

# DISCUSSION PAPER SERIES

No. 10095

## STAGGERED CONTRACTS, MARKET POWER, AND WELFARE

Luís Cabral

*INDUSTRIAL ORGANIZATION*



**Centre for Economic Policy Research**

[www.cepr.org](http://www.cepr.org)

Available online at:

[www.cepr.org/pubs/dps/DP10095.php](http://www.cepr.org/pubs/dps/DP10095.php)

# STAGGERED CONTRACTS, MARKET POWER, AND WELFARE

Luís Cabral, New York University and CEPR

Discussion Paper No. 10095  
August 2014

Centre for Economic Policy Research  
77 Bastwick Street, London EC1V 3PZ, UK  
Tel: (44 20) 7183 8801, Fax: (44 20) 7183 8820  
Email: [cepr@cepr.org](mailto:cepr@cepr.org), Website: [www.cepr.org](http://www.cepr.org)

This Discussion Paper is issued under the auspices of the Centre's research programme in **INDUSTRIAL ORGANIZATION**. Any opinions expressed here are those of the author(s) and not those of the Centre for Economic Policy Research. Research disseminated by CEPR may include views on policy, but the Centre itself takes no institutional policy positions.

The Centre for Economic Policy Research was established in 1983 as an educational charity, to promote independent analysis and public discussion of open economies and the relations among them. It is pluralist and non-partisan, bringing economic research to bear on the analysis of medium- and long-run policy questions.

These Discussion Papers often represent preliminary or incomplete work, circulated to encourage discussion and comment. Citation and use of such a paper should take account of its provisional character.

Copyright: Luís Cabral

CEPR Discussion Paper No. 10095

August 2014

## **ABSTRACT**

### **Staggered Contracts, Market Power, and Welfare\***

I show that 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, I show that, allowing firms to choose contract structure endogenously, the resulting equilibrium path features staggered contracts.

JEL Classification: L12 and L41

Keywords: dynamic competition, exclusion and staggered contracts

Luís M B Cabral  
Department of Economics  
Stern School of Business  
New York University  
44 West 4th Street  
New York, NY 10012-1126  
USA

Email: [lcabral@stern.nyu.edu](mailto:lcabral@stern.nyu.edu)

For further Discussion Papers by this author see:

[www.cepr.org/pubs/new-dps/dplist.asp?authorid=114053](http://www.cepr.org/pubs/new-dps/dplist.asp?authorid=114053)

\*Paganelli-Bull Professor of Economics and International Business, Stern School of Business, New York University; Research Fellow, IME and PPRS (IESE); and Research Fellow, CEPR; [luis.cabral@nyu.edu](mailto:luis.cabral@nyu.edu). I am grateful to Dennis Carlton, Joe Farrell, Richard Gilbert, Justin Johnson, Louis Kaplow, Kai-Üwe Kühn, João Montez, José Luis Moraga, Massimo Motta, Patrick Rey, Yossi Spiegel, Ralph Winter, Christopher Yoo, and especially Michael Riordan for helpful comments and suggestions. I am sole responsible for remaining errors.

Submitted 23 July 2014

# 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, I consider the case when a supplier sells to multiple buyers and ask whether it makes a difference whether contracts are synchronous or staggered.

As a first motivating example, consider 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 long). Moreover, Justice argued that “the security in long time contracts has been buttressed further by staggered expiration dates.”<sup>1</sup>

A second 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.<sup>2</sup> 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.<sup>3</sup>

A similar 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.”<sup>4</sup> 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.”<sup>5</sup>

A fourth example is given by television broadcast rights in the Portuguese Professional Soccer League (LPFP). As of 2013, these rights were wholly owned by one single firm, PPTV, which negotiates individually with each club. Despite PPTV’s high profitability (average rate of return of about 30%), there is no sign of credible potential entry except

---

1. *United States v. Pullman Co.*, Civil Action No. 994, 50 F.Supp. 123 (1943).

2. Jing and Winter (2012) discuss this case at length. Strictly speaking, this example does not correspond to the problem I 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.

for Benfica Lisbon, the largest club, which owns its own cable network (and by law cannot compete with PPTV for the rights of other teams' games). Lack of competition is likely due to the high entry barrier created by the contracts signed by the soccer clubs with PPTV: long in duration (5 to 10 years) and staggered in structure.

In this paper, I consider the economic effect of staggered contracts in an industry with market power. I develop an infinite period model with two sellers and two buyers. I look for stationary equilibria where sellers bid for contracts under two possible contract structures: synchronous contracts (all contracts are renewed at the same time); and staggered contracts (contracts are renewed at different times). I 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 I 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 an 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.

I extend the model to include the possibility of product differentiation. In this context, I 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, I amend the model to allow for firms to choose prices and contract length, thus allowing for contract structure to emerge endogenously. In this context, I show that, along the equilibrium path, contracts are staggered.

■ **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 involves long-term exclusive contracts. This view — usually associated to the “Chicago school” — has been challenged by a series of scholars. In particular, as Aghion and Bolton (1990) 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 the excluded party. In sum, long-term exclusive contracts may create an inefficient barrier to entry.

More closely related to my paper is the literature on “naked exclusion” (Rasmusen, Ramseyer and Wiley, 1991; Segal and Whinston, 1999; Fumagalli and Motta, 2005). 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 (1990), an additional externality now exists between buyers who sign exclusive deals with the incumbent and buyers who do not. Similarly to Aghion and

Bolton (1990), there may exist equilibria with inefficient exclusion.<sup>6</sup>

My paper extends the idea of exclusive contracts that induce externalities, market power, and possibly inefficient exclusion. I 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 I 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.<sup>7</sup>

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 paper 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), I 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). Nevertheless, my Proposition 2 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 my model — and the motivating examples presented earlier — are about an incumbent monopolist deterring entry by a rival.

Jing and Winter (2012) 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, my paper is related to the work by Gilbert and Newbery (1982), who provide conditions for the persistence of monopoly dominance. My 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 I do. In the latter sense, my 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.

---

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.

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.

## 2. Model

Consider an industry with two sellers and a sequence of short-lived pairs of buyers.<sup>8</sup> Buyers have a valuation  $u$  for one unit of the industry product during one period, zero for any additional unit. Given this, buyers choose the seller who offers the lowest price. (In Section 5, I consider the possibility of seller and buyer heterogeneity.)

For accounting purposes, I will divide contract length into two periods. Throughout the paper, when I refer to “period” I mean one half of contract length; in other words, I will assume contracts last for two periods. Let  $\delta$  be the discount factor corresponding to one period. It follows that the discount factor corresponding to the entire contract length is  $\delta^2$ .

The cost of serving one customer during one period,  $c_k$ , depends on  $k$ , the number of customers served. I make the important assumption that

**Assumption 1.**  $c_2 < c_1$

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

Throughout the paper, the equilibrium concept I use is that of Markov equilibria, that is, subgame-perfect Nash equilibria such that strategies depend only on the state of the game. The state of the game, in turn, is defined by the identity of the “incumbent” supplier, the supplier who holds the “old” contract in the case when contracts are staggered; if contracts are not staggered, then there is only one state. Either way, my assumption of Markov equilibria effectively excludes the possibility of history dependent strategies.

## 3. Staggered contracts and market power

In this section I consider two possible cases: (a) synchronous contracts, that is, the situation whereby every 2 periods all contracts are auctioned off; and (b) staggered contracts, that is, the situation whereby every period one of the contracts is auctioned off. Suppose first that, every two periods, sellers set the price for two-period supply to one buyer. Buyers then simultaneously choose one of the sellers. Since sellers are indistinguishable in the buyers’ eyes, the latter always pick the firm (or a firm) setting the lowest price. I next show that, in equilibrium, both sellers set  $p = c_2$ , where  $p$  is *per period* price, and one of the sellers wins both contracts. To see this, notice that it would not be an equilibrium for each seller to sell one contract for  $p = c_2$ , for then the price received is lower than cost (which would be  $c_1$  for each seller). Likewise, it would not be an equilibrium for each seller to sell one contract for a price  $p$  strictly greater than  $c_2$ : a slightly lower price would secure both buyers for a higher seller value. We thus conclude that the equilibrium price is  $p_y = c_2$  ( $y$  for synchronous).

Consider now the case when every period one of the buyers comes to the market demanding a 2-period contract. Let  $v_i$  be the value of a seller who holds an old contract before the new one is assigned ( $i$  for incumbent). Let  $v_e$  be the other seller’s value ( $e$  for entrant). Let  $p_i$  and  $p_e$  be the *per period* prices set by incumbent and entrant seller, respectively. The process of deriving equilibrium prices is similar to what I considered before, with the difference that I now must explicitly account for continuation values. For example, if in

---

8. Alternatively, I could assume two long-lived buyers, but then I would also need to assume buyers are myopic.

a given period the incumbent seller has the winning price,  $p_i$ , then its discounted value is given by

$$\tilde{p} + p_i - 2c_2 + \delta v_i$$

where  $\tilde{p}$  is the per period price of the preceding contract and  $v_i$  the continuation value for an incumbent seller.

My first result compares per-period price under the alternative regimes considered above. Specifically, let  $p^g$  be the per-period price under staggered contracts, whereas  $p^y$  denotes price under synchronous contracts.

**Proposition 1.** *In an anonymous equilibrium, prices are given by*

$$\begin{aligned} p^y &= c_2 \\ p^g &= c_2 + (1 - \delta)(c_1 - c_2) \end{aligned}$$

In words, Proposition 1 states that equilibrium price under staggered contracts is higher than under synchronous contracts: 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).

■ **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, I 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”);<sup>9</sup> 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. Proposition 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.

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

■ **Contract length.** I next explore the implications of Proposition 1 for the comparative statics with respect to contract length.

**Corollary 1.**  $\frac{dp^y}{d\delta} = 0 > \frac{dp^g}{d\delta}$

In words, contract length has no effect on (per period) contract price under synchronous contracts. However, under staggered contracts contract length (further) increases monopoly power. In the limit as  $\delta \rightarrow 1$ , synchronous and staggered contracts perform equally in terms of equilibrium price. In the opposite limit as  $\delta \rightarrow 0$ ,  $p^g \rightarrow c_1$ , which, by Assumption 1, is greater than  $p^y = c_2$ .

Note that there may be many good reasons why market competitiveness decreases as contract length increases (including, for example, a combination of uncertainty and sunk entry costs). The point of Corollary 1 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, I should mention that I am 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, I would expect sellers to bargain over contract transfers. If bargaining is efficient, then I would expect sellers to come to an agreement whereby 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, I would expect the existence of a secondary market to reduce the degree of monopoly power by the incumbent seller.

## 4. Staggered contracts and inefficient exclusion

Suppose that one of the sellers, say firm  $b$ , is more efficient than the other. Specifically, I assume 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).

Under synchronous contracts,  $b$  systematically wins the auction for each new contract. It follows that the equilibrium is efficient: production costs are minimized and social welfare maximized.

Consider now the case of staggered contracts. As suggested by Proposition 1, 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 that to be the case.

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

In other words, Proposition 2 states that if firm  $a$  is not too inefficient with respect to firm  $b$ , then it is able to exclude the more efficient entrant.<sup>10</sup>

---

10. In a different setting, Calzolari and Denicolò (2013) 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.

Notice that a necessary condition for Proposition 2 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  $\delta$  is too small (specifically, less than  $1/2$ ), then firm  $a$  prefers not to make a sale. Intuitively, if different values of  $\delta$  reflect different period lengths, a low  $\delta$  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  $b$ .

Note that Proposition 2 provides a different story than Corollary 1 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 I showed earlier, in the limit when  $\delta \rightarrow 1$  there is no difference between synchronous and staggered contracts. According to Proposition 2, one effect of increasing  $\delta$  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).

The *ErinMedia* case provides a possible illustration of Proposition 2. 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.”<sup>11</sup> Although Proposition 2 is cast in term of entrant’s cost advantage, I could easily adapt the model to consider the case of entrant’s quality advantage. Proposition 2 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.”<sup>12</sup>

## 5. Staggered contracts as a barrier to entry

In the previous sections, I considered the case when there is complete information regarding payoffs. When this is the case, 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 creates a bit of 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

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.

to consider the possibility of seller heterogeneity, in which case both sellers receive strictly positive expected payoffs.

In the present case, complete information implies that the entrant is always kept from winning any contract, thus receiving a zero payoff. This is true in any of the equilibria considered (except when the entrant has a large cost advantage with respect to the incumbent). In this section, I follow the same solution as in standard oligopoly models: I 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).

Specifically, I assume that, in each period and for each buyer, Nature generates a preference shock  $\xi$  which is the buyer's private information and corresponds to the buyer's preference for one of the sellers. Since in this section I return to symmetric anonymous equilibria, I assume that  $\xi$  measures the buyer's preference for the incumbent seller; that is, the buyer prefers to buy from  $i$  if and only if  $\xi - p_i > -p_e$ . In the case of synchronous contracts, I can arbitrarily designate one of the firms as incumbent.

I assume that  $\xi$  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 done 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).

It follows from part (ii) of Assumption 2 that the probability that  $i$  is selected by the buyer is given by

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

If contracts are synchronous, I define by  $v$  the (common) discounted firm value at the the beginning of a period where contracts are up for bids. If contracts are staggered, then I 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 into a market where there is one seller only. The question at hand is whether this value is lower than the value expected by an entrant into a market where contracts are all bid at the same time, that is, are synchronous.

Let us begin with synchronous contracts. From the previous sections, we conclude that  $v_e = 0$  both under synchronous and under staggered contracts. Is this also true when there is incomplete information? At this point, we are faced with a modeling problem: how exactly do synchronous contracts work when there is incomplete information? Under complete information, I assumed that buyers simultaneously choose a seller; and I showed that the winning bidder secures both contracts. In fact, this is the only Nash equilibrium. 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. I 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.

I can now establish the main finding in this section:

**Proposition 3.** *If  $c_1 - c_2$  is sufficiently large, then an entrant's expected value is lower under staggered contracts than under synchronous contracts.*

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,  $\pi_d$ . In terms of my 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 my model of staggered contracts and the Rasmusen et al (1991) model of naked exclusion with sequential contracts. In fact, my 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 3.

A more recent case is *Menasha Corp. v. News America Marketing In-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."<sup>13</sup> This is consistent with Proposition 3, especially in light of Assumption 1 (economies of scale or network effects). However, Judge Easterbrook, who presided over the case, rejected Menasha's claim.

---

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

## 6. Endogenous contract duration

In the previous sections, I 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, I need a model where contract duration is chosen by firms. In fact, starting from a symmetric state (e.g., the beginning of the world), it is only through the choice of contracts with different durations that a staggered pattern can emerge. Accordingly, in the section I amend the model presented in Section 2 as follows. In addition to two infinite lived sellers, I assume there are two infinitely lived buyers (who need one unit per period). 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, and consistently with the previous sections, I will assume only two possible contract durations, one and two periods ( $t = 1, 2$ ).

I continue to work with symmetric Markov equilibria, where there are essentially two possible states: (a) all past contracts have expired (symmetric state); (b) one of the buyer's 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, I will treat these as essentially the same. 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, I 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 4.** *Contracts are staggered along the equilibrium path, that is, no two observed contracts end at the same time.*

Notice that Proposition 4 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.

In the proof of Proposition 4, I show that an equilibrium must have the following form. Starting from an asymmetric state, the equilibrium path must be the same as the staggered contracts equilibrium derived in Proposition 1. By contrast, starting from a symmetric state the equilibrium must have the following form: firms coordinate on offering one of the buyers a one-period contract for a price of  $p = c_2$ ; and offering the other buyer a two period contract with prices such that the winning seller's discounted profit is zero.

In the proof, I show that there is no profitable deviation from such an equilibrium. Moreover, I show that a putative equilibrium with synchronized contracts of the same duration would be broken down by a seller's profitable deviation. Suppose, for example, that the equilibrium calls for firms to offer two period contracts in a synchronized pattern. Then the seller would benefit from offering one of the buyers a one period contract for a substantially low price, thus becoming the incumbent seller as in Proposition 1. 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 (1990); Rasmusen, Ramseyer and Wiley (1991); and Segal and Whinston (1999). The difference with respect to Aghion and Bolton (1990) is that, in their paper, seller and buyer “collude” to extract surplus from another seller, not another buyer. The difference with respect to Rasmusen, Ramseyer and Wiley (1991), and Segal and Whinston (1999), is that I explicitly consider calendar time and contract duration as the mechanism for implementing a “divide-and-conquer” strategy with respect to buyers.

Proposition 4 also bears some resemblance to the efficiency effect characterized by Gilbert and Newbery (1982), Bernheim and Whinston (1988) in a static context; and by Budd, Harris and Vickers (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.

## 7. Conclusion

I 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 I identify is over and above other barriers previously identified, I 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.

## Appendix

**Proof of Proposition 1:** If the incumbent seller has the winning price, then its discounted value is given by

$$\tilde{p} + p_i - 2c_2 + \delta v_i \quad (2)$$

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

$$\tilde{p} - c_1 + \delta v_e \quad (3)$$

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

$$p_e - c_1 + \delta v_i \quad (4)$$

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

$$\delta v_e \quad (5)$$

Equating (3) and (2) and solving for  $p_i$  I get the incumbent's minimum price:

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

Similarly, the entrant's minimum price is given by

$$p_e^\circ = c_1 - \delta(v_i - v_e) \quad (6)$$

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

$$p = p_i = p_e = c_1 - \delta(v_i - v_e) \quad (7)$$

Since the incumbent seller always makes a sale, we conclude that  $\tilde{p} = p_i$ . Moreover, from (2) we have

$$v_i = 2(p_i - c_2) + \delta v_i \quad (8)$$

or simply

$$v_i = 2 \frac{p_i - c_2}{1 - \delta}$$

Substituting (7) for  $p_i$  in (8) and simplifying, we get

$$v_i = c_1 - c_2 \quad (9)$$

Substituting 0 for  $v_e$  and (9) for  $v_i$  in (7), and simplifying, I get

$$p_i = c_1 - \delta(c_1 - c_2) = (1 - \delta)c_1 + \delta c_2$$

In the text I derived the values  $p_S = p^y = c_2$ . ■

**Proof of Proposition 2:** 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

$$p_e^b - c_1 + \delta v_i^b \quad (10)$$

whereas firm  $b$ 's (the entrant) expected payoff if the incumbent (firm  $a$ ) makes the sale is simply given by

$$\delta^{\frac{T}{2}} v_e^b \quad (11)$$

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

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

Substituting (12) for  $v_i^b$  in (10), equating (10) to (11) and solving for  $p_e^b$ , I 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:

$$p_e^b = c_1 \quad (13)$$

Note that this implies that

$$v_i^b = 0$$

Even though I assume that, along the equilibrium path, firm  $a$  always makes a sale, I 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

$$\tilde{p} + p_i^b - 2c_2 + \delta v_i^b \quad (14)$$

where  $\tilde{p}$  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

$$\tilde{p} - c_1 + \delta v_e^b \quad (15)$$

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  $p_i^b$ , I obtain firm  $b$ 's minimum price when it is an incumbent:

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

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:

$$p_i^b = 2c_2 - c_1 \quad (16)$$

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

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

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

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

Substituting (17) for  $v_i^a$ , I get

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

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

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

which is true by assumption.

In order to show that the proposed equilibrium is indeed an equilibrium, I 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  $p_i^a = p_e^{bo}$  and (13). ■

**Proof of Proposition 3:** The proof proceeds in three steps. First I compute the equilibrium under staggered contracts. Second I compute the equilibrium under synchronous contracts. Finally, I compare the value of an entrant in each of the two cases.

Consider first the case of staggered contracts. For simplicity, I 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 I 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. The value of an incumbent and of an entrant are given by

$$\begin{aligned} v_i &= q(p_i - 2c_2 + \delta v_i) + (1 - q)(-c_1 + \delta v_e) \\ v_e &= (1 - q)(p_e - c_1 + \delta v_i) + q\delta v_e \end{aligned} \quad (19)$$

Define

$$P \equiv p_i - p_e$$

From (1),  $q = 1 - \Phi(P)$ . 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

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

or simply

$$\begin{aligned} p_i &= \frac{1 - \Phi(P)}{\phi(P)} + (2c_2 - c_1) - \delta(v_i - v_e) \\ p_e &= \frac{\Phi(P)}{\phi(P)} + c_1 - \delta(v_i - v_e) \end{aligned} \quad (20)$$

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

$$P + \frac{2\Phi(P) - 1}{\phi(P)} = -2(c_1 - c_2) \quad (21)$$

Assumption 2 implies that the left-hand side of (21) is strictly increasing in  $P$  ranging from  $-\infty$  to  $+\infty$  as  $P$  varies from  $-\infty$  to  $+\infty$ . Moreover, the left-hand side of (21) is zero when  $P$  is zero. It follows that there exists a unique value of  $P$  satisfying (21). Moreover, since  $P > 0$  if and only if the right-hand side of (21) is positive, Assumption 1 implies that  $P < 0$ .

Substituting the first-order condition (20) into the value functions (19) and simplifying, I get

$$\begin{aligned} v_i &= \frac{(1 - \Phi(P))^2}{\phi(P)} + \delta v_e \\ v_e &= \frac{\Phi(P)^2}{\phi(P)} + \delta v_e \end{aligned} \quad (22)$$

or simply

$$v_e = \frac{1}{1 - \delta} \frac{\Phi(P)^2}{\phi(P)} \quad (23)$$

where  $P$  is given by (21).

Consider now the case of synchronous contracts which are auctioned at every even period. Suppose that firm  $i$  has made the first sale. Seller continuation values before the second auction takes place are given by

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

where  $v^\circ$  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

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

or simply

$$\begin{aligned} p_i &= \frac{1 - \Phi(P)}{\phi(P)} + (1 + \delta)(2c_2 - c_1) \\ p_e &= \frac{\Phi(P)}{\phi(P)} + (1 + \delta)c_1 \end{aligned} \quad (24)$$

Subtracting these two first-order conditions, I get

$$P + \frac{2\Phi(P) - 1}{\phi(P)} = -2(1 + \delta)(c_1 - c_2) \quad (25)$$

which determines the value of  $P$  uniquely. Substituting (24) back into the value functions, I get

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

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

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

where  $p_A^\circ$  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

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

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

$$p^\circ = \frac{1 - \Phi(0)}{\phi(0)} + \frac{\Phi(P)^2}{\phi(P)} - \frac{(1 - \Phi(P))^2}{\phi(P)} \quad (26)$$

$$= \frac{1 - \Phi(0)}{\phi(0)} - \frac{1 - 2\Phi(P)}{\phi(P)} \quad (27)$$

Plugging (26) back into the value function, I 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  $\delta$  times  $v$ . In expected terms, the entrant gets

$$v = \frac{1}{2} v^\circ + \frac{1}{2} \delta v^\circ = \frac{1}{1 - \delta} \frac{1}{2} \left( \frac{\Phi(0)^2}{\phi(0)} + \frac{\Phi(P)^2}{\phi(P)} \right) \quad (28)$$

where  $P$  is given by (25).

Next, I compare the equilibria with staggered and with synchronous contracts. Let  $G$  stand for staggered contracts and  $Y$  for synchronous contracts. From (21) and (25), we see that

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

Assumption 2 implies that  $0 > P^g > P^y$ . Moreover, from (23) and (28), we see that

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

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

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

**Proof of Proposition 4:** Define a symmetric state as the situation where both contracts have just expired; and an asymmetric state as the situation where one of the contracts still has one period to go. I will show that, in equilibrium, the subgame beginning at an asymmetric state is the same as in Proposition 1. By contrast, in the subgame beginning at a symmetric state, firms coordinate on designating one of the buyers as a “short-run buyer” and the other one as a “long-run buyer.” The short run buyer is offered a one-period contract for a price of  $p = c_2$  (that buyer is also offered a two-period contract for a prohibitively high price). The long run buyer, in turn, is offered a two-period contract for a price  $p_2 + \delta p^g$ , where  $p^g$  is given by Proposition 1, that is,

$$p^g = c_2 + (1 - \delta)(c_1 - c_2)$$

and  $p_2$  is such that the firm’s discounted profit is zero, that is,

$$p_2 - c_2 + 2\delta \frac{p^g - c_2}{1 - \delta} = p_2 - c_2 + 2\delta(c_1 - c_2) = 0$$

or simply

$$p_2 = c_2 - 2\delta(c_1 - c_2)$$

(The long run buyer is also offered a one-period contract for a prohibitively high price.) I next show that no deviation from the proposed equilibrium is profitable. Consider first a subgame where contracts are two-years long and staggered. Suppose that firm  $e$  deviates by offering a one-year contract for price  $p_1$ . If such contract offer is accepted, then firms move to a symmetric state, where the continuation payoff is zero (by a simple Bertrand competition argument) and price is  $c_2$ . Since continuation payoff is zero, the lowest price  $e$  is willing to sell a one-year contract is  $c_1$ . It follows that a buyer who switches to the entrant’s one-year contract would expect a discounted price (weakly) greater than

$$\bar{p}_e = c_1 + \delta \frac{c_2}{1 - \delta}$$

Alternatively, by going with the incumbent, the buyer expects a discounted price of

$$\bar{p}_i = \frac{p^g}{1 - \delta}$$

where  $p^g$  is given by Proposition 1. Straightforward computation shows that  $\bar{p}_i = \bar{p}_e$ . We thus conclude that there is no incentive for  $e$  to deviate.

Now consider a symmetric subgame, that is, one where both contracts have just expired. In equilibrium, both firms make zero discounted profit (again, by a simple symmetric Bertrand competition argument). The firm that makes no sales could deviate by undercutting

the firm that makes two sales, but this would lead to a negative discounted profit. The firm that makes two sales could deviate by increasing prices. However, by doing so, it would make zero or even negative profits (for example, if it increases the price of the one-year contract but not the one of the two-year contract).

To show uniqueness, consider a different subgame equilibrium starting at a symmetric state. First, suppose that both buyers offer one-year contracts. Since this leads to a continuation symmetric subgame, Bertrand competition implies that price must be  $c_2$ . Consider a deviation whereby one of the sellers offers one of the buyers a two-period contract with period prices  $(p_2, p^g)$  where  $p_2$  is such that

$$p_2 + \delta \frac{p^g}{1 - \delta} = \frac{c_2}{1 - \delta}$$

or simply

$$p_2 + \delta \frac{c_2 + (1 - \delta)(c_1 - c_2)}{1 - \delta} = \frac{c_2}{1 - \delta}$$

$$p_2 = c_2 - \delta(c_1 - c_2)$$

By setting such price, the deviant seller expects a discounted profit of

$$p_2 - c_2 + 2\delta \frac{p^g - c_2}{1 - \delta} = -\delta(c_1 - c_2) + 2\delta \frac{c_2 + (1 - \delta)(c_1 - c_2) - c_2}{1 - \delta} = \delta(c_1 - c_2) > 0$$

which implies that it cannot be an equilibrium for both buyers to purchase a one-period contract.

Consider now a subgame equilibrium, starting at a symmetric state, where both buyers offer two-year contracts. Since this leads to a continuation subgame starting at a symmetric state, Bertrand competition implies that price must be  $c_2$ . Consider a deviation whereby one of the sellers offers one of the buyers a one-period contract with price  $p_1$  such that

$$p_1 + \delta \frac{p^g}{1 - \delta} = \frac{c_2}{1 - \delta}$$

or simply

$$p_1 = c_2 - \delta(c_1 - c_2)$$

By setting such price, the deviant seller expects a discounted profit of

$$p_1 - c_2 + \delta \frac{c_2 + p^g - 2c_2}{1 - \delta} + 2\delta^2 \frac{p^g - c_2}{1 - \delta} = 2\delta^2(c_1 - c_2) > 0$$

which implies that it cannot be an equilibrium for both buyers to purchase a two-period contract. ■

■ **Synchronous contracts with sequential sales.** Alternatively, I 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 simultaneously 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

$$\tilde{p} + p_i - 2c_2$$

where  $\tilde{p}$  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

$$\tilde{p} - c_1$$

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

$$p_e - c_1 \tag{29}$$

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, I obtain the sellers' minimum prices. They are given by

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

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

$$p + c_1 - 2c_2$$

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  $2c_2 - c_1$  for the first sale. All in all, the average price in the sequential sales model is given by

$$\bar{p} = \frac{1}{2}(2c_2 - c_1) + \frac{1}{2}c_1 = c_2$$

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.

## References

- AGHION, PHILIPPE, E PATRICK BOLTON (1987), “Contracts as a Barrier to Entry,” *American Economic Review* **77** (3), 388–401.
- BERNHEIM, D., AND MICHAEL WHINSTON (1998), “Exclusive Dealing,” *Journal of Political Economy* **106**, 64–103.
- BUDD, CHRISTOPHER, CHRISTOPHER HARRIS AND JOHN VICKERS (1993), “A Model of the Evolution of Duopoly: Does the Asymmetry Between Firms Tend to Increase or Decrease?,” *Review of Economic Studies* **60**, 543–573.
- CABRAL, LUÍS (2011), “Dynamic Price Competition with Network Effects,” *Review of Economic Studies* **78**, 83–111.
- CABRAL, LUÍS, AND MICHAEL H RIORDAN (1994), “The Learning Curve, Market Dominance and Predatory Pricing,” *Econometrica* **62**, 1115–1140.
- CALZOLARI, GIACOMO, AND VINCENZO DENICOLÒ (2013), “Exclusive Contracts and Market Dominance,” CEPR Discussion Paper No. 9545.
- CARLTON, DENNIS, AND MICHAEL WALDMAN (2002), “The Strategic Use of Tying to Preserve and Create Market Power in Evolving Industries,” *Rand Journal of Economics* **33**, 194–220.
- COASE, RONALD (1960), “The Problem of Social Cost,” *Journal of Law and Economics* **3**, 1–44.
- FUMAGALLI, CHIARA, AND MASSIMO MOTTA (2006), “Exclusive Dealing and Entry, When Buyers Compete,” *American Economic Review* **96** (3), 785–795.
- GILBERT, RICHARD J., AND DAVID M. G. NEWBERY (1982), “Preemptive Patenting and the Persistence of Monopoly Power,” *American Economic Review* **72**, 514–526. American
- IACOBUCCI, EDWARD M, AND RALPH A. WINTER (2012), “Collusion on Exclusion,” University of Toronto and University of British Columbia.
- INNES, ROBERT, AND RICHARD J. SEXTON (1994), “Strategic Buyers and Exclusionary Contracts,” *American Economic Review* **84**, 566–584.
- JING, RAN AND RALPH A. WINTER (2012), “Exclusionary Contracts,” University of British Columbia.
- RASMUSEN, ERIC B., J. MARK RAMSEYER, E JOHN S. WILEY, JR (1991), “Naked Exclusion,” *American Economic Review* **81** (5), 1137–1145.
- SALOP, STEVEN, AND CRAIG ROMAINE (1999), “Economic Analysis, Legal Standards, and Microsoft,” *George Mason Law Review* **7**, 617–672.
- SEGAL, ILYA R., AND MICHAEL D. WHINSTON (2000), “Naked Exclusion: Comment,” *American Economic Review* **90** (1), 296–309.

- SIMPSON, JOHN, AND ABRAHAM L. WICKELGREN (2007), “Naked Exclusion, Efficient Breach, and Downstream Competition,” *American Economic Review* **97**, 1305–1320.
- SPECTOR, DAVID (2011), “Exclusive Contracts and Demand Foreclosure,” *Rand Journal of Economics* **42** (4), 619–638.
- STEFANADIS, CHRISTODOULOS (1998), “Selective Contracts, Foreclosure, and the Chicago School View,” *Journal of Law and Economics* **41** (2), 429–450.
- WRIGHT, JOSHUA D (2006), “Antitrust Law and Competition for Distribution,” *Yale Journal on Regulation* **23**, 168–207.