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Buyers' miscoordination, entry, and downstream competition

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Chiara Fumagalli[♥] **and Massimo Motta**[♦]

Abstract

This paper shows that buyers' coordination failures might prevent entry in an industry with an incumbent firm and a more efficient potential entrant. If there was a single buyer, or if all buyers formed a central purchasing agency, coordination failures would be avoided and efficient entry would always occur. More generally, exclusion is the less likely the lower the number of buyers. For any given number of buyers, exclusion is the less likely the more fiercely buyers compete in the downstream market. First, intense competition may prevent miscoordination equilibria from arising; second, in cases where miscoordination equilibria still exist, it lowers the maximum price that the incumbent can sustain at such exclusionary equilibria.

JEL Classification: D4, L13, L41.

Keywords: Countervailing Power; Exclusion; Buyers' Fragmentation.

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1 Introduction

Buyers have experienced increased concentration in many sectors, in particular grocery retailing.[1,2] This trend has triggered a wide debate on the effects of buyers power.[3]

We contribute to this debate by studying how concentration and competition among buyers affect the possibility of entry by a new upstream supplier in an industry characterised by scale economies. In our model, buyers' fragmentation may lead to a situation where a new upstream firm does not manage to enter a market, although endowed with lower marginal costs than an incumbent firm. When several buyers decide independently from which supplier to purchase, miscoordination equilibria may arise where all buyers buy from the incumbent even if the entrant sets a lower price: if all buyers address the incumbent, none of them has an incentive to deviate (that is, to switch to the entrant), anticipating that a single order would not allow the entrant to cover its fixed costs. Therefore, entry would not follow and the deviant buyer could only go back to the incumbent which would then charge a very high price.

However, miscoordination equilibria where entry is prevented are not unique. There also exist equilibria where entry occurs because all buyers address the supplier which offers the lower price. Hence, the entrant will be able to capture all buyers and to cover its entry cost.

In our model, entry may not occur at equilibrium due to buyers being unable to coordinate their purchasing decisions. Hence, if there was a single buyer, or if all buyers formed a central purchasing agency, miscoordination would be avoided and efficient entry would always occur. More generally, we show that exclusion is the less likely the lower the number of buyers. Since the market becomes less fragmented, *ceteris paribus* the demand generated by a deviant buyer increases and it is more likely that entry supported by a single buyer is profitable. Hence, coordination failures are less likely to occur. The formation of larger buyers, whose demand ensures that the supplier's costs are covered, may thus favour upstream entry.[4]

[1] Large retail chains play a dominant role in several countries, even though the phenomenon is not uniform. For example, in the UK supermarkets accounted for 20 per cent of grocery sales in 1960, but 89 per cent in 2002, with the top-5 stores controlling 67 per cent of all sales. France exhibits similar features. In other countries, such as Italy and the US, small independent retailers still retain a strong position in the market, although their position has eroded over time. At the EU level, retailer concentration is further strengthened by purchasing alliances (operating not only at national level but also cross-border). For an overview of recent changes in the retail sector see Dobson and Waterson (1999), Dobson (2005) and OECD (1999).

[2] Buyers' concentration has increased also in other industries such as healthcare, and cable television (in the US). In the healthcare sector, buyers (drugstores, hospitals and HMOs) aggregate into large procurement alliances in order to reduce prescription drug costs. See Ellison and Snyder (2002) and DeGraba (2005). In cable television, the concern of excessive buyer power of MSO (multiple system operators) is one of the reasons why the FTC has enforced legal ownership restrictions. See Raskovich (2003) and Chae and Heidhues (2004).

[3] The growing concern about buyer power is documented in the Symposium on Buyer Power and Antitrust, Antitrust Law Journal (2005). See also Dobson and Waterson (1999), Rey (2000) and the reports by OECD (1999), FTC (2001), EC (1999).

[4] Also Raskovich (2003) considers industries where scale economies are important, fixed costs are sunk after buyers' decisions, and where a large buyer can be pivotal to the supplier's

For any given number of buyers in the industry, we also show that the scope for miscoordination equilibria depends crucially on how fiercely buyers compete in the downstream market (in our model, tougher competition is modelled as an increase in the degree of substitutability among the final products sold by downstream firms-buyers; equivalently, it could also be thought as an increase in the integration of downstream markets, i.e. due to a reduction in transport costs across markets where buyers operate). Specifically, we find that the toughness of downstream competition has two main effects: first, it can prevent miscoordination equilibria from arising; second, in cases where miscoordination equilibria still exist, it lowers the maximum price that the incumbent can sustain at such exclusionary equilibria.

More precisely, miscoordination equilibria where the entrant supplier is excluded and buyers pay the monopoly price to the incumbent may occur only for weak downstream market competition; for intermediate levels of downstream competition, miscoordination may occur but only at a price below the monopoly level (and the fiercer competition the lower the maximum price that the incumbent can sustain); whereas miscoordination never occurs for fierce downstream competition. Indeed, if downstream competition is strong enough, buying the input at a lower price from the entrant would allow a deviant buyer to get a very large share of the downstream market. In turn, this raises its demand for the entrant's good, thereby making the deviant buyer pivotal and triggering entry.

Our paper also contributes to the literature on buyer power,[5] in particular to the branch which studies whether wholesale discounts obtained by more powerful buyers are passed on to final consumers. In particular, Von Ungern-Sternberg (1996) and Dobson and Waterson (1997) show that price discounts obtained by more concentrated buyers translate into lower final-good prices only if the buyer-retailer market is characterized by fierce competition (e.g. because product differentiation is low) and thus double marginalization is not severe.[6]

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decision to produce. However, the focus of his paper is different from ours: it analyses a setting where buyers simultaneously engage in bilateral negotiations with the supplier, and shows that being pivotal can be a disadvantage for a large buyer because it deteriorates its bargaining position.

[5] Galbraith (1952) was the first to emphasise the countervailing power of large buyers. There is by now a vast economic literature on buyer power. A rich stream of papers explains why larger buyers obtain price discounts from sellers (See Snyder, 2005, for a recent survey): (i) they can credibly threaten to integrate backwards, thereby improving their bargaining position with the supplier (Kats, 1987; Inderst and Wey, 2005b); (ii) they can intensify competition among potential suppliers (Inderst and Shaffer (forthcoming)); (iii) they negotiate over larger quantities, which represents a strategic advantage when aggregate surplus is concave in quantities (Chipty and Snyder, 1999; Inderst and Wey 2003, 2005a; Chae and Heidhues, 2004); (iv) they destabilize collusion (Snyder 1996 and Tyagi 2001). Another (recent) stream of papers studies the impact of buyer power on upstream incentives to innovate. Inderst and Wey (2003, 2005a, 2005b) show that downstream mergers may strengthen suppliers' incentives to adopt technologies with lower marginal costs, thereby raising consumer surplus and total welfare. Instead, Inderst and Shaffer (forthcoming) shows that buyer power may decrease welfare through a distortion in the supplier's choice of variety.

[6] Another paper belonging to this part of the literature is Chen (2003) which shows that an exogenous increase in the relative bargaining power of a dominant retailer benefits consumers because it triggers a decrease in the whosale price charged by the supplier to the fringe

In our paper, instead, there is no welfare gain from buyers' concentration when competition is strong enough, since miscoordination does not arise. Downstream competition pushes buyers to look for cheaper inputs and allows the most efficient buyer to get a large downstream market. Hence, the entrant gets enough demand to cover fixed costs and enters. It is only when downstream competition is weak that buyers' concentration, by solving the miscoordination problem, might benefit final consumers. The difference in the results obtained can be explained by noting that while in the above mentioned papers the market structure is given, in ours it is not: fierce downstream competition triggers entry.

Another branch of literature related to our analysis consists of the exclusive dealing models by Rasmusen, Ramseyer and Wiley (1991), Segal and Whinston (2000). In these papers, an incumbent uses exclusive contracts to profitably deter efficient entry, thereby reducing economic welfare. When the incumbent simultaneously offers exclusivity contracts to all buyers, exclusion arises because it exploits the buyers' lack of coordination on their most preferred continuation equilibrium. For some aspects the reader will find a strong similarity between our paper and those. However, Rasmusen et al. (1991) and Segal and Whinston (2000) focus on the ability of the incumbent to deter entry by using exclusionary contracts, whereas in our setting buyers' fragmentation may deter entry without the incumbent playing an active role in it. These different approaches translate into a different timing of the games. In Rasmusen et al. (1991) and Segal and Whinston (2000) it is the incumbent firm that has a first mover advantage and can offer (exclusionary) contracts. We assume, instead, that in the first stage the incumbent firm and the entrant simultaneously post their price bids. Clearly, our setting is more realistic if exclusive dealing clauses are outlawed (else, one might expect the incumbent to have a first mover advantage in the choice of contracts).[7]

The importance of downstream competition in determining the emergence of entry v. exclusionary equilibria was already identified by Fumagalli and Motta (forthcoming) in the context of exclusive dealing models: we showed there that exclusive dealing does not deter entry if downstream competition is very fierce. In a different setting, we confirm here the crucial role that downstream competition plays: in both cases, when competition is fierce, a deviant buyer would steal a larger market share to its rivals, thereby increasing the number of units of the input demanded, and attracting entry by offering enough scale to the entrant. However, in the present paper downstream competition has richer implications, in particular by showing that even when it does not prevent exclusionary equilibria from arising, downstream competition may still affect the price that the

competitors, thereby leading to lower final prices. In spite of this, total welfare may decrease because more production is allocated to the less efficient fringe competitors.

[7] Assuming that a monopolistic incumbent cannot resort to exclusive deals with buyers is far from being unrealistic. In most countries, anti-trust laws prevent dominant firms from using exclusive contracts unless they involve a minor proportion of buyers. See for instance the US v. Microsoft case in the US (US Court of Appeals, District of Columbia Circuit, Case 5212, June 28, 2001) and the ice-cream case in the EU (Langnese-Iglo v. Commission, Case T-7/93 [1995] and Schöller v. Commission, Case T-7/93 [1995]).

incumbent can sustain (in our previous paper, buyers' competition can affect equilibrium prices only if it breaks the exclusionary equilibrium).[8]

The paper is organised in the following way. Section 2 presents the model. Section 3 analyses the case where buyers are independent monopolists in order to clarify why coordination failures may prevent efficient entry. Section 4 analyses the role of downstream competition in solving (or alleviating) coordination failures. Section 5 draws some policy implications and concludes the paper.

2 The model

We consider $n \geq 2$ identical downstream firms that sell a differentiated good to final consumers, and that need a homogeneous good as an input. Downstream production requires the intermediate product in fixed proportion to output, which we normalize to one. Moreover, the only cost for downstream buyers is the cost of the input.

These downstream firms-buyers simultaneously solicit bids from two upstream firms competing for the provision of the input. One of them, firm I, is an incumbent in the industry and has already paid its entry cost. The other, firm E, is a potential entrant. If it actually enters the industry, it will have to pay the fixed sunk cost F.

Upstream production displays constant marginal cost and the potential entrant (whose marginal cost is normalized to zero) is more efficient than the incumbent: $c_E = 0 < c_I$. For simplicity (and without loss of generality) we assume that $c_I < 1/3$. This condition: (i) is sufficient for the entrant not to enjoy a "drastic" advantage over the incumbent, i.e. for its monopoly price to be larger than the marginal cost of the incumbent; (ii) allows to keep the analysis as simple as possible by ensuring that equilibrium quantities in the final market are always positive.

To make the analysis interesting, we assume that F is small enough for entry to be profitable if firm E serves all the customers (at the price c_I, which is the price that would prevail absent miscoordination issues), and that F is sufficiently large for entry to be unprofitable when the entrant is addressed by a single buyer and downstream firms are independent monopolists. The above restrictions on fixed costs are satisfied by assuming:

$$\underline{F} \equiv \frac{1}{8n} \leq F < \frac{c_I(1-c_I)}{2} \equiv \overline{F} \tag{A1}$$

To ensure that this interval it is not empty, we impose that $c_I > (1/2)(1 - \sqrt{1-1/n})$.

The timing of the game is as follows (see Figure 1 for an illustration). At time t_1, the two upstream firms take part in the (simultaneous) auctions and

[8] The effect of downstream competition is also neater in the present setting. Indeed, in an exclusive dealing setting, it is conceivable that downstream competition may favor - rather than hindering - exclusion because it destroys buyers' profits and therefore may allow the incumbent to induce buyers to accept exclusivity behind a low compensatory offer. Such an effect does not arise in the present setting, where the entrant and the incumbent post their offers simultaneously.

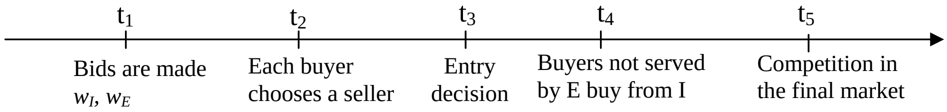

Figure 1: Time-line.

submit the price w_i (with $i = I, E$) at which they are willing to supply the good.[9] They cannot price discriminate among buyers, i.e. they will offer the same conditions to each buyer.[10]

At time t_2, each buyer decides from which seller to buy, after having observed the bids. We assume that the agreement between a buyer and a seller at t_2 is binding; in particular, once decided to patronize the incumbent, a buyer cannot change its decision in the following periods when it observes if the potential entrant actually provides the good. In other words, a contract is signed at this stage between the buyer, which commits to buy the good at the agreed upon price, and the chosen provider, which commits to provide the good at the agreed upon price.

At time t_3 the entrant observes the number of buyers S which accepted its bid and decides whether it wants to enter (and pay the fixed sunk cost F).[11,12]

At time t_4 buyers not served by the entrant have the possibility to buy from the incumbent.

At time t_5 buyers compete in the final market.

Final consumers are assumed to have the following utility function, due to

[9]For simplicity, we assume that upstream firms use linear tariffs. The results would not change qualitatively with two-part tariffs.

[10]Price discrimination would complicate the model without bringing additional insight to the analysis. Note, however, that we allow for price discrimination by the incumbent across periods: if a buyer addresses the incumbent in a later period, it can charge a different price.

[11]Examples of industries where fixed costs are sunk after buyers' decision are the following: cable television, where start-up cables networks typically obtain carriage commitments from a number of cable multiple system operators prior to sinking substantial costs into network launch (see Higgins, 1997); motion picture, where big-budget projects typically secure a good distribution deal before moving the project forward to production (see Goldberg, 1997); the airplane and railway industries, where a manufacturer may require a sufficiently large number of buyers in order to move into a new area of activity and propose a potential new airframe/train system.

[12]There exist at least two reasons why the entrant cannot sink the fixed cost and cannot credibly commit to entry before taking part in the auctions. First, the market can materialize before any commitment can be done by the entrant, for instance when buyers invite tenders for orders and producing for the order takes time; alternatively selling in a foreign market may require investments to adapt an existing product to country specific technical standards. Second, the entrant might be financially constrained and can borrow from outside investors only if obtains enough contracts from buyers (see the working paper version for a possible formalization).

Shubik and Levitan (1980).[13]

$$U(q_1,..,q_i,..q_n)=\sum_{i=1}^{n}q_i-\frac{n}{2(1+\mu)}\left[\sum_{i=1}^{n}q_i^2+\frac{\mu}{n}\left(\sum_{i=1}^{n}q_i\right)^2\right] \tag{1}$$

where q_i is the quantity of the i-th product, n is the number of products in the industry, $\mu \in [0,\infty)$ represents the degree of substitutability between the n products.

From the maximisation of the utility function subject to the income constraint, one can obtain the inverse demand functions:

$$p_i=1-\frac{1}{1+\mu}\left(nq_i+\mu\sum_{j=1}^{n}q_j\right). \tag{2}$$

We assume for simplicity that all buyers have a discount factor equal to one. We look for the subgame perfect Nash equilibrium in pure strategies of this game, and we solve it by backward induction.

In the next Section we will focus on the extreme case where buyers are independent monopolists and therefore do not interact in the downstream market (which corresponds to $\mu=0$). This will clarify why coordination failures among buyers can prevent efficient entry. We will then show why and when downstream competition can eliminate or mitigate the problem.

3 Independent downstream monopolists

At time t_5, given the price w_i it pays for the input, buyer i sells optimally $q(w_i)=(1-w_i)/2n$.

At time t_4, buyers not served by the entrant purchase the input from the incumbent, which charges the price $w_I^m = argmax\left\{(w_I-c_I)(1-w_I)/2n\right\} = (1+c_I)/2$.

At time t_3, the entrant observes how many buyers have accepted its bid and, conditional on having offered a price w_E, it anticipates the quantities they will buy from it and the profits it will realize. It will enter if and only if its gross profits are larger than the fixed cost F:

$$S\frac{w_E(1-w_E)}{2n}>F \tag{3}$$

Condition 3 identifies an integer N^* such that firm E enters if and only if the number of buyers that accepted its bid is strictly larger than N^*. Specifically, letting $\lfloor z\rfloor$ denote the largest integer smaller than or equal to z, we have

$$N^*=\left\lfloor\frac{(2n)F}{w_E(1-w_E)}\right\rfloor \tag{4}$$

[13] See Motta (2004: chapter 8) for a discussion. The main advantage of demand functions derived from this utility function is that, at given prices, market size does not vary either with the degree of substitutability or the number of products, a crucial property when - like in the present paper - we are interested in doing comparative statics on these parameters. Of course, consumer preferences can be expressed as $V=U(q_1,..,q_i,..q_n)+y$, where y is a composite good, so that a partial equilibrium analysis is fully justified.

Note that, by assumption ($A1$), the demand of a single buyer is *never* large enough to trigger entry: $N^* \geq 1$ even if the entrant charges the monopoly price $w_E^m = 1/2$.

3.1 Buyers' Choice

At time t_2, given the bids made by upstream firms, buyers simultaneously choose their supplier. Their choices are described by Lemma 1. The crucial point highlighted by Lemma 1 is that bidding a lower price than the incumbent does not guarantee that the entrant will be patronized by *all* buyers. Indeed, when $w_E < w_I$ and $w_I \leq w_I^m$ the continuation equilibrium where $S = N$ is not unique. There exist also equilibria where buyers *fail to coordinate* and the entrant does not receive enough orders to profitably enter the market. To see why focus on the case where all buyers patronize the incumbent ($S = 0$). This is an equilibrium. A single buyer knows that its order alone does not trigger entry. Thus, should it deviate and address the entrant, its order would remain unfulfilled and it should resort to the incumbent at a later stage, paying the monopoly price w_I^m. Since $w_I \leq w_I^m$ the buyer has no incentive to deviate.

Instead coordination failures do not occur when $w_E < w_I$ and $w_I > w_I^m$. Now choosing the entrant is a dominant strategy for any buyer: it will pay a lower price both if entry follows ($w_E < w_I$) and if entry does not occur and it will buy the good later from the incumbent ($w_I^m < w_I$). The unique continuation equilibrium is such that all buyers address firm E.

Lemma 1 *For given w_I and w_E, the number of buyers S which address the entrant in equilibrium is given by the following table:*

	$w_I < w_I^m$	$w_I = w_I^m$	$w_I > w_I^m$
$w_E < w_I$	$S = N$ $S = 0$	$S = N$ $S < N^*$	$S = N$
$w_E = w_I$	$S > N^*$ $S = 0$	any S	$S \geq N^*$
$w_E > w_I$	$S = 0$	$S \leq N^*$	$S = N^*$

Proof. See Appendix. ■

3.2 Upstream firms' bids

At time t_1 upstream producers take part in the simultaneous auctions. Not surprisingly, there exist equilibria *(entry equilibria)* where firm E bids a price equal to the incumbent's marginal cost (or a lower price) and receives enough orders to cover its entry cost. However, there exist also equilibria *(no-entry equilibria)* where the incumbent bids a price above c_I - even the monopoly price - and is chosen by all buyers. Thus, the more efficient producer does not enter the market. Why does not the entrant deviate and undercut the incumbent? The reason is that undercutting the incumbent does not allow firm

E to attract all the orders and to cover the entry costs. In turn, this occurs because at *any* possible price bid by firm E individual demand is insufficient to trigger entry. As shown by Lemma 1, this creates the scope for coordination failures where all buyers choose the incumbent even though the entrant bids a lower price.

Formally, we have the following.

Proposition 1 *When downstream firms are independent monopolists and buyers are unable to coordinate their actions, subgame-perfect equilibria can take the following forms:*

- ***No-entry equilibria***

  where $w_I^* \in [c_I, w_I^m]$, $w_E^* \in [0, w_I^*]$, $S = 0$;

  $w_I^* = w_E^* = w_I^m$, $S \in (0, N^*]$

  $w_I^* = w_I^m$, $w_E^* \in [0, w_I^*)$, $S \in (0, N^*)$.

- ***Entry equilibria***

  where $w_E^* \in (\overline{c}_E, c_I]$, $w_I^* \in [w_E^*, w_I^m]$, $S = N$;

  $w_E^* = w_I^* = c_I$, $S \in (N^*, N)$.

  (The price $\overline{c}_E$ *is such that* $\overline{c}_E nq(\overline{c}_E) = F$.*)*

Proof. See Appendix. ■

3.3 Perfectly Coalition Proof Nash Equilibria

Lemma 1 and Proposition 1 show that exclusion of the more efficient producer occurs because the entrant cannot successfully undercut the incumbent. This is entirely due to *coordination failures* among buyers and would not occur if they could agree to jointly address their orders to the entrant. Similarly, no coordination failure would arise if all the demand was concentrated in a single buyer.

This idea can be developed more formally applying the concept of Coalition-Proof Nash Equilibria to the continuation game where buyers take their decision. A continuation equilibrium is coalition-proof if no coalition of any size can deviate in a way that increases the payoffs of all its members. Note that the coalitional deviations must be Nash Equilibria of the game among the deviating players, holding the strategies of the others fixed.[14]

Remark 1 *If* $w_E < w_I$*, there exists only one continuation equilibrium which is Coalition-Proof. This is the continuation equilibrium where all buyers address the potential entrant.*

Proof. Any continuation equilibrium of the type $S < N$ following $w_E < w_I$ is not Coalition-Proof: a joint deviation in which the $N - S$ buyers reject the incumbent's offer would allow the entrant to provide the good and the buyers to

[14]See Bernheim, Peleg and Whinston (1987).

obtain it at a lower price. Obviously, no buyer has an incentive to deviate from such a coalitional deviation. Vice versa, no subset of buyers has an incentive to jointly deviate from $S = 0$ as they would be charged a higher price. This continuation equilibrium is Coalition-Proof, and it is the unique one. ■

In order to investigate the role of downstream competition in facilitating entry, in the rest of the paper we will focus on the case where buyers are *not* able to coordinate.

4 Buyers competing in the downstream market

In this Section we consider downstream firms-buyers which compete in the downstream market. Specifically, Section 4.1 assumes that buyers sell differentiated products (i.e. $\mu > 0$) and compete à la Cournot in the final market.[15] We will show that the more substitutable the final products - and therefore the tougher downstream competition - the less likely exclusion of the more efficient producer. Section 4.2 will then deal with the case of price competition with homogeneous goods.

4.1 Cournot competitors

As we know from Section 3, the existence of no-entry equilibria where all buyers pay the price w_I to the incumbent relies on the fact that, due to coordination failures, the entrant has no incentive to undercut the incumbent. What is crucial for this to happen is that at *any* $w_E < w_I$ a single buyer does not generate enough input demand to attract entry. Hence, in order to identify the conditions that allow for exclusion, we now study the profit of firm E when it is selected by a single buyer. We shall show that if downstream competition is fierce enough, there exists *at least* an input price $w_E^{'} < w_I$ such that a single buyer paying that price (while the remaining buyers pay w_I) would sell enough units of the product to make it profitable for firm E to enter the market. This implies that, following such bids, coordination failures do not occur. Hence, no-entry equilibria where all buyers pay the price w_I to the incumbent do not exist. The entrant would have an incentive to deviate and bid $w_E^{'}$ as this would allow to capture all buyers.

Specifically, let upstream firms bid w_I and w_E. Also, let all buyers but one address the incumbent and suppose that entry occurs. Finally, let π_E^{*d} be the *largest* profit (gross of the fixed cost) that the entrant makes when it undercuts the incumbent and supplies the deviant buyer only:

$$\pi_E^{*d}(w_I, \mu, n) = \max_{w_E \leq w_I} [w_E q_d^*(w_E, w_I, \mu, n)]$$

[15] The assumption of Cournot competition avoids dealing with several subcases and with discontinuities that occur under price competition and asymmetric costs. Hence it allows to study the scope for coordination failures as a function of μ while keeping the analysis as simple as possible. Note that assuming Bertrand competition would not change the nature of the results. See Section 4.2 for the extreme case where downstream firms sell homogeneous products.

where $q_d^*(w_E, w_I, \mu, n)$ denotes the equilibrium quantity sold by the deviant buyer in the final market. Lemma 2 studies π_E^{*d} as a function of the price w_I paid by the $n-1$ non-deviant buyers, of the intensity of downstream competition (measured by the degree of substitutability μ among the final products), and of the number of buyers n.

Lemma 2 *$\pi_E^{*d}(w_I, \mu, n)$ is (i) strictly increasing in the intensity of downstream competition μ; (ii) strictly increasing in the price paid by the non-deviant buyers w_I; (iii) strictly decreasing in the number of buyers n.*

Proof. See Appendix. ■

The intuition behind Lemma 2 is the following. Firstly (i), as final products become more similar and thus downstream competition intensifies, the deviant buyer sells more and more in the final market. Indeed, tougher downstream competition decreases equilibrium prices in the final market and therefore increases aggregate demand. On top of this, tougher downstream competition intensifies the "business stealing" effect. The deviant buyer uses a cheaper input than rivals and has a lower marginal cost. The tougher downstream competition the stronger the competitive advantage that being more efficient than rivals provides. Hence, the deviant buyer captures a larger share of the increased market demand. In turn, this raises its input demand and increases the profits that the entrant makes when it supplies the deviant buyer only.

Secondly (ii), the higher the price bid by the incumbent the less efficient the non-deviant buyers. Hence, for given w_E, the deviant buyer sells more in the downstream market. This makes it more profitable for firm E to undercut the incumbent when it is selected by the deviant buyer only.

Finally (iii), when the number of downstream firms increases, there are two forces at work. On the one hand, the larger the number of downstream competitors the lower the equilibrium prices in the final market and thus the larger aggregate demand. On the other hand, any given aggregate demand must be split among a larger number of firms. Lemma 2 establishes that the latter effect is stronger. Thus, as n increases, *market fragmentation* becomes more severe, the input demand generated by the deviant buyer decreases and so does the entrant's profit.

Lemma 2 has shown that the tougher downstream competition (i.e. the higher μ) the more profitable to serve one buyer only. Lemma 3 shows that sufficiently intense competition may allow the entrant to cover the entry costs when it undercuts the incumbent and supplies one buyer only.

Lemma 3 *There exist a threshold level $\widehat{c}_I$ of the incumbent's marginal costs and a threshold level $\widehat{F}$ of the entry cost such that the following cases arise:*

***Case I**: $c_I > \widehat{c}_I$ and $F \in [\underline{F}, \widehat{F})$.*
There exist $\mu^*(n, F)$ and $\mu^{**}(n, F)$, with $\mu^{**}(n, F) > \mu^*(n, F)$ such that:

- *if $\mu \leq \mu^*(n, F)$, then $\pi_E^{*d}(w_I, \mu, n) \leq F$ for any $w_I \leq w_I^m$.*
- *if $\mu^*(n, F) < \mu \leq \mu^{**}(n, F)$, there exists a price $w_I^{ex}(\mu, n, F) \in [c_I, w_I^m)$ such that $\pi_E^{*d}(w_I, \mu, n) \leq F$ iff $w_I \leq w_I^{ex}$.*

- *if* $\mu > \mu^{**}(n, F)$ *then* $\pi_E^{*d}(w_I, \mu, n) > F$ *for any* $w_I \geq c_I$.

Case II: *either* $c_I \leq \widehat{c}_I$ *and* $F \in [\underline{F}, \overline{F})$ *or* $c_I > \widehat{c}_I$ *and* $F \in [\widehat{F}, \overline{F}]$.
There exists $\mu^*(n, F)$ *such that:*

- *if* $\mu \leq \mu^*(n, F)$, *then* $\pi_E^{*d}(w_I, \mu, n) \leq F$ *for any* $w_I \leq w_I^m$.
- *if* $\mu > \mu^*(n, F)$, *then there exists a price* $w_I^{ex}(\mu, n, F) \in [c_I, w_I^m)$ *such that* $\pi_E^{*d}(w_I, \mu, n) \leq F$ *iff* $w_I \leq w_I^{ex}$

The price w_I^{ex} *is decreasing in* μ.

Proof. See Appendix. ■

Lemma 3 distinguishes two cases. In Case I, the efficiency gap between the incumbent and the entrant is sufficiently large and the entry cost is sufficiently low. In this case, intense downstream competition ($\mu > \mu^{**}$) eliminates coordination failures entirely. If products are highly substitutable, by obtaining a cheaper input from the entrant a single buyer can steal a lot of business from its rivals. Hence, for any price $w_I \geq c_I$ bid by the incumbent, the largest (gross) profits the the entrant make -when it undercuts the incumbent and supplies one buyer only- cover the entry costs. In other words, for any $w_I \geq c_I$, there exists at least a price $w_E' < w_I$ such that entry supported by a single buyer is profitable.

This implies that, following these bids, a continuation equilibrium where all the buyers address the incumbent does *not* exist. Any buyer is now pivotal and has the incentive to deviate unilaterally because it anticipates that entry will follow. Hence, the entrant can successfully undercut any price above c_I and the incumbent can never rely on coordination failures to sustain no-entry equilibria with profitable prices. In turn prices such that coordination failures might occur and prevent entry entail losses for the incumbent. As a result, equilibria where firm E does not enter the market do not exist.

For intermediate intensity of competition ($\mu \in (\mu^*, \mu^{**}]$), the largest (gross) profits the the entrant make -when it undercuts the incumbent and supplies one buyer only- cover the entry costs only if the incumbent bids more than w_I^{ex}, where $w_I^{ex} \in [c_I, w_I^m)$. If the incumbent bids a lower price, single-buyer entry is unprofitable at any $w_E < w_I$. Hence, the incumbent can take advantage of coordination failures but only if it does not bid too high. No-entry equilibria exist and the maximum price that can be supported in these equilibria decreases as downstream competition intensifies (i.e. as μ increases).

Finally, when downstream competition is very weak ($\mu \leq \mu^*$), even if the incumbent bids the monopoly price, at any $w_E < w_I$ a single buyer is insufficient to trigger entry. In this region, buyers sell products that are distant substitutes to each other. Hence, obtaining a cheaper input does not allow the deviant buyer to steal much of the rivals' business and to generate an input demand sufficiently large to make entry profitable. As a consequence, coordination failures support no-entry equilibria where all buyers pay the price $w_I \in [c_I, w_I^m]$ to the incumbent.

In Case II (which corresponds to either a smaller efficiency gap or a larger entry cost) intense downstream competition is not enough to entirely eliminate coordination failures. Even when final products are homogeneous (i.e. when $\mu \to \infty$), there exist some prices $w_I \geq c_I$ that the incumbent can bid such that at any $w_E < w_I$ single-buyer entry is not profitable. Hence, no-entry equilibria exist even when downstream competition is the toughest. Still, it remains true that, for fierce enough competition, the maximum price that can be sustained at no entry equilibria decreases with μ.

Proposition 2 summarizes the above discussion and describes the type of equilibria as a function of the intensity of downstream competition (see also Figure 2).

Proposition 2 *The tougher downstream competition: (i) the less likely exclusion of the more efficient producer and (ii) the lower the price that can be sustained at no entry equilibria, if they exist.*

Case I*: $c_I > \widehat{c}_I$ and $F < \widehat{F}$.*

1. *if downstream competition is weak ($\mu \leq \mu^*$), both **no-entry equilibria** and **entry equilibria** exist. The maximum price that can be sustained in no-entry equilibria is w_I^m.*
2. *if the intensity of downstream competition is intermediate ($\mu \in (\mu^*, \mu^{**}]$), both **no-entry equilibria** and **entry equilibria** exist. The maximum price that can be sustained in no-entry equilibria is $w_I^{ex} \in [c_I, w_I^m)$.*
3. *if downstream competition is tough ($\mu > \mu^{**}$), only **entry equilibria** exist.*

Case II*: either $c_I \leq \widehat{c}_I$ and $F \in \left[\underline{F}, \overline{F}\right)$ or $c_I > \widehat{c}_I$ and $F \geq \widehat{F}$.*
*Both **no-entry equilibria** and **entry equilibria** exist for any μ. However,*

1. *if competition is weak ($\mu \leq \mu^*$), the maximum price that can be sustained in no-entry equilibria is w_I^m.*
2. *if competition is stronger ($\mu > \mu^*$), the maximum price that can be sustained in no-entry equilibria is $w_I^{ex} \in [c_I, w_I^m)$.*

Proof. It follows directly from Lemma 3. ■

In the analysis above the intensity of downstream competition is measured by the degree of substitutability among final products. However, competition intensifies also if a larger number of firms compete in the downstream market (for any given degree of substitutability). As shown by Lemma 2, an increase in n has the additional effect of making the downstream market more fragmented. The latter effect dominates so that, *ceteris paribus*, the input demand generated by the deviant buyer decreases as n increases, which in turn makes single-buyer entry *less* profitable.

Therefore, as more firms populate the downstream market, the regions with no-entry equilibria expand (see Figure 2). Moreveor, for any given μ, the maximum price that can be supported at no-entry equilibria (when this price is below the monopoly price) increases. This is stated by Lemma 4:

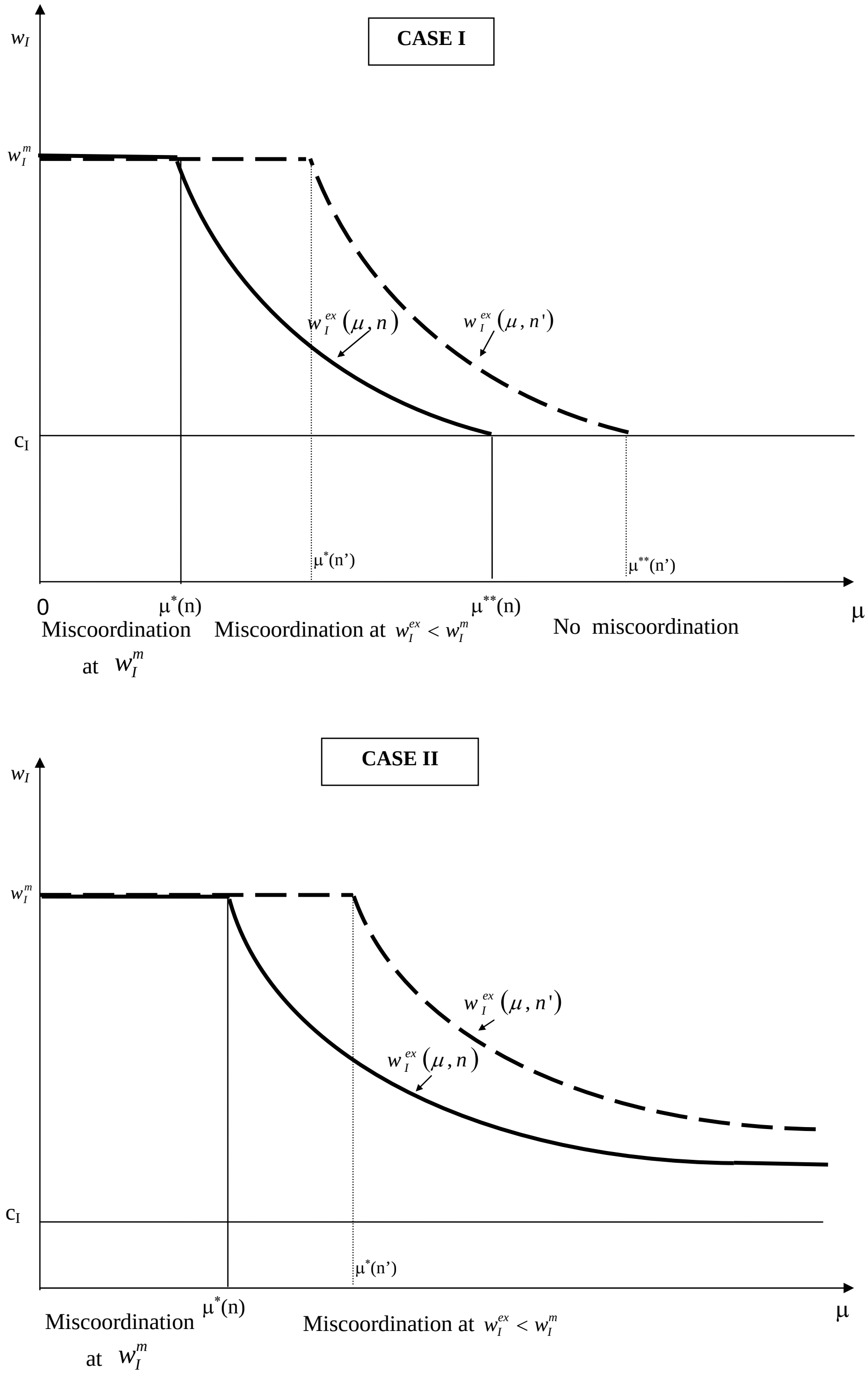

Figure 2: Maximum price supported at no-entry equilibria. Solid line: n buyers; dashed line: $n' > n$ buyers.

Lemma 4 *An increase in the number of downstream buyers makes market fragmentation more severe and exclusion more likely: the thresholds* μ^* *and* μ^{**} *and the maximum price* w_I^{ex} *are increasing in* n.

Proof. See Appendix. ■

4.2 Undifferentiated Bertrand Competitors

In the previous section, the assumption of Cournot competitors limits the toughness of competition in the downstream market. For this reason, in some cases coordination failures persist even when downstream firms sell homogeneous products.

Imagine, instead, that downstream firms compete in prices. When final products are homogeneous, using a cheaper input than rivals provides the strongest competitive advantage. A slightly lower marginal cost allows to undercut all rivals and capture the entire final market. This implies that for any price $w_I \geq c_I$ bid by the incumbent, the entrant can always find a lower price such that single buyer entry is profitable. By bidding that price the entrant attracts all the orders. Hence, irrespective of the value of c_I and of the fixed cost $F \in \left[\underline{F}, \overline{F}\right)$, no-entry equilibria do not exist.

Proposition 3 *When downstream firms are undifferentiated Bertrand competitors, only entry equilibria exist.*

Proof. See Appendix. ■

This confirms that the results obtained do not depend on the *mode* of downstream competition, and suggests that if competition was fiercer (for given number of firms and degree of substitutability) in the sense of switching to a tougher mode of competition, exclusion would be less likely; and if exclusion did persist, the prices that could be sustained at no-entry equilibria would be lower.

5 Policy Implications and conclusive remarks

This paper has showed that, unless downstream competition is very fierce, fragmented buyers may suffer from coordination failures, thereby preventing entry of a more efficient producer.

Hence, it provides a justification for anti-trust agencies when they argue that buyers' fragmentation may undermine the competitive pressure exerted by potential entrants in the upstream market, thereby making increased concentration in that market more dangerous. For instance, in a recent case, the European Commission approved the joint venture between the rail technology subsidiaries of Asea Brown Boveri (ABB) and Daimler-Benz in the German national trains market but not in the local train and systems market. The only client for mainline trains was the national railways company Deutsche Bahn which, according to the Commission, could invite tenders for several orders at the same time. Facing very large orders, foreign firms would be willing to incur the fixed costs of changing their product specifications to meet the German technical standards. In the local market, instead, train and system buyers consist of 58 different German municipal transport companies. Since their individual orders have much smaller size, the fixed costs of adapting to German specifications would not be worth incurring for foreign firms providers.[16]

Coordination failures would not occur if buyers could agree to jointly address their orders to the entrant. Hence, the formation of central purchasing agencies (or of purchasing alliances), which pool individual orders of independent buyers that still behave non-cooperatively in the downstream market, is welfare beneficial. By favouring efficient entry, it would lead to lower input prices without affecting the price-cost margin in the final market.

Coordination failures are also unlikely if competition in the downstream market is sufficiently intense. Therefore, if it were possible for a governmental agency to intervene in the market in such a way as to make downstream competition tougher, for instance reducing switching costs or increasing integration among national markets, this would also solve (or alleviate) the miscoordiation problem.

But suppose that the authorities do not have the means to intervene so as to intensify market competition. Lemma 4 shows that the formation of less fragmented buyers (for instance through mergers or acquisitions) makes exclusion less likely. It is then legitimate to ask whether concentration in the downstream market would help or not.

First, there exists no welfare gain from buyers' concentration when downstream competition is strong enough. Coordination failures do not arise and increased concentration, by enhancing market power, would be welfare detrimental.

When instead downstream competition is not sufficiently strong, the multiplicity of equilibria does not authorise sharp conclusions. Even in the regions where they are equilibria, no-entry equilibria are not unique. In fact, the equilibria where entry occurs always exist. In other words, favouring higher downstream concentration in general, on the grounds that it would eliminate or alleviate coordination failures, forgets that miscoordination might arise as well as not. There should be serious indications that coordination failures are under way, in order to allow, or promote, concentration downstream.

Further, increased concentration in the downstream market produces a trade-off between solving coordination failures and enhancing market power that we illustrate next. For the sake of the argument, suppose that no-entry equilibria are the actual outcome whenever they are possible equilibria and suppose too that miscoordination results in the highest feasible price for the incumbent (for instance, $w_I = w_I^m$ when $\mu \leq \mu^*$ and $w_I = w_I^{ex}$ when $\mu > \mu^*$).[17]

[16] Case ABB/Daimler Benz, IV/M.580, 18.10.1996. See Motta (2004), Section 5.7.3 for a description. Also in the case Enso/Stora, IV/M.1225, the EC has maintained that a large buyer may trigger the development of new capacity in the upstream market, thereby limiting the market power effect of a merger. See the Official Journal of the EC, L254 (1999), paragraph 91 and "Buyer power and the Enso/Stora decision", NERA Competition Brief (November 1999)

[17] This would be the case if we used Pareto dominance (on the supplier side) to select among

Two effects are at play here. The first is the marginal cost effect: if more concentration avoids or alleviates coordination failures, it also reduces the price at which the buyers are supplied. Since this is their marginal cost, it also tends to reduce final prices. The second is the market power effect. Given marginal cost, the lower the number of buyers the higher their final prices. Hence, downstream concentration will result in cheaper supplies when the effect of the savings in the input cost is stronger than the market power effect. For instance, in the extreme case where downstream markets are independent and thus the market power effect is absent, concentration is welfare improving whenever it leads to lower input prices.

These results appear somehow in contrast with previous work on the welfare effects of buyer power. Von Ungern-Sternberg (1996) and Dobson and Waterson (1997) find that buyer concentration improves welfare only insofar as there is enough competition in the downstream market, for it is only when buyers-retailers do not have enough market power that lower prices would be passed on to final consumers. The contrast in the results is mainly due to the fact that in their models there is only one upstream firm and concentration helps buyers gain bargaining power and win better supply terms. Upstream market structure is given in their papers. In our paper, instead, we have showed that downstream competition affects the structure of the upstream market, and facilitates entry. Although the coordination issue studied in this model might be rather specific, we believe that the main force behind our results is general. If there exists strong competition downstream, buyers will shop around for better deals from suppliers, thereby jeopardising upstream market power.

The multiplicity of equilibria which characterizes this paper makes it difficult to draw clear-cut policy implications. An interesting extension would be to formalize our problem as a global game in order to determine a unique equilibrium outcome.[18] However, this would not be a standard application of existing work (in particular, the fact that at the first stage two agents simultaneously post prices makes the analysis quite complex) and is left for future research.

More generally, it would be interesting to study how buyers form beliefs on the behaviour of other buyers, and which actions can be taken by the entrant and the incumbent) in order to influence the formation of such beliefs and determine coordination on a particular equilibrium outcome.

the equilibria of the same type.

[18]Models of speculative attacks typically give rise to multiple equilibria. Similar to the logic of our paper, attacks occur or not depending on the agents' expectations about what other agents will do. Morris and Shin (1998) reformulate the problem by assuming that individuals have a common prior and noisy private information about a state of the world, and show that uncertainty will induce a unique equilibrium corresponding to each state of the world. In our model, one could let buyers have private signals on a given state of the world (the degree of competition, or - perhaps better - the fixed costs of the entrant) and try to apply the same logic as in Morris and Shin (1998). However, we are also interested in modelling the choices of the suppliers, and this inevitably complicates the model, since suppliers' actions would carry signals to buyers. See also Morris and Shin (2003) for a recent survey on the literature on global games.

A Appendix

A.1 Proof of Lemma 1

1. Consider $w_E < w_I$.

   $S = N$ is an equilibrium. Entry follows. By deviating and addressing the incumbent, any single buyer would pay a higher price.

   No equilibrium exists where $S \in [N^*, N)$. A buyer addressing firm I would always prefer to switch to the entrant (which receives enough orders to enter and thus will provide the good) paying a lower price ($w_E < w_I$).

   If $w_I > w_I^m$ no equilibrium exists where $S \in [0, N^*)$. Any buyer choosing the incumbent has an incentive to deviate. By deviating the buyer does not expect to attract entry. However, it prefers to buy the good later from the incumbent rather than paying $w_I > w_I^m$ immediately.

   If $w_I \leq w_I^m$, $S = 0$ is an equilibrium. By assumption $A1$, if a buyer deviates and addresses firm E, entry does not follow. The deviant buyer should resort to the incumbent at t_4 paying $w_I^m \geq w_I$.

   If $w_I < w_I^m$ no equilibrium exists where $S \in (0, N^*)$. The entrant does not enter and buyers choosing it will pay w_I^m at t_4. Any of these buyers would prefer to buy from the incumbent immediately.

   Instead, if $w_I = w_I^m$, any $S \in (0, N^*)$ represents an equilibrium. Any buyer choosing the entrant (and paying w_I^m), pays the same price switching to the incumbent. Similarly, any buyer choosing the incumbent.

2. Consider now $w_E = w_I$.

   Any $S \in (N^*, N]$ is an equilibrium. Entry follows. Any buyer would pay the same price changing supplier.

   If $w_I > w_I^m$, $S = N^*$ is an equilibrium. Entry does not follow. Any buyer choosing the entrant (and paying w_I^m), would pay a higher price buying immediately from I. Any buyer choosing the incumbent would attract entry by switching to firm E and would pay the same price. No equilibrium exists where $S \in [0, N^*)$ (see argument above).

   If $w_I = w_I^m$, buyers are completely indifferent among the sellers and any S is an equilibrium.

   If $w_I < w_I^m$, $S = 0$ is an equilibrium (see argument above). No equilibrium exists where $S \in (0, N^*]$ (see argument above).

3. Finally, consider $w_E > w_I$.

   No equilibrium exists where $S \in (N^*, N]$. Entry follows. Any buyer addressing the entrant pays a lower price switching to the incumbent.

   If $w_I > w_I^m$, $S = N^*$ is an equilibrium (see argument above). No equilibrium exists where $S \in [0, N^*)$ (see argument above).

   Instead, if $w_I = w_I^m$, any $S \in [0, N^*]$ represents an equilibrium. Any buyer which switches to the incumbent pays the same price ($w_I = w_I^m$). Any buyer switching to the entrant pays either the same price (if entry does not follow) or a higher price (if entry follows).

   If $w_I < w_I^m$, $S = 0$ is an equilibrium (see argument above). No equilibrium exists where $S \in (0, N^*]$ (see argument above).

A.2 Proof of Proposition 1

First note that an equilibrium where $w_E > w_I$ and $w_I < w_I^m$ does not exist. In any continuation equilibrium firm E does not enter the market. Hence, either the incumbent, or the entrant have an incentive to deviate.

We now characterize the equilibrium solutions. According to the continuation equilibria following the bids where $w_E \leq w_I$ entry may either occur or not.

No-entry equilibria

$(w_I^* = w_I^m, w_E^* \leq w_I^m)$ is sustained as an equilibrium by having $S = 0$ following any bid where $w_E < w_I$. The incumbent has no incentive to increase the price. In turn, firm E would not obtain enough orders to enter the market by bidding a price different from w_E^*.

There exist also no-entry equilibria where $w_I^* = w < w_I^m$. They are sustained by having $S = 0$ following any bid where $w_E \leq w_I = w$, while $S = N$ following any bid $w_I > w$ and $w_E \leq w_I$. If so, the incumbent has no incentive to deviate and bid a price above w because it would lose all buyers; the entrant has no incentive to change its bid because this would not allow entry.

Note that a no-entry equilibrium where $w_I > w_I^m$ does not exist. Firm E would have an incentive to deviate and slightly undercut the incumbent as this allows to capture all the buyers.

Entry equilibria
First, firm E cannot enter the market if it bids a price $w_E > c_I$: the incumbent could profitably undercut and obtain all buyers. Firm E cannot enter the market if it bids a price $w_E \leq \bar{c}_E$ either: the demand of all buyers is not enough to cover the entry costs.

Equilibria where $w_E^* \in (\bar{c}_E, c_I]$ and $w_I^* = w_E$ with $S = N$ are sustained by having $S = N$ following any bid where $w_E < w_I$. The entrant cannot deviate by increasing its price as it would lose all orders. In turn, the incumbent is indifferent between w_I and any higher price because no buyer would patronize it in any case; instead, it captures all buyers by decreasing its price but it would not break even as the deviation price would be below c_I.

Equilibria where $w_E^* = w_I^* = c_I$ and $S \in (N^*, N)$ are sustained by having $S = 0$ following $w_E < w_I = c_I$ and $S = N$ following $w_I > w_E = c_I$. Hence, the entrant has no incentive to deviate by decreasing its price because it would lose all buyers; in turn, the incumbent gets zero profits either selling at the price c_I to S buyers or increasing its price and losing all buyers; it would earn negative profits by decreasing its price. Note that no equilibria exist where $w_E \in (\bar{c}_E, c_I)$, $w_I = w_E$ and $S \in (N^*, N)$: the incumbent makes negative profits by selling to some buyers at a price below c_I and has incentive to deviate to a price sufficiently high to make all buyers address the entrant.

Finally, there exist also entry equilibria where $w_I > w_E$: $w_E^* = w \in (\bar{c}_E, c_I], w_I^* \in (w, w_I^m]$. They are sustained by having $S = N$ following any bid where $w_I \geq w_E^*$ and $S = 0$ following any bid where $w_I^* \geq w_E > w$. In this case, firm E cannot increase its payoff by increasing the price and setting it equal or lower than the incumbent's because it would lose all the buyers. Note that equilibria of this type where $w_I > w_I^m$ do not exist. The entrant would have incentive to deviate and increase its price.

A.3 Proof of Lemma 2

First, let us solve for equilibrium quantities in the final market. Given the price w_i paid for the input and the quantities chosen by its downstream rivals, downstream firm i solves the following problem:

$$\max_{q_i} [p_i(q_1, .., q_i, ..., q_n) - w_i] q_i$$

where $p_i(.)$ is given by (2). Solving the system of FOCs $\partial \pi_i / \partial q_i = 0$ with $i = 1, .., n$, and focusing on the case where $n-1$ buyers pay the same price w_I for the input and the remaining buyer pays the price w_E, we obtain:

$$q_d^*(w_E, w_I, \mu, n) = \frac{(\mu+1)[(2n(1-w_E) + \mu(1 + n(w_I - w_E) - w_I)]}{(2n+\mu)(2n+\mu+n\mu)} \tag{5}$$

$$q_{-d}^*(w_E, w_I, \mu, n) = \frac{(\mu+1)[(2n(1-w_I) + \mu(1 + w_E - 2w_I)]}{(2n+\mu)(2n+\mu+n\mu)} \tag{6}$$

where q_{-d}^* is the equilibrium quantity sold by the non-deviant buyers. Note that $q_{-d}^* > 0$ requires

$$w_E > \frac{2(n+\mu)w_I - 2n - \mu}{\mu} \tag{7}$$

The r.h.s. of condition (7) is (strictly) increasing in μ.

By (5) and (6), if all buyers address the incumbent (i.e. if $w_E = w_I$), $q^* = \frac{(\mu+1)(1-w_I)}{(2n+\mu+n\mu)}$. Hence, for any μ and n, the incumbent's monopoly price is given by

$$w_I^m = \arg\max_{w_I} \left[\frac{(w_I - c_I)(1-w_I)n(\mu+1)}{(2n+\mu+n\mu)} \right] = \frac{(1+c_I)}{2}. \tag{8}$$

By (5), the entrant's (gross) profit when it is selected by the deviant buyer is given by:

$$\pi_E^d = w_E \frac{(\mu+1)[(2n(1-w_E) + \mu(1+n(w_I - w_E) - w_I)]}{(2n+\mu)(2n+\mu+n\mu)} \tag{9}$$

Let $w_E^*(w_I, \mu, n)$ be the entrant's bid that maximizes (9) s.t. $w_E \leq w_I$:

$$w_E^*(w_I, \mu, n) = \begin{cases} \frac{2n+\mu+w_I\mu(n-1)}{2n(2+\mu)} & \text{if } w_I \geq \frac{2n+\mu}{4n+n\mu+\mu} \\ w_I & \text{otherwise} \end{cases} \tag{10}$$

We now verify that $q_{-d}^*(w_E^*, w_I, \mu, n) \geq 0$ for any $w_I \in [c_I, w_I^m]$, μ and n. Since $w_I < 1$ w_E^* is (weakly) decreasing in μ. Moreover, the r.h.s. of (7) is (strictly) increasing in μ. Hence, if

$$\frac{1 + w_I(n-1)}{2n} \geq 2w_I - 1, \tag{11}$$

which is equivalent to

$$w_I \leq \frac{1+2n}{1+3n}, \tag{12}$$

then w_E^* satisfies condition (7) for any μ. Since the r.h.s. of (12) is (strictly) decreasing in n and since $c_I < 1/3$ implies that $w_I^m < 2/3$, it follows that condition (12) is satisfied for any $w_I \in [c_I, w_I^m]$ and any n.

By (10), when it bids a lower price than the incumbent and it is selected by the deviant buyer only, the entrant cannot earn more than:

$$\pi_E^{*d}(w_I, \mu, n) = w_E^*(w_I, \mu, n) q_d^*(w_E^*(w_I, \mu, n), w_I, \mu, n) - F \tag{13}$$

Let us compute the derivatives of π_E^{*d} with respect to μ, w_I and n.

$$sign \frac{\partial \pi_E^{d*}}{\partial \mu} = sign \left. \frac{\partial q_d^*(w_E, w_I, \mu, n)}{\partial \mu} \right|_{w_E = w_E^*} \tag{14}$$

Since $w_E^* \leq w_I < 1$ and $n \geq 2$,

$$\left. \frac{\partial q_d^*}{\partial \mu} \right|_{w_E = w_E^*} = \frac{(n-1)[4n^2(1+w_I - 2w_E^*) + 4n\mu(1-w_E^*) + \mu^2(1-w_I)]}{(2n+\mu)^2(2n+\mu+n\mu)^2} + \\ + \frac{(n-1)(3n\mu^2 + 2n^2\mu^2 + 8n^2\mu)(w_I - w_E^*)}{(2n+\mu)^2(2n+\mu+n\mu)^2} > 0$$

When the solution is unconstrained,

$$sign \frac{\partial \pi_E^{d*}}{\partial\, w_I} = sign \left. \frac{\partial q_d^*(w_E, w_I, \mu, n)}{\partial\, w_I} \right|_{w_E = w_E^*} \tag{15}$$

Since $n \geq 2$,

$$\left. \frac{\partial q_d^*}{\partial w_I} \right|_{w_E = w_E^*} = \frac{(\mu+1)\,(n-1)\,\mu}{(2n+\mu)\,(2n+\mu+n\mu)} > 0 \tag{16}$$

When the solution is constrained,

$$\frac{\partial \pi_E^{d*}}{\partial w_I} = \frac{(1-2w_I)(\mu+1)}{(2n+\mu+n\mu)} > 0 \tag{17}$$

since $w_I \leq \frac{2n+\mu}{4n+n\mu+\mu} < \frac{1}{2}$.
Finally,

$$sign \frac{\partial \pi_E^{d*}}{\partial n} = sign \left. \frac{\partial q_d^*(w_E, w_I, \mu, n)}{\partial n} \right|_{w_E = w_E^*} \tag{18}$$

Since $w_E^* \leq w_I < 1$ and we have showed above that $w_E^* \geq \frac{1+w_I(n-1)}{2n} > 2w_I - 1$,

$$\left.\frac{\partial q_d^*(w_E, w_I, \mu, n)}{\partial n}\right|_{w_E=w_E^*} = -\frac{(\mu+1)(\mu+2)[4n\mu(1-w_I)+2n^2\mu(w_I-w_E^*)+4n^2(1-w_E^*)]}{(2n+\mu)^2(2n+\mu+n\mu)^2} + -\frac{(\mu+1)(\mu+2)[\mu^2(1+w_E^*-2w_I)]}{(2n+\mu)^2(2n+\mu+n\mu)^2} < 0$$

A.4 Proof of Lemma 3

Let the incumbent bid $w_I = w_I^m$. For any $F \in [\underline{F}, \overline{F})$ and any n, $\Pi_E^{*d}(w_I^m, 0, n) = \frac{1}{8n} \leq F$ and $\lim_{\mu\to\infty} \Pi_E^{*d}(w_I^m, \mu, n) = \frac{(1-c_I+n+cn)^2}{16(n+1)n} > F$. Moreover, by Lemma 2, Π_E^{*d} is strictly increasing in μ. It follows that for any $F \in [\underline{F}, \overline{F})$ and for any n, there exists a threshold $\mu^*(F,n)$ such that $\Pi_E^{*d}(w_I^m, \mu, n) > F$ iff $\mu > \mu^*(F,n)$. Trivially, $\mu^*(F,n)$ is strictly increasing in F.

By Lemma 2, Π_E^{*d} is strictly increasing in w_I. It follows that

$$\Pi_E^{*d}(w_I, \mu, n) \leq F \text{ for any } \mu \leq \mu^*(F,n) \text{ and } w_I \leq w_I^m \tag{19}$$

Now let the incumbent bid c_I.

$$\lim_{\mu\to\infty} \Pi_E^{*d}(c_I, \mu, n) = \begin{cases} \frac{c_I(1-c_I)}{1+n} & \text{if } c_I \leq \frac{1}{1+n} \\ \frac{[1+c_I(n-1)]^2}{4(n+1)n} & \text{otherwise} \end{cases} \tag{20}$$

Simple algebra shows that $\lim_{\mu\to\infty} \Pi_E^{*d}(c_I, \mu, n) < \overline{F}$. Moreover, $\lim_{\mu\to\infty} \Pi_E^{*d}(c_I, \mu, n) > \underline{F}$ iff $c_I > \widehat{c}_I$, where

$$\widehat{c}_I(n) = \begin{cases} \frac{1}{2} - \frac{\sqrt{2n(n-1)}}{4n} < \frac{1}{1+n} & \text{if } n < 5 \\ \frac{\sqrt{2(n+1)}-2}{2(n-1)} > \frac{1}{1+n} & \text{otherwise} \end{cases} \tag{21}$$

Note that $\widehat{c}_I \in \left(\frac{1}{2}\left(1-\sqrt{1-\frac{1}{n}}\right), \frac{1}{3}\right)$. Also, when $c_I > \widehat{c}_I$ denote as $\widehat{F}$ the value of the entry cost F such that $F = \lim_{\mu\to\infty} \Pi_E^{*d}(c_I, \mu, n)$. By definition, $\widehat{F} \in (\underline{F}, \overline{F})$.

Case I: $c_I > \widehat{c}_I$ and $F < \widehat{F}$.

By definition of Case I, $\lim_{\mu\to\infty} \Pi_E^{*d}(c_I, \mu, n) > F$. Moreover, by assumption $A1$, $\Pi_E^{*d}(c_I, 0, n) < F$. Hence, there exists a threshold $\mu^{**}(F,n)$ such that $\Pi_E^{*d}(c_I, \mu, n) > F$ iff $\mu > \mu^{**}(F,n)$. By Lemma 2, Π_E^{*d} is strictly increasing in w_I. It follows that

$$\Pi_E^{*d}(w_I, \mu, n) > F \text{ for any } \mu > \mu^{**}(F,n) \text{ and } w_I \geq c_I. \tag{22}$$

where $\mu^{**}(F,n) > \mu^*(F,n)$. Moreover, $\mu^{**}(F,n)$ is strictly increasing in F.

Take $\mu \in (\mu^*, \mu^{**}]$. $\Pi_E^{*d}(w_I^m, \mu, n) > F$ while $\Pi_E^{*d}(c_I, \mu, n) \leq F$. Since Π_E^{*d} is strictly increasing in w_I, there exists a price $w_I^{ex}(\mu, F, n) \in [c_I, w_I^m)$ such that

$$\Pi_E^{*d}(w_I, \mu, n) > F \text{ iff } w_I > w_I^{ex}(\mu, F, n). \tag{23}$$

Since Π_E^{*d} is strictly increasing in μ, the price w_I^{ex} is strictly decreasing in μ. Moreover, it is strictly increasing in F.

Case II: either $c_I \leq \widehat{c}_I$ and $F \in [\underline{F}, \overline{F})$ or $c_I > \widehat{c}_I$ and $F \geq \widehat{F}$.

Take $\mu > \mu^*$. $\Pi_E^{*d}(w_I^m, \mu, n) > F$. Moreover, by definition of Case II, $\lim_{\mu\to\infty} \Pi_E^{*d}(c_I, \mu, n) \leq F$. Since Π_E^d is strictly increasing in μ, $\Pi_E^{*d}(c_I, \mu, n) \leq F$ for any μ. As proved above, there exists a price $w_I^{ex}(\mu, F, n) \in [c_I, w_I^m)$ such that

$$\Pi_E^{*d}(w_I, \mu, n) > F \text{ iff } w_I > w_I^{ex}(\mu, F, n). \tag{24}$$

w_I^{ex} is strictly decreasing in μ, and it is strictly increasing in F.

A.5 Proof of Lemma 4

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The threshold μ^* satisfies $\Pi_E^{*d}(w_I^m, \mu, n) = F$. By Lemma 2, Π_E^{*d} is (strictly) decreasing in n and (strictly) increasing in μ. It follows that μ^* is (strictly) increasing in n.

The argument which shows that μ^{**} is (strictly) increasing in n follows the same logic.

Finally, the price w_I^{ex} satisfies $\Pi_E^{*d}(w_I, \mu, n) = F$. By Lemma 2, Π_E^{*d} is (strictly) decreasing in n and (strictly) increasing in w_I. It follows that w_I^{ex} is (strictly) increasing in n.

A.6 Proof of Proposition 3

Denote with $\bar{c}_E$ the price such that $\bar{c}_E(1-\bar{c}_E) = F$. By assumption $A1$, $\bar{c}_E < c_I$.

Let the incumbent bid $w_I > \bar{c}_E$. We now show that there exists at least a price $w'_E < w_I$ such that, if all buyers but one choose the incumbent, entry is profitable. This implies that if the entrant bids that price, in the continuation game coordination failures do not occur and firm E attracts all the orders.

Specifically, consider $w_I \in (\bar{c}_E, 1/2+\sqrt{2}/4]$ and let w'_E be slightly lower. Let all buyers but one choose the incumbent. If entry occurs, the buyer which is supplied by the entrant slightly undercuts all its downstream rivals and sells $1-w_I$ units of the product. (When $\mu \to \infty$, demand in the final market is given by $p = 1-q$.) Thus, by selling to the deviant buyer, the entrant earns $\pi_E = w_I(1-w_I) > F$ for any $w_I \in (\bar{c}_E, 1/2+\sqrt{2}/4]$ and any $F \in \left[\underline{F}, \overline{F}\right)$.

Now consider $w_I > 1/2+\sqrt{2}/4$ and $w_E = 1/2 < w_I$. Let all buyers but one choose the incumbent. If entry occurs, the buyer which is supplied by the entrant sets the price $p = (1+w_E)/2 = 3/4 < w_I$ and sells $1-p = 1/4$ units of the product. Thus, by selling to the deviant buyer, the entrant earns $\pi_E = 1/8 > F$ for any $F \in \left[\underline{F}, \overline{F}\right)$.

By the previous argument, no-entry equilibria with $w_I > \bar{c}_E$ do not exist as the entrant has incentive to deviate and bid w'_E. The entrant's deviation attracts all the orders and is profitable. No-entry equilibria where $w_I < \bar{c}_E$ do not exist either. Now the entrant has no incentive to deviate and undercut the incumbent. However, in a no-entry equilibrium the incumbent would be addressed by all buyers and would suffer losses. Hence, it would have incentive to deviate.

To sum up, no-entry equilibria do not exist.

It is easy to see that entry equilibria are as follows: $w^*_E = w^*_I \in (\bar{c}_E, c_I]$, $S = N$.

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