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Buyer power from joint listing decision

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Abstract

We show that collective bargaining can enhance retailers' buying power vis-à-vis their suppliers. We consider a model of vertically related markets, in which an upstream leader faces a competitive fringe of less efficient suppliers and negotiates secretly with several firms that compete in a downstream market. We allow downstream firms to join forces in negotiating with suppliers, by creating a buyer group which selects suppliers on behalf of its members: each group member can then veto the upstream leader's offer, in which case all group members turn to the fringe suppliers. Transforming individual listing decisions into a joint listing decision makes delisting less harmful for a group member; this, in turn enhances the group members' bargaining position at the expense of the upstream leader. We also show that this additional buyer power can have an ambiguous impact on the upstream leader's incentives to invest.

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1 Introduction

During the last decades, retailers have increasingly sought to join forces so as to enhance their buyer power vis-à-vis suppliers. In Europe, the grocery industry has seen the

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emergence of several chains of independent supermarkets such as Leclerc and Système U in France, who in 1999 joined their forces further in a buying alliance called Lucie;[1] similarly, in Finland the two leading voluntary retail chains, Kesko and Tuko, attempted to merge in 1996.[2] In the US, independent retail grocers, including the Independent Grocers Association (IGA) have long used buyer groups to negotiate with suppliers.[3] Other retailing industries have undergone some consolidation as well. In France, for instance, the pharmaceutical retailing industry has seen the emergence of some buyer groups (Astera, Giphar, and Giropharm).[4]

These retailers thus rely on collective bargaining in order to gain buying power. Two commonly recognized benefits of such collective bargaining are the associated economies of scale and the ability to make a joint listing decision (or more precisely, a joint delisting decision, as we will see below). Economies of scale arise for example from common operational costs.[5] The ability to make a joint (de-)listing decision arises when a group of individual retailers can commit to a decision that binds all of its members. While economies of scale clearly bring benefits to buyer groups, whether joint listing decisions do so is less clear.

The objective of this paper is to explore when and how joint delisting decision can affect bargaining position of the buyer group, and whether larger buyer group benefits more of such joint delisting decisions. We consider a model of vertically related markets à la Rey and Tirole (2007), in which manufacturers compete by simultaneous making secret offers. Upstream, a market leader faces a competitive fringe of less efficient suppliers; downstream, firms compete and use the suppliers' input to produce a homogeneous good. We allow a number of downstream firms to join forces in negotiating with the upstream leader: they create a buyer group, which selects suppliers on behalf of its members. More precisely, we focus on a listing rule where each group member can veto the upstream leader, in which case all group members turn to the fringe suppliers and

[1] This buying alliance was dissolved in 2006, when Système U joined a European buying alliance (European Market Distribution) with another French retailing competitor, Casino. Leclerc, Système U and Casino accounted respectively for 17%, 9% and 10% of sales in French grocery and daily goods retailing in 2009 (TNS Worldpanel).

[2] The concentration was canceled by the European Commission (Case IV/M.784).

[3] IGA is the world's largest voluntary supermarket chain with more than 5,000 member stores.

[4] Astera, Giphar, and Giropharm represent around 20% of the pharmaceutical retailing industry in France.

[5] Retailers can share other fixed costs. For example, they may have economies of scale in finding or setting-up an alternative source of supply (see Katz, 1987 and Sheffman and Spiller, 1992).

also show that this rule enhances the bargaining position of the buyer group. Intuitively, transforming individual delisting decision into a joint boycott makes such a decision less harmful for a group member, since the other group members will also have to deal with the alternative, less efficient supplier. This, in turn, enhances the group members' bargaining position, by raising the value of their outside options. In our model (where secret contracting implies that the marginal input price always reflects the upstream marginal cost), this better bargaining position does not lead to lower prices for consumers. This is in line with the concern voiced by antitrust authorities; for example, the European Commission states in its Guidelines: "cost savings or other efficiencies that only benefit the parties to the joint purchasing arrangement will not suffice. Cost savings need to be passed on to consumers".[6]

The literature has used various way to generate size-related discounts. Katz (1987) models buyer power as a retailer's ability to integrate backwards by paying a fixed cost. Getting larger reduces the average cost of this alternative option and allows in this way the retailer to obtain a better price from the supplier.[7] Size may not only increase the value of a retailer's alternatives but also reduce the suppliers' alternatives. If the supplier's cost is convex, then dealing with a larger retailer reduces the (average) avoidable cost that is at stake, which weakens the seller's bargaining position; the retailer thus benefits from its larger size (Chipty and Snyder (1999));[8] similarly, when the negotiation breaks down with a large buyer, re-allocating production to the other buyers may be less valuable (Inderst and Wey (2007)). Inderst and Shaffer (2007) and Dana (2009) relate instead buyer power to the possibility, for a large buyer, to reduce the number of suppliers which it deals with.

These approaches focus on "pure" buyer power, in the sense that group members only interact on the buying side.[9] Dobson and Waterson (1997) and von Ungern-Sternberg (1996) consider instead "full mergers", in which the downstream firms not only join forces as buyers, but also eliminate competition between them as sellers. By contrast,

[6] Guidelines on the applicability of Article 101 of the Treaty on the Functionnng of the European Union to horizontal co-operation agreements (2011/C 11/01), paragraph 219.

[7] See Inderst and Valletti (2011) and Inderst and Wey (2011) for recent contributions that build on this insight.

[8] See Smith and Thanassoulis (2011) and Bedre and Caprice (2011) for recent contributions along this line.

[9] That is, while group members may be competing in their respective downstream markets, they are not competing against each other in the same markets.

we focus in this paper on the bargaining power that buyer groups confer to firms that are and remain competitors in the same downstream market.

We also study the implications of our analysis for upstream investment incentives. As in Inderst and Wey (2011), downstream competition tends to induce suppliers to over-invest in productivity, since this reduces downstream firms' outside options and thus allows the suppliers to obtain a bigger share of the industry profit. As in their paper, we also find that increasing the size of the buyer group can exacerbate this over-investment incentive; however, when the buyer group already involves a large proportion of the downstream firms, increasing its size further tends to eliminate the above mechanism (indeed, if all downstream firms join the buyer group, their outside option is no longer affected by the supplier's own productivity), which reduces investment incentives. This is in line with the concern, frequently expressed in policy circles, that suppliers respond to the exercise of buyer power "by under-investing in innovation and production" (FTC 2001, p.57).

The rest of the paper is organized as follows. We first present our framework (section 2), before showing how joint listing decisions benefit group members when they also compete against each other in the same downstream markets (section 3). Results are discussed and extended in section 4. We then build on this analysis to study the impact of buyer groups on suppliers investment (section 5). Section 6 concludes.

2 A simple framework

We consider two vertically related markets. In the upstream market a leader, U, faces a constant marginal cost of production c, whereas a competitive fringe, $\hat{U}$, supplies at cost $\hat{c} > c$. In the downstream market n competitors, $D_1, ..., D_n$, transform the intermediate product into an homogenous final good, on a one-to-one basis and at no additional cost. We assume that the inverse demand for the final good, denoted by $p = P(Q)$, satisfies the following regularity conditions:

Assumption 1: $P(0) > c$ and, for any $Q \geq 0$:

$$P'(Q) < 0 \text{ and } P'(Q) + P''(Q)\,Q < 0.$$

This standard assumption first states that the industry is viable and demand is strictly decreasing; the last part implies that downstream equilibria are well-behaved. In particular, it implies that the profit function

$$\pi\left(q_i; Q_{-i}, c\right) \equiv \left[P\left(Q_{-i} + q_i\right) - c\right] q_i$$

is strictly concave, and that a symmetric Cournot oligopoly, in which all firms face the same cost c, has a unique, symmetric and stable equilibrium,[10] in which each firm sells $q^C(c)$, solution to $q^C = R^C\left((n-1)\,q^C; c\right)$, where

$$R^C\left(Q_{-i}; c\right) \equiv \arg\max_{q_i \geq 0} \pi\left(q_i; Q_{-i}, c\right)$$

denotes the standard Cournot best response to rivals' aggregate quantity Q_{-i}. Dropping the argument c unless explicitly needed, we will denote by $Q^C \equiv nq^C$, $p^C \equiv P\left(Q^C\right)$, and $\Pi^C \equiv \left(p^C - c\right) Q^C$ the associated aggregate output, price and profit; the per-firm profit is then:

$$\pi^C \equiv \left(p^C - c\right) q^C.$$

We will assume that wholesale contracts are secret and consider the following competition game:

- Step 1: (a) U secretly offers each D_i a tariff $T_i(.)$; (b) Each D_i secretly accepts or rejects U's offer.

- Step 2: Each D_i secretly orders a quantity $\hat{q}_i$ from the fringe and, if it has accepted $T_i(.)$, a quantity q_i from U; the downstream firms then transform the intermediate product into final good, observe the total output Q and sell their own output at price $P(Q)$.

As is well-known,[11] secret contracting creates a risk of opportunism: since D_i's rivals do not observe neither U's offer nor D_i's acceptance decision, in their bilateral negotiation U and D_i have an incentive to free-ride on downstream rivals' margins; but this, in turn, prevents U from fully exerting its market power. The extent to which this is the case

[10]See Lemma 2 (with $s = n$) for a formal proof.

[11]See the seminal paper from Hart and Tirole (1990), as well as O'Brien and Shaffer (1992) and McAfee and Schwartz (1994). Rey and Tirole (2007) provides an overview of this literature.

depends on how downstream firms interpret unexpected offers; for the sake of exposition, we will focus here on *passive conjectures* and thus assume that downstream firms stick to their equilibrium beliefs.[12] A downstream firm D_i, anticipating an aggregate equilibrium output Q_{-i} from its rivals, is then willing to pay $P(Q_{-i} + q_i) q_i - \max_q \pi(q; Q_{-i}, \hat{c})$ for any quantity q_i, which leads the more efficient supplier, U, to supply $q_i = R^C(Q_{-i}; c)$.[13] It follows that the resulting equilibrium yields the Cournot outcome:

Proposition 1 *Under passive conjectures, the above competition game has a unique subgame perfect equilibrium outcome, in which:*

(i) each D_i sells the competitive quantity q^C, which it buys from U;

(ii) each D_i earns the profit it could obtain by turning instead to the competitive fringe:

$$\hat{\pi} \equiv \max_{q \geq 0} \pi\left(q; (n-1) q^C, \hat{c}\right).$$

Proof. See Hart and Tirole (1990). ■

3 Buyer group

We now suppose that, in order to join forces in their negotiation with U, $s \leq n$ downstream firms form a buyer group G, which will select suppliers on behalf of its members. To reflect this, we adapt the first step of the competition game as follows:

- Step 1a as before; in particular, each group member only observes the offer it receives, not the offers made to the other members.
- Step 1b: Each group member recommends whether to accept or reject U's offers to the group G; these offers are all accepted if members unanimously recommend

[12] When downstream firms compete in quantities in a Cournot fashion, passive beliefs correspond to the wary beliefs introduced by McAfee and Schwartz (1994).

[13] U finds indeed it profitable to supply D_i, since it can charge

$$\begin{aligned} & P\left(Q_{-i} + R^C(Q_{-i}; c)\right) R^C(Q_{-i}; c) - \max_q \pi(q; Q_{-i}, \hat{c}) \\ = \; & cR^C(Q_{-i}; c) + \max_q \pi(q; Q_{-i}, c) - \max_q \pi(q; Q_{-i}, \hat{c}) \\ \geq \; & cR^C(Q_{-i}; c). \end{aligned}$$

doing so, and all rejected otherwise. The other downstream firms decide individually whether to accept the offer they received. Acceptance decisions are again private information: members of the buyer group know whether U's offers have been accepted by the group, but do not observe non-members' decisions, and these firms only observe their own decisions.

Each group member can therefore veto U's offers to the group, in which case all group members must turn to the less efficient fringe suppliers. Members' outside options are thus the outcome of the following oligopoly game, in which s group members face a cost $\hat{c}$ and compete in quantities among themselves, anticipating that outsiders put on the market a given total quantity Q_o:

Lemma 2 *Suppose that the s members of the buyer group, facing the same cost $\hat{c}$ and anticipating an output level Q_o from firms outside the group, compete in quantities among themselves; then:*

(i) This competition yields a unique, stable equilibrium, in which each group member sells $q^s = q^s(Q_o, \hat{c})$, satisfying

$$q^s \equiv R^C(Q_o + (s-1)q^s; \hat{c}). \tag{1}$$

(ii) Furthermore, letting $\pi^s(Q_o, \hat{c}) \equiv (P(Q_o + sq^s(Q_o, \hat{c})) - \hat{c})\, q^s(Q_o, \hat{c})$ denote the associated profit for each member, we have:

- *$q^s(Q_o, \hat{c}) > 0$ (and thus $\pi^s(Q_o, \hat{c}) > 0$) if and only if $P(Q_o) > \hat{c}$;*
- *whenever $P(Q_o) > \hat{c}$,*

$$\frac{\partial q^s}{\partial Q_o}, \frac{\partial q^s}{\partial \hat{c}} < 0 \text{ and } \frac{\partial \pi^s}{\partial Q_o}, \frac{\partial \pi^s}{\partial \hat{c}} < 0.$$

Proof. See Appendix A. ■

Obviously, there always exists trivial equilibria in which at least two members reject the offer, and thus U does not supply group members: as no member is pivotal in that case, they are all indifferent about their recommendation. However, there also exists an equilibrium in which U, being more efficient, keeps supplying all firms. Furthermore, in any such equilibrium, U enters again into *bilaterally efficient* contracts, which leads it to supply the competitive quantity q^C to all firms; the introduction of a buyer group thus does not affect the equilibrium outputs, but alters the bargaining power of the group members who, by vetoing U's offers, can now secure $\pi^s(Q_o, \hat{c}) = \pi^s\left((n-s)\,q^C, \hat{c}\right)$:

Proposition 3 *There exists an equilibrium in which U supplies all firms. Furthermore, under passive conjectures, then in any such equilibrium:*

(i) all firms sell the competitive quantity q^C;

(ii) each non-member earns $\hat{\pi}^1 = \hat{\pi}$, whereas each group member earns

$$\hat{\pi}^s \equiv \pi^s\left((n-s)\,q^C, \hat{c}\right).$$

Proof. See Appendix B. ■

Thus, in equilibrium, U ends up supplying the Cournot quantity to all firms, whether they belong to the buyer group or not. Forming a buyer group however affects the division of profits. While non-member firms still earn $\hat{\pi}$, group members earn instead $\hat{\pi}^s$. Vetoing U's offers to the group not only inflicts a larger loss on U, since U is then delisted as well by the other group members, but it also leads to a situation which, although group members must then rely on less efficient suppliers, is not as bad for the vetoing firm as if it were the only one in that position. As a result, group members benefit from enhanced bargaining power, and the more so, the bigger the group G:

Proposition 4 $\hat{\pi} = \hat{\pi}^1 \leq \hat{\pi}^2 \leq ... \leq \hat{\pi}^n < \pi^C$; *furthermore, for $s > 1$, $\hat{\pi}^s > \hat{\pi}^{s-1}$ whenever $\hat{\pi}^s > 0$ (i.e., whenever $P\left((n-s)\,q^C\right) > \hat{c}$).*

Proof. See Appendix C. ■

As mentioned above, the key intuition here is that, by joining forces in their negotiation with the leading supplier, group members enhance their outside option: while turning to less efficient suppliers remains costly, it becomes less painful when the other members have to do the same. Conversely, alternative decision rules, which do not necessarily grant veto power to a group member, are less effective in enhancing that member's bargaining power, since they do not guarantee that the member will be "in good company" if it rejects U's offer.[14]

[14]Suppose for example that U's offers are accepted by G as long as $p < s$ members recommend acceptance; even if each member remains individually free to reject the offer received from U, there

4 Discussion and extensions

There is strength in numbers here: relying on less efficient suppliers becomes less and less costly when other firms have to do so as well. For that reason, joining a group not only benefits the additional member, but also benefits the existing group members. In the absence of any restriction on the size of the group, we would thus expect all firms to join the buyer group.

Also, while for the sake of presentation we focused on a single buyer group, the analysis applies as well to situations where several (separate) groups are formed: the members of a group of size s then all earn $\hat{\pi}^s$. Still, in the absence of any restriction on group size, we would expect the firms to form a single, encompassing buyer group. Indeed, prospective members benefit more from joining a larger group ($s' > s$ implies $\hat{\pi}^{s'+1} - \hat{\pi} > \hat{\pi}^{s+1} - \hat{\pi}$), and any existing group member benefits as well from switching to a larger group ($s' \geq s$ implies $\hat{\pi}^{s'+1} > \hat{\pi}^s$).

Moreover, while we focused on an homogenous final good, the analysis applies as well to downstream competitors that are differentiated. In this case, closer competitors are more likely to join forces in their negotiations with the leading supplier. Since the introduction of a buyer group does not affect the equilibrium outputs, the key intuition still refers to group members' outside option: while turning to less efficient suppliers remains costly, it is less painful when the other members who have to do the same are the ones that offer the closest substitutes. To illustrate this point, suppose for instance that the downstream market consists of a differentiated four-firm Cournot oligopoly, where D_1 and D_2 produce the same (good A), whereas D_3 and D_4 produce an imperfect substitute (good B). We thus have:

$$p_1 = p_2 = \hat{P}(Q_A, Q_B) \text{ and } p_3 = p_4 = \hat{P}(Q_B, Q_A),$$

where $Q_A = q_1 + q_2$ and $Q_B = q_3 + q_4$. For the sake of exposition, assume further that the inverse demand $\hat{P}$ is linear and given by:

$$\hat{P}(Q_A, Q_B) = 1 - Q_A - \sigma Q_B,$$

then exists equilibria in which U supplies q^C but leaves only $\hat{\pi}$ to each and every firm, within as well as without the group (indeed, if $p+1$ members recommend acceptance, no member is pivotal, and thus belonging to the buyer group makes no difference).

where $0 \leq \sigma < 1$. Suppose moreover that c and $\hat{c}$ satisfy $c = 0$ and $\hat{\pi} = \hat{\pi}^1(\hat{c}, 0) > 0$, which amounts to $\hat{c} < \frac{2}{3+2\sigma}$. In the absence of any buyer group, each D_i sells the competitive quantity $q^C = \frac{1}{3+2\sigma}$ and earns $\hat{\pi} = \left(\frac{1}{3+2\sigma} - \frac{\hat{c}}{2}\right)^2$. Suppose now that D_1 and D_2 (who produce perfect substitutes) join forces in their negotiations with U. The equilibrium quantities do not change, but these two firms now each secure a larger profit, $\hat{\pi}^{12} \equiv \left(\frac{1}{3+2\sigma} - \frac{\hat{c}}{3}\right)^2$. If instead it is D_1 and D_3, which produce imperfect substitutes, that join forces, the equilibrium quantities remain the same but these firms now each gain $\hat{\pi}^{13} \equiv \left(\frac{1}{3+2\sigma} - \frac{\hat{c}}{2+\sigma}\right)^2 < \hat{\pi}^{12}$.[15] Thus, for any $\sigma < 1$, it is more profitable for D_1 and D_2 to join forces rather than for D_1 and D_3 (see Appendix **??**).

5 Upstream investment incentives

An often-voiced concern raised by buyer power relates to its impact on suppliers' incentives to invest and innovate. To explore this issue, we now introduce investment decisions in our framework. More precisely, we add here an additional stage (step 0) at the beginning of the above competition game, in which the dominant supplier, U, can invest F in order to reduce its marginal cost c, from some initial level $\overline{c} > 0$ to a lower level $\underline{c} \in [0, \overline{c}[$. In this extended framework, we study the impact of the size of the buyer group (established before the beginning of the game) on U's equilibrium investment decision. Introducing explicitly U's cost c as an argument in the above-defined functions, we will denote by $q^C(c)$ and $\pi^C(c)$ the individual quantity and profit in a Cournot equilibrium based on cost c, by $\Pi^C(c)$ the corresponding industry profit, and by $\hat{\pi}^s(\hat{c}, c) = \pi^s\left((n-s)\, q^C(c), \hat{c}\right)$ the outside option (and equilibrium profit) of a member of a buyer group of size s. Note that, by construction, $q^n(0, \hat{c}) = q^C(\hat{c})$ and $\hat{\pi}^n(\hat{c}, c) = \pi^C(\hat{c})$; thus, Lemma 2 implies $q^C(c), \pi^C(c) > 0$ if and only $c < P(0)$, in which case $dq^C/dc, d\pi^C/dc < 0$.

Obviously, it is socially or privately interesting to invest only when this allows U to be the most effective supplier (i.e., $\underline{c} < \hat{c}, P(0)$). The incentives to invest however also depend on whether the competitive fringe, too, is an effective supplier ($\hat{c} \gtreqless P(0)$), as well as on whether U is initially more efficient than the fringe ($\overline{c} \gtreqless \hat{c}$). More precisely, in equilibrium U supplies the retailers whenever it is more efficient than the fringe, that

[15] Note that, for $\sigma = 0$, D_1 and D_3 do not benefit from joining forces $\left(\hat{\pi}^{13} = \hat{\pi}\right)$, as they do not compete in the same market.

is, whenever its cost c is lower than $\hat{c}$; we will therefore let

$$\Pi_I(c) \equiv \Pi^C(\min\{c, \hat{c}\})$$

denote the industry profit, as a function of U's cost c, and

$$\Delta_I = \Pi_I(\underline{c}) - \Pi_I(\overline{c})$$

denote the investment benefit for the industry. Similarly, since a member of a buyer group of size s obtains a profit equal to $\hat{\pi}^s(\hat{c}, \min\{c, \hat{c}\})$ when U's cost is c, U's profit can then be written as

$$\Pi_U^s(c) \equiv \Pi_I(c) - s\hat{\pi}^s(\hat{c}, \min\{c, \hat{c}\}) - (n-s)\hat{\pi}^1(\hat{c}, \min\{c, \hat{c}\}),$$

and its incentive to invest is driven by a private benefit equal to

$$\Delta_U^s = \Pi_U^s(\underline{c}) - \Pi_U^s(\overline{c}).$$

Investing is neither privately nor socially desirable (that is, $\Delta_U^s = \Delta_I = 0$) when $\hat{c} < \underline{c}$, since it does not allow U to become a viable supplier in that case. Conversely, when the competitive fringe does not offer a viable option (i.e., when $\hat{c} \geq P\left((n-s)q^C(\overline{c})\right)$), retailers obtain zero profit whether there is a buyer group or not; this leads U to fully internalize the impact of its investment on the industry profit and thus aligns its incentives with that of the industry (that is, $\Delta_U^s = \Delta_I$). The same applies when retailers form an encompassing group (i.e., $s = n$), since they then earn a profit equal to $\Pi^C(\hat{c})$, regardless of U's cost; therefore, U fully internalizes again the impact of its on the industry profit, and $\Delta_U^n = \Delta_I$.

In all other cases (that is, when $s < n$ and $\underline{c} < \hat{c} < P\left((n-s)q^C(\overline{c})\right)$), by investing U increases its profit not only by lowering its cost, but also possibly by limiting the value of retailers' outside option, if they were to turn to the fringe suppliers; indeed, we then have:

$$\begin{aligned} \Delta_U^s - \Delta_I &= s\left[\hat{\pi}^s(\hat{c}, \min\{\overline{c}, \hat{c}\}) - \hat{\pi}^s(\hat{c}, \underline{c})\right] \\ &\quad + (n-s)\left[\hat{\pi}^1(\hat{c}, \min\{\overline{c}, \hat{c}\}) - \hat{\pi}^1(\hat{c}, \underline{c})\right], \end{aligned} \tag{2}$$

where the terms in brackets are non-negative (and the first one is positive) since $\hat{\pi}^k(\hat{c}, c)$ weakly increases with c (and strictly so for $k = s$) from $\underline{c}$ to $\min\{\overline{c}, \hat{c}\}$. As a result, U has excessive incentives to invest, compared with what would maximize industry profits (that is, $\Delta_U^s > \Delta_I$):

Proposition 5 $\Delta_U^s \geq \Delta_I$ *for any* $\overline{c} > \underline{c} \geq 0$, *any* $\hat{c} \geq 0$ *and any* $s \in \{1, ..., n\}$*; more precisely:*

(i) $\Delta_U^s = \Delta_I$ *if* $\hat{c} < \underline{c}$, $\hat{c} \geq P\left((n-s)\, q^C(\overline{c})\right)$, *or* $s = n$*;*

(ii) $\Delta_U^s > \Delta_I$ *if instead* $s < n$ *and* $\underline{c} < \hat{c} < P\left((n-s)\, q^C(\overline{c})\right)$*.*

Proof. See Appendix D. ∎

Reducing retailers' rents thus gives U an additional motive for investing in cost reduction, which tends to increase its incentives to invest, beyond what would maximize industry profitability. We now show that, while creating or expanding a buyer group increases retailers' profit at the expanse of U, the impact on U's incentives to invest is however ambiguous. For example, when $\hat{c} \geq P\left(q^C(\overline{c})\right)$, the formation of a buyer group either has no effect (as long as $s < n$, since then $\hat{\pi}^s(\hat{c}, \overline{c}) = \hat{\pi}^s(\hat{c}, \underline{c}) = 0$), or reduces U's rent by $\Pi^C(\hat{c})$, regardless of U's cost (if $s = n$). Thus, while the creation or the expansion of a buyer group can reduce U's rent (if $s = n$), it never affects U's investment incentives in that case ($\Delta_U^s = \Delta_I$ for any $s \leq n$). When instead $\hat{c} < P\left(q^C(\overline{c})\right)$, setting-up a large enough group (i.e., s close enough to n) allows retailers to obtain a positive profit, and expanding it further moreover tends to make retailers' outside option less sensitive to U's cost, at it reduces the number of retailers that rely on U in this alternative scenario, and thus tends to eliminate the scope for overinvestment; thus, for s large enough, we expect Δ_U^s to decrease as s further increases, and eventually converge towards Δ_I. When instead the buyer group is initially small, expanding its size strengthens retailers' weak bargaining position, and may well do so more effectively when U is itself not too strong; this, in turn, may reinforce U's incentives to invest in cost reduction; for example, if $\hat{\pi}^s(\hat{c}, \overline{c}) > \hat{\pi}^s(\hat{c}, \underline{c}) = 0$, then U clearly has an extra incentive to invest when a buyer group of size s has formed, so as to prevent retailers from gaining any bargaining power, and thus $\Delta_U^s > \Delta_I$. The following Proposition reflects this intuition:

Proposition 6 *For any* $\overline{c} > \underline{c} \geq 0$ *and any* $s < n$*: (1)* $\Delta_U^{s+1} = \Delta_U^s$ *if* $\hat{c} \leq \underline{c}$ *or* $\hat{c} \geq P\left(q^C(\overline{c})\right)$*; (2) if instead* $\underline{c} < \hat{c} < P\left(q^C(\overline{c})\right)$*:*

(i) $\Delta_U^{s+1} < \Delta_U^s$ *for* s *large enough;*

(ii) however, if $\hat{c} \geq P\left((n-1)\, q^C(\overline{c})\right)$, *then* $\Delta_U^{s+1} \geq \Delta_U^s$ *for* s *not too large, with at least one strict inequality in that range.*

Proof. See Appendix E. ■

Setting-up of expanding a buyer group may thus *foster* U's incentives to invest if the group is not too large, and tends instead to counterbalance the overinvestment bias, and reduce investment incentives, when the group is large. To illustrate this proposition, suppose for example that the costs $\hat{c}, \overline{c}, \underline{c}$ satisfy $\hat{c} > \overline{c} > \underline{c}$, $\pi^C(\hat{c}) > 0$, and $\hat{\pi}^1(\hat{c}, \overline{c}) = \hat{\pi}^1(\hat{c}, \underline{c}) = 0$. There then exists $\bar{s}$ and $\underline{s} \geq \bar{s}$ such that $\hat{\pi}^s(\hat{c}, \overline{c}) > 0$ (resp., $\hat{\pi}^s(\hat{c}, \underline{c}) > 0$) if and only if $s \geq \bar{s}$ (resp., $s \geq \underline{s}$). We then have (Figure 1 provides an illustration for $n = 10$, $P(Q) = 1 - q$, $\hat{c} = 0.7$, $\overline{c} = 0.45$, and $\underline{c} = 0$; see E for a detailed analysis of this case):

- in the range $s < \bar{s}$, $\hat{\pi}^s(\hat{c}, \overline{c}) = \hat{\pi}^s(\hat{c}, \underline{c}) = 0$, and thus $\Delta_U^s = \Delta_I$;

- in the range $\bar{s} \leq s < \underline{s}$, $\hat{\pi}^s(\hat{c}, \underline{c}) = 0$ but $\hat{\pi}^s(\hat{c}, \overline{c})$ is positive and increases with s; as a result, U has more incentives to invest than what would maximize industry profits ($\Delta_U^s > \Delta_I$), and the more so, the larger the buyer group: Δ_U^s increases as s increases;

- finally, in the range $s > \underline{s}$, $\hat{\pi}^s(\hat{c}, \overline{c})$ and $\hat{\pi}^s(\hat{c}, \underline{c})$ are both positive and increasing in s, and while $\hat{\pi}^s(\hat{c}, \underline{c})$ remains smaller, it increases faster than $\hat{\pi}^s(\hat{c}, \overline{c})$ (and the two coincide with $\pi^C(\hat{c})$ for $s = n$), so that Δ_U^s decreases as s increases, and finally coincides again with Δ_I for $s = n$.

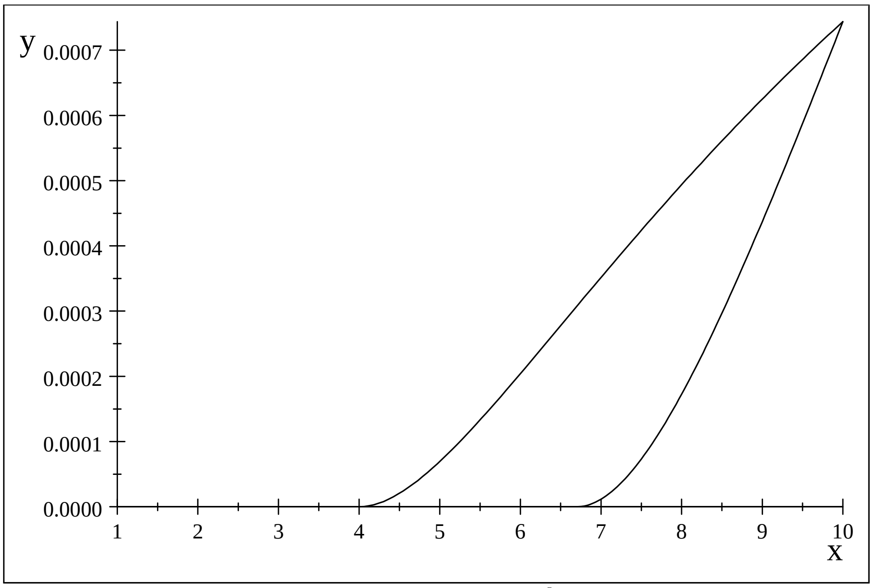

Figure 1a: Retailers' profits

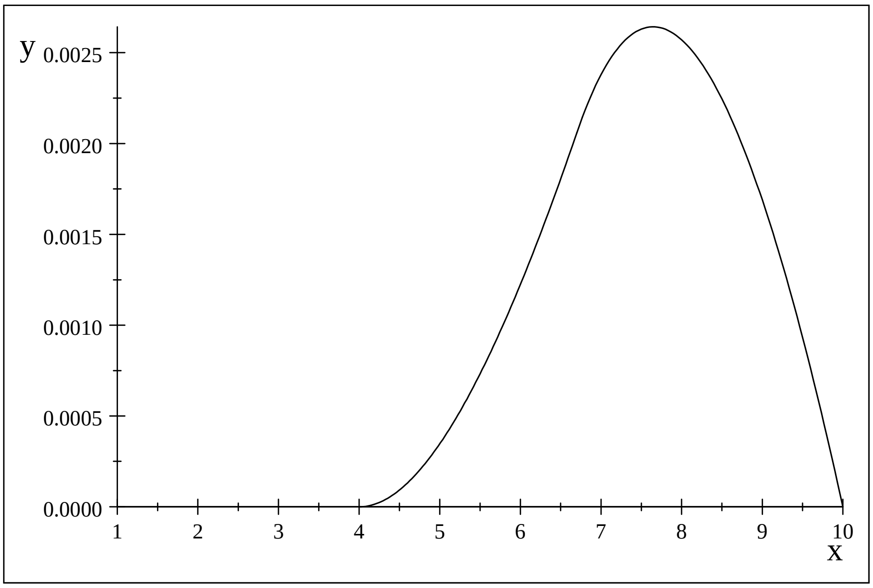

Figure 1b: Investment incentives

6 Conclusion

While the literature on buyer power has mainly studied the impact of retail mergers, in this paper we focus instead on the bargaining power that *buyer groups* confer to firms that are and remain competitors in the same retail market. We show that, by joining forces in their procurement negotiations, downstream firms can enhance their bargaining position at the expense of their suppliers. They can do so by creating a buyer group that selects suppliers on behalf of its members, in which each group member can veto an offer, in which case all group members must turn to alternative suppliers. Transforming individual listing decisions into a joint listing decision makes delisting less harmful, which in turn improves group members' bargaining position compared to outsiders.

In our framework, where secret contracting implies that contracts are bilaterally efficient, the enhanced bargaining position conferred by buyer groups does not lead to lower prices for consumers. This is in line with a concern often voiced by antitrust authorities: cost savings resulting from joint purchasing arrangement are not necessarily passed on to consumers. However, by contrast to another concern of antitrust authorities, the formation of buyer groups has no impact here on other purchasers: the equilibrium contracts are bilaterally efficient and their outside options are unchanged.

We also show that this additional buyer power can have an ambiguous impact on a supplier's incentives to invest: enlarging a buyer group may foster its incentives to invest if the group is not too large, and tends instead to counterbalance overinvestment biases, and reduce investment incentives, when the group is already quite large.

The source of buyer power that we identify originates directly from the competition in retail markets. While for the sake of presentation we focused on a buyer group only composed of firms that compete in the same downstream market, the analysis applies as well to hybrid buyer groups, where some members are on separate markets while others compete in the same market. It is however the presence of competition in the group that enhances a given member's bargaining position. Thus, prospective members benefit more from joining a group in which the number of direct competitors is the largest. Similarly, it is the closest competitors that gain most from joining forces in their negotiations with suppliers.

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Appendix

A Proof of Lemma 2

The following Lemma will be useful:

Lemma 7 *Under Assumption 1, for any $k \in \mathbb{N}^*$ and any Q and q satisfying $Q \geq q \geq 0$, $kP'(Q) + P''(Q)\, q < 0$.*

Proof. Since $P'(Q) < 0$, the expression $kP'(Q) + P''(Q)\, q$ is negative whenever $P''(Q) \leq 0$; if instead $P''(Q) > 0$, then Assumption 1, together with $P'(Q) < 0$ and $q \leq Q$, yields

$$kP'(Q) + P''(Q)\, q \leq P'(Q) + P''(Q)\, Q < 0.$$

■

Assumption 1 ensures that each group member's profit is strictly concave in its own quantity: letting q_i denote the member's output, $Q_{-i} = Q_o + \sum_{j \in S \setminus \{i\}}$ its rivals' aggregate output and $Q = Q_{-i} + q_i$ the total output, we have

$$\frac{\partial^2 \pi(q_i; Q_{-i}, \hat{c})}{\partial q_i^2} = 2P'(Q) + P''(Q)\, q_i < 0,$$

where the inequality stems from Lemma 7. Furthermore, the first-order derivative of the member's profit is:

$$\left. \frac{\partial \pi(q_i; Q_{-i}, \hat{c})}{\partial q_i} \right|_{q_i = 0} = P(Q) - \hat{c}.$$

Therefore, if $P(Q) \leq \hat{c}$, then all group members choose $q_i = 0$, in which case $Q = Q_o$ and thus $P(Q_o) \leq \hat{c}$; conversely, if $P(Q_o) \leq \hat{c}$, so that $P(Q) < \hat{c}$ for any $Q > Q_o$, each member necessarily chooses $q_i = 0$, which satisfies (1).

When instead $P(Q) > \hat{c}$, each group member must choose a positive quantity $q_i > 0$, thus satisfying the first-order condition

$$P(Q) + P'(Q)\, q_i = \hat{c}.$$

If follows that $q_i = q^s$ (i.e., all members must choose the same quantity),[16] where $q^s > 0$ thus satisfies (1) or, equivalently, the first-order condition

$$P\left(sq^s + Q_o\right) + P'\left(sq^s + Q_o\right) q^s = \hat{c}. \tag{3}$$

Let $Q^s \equiv sq^s + Q_o$ denote the aggregate equilibrium output. Differentiating (3) with respect to $\hat{c}$, Q_o and q^s yields:

$$\begin{aligned} \frac{\partial q^s}{\partial \hat{c}} &= \frac{1}{(s+1) P'(Q^s) + P''(Q^s) sq^s} < 0, \\ \frac{\partial q^s}{\partial Q_o} &= -\frac{P'(Q^s) + P''(Q^s) q^s}{(s+1) P'(Q^s) + P''(Q^s) sq^s} < 0, \end{aligned}$$

where the inequalities follow from Lemma 7.

We now turn to π^s. Using $\pi^s = \max_{q_i} \pi\left(q_i; Q_o + (s-1) q^s, \hat{c}\right)$ and the envelope theorem, we have:

$$\begin{aligned} \frac{\partial \pi^s}{\partial \hat{c}} &= \left.\frac{\partial \pi(q_i; Q_{-i}, \hat{c})}{\partial Q_{-i}}\right|_{q_i = q^s, Q = Q^s} (s-1) \frac{\partial q^s}{\partial \hat{c}} + \left.\frac{\partial \pi(q_i; Q_{-i}, \hat{c})}{\partial \hat{c}}\right|_{q_i = q^s, Q = Q^s} \\ &= P'(Q^s) q^s (s-1) \frac{\partial q^s}{\partial \hat{c}} - q^s \\ &= \left[\frac{(s-1) P'(Q^s)}{(s+1) P'(Q^s) + P''(Q^s) sq^s} - 1\right] q^s \\ &= -\frac{2P'(Q^s) + P''(Q^s) sq^s}{(s+1) P'(Q^s) + P''(Q^s) sq^s} q^s < 0, \end{aligned}$$

[16] This is a common feature of aggregative games, where one player's objective depends on others' decisions only through an aggregator (here, total output) of all individual decisions. See Anderson, Erkal and Piccinin (2011) for a recent treatment of such games.

where the inequality follows again from Lemma 7. The envelope theorem yields similarly:

$$\begin{aligned}\frac{\partial \pi^s}{\partial Q_o} &= \left.\frac{\partial \pi\left(q_i; Q_{-i}, \hat{c}\right)}{\partial Q_{-i}}\right|_{q_i=q^s, Q=Q^s}\left(1+(s-1)\frac{\partial q^s}{\partial Q_o}\right) \\ &= P'\left(Q^s\right) q^s\left(1+(s-1)\frac{\partial q^s}{\partial Q_o}\right) \\ &= P'\left(Q^s\right) q^s \frac{2P'\left(Q^s\right)+P''\left(Q^s\right) q^s}{(s+1) P'\left(Q^s\right)+P''\left(Q^s\right) s q^s} < 0,\end{aligned}$$

where the inequality follows again from $P'(Q) < 0$ and Lemma 7.

B Proof of Proposition 3

Consider a candidate equilibrium in which: (i) U supplies all firms, which implies that all group members recommend accepting U's offers, and (ii) $q_i \neq R^C\left(Q_{-i}; c\right)$ for some downstream firm D_i, where Q_{-i} denotes the aggregate equilibrium output of D_i's rivals. D_i's equilibrium profit, of the form $\pi_i = P\left(Q_{-i}+q_i+\hat{q}_i\right)\left(q_i+\hat{q}_i\right) - T_i - \hat{c}\hat{q}_i$, must satisfy $\pi_i \geq \hat{\pi}_i$, where $\hat{\pi}_i$ represents the profit that D_i can obtain with its relevant outside option: $\hat{\pi}_i = \pi^1\left(Q_{-i}, \hat{c}\right)$ if D_i does not belong to the buyer group G, whereas $\hat{\pi}_i = \pi^s\left(Q_o, \hat{c}\right)$ otherwise, where Q_o denotes the aggregate equilibrium output of firms outside G. Moreover, the constraint $\pi_i \geq \hat{\pi}_i$ must be binding; otherwise, U could deviate and slightly increase the payment T_i: under passive conjectures, D_i would still accept (or, if belonging to G, would still recommend acceptance, leading G to accept U's offers), and the deviation would thus increase U's profit. Therefore, we must have $\pi_i = \hat{\pi}_i$.

Suppose now that U deviates and offers D_i to supply $\tilde{q}_i = R^C\left(Q_{-i}; c\right)$ for some total price $\tilde{T}_i$. Under passive conjectures, D_i anticipates its rivals to stick to their equilibrium outputs, and (other) group members to keep recommending acceptance of U's offers to the group. It follows that, if D_i accepts the offer, the impact of this deviation on the joint profits of U and D_i is given by:

$$\begin{aligned}
&\left\{\left[\tilde{T}_i - c\tilde{q}_i\right] + \max_{q\geq 0}\left[P\left(Q_{-i}+\tilde{q}_i\right)\left(\tilde{q}_i+q\right) - \tilde{T}_i - \hat{c}q\right]\right\} \\
&-\left\{\left[T_i - cq_i\right] + \left[P\left(Q_{-i}+q_i+\hat{q}_i\right)\left(q_i+\hat{q}_i\right) - T_i - \hat{c}\hat{q}_i\right]\right\} \\
\geq\ & \left\{\left[\tilde{T}_i - c\tilde{q}_i\right] + \left[P\left(Q_{-i}+\tilde{q}_i\right)\tilde{q}_i - \tilde{T}_i\right]\right\} - \left\{\left[T_i - cq_i\right] + \left[P\left(Q_{-i}+q_i+\hat{q}_i\right)\left(q_i+\hat{q}_i\right) - T_i - \hat{c}\hat{q}_i\right]\right\} \\
=\ & \left(P\left(Q_{-i}+\tilde{q}_i\right) - c\right)\tilde{q}_i - \left\{\left(P\left(Q_{-i}+q_i+\hat{q}_i\right) - c\right)\left(q_i+\hat{q}_i\right) - \left(\hat{c}-c\right)\hat{q}_i\right\}.
\end{aligned}$$

The last expression is positive since $\left(P\left(Q_{-i}+\tilde{q}_i\right)-c\right)\tilde{q}_i = \max_{\tilde{q}\geq 0}\left(P\left(Q_{-i}+\tilde{q}\right)-c\right)\tilde{q}$ and:

- if $\hat{q}_i = 0$, then $q_i + \hat{q}_i = q_i \neq R^C\left(Q_{-i};c\right)$ implies

$$\left(P\left(Q_{-i}+q_i+\hat{q}_i\right)-c\right)\left(q_i+\hat{q}_i\right) < \max_{\tilde{q}\geq 0}\left(P\left(Q_{-i}+\tilde{q}\right)-c\right)\tilde{q};$$

- if $\hat{q}_i > 0$, then:

$$\begin{aligned}
\left(P\left(Q_{-i}+q_i+\hat{q}_i\right)-c\right)\left(q_i+\hat{q}_i\right) - \left(\hat{c}-c\right)\hat{q}_i &< \left(P\left(Q_{-i}+q_i+\hat{q}_i\right)-c\right)\left(q_i+\hat{q}_i\right) \\
&\leq \max_{\tilde{q}\geq 0}\left(P\left(Q_{-i}+\tilde{q}\right)-c\right)\tilde{q}.
\end{aligned}$$

  Therefore, in both cases the deviating offer increases the joint profit of U and D_i if it is accepted; there thus exists a price $\tilde{T}_i$ that is mutually profitable, i.e., that gives D_i more than $\pi_i = \hat{\pi}_i$ (so that U's offer is indeed accepted, either individually or by the group) and yet increases U's profit.

Therefore, any equilibrium in which U supplies all firms, and firms have passive conjectures, must be such that $q_i = R^C\left(Q_{-i};c\right)$ for $i = 1,...,n$; this, in turn, implies $q_i = q^C$. It follows that, in any such equilibrium:

- If D_i does not belong to G, it can secure $\hat{\pi}_i = \hat{\pi}$ by rejecting U's offer;
- If instead D_i belongs to G, it can secure $\hat{\pi}_i = \hat{\pi}^s$ by recommending the rejection of U's offers to the group.

Conversely, suppose that U offers to supply q^c to each D_i, for a total payment equal to $P\left(nq^C\right)q^C - \hat{\pi}_i$, where $\hat{\pi}_i$ is defined as above. By construction, a deviating offer that is acceptable by D_i cannot increase the joint bilateral profit of U and D_i; since D_i can secure $\hat{\pi}_i$ by rejecting U's offer (or recommending its rejection), such deviation cannot be profitable for U. Obviously, deviating and not supplying a non-member firm D_i is also unprofitable, as it would reduce U's profit by

$$\left(P\left(nq^C\right)-c\right)q^C-\hat{\pi}=\pi^1\left((n-1)\,q^C;c\right)-\pi^1\left((n-1)\,q^C;\hat{c}\right)\geq 0.$$

Finally, deviating offers that are rejected by the buyer group G cannot be profitable either, as it would reduce U's profit by

$$s\left[\left(P\left(nq^C\right)-c\right)q^C-\hat{\pi}^s\right]=s\left[\pi^s\left((n-s)\,q^C;c\right)-\pi^s\left((n-s)\,q^C;\hat{c}\right)\right]\geq 0.$$

C Proof of Proposition 4

By construction, $\hat{\pi}=\pi^1\left((n-s)\,q^C;\hat{c}\right)=\hat{\pi}^1$, $\hat{\pi}^n=\pi^n\left(0;\hat{c}\right)$ and $\pi^C=\pi^n\left(0;c\right)$; furthermore, the latter is positive from Assumption 1 and Lemma 2, which in turn implies $\pi^C=\pi^n\left(0;c\right)>\hat{\pi}^n=\pi^n\left(0;\hat{c}\right)$.

Let $\hat{q}^s\equiv q^s\left((n-s)\,q^C;\hat{c}\right)$ denote each group member's continuation equilibrium output if the group were to reject U's offers. From Assumption 1 and Lemma 2, $q^C=q^s\left((n-s)\,q^C;c\right)>0$ and:

$$q^C=q^s\left((n-s)\,q^C;c\right)>\hat{q}^s=q^s\left((n-s)\,q^C;\hat{c}\right).$$

By construction, for $s>1$, we have $\hat{\pi}^{s-1}=\pi^{s-1}\left((n-s+1)\,q^C;\hat{c}\right)$ and

$$\hat{\pi}^s=\pi^{s-1}\left((n-s)\,q^C+\hat{q}^s;\hat{c}\right).$$

The conclusion then follows from Lemma 2, which implies that the profit function $\pi^s\left(Q_o,\hat{c}\right)$ decreases as the outsiders' output Q_o increases, and does strictly so as long as it remains positive, which is the case if and only if $P\left(Q_o\right)>\hat{c}$.

D Proof of Proposition 5

The following Lemma will be useful:

Lemma 8 *For any* $k \in \{1, ...n-1\}$*, and any* $\hat{c}, c \geq 0$*:*

$$\frac{\partial \hat{\pi}^k}{\partial c}(\hat{c}, c) \geq 0, \tag{4}$$

with a strict inequality whenever $c < P(0)$ *(i.e.,* $q^C(c) > 0$*) and* $\hat{c} < P\left((n-k) q^C(c)\right)$*.*

Proof. We have:

$$\frac{\partial \hat{\pi}^k}{\partial c}(\hat{c}, c) = \left.\frac{\partial \pi^k}{\partial Q_o}(Q_o, \hat{c})\right|_{Q_o=(n-k)q^C(c)} (n-k) \frac{dq^C}{dc}(c).$$

The conclusion then follows from Lemma 2, which ensures that $\left.\frac{\partial \pi^k}{\partial Q_o}(Q_o, \hat{c})\right|_{Q_o=(n-k)q^C(c)} \geq 0$, with a strict inequality whenever $\hat{c} < P\left((n-k) q^C(c)\right)$, and (when applied to the case $Q_o = 0$ and $s = n$) $\frac{dq^C}{dc} \leq 0$, with a strict inequality whenever $c < P(0)$. ■

We now consider in turn the various cases discussed in the text:

- When $\hat{c} < \underline{c}$, investing is neither privately nor socially desirable, since it does not allow U to become a viable supplier in that case: $\Delta_U^s = \Delta_I = 0$.

- When $\hat{c} \geq P\left((n-s) q^C(\overline{c})\right)$, the competitive fringe does not offer a viable option: $\hat{\pi}^s(\hat{c}, c) = 0$, and thus $\Pi_U^s(c) = \Pi_I(c)$, for both $c = \min\{\underline{c}, \hat{c}\}$ and $c = \min\{\overline{c}, \hat{c}\}$; therefore, U fully internalize the impact of its investment on the industry profit: $\Delta_U^s = \Delta_I$.

- When $s = n$, retailers earn a profit equal to $\hat{\pi}^n(\hat{c}, c) = \Pi^C(\hat{c})$, regardless of U's cost c; this leads again U to fully internalize the impact of its on the industry profit: $\Delta_U^s = \Delta_I$.

Consider now the case where $s < n$ and $\underline{c} < \hat{c} < P\left((n-s) q^C(\overline{c})\right)$. Since $\min\{\underline{c}, \hat{c}\} = \underline{c}$, $\Delta_U^s - \Delta_I$ is indeed given by (2), and moreover $\min\{\underline{c}, \hat{c}\} = \underline{c} < \min\{\overline{c}, \hat{c}\}$. Lemma 8 then implies that the terms in brackets, $\hat{\pi}^s(\hat{c}, \min\{\overline{c}, \hat{c}\}) - \hat{\pi}^s(\hat{c}, \underline{c})$ and $\hat{\pi}^1(\hat{c}, \min\{\overline{c}, \hat{c}\}) - \hat{\pi}^1(\hat{c}, \underline{c})$, are both non-negative. The first term is moreover positive, since $\left.\frac{\partial \hat{\pi}^s}{\partial c}(\hat{c}, c)\right|_{c=\min\{\overline{c}, \hat{c}\}} > 0$:

- If $\hat{c} \leq \overline{c}$, $\hat{\pi}^s(\hat{c}, \min\{\overline{c}, \hat{c}\}) = \hat{\pi}^s(\hat{c}, \hat{c}) = \pi^C(\hat{c})$, and $\hat{c} < P\left((n-s) q^C(\overline{c})\right) (\leq P(0))$ implies $\hat{c} < P(0)$, which in turn implies $\pi^C(\hat{c}) > 0$ and thus $\hat{c} < \left(P\left(nq^C(\hat{c})\right) <\right) P\left((n-s) q^C(\hat{c})\right)$; therefore, from Lemma 8, $\left.\frac{\partial \hat{\pi}^s}{\partial c}(\hat{c}, c)\right|_{c=\hat{c}} > 0$.

- If $\hat{c} > \overline{c}$, $\hat{\pi}^s(\hat{c}, \min\{\overline{c}, \hat{c}\}) = \hat{\pi}^s(\hat{c}, \overline{c})$; $\hat{c} < P\left((n-s)\, q^C(\overline{c})\right)$ then implies $\overline{c} < \left(\hat{c} < P\left((n-s)\, q^C(\overline{c})\right) <\right) P(0)$, and thus from Lemma 8, $\frac{\partial \hat{\pi}^s}{\partial c}(\hat{c}, c)\big|_{c=\overline{c}} > 0$.

The conclusion follows.

E Upstream investment incentives

E.1 Proof of Proposition 6

Consider first the case $\hat{c} \geq P\left(q^C(\overline{c})\right) \left(\geq P\left(q^C(\underline{c})\right)\right)$.

- For any $s < n$, $\hat{\pi}^s(\hat{c}, \overline{c}) = \hat{\pi}^s(\hat{c}, \underline{c})\ (= 0)$; therefore:
  - if $q^C(\overline{c}) > 0$, then $P\left(q^C(\overline{c})\right) > \overline{c}$; $\hat{c} \geq P\left(q^C(\overline{c})\right)$ thus implies $\hat{c} > \overline{c} > \underline{c}$, and we have: $\hat{\pi}^s(\hat{c}, \min\{\overline{c}, \hat{c}\})\ (= \hat{\pi}^s(\hat{c}, \overline{c})) = \hat{\pi}^s(\hat{c}, \min\{\underline{c}, \hat{c}\})\ (= \hat{\pi}^s(\hat{c}, \underline{c})) = 0$, and thus $\Delta_U^s = \Delta_I$;
  - if $q^C(\overline{c}) = 0$, then $\hat{c} \geq P\left(q^C(\overline{c})\right) = P(0)$ implies that $\hat{c}$ is never a viable option (even when outsiders are also supplied at $\hat{c}$), and thus again $\hat{\pi}^s(\hat{c}, \min\{\overline{c}, \hat{c}\}) = \hat{\pi}^s(\hat{c}, \min\{\underline{c}, \hat{c}\}) = 0$, and $\Delta_U^s = \Delta_I$.
- For $s = n$, we also have $\hat{\pi}^n(\hat{c}, \min\{\overline{c}, \hat{c}\}) = \hat{\pi}^n(\hat{c}, \min\{\underline{c}, \hat{c}\}) \left(= \pi^C(\hat{c})\right)$, and thus $\Delta_U^s = \Delta_I$.

Therefore, for any $s \in \{1, ..., n\}$, $\Delta_U^s = \Delta_I$; thus, $\Delta_U^{s+1} = \Delta_U^s$ for any $s < n$. Likewise, if $\hat{c} \leq \underline{c}$, then $\Delta_U^s = \Delta_I = 0$ for any $s \in \{1, ..., n\}$, and thus $\Delta_U^{s+1} = \Delta_U^s$ for any $s < n$.

We now assume $\underline{c} < \hat{c} < P\left(q^C(\overline{c})\right)$, and distinguish two cases.

Case 1: $\underline{c} < \hat{c} \leq \overline{c}$. In that case, investing allows U to become an effective supplier, and

$$\Delta_U^s = \Pi_U^s(\underline{c}) = \Pi_I(\underline{c}) - s\hat{\pi}^s(\hat{c}, \underline{c}) - (n-s)\,\hat{\pi}^1(\hat{c}, \underline{c}).$$

Therefore, for $s \in \{1, ..., n-1\}$:

$$\begin{aligned} \Delta_U^{s+1} - \Delta_U^s &= \Pi_U^{s+1}(\underline{c}) - \Pi_U^s(\underline{c}) \\ &= -s\left[\hat{\pi}^{s+1}(\hat{c}, \underline{c}) - \hat{\pi}^s(\hat{c}, \underline{c})\right] - \left[\hat{\pi}^{s+1}(\hat{c}, \underline{c}) - \hat{\pi}^1(\hat{c}, \underline{c})\right] \\ &\leq 0, \end{aligned}$$

where the inequality follows from the fact that retailers' outside option increases with s; this inequality is moreover strict whenever $\hat{c} < P\left((n-s-1)\,q^C(\underline{c})\right)$, which is the case for s large enough (since $\hat{c}\left(< P\left(q^C(\overline{c})\right)\right) < P(0)$).

Case 2: $(\underline{c} <)\,\overline{c} < \hat{c} < P\left(q^C(\overline{c})\right)$. In that case, U is already an effective supplier when it faces a cost $\overline{c}$, and investing allows it to further increase its efficiency; we then have:

$$\Delta_U^s = \Delta_I + (n-s)\left[\hat{\pi}^1(\hat{c},\overline{c}) - \hat{\pi}^1(\hat{c},\underline{c})\right] + s\left[\hat{\pi}^s(\hat{c},\overline{c}) - \hat{\pi}^s(\hat{c},\underline{c})\right].$$

From Proposition 5, $\Delta_U^n = \Delta_I$ and $\Delta_U^s \geq \Delta_I$ for any $s < n$, with a strict inequality when $\hat{c} < P\left((n-s)\,q^C(\overline{c})\right)$. Therefore:

- Since $\hat{c} < P\left(q^C(\overline{c})\right)$, $\Delta_U^{n-1} > \Delta_U^n = \Delta_I$; therefore, there exists $\bar{s} \leq n$ such that $\Delta_U^{s-1} > \Delta_U^s$ for $s \in \{\bar{s}, .., n\}$.
- If in addition $\hat{c} \geq P\left((n-1)\,q^C(\overline{c})\right)$, then $\Delta_U^s = \Delta_I$ for s small enough (namely, as long as $\hat{c} \geq P\left((n-s)\,q^C(\overline{c})\right)$), whereas $\Delta_U^s > \Delta_I$ for s large enough (e.g., for $s = n-1$); therefore, there exists $\underline{s} \geq 1$ such that $\Delta_U^{s+1} \geq \Delta_U^s$, with at least one strict inequality, for $s \in \{1, ..., \underline{s}\}$.

E.2 Illustration: linear demand

Suppose that demand is linear: $P(Q) = 1 - Q$. We then have:

- $q^C(c)$ solves

$$\arg\max_q \left(P\left((n-1)q^C(c) + q\right) - c\right) q = \left(1 - (n-1)\,q^C(c) - q - c\right) q,$$

  and is thus characterized by the first-order condition

$$0 = \left(1 - (n-1)\,q^C(c) - q - c\right) q\Big|_{q=q^C} = 1 - c - (n+1)\,q^C(c) = 0,$$

  i.e.

$$q^C(c) = \frac{1-c}{n+1}.$$

- A member of a group of size s obtains

$$\hat{\pi}^s = \left(\hat{P}\left((n-s)\,q^C + (s-1)\,\hat{q}^s + \hat{q}^s\right) - \hat{c}\right)\hat{q}^s \equiv \max_q \left(\hat{P}\left((n-s)\,q^C + (s-1)\,\hat{q}^s + q\right) - \hat{c}\right) q,$$

where

$$\left(\hat{P}\left((n-s)\,q^C+(s-1)\,\hat{q}^s+q\right)-\hat{c}\right)q=\left(1-(n-s)\,q^C-(s-1)\,\hat{q}^s-q-\hat{c}\right)\hat{q}.$$

The first-order condition yields, for $q=\hat{q}^s$:

$$0=1-(n-s)\,q^C(c)-s\hat{q}^s-\hat{c}-\hat{q}^s=1-(n-s)\,q^C(c)-(s+1)\,\hat{q}^s-\hat{c},$$

or

$$(s+1)\,\hat{q}^s+(n-s)\,\frac{1-c}{n+1}=1-\hat{c},$$

leading to:

$$\begin{aligned}\hat{q}^s(\hat{c},c) &= \frac{(s+1)-(n+1)\,\hat{c}+(n-s)\,c}{(n+1)\,(s+1)},\\ \hat{\pi}^s(\hat{c},c) &= \left(\frac{(s+1)-(n+1)\,\hat{c}+(n-s)\,c}{(n+1)\,(s+1)}\right)^2.\end{aligned}$$

Therefore, $\hat{q}^s(\hat{c},c)$ and $\hat{\pi}^s(\hat{c},c)$ are positive if and only if

$$s>\hat{s}(c)=\frac{(n+1)\,\hat{c}-1-nc}{1-c}.$$

We then have $\bar{s}=\hat{s}(\overline{c})$ and $\underline{s}=\hat{s}(\underline{c})$.

In particular, for $n=10$ and $\hat{c}=0.7$, we have:

$$\hat{s}=\left[\frac{(10+1)\,\hat{c}-1-10c}{(1-c)}\right]_{\hat{c}=0.7}=\frac{10c-6.7}{c-1},$$

Thus, for $\overline{c}=0.45$ and $\underline{c}=0$: $\bar{s}=\left[\frac{10c-6.7}{c-1}\right]_{c=0.45}=4$ and $\underline{s}=\left[\frac{10c-6.7}{c-1}\right]_{c=0}=6.7$, and

$$\begin{aligned}\hat{\pi}^s(\hat{c},\overline{c}) &= \left[\left(\frac{(s+1)-(n+1)\,\hat{c}+(n-s)\,\overline{c}}{(n+1)\,(s+1)}\right)^2\right]_{n=10,\hat{c}=0.7,\overline{c}=0.45}=\frac{1}{121}\frac{(0.55s-2.2)^2}{(s+1)^2},\\ \hat{\pi}^s(\hat{c},\underline{c}) &= \left[\left(\frac{(s+1)-(n+1)\,\hat{c}+(n-s)\,\underline{c}}{(n+1)\,(s+1)}\right)^2\right]_{n=10,\hat{c}=0.7,\underline{c}=0}=\frac{1}{121}\frac{(s-6.7)^2}{(s+1)^2},\end{aligned}$$

which was used to generate Figure 1.a.

Turning to investment incentives, we have

$$\Pi^C(c) = n\hat{\pi}^1(c,c) = \frac{10}{121}(1-c)^2,$$

and thus:

$$\Delta_I = \Pi^C(\underline{c}) - \Pi^C(\overline{c}) = \left[\frac{10}{121}(1-c)^2\right]_{c=0} - \left[\frac{10}{121}(1-c)^2\right]_{c=0.45} = 5.7645 \times 10^{-2}.$$

Using $\Delta_U^s = \Delta_I + s\left[\hat{\pi}^s(\hat{c},\overline{c}) - \hat{\pi}^s(\hat{c},\underline{c})\right]$ leads to:

- For $s = 1, ..., 4$, $\hat{\pi}^s(\hat{c},\overline{c}) = \hat{\pi}^s(\hat{c},\underline{c}) = 0$ and thus $\Delta_U^s = \Delta_I$.
- For $s = 5, 6$, $\hat{\pi}^s(\hat{c},\overline{c}) > \hat{\pi}^s(\hat{c},\underline{c}) = 0$ and thus U's bias is positive:

  $$\Delta_U^s - \Delta_I = s\hat{\pi}^s(\hat{c},\overline{c}) = s\frac{1}{121}\frac{(0.55s-2.2)^2}{(s+1)^2} > 0,$$

  and increases with s.
- For $s = 7, ..., 9$, $\hat{\pi}^s(\hat{c},\overline{c}) > \hat{\pi}^s(\hat{c},\underline{c}) > 0$ and thus U's bias remains positive:

  $$\Delta_U^s - \Delta_I = s\left[\hat{\pi}^s(\hat{c},\overline{c}) - \hat{\pi}^s(\hat{c},\underline{c})\right] = s\left[\frac{1}{121}\frac{(0.55s-2.2)^2}{(s+1)^2} - \frac{1}{121}\frac{(s-6.7)^2}{(s+1)^2}\right] > 0,$$

  but decreases as s increases, as illustrated by Figure 1.b.
- Finally, for $s = 10$, $\hat{\pi}^s(\hat{c},\overline{c}) = \hat{\pi}^s(\hat{c},\underline{c}) > 0$, and thus again $\Delta_U^s = \Delta_I$.

F Illustration ??

We study here the differentiated four-firm Cournot oligopoly introduced in section 4, in which D_1 and D_2 produce good A whereas D_3 and D_4 produce good B.

In the absence of any buyer group, each D_i ($i = 1, 2, 3, 4$) sells the competitive quantity q^C, which solves

$$\max_q \hat{P}\left(q^C + q, 2q^C\right) q = \left(1 - \left(q^C + q\right) - 2\sigma q^C\right) q.$$

As this profit is concave, q^C is thus characterized by the first-order condition:[17]

$$0 = 1 - \left(q^C + q\right) - 2\sigma q^C - q\Big|_{q=q^C} = 1 - (3 + 2\sigma)\, q^C,$$

i.e.,

$$q^C = \frac{1}{3 + 2\sigma}.$$

Furthermore, each D_i earns the profit it could obtain by turning to the competitive fringe:

$$\hat{\pi} = \left(\hat{P}\left(q^C + \hat{q}, 2q^C\right) - \hat{c}\right)\hat{q} \equiv \max_q \left(\hat{P}\left(q^C + q, 2q^C\right) - \hat{c}\right) q,$$

where

$$\begin{aligned}\left(\hat{P}\left(q^C + q, 2q^C\right) - \hat{c}\right) q &= \left(1 - (1 + 2\sigma)\, q^C - q - \hat{c}\right)\hat{q} \\ &= \left(1 - \frac{1 + 2\sigma}{3 + 2\sigma} - q - \hat{c}\right)\hat{q} \\ &= \left(\frac{2}{3 + 2\sigma} - q - \hat{c}\right) q.\end{aligned}$$

The profit $\hat{\pi}$ is positive when $\hat{c} < \frac{2}{3+2\sigma}$, in which case $\hat{q}$ is determined by the first-order condition:

$$\frac{2}{3 + 2\sigma} - \hat{c} - 2\hat{q} = 0,$$

i.e.,

$$\hat{q} = \frac{1}{3 + 2\sigma} - \frac{\hat{c}}{2},$$

leading to

$$\hat{\pi} = \left(\frac{1}{3 + 2\sigma} - \frac{\hat{c}}{2}\right)^2.$$

Suppose now that D_1 and D_2 form a buyer group. Equilibrium quantities remain the same, and outsiders still earn $\hat{\pi}$, but the group members now each secure:

$$\hat{\pi}^{12} = \left(\hat{P}\left(2\hat{q}^{12}, 2q^C\right) - \hat{c}\right)\hat{q}^{12} \equiv \max_q \left(\hat{P}\left(\hat{q}^{12} + q, 2q^C\right) - \hat{c}\right) q,$$

[17]In what follows, $\hat{P}_1$ denotes the partial derivative of $\hat{P}$ with respect to its first argument.

where

$$\begin{aligned}\left(\hat{P}\left(\hat{q}^{12}+q,2q^{C}\right)-\hat{c}\right)q &= \left(1-\left(\hat{q}^{12}+q\right)-2\sigma q^{C}-\hat{c}\right)\hat{q} \\ &= \left(1-\left(\hat{q}^{12}+q\right)-\frac{2\sigma}{3+2\sigma}-\hat{c}\right)\hat{q} \\ &= \left(\frac{3}{3+2\sigma}-\left(\hat{q}^{12}+q\right)-\hat{c}\right)q.\end{aligned}$$

The first-order condition yields, for $q=\hat{q}^{12}$:

$$\frac{3}{3+2\sigma}-\hat{c}-3\hat{q}^{12}=0,$$

i.e.,

$$\hat{q}^{12}=\frac{1}{3+2\sigma}-\frac{\hat{c}}{3},$$

leading to

$$\hat{\pi}^{12}=\left(\frac{1}{3+2\sigma}-\frac{\hat{c}}{3}\right)^{2}.$$

If instead D_1 and D_3 form a buyer group, they each gain:

$$\hat{\pi}^{13}=\left(\hat{P}\left(q^{C}+\hat{q}^{13},q^{C}+\hat{q}^{13}\right)-\hat{c}\right)\hat{q}^{13}\equiv\max_{q}\left(\hat{P}\left(q^{C}+q,q^{C}+\hat{q}^{13}\right)-\hat{c}\right)q,$$

where

$$\begin{aligned}\left(\hat{P}\left(q^{C}+q,q^{C}+\hat{q}^{13}\right)-\hat{c}\right)q &= \left(1-\left(q^{C}+q\right)-\sigma\left(q^{C}+\hat{q}^{13}\right)-\hat{c}\right)\hat{q} \\ &= \left(1-\frac{1+\sigma}{3+2\sigma}-q-\sigma\hat{q}^{13}-\hat{c}\right)\hat{q} \\ &= \left(\frac{2+\sigma}{3+2\sigma}-q-\sigma\hat{q}^{13}-\hat{c}\right)q.\end{aligned}$$

The first-order condition yields, for $q=\hat{q}^{13}$:

$$\frac{2+\sigma}{3+2\sigma}-(2+\sigma)\,\hat{q}^{13}-\hat{c}=0,$$

i.e.,

$$\hat{q}^{13} = \frac{1}{3+2\sigma} - \frac{\hat{c}}{2+\sigma},$$

leading to

$$\hat{\pi}^{13} = \left(\frac{1}{3+2\sigma} - \frac{\hat{c}}{2+\sigma}\right)^2.$$

It is straightforward to check that $\hat{\pi}^{12} > \hat{\pi}^{13} > \hat{\pi}$.