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Exclusive Contracts and Post-Entry competition

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Abstract

The Chicago-school's view of exclusive dealing holds that an incumbent firm would not find it profitable to exclude a more efficient entrant in the absence of pro-competitive efficiencies. Underlying this view, however, is a presumption that the incumbent would engage in Bertrand competition with the entrant post-entry. Assuming other forms of post-entry competition instead, we find that the Chicago-school misses an important component of the incumbent's incentive for exclusion. We show that this component can be strong enough that anti-competitive exclusion can sometimes be profitable for the incumbent even when there are no externalities across buyers. We also show how these other forms of competition affect post-Chicago models of exclusive dealing in which the incumbent engages in a divide-and-conquer strategy to exclude an entrant.

Keywords: Cournot, Stackelberg, exclusive dealing, divide and conquer

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1 Introduction

The Chicago-school's view of exclusive dealing holds that an incumbent firm cannot profitably foreclose a more efficient entrant by asking its buyers to sign exclusive contracts (see, for example, Director and Levi, 1956; Posner, 1976; and Bork, 1978). According to this view, the compensation that would be needed to induce buyers to sign an exclusive contract with the incumbent would always be more than the incumbent could expect to gain from the exclusion (because of the deadweight loss that the incumbent's monopoly pricing would engender). As Whinston (2006) notes, this view has had, and continues to have, enormous influence on the making of public policy and how courts perceive these types of contracts.

It is now well known, however, that the Chicago-school's view of exclusive dealing implicitly assumes that each buyer is pivotal in the sense that each buyer's purchases alone are enough to induce entry. Rasmusen et al (1991) showed, for example, that when this is not the case, an incumbent may be able to induce exclusion cheaply by exploiting coordination failures among the buyers. And, Segal and Whinston (2000) showed that even without coordination failures, an incumbent may be able to induce exclusion profitably using a divide and conquer strategy, as long as it does not have to sign up every buyer.[1] These post-Chicago models have also had an enormous influence on policy.[2] Among other things, they highlight the importance of scale economies as a key factor for courts and policy makers to consider.[3]

Farrell (2005) also challenged the Chicago-school's view of exclusive dealing, arguing that it is not robust to the assumption that the firms would compete à la Bertrand post entry. He gave an example of Cournot competition with linear demand (and one potential buyer), and found that the buyer and incumbent would jointly lose from a more efficient entrant's entry if (and only if) a certain condition on the firms' marginal costs holds.[4] He then noted that when this condition holds, the buyer and incumbent would jointly have an incentive to

[1] This assumes that the incumbent's contract offers are observable to all buyers. When they are not, the efficacy of divide and conquer strategies may depend on the buyers' beliefs (Miklós-Thal and Shaffer, 2016).

[2] Subsequent literature has extended the Chicago-school setting to allow for competing buyers (Fumagalli and Motta, 2006; Simpson and Wickelgren, 2007; Wright, 2009), asymmetric information about entry barriers (Giardino-Karlinger, 2015), and loyalty discounts (Elhauge and Wickelgren, 2015; Chen and Shaffer, 2014, 2018). It has also looked at the impact of exclusives on investment decisions (Besanko and Perry, 1993; Segal and Whinston, 2000; Fumagalli et al, 2012), and considered settings in which no seller has a first-mover advantage (Mathewson and Winter, 1987, Bernheim and Whinston, 1998; Calzolari and Denicolo, 2015).

[3] Whinston (2006; 147) writes "... the critical factor leading to this conclusion [that exclusion can be profitable] is the presence of scale economies, which makes [the entrant's] entry decision for one buyer depend on the availability of other buyers. This suggests that the presence of scale economies should be one of the central factual questions in settings in which exclusive contracts are alleged to be harming competition."

[4] Farrel (2005; 469) writes "In Cournot competition, for instance, if [the buyer]'s demand is linear ($p = 1 - Q$), and if [the incumbent's] unit cost is c and [the entrant's] is e, then calculation shows that [the buyer] and [the incumbent] jointly lose from [the entrant's] entry if and only if $1 - 2c - 3c^2 + 8ec - 4e^2 > 0$."

agree on a contract to exclude the entrant, contrary to the assertions of the Chicago school.

Farrell's work has not received nearly as much attention in the literature or among policy makers as the earlier post-Chicago models have. In part, this may be because it left many questions unanswered. It did not explain why exclusion might sometimes be profitable under Cournot competition, but not under Bertrand competition, nor did it make any attempt to assess how restrictive the condition for exclusion was. Would it hold, for example, if the entrant was 5% more efficient than the incumbent? What if it were 10% more efficient?

There is also no mention in Farrell (2005) of other forms of post-entry competition, nor does it allow for more than one buyer. This raises further questions. Is the Cournot case an outlier? How would, for example, the ability to collude tacitly with the entrant post entry affect the incumbent's incentive for exclusion? Would it make exclusion more or less likely relative to Cournot? How would a Stackelberg game in which the incumbent was the leader affect its incentive for exclusion? Does it depend on how many buyers there are? Would these other forms of competition make it easier or harder to divide and conquer the entrant?

In this paper, we extend Farrell (2005) by addressing these unanswered questions. We begin with the intuition and show in a model with one buyer and general demand how and why exclusion can sometimes (depending on the firms' marginal costs and curvature of demand) be profitable under Cournot competition but never under Bertrand competition. We show the tradeoffs involved and illustrate them graphically. We then specialize to linear demand and show that when the entrant's cost advantage is placed on a continuum between no cost advantage on the one hand, and a cost advantage so large on the other hand that the incumbent would not be able to profitably sell its good at the entrant's monopoly price, the incumbent would be able to profitably exclude the entrant on two-thirds of this range.

Turning to other forms of post-entry competition, while continuing to focus on a single buyer, we find that giving firms the ability to cooperate post-entry (such that the incumbent and entrant would be able to support prices above Cournot in the post-entry game) unambiguously *increases* the incumbent's incentives for exclusion pre-entry. This is so whether one uses Bertrand or Cournot competition as the benchmark. In contrast, we find that a post-entry game in which the incumbent is a Stackelberg leader (and the entrant is a Stackelberg follower) unambiguously *decreases* the incumbent's incentive for exclusion relative to Cournot (but increases it relative to Bertrand) competition. In the case of linear demand, for example, we find that exclusion is never privately profitable under Stackelberg competition.

Lastly, in the case of multiple buyers and scale economies, we find that each of the post-entry forms we consider (from Stackelberg, to Cournot, to more cooperative outcomes) make it easier in some cases for the incumbent to divide and conquer the entrant — but harder in other cases — relative to Bertrand competition. Although the proportion of buyers that can profitably be signed to an exclusive contract is higher in these other forms (because the incumbent loses less on each buyer that is signed relative to Bertrand competition), more buyers may have to be signed to induce exclusion (because the entrant's profits may be higher, particularly if its cost advantage is small). On balance either effect can dominate.

One might think that a change in post-entry competition from Bertrand to Cournot (and similarly for the other forms of post-entry competition) would have mostly ambiguous effects on an incumbent's ability to profitably foreclose a more efficient entrant (because although the buyer's loss from exclusion would be smaller under Cournot, the incumbent's gain from exclusion would also be smaller).[5] But if this were correct, it would suggest that the way to interpret Farrell's condition for exclusion is that sometimes the incumbent's incentive for exclusion increases and sometimes it decreases — which is not the case. We find instead that Cournot competition (and the other forms of competition) always leads to an increase in the incumbent's incentive for exclusion relative to Bertrand. This suggests that a better way to interpret the condition is to recognize that sometimes the increase in the incumbent's incentive for exclusion will be enough to offset the deadweight loss from monopoly pricing, and sometimes it will not be — whereas the incumbent's incentive for exclusion is never enough to offset the deadweight loss from monopoly pricing under Bertrand competition.

The incumbent's incentive for exclusion increases in the Cournot case (and the other cases) because, unlike in the case of Bertrand competition, where the incumbent's gain from exclusion is equal to the price increase it can expect to achieve times the quantity it can expect to sell, the gain to the incumbent in the Cournot case is equal to the price increase it can expect to achieve times the quantity it can expect to sell *plus* its profit margin under Cournot times the expected increase in its sales (in going from its Cournot quantity in the presence of entry to the monopoly quantity in the entrant's absence). This additional component in the incumbent's gain is not a transfer from the buyer, and hence is additional profit that can go towards offsetting the buyer's deadweight loss. It has been missed in the literature because the incumbent's profit margin under Bertrand is always zero. This suggests that what drives the Chicago-school's view is not that firms compete in prices (as opposed to quantities) per se, but rather that the post-entry price will necessarily be equal to the incumbent's marginal cost. Once this is relaxed, profitable exclusion becomes possible.

The extra component in the incumbent's gain matters even when the incumbent must resort to a divide-and-conquer strategy to exclude the entrant – because it means that the loss the incumbent incurs on each buyer that it signs will necessarily be smaller under the

[5] The buyer's loss would be smaller under Cournot competition because the price reduction when entry occurs would be smaller than under Bertrand competition. The incumbent's gain under Cournot competition would be smaller because, under Cournot competition, the incumbent earns positive profit when entry occurs.

forms of post-entry competition we consider than under Bertrand. Simply put, the gain from each signed buyer relative to how much each has to be compensated is increasing in the buyer's price, and prices in the cases we consider are higher than prices under Bertrand. All else equal, this also suggests a greater incentive for exclusion in the cases that we consider.

In summary, we find that by focusing on Bertrand competition post entry, the Chicago-school systematically underestimates the incumbent's incentive for exclusion relative to most other forms of post-entry competition[6], and this underestimation can be strong enough that anticompetitive exclusion can often be profitable for the incumbent even where there are no externalities across buyers. Hence, contrary to widespread belief,[7] we find that economies of scale are not a prerequisite for exclusion to be profitable. And when there are externalities across buyers, and scale economies are found to be important, we find that alternative forms of post-entry competition can lead to exclusionary outcomes over a much wider range of fixed costs than in the Bertrand case. Exclusion is always anti-competitive in our setting, and unlike in Rasmusen et al's (1991) setting, there need not be any coordination failures.

Our bottom line conclusion is thus that anticompetitive exclusion can occur over a much wider set of circumstances (more likely to be profitable) than previously thought. This has implications for public policy in that it suggests a new factor — the nature of competition between the incumbent and the entrant post entry — for policy makers to consider when evaluating the potential profitability and welfare implications of exclusive-dealing contracts.

The rest of the paper proceeds as follows. In Section 2, we extend the standard Chicago-school setup to allow for other forms of post-entry competition. We consider Cournot competition in Section 2.1, more cooperative outcomes in Section 2.2, and a Stackelberg game in Section 2.3. In Section 3, we extend the model to allow for multiple buyers and scale economies. In Section 4, we conclude the paper and suggest extensions for future research.

2 The model

As in the standard Chicago-school set up, there are three players in our baseline model: an incumbent firm, a potential entrant, and a single buyer (later, we will extend the model to allow for a unit mass of buyers). We assume the incumbent can produce a single good at a constant marginal cost of $\overline{c} \geq 0$. In contrast, we assume the potential entrant can produce

[6] This is the case as long as the post-entry prices would be above the incumbent's marginal cost.

[7] The European Commission's (2005) discussion paper on exclusionary abuses notes that entry is much more costly when there are economies of scale, and concludes that "In assessing barriers to expansion and entry it is useful therefore to consider the minimum efficient scale in the market concerned (p. 14)." See also Salop (2006), who notes the importance of scale economies for exclusion for exclusion to be privately profitable, and the Canadian Supreme Court's decision in Nutrasweet, 1990, as discussed in Winter (2009).

the same good (if it enters) at a constant marginal cost of c, where $0 \leq c \leq \overline{c}$. We thus assume that the potential entrant has a unit cost advantage, which we denote by $\delta := \overline{c} - c$.

On the demand side, we let $D(p)$ denote the buyer's demand for the good as a function of the market price p. We assume that for all $p > 0$ such that $D(p) > 0$, $D(p)$ is downward sloping and continuously differentiable. We write the buyer's inverse demand as $p(Q)$, where Q is the total quantity supplied (i.e., if q_I denotes the quantity supplied by the incumbent and q_E denotes the quantity supplied by the potential entrant, then $Q = q_I + q_E$). It follows that for all $Q > 0$ such that $p(Q) > 0$, $p(Q)$ is also decreasing and continuously differentiable.

To ensure there is a finite upper bound on the quantity demanded at any positive price, we assume there exists some $Q^O > 0$ such that $p(Q) > 0$ for all $Q < Q^O$, and $p(Q) = 0$ for all $Q \geq Q^O$. In addition, we assume that for all $Q < Q^O$ and $i \in \{I, E\}$, $p''(Q)$ is such that[8]

$$p'(Q) + p''(Q)\, q_i < 0.$$

These assumptions ensure the existence of a unique equilibrium in quantities in the event that the incumbent and the entrant decide to engage in Cournot competition post entry.[9]

Before the entrant can enter and produce the good, however, we assume that the incumbent can offer the buyer an exclusive contract that will keep the entrant out if accepted. Formally, we assume the game has three stages. At stage 1, the incumbent decides whether to offer the buyer an exclusive contract. If it does so, we assume that it takes the form of a payment x, where $x \geq 0$ denotes the lump-sum payment offered by the incumbent to the buyer if the contract is signed (later, we will allow for multiple buyers and discriminatory payments).[10] At stage 2, and after having observed the outcome at stage 1, the entrant decides whether to enter the market and compete against the incumbent. Entering involves paying a non-zero entry cost, $\epsilon \geq 0$. (We will assume that ϵ is low enough that the entrant will always find it profitable to enter if there is no signed contract between the buyer and the incumbent.) At stage 3, the incumbent and the entrant compete by choosing how much quantity to supply the buyer, given that (a) the buyer did not sign the incumbent's contract at stage 1 and (b) the entrant chose to enter the market at stage 2. If the entrant did not enter the market at stage 2, or if the buyer did sign the incumbent's contract at stage 1, then we assume the incumbent supplies the monopoly quantity and earns the monopoly profit.

We will focus on three forms of post-entry competition in what follows. First, we will look

[8] This ensures that the familiar Cournot reaction functions are decreasing when both sellers are active.

[9] They satisfy, for example, the necessary and sufficient conditions in Gaudet and Salant (1991).

[10] Following the literature, this implicitly assume that although the incumbent and the buyer can contract on exclusivity to keep the entrant out, they are unable to contract directly on the future quantity or price of the good. As Whinston (2006) suggests, this may be because the exact nature of the good is as yet unclear.

at a setting in which the firms simultaneously choose how much to produce in the event of entry (i.e., the case of post-entry Cournot competition). Second, we will look at a setting in which the firms are able to coordinate their post-entry quantities (i.e., the case of post-entry cooperative outcomes). Third, we will look at a setting in which the incumbent can commit to its quantity before the entrant (i.e., the case of post-entry Stackelberg competition).

In all three cases, we assume for convenience that both firms would be willing to supply positive quantities if entry occurs. This is tantamount to assuming that the entrant's cost advantage is not too large. Thus, we henceforth assume that $\delta < \overline{\delta}$, where $\overline{\delta} > 0$ is the smallest advantage such that the incumbent's Cournot quantity would be zero post entry.

2.1 Post-entry Cournot competition

We begin by assuming that the firms would engage in Cournot competition post entry. Thus, assuming the entrant enters, we define q_I^C and q_E^C as the quantities that respectively solve

$$\max_{q_I} \left(p\left(Q\right) - \overline{c}\right) q_I \Longleftrightarrow q_I = \frac{p\left(q_I + q_E\right) - \overline{c}}{-p'}$$

and

$$\max_{q_E} \left(p\left(Q\right) - c\right) q_E \Longleftrightarrow q_E = \frac{p\left(q_I + q_E\right) - c}{-p'}.$$

Our assumptions imply that q_I^C and q_E^C are positive and unique. Summing them up gives the aggregate quantity supplied in the market. We will refer to it as the Cournot quantity:

$$Q^C := q_I^C + q_E^C.$$

From the Cournot quantity, we obtain the corresponding Cournot price and profits,

$$p^C := p\left(Q^C\right),$$

$$\pi_I^C := \left(p^C - \overline{c}\right) q_I^C,$$

and

$$\pi_E^C := \left(p^C - c\right) q_E^C.$$

In the absence of entry, we assume that the incumbent will act as a monopolist. To this end, we let Q^M, p^M and π^M denote the respective monopoly quantity, price and profit:

$$Q^M := \arg\max_{Q} \left(p\left(Q\right) - \overline{c}\right) Q,$$

$$p^M := p\left(Q^M\right),$$

and

$$\pi^M := \left(p^M - \bar{c}\right) Q^M.$$

All else being equal, it is clear that the buyer would be better off with entry than without entry. We can see this by comparing the surplus that it would expect to get if entry occurs,

$$S^C := \int_{p^C}^{\infty} D(s)\, ds = \int_0^{Q^C} p(v)\, dv - p^C Q^C, \tag{1}$$

with the surplus that it would expect to get if entry does not occur,

$$S^M := \int_{p^M}^{\infty} D(s)\, ds = \int_0^{Q^M} p(v)\, dv - p^M Q^M, \tag{2}$$

and then noting that $p^M > p^C$ (equivalently, $Q^C > Q^M$) necessarily implies that $S^C > S^M$.

It follows that the buyer must be compensated if it is to sign an exclusive contract. In particular, it must receive a payment of at least $S^C - S^M$ from the incumbent. Otherwise, the buyer would be better off not signing the contract and reaping the benefits of entry.

Let $x^C := S^C - S^M$ denote the minimum payment needed for exclusion. Then, after substituting the expression for S^C from (1), and the expression for S^M from (2), we obtain

$$x^C = \left(p^M - p^C\right) Q^M + \left(\int_{Q^M}^{Q^C} p(v)\, dv - p^C\left(Q^C - Q^M\right)\right). \tag{3}$$

The expression in (3) suggests that the buyer's loss from signing an exclusive contract can be decomposed into two components. The first component, $\left(p^M - p^C\right) Q^M$, represents the loss to the buyer (gain to the incumbent) from the higher price it has to pay on the Q^M units that it purchases. With entry, the buyer would have paid p^C for each of these units. Absent entry, the buyer will be paying p^M for each of these units. The second component, $\int_{Q^M}^{Q^C} p(v)\, dv - p^C\left(Q^C - Q^M\right)$, represents the loss to the buyer from purchasing $Q^C - Q^M$ fewer units at the per-unit price that it would have been able to obtain if entry had occurred.

This second component, which represents a pure deadweight loss to society in the sense that neither the buyer nor the incumbent will realize this surplus in the absence of entry, forms the crux of the Chicago-school's view that exclusion will not be privately profitable. According to the Chicago school, the incumbent will not generally have the means and/or the desire to pay the buyer for exclusion, because the loss to the buyer would be expected to exceed the gain to the incumbent by the resulting deadweight loss from monopoly pricing.

Our main insight is that this need not hold when the post-entry price would be above the incumbent's marginal cost. The reason is that then the entrant would be earning more than its product is contributing to overall surplus, and the Chicago-school's view of exclusive dealing would be systematically *underestimating* the incumbent's gain from deterring entry.

Proposition 1. *When the post-entry price would be above the incumbent's marginal cost – as it would be when the post-entry game is in quantities — the Chicago-school's view of exclusive dealing misses an important component of the incumbent's incentive for exclusion.*

To see this, note that in our case of Cournot competition, the gain to the incumbent from inducing exclusion is not just $\left(p^M - p^C\right) Q^M$ (which is the first component in (3)), but also $\left(p^C - \overline{c}\right)$ times the extra quantity it would produce when entry is deterred. Although this extra quantity, $Q^M - q_I^C$, is a natural consequence of the incumbent and entrant's goods being substitutes in demand, its impact has been missed in the literature because under Bertrand competition, the incumbent's profit margin in the presence of entry is always zero.

Formally, let $G^C := \pi^M - \pi_I^C$ denote the incumbent's gain from exclusion. Then, after substituting the expressions for π^M and π_I^C into G^C, and rearranging, it is easy to see that

$$G^C = \left(p^M - p^C\right) Q^M + \left(p^C - \overline{c}\right) \left(Q^M - q_I^C\right). \tag{4}$$

The first component in (4) is the same as the first component in (3), but the second component, $\left(Q^M - q_I^C\right) \left(p^C - \overline{c}\right)$, has no counterpart in (3). It follows that whether the incumbent's gain from exclusion exceeds the buyer's loss from exclusion turns on whether the second component in (4) exceeds the second component in (3). If it does, then exclusion is privately profitable. If it does not, then exclusion is not privately profitable. Put differently, exclusion will be privately profitable for the incumbent if and only if $G^C - x^C$ is strictly positive, where

$$G^C - x^C = \left(p^C - \overline{c}\right) \left(Q^M - q_I^C\right) - \left(\int_{Q^M}^{Q^C} p\left(v\right) dv - p^C \left(Q^C - Q^M\right)\right). \tag{5}$$

Figure 1 captures the incumbent's tradeoff. For a representative $p(Q)$, $\overline{c}$, and c, it depicts the corresponding monopoly and Cournot prices, p^M and p^C, on the vertical axis, and the incumbent's Cournot quantity, q_I^C, the monopoly quantity, Q^M, and the Cournot quantity, Q^C, on the horizontal axis. Various areas are then named and shaded. As can be seen from this, the buyer's loss from exclusion is given by areas $A + B + C$, whereas the incumbent's gain from exclusion is given by areas $A + B + D$. It follows that whether exclusion will be privately profitable for the incumbent thus depends on the relationship between area D (which is the first component in (5)) versus area C (which is the second component in (5)).

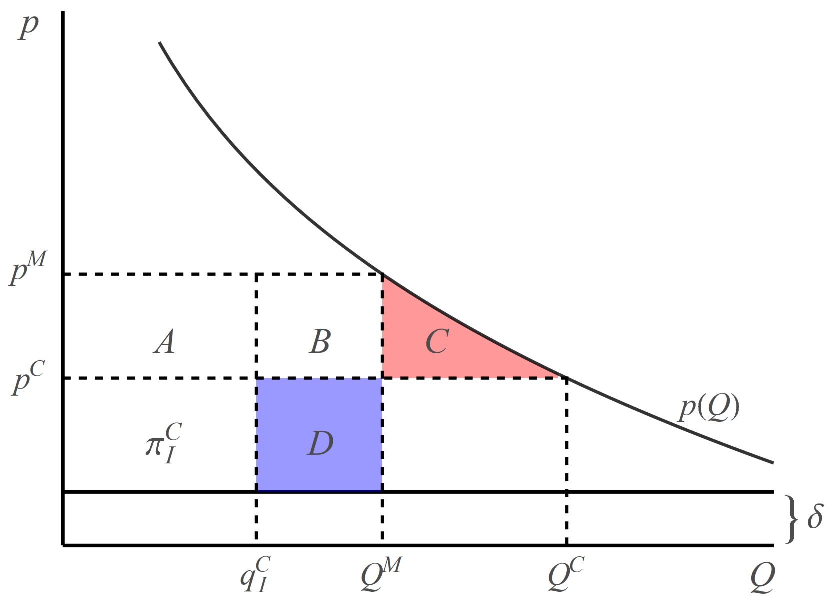

Figure 1. Incumbent's tradeoff. Exclusive dealing is privately profitable for the incumbent as long as area D (blue) is larger than area C (red).

This relationship is ambiguous in general. It depends on the size of the entrant's cost advantage and the curvature of the buyer's demand. The easiest way to see this is by focusing on the bounds of δ. We know that δ is bounded below by zero and above by $\overline{\delta}$. Consider first the case in which δ approaches zero (i.e., the entrant's cost advantage goes to zero). Then, after canceling common terms and rearranging things, the limit of (5) can be written as

$$\lim_{\delta \to 0} \left(G^C - x^C \right) \ = \ \pi^C - \int_{Q^M}^{Q^C} (p\,(v) - \overline{c}) dv, \tag{6}$$

where π^C is the single-firm (symmetric) Cournot profit, and Q^M and Q^C are the monopoly and Cournot quantities, respectively, when both firms' have marginal costs equal to $\overline{c}$. From this, it is straightforward to show that there exist convex and concave demand functions such that (6) is strictly positive. It is also straightforward to show that (6) is strictly positive when the buyer's (inverse) demand is linear (i.e., $p(Q) = a - bQ$).[11] See the example below. This establishes that exclusion can be privately profitable for the incumbent when $\delta \to 0$.

[11] We can gain some intuition for its sign by noting that the second term in (6) is the difference between total surplus at the Cournot quantity and total surplus at the monopoly quantity, and that the ratio of producer surplus to consumer surplus when demand is linear is two in the monopoly case and one in the Cournot case (with 2 firms). The condition in (6) then simplifies to three times the difference between the consumer surplus under monopoly and half the consumer surplus under Cournot, which is strictly positive. More generally, see Anderson and Renault (2003) for bounds on these ratios under monopoly and Cournot.

However, the same cannot be said at the other end. Suppose instead that δ approaches its upper bound (so that the cost difference is large). Then, by the definition of $\overline{\delta}$, it follows that $q_I^C \to 0$ and $p^C \to \overline{c}$, which implies that $\left(p^C - \overline{c}\right)\left(Q^M - q_I^C\right) \to 0$. This means that

$$\lim_{\delta \to \overline{\delta}} G^C = \left(p^M - p^C\right) Q^M, \tag{7}$$

and therefore that

$$\lim_{\delta \to \overline{\delta}} \left(G^C - x^C\right) \; = \; -\left(\int_{Q^M}^{Q^C} p\left(v\right) dv - p^C\left(Q^C - Q^M\right)\right) \; < \; 0. \tag{8}$$

Here the limit of $G^C - x^C$ is strictly negative, implying that the incumbent's gain when δ approaches $\overline{\delta}$ is always outweighed by the buyer's loss. The reason is that area D vanishes when $\delta \to \overline{\delta}$, whereas area C does not (because $Q^C > Q^M$ even when $\delta \to \overline{\delta}$). The Chicago-school's view thus holds in this case: the deadweight loss to the buyer from the incumbent's monopoly pricing cannot be fully compensated when the cost difference is sufficiently large.

Combining our results in (6) and (8), we see that exclusion can be profitable for the incumbent for some δ, but not for all δ. The proposition below summarizes our findings.

Proposition 2. *(Single-buyer case) There exist $p(Q)$ and δ such that exclusion is profitable for the incumbent when there would otherwise be Cournot competition post entry. For all such $p(Q)$, exclusion will be profitable for the incumbent if and only if δ is sufficiently small.*

Our results in Proposition 2 contrast with the case of post-entry Bertrand competition, where it is known that the incumbent's gain from exclusion is always less than the buyer's loss from exclusion in the single-buyer case. We have shown above that this well-known Chicago-school argument overstates its case when the post-entry game is in quantities, however, because it systematically *underestimates* the incumbent's gain from deterring entry in this setting. Per Proposition 2, this extra gain can even be enough to outweigh the deadweight loss to the buyer in some cases, as long as the entrant's cost advantage δ is not too large.

We have thus shown that when there would be post-entry Cournot competition, exclusion can sometimes be profitable for the incumbent when the entrant produces the same good and there is only one buyer (thus ruling out externalities across buyers as the reason for exclusion). It remains to see how small the cost advantage must be for profitable exclusion.

2.1.1 Example with linear demands

Let $p(Q) = a - bQ$ and assume that $\delta \in (0, \overline{\delta})$. The firms' profits under entry are equal to

$$\pi_I = (a - b(q_I + q_E) - \overline{c})\, q_I$$

and

$$\pi_E = (a - b(q_I + q_E) - c)\, q_E.$$

Setting up the first-order conditions and simultaneously solving them yields

$$q_I^C = \frac{1}{3b}(a - 2\overline{c} + c) \tag{9}$$

and

$$q_E^C = \frac{1}{3b}(a - 2c + \overline{c}), \tag{10}$$

from which it follows that the Cournot quantity, price, and equilibrium profits are

$$Q^C = q_I^C + q_E^C = \frac{2a - \overline{c} - c}{3b},$$

$$p^C = p\left(q_I^C + q_E^C\right) = \frac{1}{3}(a + \overline{c} + c),$$

$$\pi_I^C = \frac{(a - 2\overline{c} + c)^2}{9b}, \tag{11}$$

and

$$\pi_E^C = \frac{(a - 2c + \overline{c})^2}{9b}. \tag{12}$$

On the buyer side, the surplus the buyer would expect to get if entry occurs is thus

$$S^C = \frac{1}{2}\left(a - p^C\right)\left(q_I^C + q_E^C\right) = \frac{(2a - \overline{c} - c)^2}{18b}. \tag{13}$$

In the absence of entry, we have assumed that the incumbent will act as a monopolist. Solving for the monopoly quantity, price, profit, and buyer surplus in this case yields:

$$Q^M = \frac{a - \overline{c}}{2b},$$

$$p^M = p\left(Q^M\right) = \frac{a + \overline{c}}{2},$$

$$\pi_I^M = \frac{(a - \overline{c})^2}{4b},$$

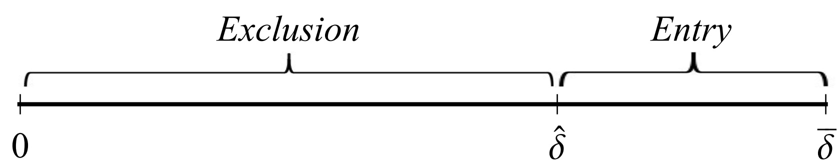

Figure 2. Range of exclusion with a single buyer under Cornout competition.

and

$$S^M = \frac{1}{2}\left(a - p^M\right) Q^M = \frac{(a-\overline{c})^2}{8b}. \tag{14}$$

Comparing terms, it follows that for exclusion to be profitable, the loss to the buyer, i.e., $S^C - S^M$, must be smaller than the gain to the incumbent, i.e., $\pi_I^M - \pi_I^C$. This requires that

$$\pi_I^M - \pi_I^C - \left(S^C - S^M\right) > 0$$
$$\Updownarrow$$
$$\frac{(a-\overline{c})^2}{4b} - \frac{(a-2\overline{c}+c)^2}{9b} - \left(\frac{(2a-\overline{c}-c)^2}{18b} - \frac{(a-\overline{c})^2}{8b}\right) > 0$$
$$\Updownarrow$$
$$(a - 3\overline{c} + 2c)\,\frac{a+\overline{c}-2c}{24b} > 0.$$

Or, in other words, it must be that

$$\delta \; < \; \frac{a-c}{3}. \tag{15}$$

To see how the right-hand side of (15) compares to the upper bound of δ, note that $\overline{\delta}$ is defined to be the cost difference that would just make $q_I^C = 0$ in (9). Solving for this cost difference gives $\overline{\delta} = (a-c)/2$. Letting $\hat{\delta} := (a-c)/3$, it thus follows that entry will be excluded for all δ between 0 and $\hat{\delta}$, whereas it will not be excluded for all δ between $\hat{\delta}$ and $\overline{\delta}$.

The results for the case of linear demand are depicted in Figure 2 above. Here we can see that exclusion is profitable for the incumbent over the first two-thirds of the range of δ (suggesting that, at least in this case, the condition that δ must be sufficiently small is not particularly restrictive). Moreover, we can also see that once exclusion becomes profitable for the incumbent for some $\delta > 0$, it will remain profitable for all lower values of δ as well.

2.2 Post-entry cooperative outcomes

We now allow the firms to coordinate their quantities post entry. There may be different ways to do this in practice. It may be, for example, that this can be done through some form of explicit collusion, or the coordination may come about through tacit collusion in a repeated game sense (because the firms mutually recognize that through repeated interactions, they can support higher prices with implicit threats of punishment). In either case, we assume that coordination in the post-entry game is imperfect in the sense that (i) side payments to achieve the first best are not feasible (e.g., we do not allow the incumbent to shut down in exchange for a payment from the more efficient entrant), and (ii) the firms' ability to support higher post-entry prices (i.e., prices that exceed p^C) may be limited (e.g., in practice, even firms that are not explicitly colluding might be wary of triggering a costly government investigation into potential wrongdoing).[12] We also assume that neither firm can be forced to accept an outcome that would make it worse off. That is, we assume that if the coordination is to succeed, each firm must be made weakly better off relative to its payoff under Cournot.

With these assumptions, we can characterize what we mean by (i) a feasible coordinated outcome and (ii) a supportable post-entry price. Starting with the former, we say that a coordinated outcome is feasible if and only if at the respective quantity choices of the incumbent and entrant, each firm would earn a payoff that is weakly greater than the payoff it would earn under Cournot. So, for example, we say that a quantity choice of $\overline{q}_I$ for the incumbent and $\overline{q}_E$ for the entrant represents a *feasible coordinated outcome* if and only if

$$p(\overline{q}_I + \overline{q}_E) \geq \overline{c}, \quad \overline{q}_I \;\geq\; \frac{(p^C - \overline{c})q_I^C}{p(\overline{q}_I + \overline{q}_E) - \overline{c}}, \quad \text{and} \quad \overline{q}_E \;\geq\; \frac{(p^C - c)q_E^C}{p(\overline{q}_I + \overline{q}_E) - c}. \tag{16}$$

It is easy to see from this that the Cournot outcome is feasible (because $p^C \geq \overline{c}$ and the latter inequalities hold with equality at the Cournot quantities) — and thus we know that there always exists at least one feasible coordinated outcome. More generally, however, depending on c, $\overline{c}$, and demand $p(Q)$, there may be a multiplicity of outcomes. To keep track of them in what follows, we denote the set of all feasible coordinated outcomes by $\Omega(c, \overline{c}, p(Q))$, where

$$\Omega(c, \overline{c}, p(Q)) \;:=\; \left\{ (q_I, q_E) \mid p(q_I + q_E) \geq \overline{c},\; q_I \geq \frac{(p^C - \overline{c})q_I^C}{p(q_I + q_E) - \overline{c}},\; q_E \geq \frac{(p^C - c)q_E^C}{p(q_I + q_E) - c} \right\}.$$

Notice that the outcomes in this set give rise to potentially different post-entry prices.

Definition: We say that a price p is supportable by a feasible coordinated outcome if and only if there exist quantities q_I and q_E such that $p = p(q_I + q_E)$ and $(q_I, q_E) \in \Omega(c, \overline{c}, p(Q))$.

Not all prices can be supported, however. It is easy to see, for example, that all sup-

[12] One can imagine that such an investigation is more likely to be triggered the higher is the post-entry price relative to Cournot. In the extreme, for example, it may be that a post-entry price that is less than 10% higher would not be enough to trigger an investigation, but a post-entry price more than this would be.

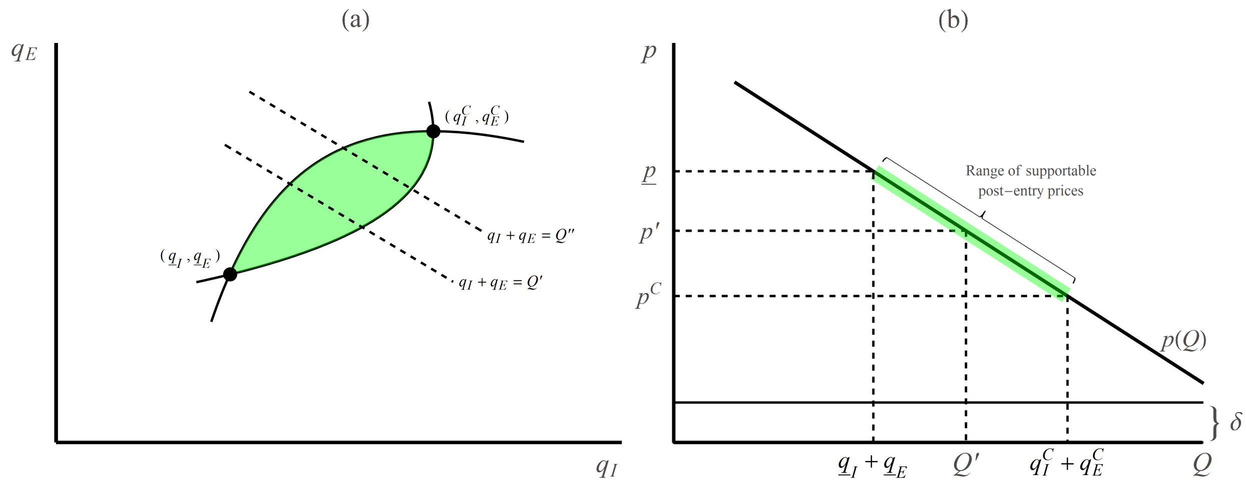

Figure 3. The set of feasible coordinated outcomes, and the associated set of supportable post-entry prices.

portable prices must be weakly greater than the Cournot price.[13] And, in the special case in which $\delta = \overline{\delta}$, only the Cournot price can be supported.[14] For all $\delta < \overline{\delta}$, though, our assumptions give rise to a multiplicity of outcomes and associated supra competitive prices.

Figures 3a and 3b are illustrative. The shaded region in Figure 3a depicts the set of feasible coordinated outcomes for a representative c and $\overline{c}$, assuming that $p(Q) = a - bQ$.[15] Figure 3b depicts the corresponding set of supportable prices. Pure horizontal movements from left to right in the shaded region in Figure 3a correspond to lower supportable prices in Figure 3b, as do pure vertical movements from bottom to top. The reason is that they increase the total quantity sold. Movements from the upper left to the lower right along a given dashed-line segment in the shaded region in Figure 3a correspond to no change in the supportable price (because the sum of the entrant and incumbent's quantities is unchanged in this case), whereas movements across dashed-line segments in the shaded region (either to the left or the right) do affect the price. The lowest price that can be supported occurs at the upper-right most point of the set in Figure 3a (the Cournot outcome). The highest price

[13] The idea is that for any $p < p^C$, industry profits would be strictly less than the Cournot industry profit, and thus it would not be possible to make both firms weakly better off than they would be under Cournot.

[14] When the entrant's cost advantage reaches $\delta = \overline{\delta}$, industry profits are maximized with the entrant producing its monopoly quantity and the incumbent producing zero. At any other price, industry profits would be lower, and there would be no way to make both firms better off than they would be under Cournot.

[15] The concave curve in Figure 3a depicts the locus of quantity pairs (q_I, q_E) such that the incumbent would earn its Cournot profit. Quantity pairs below (above) this curve yield higher (lower) profit for the incumbent. The convex curve depicts the locus of quantity pairs (q_I, q_E) such that the entrant would earn its Cournot profit. Quantity pairs to the left (right) of this curve yield higher (lower) profit for the entrant.

that can be supported occurs at the lower-left most point of the set ($q_I = \underline{q}_I$ and $q_E = \underline{q}_E$).

We do not attempt to narrow the feasible set with further restrictions because, depending on the industry at hand and how aggressive competition authorities are, some firms in some cases might only be able to support prices that are slightly above Cournot, whereas other firms in other cases might be able to support prices that are close to the monopoly level (either the incumbent's or the entrant's). Moreover, there is no need to presume whether the gains from coordinating higher prices would be split equally or unequally. Depending on their relative bargaining powers, one can imagine that the gains from coordination may accrue entirely to the incumbent, entirely to the entrant, or be split somewhere in between.

Despite the plethora of outcomes, however, we have the following useful result:[16]

Lemma 1. *In all feasible coordinated outcomes, $q_I \leq q_I^C$ and $q_E \leq q_E^C$.*

Lemma 1 essentially implies that there can be no feasible coordinated outcome in which one firm produces and sells more than its Cournot quantity. While this firm would undoubtedly see its profit increase (from selling a larger quantity at a supra-competitive price), the firm bearing the full brunt of the quantity reduction would see its profit fall. This finding provides the final building block that we need to assess the incentives for exclusion pre-entry.

When coordination is allowed, not only will the incumbent's gain from exclusion be affected, but the buyer's loss from exclusion will be affected as well – giving rise to an overall greater incentive to exclude the entrant relative to the Bertrand case. To see this, let $(\overline{q}_I, \overline{q}_E) \in \Omega(c, \overline{c}, p(Q))$ be the expected coordinated outcome (with $\overline{q}_I$ being the incumbent's quantity and $\overline{q}_E$ being the entrant's quantity), and let $\overline{p} := p(\overline{Q})$ be the associated post-entry price, where $\overline{Q} = \overline{q}_I + \overline{q}_E$. Then, following our reasoning in Section 2.1, which compared the incumbent's gain from exclusion G with the buyer's loss from exclusion x, we can see that exclusion will be profitable for the incumbent if and only if $\overline{G} - \overline{x}$ is strictly positive, where

$$\overline{G} = \left(p^M - \overline{p}\right) Q^M + \left(\overline{p} - \overline{c}\right) \left(Q^M - q_I^C\right),$$

$$\overline{x} = \left(p^M - \overline{p}\right) Q^M + \left(\int_{Q^M}^{\overline{Q}} p\left(v\right) dv - \overline{p}\left(\overline{Q} - Q^M\right)\right),$$

and

$$\overline{G} - \overline{x} \ = \ \left(\overline{p} - \overline{c}\right) \left(Q^M - \overline{q}_I\right) - \left(\int_{Q^M}^{\overline{Q}} p\left(v\right) dv - \overline{p}\left(\overline{Q} - Q^M\right)\right). \tag{17}$$

The first term in (17), $\left(\overline{p} - \overline{c}\right)\left(Q^M - \overline{q}_I\right)$, represents that part of the incumbent's gain from exclusion that is not a loss to the buyer. It is larger the larger is the gap between the

[16] The proof of Lemma 1 is given in the appendix.

post-entry price and the incumbent's marginal cost, and between the incumbent's monopoly quantity and its post-entry quantity. As we saw earlier, there is no corresponding term in the case of Bertrand competition (because the incumbent's profit margin in the Bertrand case is always zero post entry). The second term in (17), $-\left(\int_{Q^M}^{\overline{Q}} p\,(v)\,dv - \overline{p}\left(\overline{Q} - Q^M\right)\right)$, although representing a loss to the buyer, represents a smaller loss to the buyer than under Bertrand. The reason is that the post-entry quantity that would be sold on the market when the quantities can be coordinated is less than under Bertrand, implying that the deadweight loss in moving to exclusion is also less. Both factors contribute to the incumbent having a greater incentive to exclude the entrant when the post-entry outcome can be coordinated.

We can easily extend the comparison to the case of Cournot competition by comparing the expression for the incumbent in (17) with the analogous expression for the incumbent in (5). Our finding that $\overline{q}_I \leq q^C$ (true for any feasible coordinated outcome), and the fact that the associated price $\overline{p}$ must be greater than p^C in any outcome other than the Cournot outcome itself, implies that the first term in (17) will be greater than the first term in (5), while the second term in (17) will be less than the second term in (5). As in the previous comparison, both effects go in the same direction, implying that the incumbent's incentive in the case of coordination will also be greater relative to the case of Cournot competition.

Proposition 3. *(Single-buyer case) The incumbent's incentive to exclude the entrant will be greater when the post-entry outcome can be coordinated than when it cannot. This holds whether the benchmark for comparison is Bertrand competition or Cournot competition.*

Normally, at this point, we would still need to verify whether there exist $p(Q)$ such that exclusion can be profitable for the incumbent, similar to what we did in Section 2.1 for the Cournot case. But that is not necessary here. Proposition 3 establishes that the incumbent's incentive for exclusion is at least as great in any feasible coordinated outcome as it is under Cournot, and thus, at a minimum, exclusion will be profitable for the incumbent whenever it is profitable under Cournot. In some cases, though, the incumbent's incentive will be much stronger. For example, when conditions are such that the incumbent's monopoly quantity is in the set of feasible coordinated outcomes (as it is in Figure 3a), and if this were expected to be the outcome, then the incumbent would always find it profitable to exclude the entrant (because the second term in (17) would then be zero, leaving only the positive first term).

The foregoing suggests that the incumbent's incentive for exclusion can vary widely even among coordinated outcomes. To obtain further results, it is therefore useful to compare across different outcomes. The following propositions summarize what we can say in general:

Proposition 4. *(Single-buyer case) Among outcomes that have the same supportable price p, the incumbent's incentive for exclusion will be greater the smaller is its quantity q_I.*

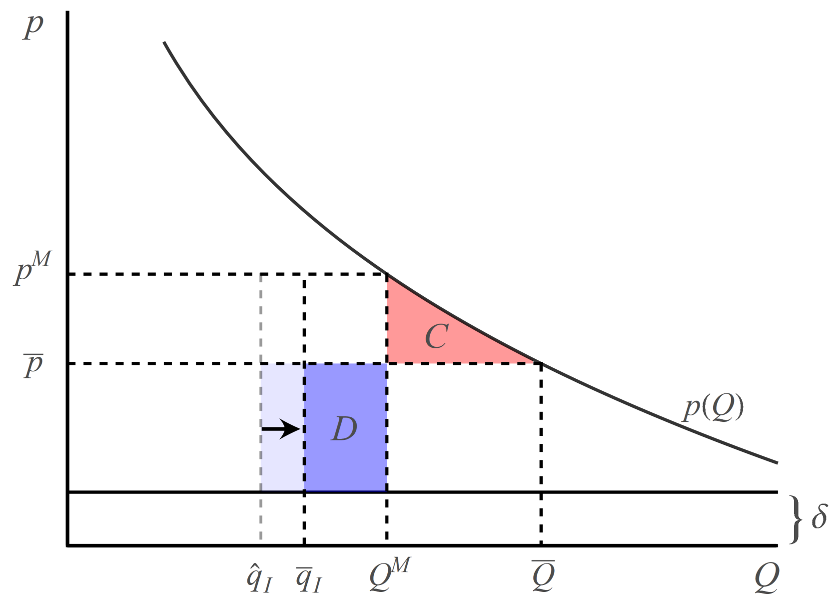

Figure 4. Impact of a rise in the incumbent's post-entry quantity, holding fixed the post-entry coordinated price.

Proposition 5. *(Single-buyer case) Among outcomes that have the same quantity q_I, the incumbent's incentive for exclusion will be greater the larger is the supportable price p.*

The claims in Propositions 4 and 5 follow directly from (17) and can be seen first hand from Figures 4 and 5. Figure 4 compares two feasible coordinated outcomes $(\hat{q}_I, \hat{q}_E)$ and $(\overline{q}_I, \overline{q}_E)$, where the supportable price p is equal to $\overline{p}$ in the two cases, but where the incumbent's post-entry quantity is higher in the latter. In this case, even though the buyer's loss is the same in the two outcomes, we can see that the incumbent's gain is lower under $(\overline{q}_I, \overline{q}_E)$.

Figure 5 compares the feasible coordinated outcome $(\tilde{q}_I, \tilde{q}_E)$ with the feasible coordinated outcome $(\overline{q}_I, \overline{q}_E)$. Here, $(\overline{q}_I, \overline{q}_E)$ is such that it leads to a lower post-entry price, but has the same post-entry quantity for the incumbent (i.e., $\tilde{q}_I = \overline{q}_I$). In this case, both the buyer's loss from exclusion is higher and the incumbent's gain from exclusion is lower under $(\overline{q}_I, \overline{q}_E)$.

This last outcome in particular has policy implications. It is often the case that competition authorities and policy makers have budget constraints that require scarce resources to be allocated in the most effective manner. Sometimes hard decisions have to be made as to whether a fixed budget would be better spent at the margin pursuing alleged price-fixing cases or going after potential abuse of dominance cases (such as, for example, the case of an incumbent who is offering an exclusive-dealing arrangement). The implication of Proposition 4 is that by prioritizing the former (going after alleged price-fixing cases), the authorities may, indirectly, also benefit from a decline in the latter. This follows because more rigorous

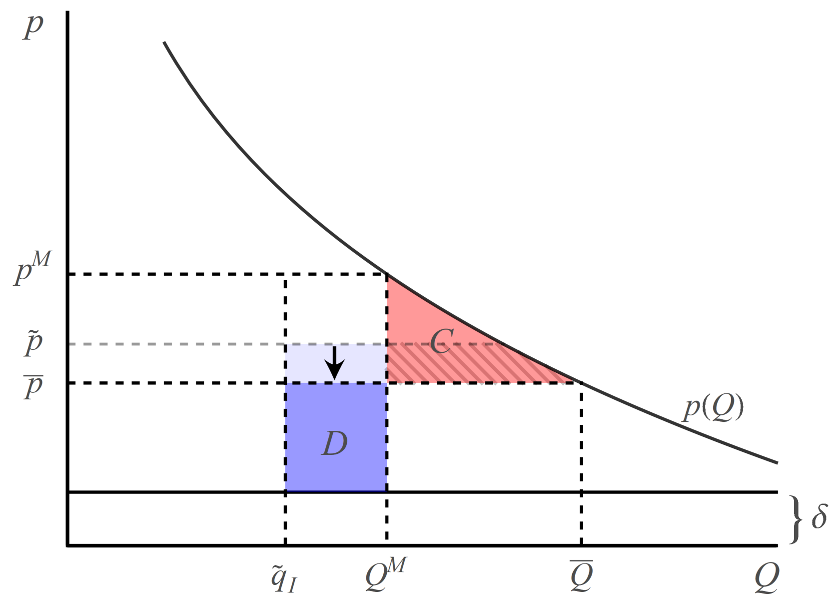

Figure 5. Impact of a reduction in the post-entry coordinated price, holding fixed the incumbent's post-entry quantity.

enforcement of the former would be expected to lead to lower supportable prices, all else equal, which in turn implies that the incumbent will then have less incentive for exclusion.

2.3 Post-entry Stackelberg competition

The last post-entry setting we consider is that of a non-cooperative Stackelberg leader-follower game in which the incumbent is the Stackelberg leader and the entrant is the Stackelberg follower. A Stackelberg setting differs from a Cournot setting in that under the former, firms choose their quantities sequentially, whereas under the latter, firms choose their quantities simultaneously. This difference matters for at least two main reasons. First, it means that, in a Stackelberg game, unlike in a Cournot game, the entrant gets to observe the incumbent's quantity choice before it must choose its own quantity (and thus it has the ability to react to the incumbent's choice – either by raising or lowering its quantity). Second, it means that in a Stackelberg game, unlike in a Cournot game, the incumbent can choose its quantity strategically, knowing that the entrant can and will react to the choice it makes. This potentially gives the incumbent a significant advantage over the entrant, which it can then use to increase its profit relative to what it would have been under Cournot.

A Stackelberg setting also differs significantly both qualitatively and quantitatively from our coordinated-outcomes setting. One difference is that under Stackelberg, the firms' quantities are chosen non-cooperatively, as opposed to cooperatively in the case of coordinated outcomes. More importantly, though, the "philosophies" of the two post-entry settings are different. Unlike in the coordinated-outcomes setting, the net effect in the Stackelberg setting is not to increase overall industry profits from which each firm can be made weakly better off, but rather for the incumbent to gain at the expense of the entrant by capturing a larger share of the industry profit (even if the industry profit is reduced in the process).

Our purpose here is to consider how these differences affect the incumbent's incentives for exclusion, and ultimately to rank the case of Stackelberg competition relative to the previously considered Bertrand, Cournot, and coordinated-outcomes settings. To this end, we begin by noting that under Stackelberg, the post-entry game takes place in two substages. First, the incumbent chooses its quantity q_I. Then, the entrant, after observing the incumbent's choice, chooses its quantity q_E. Solving the game backwards, we let $q_E = q_E(q_1, c)$ denote the entrant's optimal quantity choice in stage two, and we let $q_I = q_I^S$ denote the incumbent's optimal quantity choice in stage one, where q_I^S is the quantity that solves

$$\max_{q_I} \left(p\left(q_I + q_E(q_1, c)\right) - \bar{c}\right) q_I).$$

In what follows, we refer to q_I^S as the incumbent's Stackelberg quantity, $q_E^S := q_E(q_I^S, c)$ as the entrant's Stackelberg quantity, and $Q^S := q_I^S + q_E^S$ as the overall Stackelberg quantity. From this, we can then obtain the corresponding Stackelberg price and profit of each firm:

$$p^S := p\left(Q^S\right),$$

$$\pi_I^S := \left(p^S - \bar{c}\right) q_I^S,$$

and

$$\pi_E^S := \left(p^S - c\right) q_E^S.$$

We continue to assume that the incumbent will act as a monopolist in the absence of entry, and thus we continue to let π^M and S^M denote the profit and surplus, respectively, that the incumbent and the buyer would expect to receive if entry does not occur. In contrast, if entry does occur, the surplus that the buyer would expect to receive can be written as:

$$S^S := \int_{p^S}^{\infty} D\left(s\right) ds = \int_0^{Q^S} p\left(v\right) dv - p^S Q^S.$$

Using the same reasoning as in the previous subsections, it then follows that exclusion will be privately profitable for the incumbent if and only if $G^S - x^S$ is strictly positive, where

$$G^S = \left(p^M - p^S\right) Q^M + \left(p^S - \bar{c}\right)\left(Q^M - q_I^S\right),$$

$$x^S = \left(p^M - p^S\right) Q^M + \left(\int_{Q^M}^{Q^S} p\left(v\right) dv - p^S \left(Q^S - Q^M\right) \right),$$

and

$$G^S - x^S \ = \ \left(p^S - \overline{c}\right) \left(Q^M - q_I^S\right) - \left(\int_{Q^M}^{Q^S} p\left(v\right) dv - p^S \left(Q^S - Q^M\right) \right). \tag{18}$$

We are now ready to compare the incumbent's expression in (18) with the analogous expressions that arise in the Bertrand, Cournot, and coordinated-outcomes settings. The comparisons hinge on two important features: how does the incumbent's Stackelberg quantity compare to its quantities in these other settings, and how does the overall Stackelberg quantity compare to the overall quantities that would be supplied in these other settings?

With respect to the incumbent's quantity, it is easy to see that $q_I^S \geq q_I^C$ (this is an immediate consequence of our assumption that the firms' reaction functions are downward-sloping), and thus for all $\overline{q}_I$ that may arise in a feasible-coordinated outcome, we have

$$q_I^S \ \geq \ q_I^C \ \geq \ \overline{q}_I. \tag{19}$$

Similarly, with respect to the overall quantity, it is easy to see that $Q^S \geq Q^C$ (the reduction in the entrant's quantity in Stackelberg will be less than the increase in the incumbent's quantity), and thus for all $\overline{Q}$ that may arise in a feasible-coordinated outcome, we have

$$Q^S \ \geq \ Q^C \ \geq \ \overline{Q}. \tag{20}$$

Using these comparative statics, we obtain our main result under Stackelberg:

Proposition 6. *(Single-buyer case) When the post-entry competition between the incumbent and entrant would be a Stackelberg leader-follower game, with the incumbent being the leader and the entrant the follower, the incumbent's incentive for exclusion will be greater than it is in the Bertrand setting, but less than it is in the Cournot and coordinated-outcomes settings.*

The Stackelberg setting does better than the Bertrand setting because of the extra component in the incumbent's gain from exclusion and the fact that the buyer's loss from exclusion would be lower (because the post-entry price would be higher). But it does worse than the Cournot and coordinated-outcome settings because, relative to those settings, the incumbent's quantity is higher and the post-entry price is lower under Stackelberg competition.

To get a sense of how much the incumbent's incentives may be reduced compared to Cournot and coordination, it is useful to superimpose a graph of the Stackelberg case onto a graph of the Cournot case for a given c, $\overline{c}$, and linear demand $p(Q) = a - bQ$. Figure 6

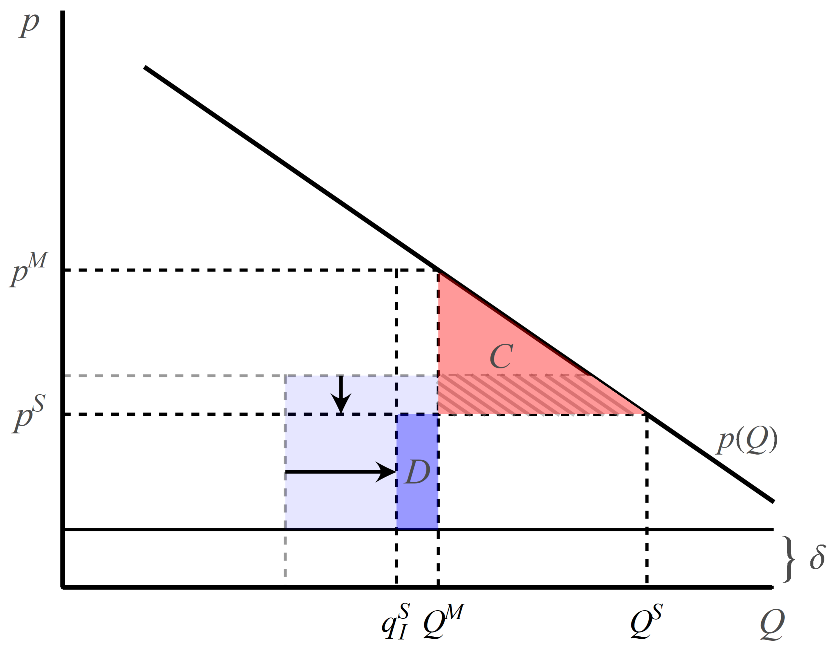

Figure 6. Decreased incentive for exclusion under Stackelberg, compared to Cournot.

depicts the two components of the incumbent's incentive for exclusion in the Cournot case as areas D and C, respectively. It then shows how they are affected in the Stackelberg case.

As implied by Proposition 6, we can clearly see that area D 'shrinks' and area C 'expands' under Stackelberg, giving rise to a reduced incentive for exclusion relative to Cournot. We can also see the degree to which area D shrinks and area C expands. And, in perhaps the most striking thing to notice, we can see that whereas area D is larger than area C (implying that exclusion would be profitable for the incumbent under Cournot), the opposite is true for the analogous areas under Stackelberg (implying that exclusion would not be profitable for the incumbent under Stackelberg – even though everything else is the same in both cases).

This latter finding begs the question: how representative is it? We showed previously (see Figure 2) that when $p(Q) = a - bQ$ (as it is in Figure 6), exclusion is privately profitable for the incumbent over the first two-thirds of the feasible region of δ when the firms compete *a la* Cournot post entry. In contrast, we can show (see the appendix) that when $p(Q) = a - bQ$, exclusion is *never* privately profitable for the incumbent when the firms compete *a la* Stackelberg post entry. In this sense, Figure 6 is indeed representative. Assuming the demand function is linear, we could have chosen any feasible c and $\bar{c}$ for which exclusion would be privately profitable in the Cournot case, and we would have found that, given the same c and $\bar{c}$, exclusion would not be privately profitable in the Stackelberg case.

But there is also a sense in which Figure 6 is not representative. We can show there are other demands for which exclusion *can* be profitable. It can be profitable, for example, if demand is sufficiently concave and the entrant's cost advantage is not too large.[17] The end result is similar to what we found under Cournot (albeit over a smaller set of circumstances).

Proposition 7. *(Single-buyer case) There exist $p(Q)$ and δ such that exclusion is profitable for the incumbent when there would otherwise be Stackelberg competition post entry. For all such $p(Q)$, exclusion will be profitable for the incumbent if and only if δ is sufficiently small.*

At the upper end of δ, for example, as $\delta \to \overline{\delta}$, the first term in (18) vanishes leaving only the negative second term. Exclusion is never profitable in this case. But, for small enough δ, for example as $\delta \to 0$, exclusion can be profitable (as seen in our example in the appendix).

This concludes our critique of the Chicago-school's view that an incumbent firm will never find it profitable to exclude a more efficient entrant in the absence of pro-competitive efficiencies. To the contrary, we have seen that this assertion fails to hold in each of the post-entry games we considered. What the Chicago school misses is that the incumbent can sometimes gain from the exclusion independent of the buyer's loss, and that this will be the case whenever the post-entry price would exceed the incumbent's marginal cost. In essence, by assuming only one buyer and Bertrand competition post entry, the Chicago School ignores not just potential externalities among buyers, but also potential externalities among sellers.

3 Multiple buyers and economies of scale

The Chicago-school's view is typically exposited in the context of a single buyer, where the buyer is implicitly assumed to be large enough to support entry by itself. The post Chicago-school synthesis that began with the work of Rasmusen et al (1991), and which was extended by Segal and Whinston (2000), noted this and suggested that if instead multiple buyers were needed to support the entrant's entry (because of scale economies), then, contrary to the Chicago-school's claims, anti-competitive exclusion could indeed be privately profitable.[18]

Rasmusen et al's insight was to notice that when multiple buyers are needed to support entry, the incumbent might be able to profitably induce exclusion by exploiting coordination failures among them. Segal and Whinston followed by showing that even in the absence of coordination failures, the incumbent might be able to profitably induce exclusion through a

[17] We show this in the appendix for the demand function $p(Q) = 1 - Q^4$ when $c = \overline{c}$.

[18] Aghion and Bolton (1987) have also critiqued the Chicago-school's view that exclusive dealing could not be anticompetitive. Unlike the aforementioned articles, however, which focus on externalities among buyers as the impetus for the exclusion, they do so in the context of rent-shifting via penalties for breach of contract.

divide-and-conquer strategy, as long as it did not have to sign up every buyer to an exclusive. As in Rasmusen et al, however, this was shown assuming that firms compete à la Bertrand.

Segal and Whinston's idea is predicated on the observation that the greater the entrant's economies of scale (fixed costs relative to the entrant's post-entry profit), the fewer the number of buyers the incumbent will have to sign to induce exclusion. To see how it works, and ultimately to provide a framework in which to compare Bertrand competition versus the kinds of post-entry competition we have considered, assume there is a unit mass of identical buyers, each with an inverse demand function of $p(Q)$. Assume also that the timing of the game is the same as before, with the only difference being that the incumbent can make discriminatory divide-and-conquer-offers in stage 1. We further assume that the buyers can observe each other's contract offers before they accept or reject, and we will focus on perfectly-coalition proof Nash equilibria (PCPNE) in order to rule out coordination failures.

Segal and Whinston's insight is that the incumbent's payments do not have to be profitable on a buyer-per-buyer basis when multiple buyers are needed to support entry. Rather, to determine whether exclusion would be profitable, the incumbent only has to compare the sum of the payments that would be needed to deter the entrant to the sum of the gains.

To continue, suppose, as in Segal and Whinston, that firms compete à la Bertrand post entry, so that in the event of entry, the equilibrium price to each buyer would be bid down to $\bar{c}$, resulting in a per-buyer profit of $\pi_I^B = 0$ for the incumbent, a per-buyer profit of $\pi_E^B = (\bar{c} - c)D(\bar{c})$ for the entrant, and a per-buyer surplus of $S^B = \int_{\bar{c}}^{\infty} D(s)\,ds$. Suppose also that the entrant would be deterred if and only if the incumbent signs at least $\alpha \in (0,1]$ share of the buyers to an exclusive contract in stage 1. Then, as Segal and Whinston show, the condition for determining whether the incumbent can profitably deter the entrant is not

$$\pi^M - (S^B - S^M) \geq 0,$$

as it is in the classic Chicago-school case with a single buyer, but rather[19]

$$\pi^M - \alpha \left(S^B - S^M\right) \geq 0. \tag{21}$$

Segal and Whinston conclude from this that exclusion can sometimes be profitable (in contrast to the Chicago-school). Although the incumbent gains π^M when it excludes, its cost of exclusion is only $\alpha(S^B - S^M)$. Notice that exclusion will be profitable in this case if α is sufficiently close to zero, whereas it will not be profitable if α is sufficiently close to one. Since the left-hand-side of (17) is decreasing in α, it follows that there exists $\alpha \in (0,1)$

[19] This follows from the fact that the incumbent gains π^M in total from all buyers when entry is deterred, even though it only needs to offer an exclusive contract with a payment of $S^B - S^M$ to α share of the buyers.

such that the incumbent will just be indifferent between excluding the entrant or not. Let

$$\alpha^B := \frac{\pi^M}{S^B - S^M} \tag{22}$$

denote this critical value. α^B's interpretation is that it is the largest share of buyers that the incumbent would be willing to sign to an exclusive contract, given that each buyer would have to be compensated $S^B - S^M$ to sign.[20] If this would be enough to deter the entrant from entering, then exclusion will be profitable. Otherwise, exclusion will not be profitable.

3.1 Other forms of post-entry competition

Segal and Whinston's insight extends also to the settings we have considered. Let π_I^*, π_E^*, and S^* denote the incumbent's profit, the entrant's profit, and the buyer's surplus, respectively, for a given setting and expected outcome (e.g., in the Cournot case, $\pi_I^* = \pi_I^C$, $\pi_E^* = \pi_E^C$, and $S^* = S^C$; in the Stackelberg case, $\pi_I^* = \pi_I^S$, $\pi_E^* = \pi_E^S$, and $S^* = S^S$; and in the coordinated case, the profits and buyer's surplus correspond to the expected outcome in the set of feasible coordinated outcomes). Then, Segal and Whinston's insight is that when multiple buyers are needed to support entry, an incumbent that successfully deters the entrant will earn an extra $\pi^M - \pi_I^*$ from each of its buyers, whereas its cost will only be $S^* - S^M$ times the number of buyers it has to sign up. It follows that if the incumbent has to sign up α share of the buyers, then the condition for determining whether the incumbent can profitably deter the entrant is not $\pi^M - \pi_I^* - \left(S^* - S^M\right) \geq 0$, as it is when there is only one buyer, but rather

$$\pi^M - \pi_I^* - \alpha \left(S^* - S^M\right) \geq 0. \tag{23}$$

Here, we can see that profitable exclusion is more likely when multiple buyers are needed to support entry in the sense that if exclusion would be profitable in the single-buyer case, then it will also be profitable in the multiple-buyer case, whereas the converse is not true. In the former instance, (23) holds even when $\alpha = 1$. In the latter instance, where exclusion can only be profitable when there are multiple buyers, (23) holds if and only if $\alpha \leq \alpha^*$, where

$$\alpha^* := \frac{\pi^M - \pi_I^*}{S^* - S^M}. \tag{24}$$

The interpretation of α^* is that it is the largest share of buyers that the incumbent would be willing to sign to an exclusive contract — at a cost of $S^* - S^M$ per buyer — when the firms would otherwise engage in the post-entry game at hand (where it is understood that

[20] Notice that any amount less than $S^B - S^M$ would be rejected because it would not be coalition proof.

α^* depends on which game, and in the coordinated case, which outcome, would be played).

Comparing α^* to its analog in the Bertrand case, we obtain the following result:

Proposition 8. *(Multiple-buyer case) Relative to Bertrand competition, the incumbent's incentives for exclusion are strengthened when the post-entry competition would otherwise be Cournot, coordinated, or Stackelberg, in the sense that $\alpha^* > \alpha^B$ for all cost differences $\delta < \overline{\delta}$.*

Proposition 8 implies that the incumbent always has a stronger incentive for exclusion in the post-entry games we consider in the sense that it would be willing to sign up a larger share of the buyers in these games than it would if the post-entry game were Bertrand. This holds trivially for all $p(Q)$ and δ in which exclusion would be profitable for the incumbent even in the case of a single buyer (because then the incumbent earns positive profit from each of its signed buyers, and thus would be willing to sign up all of its buyers if need be). In this case, α^* is greater than one and we know that α^B is always less than one. But it also holds for those instances in which $\alpha^* < 1$ (i.e., it holds even when $S^* - S^M > \pi^M - \pi_I^*$). Intuitively, in these latter cases, the incumbent loses profit from each buyer that it signs, but because it loses less per buyer than it would under Bertrand (we know this from Propositions 1, 3, and 6), it is willing to sign up more buyers in total. Another way of thinking of this is that the incumbent's gain relative to the buyer's loss is in general increasing in the price paid by the buyer for all feasible $p(Q)$ (see the proof of Proposition 8 in the appendix). Since the post-entry prices in the settings we have considered are all higher than the Bertrand price, for all $\delta < \overline{\delta}$, this means that the ratio of the incumbent's gain relative to the buyer's loss will also be unambiguously higher in these settings. All else equal, this leads to a strengthening of incentives for exclusion in each of the post-entry games we consider relative to Bertrand.

3.2 Profitable exclusion

It would be tempting, but wrong, to conclude from this that exclusion is always more likely to arise in the games we consider, and that if conditions are such that exclusion is profitable under Bertrand, then it must also be profitable in these other games. As we shall see, there exist $p(Q)$ and settings for which this is true, but for other $p(Q)$, there may exist δ and ϵ such that exclusion would only be profitable under Bertrand competition. Or there might be $p(Q)$, δ, and ϵ in which exclusion would be profitable under Bertrand and Cournot competition, for example, but not under Stackelberg competition. The reason is that although it is true that the increased incentive for exclusion in the post-entry games we consider means that the incumbent would be willing to sign up more buyers in these games, the number of buyers that it would have to sign up may be higher as well. The latter depends not only on how large the entrant's fixed costs are, but also on how the entrant's post-entry profit differs across games and outcomes, a comparison that can go either way depending on $p(Q)$ and δ.

To make progress, it is useful to let $\xi^* := \{(p(Q), \delta) \mid \pi^M - \pi_I^* - (S^* - S^M) \geq 0\}$ denote the set of all $(p(Q), \delta)$ such that it would be profitable for the incumbent to exclude the entrant even if it had to sign up every buyer. Similarly, let ξ^{*c} denote its complement. Then there are two cases to consider when comparing the settings we consider to that of Bertrand:

Case 1: $(p(Q), \delta) \in \xi^*$

In this case, we know that exclusion is profitable for the incumbent in the post-entry game at hand no matter how small the entrant's fixed cost ϵ may be, whereas exclusion is only profitable for the incumbent in the case of Bertrand competition if ϵ is large enough.[21]

Case 2: $(p(Q), \delta) \in \xi^{*c}$

In this case, we know that exclusion will be profitable for the incumbent if and only if the entrant would be deterred when the incumbent has signed α^* share of the buyers. Since the most the entrant can earn if it enters and competes for the unsigned buyers in this case is then $(1 - \alpha^*)\, \pi_E^* - \epsilon$, it follows that entry will be profitably deterred if and only if

$$\epsilon \ > \ \epsilon^* := (1 - \alpha^*)\, \pi_E^*. \tag{25}$$

Similarly, we know that exclusion will be profitable for the incumbent when the firms would otherwise engage in Bertrand competition if and only if the entrant would be deterred when $\alpha = \alpha^B$. It follows that entry will profitably be deterred in this case if and only if

$$\epsilon \ > \ \epsilon^B := \left(1 - \alpha^B\right) \pi_E^B. \tag{26}$$

We can thus see that in both instances, exclusion will be profitable for the incumbent if and only if the entrant's fixed costs are high enough. How high they have to be depends on the strength of the incumbent's gain from exclusion (which determines the critical values of α), and the entrant's expected profit on entering the market. Intuitively, the weaker the incumbent's gain from exclusion, and the greater the entrant's expected profit on entering the market, the higher the entrant's fixed costs will have to be for exclusion to be profitable.

As can be seen from (25) and (26), the thresholds differ across settings and outcomes. On the one hand, we have already seen that the incumbent's incentive for exclusion is always

[21] This follows because $\alpha^B < 1$ implies that if the entrant's fixed costs are small enough, the entrant would necessarily earn strictly positive profit when only α^B share of the buyers are signed to an exclusive contract.

stronger in the post-entry settings we consider (weaker in the Bertrand case). By itself, this suggests that $\epsilon^* < \epsilon^B$. On the other hand, we can see that the comparison between ϵ^* and ϵ^B also depends on the comparison between π_E^* and π_E^B, which can go either way. For any $p(Q)$ and δ sufficiently small, it is easy to see that $\pi_E^* > \pi_E^B$ (since the limit of π_E^B goes to zero as the entrant's cost advantage vanishes). However, for δ sufficiently large, the opposite is true (the pricing constraint imposed on the entrant from Bertrand competition weakens as δ increases). The latter, when combined with the fact that $\alpha^* > \alpha^B$, ensures that $\epsilon^* < \epsilon^B$.

The next proposition summarizes what we have learned from these two cases.

Proposition 9. *(Multiple-buyer case) The threshold of fixed costs that determines the cutoff for when exclusion is privately profitable for the incumbent is lower in the post-entry settings we consider than in the Bertrand case if and only if $(p(Q), \delta) \in \xi^*$ or δ is sufficiently large.*

Proposition 9 gives necessary and sufficient conditions on $p(Q)$ and δ to ensure that exclusion is more likely to arise (occur over a larger region of fixed costs) when the firms engage in the post-entry settings we consider. The first condition, $(p(Q), \delta) \in \xi^*$, ensures that exclusion would be profitable for the incumbent in the post-entry setting at hand even if it had to sign up every buyer to an exclusive. It follows that $\epsilon^* < \epsilon^B$ in this case, because ϵ^* is then always less than zero, whereas ϵ^B is always greater than or equal to zero. The second condition, that δ be sufficiently large when $(p(Q), \delta) \in \xi^{*c}$, ensures that π_E^B will be close enough to π_E^* (we know in the limit as $\delta \to \overline{\delta}$ that $\pi_E^B > \pi_E^*$) that, along with our finding in Proposition 8 that $\alpha^* > \alpha^B$, means that $\epsilon^* < \epsilon^B$ even when ϵ^* is greater than zero.

It should be noted that values of δ that would otherwise be too small for the second condition to hold may be just what is needed to make the first condition hold (we know from Propositions 2 and 7 that a necessary condition for $(p(Q), \delta) \in \xi^*$ to hold is that δ must be sufficiently small). This raises the possibility that there exist $p(Q)$ such that exclusion will always be more likely to arise in the post-entry setting at hand. Nevertheless, as we will see, we also cannot rule out the possibility that there may exist $p(Q)$, δ, and ϵ in which exclusion would not be profitable in our post-entry setting, but would be profitable under Bertrand.

To obtain further insights, we now specialize to the case of linear demands.

3.2.1 Cournot with linear demands

Let $p(Q) = a - bQ$ and assume that $\delta \in (0, \overline{\delta})$. Assume also that $\epsilon < \min\left\{\pi_E^C, \pi_E^B\right\}$ (so that entry is always profitable if there are no signed buyers). Then, the profits under entry are

$$\pi_I^C = \frac{(a - 2\overline{c} + c)^2}{9b}, \ \ \pi_E^C = \frac{(a - 2c + \overline{c})^2}{9b},$$

in the case of Cournot competition, and

$$\pi_I^B = 0, \;\; \pi_E^B = \frac{(a - \bar{c})(\bar{c} - c)}{b}$$

in the case of Bertrand competition. Comparing the profits under entry in the two cases, we have that $\pi_E^B > \pi_E^C$ if (and only if) the entrant's cost advantage is such that $\delta > \frac{a-c}{5}$. Combining this result with our finding in (15) (which establishes that $(p(Q), \delta) \in \xi^*$ holds for all $\delta < \hat{\delta} = \frac{a-c}{3}$ in the Cournot case), we can see that either the first, the second, or both conditions in Proposition 9 hold for all δ. Remarkably, this implies that $\epsilon^* < \epsilon^B$ throughout the entire feasible range of δ in the Cournot case when the buyers' demands are linear.

It immediately follows that exclusion will be profitable for the incumbent over a wider range of fixed costs when $p(Q)$ is linear and the firms compete à la Cournot. There are settings in which exclusion would never be profitable, settings in which exclusion would be profitable under both Cournot and Bertrand competition, and settings in which exclusion would be profitable under Cournot competition but not under Bertrand competition. But it cannot be the case that exclusion would be profitable under Bertrand but not under Cournot.

These regions are depicted in Figure 7 below. In the upper-most region (shaded in green) in Figure 7, which corresponds to relatively high entry costs, we have that exclusion is profitable under both Cournot and Bertrand competition. For any given δ, this region occurs for all feasible $\epsilon > \epsilon^B$. In the middle region (shaded in blue) in Figure 7, which is bounded above by $\epsilon = \epsilon^B$ and below by $\epsilon = \epsilon^C$, exclusion is profitable under Cournot competition but not under Bertrand competition. And, lastly, in the bottom most region (not shaded) in Figure 7, which is bounded above by $\epsilon = \epsilon^C$, exclusion is never profitable.

We can also see from Figure 7 that along the axis where $\epsilon = 0$, exclusion is never privately profitable under Bertrand competition, but will be privately profitable under Cournot competition for all $\delta < \hat{\delta}$. For higher ϵ, exclusion may or may not be profitable, but if it is profitable, it will first become profitable for the incumbent when the firms would otherwise compete à la Cournot, and only later when the firms would otherwise compete à la Bertrand.

3.2.2 Coordination with linear demands

The analysis is more difficult when the firms can coordinate their quantity choices post entry. The reason is that the Cournot outcome is then only one of a large number of potential outcomes that can arise. Nevertheless, we would expect similar qualitative results to hold if the anticipated outcome is close to Cournot and, as we shall see, even if it is a bit farther away. That is, for many of the feasible outcomes in this case, we would expect exclusion to be privately profitable for the incumbent over a wider range of fixed costs when demand is

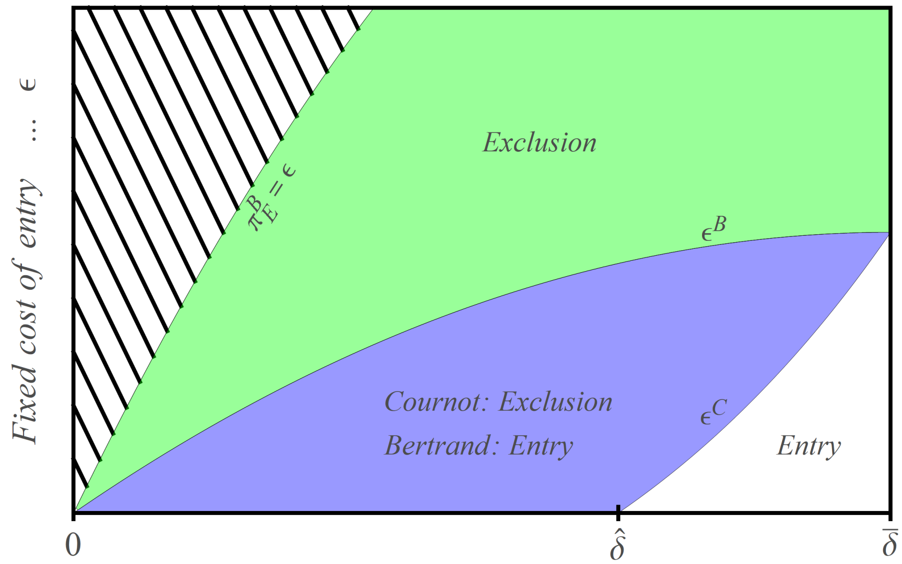

Figure 7. Multiple buyers and linear demand: comparing Bertrand and Cournot.

linear than would be the case for the same demand when the firms compete à la Bertrand.

One can imagine, for example, an outcome in which the firms coordinate on an overall quantity that is 1/3 of the Cournot quantity plus 2/3 of the entrant's monopoly quantity, with an agreed upon proportional reduction in their individual quantities so as to preserve their Cournot market shares. Given this outcome, we can derive the incumbent's quantity $\overline{q}_I$, the entrant's quantity $\overline{q}_E$, the overall quantity $\overline{Q}$, and the profits under entry, $\overline{\pi}_I$ and $\overline{\pi}_E$:

$$\overline{q}_I = \left(\frac{q_I^C}{q_I^C + q_E^C}\right)\overline{Q}, \quad \overline{q}_E = \left(\frac{q_E^C}{q_I^C + q_E^C}\right)\overline{Q},$$

$$\overline{Q} = \frac{5a - 4c - \overline{c}}{9b},$$

$$\overline{\pi}_I = \frac{4\left(a + c - 2\overline{c}\right)^2\left(5a - 4c - \overline{c}\right)}{81b(2a - c - \overline{c})}, \quad \overline{\pi}_E = \frac{\left(4a - 5c + \overline{c}\right)\left(a - 2c + \overline{c}\right)\left(5a - 4c - \overline{c}\right)}{81b(2a - c - \overline{c})}.$$

Comparing $\overline{\pi}_E$ and π_E^B, we find that a sufficient condition for the second condition in Proposition 9 to hold is that $\delta > \frac{9}{41}(a - c)$. And since the upper bound on δ for $(p(Q), \delta) \in \xi^*$ to hold is always weakly greater under coordination than it is in the Cournot case, we have that a sufficient condition for the first condition in Proposition 9 to hold is that $\delta < \hat{\delta} = \frac{a-c}{3}$. It follows, once again, that at least one of the conditions in Proposition 9 holds for all δ.

The conclusion for the outcome here is thus the same as it is under Cournot: exclusion will be profitable for the incumbent over a wider range of fixed costs than under Bertrand. Figure 8 illustrates the three feasible regions. In the upper-most region (shaded in green)

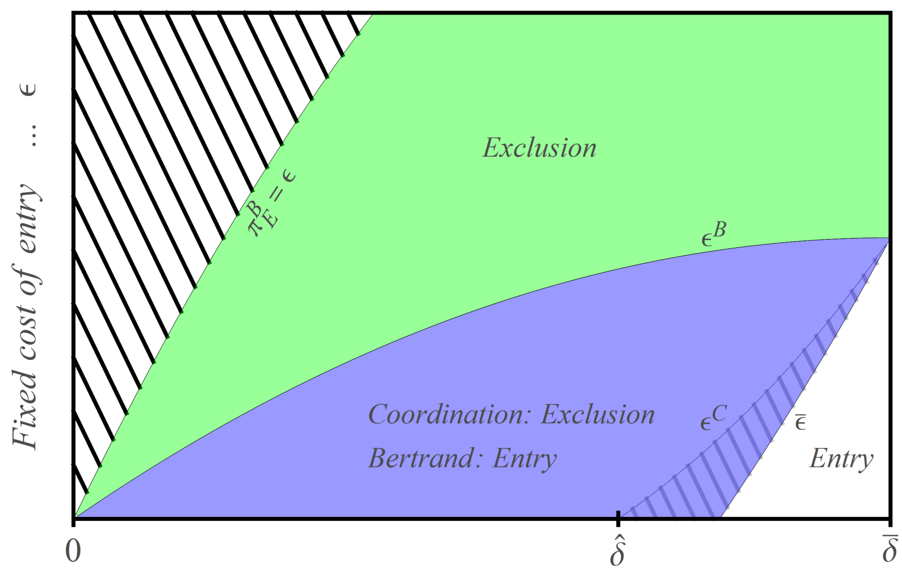

Figure 8. Multiple buyers and linear demand: comparing Bertrand and Coordination.

in Figure 8, which corresponds to relatively high entry costs, we have that exclusion is profitable under both the coordinated outcome here and Bertrand competition. For any given cost advantage δ, this region occurs for all feasible $\epsilon > \epsilon^B$. In the middle region (shaded in blue) in Figure 8, which is bounded above by the curve $\epsilon = \epsilon^B$ and below by the curve $\epsilon = \overline{\epsilon}$, exclusion is privately profitable under the coordinated outcome here but not under Bertrand competition.[22] And lastly, in the bottom-right most region (not shaded) of Figure 8, which is bounded above by the curve $\epsilon = \overline{\epsilon}$, exclusion is never privately profitable.

We can also see from Figure 8 that along the axis where $\epsilon = 0$, exclusion is privately profitable over a larger range of δ for the outcome here than it is under Cournot competition. For higher ϵ, exclusion may or may not be privately profitable, but if it is profitable, it will first become profitable for the incumbent when the firms would otherwise coordinate on the outcome here and only later when the firms would compete à la Cournot or à la Bertrand.

3.2.3 Stackelberg with linear demands

The Stackelberg case differs from the preceding two cases in that it is already known from the discussion at the bottom of page 19 (see also the appendix) that $(p(Q), \delta) \in \xi^*$ fails to hold when demand is linear. Thus, continuing with our example in which $p(Q) = a - bQ$, it follows from Proposition 9 that the threshold of fixed costs that determine when exclusion would be profitable under Stackelberg, ϵ^S, will be less than the threshold of fixed costs that determine

[22]The diagonal blue region that is below ϵ^C but above $\overline{\epsilon}$ corresponds to settings in which exclusion would not be profitable under Cournot, but would be profitable under the particular coordinated outcome at hand.

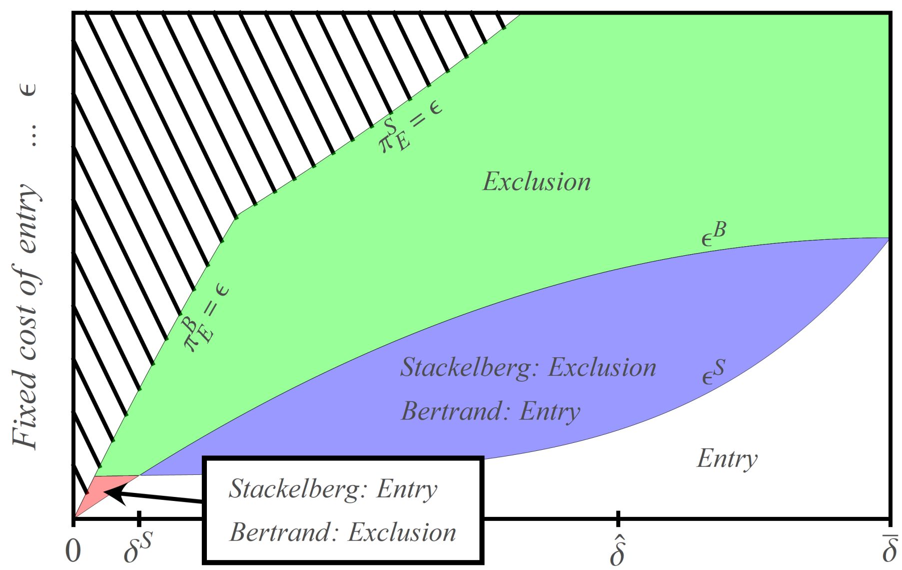

Figure 9. Multiple buyers and linear demand: comparing Bertrand and Stackelberg.

when exclusion would be profitable under Bertrand, ϵ^B, if and only if δ is sufficiently large.

Using the expressions given in the appendix, it is straightforward to solve for the δ at which ϵ^S is equal to ϵ^B. This yields four feasible regions, which we illustrate in Figure 9.

In the upper-most region (shaded in green) of Figure 9, which corresponds to relatively high entry costs, exclusion is profitable under both Stackelberg and Bertrand competition. This region occurs for all feasible $\epsilon > \max\{\epsilon^S, \epsilon^B\}$. In contrast, in the lower-most region (not shaded) of Figure 9, which occurs for all feasible $\epsilon < \max\{\epsilon^S, \epsilon^B\}$, exclusion is never privately profitable. Both regions also occur in the earlier cases. What is different here is that now there are two other regions. For $\delta < \delta^S$, there is a small region (shaded in red) in Figure 9, which is bounded above by the curve $\epsilon = \epsilon^S$ and below by the curve $\epsilon = \epsilon^B$, in which exclusion is privately profitable under Bertrand competition but not under Stackelberg competition. And for $\delta > \delta^S$, there is a large region (shaded in blue) in Figure 9, which is bounded above by the curve $\epsilon = \epsilon^B$ and below by the curve $\epsilon = \epsilon^S$, in which exclusion is privately profitable under Stackelberg competition but not under Bertrand competition.

Here we can see that exclusion can sometimes be profitable under Bertrand even when it would not be profitable under Stackelberg. The reason is that for sufficiently small δ, the number of buyers the incumbent would have to sign up under Stackelberg would be significantly more than the number of buyers the incumbent would have to sign up under Bertrand, making it possible for exclusion to be profitable in the latter but not the former.

4 Conclusion

Economists have known for some time that the Chicago-school's view of exclusive dealing depends critically on the absence of externalities among the buyers.[23] What seems to have received less attention (Farrel, 2005, is an exception), however, is that the Chicago-school's view of exclusive dealing also depends critically on the the absence of externalities among the sellers (i.e, incumbent and entrant). Specifically, in the Chicago-school story, Bertrand competition post entry ensures that the entrant will earn no more than the difference between the incumbent's marginal cost and its own marginal cost times the quantity that it sells. Or, in other words, it ensures that the entrant will earn no more than its product's incremental contribution to the overall surplus created by its own and the incumbent's product. In contrast, in the post-entry settings we have considered, the entrant always earn more than its product's incremental contribution. This imposes a negative externality on the joint surplus of the incumbent and the buyer in the event of entry, and can mean that sometimes the incumbent and buyer would be jointly better off without entry than they are with entry.

Our findings thus suggest that Bertrand competition is a knife-edge assumption. Any post-entry setting that leads to a market price that exceeds the incumbent's marginal cost will cause the entrant to earn more than its product's incremental contribution, which in turn can potentially lead to privately profitable exclusion. We have focused on three post-entry settings in this paper: Stackelberg competition (with the incumbent as the leader), Cournot competition (which implies that the firms' quantities are chosen simultaneously and non-cooperatively), and a setting in which the firms can coordinate their quantity choices. We are able to rank the three in terms of the incumbent's incentive for exclusion. Because the coordination case leads to the largest externality (highest post-entry price), the Cournot case the next largest, and the Stackelberg case the smallest, we find that the incumbent's incentive for exclusion will be largest when the post-entry setting is one of coordination,[24] next largest when the firms compete à la Cournot post-entry, and smallest (but still greater than what it would be under Bertrand) when the post-entry setting is a Stackelberg game.

We showed that in each setting, the change in the incumbent's incentives can be sufficiently strong as to make exclusion privately profitable even in the case of one buyer. This has implications for policy. Whereas policy makers in the post-Chicago world have gotten used to focusing on the number of buyers and the size of the entrant's economies of scale

[23] Once this assumption is relaxed, so that the entrant's entry decision for one buyer ia allowed to depend on the availability of other buyers, buyer coordination failures (Rasmusen et al, 1991) and/or the use of divide-and-conquer strategies (Segal and Whinston, 2000) can lead to profitable anti-competitive exclusion.

[24] It is ironic that a coordination failure among buyers can lead to more exclusion, per Rasmusen et al, (1991), whereas our findings imply that a coordination failure among the sellers can lead to less exclusion.

as key factors in determining whether exclusive contracts can be harmful, our findings suggest that exclusive contracts can sometimes be harmful even if there is only one buyer and economies of scale are de-minimis. Our findings thus point to an additional factor that needs to be considered by policy makers — the nature of the firms' post-entry competition. Or, to put it another way, focusing on the externalities among buyers is not enough. Externalities among sellers can be just as important to consider, and in some cases, even more important.

Our findings also suggest that even when the incumbent's incentives are not sufficiently strong as to make exclusion privately profitable in the case of a single buyer, they can still affect the profitability of exclusion when there are multiple buyers. The reason is that the incumbent always loses less per buyer in the settings we consider (than under Bertrand competition), and therefore the incumbent would be willing to sign up a larger share of the buyers under any given divide-and-conquer strategy. One nuance though is that the number of buyers that the incumbent will have to sign up to induce exclusion may be larger in the settings we consider, and so therefore, on balance, the net effect is ambiguous. We have shown, for example, that there may be instances in which the incumbent and entrant might find exclusion to be privately profitable under Bertrand competition even when it would not be profitable under Stackelberg competition. For a wide range of entry costs and marginal cost differences, however, we would expect exclusion to be more profitable in our settings.

It should be noted that we have taken the form of post-entry competition as given. This may not be entirely innocuous. Although the incumbent might prefer to compete in one of our settings (as opposed to the Bertrand case) all else equal, the entrant might not, especially if it would make exclusion more likely. At issue is whether we would expect post-entry competition to look more like a Bertrand game, or more like one of the other settings, and whether there are steps the firms might take to commit to one or another outcome.[25] Typically, one justifies Cournot competition, for example, as the outcome of a potentially more complicated multi-stage game in which capacity choices play an important role (Kreps and Scheinkman, 1983). Given this, our results suggest that an entrant might do well to invest in additional capacity ex-ante so as to mitigate the effects of any capacity constraints ex-post. By doing so, it might be able to nudge the outcome closer to the Bertrand case.

Beyond the transparent differences in the assumed post-entry competition, however, things are usually not so black and white. Instead, what really seems to matter for our results is the degree to which the incumbent's price would be bid down post-entry (e.g., would it be bid down to its marginal cost), and whether it would be able to make some sales

[25] The firms may also differ in their preferences over the post-entry settings we consider. The entrant may, for example, prefer to be a Stackelberg follower rather than a Cournot competitor, and may signal as such. Or, in the coordination case, the firms may differ on which post-entry price would be best to coordinate on.

at a positive mark-up. In suggesting that it would not, previous literature has taken, in our view, an extreme view of competition and perhaps relied too much on the assumption that the incumbent and entrant's goods are homogeneous. Relaxing this assumption (e.g., by allowing for some differentiation among the different products), while still assuming that the firms compete in prices, might lead to similar results. We leave this for future research.

Appendix

Proof of Lemma 1: We need to show that $q_I \leq q_I^C$ and $q_E \leq q_E^C$ in all feasible coordinated outcomes. To this end, let $(q_I, q_E) \in \Omega(c, \overline{c}, p(Q))$ and suppose that $q_I > q_I^C$. Then,

$$\begin{aligned} (p(q_I + q_E) - c)\, q_E &< \left(p(q_I^C + q_E) - c\right) q_E, && \text{(A.1)} \\ &< \left(p(q_I^C + q_E^C) - c\right) q_E^C, && \text{(A.2)} \\ &= \pi_E^C, && \text{(A.3)} \end{aligned}$$

where (A.1) follows because $p'(Q) < 0$, (A.2) follows because the Cournot outcome is unique, and (A.3) follows from the definition of π_E^C. These conditions collectively imply that $(p(q_I + q_E) - c)q_E < \pi_E^C$ when $q_I > q_I^C$, which contradicts the requirement that $(p(q_I + q_E) - c)q_E \geq \pi_E^C$ in any feasible coordinated outcome. It follows, therefore, that q_I cannot be greater than q_I^C. An analogous proof establishes that $q_E \leq q_E^C$ in any feasible coordinated outcome. **Q.E.D.**

Stackelberg Example with Linear Demand: We will show here that for all $\delta \in (0, \overline{\delta})$, it is never profitable for the incumbent to exclude the entrant in the single-buyer case when $p(Q) = a - bQ$. With this $p(Q)$, the incumbent and entrant's profit under entry is given by

$$\pi_I = (a - b\,(q_I + q_E) - \overline{c})\, q_I, \quad \text{and} \quad \pi_E = (a - b\,(q_I + q_E) - c)\, q_E.$$

Setting up the entrant's first-order condition and solving it yields

$$q_E(q_I) = \frac{a - c - bq_I}{2b}.$$

The incumbent takes the entrant's quantity $q_E(q_I)$ into account and then chooses its own q_I to maximize $(a - b\,(q_I + q_E(q_I)) - \overline{c})\, q_I$. This results in the following Stackelberg quantities:

$$q_I^S = \frac{1}{2b}\,(a - 2\overline{c} + c) \tag{A.4}$$

and

$$q_E^S = \frac{1}{4b}\,(a - 3c + 2\overline{c})\,, \tag{A.5}$$

from which it follows that the Stackelberg quantity, the price, and the firms' profits are

$$Q^S = q_I^S + q_E^S = \frac{3a - 2\overline{c} - c}{4b},$$

$$p^S = p\left(q_I^S + q_E^S\right) = \frac{1}{4}\,(a + 2\overline{c} + c)\,,$$

and

$$\pi_I^S = \frac{(a - 2\overline{c} + c)^2}{8b}, \quad \pi_E^S = \frac{(a - 3c + 2\overline{c})^2}{16b}. \tag{A.6}$$

On the buyer side, the surplus the buyer would expect to get if entry occurs is thus

$$S^S = \frac{1}{2}\left(a - p^S\right)\left(q_I^S + q_E^S\right) = \frac{(3a - 2\overline{c} - c)^2}{32b}. \tag{A.7}$$

The incumbent will act as a monopolist in the absence of entry. Solving for the monopoly quantity, price, profit and buyer surplus in this case yields the expressions in (14) in the text.

Comparing terms, it follows that for exclusion to be profitable, the loss to the buyer, i.e., $S^S - S^M$, must be smaller than the gain to the incumbent, i.e., $\pi_I^M - \pi_I^S$. This requires that

$$\pi_I^M - \pi_I^S - \left(S^S - S^M\right) > 0$$

$$\Updownarrow$$

$$\frac{(a - \overline{c})^2}{4b} - \frac{(a - 2\overline{c} + c)^2}{8b} - \left(\frac{(3a - 2\overline{c} - c)^2}{32b} - \frac{(a - \overline{c})^2}{8b}\right) > 0$$

$$\Updownarrow$$

$$\frac{-a^2 + 4a\overline{c} - 2ac - 8\overline{c}^2 + 12\overline{c}c - 5c^2}{32b} \quad \equiv \quad d\left(\overline{c}, c\right) \; > \; 0.$$

We may note that $d\left(\overline{c}, c\right)$ is increasing in $\overline{c}$ up to $\frac{1}{4}a + \frac{3}{4}c$ and then decreasing after that. Inserting $\overline{c} = \frac{1}{4}a + \frac{3}{4}c$ into $d\left(\overline{c}, c\right)$ we get that $d = -\frac{1}{2}\left(a - c\right)^2 < 0$. We can conclude that it is never profitable to exclude when demand is linear and post-entry competition is Stackelberg. **Q.E.D.**

Stackelberg Example with Concave Demand: It is straightforward to show that exclusion can be profitable in the single-buyer case under Stackelberg. As an example, suppose demand is equal to $p(Q) = 1 - Q^4$ and $c = \overline{c} = 0$. It is easy to verify that the incumbent's and entrant's (approximate) post-entry equilibrium quantities and profits, are $q_I^S \approx 0.615$ and $q_E^S \approx 0.22$, and $\pi_I^S \approx 0.254$ and $\pi_E^S \approx 0.113$, and that the resulting (approximate) Stackelberg price is $p^S \approx 0.513$.

The incumbent's monopoly (approximate) quantity and price is $Q^M \approx 0.669$ and $p^M = 0.8$. We may then note that the incumbent's incentive is given by comparing area C (part of the consumer's loss, see Figure 1)

$$\begin{aligned} C &= \int_{Q^M}^{Q^S} p(Q)\,dQ - p^S\left(Q^S - Q^M\right) \\ &\approx \int_{0.669}^{0.835} \left(1 - Q^4\right) dQ - 0.513\,(0.835 - 0.669) \\ &\approx 0.02646 \end{aligned}$$

to area D (part of the incumbent's gain, see Figure 1)

$$\begin{aligned} D &= \left(p^S - \bar{c}\right)\left(Q^M - q_I^S\right) \\ &\approx 0.513\,(0.669 - 0.615) \\ &\approx 0.02770. \end{aligned}$$

Given that $D > C$, we can conclude that it is profitable for the incumbent to exclude the entrant. **Q.E.D.**

Proof of Proposition 8: We need to show that $\alpha^* > \alpha^B$ for all $\delta < \overline{\delta}$. To begin, note that we have already shown that the incumbent's incentive for exclusion is higher in the single-buyer case in each of the settings we consider relative to Bertrand.[26] This implies that

$$\pi^M - \pi_I^* - \left(S^* - S^M\right) \;>\; \pi^M - \left(S^B - S^M\right). \tag{A.8}$$

Dividing the left and right-hand sides of (A.8) by $S^B - S^M$, and then taking the resulting inequality and multiplying the left-hand side only by $(S^B - S^M)/(S^* - S^M) > 1$, yields

$$\begin{aligned} \frac{\pi^M - \pi_I^*}{S^* - S^M} - 1 &> \frac{\pi^M}{S^B - S^M} - 1 \\ &\Updownarrow \\ \alpha^* &> \alpha^B. \end{aligned}$$

This establishes what we set out to show. Another way of establishing that $\alpha^* > \alpha^B$ for all $\delta < \overline{\delta}$ is to let the buyer's surplus at price $z > 0$ be denoted by $S^z := \int_z^\infty D(s)\,ds$, and define

$$\Phi(z) := \frac{(P^M - z)Q^M}{S^z - S^M}. \tag{A.9}$$

[26] This was done by comparing (5), (17), and (18) with the analogous expression in the Bertrand case.

Then, it follows that for all $\delta < \overline{\delta}$,

$$\alpha^* - \alpha^B = \frac{\pi^M - \pi_I^*}{S^* - S^M} - \frac{\pi^M}{S^B - S^M} \tag{A.10}$$

$$\geq \frac{(P^M - P^*)Q^M}{S^* - S^M} - \frac{(P^M - \overline{c})Q^M}{S^B - S^M} \tag{A.11}$$

$$= \int_{\overline{c}}^{P^*} \frac{\partial \Phi(z)}{dz} dz. \tag{A.12}$$

Here, we can see that (A.12) is strictly positive given that $P^* > \overline{c}$ and

$$\frac{\partial \Phi(z)}{dz} = \frac{-(S^z - S^M)Q^M + (P^M - z)Q^M Q^z}{(S^z - S^M)^2} \tag{A.13}$$

$$= \frac{Q^M \left((P^M - z)Q^z - (S^z - S^M)\right)}{(S^z - S^M)^2},$$

which is positive, because $(S^z - S^M)^2 > 0$, $Q^M > 0$, and $(P^M - z)Q^z > (S^z - S^M)$.
Q.E.D.

Proof of Proposition 9: There are three parts to this proof. First, we will show that if $(p(Q), \delta) \in \xi^*$ then $\epsilon^* \leq \epsilon^B$. Second, we will show that if δ is sufficiently large then $\epsilon^* \leq \epsilon^B$. Third, we will show that $\epsilon^* \leq \epsilon^B$ only if $(p(Q), \delta) \in \xi^*$ or δ is sufficiently large. Recall that

$$\epsilon^* \leq \epsilon^B \tag{A.14}$$

$$\Updownarrow$$

$$\left(1 - \frac{\pi^M - \pi_I^*}{S^* - S^M}\right) \pi_E^* \leq \left(1 - \frac{\pi^M}{S^B - S^M}\right) \pi_E^B. \tag{A.15}$$

Part 1: Suppose that $(p(Q), \delta) \in \xi^*$. Then, it follows from the definition of ξ^* and $\pi_E^* > 0$ that the left-hand side of (A.15) is weakly negative. Since we have already seen that the right-hand side of (A.15) is weakly positive (strictly positive if $\delta > 0$), it follows that $\epsilon^* \leq \epsilon^B$.

Part 2: Suppose that $(p(Q), \delta) \in \xi^{*c}$. Then, to prove that $\epsilon^* \leq \epsilon^B$ if the entrant's cost advantage δ is sufficiently large, we must show that there exists $\delta > 0$ such that for all δ greater than this, $\epsilon^* \leq \epsilon^B$. We will proceed in two steps. First, we will show that $\epsilon^* = \epsilon^B$ when $\delta = \overline{\delta}$. Then, we will show that $\epsilon^B - \epsilon^*$ is decreasing in the limit as δ approaches $\overline{\delta}$ from the left (implying that for δ close enough to $\overline{\delta}$, $\epsilon^* < \epsilon^B$ and remains thus until $\delta = \overline{\delta}$).

We begin by showing that $\epsilon^* = \epsilon^B$ when $\delta = \overline{\delta}$. Recall that $\overline{\delta} > 0$ is the smallest entrant's cost advantage such that the incumbent's Cournot quantity would be zero post entry. This has several implications. First, it means that at $\delta = \overline{\delta}$, with the incumbent's Cournot quantity at zero, the entrant's Cournot quantity is the quantity that solves $\max_{q_E}(p(q_E) - c)q_E$. Call this quantity q_E^* and note that it is the same quantity that the entrant would choose if it were a monopolist and maximizing overall joint profit. Second, it means that $\overline{c} = p(q_E^*)$ (otherwise, q_I^C would be positive) and therefore that $D(\overline{c}) = q_E^*$. Third, it means that $\pi_I^C = 0$ (because $q_I^C = 0$), $\pi_E^B = \pi_E^C$ (because $\pi_E^B = (\overline{c} - c)D(\overline{c}) = (p(q_E^*) - c)q_E^* = \pi_E^C$) and $S^C = S^B$ (because the entrant's Cournot price in this case is equal to its Bertrand price). It follows immediately from this that (A.15) holds with equality when $\epsilon^* = \epsilon^C$. It is easy to see that the Stackelberg case is no different. Normally, the incumbent would want to exercise its first-mover advantage by increasing its quantity above q_I^C. But here, given that δ is at its upper bound, it would not want to do so because this would only serve to depress the price below $\overline{c}$, causing it to earn negative profit. It follows, therefore, that nothing would change under Stackelberg, and therefore (A.15) will also hold with equality when $\epsilon^* = \epsilon^S$. Ditto for all feasible outcomes in the coordinated case, because the Cournot outcome is the only feasible outcome when $\delta = \overline{\delta}$ (given that $q_E = q_E^C$ already maximizes overall joint profit).

Next, we focus on a comparison between the entrant's Bertrand profit and its profit in the other cases as δ approaches $\overline{\delta}$ from the left. Starting with the Cournot case, we have

$$\pi_E^B - \pi_E^C \quad = \quad \delta D(\delta + c) - \left(p(q_I^C + q_E^C) - c\right) q_E^C. \tag{A.16}$$

Taking the left derivative of $\pi_E^B - \pi_E^C$ with respect to δ and evaluating it at $\delta = \overline{\delta}$, yields

$$\left.\frac{\partial\left(\pi_E^B - \pi_E^C\right)}{\partial \delta_-}\right|_{\delta=\overline{\delta}} \quad = \quad q_E^C \, \frac{\partial p(Q)}{\partial Q} \, \frac{\partial q_I^C}{\partial \delta_-} \quad < \quad 0, \tag{A.17}$$

which holds because $q_E^C > 0$, $p(Q)$ is decreasing in Q, and q_I^C is decreasing in δ, for all $\delta < \overline{\delta}$. The implication of $\pi_E^B - \pi_E^C$ decreasing in the limit as δ approaches $\overline{\delta}$ from the left, coupled with the fact that we have already shown that $\pi_E^B = \pi_E^C$ at $\delta = \overline{\delta}$, means that for δ close enough to $\overline{\delta}$, π_E^C will be less than π_E^B (and will remain so for all higher $\delta < \overline{\delta}$ until $\delta = \overline{\delta}$). It then follows from this and the result in Proposition 8 that for δ close enough to $\overline{\delta}$, $\epsilon^C \leq \epsilon^B$.

The Stackelberg case can be handled similarly, but a quicker way is simply to note that the entrant's Stackelberg profit is always weakly less than its Cournot profit, from which it follows (again using the result in Proposition 8) that for δ sufficiently close to $\overline{\delta}$, $\epsilon^S \leq \epsilon^B$.

The coordination case is the most difficult of the three cases to assess because there are potentially many outcomes, all of which yield a profit for the entrant that is weakly greater than π_E^C. Nevertheless, we can use the same method to show that even if the entrant earns its maximum possible profit under coordination, it will still be less than π_E^B for δ sufficiently close to $\overline{\delta}$. To see this, note that its maximum possible profit is given by the solution to

$$\max_{q_E, q_I} (p(Q) - c)\, q_E \quad s.t. \quad (p(Q) - c - \delta)\, q_I \;\geq\; \left(p(q_I^C + q_E^C) - c - \delta\right) q_I^C, \tag{A.18}$$

where the constraint in (A.18) ensures that the incumbent will earn at least as much profit in the case of coordination as it does under Cournot. Let the solution to (A.18) be given by $q_E = \hat{q}_E(\delta)$ and $q_I = \hat{q}_I(\delta)$, for a maximized profit of $\hat{\pi}_E = (p(\hat{q}_I + \hat{q}_E) - c)\, \hat{q}_E$. Comparing the entrant's profit under Bertrand with its profit $\hat{\pi}_E$, and forming the difference, we have

$$\pi_E^B - \hat{\pi}_E \;=\; \delta D(\delta + c) - (p(\hat{q}_I + \hat{q}_E) - c)\, \hat{q}_E. \tag{A.19}$$

Taking the left derivative of $\pi_E^B - \hat{\pi}_E$ with respect to δ and evaluating it at $\delta = \overline{\delta}$, yields

$$\left.\frac{\partial\left(\pi_E^B - \hat{\pi}_E\right)}{\partial \delta_-}\right|_{\delta=\overline{\delta}} \;=\; \hat{q}_E \frac{\partial p(Q)}{\partial Q} \frac{\partial \hat{q}_I}{\partial \delta_-} \;<\; 0, \tag{A.20}$$

which has the same sign as in (A.17) because $\hat{q}_E > 0$, $p(Q)$ is decreasing in Q, and $\hat{q}_I$ is decreasing in δ (the constraint in (A.18) becomes more relaxed as δ increases, allowing the entrant to profitably lower q_I), for all $\delta < \overline{\delta}$. The implication of $\pi_E^B - \hat{\pi}_E$ decreasing in the limit as δ approaches $\overline{\delta}$ from the left, coupled with the fact that we have already shown that $\pi_E^B = \pi_E^*$ at $\delta = \overline{\delta}$ for all feasible outcomes in the coordination case, means that for δ close enough to $\overline{\delta}$, π_E^* will be less than π_E^B (and will remain so for all higher $\delta < \overline{\delta}$ until $\delta = \overline{\delta}$). It then follows from this and the result in Proposition 8 that for δ close enough to $\overline{\delta}$, $\epsilon^* \leq \epsilon^B$.

Part 3: Suppose that $(p(Q), \delta) \in \xi^{*c}$. Then, to prove that $\epsilon^* \leq \epsilon^B$ only if the entrant's cost advantage δ is sufficiently large, we must show that there exists $\delta > 0$ such that for all δ less than this, $\epsilon^* > \epsilon^B$. But this is trivial to show, because in the limit, as the entrant's cost advantage $\delta \to 0$, ϵ^B goes to zero ($\pi_E^B = 0$ when $\delta = 0$), whereas ϵ^* is bounded above zero.
Q.E.D.

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