Appendices to

Exclusive Dealing and Entry, when Buyers Compete

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This file contains the proofs for the following cases.

B. The incumbent can commit on future prices.

C. Breach of exclusivity can be remedied by the payment of expectation damages.

D. Downstream firms are independent monopolists (and upstream firms use linear prices).

E. Downstream firms compete in quantities and sell homogeneous goods (and upstream firms use linear prices).

(For shortness, we focus on the case of sequential offers, apart from Appendix D.)

B Price commitment

This Appendix studies the case where exclusive contracts include the commitment to provide the input at a certain linear price (i.e. they take the form (w_I, x)) and shows that intense downstream competition does not prevent the incumbent from excluding. Both under weak and tough competition, the incumbent commits to a "low" price and extracts the surplus enjoyed by buyers paying this price instead of a higher price. However, when downstream markets are independent, it commits to the price c_I which maximizes the joint surplus of the incumbent and the buyers, whereas under intense downstream competition the incumbent has to commit to a lower price in order to prevent entry.

Proposition B.1. *When exclusive contracts include a price commitment and the incumbent makes sequential offers, exclusion is profitable.*

Proof. 1. *Independent downstream monopolists.*

Case 1: *the first buyer signs the exclusive deal.* The incumbent earns $(1-c_I)^2/16$ from the second buyer if it does not sign the contract, as by assumption A1 entry does not occur and the free buyer will have to buy from the incumbent at the monopoly price $(1+c_I)/2$. If the incumbent offers the contract (w_I, x_2) to the second buyer, it requires a compensation $x_2 = \left[(1-c_I)^2/32 - (1-w_I)^2/8\right]$ to sign. Hence, the optimal contract such that the second buyer signs solves $\max_{w_I} \left[(w_I - c_I)(1-w_I)/4 - (1-c_I)^2/32 + (1-w_I)^2/8\right]$. The optimal wholesale price is $w_I^* = c_I$ (which maximizes the joint surplus of the vertical structure) and the compensation $x_2^* = -3(1-c_I)^2/32$. Note that the second buyer is willing to pay to sign this contract and the incumbent attains a larger profit than in the case where the second buyer rejects. Thus, if the first buyer signed the contract, the incumbent offers $\left(w_I^* = c_I, x_2^* = -3(1-c_I)^2/32\right)$ and the second buyer also signs.

Case 2: *the first buyer rejects the exclusive deal.* If the second buyer also rejects, entry occurs (by assumption A1) and the incumbent's payoff is 0. The free buyers earn $\pi_{B|S=0} = (1-c_I)^2/8 - \varepsilon$. Hence, if the incumbent offers the contract (w_I, x_2) to the second buyer, it requires a compensation $x_2 = \left[(1-c_I)^2/8 - (1-w_I)^2/8\right]$ to sign. The optimal contract such that the second buyer signs solves $\max_{w_I}[(w_I - c_I)(1-w_I)/4 - (1-c_I)^2/8 + (1-w_I)^2/8]$. The optimal wholesale price is $w_I^* = c_I$, and the compensation $x_2^* = 0$. Note that the incumbent does not earn anything from the second buyer, but it will earn $(1-c_I)^2/16$ from the first one as its demand does not attract entry and it will have to buy from the incumbent paying the monopoly price. Hence, if the first buyer rejected, for the incumbent it is optimal to offer $(w_I^* = c_I, x_2^* = 0)$ to the second buyer and make it sign.

Let us analyze the first buyer's decision. It anticipates that the second buyer always signs so that entry will not occur even though it rejects the contract. Hence, it requires a compensation $x_1 = \left[(1-c_I)^2/32 - (1-w_I)^2/8\right]$ to sign a contract which commits to an input price w_I. For the incumbent it is optimal to make the first buyer sign offering the contract $\left(w_I^* = c_I, x_1^* = -3(1-c_I)^2/32\right)$. In equilibrium both buyers sign and the incumbent's total payoff is $3(1-c_I)^2/16$. Note that under price commitment the incumbent extracts the entire surplus enjoyed by buyers when they pay the price c_I instead of the monopoly price, which is larger than the upstream monopoly profits. Thus exclusion is more profitable with respect to the case where exclusive contracts do not include a price commitment: $3(1-c_I)^2/16 > (1-c_I)^2/8$.

2. *Bertrand competitors.* First, let us denote with $\widehat{w}$ the price such that if a buyer signs a contract committing to $\widehat{w}$ and the other buyer rejects, for the entrant it is not profitable to slightly undercut $\widehat{w}$ and serve the free buyer. Thus the price $\widehat{w}$ satisfies $\widehat{w}(1-\widehat{w})/2 - F = 0$. Note that, by the assumption $(1-c_I)c_I/2 - F > 0$, $\widehat{w} \in (0, c_I)$.

Case 1: *the first buyer rejects the exclusive deal.* Imagine the incumbent offers (w_2, x_2) to the second buyer. If the second buyer also rejects, its payoff will be 0. If it signs a contract where the incumbent commits to a price $w_2 > \widehat{w}$, its gross payoff will be 0. The entrant will enter, will offer a price $w_E^f = \min\{c_I, w_2\}$ and will capture the free buyer. The latter will monopolize the downstream market whereas the signer will remain inactive. Instead, if the second buyer signs a contract where the incumbent commits to a price $w_2 \leq \widehat{w}$, its gross payoff will be $(1-w_2)^2/4 - \varepsilon$. The entrant will not enter, the free buyer will remain inactive and the signer will monopolize the downstream market. (Note that the incumbent will not serve the free buyer which could not buy from the entrant. It should offer a price $w_I \leq w_2 < c_I$ and would suffer losses.) To sum up, the second buyer requires (indeed, it is willing to pay) x_2 to sign a contract where the incumbent commits to the input price w_2 where

$$x_2 = \begin{cases} 0 & \text{if } w_2 > \widehat{w} \\ -\left[\frac{(1-w_2)^2}{4} - \varepsilon\right] & \text{if } w_2 \leq \widehat{w} \end{cases}$$

If the second buyer rejects the contract, the incumbent' payoff is 0. By offering a contract such that the second buyer signs, the incumbent earns 0 if it commits to a price $w_2 > \widehat{w}$, whereas it earns $(w_2 - c_I)(1-w_2)/2 + \left[(1-w_2)^2/4 - \varepsilon\right]$ if it commits to a price $w_2 \leq \widehat{w}$ (it will serve the signer which will monopolize the market and which is willing to pay to sign the exclusive contract). Note that in the latter case the incumbent appropriates the joint surplus of the two successive monopolists. For $c_I < 1/2$ and ε sufficiently low, its payoff is positive for any $w_2 \in [0, \widehat{w}]$ and increasing in w_2. Hence, it is optimal to have the second buyer sign offering the contract $\left(w_2 = \widehat{w}, x_2 = -\left((1-\widehat{w})^2/4 - \varepsilon\right)\right)$. The incumbent earns $(\widehat{w} - c_I)(1-\widehat{w})/2 + \left[(1-\widehat{w})^2/4 - \varepsilon\right] > 0$.

Case 2: *the first buyer signs the contract* (w_1, x_1). If $w_1 \leq \widehat{w}$ and the second buyer rejects the contract, the entrant will not enter and the free buyer will remain inactive. Instead, if $w_1 > \widehat{w}$ it is the signer which will remain inactive and the free buyer, which will be offered the price $w_E^f = \min\{c_I, w_1\}$, will monopolize the market. Hence, the second buyer will earn the payoff $\pi_{B_2}^f$ if it rejects the contract, where

$$\pi_{B_2}^f = \begin{cases} 0 & \text{if } w_1 \leq \widehat{w} \\ \frac{(1-w_E^f)^2}{4} - \varepsilon & \text{if } w_1 > \widehat{w} \end{cases}$$

If the second buyer signs the exclusive deal and in its contract the incumbent commits to a lower price than the one offered to the rival, the second buyer will monopolize the downstream market. Otherwise, its gross payoff will be 0. Hence, signing a contract where the incumbent commits to the price w_2 the second buyer will earn the payoff $\Pi_{B_2}^s$ (gross of the compensation), where

$$\Pi_{B_2}^s = \begin{cases} 0 & \text{if } w_2 \geq w_1 \\ \frac{(1-w_2)^2}{4} - \varepsilon & \text{if } w_2 < w_1 \end{cases}$$

To sum up, the second buyer requires $x_2 = \pi_{B_2}^f - \Pi_{B_2}^s$ to sign. Is it optimal for the incumbent to have the second buyer sign the contract?

If the exclusive contract offered to the first buyer commits to $w_1 > \widehat{w}$, it is not. The intuition is that the second buyer earns a large payoff rejecting the contract (entry will occur and it will monopolize the downstream market) and this makes it unprofitable for the incumbent to have it sign. To see this, let us compare the incumbent's payoff when the second buyer rejects the contract (in which case the first buyer decides to be inactive and the incumbent earns $\pi_I^r = -x_1$) with the incumbent's payoff π_I^s when the second buyer signs the contract, where

$$\pi_I^s = \begin{cases} (w_1 - c_I)\frac{(1-w_1)}{2} - x_1 - \left[\frac{(1-w_E^f)^2}{4} - \varepsilon\right] & \text{if } w_2 > w_1 \\ (w - c_I)\,Q^e(w) - x_1 - \left[\frac{(1-w_E^f)^2}{4} - \varepsilon\right] & \text{if } w_2 = w_1 = w \\ -x_1 + (w_2 - c_I)\frac{1-w_2}{2} + \left[\frac{(1-w_2)^2}{4} - \varepsilon\right] - \left[\frac{(1-w_E^f)^2}{4} - \varepsilon\right] & \text{if } w_2 < w_1 \end{cases}$$

and $Q^e(w)$ tends to $1 - w$ as $\varepsilon \to 0$.

If the incumbent offers the second buyer a price $w_2 > w_1$, it will serve only the first buyer and will have to pay the second one to make it sign. For ε low enough, the payment to the second buyer is larger than the highest payoff that the incumbent realizes serving the first buyer: since $w_E^f \leq c_I$, $(1-w_E^f)^2/4 - \varepsilon \geq (1-c_I)^2/4 - \varepsilon > (1-c_I)^2/8 = \max(w_1 - c_I)(1-w_1)/2$. Hence, $\pi_I^s < -x_1$ and the incumbent is better off if the second buyer rejects.

If the incumbent offers the second buyer the same price as the first one, it will serve both buyers and will have to pay the second one to make it sign. Also in this case the payment to the second buyer is larger than the highest payoff that the incumbent realizes serving both buyers: since $w_E^f \leq c_I$, $(1-w_E^f)^2/4-\varepsilon \geq (1-c_I)^2/4-\varepsilon > \max\left((w-c_I)\,Q^e(w)\right)$ (Appendix A of the paper proves that the difference tends to 0 as $\varepsilon \to 0$). Hence, $\pi_I^s < -x_1$ and the incumbent is better off if the second buyer rejects.

If the incumbent offers the second buyer a price $w_2 < w_1$, it will serve only the second buyer which requires $x_2 = \left[(1-w_2)^2/4-\varepsilon\right] - \left[(1-w_E^f)^2/4-\varepsilon\right]$ to sign. Since $w_E^f \leq c_I$, $(1-w_E^f)^2/4-\varepsilon \geq (1-c_I)^2/4-\varepsilon = \max\left((w_2-c_I)\,(1-w_2)\,/2+\left[(1-w_2)^2/4-\varepsilon\right]\right)$. Hence, $\pi_I^s \leq -x_1$ and for the incumbent it is not profitable to have the second buyer sign.

Instead, if the exclusive contract offered to the first buyer commits to $w_1 \leq \widehat{w}$, it is profitable to have the second buyer sign offering a contract where w_2 is slightly below w_1. To see this, let us compare the incumbent's payoff when the second buyer rejects and when the second buyer signs. In the former case, the entrant will not enter and the free buyer will remain inactive. Hence, the incumbent serves the signer and earns $\pi_I^r = (w_1-c_I)\,(1-w_1)\,/2-x_1$. By offering a contract such that the second buyer signs, the incumbent earns:

$$\pi_I^s = \begin{cases} (w_1-c_I)\,\frac{1-w_1}{2}-x_1 & \text{if } w_2 > w_1 \\ (w-c_I)\,Q^e(w)-x_1 & \text{if } w_2 = w_1 = w \\ (w_2-c_I)\,\frac{1-w_2}{2}+\left[\frac{(1-w_2)^2}{4}-\varepsilon\right]-x_1 & \text{if } w_2 < w_1 \end{cases}$$

If the incumbent offers the second buyer a price $w_2 > w_1$, it will serve only the first buyer and the second buyer will remain inactive. It would remain inactive also if it rejected, since entry would not follow. Hence the incumbent makes the second buyer sign behind the payment of $x_2 = 0$ and earns the same payoff as if the second buyer rejects ($\pi_I^s = \pi_I^r$).

The incumbent makes the second buyer sign behind the payment of $x_2 = 0$ also if it offers to the second buyer the same price as the first one. However, by making the second buyer sign, the incumbent sells additional input at a price below its marginal cost (recall that $w_1 \leq \widehat{w} < c_I$) with respect to the case where the second buyer rejects. It is better off in the latter case ($\pi_I^r > \pi_I^s$).

Instead, the incumbent is better off if it makes the second buyer sign a contract which commits to a price w_2 *slightly* below w_1. It serves only the second buyer (and obtains the same payoff as if it served only the first one) and it collects from it the payment $\frac{(1-w_2)^2}{4}-\varepsilon$ (if it signs, it monopolizes the market, whereas it remains inactive if it rejects). Hence, $\pi_I^s > \pi_I^r$.

Let us analyze the first buyer's decision. It anticipates that its payoff is zero both if it signs (if $w_1 > \widehat{w}$, the second buyer rejects and monopolizes the market; if $w_1 \leq \widehat{w}$, the second buyer signs and is offered a lower price) and if it rejects (in this case, the second buyer signs and is offered a price such that firm E will not enter the market). Hence, the first buyer requires $x_1 = 0$ to sign. In equilibrium the incumbent offers $(w_1 = \widehat{w},\ x_1 = 0)$ to the first buyer which rejects, and $(w_2 = \widehat{w},\, x_2 = -\left((1-\widehat{w})^2/4-\varepsilon\right))$ to the second buyer which signs. Entry does not occur. Note that the incumbent's payoff amounts to $(\widehat{w}-c_I)\,(1-\widehat{w})\,/2+\left[(1-\widehat{w})^2/4-\varepsilon\right] > 0$: even though downstream firms compete à la Bertrand, exclusion is profitable. However, in order to deter entry the incumbent has to commit to the price $\widehat{w} < c_I$, which does not maximize the joint surplus of the incumbent and of the buyer.

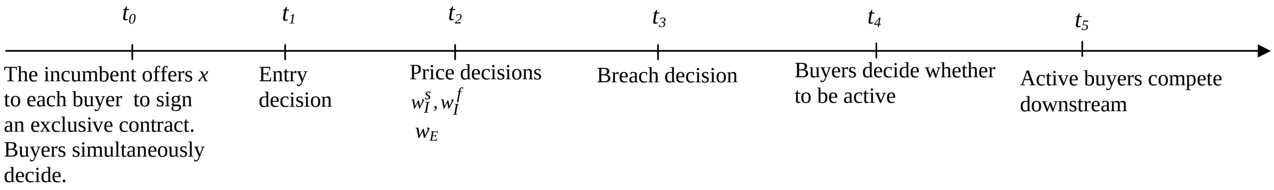

Figure 1: Time-line when the contract can be breached

C Breach of the exclusive contract

Throughout the paper, following Rasmusen et al. (1991) and Segal and Whinston (1996, 2000), we assume that exclusive deals cannot be breached or, equivalently, that if the buyers broke the deal with the incumbent, they would have to pay infinite penalties. In this Appendix, we study the case where buyers can breach the exclusive agreement behind the payment of *expectation damages*, i.e. a payment that makes the victim of breach - in this case the incumbent - as well off as if the contract had been fulfilled. The game changes as follows: after the upstream firms' decision on input prices, buyers decide whether to purchase from the incumbent or to breach the contract and address the entrant. The rest of the game is the same as in Section I of the paper. The new time-line is illustrated by the Figure 1. Note that, for consistency, we keep here a positive fixed cost ε to operate in the downstream market, as in the paper. However, the same results would carry over if $\varepsilon = 0$.

Proposition C.1 shows that exclusive deals can never deter entry, independently of the intensity of competition in the downstream markets. Entry will occur even though both buyers sign the exclusive deals, because it turns out that the price that induces the breach of the contract(s) allows the entrant to cover its fixed costs. Hence, a buyer which signs the deal does not exert a negative externality on other buyers.

Proposition C.1. *When buyers can breach the exclusivity obligation behind the payment of expectation damages and the incumbent makes sequential offers, entry always occurs.*

Proof. 1. *Independent monopolists.* Let us analyze time t_2 price decisions when one buyer signed the exclusive deal and firm E entered the market. For given w_I, the incumbent earns $(w_I - c_I)(1 - w_I)/4$ both if the signer breaches and if it fulfills the contract (expectation damages make the incumbent as well off as if exclusivity had been respected). Hence, at time t_2 it chooses the price $w_I^s = (1 + c_I)/2$, and will earn $(1-c_I)^2/16$. Given this price, the signer breaches the contract if (and only if) patronizing the entrant and paying the expectation damages makes it at least as well off as buying from the incumbent: $(1 - w_E)^2/8 - (1 - c_I)^2/16 - \varepsilon + x_i \geq (1 - c_I)^2/32 - \varepsilon + x_i$. This inequality is satisfied iff $w_E \leq 1 - \sqrt{3}(1 - c_I)/2$. Hence, at time t_2 the entrant chooses the price $w_E^s = \min\left\{1 - \sqrt{3}(1 - c_I)/2, 1/2\right\} > 0$ and sells to the signer. (The entrant's monopoly price is $1/2$ and $1 - \sqrt{3}(1 - c_I)/2 \geq 1/2$ for $c_I \in \left[1 - \sqrt{3}/3, 1/2\right]$). It is easy to check that $1 - \sqrt{3}(1 - c_I)/2 > c_I$ for any $c_I < 1/2$. (The damages, i.e. the monopoly profits, are strictly lower than the buyer's gain when it pays the price c_I instead of the monopoly price. Hence, a price above c_I is sufficient to induce the buyer to breach the contract.) Thus the entrant earns more selling to a signer at the price w_E^s rather than selling to a free buyer at the price c_I. Since by assumption A1 entry at t_1 is profitable if both buyers reject the exclusive deal, *a fortiori* entry is profitable if at least one buyer signs the contract.

We can now solve for decisions at time t_0.

Case 1: *the first buyer signs the contract.* If the second buyer also signs, its payoff is $\pi_{B|S=2} = (1-c_I)^2/32 + x_2 - \varepsilon$: entry occurs, the signers breach the contract and, after paying the damages, they are as well off as if they bought from the incumbent paying the price $(1+c_I)/2$. If the second buyer rejects, entry occurs (since the signer will breach the contract) and the free buyer pays c_I for the input earning $\pi^f_{B|S=1} = (1-c_I)^2/8 - \varepsilon$. Hence, the second buyer requires $x_2 = x^* = 3(1-c_I)^2/32$ to sign. If both buyers sign (and then breach), the incumbent collects total damages $(1-c_I)^2/8$. If the second buyer rejects, it collects damages $(1-c_I)^2/16$ from the first buyer. Hence, it is not willing to have the second buyer sign behind the payment of x^*. To sum up, if the first buyer signed, the second rejects.

Case 2: *the first buyer rejects the exclusive deal.* The second buyer earns $\pi^s_{B|S=1} = (1-c_I)^2/32 + x_2 - \varepsilon$ if it signs. If it rejects, it pays c_I for the input and earns $\pi_{B|S=0} = (1-c_I)^2/8 - \varepsilon$. Also in this case the second buyer requires $x_2 = x^* = 3(1-c_I)^2/32$ to sign. The incumbent is not willing to offer it as making the second buyer sign allows it to collect damages $(1-c_I)^2/16 < x^*$. Hence, if the first buyer rejected, the second buyer also rejects. The first buyer anticipates that the second buyer always rejects and requires $x_1 = x^* = 3(1-c_I)^2/32$ to sign. The incumbent is not willing to offer it. In equilibrium $S = 0$ and entry occurs.

2. *Bertrand competitors.* Let us study time t_2 price decision and time t_1 entry decision according to the number of buyers which signed the deal.

Let us start from the case where both buyers signed the exclusive deal ($S = 2$). Both if the signers fulfill and if they breach the contracts the incumbent earns the same expected payoff. Hence, at time t_2 it chooses the price $w_{I|S=2}$ which maximizes this expected payoff, earning the gross profit $\Pi_{I|S=2}$ which tends to $(1-c_I)^2/4$ as ε tends to 0 (see the proof in Appendix A of the paper). Note that, for a given $w_E < w_{I|S=2}$, it will never be the case that both buyers breach the contracts, since their gross payoff would be 0 and they would not be willing to pay any positive damages. If a single buyer breaches the contract, it monopolizes the downstream market, earning $(1-w_E)^2/4 - \varepsilon + x_i$. Yet, it has to pay the damages $\Pi_{I|S=2}$. If it does not breach, its payoff is $0 + x_i$. It breaches if (and only if) $(1-w_E)^2/4 - \varepsilon - \Pi_{I|S=2} \geq 0$. Recall that $(1-c_I)^2/4 - \varepsilon - \Pi_{I|S=2} > 0$ and tends to 0 as ε tends to 0. Hence, at time t_2 the price w_E^s that the entrant must set to induce the breach of the contract by one buyer is above c_I (and w_E^s tends to c_I as $\varepsilon \to 0$). Since the buyer which breaches the contract covers the entire downstream market, entry is profitable (the entrant's payoff tends to $c_I(1-c_I)/2 - F > 0$ by A1). To sum up, if both buyers sign the contract, entry occurs and the buyers' gross payoff is 0.[1]

[1] If $\varepsilon = 0$, following $S = 2$, at time t_2 the incumbent chooses the price $w_{I|S=2} = (1+c_I)/2$ and the damages in case of breach amount to the monopoly profits. If the entrant offers a price slightly below c_I, one buyer breaches the exclusive agreement. By slightly undercutting its rival it captures the entire downstream market and earns

Let us consider the case where one buyer signs the contract ($S = 1$). At time t_2 the entrant chooses the price $w_E = c_I$. If the contract is not breached, the free buyer pays the price c_I for the input and captures the entire downstream market while the signer remains inactive. The incumbent's gross payoff is 0 so that the expectation damages are also 0. The signer's gross payoff is 0 both if it breaches the contract and if it does not. In both cases entry is profitable, but the signer's decision crucially affects the free buyer's payoff. In the former case the signer and the free buyer pay the same price c_I for the input and sell a total quantity which tends to $1 - c_I$ as $\varepsilon \to 0$. The entrant earns a payoff which tends to $(1 - c_I)c_I - F > 0$ by A1. The free buyer's payoff is 0. In the latter case the free buyer monopolizes the downstream market selling $(1 - c_I)/2$ and earning $(1 - c_I)^2/4 - \varepsilon$. The entrant's payoff is $c_I(1 - c_I)/2 - F > 0$ by A1.

To sum up, at time t_1 entry always occurs, for any buyers' decisions at date 0. By proceeding backwards, it is easy to check that "entry equilibria" can take different forms according to the decisions taken in case of indifference. Imagine that the signer breaches the contract when $S = 1$. Hence, the incumbent can have the second buyer sign behind the payment of no compensation, even when the first buyer signed the exclusive deal. This suggests why there exists an "entry equilibrium" where both buyers sign (and one breaches) and where the incumbent collects the damages (which tend to $(1 - c_I)^2/4$ as $\varepsilon \to 0$). Imagine, instead, that the signer does not breach the contract when $S = 1$. If a buyer signs, the incumbent should pay $(1 - c_I)^2/4 - \varepsilon$ to the other buyer, to make it sign. This is not profitable since $(1 - c_I)^2/4 - \varepsilon$ is larger than $\Pi_{I|S=2}$ (see the proof in Appendix A of the paper). This suggests why there exist "entry equilibria" where one buyer signs and "entry equilibria" where both buyers reject. The incumbent's payoff is 0.

the monopoly profits. This is enough to pay the expectation damages to the incumbent. The input demand of the breacher allows the entrant to cover its fixed costs ($c_I(1-c_I)/2 > F$ by A1). Hence, entry occurs even if both buyers signed the exclusive deal and also when $\varepsilon = 0$ "exclusion equilibria" do not exist.

D Independent monopolists

Proposition D.1. *When downstream firms are independent monopolists,*

(i) there exist both ***"exclusion equilibria"*** *and* ***"entry equilibria"*** *, if the incumbent makes simultaneous and non-discriminatory offers;*

(ii) there exist only ***"exclusion equilibria"****, if the incumbent makes simultaneous and discriminatory offers;*

(iii) there exists a unique ***"exclusion equilibrium"*** *where the incumbent excludes at no cost, if the incumbent makes sequential offers.*

Proof. *(i) Simultaneous and non-discriminatory offers.* Consider the case where both buyers accept the contract ($S = 2$), the entrant does not enter, and the incumbent sets the monopoly price $w_{I|S=2} = (1 + c_I)/2$. Each buyer obtains a payoff $\pi_{B|S=2} = (1 - c_I)^2/32 + x - \varepsilon$ and the incumbent earns $\pi_{I|S=2} = (1 - c_I)^2/8 - 2x$.[2] Since the demand of a single buyer does not attract entry (by assumption A1), no buyer has an incentive to deviate from $S = 2$. If it rejected the contract, entry would not occur. Hence, it would have to buy from the incumbent at the same price $w_{I|S=2} = (1 + c_I)/2$, but it would lose the compensation $x \geq 0$. In equilibrium the incumbent offers a compensation $x \in \left[0, (1 - c_I)^2/16\right]$ and both buyers sign. Equilibria where $x > 0$ are sustained by the continuation equilibria following any offer $\widehat{x} < x$ being such that no buyer accepts.

Equilibria where no buyer accepts ($S = 0$) and entry occurs also exist. In these equilibria each buyer will buy from E at the price $w_{E|S=0} = c_I$, and will have a payoff $\pi_{B|S=0} = (1 - c_I)^2/8 - \varepsilon$. (By assumption A1 E will find entry profitable when no exclusive contracts are signed: $F < c_I(1 - c_I)/2 = \Pi_{E|S=0}$.) Note that these equilibria are sustained by the continuation equilibria following any offer $x \leq x^*$ being such that no buyer accepts. ($x^* = 3(1 - c_I)^2/32 = \Pi_{B|S=0} - \Pi_{B|S=1} (= \Pi_{B|S=2})$ denotes the minimum compensation required by a buyer to sign the contract given that the rival does not sign.) Given these continuation equilibria and that the incumbent cannot discriminate among the compensations, it has no incentive to deviate. It would have to offer slightly more than x^* to *both* buyers but $\Pi_{I|S=2} = (1 - c_I)^2/8 < 2x^*$ implies that the deviation is not profitable.

(ii) Simultaneous and discriminatory offers. "Entry equilibria" do not exist. The crucial point is that even if it is not profitable for the incumbent to offer $x^* = 3(1 - c_I)^2/32$ to both buyers, it is profitable to offer it to a *single* buyer $\left(\pi_{I|S=2} = (1 - c_I)^2/8 - x^* > 0\right)$. Thus imagine that both buyers reject the exclusive contract. The incumbent can deviate offering slightly more than x^* to *one* buyer and no compensation to the other. (Recall that the dominant strategy for a buyer which is offered slightly more than x^* is to sign the exclusive deal.) Given that the former buyer signs and that individual demand does not trigger entry, the other buyer cannot do better than signing. Hence, the *unique* continuation equilibrium following this offer is that $S = 2$ and entry is deterred. The incumbent's deviation is profitable. As showed by (i), by exploiting

[2] In each independent market, characterized by the demand $q = (1 - p)/2$, there are two successive monopolies. Because of double marginalization, the profits of the vertical chain are lower than under vertical integration.

the buyers' coordination failure the incumbent can exclude at no cost: $x_1 = x_2 = 0$ followed by $S = 2$ is an equilibrium. There also exist equilibria where the incumbent offers strictly positive compensations (such that $x_1 + x_2 \leq x^*$). They are sustained by the continuation equilibria following any offer where either $\widehat{x}_1 < x_1$ or $\widehat{x}_2 < x_2$ being such that no buyer accepts.

(iii) Sequential offers. Let us analyze the second buyer's decision, when *the first buyer rejects the contract.* If it also rejects, entry occurs. If it accepts, by assumption A1 entry is prevented. Hence, it requires at least x^* to accept. For the incumbent it is profitable to have the second buyer sign behind the payment of x^* as it monopolizes the market and earns $(1-c_I)^2/8-x^* > 0$. Hence, if the first buyer rejects, the second signs. Let us consider now the case where *the first buyer signs the contract.* Since entry does not occur both if the second buyer signs and if it rejects, the second buyer accepts even if $x_2 = 0$. The first buyer, anticipating that the second always accepts, accepts even if $x_1 = 0$. In equilibrium, $x_1 = x_2 = 0$ and $S = 2$.

E Cournot Competition with Homogeneous Goods

This Appendix studies the case where downstream firms compete à la Cournot and sell homogeneous goods (and upstream firms use linear prices). We restrict the incumbent's marginal cost to be $c_I \leq 5/13$. The assumption that c_I is close enough to $c_E = 0$ implies that, in the sub-game following $S = 1$, the entrant will serve the free buyer at the wholesale price c_I. One can check that for $c_I > 5/13$ the entrant will set $w^f_{E|S=1} < c_I$ at equilibrium and that our results are *a fortiori* valid. Further, this assumption is sufficient for both the signer and the free buyer to sell positive quantities at equilibrium.

Note that, since the signer also makes sales, the free buyer does not capture the entire downstream market. Hence, within the range of fixed costs identified by assumption $A1$, there exists a threshold level F'such that the input demand of the free buyer triggers entry if (and only if) fixed costs are not too large (i.e. $F < F'$). In this case, downstream competition prevents exclusion. Instead, if fixed costs are high enough, Segal and Whinston (1996, 2000)'s results are restored.

Proposition E.1. *When upstream firms use linear prices, the incumbent makes sequential offers and downstream firms compete à la Cournot with homogeneous goods, there exists a threshold level of fixed costs $F' \equiv 5c_I(1 - c_I)/12$ such that:*

*(i) if fixed costs are sufficiently low ($F \in [c_I(1 - c_I)/4, F')$), only **"entry equilibria"** exist.*

(ii) if fixed costs are high enough ($F \in [F', c_I(1 - c_I)/2)$), the incumbent excludes at no cost.

Proof. *(i) Low fixed costs* ($F \in [c_I(1 - c_I)/4, F')$).

Case 1: *the first buyer signs the exclusive deal.* If the second buyer also signs entry does not occur. The incumbent charges the buyers the wholesale price $w^*_I = (1 + c_I)/2$ and earns the (gross) profit $\Pi_{I|S=2} = (1 + c_I)^2/6$. Buyers realize the payoff $\pi_{B|S=2} = (1 - c_I)^2/36 - \varepsilon + x_i$. If the second buyer rejects, entry occurs. The entrant anticipates that at time t_2 it will capture the free buyer charging the price c_I, while the incumbent will sell to the signer at the price $w_{I|S=1} = (1 + 3c_I)/4 > c_I$. Since the signer makes sales, the free buyer does not cover the entire downstream market. Still, its input demand is large enough to make entry profitable: $\pi_{E|S=1} = 5c_I(1 - c_I)/12 - F > 0$ by $F < F'$. The free buyer makes profits $\pi^f_{B|S=1} = 25(1-c_I)^2/144-\varepsilon$. Therefore, it requires at least $x_2 = \pi^f_{B|S=1}-\Pi_{B|S=2} = 7(1-c_I)^2/48$ to accept. The incumbent cannot profitably induce this buyer to sign: the (gross) gain that it makes by successfully excluding is lower than what required by the buyer to sign: $\Pi_{I|S=2}-\Pi_{I|S=1} = (1 - c_I)^2/6 - (1 - c_I)^2/24 = 3(1 - c_I)^2/24 < 7(1 - c_I)^2/48$. Hence, if the first buyer signs, the second buyer rejects.

Case 2: *the first buyer rejects the exclusive deal.* If the second buyer also rejects, entry occurs. The entrant's optimal price is $w_{E|S=0} = c_I$, it makes profits $\pi_{E|S=0} = 2c_I(1 - c_I)/3 - F > 0$ by assumption $A1$, and buyers earn $\pi_{B|S=0} = (1-c_I)^2/9-\varepsilon$. If the second buyer signs, entry occurs. The second buyer purchases from the incumbent and earns $\pi^s_{B|S=1} = (1-c_I)^2/36-\varepsilon+x_2$. Hence, it requires $x_2 = \pi_{B|S=0} - \Pi^s_{B|S=1} = (1 - c_I)^2/9 - (1 - c_I)^2/36 = (1 - c_I)^2/12$ to sign. Since entry occurs anyway, the incumbent's gain from having the second buyer sign the exclusive deal is $\Pi_{I|S=1} - \Pi_{I|S=0} = (1-c_I)^2/24 < (1-c_I)^2/12$. Therefore, it cannot profitably compensate the second buyer.

Let us now consider the decision of the first buyer. Anticipating that the second buyer always rejects, the first one requires $x_1 = \pi_{B|S=0} - \Pi^s_{B|S=1} = (1-c_I)^2/12$ to sign. But again, the incumbent's gain from having only one buyer sign the exclusive deal is $\Pi_{I|S=1} - \Pi_{I|S=0} = (1-c_I)^2/24 < (1-c_I)^2/12$. Hence, in equilibrium both buyers reject the exclusive dealing offer and entry occurs.

(ii) *High fixed costs* ($F \in [F', c_I(1-c_I)/2)$).

If $F \geq F'$, purchases from a single buyer are not enough to attract entry. Therefore, we are back to the same situation as under independent markets, where the incumbent is able to achieve exclusion at zero cost.