Staggered Contracts, Market Power, and Welfare

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Abstract. Exclusive, staggered supply contracts can decrease industry competition when there are economies of scale: buyers pay a higher price to the incumbent seller and the expected value received by an entrant seller is lower when contracts are staggered. Moreover, under staggered contracts there may exist equilibria where an inefficient firm forecloses a more efficient one. Given that contracts are staggered, contract length further increases market power; however, increasing contract length may also eliminate the inefficient foreclosure equilibrium. Finally, allowing firms to choose contract structure endogenously, the resulting equilibrium path features staggered contracts.

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1. Introduction

In some industries, firms maintain a position of monopoly or market dominance by securing exclusive, long-term contracts with key suppliers or customers. In this paper, we consider the case when a supplier sells to multiple buyers and ask whether it makes a difference whether contracts are synchronous or staggered.

An older motivating example is provided by the case of Pullman Co.'s sleeping car services. From the beginning of the 20th century and until the 1940s, Pullman held a quasi-monopoly position in supplying railroads with sleeping car services. In the 1940s, the Justice Department sued Pullman, arguing that its monopoly position was maintained by means of several practices, including long term, exclusive contracts (as long as 15 years). Moreover, the Justice Department argued that "the security in long time contracts has been buttressed further by staggered expiration dates."[1]

A more recent example is given by Nielsen, which during the 1980s maintained a monopoly over the provision of market-tracking services for grocery store produce sales in Canada.[2] In this industry, the key inputs are raw scanner data provided by the major grocery chains. When Information Resources Incorporated (IRI) threatened to enter the market, Nielsen responded by signing exclusive, long-term contracts (three years or longer) with Canada's grocery chains. Moreover, by Nielsen's own admission, the contracts were staggered as a means to create an additional barrier to competition:

> After we did our retailer deals five years ago, we recognized that we were vulnerable because virtually all of these agreements expired around the same time. We set ourselves a goal then to pursue a practice that would result in our retailer and distributor contracts expiring at different times. This would make it much more difficult for any competitor to set up a service unless he was prepared to invest in significant payments before he had a revenue stream.[3]

A still more example, also involving Nielsen, is given by the market for TV ratings. ErinMedia, a potential competitor to Nielsen, alleged that Nielsen maintained its monopoly position, inter alia, through "securing multi-year staggered contracts with ABC, CBS, NBC, and FOX Broadcasting."[4] In fact, one commentator stressed the importance of staggered contracts by arguing that "the staggering of the contracts gets the four [networks] to be unable to reselect a new source at the same time."[5]

In this paper, we consider the economic effect of staggered contracts in an industry with market power. We develop an infinite period model with two sellers and two buyers. We look for stationary equilibria where sellers bid for contracts under two possible contract

1. *United States v. Pullman Co.*, Civil Action No. 994, 50 F.Supp. 123 (1943).
2. Jing and Winter (2014) discuss this case at length. Strictly speaking, this example does not correspond to the problem we start with: a monopolist selling to customers under exclusive, staggered contracts. Rather, it features a monopsonist buying from suppliers under exclusive, staggered contracts. However, the main problems and the qualitative results in the paper extend to the monopsony case.
3. *Canada (Director of Investigation and Research) v. The D & B Companies of Canada Ltd.* (1995), 64 C.P.R. (3d) 216 (Comp.Trib.).
4. *ErinMedia, LLC v. Nielsen Media Research, Inc.*, No. 8:05-CV-1123-T-24-EAJ., 401 F.Supp.2d 1262 (2005)
5. Allison Romano, "Startup Sues Nielsen," *Broadcasting & Cable*, July 20, 2005.

structures: synchronous contracts (all contracts are renewed at the same time); and staggered contracts (contracts are renewed at different times). We show that equilibrium price is higher under staggered contracts than under synchronous contracts. Moreover, under staggered contracts per-period price is increasing in contract length, whereas under synchronous contracts it is invariant with respect to contract length. In other words, staggered contracts imply an increase in price and an increase in the derivative of price with respect to contract length.

Next we consider the case when one of the sellers is more efficient than the other and show that, if the efficiency difference is not too high, then there exists a staggared-contracts equilibrium where the inefficient seller makes all of the sales. Moreover, a necessary condition for such an equilibrium to exist is that contract length not be too long.

We extend the model to include the possibility of product differentiation. In this context, we show that an entrant's value is lower under staggered contracts. In this sense, in addition to higher prices staggered contracts also increase the level of entry barriers (or, to be more precise and avoid taking a stand on the definition of entry barriers: staggered contracts make entry less likely in equilibrium).

Finally, we amend the model to allow for firms to choose prices and contract length, thus allowing for contract structure to emerge endogenously. In this context, we show that, along the equilibrium path, contracts are staggered. Specifically, in the first period, when two buyers arrive in the market simultaneously, one of the sellers sells a one-period contract to one of the buyers and a two-period contract to the other seller; and thereafter sales take place in two-period staggered contracts.

■ **Related literature.** Conceptually, the Coase theorem (Coase, 1960) provides an important reference point to judge the competitive effects of long-term contracts: if all parties enter into the contract; and if there are no significant externalities; then there is no reason to believe the market solution is inefficient, even if it involves long-term exclusive contracts. This view — usually associated with the "Chicago school" — has been challenged by a series of scholars. In particular, as Aghion and Bolton (1987) point out, to the extent that there are externalities in contracting, it is quite possible that two parties agree on an exclusive contract that is socially inefficient: both parties gain from the contract but that gain is more than outweighed by the loss to an excluded party. In sum, long-term exclusive contracts may create an inefficient barrier to entry.

More closely related to the present paper is the literature on "naked exclusion" (Rasmusen et al., 1991; Segal and Whinston, 2000; Fumagalli and Motta, 2006). This literature considers the case when an incumbent sells to a series of buyers and produces with a technology subject to increasing returns to scale. By securing contracts with a large enough number of buyers, an incumbent is able to exclude a potential entrant who, having only access to a small share of the market, is unable to cover its average cost. Differently from Aghion and Bolton (1987), an additional externality now exists between buyers who sign exclusive deals with the incumbent and buyers who do not. Similarly to Aghion and Bolton (1987), there may exist equilibria with inefficient exclusion.[6]

The present paper extends the idea that contracts may induce externalities, market

6. Similarly to economies of scale, the argument can also be made that contracts which link two markets with economies of scope may lead to effectively foreclose an entrant in one of those markets. See Bernheim and Whinston (1998), Carlton and Waldman (2002), for more on this.

power, and possibly inefficient exclusion. We do so by considering specifically the role played by staggered contracts as well as contract length. In addition to the different focus (on staggered contracts), one important difference with respect to the previous literature is that we assume both sellers are present in the market at all moments of an infinite period game. In other words, incumbency results from equilibrium play, not from a finite extensive form.[7]

Reflecting the conventional antitrust wisdom, Salop and Romaine (1999) wrote that "contracts that do not all expire at the same time ... increase the coordination problem and entry costs facing the new entrant." However, not much has been done to formalize this argument. (A decade earlier, Tirole (1988) wrote that "modeling contract duration would shed some light on the common allegation that established suppliers optimally deter entry through staggered contracts with their downstream customers.")

Among the few papers that address the issue of staggered contracts formally, Segal and Whinston (2007) consider a model with two sellers and a continuum of buyers. They show that, if there are economies of scale and sales are sequential, then once one of the sellers has a slight lead all the remaining buyers purchase from the same seller. Depending on the shape of the cost function, this may lead to inefficient allocation of buyers to firms. This contrasts with the simultaneous-sales case, when the equilibrium allocation is efficient. Unlike Segal and Whinston (2007), we consider an infinite period model where contracts are staggered in calendar time (rather than sold sequentially to a series of buyers who consume in one period only). Moreover, we consider teh endogenous determination of contract structure. That said, our Proposition 3 shares some of the features of their central result, namely the possibility of inefficient exclusion if contracts are staggered.

Iacobucci and Winter (2012) develop a model with staggered contracts in an infinite-period setting. However, their focus is on collusion among several incumbent firms, whereas the present model — and the motivating examples presented earlier — are about an incumbent monopolist deterring entry by a rival.

Jing and Winter (2014) discuss the Canadian Nielsen case (presented earlier) in great detail, and argue that exclusive contracts (in the particular setting they examine) have an anti-competitive effect. They also suggest that staggered contracts increase the size of that barrier, though they do not provide a formal argument for the latter.

From an oligopoly theory point of view, the present paper is related to the work by Gilbert and Newbery (1982), who provide conditions for the persistence of monopoly dominance. Our assumption regarding monopoly and duopoly profits is essentially identical to theirs. Their work does not consider the issue of contracts (either their length or synchronicity); and they do not consider an infinite period model as we do. In the latter sense, the present model is closer to Cabral (2011), a paper that develops a general theory of dynamic competition with network effects. Again, the novelty of the present paper is to consider the role played by staggered contracts.

2. Homogeneous product

In this section we consider the simplest model to illustrate the market-power effect of staggered contracts. Specifically, we compare the equilibria of two industries that differ in

7. Spector (2011) also considers the case when both sellers are present in the market at the time of contracting. However, he does not focus specifically on staggered contracts.

contract structure: one with synchronous contracts, one with staggered contracts.

■ **Synchronous contracts.** Consider an industry with two sellers and an infinite sequence of short-lived pairs of buyers. In every even period, beginning at $t = 0$, sellers simultaneously offer two-period contracts to two buyers. Buyers live for two periods, have a valuation u for one unit of the industry product during one period, zero for any additional unit during that period. Since sellers only offer two-period contracts, we assume without loss of generality that sellers compete on the per-period price they offer. Specifically, buyers choose the seller who offers the lowest price.[8]

The cost of serving one customer during one period, c_k, depends on k, the number of customers served. we make the important assumption that c_k is strictly decreasing:

Assumption 1. $c_2 < c_1$

In words, we assume economies of scale in serving customers.

Since we are not interested in collusive behavior, we restrict the analysis to history-independent strategies. The first result establishes the equilibrium of the unique Nash equilibrium under such strategies.

Proposition 1. *The history-independent equilibrium price in a synchronous-contracts game is given by* $p^y = c_2$

Proof of Proposition 1: Since we are looking at history-independent strategies, we focus on the one-shot game where firms compete for a specific pair of buyers. First we show that, in equilibrium, it cannot be the case that firms serve one customer each. For that to be an equilibrium, the price charged would need to be greater than c_1. But since $c_2 < c_1$, a profitable deviation would be for one of the firms to set $c \in (c_2, c_1)$, which would result in greater profit.

Given that a firm sells to both customers, it must be that $p = c_2$. If $p < c_2$, then the firm receives negative profit and would be better of setting a higher price. If $p > c_2$, the rival firm would benefit by setting $p \in (c_2, p)$. ■

■ **Staggered contracts.** Consider an industry with two sellers and an infinite sequence of short-lived buyers. In each period, beginning at $t = 0$, sellers simultaneously offer two-period contracts to the buyer who is born during that period. As in the synchronous case, each buyer lives for two periods, has a valuation u for one unit of the industry product during one period, zero for any additional unit during that period. Also as in the synchronous case, since sellers only offer two-period contracts we assume without loss of generality that sellers compete on the per-period price they offer; and the buyer chooses the seller who offers the lowest price.

Since we are not interested in collusive behavior, we restrict the analysis to Markov Perfect Equilibria, subgame-perfect Nash equilibra such that prices depend only on the identity of the incumbent (and where $t = 0$ is treated as a separate state).

The first result establishes the equilibrium of the unique Nash equilibrium under such strategies. Differently from the case of synchronous contracts, we now need to explicitly consider the discount factor (between consecutive periods), which we denote by δ.

8. In Section 3, we consider the possibility of seller and buyer heterogeneity.

Proposition 2. *The Markov equilibrium price at $t > 0$ in a staggered-contracts game is given by*

$$p^g = c_2 + \frac{1-\delta}{1+\delta}\,(c_1 - c_2)$$

Proof of Proposition 2: Consider a period $t > 0$. Denote by incumbent seller (subscript i) as the seller who currently holds a contract with the buyer who was born at $t-1$. If the incumbent seller has the winning price, then its discounted value is given by

$$\widetilde{p} + p_i - 2\,c_2 + \delta\,v_i \tag{1}$$

where $\widetilde{p}$ is the per period price of the continuing contract (a contract which buyer and seller are locked in to); p_i the price set by i for the contract beginning in the current period; δ the discount factor; and v_i the value of being an incumbent.

If the entrant makes the sale then the incumbent's value is

$$\widetilde{p} - c_1 + \delta\,v_e \tag{2}$$

Similarly, expected payoff for the entrant in case the entrant makes the sale is given by

$$p_e - c_1 + \delta\,v_i \tag{3}$$

whereas the entrant's expected payoff if the incumbent makes the sale is simply given by

$$\delta\,v_e \tag{4}$$

Equating (2) and (1) and solving for p_i we get the incumbent's minimum price:

$$p_i^\circ = 2\,c_2 - c_1 - \delta\left(v_i - v_e\right)$$

Similarly, the entrant's minimum price is given by

$$p_e^\circ = c_1 - \delta\left(v_i - v_e\right) \tag{5}$$

It can be shown that $p_i^\circ < p_e^\circ$ if and only if $c_2 < c_1$, which is true by Assumption 1. It follows that, in every period, the incumbent makes the sale. This implies that $v_e = 0$ and the equilibrium price is given by

$$p = p_i = p_e = c_1 - \delta\left(v_i - v_e\right) \tag{6}$$

Since the incumbent seller always makes a sale, we conclude that $\widetilde{p} = p_i$ for $t > 1$. Moreover, from (1) we have

$$v_i = 2\left(p_i - c_2\right) + \delta\,v_i \tag{7}$$

Solving (6)–(7), we get

$$v_i = \frac{2\,(c_1 - c_2)}{1+\delta} \tag{8}$$

$$p_i = c_2 + \frac{1-\delta}{1+\delta}\,(c_1 - c_2) \tag{9}$$

the value presented in the proposition. ■

■ **Staggered contracts and equilibrium price.** Comparing Propositions 1 and 2 we get the first result regarding the relation between staggered contracts and market power.

Corollary 1. *The stationary price under staggered contracts is strictly greater than under synchronous contracts.*

In words, Corollary 1 suggests that staggered contracts increase seller monopoly power. The intuition is that staggered contracts create differentiation in an otherwise homogenous duopoly. If contracts are bid in a synchronous manner, then the "Bertrand trap" kicks in and all of the benefits from economies of scale are bid away, leading to zero profits. Under staggered contracts, however, firms are asymmetric when bidding for contracts: effectively, one of the firms has lower cost than the other, for it has already committed to selling to one of the buyers. This cost difference allows the incumbent to increase price above marginal cost without losing the new buyer (that is, the contract free buyer).

Corollary 1 is limited to the comparison of stationary prices. In the staggered contracts world, if both firms are present at $t = 0$, then the equilibrium price set to the first buyers will be such that firm discounted profits are zero. This results in a price below cost during the first period, possibly a negative price. In this sense, staggered prices imply higher prices for $t > 0$ but lower prices at $t = 0$. In Section 4 we focus on how prices are determined at $t = 0$.

In the next section we consider an alternative assumption regarding the beginning of the world, namely the case when both sellers and consumers arrive sequentially.

■ **Contract length.** We next explore the implications of Propositions 1 and 2 for the comparative statics with respect to contract length. So far, we assumed, for convenience, that contracts last for two periods. Since we did not define period length, two-period contracts per se do not say much about contract length.

Suppose the underlying model is defined in continuous time and let period length be given by Δ. Then the discount factor is given by

$$\delta = \exp(-\Delta\, r)$$

where r is the continuous time discount rate. In this context, a longer contract length corresponds to a higher Δ; and a higher Δ corresponds (one-to-one) to a lower δ. In other words, we can measure contract length (inversely) by δ. Specifically, let the unit of time be given by Δ (say, one month). Let contract length be defined by number of units Δ, say $n\,\Delta$. The higher the value of n, the lower the associated value of δ.

Given this understanding of the measurement of contract length, we can now present the second corollary of Propositions 1 and 2.

Corollary 2. *Under synchronous contracts, per-period price is invariant with respect to contract length. Under staggered contracts, per-period price (other than the very first contract) is increasing in contract length.*

Note that there may be many good reasons whey market competitiveness decreases as contract length increases (including, for example, a combination of uncertainty and sunk entry costs). The point of Corollary 2 is that, under staggered contracts, contract length becomes an additional source of monopoly power even in the absence of uncertainty and sunk costs.

At this point, it should mentioned that we are implicitly making the assumption that buyers cannot transfer contracts post sale. If resale is possible, then, starting from a subgame where each seller owns one contract, we would expect sellers to bargain over contract transfers. If bargaining is efficient, then we would expect sellers to come to an agreement such that the seller holding the new contract would also secure the old one. Assuming that sellers split the gain from the agreement as in the Nash bargaining solution, this would increase payoffs for both sellers. In fact, an entrant now looks forward to a higher payoff in case it acquires a new contract: not only does it get the new contract but then it also obtains the other one from the incumbent. In other words, we would expect the existence of a secondary market to reduce the degree of monopoly power by the incumbent seller.

■ **Network effects.** The model presented so far, and in particular Assumption 1, assume economies of scale in selling the good in question: the per unit cost of serving two customers, c_2, is lower than the per unit cost of serving one customer only, c_1. However, we could re-write the model as one of network effects, whereby the buyer's value, u_i, depends on the number of buyers who purchase from the same seller. Assumption 1 would then correspond to $u_2 > u_1$.

As a motivating example for the network effects interpretation of the model, consider the case *Amigo Gift Association v. Executive Properties, Ltd.* Amigo is a trade organization comprising 104 members who sell giftware and decorative accessories to retail dealers. In the 1980s (when the case takes place), they were located in Executive Park, a commercial and industrial park in Kansas City, Missouri. The lease contracts between plaintiff and defendant were exclusive in nature ("Amigo will not permit its members to participate or form in the future any competitive giftware marts within a radius of 75 miles of the current location for a period of ten years");[9] and had a duration that varied from 3 to 10 years.

Amigo alleged that the effect of variable expiration dates of the individual leases made it difficult for them to leave their current location at Executive Park, thus increasing the seller's market power and in violation of Sections 1 and 2 of the Sherman Act. Accordingly, they requested an injunction that would include reforming the lease terms to one-year. Corollary 1 provides support for Amigo's claim of increased market power, as well as the remedy sought (synchronized, short-term contracts). The plaintiffs' request for preliminary injunctive relief was denied, however.

■ **Inefficient exclusion.** Consider the staggered-contracts model introduced above. Suppose that one of the sellers, say firm b, is more efficient than the other. Specifically, suppose that firm a must pay an additional cost d per period each time it is active (regardless of whether it sells one unit or two units). Suppose moreover that only firm a is present at $t = 0$, whereas firm b enters at $t = 1$.

In this context, a tantalizing possibility raised by Proposition 2 is that there exists an equilibrium where the high-cost firm remains an incumbent at all times. Specifically, Proposition 2 suggests that, under staggered contracts, incumbency creates a seller advantage. Can this advantage be so great that it outweighs firm a's cost disadvantage? The next result provides conditions for this to be the case. (We continue to work with Markov Perfect Equilibria, subgame-perfect Nash equilibra such that prices depend only on the identity of the incumbent, and where $t = 0$ is treated as a separate state.)

Proposition 3. *If $d < 2\,(2\,\delta - 1)\,(c_1 - c_2)$, then there exists an equilibrium where firm a makes all sales.*

9. *Amigo Gift Association v. Executive Properties, Ltd.*, 588 F. Supp. 654, 656 (W.D. Mo. 1984).

Proof of Proposition 3: Suppose that firm b is currently the entrant. Firm b's expected payoff in case firm b makes the sale (an off-the-equilibrium event) is given by

$$p_e^b - c_1 + \delta\, v_i^b \tag{10}$$

where p_e^b is the price set by firm b and v_i^b is firm b's value when it is an incumbent.

If instead the incumbent (firm a) makes the sale, then firm b's (the entrant) expected payoff is simply given by

$$\delta\, v_e^b \tag{11}$$

Given the equilibrium hypothesis that firm a makes all of the sales, we have

$$\begin{aligned} v_i^b &= p_e^b - c_1 \\ v_e^b &= 0 \end{aligned} \tag{12}$$

Substituting (12) for v_i^b in (10), equating (10) to (11) and solving for p_e^b, we obtain firm b's minimum price when it is an entrant:

$$p_e^{b\circ} = c_1$$

Consistently with the equilibrium hypothesis that firm a makes all sales, firm b sets its price at the minimum level consistent with its no-deviation constraint:

$$p_e^b = c_1 \tag{13}$$

Note that this implies that

$$v_i^b = 0$$

Even though we assume that, along the equilibrium path, firm a always makes a sale, we need to consider the off-the-equilibrium possibility of firm b being an incumbent. If that is the case, then firm b's discounted value in case firm b makes the current sale is given by

$$\widetilde{p} + p_i^b - 2\, c_2 + \delta\, v_i^b \tag{14}$$

where $\widetilde{p}$ is the per period price of the continuing contract (a contract to which buyer and seller are locked in). If the entrant (firm a) makes the sale then firm b's value is

$$\widetilde{p} - c_1 + \delta\, v_e^b \tag{15}$$

Substituting 0 for v_i^b in (14), 0 for v_e^b in (15), and solving the equality of the two expressions with respect to p_i^b, we obtain firm b's minimum price when it is an incumbent:

$$p_i^{b\circ} = 2\, c_2 - c_1$$

Consistently with the equilibrium hypothesis that firm a makes all sales, firm b sets its price at the minimum level consistent with its no-deviation constraint:

$$p_i^b = 2\, c_2 - c_1 \tag{16}$$

In equilibrium, firm a (the incumbent) matches firm b's price when firm b is an entrant, that is, p_e^b, which is given by (13), and makes a sale. This implies

$$v_i^a = \frac{2\,(c_1 - c_2) - d}{1 - \delta} \tag{17}$$

If firm a ever happens to be an entrant, it matches firm b's price when firm b is an incumbent, that is, p_i^b, which is given by (16), and makes a sale. This implies

$$v_e^a = (2\,c_2 - c_1) - c_1 - d + \delta\, v_i^a$$

Substituting (17) for v_i^a, we get

$$v_e^a = \frac{2\,(2\,\delta - 1)\,(c_1 - c_2) - d}{1 - \delta} \tag{18}$$

Note that $v_e^a > 0$ if and only if

$$d < 2\,(2\,\delta - 1)\,(c_1 - c_2)$$

which is true by assumption.

Ir order to show that the proposed equilibrium is indeed an equilibrium, we must show that firm a would not want to set a lower price, thus leaving the sale to firm b. Suppose that firm a is the entrant and prices above firm b, thus losing the sale to firm b. It follows that firm a's expected payoff is

$$\delta\, v_e^a$$

But since $v_e^a > 0$, this is strictly lower than v_e^a. When firm a is the incumbent, letting firm b make a sale would imply a payoff of

$$p_i^a - c_1 - d + \delta\, v_e^a = -d + \delta\, v_i^a < v_i^a$$

where the equality follows from $p_i^a = p_e^{b\circ}$ and (13). ■

In other words, Proposition 3 states that if firm a is not too inefficient with respect to firm b, then it is able to exclude the more efficient entrant.[10] A necessary condition for Proposition 3 is that $\delta > \frac{1}{2}$, in other words, that contract length not be too long. The reason is that the less efficient firm must credibly "threaten" to make a sale if it finds itself in the position of being an entrant. Given firm b's price as an incumbent, making a sale as an entrant implies that firm a set a price below cost. If the value of δ is too small (specifically, less than 1/2), then firm a prefers not to make a sale. Intuitively, if different values of δ reflect different period lengths, a low δ implies a long period of pricing below cost, making is less attractive for firm a to enter (or re-enter). This in turn breaks down the credibility of the equilibrium that excludes firm b.

Proposition 3 provides a different story than Corollary 2 regarding the role played by contract length. Under a symmetric equilibrium, an increase in contract length increases equilibrium price under staggered contracts. Intuitively, longer contract length increases the asymmetry between incumbent and entrant. In fact, as we showed earlier, in the limit when $\delta \to 1$ there is no difference between synchronous and staggered contracts. According to Proposition 3, one effect of increasing δ is to allow for the inefficient exclusion equilibrium to exist. In that sense, increasing contract length may lead to higher social welfare by virtue of eliminating a bad equilibrium (that is, an equilibrium where an inefficient firm excludes an efficient one).

10. In a different setting, Calzolari and Denicolò (2015) show that, if the more efficient firm's advantage is small, then exclusive contracts are pro-competitive; whereas if the cost advantage is large then they are anti-competitive.

The *ErinMedia* case provides a possible illustration of Proposition 3. In its case against Nielsen, ErinMedia asserted that Nielsen's ratings are based on a small sample and outdated collection methodologies; and that, by contrast, ErinMedia's "data collection process allows it to directly access and collect data of potentially millions of television viewers." Moreover, "ErinMedia has developed advanced database technologies that allow it to analyze second-by-second television viewing statistics."[11] Although Proposition 3 is cast in term of entrant's cost advantage, we could easily adapt the model to consider the case of entrant's quality advantage. Proposition 3 thus provides an equilibrium story for the alleged exclusion of a superior competitor, ErinMedia, by means of incumbent's anticompetitive strategy; that is, it provides an answer to Nielsen's claim that ErinMedia could not prove how staggered contracts would exclude competition if ErinMedia is really a more efficient supplier.

In March 2008, ErinMedia and Nielsen settled out of court, so we will never know whether the Court would buy into ErinMedia's claim. While the details of the agreement remain confidential, "it appears clear that [ErinMedia] did not receive the kind of 'injunctive relief' that would have forced Nielsen to alter its business agreements with the major television networks, making it easier for other competitors to enter the marketplace."[12]

3. Differentiated product

In the previous section, we considered the case when there is complete information regarding payoffs. When this is the case and contracts are staggered, prices are set as under Bertrand competition with asymmetric costs. In the asymmetric-cost Bertrand model, the lower-cost seller sets a price equal to the cost of the high-cost seller. This implies that the high-cost seller's equilibrium profit is zero. It also suggests a puzzle: if the high-cost seller's payoff is zero, then why does it bother to be present in the market at all? The most common answer to this paradox is to consider the possibility of seller heterogeneity, in which case both sellers receive strictly positive expected payoffs.

In this section, we follow the same solution as in standard oligopoly models: we add some degree of agent heterogeneity so as to obtain strictly positive expected payoffs for all players and equilibrium outcomes that are continuous with respect to exogenous parameters (for example, a probability of entry that varies continuously with respect to costs and profits).

In the previous section, we assumed that each buyer has a valuation u for one unit of the product. In this section we assume that, in each period, each buyer has a valuation ζ_j for one unit of the product sold by firm j; zero for any additional unit during that period; and an outside option that is worth $-\infty$. we assume that the values of ζ_j are independently drawn from a commonly-known distribution function (the same cdf for both firms and for all consumers).

We will focus on anonymous equilibria, that is, equilibria that do not depend on the seller's identity (only on its state). For this reason, a sufficient statistic of the buyer's preference is the relative preference for one of the sellers (e.g., the incumbent seller), which we denote by ξ. For example, if ξ is the relative preference for seller i vis a vis seller e, then

11. *ErinMedia, LLC v. Nielsen Media Research, Inc.*, No. 8:05-CV-1123-T-24-EAJ., 401 F.Supp.2d 1262 (2005).
12. See http://www.mediapost.com/publications/article/79551/erinmedia-settles-antitrust-suit-with-nielsen-ter. html, accessed on June 2014.

the buyer purchases from seller i if and only if $\xi - p_i > -p_e$.

We assume that ξ is distributed according to cdf $\Phi(\xi)$ which has the following properties:

Assumption 2. *(i) $\Phi(\xi)$ is twice continuously differentiable; (ii) $\phi(\xi) = \phi(-\xi)$; (iii) $\phi(\xi) > 0$, $\forall \xi$; (iv) $\Phi(\xi)/\phi(\xi)$ is strictly increasing.*

Part (i) is included for technical simplicity; part (ii) follows from the assumption of symmetry between sellers; part (iii) implies that the likelihood that a given seller makes a sale is always strictly positive, though possibly very small. Finally, part (iv) corresponds to a standard assumption in auction theory and other fields (monotone hazard rate). It is satisfied by most symmetric distribution functions (including the normal, uniform and t distributions).

As in the previous section, we consider separately the synchronous- and the staggered-contracts case

■ **Staggered contracts.** Consider an industry with two sellers and an infinite sequence of short-lived buyers. In each period, beginning at $t = 0$, sellers simultaneously offer two-period contracts to the buyer who is born during that period and lives for two periods.

We define by v_i (reap. v_e) the discounted value for a seller who has (resp. does not have) a contract at the time it bids for the newly available contract. v_e thus measures the expected value of an entrant. The question at hand is how this value is determined in an industry with staggered contracts. The next result answers this question. We will then answer the corresponding question for an industry with synchronous contracts and compare the values of v_e.

Lemma 1. *In an industry with staggered contracts, the value of an entrant seller is given by*

$$v_e = \frac{1}{1-\delta} \, \frac{\Phi(P)^2}{\phi(P)}$$

where P is the (unique) solution of

$$P + \frac{2\,\Phi(P) - 1}{\phi(P)} = -2\,(c_1 - c_2)$$

Proof of Lemma 1: For simplicity, we assume that the price for the entire contract is received at the beginning of the first period (of the two periods that the contract lasts for). Moreover, differently from the previous sections we let p_i and p_e denote the discounted price for the entire duration of a contract. (In other words, price per period is given by p_i and p_e divided by $1 + \delta$.)

Let q be the probability that the incumbent seller is chosen by the buyer. It follows from part (ii) of Assumption 2 that the probability that i is selected by the buyer is given by

$$q = \mathcal{P}(\xi - p_i > -p_e) = 1 - \Phi(p_i - p_e) = \Phi(p_e - p_i) \tag{19}$$

The value of an incumbent and of an entrant are given by

$$\begin{aligned} v_i &= q\left(p_i - 2\,c_2 + \delta\,v_i\right) + (1-q)\left(-\,c_1 + \delta\,v_e\right) \\ v_e &= (1-q)\left(p_e - c_1 + \delta\,v_i\right) + q\,\delta\,v_e \end{aligned} \tag{20}$$

Define

$$P \equiv p_i - p_e$$

From (19), $q = 1 - \Phi(P)$. It follows that $\partial q / \partial p_i = -\phi(P)$, whereas $\partial q / \partial p_e = \phi(P)$. The first-order conditions for an incumbent and for an entrant's value maximization are given by

$$\begin{aligned} 1 - \Phi(P) - \phi(P)\Big(p_i - 2\,c_2 + \delta\, v_i - (-c_1 + \delta\, v_e)\Big) &= 0 \\ \Phi(P) - \phi(P)\Big(p_e - c_1 + \delta\, v_i - \delta\, v_e\Big) &= 0 \end{aligned}$$

or simply

$$\begin{aligned} p_i &= \frac{1 - \Phi(P)}{\phi(P)} + (2\,c_2 - c_1) - \delta\,(v_i - v_e) \\ p_e &= \frac{\Phi(P)}{\phi(P)} + c_1 - \delta\,(v_i - v_e) \end{aligned} \tag{21}$$

Subtracting these two first-order conditions and simplifying, we get

$$P + \frac{2\,\Phi(P) - 1}{\phi(P)} = -2\,(c_1 - c_2) \tag{22}$$

Assumption 2 implies that the left-hand side of (22) is strictly increasing in P ranging from $-\infty$ to $+\infty$ as P varies from $-\infty$ to $+\infty$. Moreover, the left-hand side of (22) is zero when P is zero. It follows that there exists a unique value of P satisfying (22). Moreover, since $P > 0$ if and only if the right-hand side of (22) is positive, Assumption 1 implies that $P < 0$.

Substituting the first-order condition (21) into the value functions (20) and simplifying, we get

$$\begin{aligned} v_i &= \frac{\big(1 - \Phi(P)\big)^2}{\phi(P)} + \delta\, v_e \\ v_e &= \frac{\Phi(P)^2}{\phi(P)} + \delta\, v_e \end{aligned} \tag{23}$$

or simply

$$v_e = \frac{1}{1 - \delta}\,\frac{\Phi(P)^2}{\phi(P)} \tag{24}$$

where P is given by (22). ■

■ **Synchronous contracts.** Consider an industry with two sellers and an infinite sequence of short-lived pairs of buyers. In every even period, beginning at $t = 0$, sellers simultaneously offer two-period contracts to two buyers, who live for two periods.

At this point, we are faced with a modeling problem: how exactly do synchronous contracts work when there is incomplete information? Under complete information, we assumed that buyers simultaneously choose a seller; and we showed that the winning bidder secures both contracts. In fact, this is the only Nash equilibrium (modulo a change in seller identity). With incomplete information, if both contracts are auctioned simultaneously, then there is a positive probability (50%, to be more precise) that each seller gets one contract, an outcome that is likely to be inefficient (especially if c_2 is significantly lower than c_1).

In a real-world situation, we would expect the selling protocol to account for the possibility of fixing these coordination mistakes. We model this by assuming that, under the synchronous contracts regime, contracts are auctioned sequentially (though at the same calendar date). The value of an entrant is then the (symmetric) value of the two-stage game played between buyers.

From the previous section, we conclude that the value of a firm is zero under synchronous contracts. As one might expect, incomplete information implies a positive rent in the equilibrium of a pricing game, which in turn implies a positive v. The next result formalizes this idea.

Lemma 2. *In an industry with synchronous contracts, equilibrium firm value is given by*

$$v = \frac{1}{1-\delta}\,\frac{1}{2}\left(\frac{\Phi(0)^2}{\phi(0)} + \frac{\Phi(P)^2}{\phi(P)}\right)$$

where P is the (unique) solution of

$$P + \frac{2\,\Phi(P) - 1}{\phi(P)} = -2\,(1+\delta)\,(c_1 - c_2)$$

Proof of Lemma 2: Suppose that firm i has made the first sale. Seller continuation values before the second auction takes place are given by

$$\begin{aligned} v_i &= q\left(p_i - 2\,(1+\delta)\,c_2\right) + (1-q)\left(-\,(1+\delta)\,c_1\right) + \delta^2\,v^\circ \\ v_e &= (1-q)\left(p_e - (1+\delta)\,c_1\right) + \delta^2\,v \end{aligned}$$

where v° is the value before the first sale is made in a given even period. The first-order conditions for an incumbent and for an entrant are given by

$$\begin{aligned} 1 - \Phi(P) - \phi(P)\left(p_i - 2\,(1+\delta)\,c_2 + (1+\delta)\,c_1\right) &= 0 \\ \Phi(P) - \phi(P)\left(p_e - (1+\delta)\,c_1\right) &= 0 \end{aligned}$$

or simply

$$\begin{aligned} p_i &= \frac{1-\Phi(P)}{\phi(P)} + (1+\delta)\,(2\,c_2 - c_1) \\ p_e &= \frac{\Phi(P)}{\phi(P)} + (1+\delta)\,c_1 \end{aligned} \tag{25}$$

Subtracting these two first-order conditions, we get

$$P + \frac{2\,\Phi(P) - 1}{\phi(P)} = -2\,(1+\delta)\,(c_1 - c_2) \tag{26}$$

which determines the value of P uniquely. Substituting (25) back into the value functions, we get

$$v_i = \frac{1-\Phi(P)^2}{\phi(P)} + \delta^2\, v^\circ$$
$$v_e = \frac{\Phi(P)^2}{\phi(P)} + \delta^2\, v^\circ$$

Consider now the first auction in the sequence. Firm A's value functions is given by

$$v = \Big(1-\Phi(P^\circ)\Big)\left(p_A^\circ + \frac{\big(1-\Phi(P)\big)^2}{\phi(P)}\right) + \Phi(P^\circ)\,\frac{\Phi(P)^2}{\phi(P)} + \delta^2\, v^\circ$$

where p_A° is firm A's price and $P^\circ \equiv p_A^\circ - p_B^\circ$ is the price difference between firm A and firm B at the beginning of the period (when there is no differentiation between incumbent and entrant). Firm A's first-order condition for profit maximization is given by

$$1-\Phi(P^\circ) - \phi(P^\circ)\left(p_A^\circ + \frac{\big(1-\Phi(P)\big)^2}{\phi(P)} - \frac{\Phi(P)^2}{\phi(P)}\right) = 0$$

Since the equilibrium is symmetric, $P^\circ = 0$ and $p_A^\circ = p_B^\circ = p^\circ$, and hence

$$p^\circ = \frac{1-\Phi(0)}{\phi(0)} + \frac{\Phi(P)^2}{\phi(P)} - \frac{\big(1-\Phi(P)\big)^2}{\phi(P)} \tag{27}$$
$$= \frac{1-\Phi(0)}{\phi(0)} - \frac{1-2\,\Phi(P)}{\phi(P)} \tag{28}$$

Plugging (27) back into the value function, we get

$$v^\circ = \frac{1}{1-\delta^2}\left(\frac{\Phi(0)^2}{\phi(0)} + \frac{\Phi(P)^2}{\phi(P)}\right)$$

Consider now a potential entrant that arrives at a random time t. If t is even, then such entrant will receive v. If t is odd, then the entrant gets δ times v. In expected terms, the entrant gets

$$v = \frac{1}{2}\, v^\circ + \frac{1}{2}\,\delta\, v^\circ = \frac{1}{1-\delta}\,\frac{1}{2}\left(\frac{\Phi(0)^2}{\phi(0)} + \frac{\Phi(P)^2}{\phi(P)}\right) \tag{29}$$

where P is given by (26). ■

■ **Staggered contracts and firm value.** We now compare the value of an entrant in the equilibrium of an industry with staggered contracts to that of an industry with synchronous contracts.

Proposition 4. *If $c_1 - c_2$ is sufficiently large, then an entrant's expected value is lower under staggered contracts than under synchronous contracts.*

Proof of Proposition 4: Let G stand for staggered contracts and Y for synchronous contracts. From (22) and (26), we see that

$$P^g + \frac{2\,\Phi(P^g) - 1}{\phi(P^g)} = -(1+\delta)\,(c_1 - c_2)$$
$$P^y + \frac{2\,\Phi(P^y) - 1}{\phi(P^y)} = -2\,(1+\delta)\,(c_1 - c_2)$$

Assumption 2 implies that $0 > P^g > P^y$. Moreover, from (24) and (29), we see that

$$v_e^g = \frac{1}{1-\delta}\,\frac{\Phi(P^g)^2}{\phi(P^g)}$$
$$v_e^y = \frac{1}{1-\delta}\,\frac{1}{2}\left(\frac{\Phi(0)^2}{\phi(0)} + \frac{\Phi(P^y)^2}{\phi(P^y)}\right)$$

As $c_1 - c_2 \to \infty$, both P^y and $P^g \to -\infty$, which in turn implies that $v_e^g \to 0$ whereas $v_e^y \to \frac{1}{8\,(1-\delta)\,\phi(0)} > 0$. ■

The intuition for this result is akin to the idea of persistence of monopoly in dynamic games. Gilbert and Newbery (1982) consider a model where an incumbent monopolist and a potential entrant bid for a patent that provides the entrant the means to compete against the monopolist. If duopoly profits are less than one half of monopoly profits, then in equilibrium the incumbent overbids the entrant, whereby the monopoly market structure persists. The idea is that what the monopolist has to lose from letting the entrant come in, $\pi_m - \pi_d$, is more than what the entrant has to gain from entering the market, π_d. In terms of the present model's notation, this corresponds to the assumption $c_2 < c_1$. In other words, the fact that there are increasing returns to scale makes an incumbent more aggressive, which in turn makes entry more difficult. Under synchronous contracts, there is an element of "incumbent" pressure: the buyer who is able to secure the first contract becomes more aggressive in bidding for the second one. However, at the time of bidding for the first contract, both buyers are equally placed. As a result, the discounted payoff for a newcomer is greater than under staggered contracts (where a newcomer is always at a disadvantage with respect to an incumbent).

The above discussion also illustrates an important difference between the present model of staggered contracts and the Rasmusen et al. (1991) model of naked exclusion with sequential contracts. In fact, the present version of synchronous contracts also features a sequential bidding process. Even so, staggered contracts imply an additional decrease in entrant's payoff, thus an additional barrier to entry.

The possibility that staggered contract raise an entry barrier has been present in several antitrust cases. For example, in *U.S. v. Pullman Co* the Court noted that staggered expiration dates increased Pullman's bargaining power in negotiating with individual railroads. The defendant argued that, to the extent that any railroad is free to hire a competitor, there was no issue of market power. However, the Court noted that "there have been no others in the field since Pullman bought out Wagner more than forty years ago." Although the Court did not explicitly correlate staggered contracts to entry barriers, the argument seems consistent with Proposition 4.

A more recent case is *Menasha Corp. v. News America MarketingIn-Store, Inc.*, two sellers of at-shelf coupon dispensers sold to manufacturers for use in supermarket promotions. Unlike Menasha, News America offered exclusive, long-term, staggered contracts. Menasha argued that the contracts' staggered expiration dates prevented Menasha from "organiz[ing] a network of retailers [to obtain] critical mass."[13] This is consistent with Proposition 4, especially in light of Assumption 1 (economies of scale or network effects). However, Judge Easterbrook, who presided over the case, rejected Menasha's claim.

4. Endogenous contract structure

In the previous sections, we compared two possible situations: one where contracts are synchronized in time and one where they are staggered in time. This suggests an additional research question: which contract form would one expect to emerge in equilibrium: synchronized or staggered contracts?

In order to answer this question, we need a model where contract duration is chosen by firms. In fact, starting from a symmetric state (e.g., the beginning of the world, $t = 0$), it is only through the choice of contracts with different durations that a staggered pattern can emerge. Accordingly, in the section we amend the model presented in Section 2 as follows. In addition to two infinitely-lived sellers, we assume there are two infinitely-lived buyers (who need one unit per period and are willing to pay u for that unit). The timing of each period is now as follows: first firms simultaneously offer contracts p_{ijt}, where i is the firm's identity, j the buyer's identity, and t contract length. Then buyers simultaneously choose one of the four contract offerings each receives. For simplicity, we assume only two possible contract durations, one and two periods ($t = 1, 2$). This is the simplest set of primitives that allows for either equilibrium contract structure (synchronous contracts, staggered contracts) to endogenously emerge in equilibrium.

We continue to work with Markov Perfect equilibria, where there are essentially two possible states: (a) all past contracts have expired (symmetric state); (b) one of the contracts still has one period to go (asymmetric state). Note that there are actually several possible states (b), depending on the identity of buyer and seller. However, for the purpose of equilibrium analysis, we will treat these as the same; in other words, we will consider anonymous equilibria, where the particular identity of each seller is not taken into consideration. Moreover, there is a state where both buyers' contracts still have one period to go. However, to the extent that there are no pricing decisions at that state, we will ignore it from consideration when deriving equilibrium strategies.

The question at hand is whether equilibrium play results in contracts being staggered or synchronized in calendar time.

Proposition 5. *There exists no Markov perfect equilibrium such that, along the equilibrium path, two contracts end in the same period.*

Proof of Proposition 5: In a given period of a Markov equilibrium, there are three possibilities: (a) both contracts expired in the previous period, and thus both buyers make their choices in the current period; (b) one of the contracts is still pending, in which case only one of the buyers makes a choice in the current period; (c) both contracts are still pending, in which case no decision is made in the current period.

13. *Menasha Corp. v. News America Marketing In-Store, Inc.*, 354 F.3d 661 (7th Cir. 2004).

Let Y be a period corresponding to situation (a), that is, synchronous contract expiration; and let G be a period corresponding to situation (b), that is, staggered contract expiration. If at time t we have G and at time $t+1$ we have Y, then we say there is a transition $G \to Y$. Considering the possible contract choices made by buyers at G and Y, there are four possible Markov equilibrium configurations in terms of state transitions:

- $(G \to Y, Y \to Y)$
- $(G \to G, Y \to Y)$
- $(G \to Y, Y \to G)$
- $(G \to G, Y \to G)$

(Note that the transition $Y \to Y$ may take place in the form of two one-period contracts or two two-period contracts.) We will argue that in all cases but $(G \to G, Y \to G)$ there exists a profitable deviation from a putative Markov Perfect equilibrium. This in turn implies that in a Markov equilibrium G must be an absorbing state.

Consider first the $(G \to Y, Y \to Y)$ case. Once at state Y (an absorbing state), seller value is zero: both sellers set $p_{ik1} = p_{ik2} = c_2$ and one of the sellers gets both contracts (either both one-period or both two-period contracts). If this were not the case, for example $p_{ik1} \neq c_2$, then there would be a profitable deviation of a one-period contract with a different price (a lower price if there exists a $p_{ik1} > c_2$, a higher price if there exists a $p_{ik1} < c_2$). (The reasoning is analogous to that of the proof of Proposition 1.)

The transition $G \to Y$ implies that, at state G, the (single) buyer accepts a one-period contract. Let $\widehat{p}$ be the equilibrium value of this one-period contract price. An equilibrium constraint is that the incumbent seller and the current buyer cannot profitably deviate to a two-period contract. Along the equilibrium path, the buyer expects to pay $\widehat{p}$ in the current period and c_2 in future periods. (Note this is true regardless of whether the $Y \to Y$ transition takes place through one-period or two-period contracts.) Suppose the seller offers a two-period contract with per-period price p' that leaves the buyer indifferent with respect to a one-period contract. This implies that the two-period contract is equivalent to paying $\widehat{p}$ in the first period and c_2 in the second period. If the incumbent seller were to offer such two-period contract, then it would make a profit of $\widehat{p} - c_2$ in the first period and $\widehat{p} - c_2$ in the next period. In fact, as per the putative Markov equilibrium, in the next period the incumbent seller offers a one-period contract to the then single active buyer for a price $\widehat{p}$. If instead the seller were to sell the one-period contract then profit would be given by $\widehat{p} - c_2$ only.

Finally, if this were to be a Markov equilibrium, then $\widehat{p}$ must be strictly greater than c_2. Equilibrium perfection implies that the rival's price for a one-period contract be (weakly) greater than c_1. Therefore, if $\widehat{p} \leq c_2$ then the incumbent seller is better off by increasing price. If follows that there exists a profitable deviation from a $(G \to Y, Y \to Y)$ equilibrium.

A similar line of argument implies that, in the $(G \to Y, Y \to G)$ case, when at G the incumbent seller has an incentive to deviate and offer a two-period contract, which contradicts the $G - Y$ equilibrium state transition hypothesis.

Consider now the $(G \to G, Y \to Y)$ transition case. Suppose first that, in state Y, both buyers purchase a one-period contract. It must be that $p_{ik1} = c_2$ (for both sellers i and both buyers k) and that both buyers purchase from the same seller; otherwise, there would be a profitable deviation of a one-period contract with a different price (a lower price if there exists a $p_{ik1} > c_2$, a higher price if there exists a $p_{ik1} < c_2$). (The reasoning is analogous to that of the proof of Proposition 1.)

Moreover, it must be that there is no profitable deviation to a two-period contract. Let seller i be the seller making a sale (of two one-period contracts). For this seller, an accepted two-period contract offer to buyer k would be profitable if and only if

$$(1+\delta)\,(p_{ik2}-c_2)+\delta^2\,v_1>0 \tag{30}$$

where v_1 is the incumbency value derived in (8), that is,

$$v_1=\frac{2\,(c_1-c_2)}{1+\delta} \tag{31}$$

In equilibrium, the buyer is paying c_2 per period, or a discounted value of $c_2/(1-\delta)$. By accepting a two-period contract offer, buyer k would be better off if and only if

$$(1+\delta)\,p_{ik2}+\delta^2\,\frac{p^g}{1-\delta}<\frac{c_2}{1-\delta} \tag{32}$$

where p^g is given by Proposition 2, that is,

$$p^g=c_2+\frac{1-\delta}{1+\delta}\,(c_1-c_2) \tag{33}$$

The system of equations (30)–(33) is equivalent to $\underline{p} < p_{ik2} < \overline{p}$, where

$$\begin{aligned}\underline{p} &\equiv c_2-\frac{2\,\delta^2}{1+\delta^2}\,(c_1-c_2)\\ \overline{p} &\equiv \frac{1}{1-\delta^2}\left(c_2-\frac{\delta^2}{1+\delta}\,\big((1-\delta)\,c_1+2\,\delta\,c_2\big)\right)\end{aligned}$$

Moreover, computation establishes that

$$\overline{p}-\underline{p}=\frac{\delta^2}{1+2\,\delta+\delta^2}\,(c_1-c_2)>0$$

It follows that there exists a value of p_{ik2} such that a buyer would accept and a seller would be better off.

Suppose instead that, in state Y, both buyers purchase a two-period contract. It must be that $p_{ik2}=c_2$ and that both buyers purchase from the same seller. Moreover, there cannot be any profitable deviation to a one-period contract. Let seller i be the seller making a sale (of two two-period contracts). For this seller, an accepted one-period contract offer to buyer k would be profitable if and only if

$$p_{ik1}-c_2+\delta\,v_1>0 \tag{34}$$

where v_1 is the incumbency value given by (31). In equilibrium, the buyer is paying c_2 per period, or a discounted value of $c_2/(1-\delta)$. By accepting a one-period contract offer, buyer k would be better off if and only if

$$p_{ik1}+\delta\,\frac{p^g}{1-\delta}<\frac{c_2}{1-\delta} \tag{35}$$

where p^g is given (33). The system of equations (34), (35), (31) and (33) is equivalent to $\underline{p} < p_{ij1} < \overline{p}$, where

$$\underline{p} \equiv c_2 - \frac{2\,\delta}{1+\delta}\,(c_1 - c_2)$$
$$\overline{p} \equiv \frac{1}{1+\delta}\big(c_2 - \delta\,(c_1 - 2\,c_2)\big)$$

Moreover, computation establishes that

$$\overline{p} - \underline{p} = \frac{\delta}{1+\delta}\,(c_1 - c_2) > 0$$

It follows that there exists a value of p_{ik1} such that a buyer would accept and a seller would be better off. This establishes that there can be no equilibrium such that $(G \to G, Y \to Y)$.

Finally, if follows that the only candidate for an equilibrium configuration is $(G \to G, Y \to G)$; but in this case no two contracts ever end in the same period. ■

Proposition 5 states that, if there exists a Markov equilibrium, then along the equilibrium path no two contracts end in the same period.[14] By symmetry, at $t = 0$ both buyers purchase a contract simultaneously. Therefore, it must be that one buyer purchases a one-period contract and the other a two-period contract. Beginning at $t = 1$, the active buyer in each period purchases a two-period contract.

Based on the analysis in Section 2, we can actually construct such an equilibrium. The price of a two-period contract at G and the value of an incumbent seller are given as in the staggered-contract equilibrium considered in Section 2, whereas the price of a one-period contract ensures there is no profitable deviation by the rival seller:

$$v_1^g = \frac{2\,(c_1 - c_2)}{1+\delta}$$
$$p_2^g = c_2 + \frac{1-\delta}{1+\delta}\,(c_1 - c_2)$$
$$p_1^g = c_1$$

Specifically, in equilibrium and in state G the incumbent seller offers contracts with the above prices, whereas the rival seller offers both one- and two-period contracts with a per-period contract price set at c_1.

In state Y, one of the buyers is designated a one-period contract buyer, one a two-period contract buyer. One of the sellers sells both contracts. Prices are set so that discounted profits are zero:

$$p_1 + p_2 - 2\,c_2 + \delta\,v_1 = 0 \tag{36}$$

The non-selling seller has no incentive to sell the same contracts to the same buyers: doing so would require setting lower prices and receiving a negative discounted value. The non-selling seller also has no incentive to sell a one-period contract to the one-period contract

14. Notice that Proposition 5 is a statement about the nature of contracts along the equilibrium path. Naturally, there are subgames where the two buyers' contracts end in the same period (or are sold in the same period). However, along the equilibrium path (that is, for the contracts that are actually observed), the termination date is always different. Moreover, the only time we observe two contracts starting at the same is in the very first period.

buyer so long as $p_1 \leq c_1$. The non-selling seller has no incentive to sell a two-period contract to the two-period contract buyer so long as $p_1 \geq c_2$. In fact (36) would then imply a negative discounted value.

Proposition 5 shows that contracts cannot be synchronous when chosen endogenously: one of the sellers always has an incentive to deviate and stagger contracts. The reason why such deviation pays off is that there is an externality at play: effectively, the seller "colludes" with the one period buyer and divides the surplus extracted from the two period buyer. Analogously, if equilibrium calls for firms to offer one period contracts in a synchronized pattern, then the seller would "collude" with the two period buyer and divide the surplus extracted from the one period buyer.

In this sense, the staggered contracts outcome shares some of the features of Aghion and Bolton (1987); Rasmusen et al. (1991); and Segal and Whinston (2000). The difference with respect to Aghion and Bolton (1987) is that, in their paper, seller and buyer "collude" to extract surplus form another seller, not from another buyer. The difference with respect to Rasmusen et al. (1991), and Segal and Whinston (2000), is that we explicitly consider calendar time and contract duration as the mechanism for implementing a "divide-and-conquer" strategy with respect to buyers.[15]

5. Conclusion

We have shown that exclusive, long, staggered contracts create a barrier to entry over and above other possible barriers to entry. As a result, buyers pay a higher price under staggered contracts. Moreover, such price is increasing in contract length.

In order to stress the point that the barrier we identify is over and above other barriers previously identified, we considered an ideal world with no information asymmetries across sellers and where there exists a potential entrant who is always present, always bids simultaneously for new contracts against a rival buyer, and has infinite financing abilities. In this context, long-term contracts or staggered contracts do not constitute a barrier to entry per se. However, the *combination* of long-term contracts and staggered contracts does create a barrier to entry.

15. Proposition 5 also bears some resemblance to the efficiency effect characterized by Gilbert and Newbery (1982), Bernheim and Whinston (1998) in a static context; and by Budd et al. (1993), Cabral and Riordan (1994) in a dynamic context. Broadly speaking, the idea is that, under dynamic competition, motion along the state space tends to be in the direction that maximizes joint firm value. In the present context, joint seller payoff is maximized under staggered contracts.

Appendix

■ **Syncrhonous contracts with sequential sales.** Alternatively, we could consider an extensive form with sequential sales: Nature determines an ordering of buyers. Then both sellers simultaneously set prices to be paid by the first buyers. After the first buyer chooses one of the sellers, the sellers simultaneous set prices for the second buyers, who then picks one of the sellers.

Considered the subgame that begins with setting prices for the second buyers. Denote by incumbent (index i) the sellers who made the first sale and entrant (index e) the one who did not. If the incumbent seller makes the second sale, then its payoff is given by

$$\widetilde{p} + p_i - 2\,c_2$$

where $\widetilde{p}$ is the period price of the contract with the first buyer (a contract to which buyer and seller are locked in). If the entrant makes the second sale then the incumbent's payoff is

$$\widetilde{p} - c_1$$

Similarly, the entrant's payoff in case the entrant makes the second sale is given by

$$p_e - c_1 \tag{37}$$

whereas the entrant's payoff if the incumbent makes the second sale is zero. By equating payoff from making a sale and payoff from not making a sale, we obtain the sellers' minimum prices. They are given by

$$\begin{aligned} p_i^\circ &= 2\,c_2 - c_1 \\ p_e^\circ &= c_1 \end{aligned}$$

Assumption 1 implies that $p_i^\circ < p_e^\circ$. It follows that the seller who makes the first sale also makes the second sale, specifically, sets a price c_1 for the second sale. This implies that, by making the first sale for a price p, a seller expects a continuation payoff of

$$p + c_1 - 2\,c_2$$

whereas missing the first sale means missing the second one as well, for a payoff of zero. It follows that (both) firms set a price of $2\,c_2 - c_1$ for the first sale. All in all, the average price in the sequential sales model is given by

$$\underline{p} = \frac{1}{2}\big(2\,c_2 - c_1\big) + \frac{1}{2}\,c_1 = c_2$$

In other words, from the point of view of average price it does not matter whether sales are simultaneous or sequential. Buyers do care: in particular, it's better to be the first buyer than to be the second buyer.

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