the qualitative results obtained here are valid for any continuous density $f(x)$ with a support such that the lower bound is finite and that contains the interval $[0, \frac{1}{2}]$.

⁶When production takes place before entry, the analysis is slightly modified. When the buyer switches to the entrant, the incumbent must now incur a loss of $c = \frac{1}{2}$. Thus the Bertrand equilibrium in the post-entry game now is $P = c_e$, so that entry will be precluded (since the entrant always makes nonpositive profits). To avoid an outcome where *ex post* competition (after entry) drives out *ex ante* competition (see Partha Dasgupta and Stiglitz, 1984), we then need to assume that the entrant

sometimes makes losses when he does not enter into the incumbent's market. In other words, the entrant sometimes has a negative opportunity cost (see our earlier paper).

⁷In general, what matters is not the actual unit cost of the entrant but his opportunity cost of not entering. If one takes this interpretation, then nonobservability of the entrant's opportunity cost is a mild assumption.

⁸One often observes contracts where a retailer provides a minimum price warranty of the form: "If the buyer is offered a lower price by another retailer for the same good, within t periods, he can then claim back the difference between the high and the low price." These are examples of contracts which are contingent on the entrant's offer. Of course, if such contracts are written then entry is precluded (since the entrant makes zero profits). See our discussion of these contracts in Section IV.

pay if he does not trade with the incumbent. In other words, P_0 represents *liquidated damages*.

When a contract $c = \{P, P_0\}$ is signed, the buyer gets a surplus of $1 - P$ if there is no entry. Furthermore, if there is entry, he will only switch to the entrant if the latter offers a surplus of at least $1 - P$. We shall assume that when the buyer is indifferent between switching and not switching, he trades with the entrant. Thus in the post-entry equilibrium, the buyer also gets a surplus of $1 - P$. Then a contract $c = \{P, P_0\}$ is acceptable to the buyer only if

$$(3) \quad 1 - P \geq \frac{1}{4}.$$

Next, an entrant can only attract the buyer if he sets a price \tilde{P} , such that

$$(4) \quad \tilde{P} \leq P - P_0$$

(in equilibrium the entrant sets, $\tilde{P} = P - P_0$). And entry only occurs if the entrant makes positive profits:

$$(5) \quad \tilde{P} - c_e \geq 0.$$

Thus, when a contract $c = \{P, P_0\}$ is signed the probability of entry becomes

$$(6) \quad \phi' = \max\{0; P - P_0\}.$$

The incumbent now faces the following program:

$$(7) \quad \max_{P, P_0} \phi' \cdot P_0 + (1 - \phi')(P - c),$$

$$\text{subject to} \quad 1 - P \geq \frac{1}{4}.$$

It is straightforward to verify that the optimal contract is then given by $c = \{\frac{3}{4}, \frac{1}{2}\}$.

There are several conclusions to be drawn. First, the incumbent's expected payoff of signing the contract $c = \{\frac{3}{4}, \frac{1}{2}\}$ is given by $\pi = \frac{1}{16} + \frac{1}{4}$. If he had not signed a contract, or if he had signed a contract that completely blocks entry, his expected payoff would be $\frac{1}{4}$. Hence he is strictly better off signing this contract and the buyer is not worse off.

Second, when $c = \{\frac{3}{4}, \frac{1}{2}\}$ is signed, the probability of entry is $\phi' = \frac{3}{4} - \frac{1}{2} = \frac{1}{4}$. Thus the optimal contract prevents entry to some extent but does not preclude entry completely. The contract $c = \{P, P_0\}$ changes the entry game in a subtle way. On the one hand, it sets a large entry fee, P_0 , to the entrant. This reduces the likelihood of entry. But $P_0 = \frac{1}{2}$, does not completely eliminate entry, since the contract commits the incumbent to set a price $P = \frac{3}{4}$. Thus all entrants with costs $c_e \leq \frac{1}{4}$ will find it profitable to enter. Furthermore, even if the incumbent had the opportunity of lowering the price P below $\frac{3}{4}$ in the post-entry game, he would not want to do this. *The incumbent is strictly better off when the buyer switches to the entrant* in the post-entry game, for then he gets a surplus of $\frac{1}{2}$ compared with a maximum surplus of $P - c = \frac{1}{4}$, if he retained the buyer.

By signing a contract, the incumbent and the buyer form a coalition which acts like a nondiscriminating monopolist with respect to the entrant. The coalition sets P_0 like a monopolist sets its price when it cannot discriminate between buyers with different willingnesses to pay.⁹ If c_e were observable, the contract could specify P_0 as a function of c_e and the coalition would be able to extract all of the entrant's surplus ($P_0 = \frac{1}{2} - c_e$).

The idea that the incumbent and the buyer can get together and extract some of the entrant's rent is very general. It does not depend, for instance, on the assumption that the seller sets the contract. Peter Diamond and Eric Maskin (1979) have obtained a similar result in the context of a model of search with breach of contract, where neither the buyer nor the seller has the power of making take-it-or-leave-it offers. Rather, Diamond and Maskin assume that the outcome of the bargaining game between a buyer and a seller is given by the Nash-bargaining solution.

⁹An interesting feature of the optimal contract is that if the probability of entry ϕ increases, then the optimal price P_0 may decrease. For example if the incumbent's unit cost is k then $\phi = k$ and $P_0^* = 1 - k(1 - k) - k/2$. Thus $dP_0^*/dk < 0$ for $k < \frac{3}{4}$.

Given that the incumbent and the buyer can only act as nondiscriminating monopolists, with respect to potential entrants, the optimal contract introduces a *social cost*, for it sometimes blocks the entry of a firm with a lower cost of production than the incumbent. When an optimal contract is signed, entrants with costs $c_e \in [\frac{1}{4}, \frac{1}{2}]$ do not enter.

To close this section we explain why the buyer and the seller can restrict themselves to simple contracts, $c = \{P, P_0\}$. The buyer and the seller can form a coalition whose value is $\frac{1}{2}$ when they do not allow entry into the market (the buyer's reservation price is one and the incumbent's cost is $c = \frac{1}{2}$). They can raise their payoff by allowing entry and making the entrant pay a fee, which in general will be a function of the entrant's cost, c_e . But the entrant's cost is private information so that the coalition faces a revelation of information problem. Now, a direct mechanism would specify a transfer from the entrant to the coalition, which is a function of the entrant's cost report: $t(c_e)$. This function $t(c_e)$ must satisfy the incentive-compatibility (IC) constraints: for all $c_e \in [0, 1]$,

$$(IC) \quad \pi(c_e) - t(c_e) \geq \pi(\hat{c}_e) - t(\hat{c}_e) \\ \text{for all } \hat{c}_e \in [0, 1].$$

(Where $\pi(c_e)$ is the entrant's rent when his cost is c_e .) The IC constraints imply that $t(c_e) = t$ for all $c_e \in [0, 1]$. In other words, the entry fee is independent of the entrant's cost.

Next, the entrant's rent is given by the difference between the incumbent's cost and his cost, c_e (i.e., $\pi(c_e) = \frac{1}{2} - c_e$). The coalition chooses t to maximize:

$$t \cdot \Pr(\pi(c_e) \geq t) = t \cdot \Pr\left(\frac{1}{2} - c_e \geq t\right) \\ = t\left(\frac{1}{2} - t\right).$$

Then the optimal transfer is $t^* = \frac{1}{4}$ and the expected surplus raised is $\frac{1}{16}$. Notice that the optimal contract $c = \{P = \frac{3}{4}, P_0 = \frac{1}{2}\}$ also raises a surplus of $\frac{1}{16}$ from the entrant. We can now appeal to the revelation principle (Dasgupta, Peter Hammond, and Maskin,

1979), which says that no indirect mechanism does better than the best direct mechanism. That is, no other contract exists that raises a higher surplus than $\frac{1}{16}$. Therefore there is no loss in restricting the contracts to be of the form $c = \{P, P_0\}$.¹⁰

II. Asymmetric Information About the Probability of Entry

In Section I it was assumed that both the incumbent and the buyer know the true probability of entry. This is not always realistic and one would expect that often the incumbent is better informed about the possibility of entry than the buyer. For example, if the incumbent is a high-tech firm and is the only one to have the know-how to produce a given intermediate good, then it is likely to be much better informed than its customers about the ability of a potential competitor in acquiring this know-how and thus produce the intermediate good. Hence, in this section we assume that the incumbent has some private information about the likelihood of entry.¹¹

Asymmetric information has important consequences for the determination of the optimal nominal length of the contract. Under symmetric information, there is no incentive for writing a contract of finite nominal length. On the contrary, the incumbent always gains by locking the buyer into a contract in every period, for then an entrant cannot avoid paying the entry fee by entering at a time when the buyer is not bound by a contract to the incumbent. Under asymmetric information, on the other hand, the seller may wish to sign a contract of finite nominal length in order to signal to the buyer that entry is unlikely. Of course, the seller could also signal his information by

¹⁰In the above discussion we have restricted ourselves to deterministic mechanisms. Since all agents are assumed to be risk neutral, there is no loss of generality in considering only deterministic mechanisms (see Maskin, 1981).

¹¹One can think of situations where the buyer is better informed about the probability of entry. Then we have a classic self-selection problem and all the results obtained in this section would also apply to this case.

offering a contract with lower liquidated damages, P_0 . Such a contract would reduce the buyer's switching cost and could only profitably be offered by a seller facing a low probability of entry. We show however, that under certain conditions, signaling through the length of the contract is strictly better than signaling through liquidated damages.

To keep the analysis simple, we shall assume that the probability of entry is either "high" or "low." The incumbent knows the true probability but the buyer does not. Furthermore, as in Section I, the incumbent makes the contract offer. The situation described here is akin to an "informed Principal" problem (see Roger Myerson, 1983, and Maskin and Jean Tirole, 1985).

As in Section I, we shall assume that the entrant's costs are uniformly distributed on $[0, 1]$. The incumbent's cost, on the other hand, is either $c = \frac{1}{2}$ or $c = k$, where $0 < k < \frac{1}{2}$. Then the probability of entry is low when $c = k$ and it is high when $c = \frac{1}{2}$, since when $c = k$, we have

$$(8) \quad \phi \equiv \Pr(c_e \leq k) = k < \frac{1}{2},$$

and when $c = \frac{1}{2}$, we have

$$(9) \quad \bar{\phi} \equiv \Pr(c_e \leq \frac{1}{2}) = \frac{1}{2}.$$

The buyer's prior beliefs about the incumbent's costs are given by $m = \Pr(c = k)$.

Under asymmetric information, it is no longer true that the seller can restrict himself with no loss to simple contracts, $c = \{P, P_0\}$. In fact, we show in our earlier paper that the incumbent seller can achieve the symmetric information optimal outcome by offering contracts of the form $c = \{P, P^e, P_0\}$ where P_0 is defined as in the previous section, P is the price the buyer pays if he trades with the incumbent and entry did not occur and P^e is the price the buyer pays if he trades with the incumbent and entry took place. Alternatively, when the incumbent only offers contracts of the form $c = \{P, P_0\}$, he can never attain the symmetric information optimal outcome. Thus simple contracts $c = \{P, P_0\}$ are suboptimal under asymmetric

information. Thus, if the more general contracts $c = \{P, P^e, P_0\}$ are feasible asymmetric information puts no restrictions on the nominal length of the contract.

We give the following argument for why such contracts may not be feasible: First, "entry" may be a very complicated event to describe, when a firm can enter with a non-homogeneous good. The incumbent must then decide what commodities qualify as "entrants" and, even if a list of such commodities can be defined, an entrant would have an incentive to produce a good which is not on that list whenever $P > P^e$. Alternatively, if $P^e > P$, there would be an incentive for the incumbent to claim that entry has occurred whenever there is an ambiguity about the event of entry. In short, the event of entry may be difficult to observe, let alone to verify.

Second, when $P > P^e$, the buyer could bribe someone to "enter" only to force the incumbent to lower his price. Vice versa, when $P < P^e$, the incumbent may want to bribe someone to enter.

When only simple contracts $c = \{P, P_0\}$ are feasible, asymmetric information can put restrictions on both the liquidated damages P_0 , and the length of the contract. In the present model, contract length is somewhat artificially defined since production and trade take place only once. It should however be clear from what follows that the conclusions reached here carry over to a model with N periods of production and trade ($N \geq 2$) where entry can take place in any of these N periods.

Here we compare the asymmetric information-contracting solution with the no-contracting solution and show that when the difference between high and low costs is sufficiently large, the low-cost incumbent is better off not signing a contract and leaving options open until the entry decision is taken by the potential competitor. In a model with N periods, this result would be modified and the low-cost incumbent would be better off signing a *shorter* contract than the high-cost incumbent.

When the seller makes a contract offer $c = \{P, P_0\}$, he conveys information about his type, so that the buyer's beliefs change.

Let the buyer's posterior beliefs be

$$(10) \quad \beta(c) = \Pr(\phi = \bar{\phi}/c).$$

The buyer will only accept the contract if

$$(11) \quad 1 - P \geq \beta(c)\bar{\phi}/2 \\ + (1 - \beta(c))\underline{\phi}(1 - k)$$

From (8) and (9) we can rewrite (11) as

$$(12) \quad 1 - P \geq (\beta(c)/4) \\ + (1 - \beta(c))k(1 - k)$$

When the incumbent signs a contract $c = \{P, P_0\}$, the probability of entry is given by

$$(13) \quad \Pr(c_e \leq P - P_0) = P - P_0.$$

Thus, the incumbent's payoff when he is respectively of type $\bar{\phi}$ or $\underline{\phi}$ is given by

$$(14) \quad V(c, \bar{\phi}) = (P - P_0)(P_0 - P + \frac{1}{2}) + P - \frac{1}{2} \\ V(c, \underline{\phi}) = (P - P_0)(P_0 - P + k) + P - k$$

for $P > P_0$, (otherwise $V(c, \bar{\phi}) = P - \frac{1}{2}$ and $V(c, \underline{\phi}) = P - k$). It is straightforward to verify that the Spence-Mirrlees condition is satisfied:

$$(15) \quad d/dk[-\partial V/\partial P/\partial V/\partial P_0] < 0.$$

In other words, it is more costly for an incumbent facing a higher probability of entry to lower P_0 than it is for an incumbent facing a lower probability of entry. Given condition (12) we can draw Figure 1 where $\bar{c}^* = \{P = \frac{3}{4}; P_0 = \frac{1}{2}\}$ is the optimal symmetric information contract when $\phi = \bar{\phi}$. Notice that this contract will always be accepted by the buyer since the right-hand side in (12) is increasing in β and when $\beta = 1$ (12) becomes

$$(16) \quad 1 - P \geq \frac{1}{4}.$$

In addition, the contract \bar{c}^* is the best con-

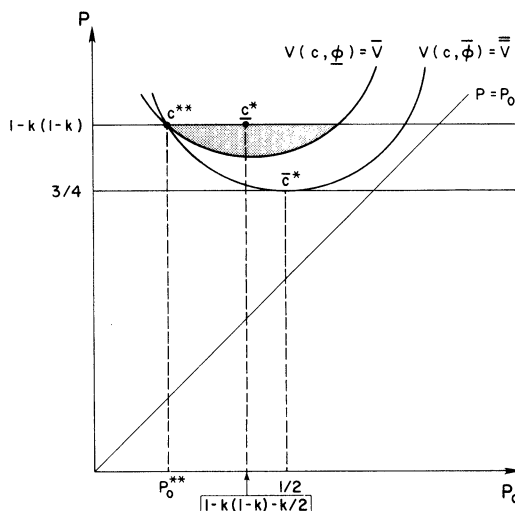


FIGURE 1

tract for the high-cost incumbent, among the class of contracts which generate beliefs $\beta(c) = 1$. It is common in signaling models to obtain a plethora of equilibria and our model is no exception to this rule. Any pair of contracts (c, \bar{c}^*) where c is such that $P = 1 - k(1 - k)$ and $0 \leq P_0 \leq P_0^*$ (see Figure 1) constitutes a separating equilibrium. Furthermore, any point in the shaded area in the diagram may be a pooling or semiseparating equilibrium of the signaling game. Following David Kreps (1984), however, we can refine the Bayesian equilibrium concept by using dominance and stability arguments and thus single out the best separating equilibrium (c^{**}, \bar{c}^*) where c^{**} is defined as $c^{**} = \{P = 1 - k(1 - k); P_0 = P_0^*\}$. How is P_0^* determined? It is the solution to the equation

$$V(c^{**}, \bar{\phi}) = V(\bar{c}^*, \bar{\phi}),$$

which can be rewritten as

$$(17) \quad (P - P_0)(P_0 - P + \frac{1}{2}) + P - \frac{1}{2} = \frac{1}{16} + \frac{1}{4},$$

where $P = 1 - k(1 - k)$.

Now P_0^* is the smaller root of this quadratic equation (see Figure 1) and is given

by

$$(18) \quad P_0^* = ((2P - \tfrac{1}{2}) - \sqrt{4P - 3})/2.$$

How does the optimal contract for the low-cost incumbent under asymmetric information compare with the optimal symmetric information contract given by $\underline{c}^* = \{P = 1 - k(1 - k); P_0 = (2P - k)/2\}$?

The optimal contract under asymmetric information, c^{**} specifies the same price P as c^* , but it specifies lower liquidated damages: $P_0^* < P_0$. It is straightforward to compute that $P_0^* < P_0$ reduces to

$$(19) \quad 1 + 4k^2 > 5k - \tfrac{1}{2}.$$

And for all $0 < k < \tfrac{1}{2}$ this inequality is verified.

Intuitively, the incumbent with low costs signals his type by offering to reduce liquidated damages below the first-best level. His information is credibly transmitted since it is too costly for the high-cost incumbent to reduce P_0 to that level and thereby induce too much entry.

We now show that for small k , the low-cost incumbent is better off not signing a contract than signing c^{**} . If the low-cost seller does not sign a contract, his expected profits are given by

$$(20) \quad (1 - \phi)(1 - k) = (1 - k)^2.$$

If he signs c^{**} he gets

$$(21) \quad V(c^{**}, \phi) \\ = (P - P_0^*)(k - (P - P_0^*)) + P - k,$$

where $P = 1 - k(1 - k)$

$$\text{and} \quad P - P_0^* = \tfrac{1}{4} + \tfrac{1}{2}\sqrt{4(1 - k(1 - k)) - 3}.$$

It remains to show that for small k , we have

$$(22) \quad \left[\tfrac{1}{4} + \tfrac{1}{2}\sqrt{4(1 - k(1 - k)) - 3} \right] k \\ - \left[\tfrac{1}{4} + \tfrac{1}{2}\sqrt{4(1 - k(1 - k)) - 3} \right]^2 \\ + 1 - k(1 - k) - k \leq (1 - k)^2$$

And (22) reduces to

$$(23) \quad k \leq \tfrac{1}{4} + \tfrac{1}{2}\sqrt{4(1 - k(1 - k)) - 3}$$

which is clearly verified for small k . Also, for k close to $\tfrac{1}{2}$, (23) is not satisfied. We summarize the above discussion in the following proposition:

PROPOSITION 1: *Under asymmetric information about the probability of entry (or equivalently about the incumbent's costs), the optimal contracting solution is such that*

(a) *the high-cost incumbent signs the optimal symmetric information contract $\bar{c}^* = \{P = \tfrac{3}{4}; P_0 = \tfrac{1}{2}\}$.*

(b) *the low-cost incumbent either signs the second-best contract*

$$c^{**} = \left\{ P = 1 - k(1 - k); \right. \\ \left. P_0^* = P - \tfrac{1}{4} - \tfrac{1}{2}\sqrt{4P - 3} \right\}$$

(when k is close to $\tfrac{1}{2}$) or does not sign a long-term contract at all (when k is close to zero).

(c) *c^{**} is characterized by the property that liquidated damages (P_0^*) are lower than in the optimal symmetric information contract,*

$$\underline{c}^* = \{P = 1 - k(1 - k); P_0 = P - (k/2)\}.$$

One can explain Proposition 1(b) as follows. As k becomes smaller the price $P = 1 - k(1 - k)$ rises, which makes it more attractive for the high-cost firm to mimic the low-cost firm's behavior. In order to discourage the high-cost firm from cheating, the low-cost firm must therefore increase the gap $P - P_0 = [\tfrac{1}{4} + \tfrac{1}{2}(4(1 - k(1 - k)) - 3)^{1/2}]$. But this is equivalent to raising the probability of entry after a contract has been signed (see equation (13)). There comes a point where $\phi' = P - P_0 \geq \phi = k$; that is, by raising $P - P_0$, the low-cost firm raises the *ex post* probability of entry (ϕ') above the *ex ante* probability of entry (ϕ) (see (23)). This essentially involves subsidizing some inefficient entrants to enter the market. The incumbent

then gets a negative transfer from the entrant. He can do strictly better by not offering any transfer (i.e., by not signing a contract at all).

We have thus established that the *nominal* length of the contract may serve as a signal of the probability of entry. This result confirms the following basic intuition:

The buyer reasons as follows when he is offered a contract: "If the incumbent wants to sign a contract of a long duration he must be worried about entry, so that I infer from this that the probability of entry is high and I will only accept to sign this contract if he charges a low price. If, on the other hand, the incumbent offers a short-term contract, he reveals that he is not much preoccupied about entry, so that I will be willing to accept a higher price."

The result obtained in Proposition 1(c) implies that the social cost is smaller in the asymmetric information case than in the symmetric information case. That is, liquidated damages (P_0^*) are smaller in c^{**} than in c^* ; therefore fewer efficient firms will be kept out of the market. It is worth emphasizing this point, since one usually thinks of asymmetric information as a constraint that prevents agents from reaching a socially efficient outcome (a first-best optimum). This is a general theme in Agency theory (see Oliver Hart and Holmström, 1985). Here, on the contrary, asymmetric information about the incumbent's costs may actually force agents to choose the socially efficient outcome (whenever the condition in (23) is verified). *The informational asymmetry constrains the monopoly power of the incumbent and the buyer with respect to the entrant.* There is another interpretation of this result. Remember that the incumbent and the buyer are constrained in the first place by the informational asymmetry about the entrant's costs. Then, the conclusion reached here is that if there exists another informational asymmetry between the buyer and the incumbent (about the latter's cost) *the two informational constraints may cancel each other out.*

This is an important observation for agency theory. Informational constraints do not necessarily add up; they may cancel out.

III. Optimal Contracts with Several Buyers

One may wonder to what extent the results obtained in Sections I and II depend on the assumption that there is only one incumbent seller and one buyer? This section attempts to give a partial answer to this question. We compare in turn the situation where there is one buyer but several incumbent sellers, and the situation where there is one incumbent seller but several buyers. All the results established in Section I are valid in each case. Moreover, new interesting features are introduced in the latter situation, where a single incumbent negotiates with several buyers.

Consider first the situation where there are two or more identical sellers but only one buyer. Then, Bertrand competition essentially gives all the bargaining power to the buyer; he gets all of the surplus but the form of the optimal contract does not change. The buyer sets P_0 in the same way as the seller does, when the seller makes the contract offer.

The interesting situation is when there are several buyers and one seller. In this case, the entrant's profits depend on how many customers he can serve in the post-entry game. What is crucial, however, is how the size of the entrant's potential market affects the probability of entry. If the probability of entry is independent of the size of the market, then the case of several buyers reduces to the case of one buyer. In general, however, the size of the market will affect the probability of entry. For example, if the entrant must pay a fixed cost of entry, then his average cost is decreasing in the number of customers served and the probability of entry is increasing in the number of customers.

In this latter case, when one buyer signs a long-term contract with the incumbent, he imposes a negative externality on all other buyers. By locking himself into a long-run relation with the seller, he reduces the size of the entrant's potential market so that, *ceteris paribus*, the probability of entry will be smaller. As a result, the other buyers will have to accept higher prices. We show that the incumbent can exploit this negative ex

ternality to extract more (possibly all) surplus out of each buyer. In some cases, the seller can impose the monopoly price ($P = 1$) on each buyer, even though the *ex ante* probability of entry is arbitrarily close to one (*ex ante* refers to the no-contract situation). In addition, the seller can extract part of the entrant's surplus by choosing damages (P_0) appropriately, so that we get the paradoxical result that a seller facing a threat of entry may be better off than a natural monopoly. To reach this conclusion, we must push the logic of the game to its limits. This result is thus interesting mainly for illustrative purposes.

We will only consider the case of two buyers and one seller.¹² Both buyers are identical and have a reservation price $P = 1$. The incumbent is as described in Section I. The entrant has the same unit costs as in Section I; in addition, he may face a fixed cost of entry, $F \geq 0$. We shall first consider the problem where F is strictly positive. Then, in the absence of any contract, the entrant's profit is given by

$$(24) \quad \pi_e = 2\left(\frac{1}{2} - c_e\right) - F.$$

Thus, the *ex ante* probability of entry is given by

$$(25) \quad \phi = Pr(\pi_e \geq 0) = (1 - F)/2.$$

Suppose now that one of the buyers signs a contract with the incumbent where $P_0 = +\infty$. Then in the post-entry game, this buyer will never switch to the entrant. The latter can now hope to get at most:

$$(26) \quad \hat{\pi}_e = \frac{1}{2} - c_e - F.$$

The other buyer therefore faces a lower likelihood of entry given by

$$(27) \quad \hat{\phi} = Pr(\hat{\pi}_e \geq 0) = (1 - 2F)/2.$$

More generally, whenever one buyer signs a contract with the incumbent of the form

$c = \{P, P_0\}$, the other buyer faces a new probability of entry given by

$$(28) \quad \hat{\phi} = \max\left\{\frac{P - P_0 + \frac{1}{2} - F}{2}; \frac{1 - 2F}{2}\right\}.$$

We will analyze the negotiation game where the incumbent makes simultaneous contract offers to both buyers. The case where the incumbent makes sequential offers is considered in our earlier paper. There we establish that the timing of offers does not matter. The same outcome is obtained in the simultaneous offers case as in the sequential offers case.

The incumbent can without loss restrict the set of contracts to be of the form $c = \{P, P_0, P^r, P_0^r\}$, where

P = the price a buyer must pay if he trades with the incumbent and the other buyer has signed a long-term contract;

P_0 = the damages a buyer must pay if he switches to the entrant and the other buyer has signed a contract with the incumbent;

P^r = the price a buyer must pay if he trades with the incumbent and the other buyer did not sign a contract;

P_0^r = the damages a buyer must pay if he trades with the entrant and the other buyer did not sign a contract with the incumbent.

It is implicitly assumed here that all contracts are publicly observable. This is a strong assumption. In practice, all contracts are not observable. As a result, one can never be certain when a contract is observed, whether there does not exist a hidden contract which cancels the effects of the observed contract. In our model, however, the incumbent has an incentive to publicize all of his contracts, as will become clear below. Thus, hidden contracts are not a problem.

When the seller makes a contract offer $c = \{P, P_0, P^r, P_0^r\}$ to each buyer, B_1 and B_2 , the latter play a noncooperative game where they have two pure strategies: "accept" and "reject." The payoff matrix of this game is represented in Table 1. By choosing P^r and P_0^r appropriately, the incumbent can ensure that $\phi = (1 - 2F)/2$.

¹²We deal with the generalization to n buyers ($n \geq 2$) in our earlier paper.

TABLE 1— B_1

	Accept	Reject
Accept	$1 - P$ $\hat{\phi}/2$	$1 - p^r$ $\phi/2$
Reject	$1 - P$ $1 - p^r$	$\hat{\phi}/2$ $\phi/2$

Essentially, this involves choosing P_0^r large enough so that the buyer who accepted a contract will not switch to the entrant. Now, accept is a (weakly) dominant strategy when

$$(29) \quad 1 - P \geq \hat{\phi}/2 = (1 - 2F)/4;$$

$$(30) \quad 1 - P^r > \phi/2.$$

When the incumbent offers a contract to both buyers such that (29) and (30) are satisfied (and such that $\hat{\phi} = (1 - 2F)/2$), the unique Nash equilibrium is for both buyers to accept the contract offer. As a result, both buyers receive a strictly lower payoff in equilibrium than if they both rejected the contract, since $\hat{\phi} < \phi$.

Thus when there are several buyers contracting with the incumbent, there is another reason why rational buyers are willing to perpetuate the monopoly position of the seller. As Steven Salop puts it, contracts "...are valued by each buyer individually even while they create an external cost to all other buyers" (1986, p. 273). He calls this situation a "*free-rider effect in reverse*" (emphasis added).

In addition to this effect, the seller can set P_0 appropriately so as to extract the maximum expected surplus from the entrant. To summarize, in this simple model with simultaneous offers, the set of optimal contracts is given by

$$(31) \quad c^* = \left\{ P = 1 - \frac{(1 - 2F)}{4}; \right. \\ \left. P_0 = P - \frac{F + 1}{4}; \right. \\ \left. P^r < 1 - \frac{\phi}{2}; P_0^r > P^r + \frac{1}{2} + F \right\}.$$

And at the optimum the incumbent's expected payoff is given by

$$(32) \quad \pi = (2(P - P_0) - F)(2(P_0 - P + \frac{1}{2})) \\ + 2(P - \frac{1}{2}) \\ = \frac{(1 - F)^2}{2} + 1 - \frac{(1 - 2F)}{2}.$$

Suppose now that $F \geq \frac{1}{2}$, then $\hat{\phi} = 0$ and the incumbent is able to impose the monopoly price ($P = 1$) on the buyer. His expected payoff at the optimum is then given by

$$(33) \quad \pi = ((1 - F)^2/2) + 1.$$

Thus the incumbent does strictly better than a natural monopoly, since he can also extract some of the potential entrant's surplus. On the other hand, when $F = 0$, we have $\hat{\phi} = \phi = \frac{1}{2}$, and the "free-rider effect in reverse" disappears, so that the two buyers case reduces to a one-buyer case, where the customer purchases two units rather than one. In other words, when the probability of entry is independent of the size of the market, competition among buyers does not matter.

Thus the principles established in the one buyer-one seller case remain valid when we allow for either more than one buyer or more than one seller. The analysis is somewhat incomplete since we did not deal with the several buyers-several sellers case. The results obtained in Section I carry through to this more general model (see Diamond-Maskin). As far as the results in this section are concerned, it is likely that sellers will not be able to exploit to the same extent the free-rider effect in reverse.

IV. Conclusion

The principles formalized in this paper are very general. What is basically required for contracts to constitute a barrier to entry is that post-entry profits for the incumbent in the absence of any contract be lower than pre-entry profits (and vice versa for consumers). In addition, it is necessary that the incumbent cannot discriminate between entrants of various levels of efficiency. This is a

rather mild assumption if one interprets the entrant's cost as an opportunity cost of entry as in our earlier paper. Throughout the paper we interpreted P_0 to be "liquidated damages," but P_0 may also represent down payments, deposits, collateral, future discounts, and benefits, etc. Thus, the analysis developed here has potentially a wide range of applicability.

Casual empiricism suggests that "endogenous switching costs" for customers are a widespread phenomenon. In the housing market, for example, advance deposits in rental contracts can be interpreted as serving this function (there are, of course, also moral hazard reasons for requiring deposits). Paul Klemperer (1986) provides a number of examples of endogenous switching costs, like frequent flyer programs, trading stamps, deferred rebates by shipping firms, etc. Also, fixed fees in franchise contracts may be used to extract some rent from a potential competitor. The contract between Automatic Radio Manufacturing Co. and Hazeltine Research (see *Automatic Radio Manufacturing Co. v. Hazeltine Research Inc.*, 1950) is a good example. Automatic Radio had to pay a fixed fee irrespective of whether it exploited the patents licensed by Hazeltine. Any new licensor therefore faced an entry barrier equal to the amount of this fee. Another striking example is the case of Bell Laboratories when it invented the transistor. There were other research institutes competing with Bell Laboratories. In order to preempt them, Bell Labs offered to publicize the technology to any potential licensee, in exchange for a fixed fee of \$25,000. This fee served the same function as P_0 , in the contract above. Moreover Bell Lab's strategy was to become the industry standard. Thus any individual licensee would have to take into account the additional switching cost of not being standardized (see E. Braun and S. Macdonald, 1978). Our analysis provides a rationale for the practices described here and explains why rational customers cooperate with firms in these anticompetitive practices. Unfortunately, the variety and potential complexity of these contractual clauses makes the task for antitrust authorities very difficult.

A rapidly growing literature on exogenous switching costs is related to our present study (see Klemperer for a recent thorough exposition). The welfare conclusions obtained in this research are radically different from ours. For example, in Klemperer, entry may be socially inefficient because consumers dissipate the gains from entry (in terms of lower prices and higher output) by incurring the socially wasteful switching costs. In our model, the social cost comes from insufficient entry; when entry occurs it is always welfare improving. Salop also studies the effect of various clauses, such as the "meeting the competition clause" or the "clause of the most favored nation" on competition. His emphasis is more on cartel coordination than entry prevention. In our model a "meeting the competition clause" would preclude entry since the entrant could never undercut the incumbent. *We have shown, however, that it is optimal not to eliminate entry completely.* Therefore, such clauses will never be adopted for entry-deterrence purposes; they may however be useful to facilitate cartel coordination, as Salop shows, since they increase the cost of price cutting.

Our theory of contract length is a substantial departure from existing theories. Most explanations have emphasized the idea that contract length is determined as a tradeoff between recontracting costs and the costs associated with the incompleteness of the contract (see Williamson, 1975, 1985; Ronald Dye, 1985a; Jo Anna Gray, 1976). A notable exception is Harris and Holmström. In practice, uncertainty about the future and the cost of writing complete contracts are without doubt important elements in the determination of contract length. The difficulty from a theoretical perspective is however that uncertainty about the future and "transaction costs" are notoriously vague categories. If contracts are to be incomplete what contingencies should the parties leave out of the contract? This is a very difficult question which has only received partial answers (see Dye, 1985b, and Hart-Holmström). Explanations of contract length based on contractual incompleteness crucially depend on how one answers this question (see Dye, 1985b). In this paper we have

sidestepped the difficulty to provide a story based on asymmetric information. We believe that signaling aspects are important in the determination of contract length and view our explanation as complementary to the existing theories.

Recently, Benjamin Hermalin (1986) has developed another theory of contract length based on asymmetric information. He considers a competitive labor market where initially workers have private information about productivity but where in a later stage this information becomes public (for example, through output observations). He shows that by varying contract length, it is impossible for firms to *profitably* screen out low-productivity workers from high-productivity workers. Ideally, a firm wants to retain only high-productivity workers, but long-term contracts are most attractive to low-productivity workers. Thus, by screening out workers, the firm achieves the opposite of what it wants: it offers long contracts to low-productivity workers and short contracts to high-productivity workers. In equilibrium, either firms offer only short-term contracts, or they offer "trivial" long-term contracts that replicate the outcome achieved with short-term contracts. In our model, on the contrary, signaling (or screening) works. Moreover, when it is optimal for the low-cost incumbent to sign a short-term contract, there does not exist an alternative trivial long-term contract. One can view our explanation and Hermalin's as dual: in his model the high-productivity sellers do not want to be locked in a long-term contract; here it is the buyer who does not want to forego future opportunities.

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