Exclusive Dealing Under Asymmetric Information about Entry Barriers

Liliane Giardino-Karlinger*

March 27, 2015

Abstract

This paper revisits the naked exclusion model of Segal and Whinston (SW, 2000). I study the case of asymmetric information on the rival's entry cost: The rival type is observable to the incumbent seller, but not to the buyers. At the separating equilibria, the incumbent will use Exclusive Dealing (ED) contracts to signal the rival type, and will only exclude weak rivals; at the pooling equilibria, ED contracts may also allow for exclusion of low-cost types, who could never be excluded in the full information setting of SW.

JEL Classification: L12, L42

Keywords: Monopoly; Monopolization Strategies, Vertical Restraints; Exclusive Dealing; Exclusion; Asymmetric Information

*Università LUISS Guido Carli, Department of Economics and Finance, Viale Romania, 32, 00197 Roma - ITALY, Tel. +39-06-8522 5902, Fax +39-06-8522 5973, Email: lgiardino@luiss.it

1 Introduction

The theory of "naked exclusion" provides a powerful counter-argument to the Chicago School doctrine on Exclusive Dealing (ED), according to which ED contracts cannot be motivated by exclusion because a rational buyer would never sign an ED contract that does not fully compensate her for the loss of a second source. As shown by Rasmusen et al (1991) and Segal and Whinston (2000), henceforth SW, this argument breaks down when there are multiple buyers, and the rival seller must serve more than one buyer to cover its entry costs. The incumbent supplier can then target a subset of its buyers with ED contracts, just sufficiently many to prevent the rival from reaching its minimum scale; the remaining buyers will then be locked in to the incumbent supplier, who can then extract from the free buyers all the rent needed to fully compensate the signing buyers.

The purpose of this paper is to study the scope for such "divide-and-conquer" strategies when there is asymmetric information regarding the level of entry barriers in the industry. If define entry barriers as "low" if a single buyer is sufficient for the rival supplier to cover its fixed costs of entry, and as "high" if the rival supplier needs to serve both buyers to cover its entry costs. I assume that both incumbent and entrant know the exact level of the entry costs, while the buyers cannot observe it. This setup is therefore different from the literature on rent-shifting through ED contracts, where the entrant type is typically unobservable to both incumbent and buyers.[1]

If the entrant's type is observable to the incumbent, but not to the buyers, talk is cheap: The incumbent has strategic reasons to misrepresent the entrant's true type, making buyers believe that entry costs are high when in fact they are low. This paper asks if ED contracts can be used by the incumbent as a costly signaling device to reveal the entrant's type: If entry barriers are high, exactly one buyer is publicly offered a sufficiently high compensation by the incumbent, while the other buyer remains free. This offer credibly communicates that entry costs are high: If they were low instead, then entry would occur all the same (the entrant would just serve the free buyer), making the ED offer to only one buyer unprofitable for the incumbent.

I closely follow SW in studying both simultaneous and sequential, uniform and discriminatory offers. Equilibria where ED contracts are used to signal the entrant's type belong to the class of separating equilibria: I will argue that for this class of equilibria, exclusion will occur whenever it arises also in SW, but unlike SW, exclusion will always be costly, even if offers can be made sequentially.

Finally, I also study the use of ED contracts where they do not reveal the entrant's type, i.e. where they sustain a pooling equilibrium. At the exclusionary pooling equilibria, I will show that even strong entrants

[1] see Aghion and Bolton (1987), Innes and Sexton (1994), Marx and Shaffer (2004), Spector (2011), Figueroa et al (2014).

can be excluded, which cannot happen in the full-information benchmark of SW. Moreover, exclusion can be almost without cost if the probability of a strong entrant is sufficiently low.

Thus, asymmetric information amplifies the exclusionary potential of ED contracts, in particular in those cases where such contracts cannot be used to signal entry barriers.

This paper builds on the literature on exclusionary effects of ED contracts initiated by Rasmusen et al (1991) and SW. In a very similar framework, Innes and Sexton (1994) study the possibility of strategic buyers contracting with the entrant prior to entry. The case of buyers competing against each other on a common downstream market is analyzed in Yong (1999), Fumagalli and Motta (2006), Simpson and Wickelgren (2007), Abito and Wright (2008), Wright (2009), and Argenton (2010).

A key assumption common to all these papers is that all relevant parameters are common knowledge among the firms, and that all contracts are public. There is only a small and very recent literature studying the impact of informational frictions on the exclusionary potential of ED contracts: Majumdar and Shaffer (2009) study the case where the upstream firms produce differentiated inputs, and buyers hold private information on the state of demand; in this setup, the incumbent can use market-share contracts (which coincide with ED contracts whenever the required share reaches 100%) to reduce the buyers' information rent, which will however aggravate the distortion at the bottom. Calzolari and Denicolò (2014) analyze the case of a continuum of buyer types with private valuations, and show that ED contracts can be both profitable and anticompetitive.

Chen and Shaffer (2014) study the case of stochastic entry costs (unobservable to both the incumbent and the buyers), and show that contracts with minimum-share requirements of less than 100% can sometimes be profitable for the incumbent when ED contracts would not be, although the buyers are allowed to communicate among themselves. Ide et al (2015) introduce buyers' private information on demand into the framework of Aghion and Bolton (1987), and find that asymmetric information forces the incumbent to offer less exclusionary contracts, and that exclusion may disappear altogether. Yehezkel (2008) shows that a high-quality incumbent facing a retailer with private demand information will foreclose the low-quality substitute even if both varieties would optimally be offered under vertical integration.

When the entrant's product is of unknown quality, Johnson (2012) finds that adverse selection allows the incumbent to exclude over a broader range of parameters even when exclusive contracts can be costlessly breached by retailers. Nocke and Peitz (2015) consider the possibility of a quality-enhancing technology to act as a signal for the entrant's quality, but only if this technology is licensed exclusively to either the incumbent or the entrant.

Finally, Miklos-Thal and Shaffer (2014) study the case where the incumbent's offer to any one buyer is not observable by the other buyers, and show that this breaks exclusionary equilibria.

2 The model

Consider an industry composed of an incumbent firm (I), a potential entrant (E), and 2 identical buyers, called B1 and B2.

Timing of the game is as follows: In $t = 1$, the incumbent can offer exclusive dealing (ED) contracts to the buyers; a buyer who accepts the ED contract commits to purchasing only from the incumbent in $t = 3$, and receives an up-front compensation x. Buyers' decisions are denoted by $s_i = 1$ if B_i accepted, and $s_i = 0$ otherwise. In $t = 2$, firm E observes how many buyers accepted the incumbent's ED contracts, and decides whether to enter or not. In $t = 3$, active firms set prices. No supplier can commit to prices prior to $t = 3$. I can discriminate between those buyers who accepted the ED contract and those who did not ("free buyers"), charging them p_s and p_f, respectively; E can only make offers to the free buyers, charging them p_E. The game ends after period 3.[2]

Each buyer has a well-behaved downward-sloping demand function $q(p)$.[3] E can produce the good at a lower marginal cost than I, where $\triangle = c_I - c_E$ denotes the efficiency gap between the two suppliers. Without entry, I charges all buyers the profit-maximizing price $p^m = \arg\max_p (p - c_I)\, q(p)$ and makes profits $\pi = (p^m - c_I)\, q(p^m)$ on each buyer. In case of entry, I charges its committed buyers $p_s = p^m$, and competes with E à la Bertrand for the free buyers, resulting in price $p_E = c_I$ for the latter.[4] A buyer who signed up with I in $t = 1$ thus suffers a loss in surplus denoted by $x^* = CS(c_I) - CS(p^m)$; we have that $x^* > \pi$, because of the deadweight loss of monopoly pricing under elastic demand, and we assume $x^* < 2\pi$.

E enters in period 2 if and only if its gross profits are sufficient to cover the fixed entry cost. The entrant can be of two types: A "weak" entrant needs *both* buyers to cover its entry costs: $F \in (\triangle q(c_I), 2\triangle q(c_I)]$, while a "strong" entrant needs *only one* buyer to cover its entry costs: $F \in (0, \triangle q(c_I)]$. The ex-ante probability of E being weak is μ (and so the probability of E being strong is $1 - \mu$). E's type is observable to I, but not to the buyers.

As shown by Segal and Whinston (2000), henceforth SW, under perfect information a strong entrant can never be excluded; a weak entrant can be excluded using divide-and-conquer strategies where only one buyer

[2] If suppliers and buyers interact repeatedly, vertical exclusion can also be obtained without enforceable ED contracts, see Asker and Bar-Isaac (2014).

[3] The assumption that buyer demands be independent from each other is crucial: When buyers compete fiercely in the downstream market, naked exclusion equilibria will break down, see Fumagalli and Motta (2006).

[4] Assuming the standard rationing rule, i.e. demand splitting at equal prices, we need I to set p_f by randomizing uniformly over $[c_I, c_I + \varepsilon]$ with ε small enough, see Blume (2003).

is offered $x = x^*$, and the other zero. And if I can make sequential discriminatory offers, exclusion can be achieved at almost no cost.[5]

The solution concept applied to the game under asymmetric information about entry barriers is the Perfect Bayesian Equilibrium (PBE). We will characterize both the separating PBEs, where the signal chosen by the informed principal (i.e. the ED compensation offered by I) identifies the entrant's type exactly, and the pooling PBEs, where the observed signal reveals no additional information about E's type.

3 Separating Equilibria

In a separating equilibrium (SE), the incumbent's ED contract offers differ with E's type, thus allowing the buyers to infer E's type from the contract offers they observe. We follow the standard taxonomy in the literature by considering, one by one, (i) simultaneous non-discriminatory offers, (ii) simultaneous discriminatory offers, and (iii) sequential offers.

When offers are constrained to be simultaneous and uniform, the full-information benchmark of SW admits both non-exclusionary and exclusionary equilibria; the latter can only arise because of miscoordination among buyers: Although the incumbent cannot fully compensate all of them for the loss of the more efficient supplier, buyers will still be willing to accept an ED contract even at a small compensation if they expect all other buyers to sign up as well, so that no individual buyer is pivotal for E's entry any more.

Under asymmetric information about entry barriers, it is still possible that the incumbent's non-discriminatory offers exclude a weak entrant: But even more so than under full information, exclusion is a razor-edge case which relies heavily both on buyer miscoordination (as under full information) and on a particular shape of buyers' beliefs (specific to the asymmetric information case). Moreover, in equilibrium the incumbent cannot make positive profits from exclusion: Since, at any separating PBE, the incumbent's offer reveals the entrant type to the buyers, the former must not have an incentive to misrepresent a strong entrant as a weak one in order to make positive profits. The incumbent's profits must therefore be constant (at zero) across both entrant types, so that if the entrant is weak (and hence excluded), the buyers' compensations fully absorb the profits the incumbent makes on serving these buyers.

Proposition 1: *Under simultaneous and non-discriminatory offers, the separating PB equilibria are characterized as follows:*

[5] It is also crucial that contracts be observable, as otherwise naked exclusion will break down for the most common belief classes, see Miklós-Thal and Shaffer (2014).

(i) Incumbent's offer schedule:

E's type	I's offer to B1, B2
weak (w)	$x_1^w = x_2^w = x^w$
strong (s)	$x_1^s = x_2^s = x^s$

(ii) Non-exclusionary equilibria: $x^w, x^s \in [0, x^*]$ *and* $x^s \neq x^w$

(ii-a) Buyers' posterior beliefs that E is weak:

$$\beta_i(x_1, x_2) = \begin{cases} 1 & \text{if } x_1^w = x_2^w = x^w \\ 0 & \text{otherwise} \end{cases}, i = 1, 2$$

(ii-b) Buyers' strategies are

$$s_i(x_1, x_2) = 0, \forall x \in [0, x^*], i = 1, 2$$

(iii) Exclusionary equilibria: $x_1^w = x_2^w = \pi$ *and* $x^s \in [0, x^*] \setminus \pi$

(iii-a) Buyers' posterior beliefs that E is weak:

$$\beta_i(x_1, x_2) = \begin{cases} 1 & \text{if } x_1^w = x_2^w = \pi \\ 0 & \text{otherwise} \end{cases}, i = 1, 2$$

(iii-b) Buyers' strategies are

$$s_i(x_1, x_2) = \begin{cases} 1 & \text{if } x_1^w = x_2^w = \pi \\ 0 & \text{otherwise} \end{cases}, i = 1, 2$$

Proof:

At any separating equilibrium, I's offers reveal E's type to the buyers, so that we must have $x^w \neq x^s$ at any such equilibrium.

(1) Non-exclusionary separating PBEs: Suppose E is weak; then, at the continuation equilibrium following I's offers $x_1^w = x_2^w$, both buyers must reject I's offer (as one buyer accepting I's offer is sufficient to preempt E in that case); we therefore must have $x^w \leq x^*$, because otherwise it would be a strictly dominant strategy to accept I's offer. If E is strong, instead, at most one buyer may accept I's offer at any non-exclusionary equilibrium (if both accept, entry is preempted even if E is strong); such a buyer will require a compensation of $x^s \geq x^*$ to accept; but I's profits if the buyer accepts are $\pi - x^s$, which are negative for all $x^s \geq x^*$; I can avoid losses by making an offer that will not be accepted, $x^s \in [0, x^*]$, and so both buyers will reject I's offer at the continuation equilibrium.

Finally, at the candidate equilibrium, E is never excluded, so that I earns zero profits under both entrant types; thus, there is no incentive for I to misrepresent the entrant type to the buyers, i.e. offer x^s when E is weak, or x^w when E is strong. Similarly, there is no incentive to deviate to any offer $x \neq x^w$ or $x \neq x^s$

in either case, because buyers will then place probability 1 on E being strong, so that entry occurs with certainty. Thus, buyers' beliefs are consistent with I's optimization behavior, and their choices optimize in turn against these beliefs, i.e. we identified a PBE.

(2) Exclusionary separating PBEs: If E is weak, at least one buyer must accept I's offer, so that E is indeed excluded at equilibrium; now, a buyer will accept I's offer either because it is a (weakly) dominant strategy to do so: $x^w \geq x^*$, or because the buyer expects the other buyer to accept as well, so that any non-negative compensation $x^w \geq 0$ will be accepted. Clearly, offers $x_1^w = x_2^w \geq x^*$ cannot be sustained in equilibrium, because I cannot break even under these offers: $2\pi < 2x^* \leq 2x^w$. Thus, if both buyers are to accept I's offer at equilibrium, these offers are restricted to $x_1^w = x_2^w \leq \pi$; and following such an offer, there are two continuation equilibria, one where both buyers accept, and one where both reject. Clearly, at the exclusionary equilibrium, both must accept when offered $x_1^w = x_2^w$. If E is strong instead, each buyer is pivotal for entry, and will not accept any compensation falling short of x^*. Again, I cannot break even when $x^s \geq x^*$ for both buyers, so that $x^s \in [0, x^*]$, with both buyers rejecting I's offer at the continuation equilibrium. Thus, I will earn profits of zero when E is strong. Clearly, I must not earn any higher profits when E is weak, as this would then create incentives to misrepresent a strong entrant as weak, making offers for the weak entrant type non-credible. Thus, for buyers' beliefs to be consistent with I's optimal offers, both x^w and x^s must yield the same profits for I: $2\pi - 2x^w = 0$, which solves for $x^w = \pi$. $\square$

Let us now turn to the case where the incumbent can make discriminatory offers to the buyers. We know from SW that under full information, this amplifies the exclusionary potential of ED contracts because it allows the incumbent to play divide-and-conquer strategies among the buyers. Exclusion no longer relies on buyer miscoordination, but is induced by pitting the buyers against each other. We will now show that this is also the case under asymmetric information, and that the contracts offered by the incumbent will have a similar structure as the discriminatory contracts in SW:If the entrant is weak, the incumbent offers to fully compensate one of the two buyers, while offering zero compensation to the other buyer; the first buyer will thus sign the ED contract, while the other buyer remains uncommitted.

The incumbent would have no interest to make such an offer if E were strong instead: With one free buyer left in the market, E would enter and serve this buyer, thus making it impossible for I to recover the losses made on the first buyer. Thus, by exposing himself heavily towards one buyer (i.e. offering a contract that would imply losses if entry were to occur after the contract was accepted), the incumbent sends a credible message to its buyers that the entrant is weak.

Thus, under asymmetric information, ED contracts play a much richer role in exclusion: not only do they induce contractual externalities among buyers, they also carry information about the level of entry barriers.

The very fact that the incumbent makes a divide-and-conquer offer will inform buyers that the entrant is weak, and the "maverick" buyers who are not signed up by the incumbent are needed to give credibility to this information.

Proposition 2: *Under simultaneous and discriminatory offers, the separating PB equilibria are characterized as follows:*

(i) Incumbent's offer schedule:

E's type	I's offer to B1, B2
weak (w)	$x_1^w = x^*, x_2^w = 0$
strong (s)	$x_1^s < x^*, x_2^s < x^*$

(ii) Buyers' posterior beliefs that E is weak:

$$\beta_i\left(x_1, x_2\right) = \begin{cases} 1 & \text{if } x_1 \geq x^*, x_2 = 0 \\ 0 & \text{otherwise} \end{cases} , i = 1, 2$$

(iii) Buyers' strategies are

$$s_i\left(x_1, x_2\right) = \begin{cases} 0 & \text{if } x_i < x^* \\ 1 & \text{if } x_i \geq x^* \end{cases} , i = 1, 2$$

so that at the separating equilibrium, $(s_1 = 1, s_2 = 0)$ *if E is weak, and* $(s_1 = s_2 = 0)$ *if E is strong. Thus, the weak (strong) entrant is always (never) excluded.*

Proof:

Let us start with the buyer choice stage: Suppose buyers are offered some $x_1 \geq x^*, x_2 = 0$, and therefore attach probability 1 to E being weak, as required by the candidate SE. It will then be rational for B1 to sign the ED contract, because it gives her a total surplus of $CS\left(p^m\right) + x_1$; since B2 rejects I's contract at the candidate equilibrium, B1 is pivotal for E's entry and could guarantee herself a surplus of $CS\left(c_I\right) \leq CS\left(p^m\right) + x_1$. Given that B1 signs, B2 will be indifferent between accepting and rejecting: B2 places probability 1 on E being weak, and a weak E is excluded as soon as B1 signs, so that B2's expected surplus is $CS\left(p^m\right)$ for $s_2 = 0, 1$. Rejecting is thus a rational choice.

Incumbent I can deviate from the candidate SE in two ways: on schedule (i.e. offering (x_1^w, x_2^w) when E is strong, or (x_1^s, x_2^s) when E is weak), and off schedule (i.e. offering some (x_1, x_2) not contained in the equilibrium offer schedule). We will examine each deviation in turn.

Consider first on-schedule deviations: Deviating from (x_1^w, x_2^w) to (x_1^s, x_2^s) when E is weak leads both buyers to reject I's offer, so that a weak E can enter, and I will make zero profits. Sticking to (x_1^w, x_2^w) instead yields profits of $2\pi - (x_1^w + x_2^w) > 0$ by assumption, so that this deviation is not profitable.

Likewise, I will never want to deviate from (x_1^s, x_2^s) to (x_1^w, x_2^w) when E is strong: Since B2 always rejects an offer $x_2^w = 0$, a strong entrant would still enter after (x_1^w, x_2^w) has been offered, even though there is only one free buyer left: B2 would then be served by E, and I would make losses of $\pi - x_1^w < 0$, making this on-schedule deviation unprofitable for I as well.

Let us now turn to off-schedule deviations: If E is weak, (x_1^w, x_2^w) is the cheapest offer that leads B1 to accept ED: I will never want to offer more than $x_1 = x^*$ and/or $x_2 = 0$, and any deviation to some $(x_1' < x^*, x_2 < x^*)$ will be followed by buyers believing that E is strong, so that they will both reject and trigger E's entry, which is clearly unprofitable for I.

If E is strong, deviating away from $(x_1^s < x^*, x_2^s < x^*)$ to some off-schedule offer different from $(x_1 \geq x^*, x_2 = 0)$ will lead buyers to believe that E is strong with probability 1, so that it will not be accepted unless $x_1^s \geq x^*, x_2^s \geq x^*$. And a deviation to an off-schedule offer $(x_1 > x^*, x_2 = 0)$ is not profitable either because even though buyers will believe that E is weak, B2 will not sign, and so I cannot preempt entry by E.□

Note that $(x_1^w = x^*, x_2^w = 0)$ is the unique equilibrium offer when E is weak.[6] To see why, suppose there was an equilibrium offer schedule where $(x_1^w > x^*, x_2^w = 0)$, i.e. where B1's surplus is strictly larger than $CS\,(c_I)$. Suppose that I makes an off-schedule deviation offer which slightly reduces B1's compensation: $(x_1' \in [x^*, x_1^w)\,, x_2^w = 0)$. Then, even if the buyers place probability 1 on E being strong upon observing such a deviation, B1 will still accept E's offer, since $CS\,(p^m) + x_1' \geq CS\,(c_I)$. B2 will reject, and I makes profits of $2\pi - x_1' > 2\pi - x_1^w$. In this way, we can eliminate all offer schedules where $(x_1^w > x^*, x_2^w = 0)$.

Thus, the cost of exclusion under simultaneous discriminatory contracts is exactly the same as in SW, and exclusion can only arise when E is weak, i.e. when divide-and-conquer strategies would have led to exclusion in the full-information benchmark as well.

Proposition 3: *Under sequential and discriminatory offers, the separating PB equilibria reveal the entrant's type either to the first buyer or to the second buyer.*

(i) Incumbent's offer schedule:

E's type	I's offer to B1, B2	
weak	(I) $x_1^w = 0, x_2^w = x^*$	or (II) $x_1^w = x^*, x_2^w = 0$
strong	$x_1^s = x_2^s = 0$	

followed by: $(s_1 = 0, s_2 = 1)$ *under (I),* $(s_1 = 1, s_2 = 0)$ *under (II), and* $(s_1 = s_2 = 0)$ *under* $(0,0)$*, i.e. the weak (strong) entrant is always (never) excluded.*

[6] Uniqueness is up to the identity of buyers 1 and 2. There exists of course a symmetric SE where $\left(x_1^w = 0, x_2^w = x^*\right)$ and beliefs and buyer choices are adjusted accordingly.

(ii) Posterior probabilities of E being weak sustaining Offer (I):

$$\beta_1(x_1) = \begin{cases} \mu & \text{if } x_1 = 0 \\ 0 & \text{if } x_1 > 0 \end{cases}$$
$$\beta_2(x_1, x_2) = \begin{cases} 1 & \text{if } x_1 = 0, x_2 > 0 \\ 0 & \text{if } x_1 > 0 \text{ or } x_1 = x_2 = 0 \end{cases}$$

(iii) Posterior probabilities of E being weak sustaining Offer (II):

$$\beta_1(x_1) = \begin{cases} 0 & \text{if } x_1 < x^* \\ 1 & \text{if } x_1 \geq x^* \end{cases},$$
$$\beta_2(x_1, x_2) = \begin{cases} 1 & \text{if } x_1 > 0, x_2 = 0 \\ 0 & \text{otherwise} \end{cases}$$

(iv) Buyers' strategies for both Offers (I) and (II):

$$s_1(x_1) = \begin{cases} 0 & \text{if } x_1 < x^* \\ 1 & \text{if } x_1 \geq x^* \end{cases}, s_2(x_1, x_2) = \begin{cases} 0 & \text{if } x_2 < x^* \\ 1 & \text{if } x_2 \geq x^* \end{cases}$$

Proof:

Let us start with the candidate equilibrium offer $(x_1^w = 0, x_2^w = x^*)$, where the entrant type is not immediately revealed. Clearly, there can be no separating equilibrium where $x_1^w = 0$ is followed by B1's *acceptance*, because B1 would then always be locked in to I, even if E turns out to be strong.

Thus, let I offer $x_1^w = 0$, so B1's posterior beliefs coincide with the prior ones (no updating possible); B1's expected payoff from rejection is thus $\mu CS(p^m) + (1-\mu) CS(c_I)$ which exceeds the payoff from acceptance, i.e. $CS(p^m)$. Thus, B1 rejects I's offer, while B2 is offered and accepts $x_2^w = x^*$. Since $2\pi - x^* > 0$ by assumption, this offer is immune to on-schedule deviations from (x_1^w, x_2^w) to (x_1^s, x_2^s) when E is weak; and it is also immune to on-schedule deviations from (x_1^s, x_2^s) to (x_1^w, x_2^w) when E is strong, because E will still enter as long as B1 is free, and so I would make negative profits $\pi - x^* < 0$ under this deviation.

It remains to show that there is no profitable off-schedule deviation for I. Clearly, if E is weak, $(x_1^w = 0, x_2^w = x^*)$ is the cheapest offer that achieves exclusion: Under $x_1^w = 0$ followed by B1's rejection, B2 will never accept any $x_2^w < x^*$, because she can guarantee herself at least surplus $CS(c_I)$ by rejecting I's offer and triggering E's entry. And clearly, I cannot increase its profits by offering some $x_1^w > 0$ and/or $x_2^w > x^*$.

Finally, if I offers $x_1^w > 0$ to induce B1 to accept ED, B1's posterior beliefs attach probability 1 to E being strong, so that B1 (and later B2) will require at least $x_1^w = x^*$ to accept. There is thus no way to achieve exclusion at a lower cost than $x_1^w + x_2^w = x^*$.

Next, let us turn to the candidate SE offer schedule $(x_1^w = x^*, x_2^w = 0)$, which reveals E's type already through the first offer made by I. Both buyers will attach probability 1 to E being weak upon observing $x_1^w = x^*$, and it is therefore rational for B1 to accept and for B2 to reject. Again, B2's rejection guarantees that I's offers are immune to on-schedule deviations: In particular, offering $(x_1^w = x^*, x_2^w = 0)$ when E is strong is unprofitable for I, because B2 would be served by E then, leaving I with payoffs $\pi - x^* < 0$. An off-schedule deviation offer to B1 of $x_1 < x^*$ results in both buyers attaching probability 1 to E being strong, making exclusion impossible for I.□

The interesting difference between this result and the SW equilibria under sequential discriminatory offers is that exclusion is no longer for free. Under full information, the first buyer accepts any compensation, no matter how small, because she knows that I can always convince B2 to accept at the next stage (which is then no longer necessary, once B1 signed). When buyers do not observe E's type instead, I must credibly communicate E's type to the buyers to be able to exclude E, and the cost of signaling E's type is exactly the same as under simultaneous offers, namely x^*.

4 Pooling Equilibria

Pooling equilibria (PEs) are characterized by contracts which do not reveal the entrant's type, i.e. where I makes the same offer no matter if E is weak or strong (superscript p stands for "pooling"). There is of course no direct analogue to a pooling equilibrium in the full information benchmark of SW.

Proposition 4: *Under simultaneous and non-discriminatory offers, the following pooling PB equilibria exist:*

(i) Non-exclusionary pooling PBEs: The incumbent offers $(x_1 = x_2 = x^p) \in R_+^2$ followed by $(s_1 = s_2 = 0)$ for both entrant types, with $x_i^p \in [0, x^*]$ for both $i = 1, 2$

(i-a) Posterior probabilities of E being weak:

$$\beta_i(x_1, x_2) = \begin{cases} \mu & \text{if } x_i = x^p \text{ for both } i = 1,2 \\ 0 & \text{otherwise} \end{cases}, i = 1, 2$$

(i-b) Buyers' strategies:

$$s_i(x_1, x_2) = \begin{cases} 1 & \text{if } x_i > x^* \\ 0 & \text{otherwise} \end{cases}, i = 1, 2$$

(ii) Exclusionary pooling PBEs: The incumbent offers $(x_1 = x_2 = x^p) \in R_+^2$ followed by $(s_1 = s_2 = 1)$ for both entrant types, with $x^p \in [(1-\mu)x^*, \pi]$ for both $i = 1, 2$.

(ii-a) Posterior probabilities of E being weak:

$$\beta_i(x_1, x_2) = \begin{cases} \mu & \text{if } x_i \geq x^p \text{ for both } i = 1,2 \\ 0 & \text{otherwise} \end{cases}, i = 1, 2$$

(ii-b) Buyers' strategies:

$$s_i(x_1, x_2) = \begin{cases} 1 & \text{if } x_1 \geq x^p, x_2 \geq x^p \text{ or } x_i \geq x^* \\ 0 & \text{otherwise} \end{cases}, i = 1, 2$$

Proof:

(i) Non-exclusionary Pooling PBEs:

We first show optimality of the buyers' strategy $s_i(x_1, x_2)$ given some $(x_i, x_j = x^p)$ and buyers' beliefs $\beta_i(x_1, x_2)$: If I offers $(x_i, x_j = x^p)$, then B_i's surplus when she accepts is $CS(p^m) + x_i$. At the continuation equilibrium where both buyers reject instead, either type of E enters (with two free buyers, entry is feasible even if E is weak). Thus, B_i's surplus from rejection is $CS(c_I)$. Acceptance is therefore rational iff $CS(p^m) + x_i \geq CS(c_I)$, which is equivalent to $x_i \geq x^*$; otherwise, the buyer will optimally reject.

Let us now turn to the incumbent, who offers $x_1 = x_2 = x^p$ at the candidate equilibrium, followed by rejection by both buyers. We will now argue that these offers are indeed optimal for I given the buyers' beliefs. Suppose that E is weak, and that I wants to deviate to some offer $x_1 = x_2 \neq x^p$ that induces the buyers to sign, thus preempting E. Any deviation offer $x_1 = x_2 = x^p$ is followed by $\beta_i(x_1, x_2) = 0$ for both buyers, i.e. their posterior beliefs attach probability 1 to E being strong, so that each of them considers himself pivotal. Then, each buyer $i = 1, 2$ will require a compensation of at least $x_i > x^*$ in order to sign. When E is weak, it is sufficient for I to sign up one buyer to exclude E; but since offers cannot be discriminatory, I can either sign up both buyers or neither, and to sign up both buyers, I must offer each $x_i > x^*$. But such an offer pair is not feasible for I: $2x_i > 2x^* > 2\pi$.

If E is strong, then E can only be preempted if I manages to sign up both buyers; but again, a deviation to some $x_1 = x_2 \neq x^p$ that induces both buyers to sign implies a non-feasible offer $2x_i > 2x^* > 2\pi$.

Thus, for both entrant types, it is optimal for I to offer some $x_i^p \in [0, x^*]$ for both $i = 1, 2$, such that both offers will be rejected at the continuation equilibrium where buyers make their choice: $(s_1 = s_2 = 0)$.

(ii) Exclusionary Pooling PBEs:

Let us start with I's offers $(x_i = x_j \geq x^p)$. As before, B_i's surplus when accepting I's offer is $CS(p^m) + x_i$. Any $x_i \geq x^*$ will always be accepted. If instead $x_i < x^*$, then B_i will only accept if ED gives her a higher expected surplus than remaining a free buyer. The expected surplus following a rejection depends on i's beliefs about E's type: Given that B_j accepts ED in equilibrium, and that B_i does not update her beliefs whenever $x_i = x_j \geq x^p$, entry will occur iff E is strong, to which B_i attaches (posterior) probability $1 - \mu$, and so B_i's expected surplus when remaining a free buyer is $(1 - \mu) CS(c_I) + \mu CS(p^m)$. B_i will therefore accept I's offer $(x_i = x_j \geq x^p)$ iff:

$$CS(p^m) + x_i \geq (1 - \mu) CS(c_I) + \mu CS(p^m)$$

Rearranging this expression gives $x_i \geq (1 - \mu) x^*$, which gives the lower bound on x_i^p stated in part (ii) of the proposition.

If I makes an out-of-equilibrium offer $(x_i = x_j < x^p)$, then B_i will attach probability 1 to E being strong, so that her expected surplus from rejection is $CS(c_I)$. B_i will therefore always reject such a deviation offer since $x_i < x^p$ and $x^p \leq \pi < x^*$ implies $x_i < x^*$. Thus, the strategy profile $s_i(x_1, x_2)$, $i = 1, 2$ is indeed optimal given buyers' beliefs $\beta_i(x_1, x_2)$.

For I, offering $(x_1 = x_2 = x^p)$ preempts entry for all E types, and yields profits of $2\pi - 2x^p$, which are non-negative because we require that $x^p \leq \pi$ at equilibrium. Deviating to an offer $x_i = x_j < x^p$ triggers both buyers' rejection, reducing I's profits to zero, thus (weakly) lower than the profits obtained from the equilibrium offers $(x_1 = x_2 = x^p)$. Offering $x_i = x_j > x^p$ still induces both buyers to accept, but reduces I's profits below $2\pi - 2x^p$, thus making the deviation again unprofitable to I.$\square$

Comparing the pooling PBEs to the separating PBEs under simultaneous and non-discriminatory offers (compare Propositions 1 and 4), we notice that at the pooling PBEs, exclusion is not only feasible, but also profitable for I. Recall that at the separating PBEs, exclusion could arise only in the razor-edge case where I's offers transferred all of I's profits to the buyers. Under the pooling PBEs, this is no longer a necessary condition for exclusion to arise: Exclusion will occur for both types of entrants, whose type will not be revealed to the buyers, and so there is no need to provide the right incentives for I to reveal the type. Rather, I can profitably exclude E exploiting the buyers' misaligned beliefs, which are very similar in spirit to the miscoordination equilibria identified by SW in the full information benchmark.

Proposition 5: *Under simultaneous discriminatory offers, the pooling PB equilibria are characterized as follows:*

(1) Exclusionary pooling PBEs: The incumbent offers $(x_1^p, x_2^p) \in R_+^2$ followed by $(s_1 = s_2 = 1)$ for both entrant types, with $x_i^p \in [(1-\mu)x^*, x^*]$ for both $i = 1, 2$ and $x_1^p + x_2^p \leq 2\pi$. If $x_i^p = x^*$ for one $i = 1, 2$, then $x_j^p = 0$ for $j \neq i$.

(ii-a) Posterior probabilities of E being weak:

$$\beta_i(x_1, x_2) = \begin{cases} \mu & \text{if } x_i \geq x_i^p \text{ for both } i = 1, 2 \\ 0 & \text{otherwise} \end{cases}, i = 1, 2$$

(ii-b) Buyers' strategies:

$$s_i(x_1, x_2) = \begin{cases} 1 & \text{if } x_1 \geq x_1^p \cap x_2 \geq x_2^p \text{ or } x_i \geq x^* \\ 0 & \text{otherwise} \end{cases}, i = 1, 2$$

(2) Under simultaneous discriminatory offers, there do not exist any non-exclusionary pooling PB equilibria.

Proof:

(1) Exclusionary Pooling PBEs:

Let us start with the buyers' optimal strategies. As before, B_i's surplus when accepting I's offer is $CS(p^m) + x_i^p$. Accepting $x_i^p = x^*$ is always rational. If $x_i^p < x^*$, then B_i will only accept if ED gives her a higher expected surplus than remaining a free buyer: Since B_j accepts I's offer in equilibrium, B_i attaches (posterior) probability $1-\mu$ to E entering (recall that I's offers to not reveal E's type at the Pooling PBE), and so B_i's expected surplus when remaining a free buyer is $(1-\mu)\,CS(c_I) + \mu CS(p^m)$. B_i will therefore accept iff:

$$CS(p^m) + x_i^p \geq (1-\mu)\,CS(c_I) + \mu CS(p^m)$$

Rearranging this expression gives $x_i^p \geq (1-\mu)\,x^*$, which gives the lower bound on x_i^p stated in part (ii) of the proposition.

If I makes an out-of-equilibrium offer $(x_1 < x_1^p, x_2^p)$, then B1 will attach probability 1 to E being strong, so that her expected surplus from rejection is $CS(c_I)$. B1 will therefore reject the deviation offer unless $x_1 \geq x^*$. The same holds for B2, who did not receive a deviating offer but observes the deviation offer to B1: Attaching probability 1 to E being strong, B2 will also reject unless $x_2^p \geq x^*$. Thus, the strategy profile $s_i(x_1, x_2), i = 1, 2$ is indeed optimal given buyers' beliefs $\beta_i(x_1, x_2)$.

For I, offering (x_1^p, x_2^p) preempts entry for all E types, and yields profits of $2\pi - (x_1^p + x_2^p)$, which are non-negative because we require that $x_1^p + x_2^p \leq 2\pi$ at equilibrium. Clearly, I has no incentive to deviate to an offer *exceeding* either x_1^p or x_2^p. Deviating to an offer $x_i < x_i^p$ to B_i triggers i's rejection, unless $x_i \geq x^*$. The deviation also triggers j's rejection, unless $x_j \geq x^*$. Since we cannot have both $x_i \geq x^*$ and $x_j \geq x^*$, at least one buyer will therefore reject the deviation offer. If E is weak (so that one accepting buyer is sufficient to exclude E), I's deviation was profitable for I. But at the pooling equilibrium, I's strategy must be optimal for *all* E types. We can therefore rule out equilibrium offers where $x_i^p > x^*$ for some $i = 1, 2$, or $\left(x_i^p > 0, x_j^p = x^*\right)$. At equilibrium, we must therefore have $x_i^p \leq x^*$ for both $i = 1, 2$, and $x_i^p = 0$ whenever $x_j^p = x^*$, so that any deviation to an offer $x_i < x_i^p$ for one or both buyers will trigger rejection by both buyers, and hence entry, making the deviation unprofitable to I.

(2) Suppose to the contrary that a non-exclusionary pooling equilibrium exists, implying that I's strategy is optimal for *all* E types. Now, suppose that E is weak; then, I could break such a non-exclusionary equilibrium by offering $x_i = x^*$ to buyer i, making it individually rational for buyer i to accept. Buyer j will be offered $x_j = 0$, and will reject; but since one buyer is sufficient to deter entry when E is weak, I will make profits of $2\pi - x^* > 0$, so that I's deviation was profitable. $\square$

The exclusionary PEs (both under uniform and discriminatory offers) have the interesting feature that even a strong entrant can be excluded, provided it is likely enough that the entrant is weak. Comparing PEs to SEs, notice that at the exclusionary SE, at most one buyer signs the ED contract, while the other remains free; at the PE instead, both buyers will sign, i.e. there is no free buyer left in the market. At a SE, one buyer must be left free to give credibility to I's offer to the other buyer, which is meant to signal to both buyers that E is weak. At a PE, E's type will never be revealed, so that I does not incur any signaling cost.

If the probability of E being weak is very high ($\mu \to 1$), exclusion can be achieved at almost no cost. To get a sense of the lower bound on μ at which exclusionary PEs can be sustained, consider symmetric offers to both buyers, $x_1^p = x_2^p$, and let them have linear demands and constant marginal costs. Then $x^* = CS(c_I) - CS(p^m) = \frac{3}{2}\pi$, so that exclusion can be achieved whenever $x_i^p = (1-\mu)\frac{3}{2}\pi \leq \pi$, i.e. whenever $\mu \geq \frac{1}{3}$.

Proposition 6:

Under sequential and discriminatory offers, the following pooling PB equilibria exist:

(1) Exclusionary PBEs:

(i) The incumbent offers $x_1^p \geq 0$, $x_2^p \geq 0$ *for both entrant types, with* $x_1^p + x_2^p \leq 2\pi$ *and* $x_i^p \in [(1-\mu)x^*, x^*]$ *for both* $i = 1, 2$. *I's offers are followed by* $s_1 = 1$ *and* $s_2 = 1$*, respectively.*

(ii) Posterior probabilities of E being weak:

$$\begin{aligned} \beta_1(x_1) &= \begin{cases} \mu & \text{if } x_1 = x_1^p \\ 0 & \text{otherwise} \end{cases} \\ \beta_2(x_1, x_2) &= \begin{cases} \mu & \text{if } x_1 = x_1^p, x_2 = x_2^p \\ 0 & \text{otherwise} \end{cases} \end{aligned}$$

(iii) Buyers' strategies:

$$s_1(x_1) = \begin{cases} 1 & \text{if } x_1 = x_1^p \text{ or } x_1 \geq x^* \\ 0 & \text{otherwise} \end{cases}, s_2(x_1, x_2) = \begin{cases} 1 & \text{if } x_1 = x_1^p, x_2 = x_2^p \text{ or } x_2 \geq x^* \\ 0 & \text{otherwise} \end{cases}$$

(2) Under sequential and discriminatory offers, there do not exist any non-exclusionary pooling PB equilibria.

Proof:

(1) Again, we start with the buyers, noting that accepting $x_i^p \geq x^*$ is always rational. Suppose Buyer 1 (wlog the first buyer to receive I's offer) receives the equilibrium offer $x_1^p < x^*$, so that her posterior beliefs are $\beta_1(x_1) = \mu$; if Buyer 1 decides to reject (rather than accept, as required at equilibrium), she anticipates

that if E is weak, I can always exclude E by making a deviation offer to the second buyer, where $x_2^d \geq x^*$. Thus, $B1$'s expected surplus from rejecting I's offer is $(1-\mu)\,CS\,(c_I) + \mu CS\,(p^m)$. $B1$ will therefore accept I's offer iff:

$$CS\,(p^m) + x_1^p \geq (1-\mu)\,CS\,(c_I) + \mu CS\,(p^m)$$

Next, consider Buyer 2, at the continuation equilibrium following $x_1 = x_1^p, s_1 = 1, x_2 = x_2^p$. Buyer 2 cannot update her beliefs upon observing this equilibrium play, and will therefore accept I's offer under the same condition as Buyer 1, i.e. iff

$$CS\,(p^m) + x_2^p \geq (1-\mu)\,CS\,(c_I) + \mu CS\,(p^m)$$

This yields condition $x_i^p \geq (1-\mu)\,x^*$, the lower bound on x_i^p stated in part (1-i) of the proposition.

Any deviating offer by the incumbent would be followed by buyers updating their beliefs toward a strong entrant, thus rejecting I's offer. Equilibrium offers, instead, will be accepted and yield non-negative profits $2\pi - (x_1^p + x_2^p)$. As shown in the proof of Proposition 5, we can rule out equilibrium offers where $x_i^p > x^*$ for some $i = 1, 2$, and $\left(x_i^p > 0, x_j^p = x^*\right)$, which yields the upper bound x^* on x_i^p stated in part (1-i) of the proposition. Thus, our candidate pooling equilibria are indeed PBEs.

(2) As in the proof of Proposition 5 (2): Suppose to the contrary that a non-exclusionary pooling equilibrium exists, implying that I's strategy is optimal for *all* E types. Now, suppose that E is weak; then, I could break such a non-exclusionary equilibrium by offering $x_i = x^*$ to buyer i (either the first or the second buyer), making it individually rational for buyer i to accept. Buyer j will be offered $x_j = 0$, and will reject; but since one buyer is sufficient to deter entry when E is weak, I will make profits of $2\pi - x^* > 0$, so that I's deviation was profitable. □

Clearly, the existence of pooling equilibria under sequential (and discriminatory) offers hinges crucially on the very peculiar belief structure given in Proposition 6. As such, these equilibria may not be particularly robust. But more importantly, Proposition argues that we cannot have non-exclusionary pooling equilibria under sequential offers; this confirms the same finding for the case of simultaneous and discriminatory offers (Proposition 5). This is in stark contrast to the separating equilibria under the same protocol (Propositions 2 and 3), and to the full information benchmark, where strong entrants can never be excluded.

We can therefore conclude that under sequential (and discriminatory) offers, either the weak entrant will always be excluded, while the strong entrant will enter (separating PBEs), or that all types of entrants will be excluded (pooling PBEs). In other words, the exclusionary potential of ED contracts found in SW (the full information benchmark) represents the *lower* bound on the level of exclusion that can be achieved by

ED contracts under asymmetric information about entry barriers; if anything, ED contracts turn out to be even more exclusionary under such an asymmetric information structure.

5 Conclusion

This paper points to a new role of ED, besides the well-known functions of rent-shifting and generating contracting externalities: signaling the entrant type if the latter is observable only to the incumbent supplier, but not to the buyers. We saw that at the separating equilibria, exclusion will occur whenever it arises also in SW, but will always be costly, even if offers can be made sequentially. At the exclusionary pooling equilibria, instead, even strong entrants will be excluded, which cannot happen in the full-information benchmark of SW. Moreover, exclusion can be almost without cost if the probability of a strong entrant is sufficiently low.

References

[1] Abito, José Miguel, and Julian Wright, 2008. "Exclusive Dealing with Imperfect Downstream Competition," *International Journal of Industrial Organization*, 26(1): 227–246.

[2] Aghion, Philippe, and Patrick Bolton, 1987. "Contracts as a Barrier to Entry," *American Economic Review*, 77(3): 388–401.

[3] Argenton, Cédric, 2010. "Exclusive Quality." *Journal of Industrial Economics*, 58(3): 690–716.

[4] Asker, John and Heski Bar-Isaac, 2014. "Raising Retailers' Profits: On Vertical Practices and the Exclusion of Rivals," *American Economic Review*, 104(2): 672-686.

[5] Blume, Andreas, 2003. "Bertrand without fudge," *Economics Letters,* 78(2): 167-168.

[6] Calzolari, Giacomo, and Vincenzo Denicolò, 2014. "Exclusive contracts and market dominance," unpublished manuscript.

[7] Chen, Zhijun and Greg Shaffer, 2014. "Naked exclusion with minimum-share requirements," RAND Journal of Economics, 45(1): 64–91.

[8] Figueroa, Nicolás, Enrique Ide and Juan-Pablo Montero, 2014. "Discounts as a Barrier to Entry," unpublished manuscript.

[9] Fumagalli, Chiara, and Massimo Motta, 2006. "Exclusive Dealing and Entry, when Buyers Compete," *American Economic Review*, 96(3): 785-795.

[10] Ide, Enrique, Juan-Pablo Montero, and Nicolás Figueroa, 2015. "Exclusionary Contracts under Asymmetric Information," unpublished manuscript.

[11] Innes, Robert, and Richard J. Sexton, 1994. "Strategic Buyers and Exclusionary Contracts," *American Economic Review*, 84(3): 566-84.

[12] Johnson, Justin P., 2012. "Adverse Selection and Partial Exclusive Dealing, " unpublished manuscript.

[13] Majumdar, Adrian, and Greg Shaffer, 2009. "Market-Share Contracts with Asymmetric Information," *Journal of Economics & Management Strategy*, 18(2): 393–421.

[14] Marx, Leslie, and Greg Shaffer, 2004. "Rent-Shifting, Exclusion, and Market-Share Discounts," unpublished manuscript.

[15] Miklós-Thal, Jeanine, and Greg Shaffer, 2014. "Naked Exclusion with Private Offers," unpublished manuscript.

[16] Nocke, Volker, and Martin Peitz, 2015. "Exclusive Dealing and Asymmetric Information," unpublished manuscript.

[17] Rasmusen, Eric B., J. Mark Ramseyer and John Shepard Wiley, Jr, 1991. "Naked Exclusion," *American Economic Review*, 81(5): 1137–45.

[18] Segal, Ilya R., and Michael D. Whinston, 2000. "Naked Exclusion: Comment," *American Economic Review*, 90(1): 296-309.

[19] Simpson, John, and Abraham L. Wickelgren, 2007. "Naked Exclusion, Efficient Breach, and Downstream Competition," *American Economic Review*, 97(4): 1305–1320.

[20] Spector, David, 2011. "Exclusive Contracts and Demand Foreclosure," RAND Journal of Economics, 42 (4): 619–638.

[21] Wright, Julian, 2009. "Exclusive Dealing and Entry, When Buyers Compete: Comment," *American Economic Review*, 99(3): 1070-81.

[22] Yehezkel, Yaron, 2008. "Retailers' choice of product variety and exclusive dealing under asymmetric information," RAND Journal of Economics, 39(1): 115–143.

[23] Yong, Jong-Say, 1999. "Exclusionary Vertical Contracts and Product Market Competition." *Journal of Business*, 72(3): 385–406.