Buyer Power and Quality Improvement*

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Abstract

This paper analyses the sources of buyer power and its effect on sellers' investment. We show that a retailer extracts a larger surplus from the negotiation with an upstream manufacturer the more it is essential to the creation of total surplus. In turn, this depends on the rivalry between retailers in the bargaining process. Rivalry increases when the retail market is more fragmented, when the retailers are less differentiated and when decreasing returns to scale in production are larger. The allocation of total surplus affects also the incentives of producers to invest in product quality, an instance of the hold up problem. This not only makes both the supplier and consumers worse off, but it may harm also the retailers.

KEYWORDS: Retailers' power; Hold-up; Supplier's under-investment.

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1 Introduction

In the last decades, the retailing sector - in particular grocery retailing - has experienced a movement towards increased concentration. Broadly speaking, large retail chains and multinational retail companies (such as Wal-Mart, Carrefour, the Metro group) now play a dominant role, even though the phenomenon is not uniform across countries.[1] At the EU level, retailer concentration is further strengthened by purchasing alliances (operating not only at national level but also cross-border such as Euro Buying or Buying International Group). Buyer power is on the rise also in other industries, such as automobile,[2] and healthcare and cable television (in the US).[3]

These trends have triggered investigations by anti-trust agencies and policy institutions around the world on the effects of increasing buyer power.[4] One concern that is often expressed is that excessive buyer power may deteriorate suppliers' incentive by squeezing their profit margins and thus indirectly harm consumers and overall welfare. For instance, according to the FTC report, "even if consumers receive some benefits in the short run when retailers use their bargaining leverage to negotiate a lower price, they could be adversely affected by the exercise of buyer power in the longer run, if the suppliers respond by under-investing in innovation or production" (FTC 2001, p.57).

In this paper we formalize this argument by studying the impact of buyer power on a supplier's incentive to improve quality.

Our model assumes a monopolistic firm and two retail outlets, owned by either two independent retailers or a retail chain. First, the supplier chooses the (non-contractible) quality of its product. Higher quality makes final consumers more willing to pay for the good, thereby increasing total industry profits. We

[1] For example, in the UK supermarkets accounted for 20% of grocery sales in 1960, but 89% in 2002, with the top-5 stores controlling 67% 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. Moreover, in the US the supermarket industry is experiencing an unprecedented merger wave. For an overview of recent changes in the retail sector see Dobson and Waterson (1999), Dobson (2005) and OECD (1999).

[2] The increased bargaining power of automakers when negotiating with parts suppliers is documented, among the others, by Peters (2000).

[3] 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 restrictions on their size. See Raskovich (2003) and Chae and Heidhues (2004). 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).

[4] 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).

allow quality to be improved through either a fixed and sunk investment (e.g. by engaging in R&D, advertising, etc.) or the use of more valuable inputs. After the quality decision, supply conditions are determined in bilateral negotiations. While most of the literature on buyer power employs specific cooperative solution concepts, we explicitly specify a non-cooperative bargaining procedure. In particular, we assume that retailers make take-it-or-leave-it offers to the supplier. Moreover, we do not impose any restriction on the type of contracts that firms can offer.

The solution of the negotiation game - given the quality choice - provides the following insights. Firstly, equilibrium supplies maximize total industry profits. Note that efficient supplies are not implied by assumptions on specific contractual forms, but derived endogenously from negotiation. Secondly, total industry profits are distributed in the following way. Trivially, a consolidated retailer extracts the entire surplus from the negotiation with the supplier. Instead, each independent retailer appropriates its marginal contribution, i.e. the additional surplus created when one more retailer is supplied. In turn, retailers' marginal contribution is determined by demand and supply conditions. To fix ideas, consider the case where the supplier's costs are linear. If retailers are perceived as perfectly substitutable by final consumers (because there is neither geographical differentiation nor differentiation in the provision of sale services), the maximum industry profit can be achieved by supplying one retailer only. Hence, the marginal contribution of each retailer is zero, and the supplier appropriates the entire surplus from the negotiation, even though retailers make take-it-or-leave-it offers. Differently stated, this case exhibits the strongest rivalry among retailers in the negotiation with the supplier. As retailers' differentiation increases, their marginal contribution increases as well (and rivalry weakens). Thus, the share of total profits they absorb in the negotiation increases. Indeed, if retailers operate in completely insulated markets, each of them contributes to half of total profits. In this case retailers appropriate the entire surplus from the negotiation, even though they are fragmented.

The convexity of the supplier's cost function creates an alternative (and indirect) source of rivalry between retailers. As marginal costs become steeper, retailers' marginal contribution decreases and they appropriate a smaller share of total surplus.

We then analize the quality choice made by the upstream firm. We show that the formation of more powerful buyers (either through consolidation or a reduction of buyer's rivalry), by reducing the share of total profits that the supplier extracts from the negotiation, weakens its incentive to engage in quality improvement. Hence, it makes both the supplier and final consumers worse off. Furthermore, it may harm also retailers. On the one hand, the exercise of buyer power allows retailers to appropriate a larger share of total profits. On the other hand, by deteriorating incentives, it also reduces the total profits that can be distributed. If rivalry between retailers is sufficiently weak, the latter effect dominates.

Finally, we show that repeated interaction may induce the producer to choose the efficient quality level even in the presence of powerful buyers.

Related literature This paper relates to the growing literature on buyer power. This literature has addressed three main issues: (i) why larger buyers obtain better deals from sellers; (ii) whether wholesale discounts obtained by large buyers are passed on to final consumers; (iii) what are the implications of buyer power for suppliers' incentives.

The literature exploring the sources of buyer power is very heterogeneous.[5,6] In a number of papers, size discounts arise because large buyers are better bargainers than small ones. This occurs for various reasons. Larger buyers can distribute the costs to generate alternative supply options over a larger number of units. This makes their threat to integrate backwards credible and improves their bargaining position with the supplier (Katz, 1987; Inderst and Wey, 2005b). In Inderst and Shaffer (forthcoming) a consolidated retailer may commit to stock only one variety at all outlets, thereby intensifying competition among potential suppliers. In other papers, including Chipty and Snyder (1999) and Inderst and Wey (2003, 2005a), the effect of buyer size on bargaining is more subtle. To see the point, consider a supplier which bargains separately and simultaneously with a small and a large buyer. Each buyer views itself as marginal, conjecturing that the other has completed its negotiation with the supplier efficiently. Hence, the incremental surplus over which the supplier and a buyer negotiate is computed assuming that the producer already supplies the other buyer. Since negotiation with the small buyer involves a smaller quantity, the incremental surplus associated to the large buyer is computed considering a smaller quantity as a starting point. If aggregate surplus across all negotiations is *concave* in quantity, it follows that the incremental surplus from the negotiation involving the large buyer is higher *per-unit* than the incremental surplus from the transaction involving the small one. This higher

[5] Heterogeneity arises because there exists no single canonical formalization of the exchange between upstream and downstream firms. In particular, models differ for the assumptions on the class of contracts that firms can offer and on the bargaining procedure.

[6] See Snyder (2005) for a recent survey. For empirical and experimental evidence documenting the existence of buyer-size effects, see Scherer and Ross (1990, pp. 533-35), the summary in Ellison and Snyder (2002) and Normann, Ruffle and Snyder (2005).

per-unit incremental surplus translates into a lower per-unit price for the large buyers. The aggregate surplus function is concave, for instance, if the supplier has (strictly) convex production costs.

We contribute to this literature emphasizing that buyer power is determined by the extent to which a buyer is essential to the creation of total surplus. In turn, this depends on buyers' size but also on demand and supply conditions. In particular, the demand channel has been scarcely explored so far.

In another strand of the literature, size discounts emerge because larger buyers destabilize collusion. For instance, a larger buyer, by accumulating a backlog of unfilled orders, may mimic a demand boom and force *sellers* to collude on lower prices (Snyder, 1996). Instead, in Tyagi (2001) it is the supplier which has incentives to offer lower prices to larger buyers in order to amplify cost asymmetries among downstream firms and undermine collusion in the *final market*.

Finally, buyer power may originate from risk aversion, as shown by Chae and Heidhues (2004) and DeGraba (2005).

The literature which studies the welfare effects of buyer power is less abundant. Most of the papers address the question of whether lower wholesale prices secured by powerful buyers imply lower final-good prices or higher welfare and show that this is not necessarily the case.[7] For instance, 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 downstream firms compete fiercely in the final market (e.g. because product differentiation is low) and thus double marginalization is not severe.[8] In these papers the upstream market structure is given. Instead, Fumagalli and Motta (2006) considers the possibility of entry and shows that there is no welfare gain from buyers' concentration when downstream competition is strong enough. The reason being that intense downstream competition removes miscoordination failures among buyers and allows them to be supplied by a more efficient new entrant. Chen (2003) shows that an *exogenous* increase in the relative bargaining power of a dominant retailer benefits consumers because it triggers a decrease in the wholesale price charged by the supplier to the *fringe competitors*, thereby leading to lower final prices. In

[7]Note that, in order to study this issue, these papers rule out the possibility to offer efficient vertical contracts, i.e. contracts that allow to maximize aggregate profits. Indeed, if efficient contracts were feasible, increased concentration in the downstream market would have no impact on final prices because total industry profits would always be maximized, irrespective of the structure of the downstream market.

[8]In these papers, a merger between two buyers corresponds to one firm vanishing from the market. The remaining firms continue being symmetric so that they evaluate the impact of an increase in downstream concentration, not the impact of the formation of a larger buyer.

spite of this, total welfare may decrease because more production is allocated to the less efficient fringe competitors.

Only recently, some papers have begun to examine the impact of buyer power on the suppliers' incentives to invest and innovate.[9] Inderst and Shaffer (forthcoming) and Chen (2006) confirm the aforementioned concerns and show that buyer power may decrease welfare through a distortion in the variety of products offered to consumers. Specifically, in Inderst and Shaffer (forthcoming) manufacturers anticipate that a consolidated retailer will stock only one product at all outlets, and choose an inefficient *type* of variety in order to fit "average" preferences. In Chen (2006), a more powerful retailer induces a monopolist manufacturer to reduce the *number* of varieties offered to consumers, thereby exacerbating the distortion in product diversity caused by upstream monopoly. We show that buyer power may lead also to quality deterioration.

By contrast, Inderst and Wey (2003, 2005a, 2005b) and Vieira-Montez (2004) challenge the view that the formation of larger buyers will invariably stifle investment by upstream firms. Indeed, downstream mergers may strengthen suppliers' incentives to invest in capacity or to adopt technologies with lower marginal costs, thereby raising consumer surplus and total welfare. For instance, in Inderst and Wey (2005b), in the presence of a large buyer - which differently from small ones can credibly threaten to integrate backwards - the supplier benefits more from a reduction in marginal costs. Such a reduction makes the supplied firms more efficient so that, in case of backward integration, the large buyer will face tougher competitors. This reduces the large buyer's outside option and allows that supplier to extract more surplus when negotiating with it. Inderst and Wey (2003 and 2005a) suggest a different mechanism. When negotiating with fewer but larger buyers, the supplier can roll over more of "inframarginal" but less of "marginal" costs. Hence, the presence of a large buyer makes the supplier more willing to choose a technology with lower incremental costs at high quantities.

This paper relates to the literature on the hold-up problem, dating back to Klein et al. (1978) and Williamson (1979). This literature typically studies whether vertical integration (involving investing-parties) alleviates the problem (see for instance, Grossman and Hart, 1989 and Hart and Moore, 1990). Instead our model studies the impact of fundamentals (preferences and technology) on the

[9] Differently from the previous ones, these models allow for sufficiently complex vertical contracts so that aggregate profits are always maximized. The structure of the downstream market affects only the distribution of surplus between upstream and downstream firms. This allows to isolate the effect of increased concentration in the downstream market on suppliers' incentives from the effect on final prices and quantities, and to focus only on the former.

severity of the hold-up problem, through their effect on rivalry among retailers in the negotiation with the producer.

The plan of the paper is the following. Section 2 presents the basic model and the negotiation stage. Section 3 studies the case of demand side rivalry between downstream firms. Supply side rivalry is analysed in Section 4. Section 5 studies the case where the producer and retailers interact repeatedly. The more tedious proofs are collected in an appendix, where we also analyze an extension of the model with multiple producers.

2 Basic Model

We assume a monopolistic upstream supplier, or "producer" (denoted as P). To fix ideas we suppose that in the downstream market the product is distributed to final consumers, and there are two independent retail outlets, or "downstream firms" (denoted as D_1 and D_2).

The timing of agents' decisions is the following:

- At time t_0 the producer chooses the quality level X of its product. Quality is not contractible. Quality chosen at time t_0 has commitment value.
- At time t_1 retailers make simultaneous take-it-or-leave-it offers to the producer. The proposed contracts leave the producer the right to choose the quantity to be delivered to retailers and sold in final markets.
- At time t_2 production and deliveries takes place and the good is distributed in the final market.

For simplicity we assume that retailing does not involve additional costs. This is equivalent to assuming (more realistically) that retailers face a constant marginal cost (constant returns to scale). Revenues of retailer D_i are given by a function $R_i(q_1, q_2, X)$, which is assumed to be continuous, strictly concave in q_i, weakly decreasing in q_j and null for $q_i = 0$. All these assumptions are satisfied by the structural specification considered later on.

The production technology is summarized by a (weakly) convex cost function $C(Q)$ such that $C(0) = 0$. This cost does not include sunk costs incurred to attain quality X. For notational simplicity we will omit X whenever this causes no confusion. Also, without substantial loss of generality, we assume that retailers' revenue functions are symmetric, and we write $R(q', q'', X) := R_1(q', q'', X) = R_2(q'', q', X)$.

An assumption of our analysis is that the retailers let the producer choose the quantities (q_1, q_2) that will be sold on the downstream market and determine such quantities indirectly through their contractual offers.[10] An alternative interpretation is that the quantity delivered to a retailer is a capacity constraint in downstream competition and R_1, R_2 are downstream equilibrium revenue functions. If the downstream firms compete *à la* Cournot (under capacity constraints) the results do not change. We conjecture that our results would also hold under downstream price competition.

2.1 Negotiation stage

To compute the (efficient) subgame perfect equilibrium outcome we first examine the subgame starting at date t_1. At date t_2 (in a subgame perfect equilibrium) the producer simply maximizes its payoff as determined by the accepted contracts, all the interesting action takes place at date t_1. We therefore refer to the subgame starting at date t_1 simply as the "negotiation stage".

In most of the literature, bargaining between the supplier and the retailer(s) is solved adopting a specific cooperative solution concept. Instead, we explicitly specify a non-cooperative bargaining protocol. The assumption that retailers make take-it-or-leave-it offers does not imply that they can always appropriate the entire surplus associated to the negotiation. Therefore, this assumption allows us to study situations where the retailer's bargaining power changes as a function of the fundamentals, such as technology and the degree of substitutability between retailers.

A relevant benchmark in the analysis of negotiation is whether the firms adopt efficient contracts, i.e. contracts that allow to maximize industry profits. We emphasize that the selection of efficient contracts is a *result* of our analysis, not an assumption, since firms are free to propose any kind of contract. In general, we allow for nonlinear contracts whereby the payment to the supplier by one retailer depends on the quantity sold to *both* retailers (and re-sold by them on the downstream market).[11] In particular, we also allow retailers to offer *exclusive contracts* where the supplier commits not to sell the product to the rival retailer (an exclusive contract is a contract that inflicts a sufficiently high penalty to the producer if it sells a positive quantity to the rival retailer). Exclusive contracts play an important role in deriving the essential uniqueness of the equilibrium outcome in

[10] They can also offer forcing contracts.

[11] See Villas-Boas (2005) and Bonnet et al. (2005) for empirical evidence documenting that manufacturers and retailers use non linear pricing contracts.

the negotiation stage (see the proof of Proposition 1). For concreteness, although we allow any nonlinear contract, we often focus our attention on equilibrium contracts where retailer i pays back to the producer the revenue $R_i(q_1, q_2)$ collected and the supplier pays to retailer i a fixed amount (slotting allowance) S_i.

Our negotiation stage is similar to a "menu auction" in the sense of Bernheim and Whinston (1986), with P playing the role of the "auctioneer" and D_1 and D_2 playing the role of the "bidders".[12] We postpone the discussion of this point until after the main result of this subsection.

We let $\widetilde{\Pi}$ denote the profit (gross of sunk costs) of a vertically integrated monopolist, and let $\overline{\Pi}$ denote the profit of an integrated firm who operates only one retailing outlet:[13]

$$\widetilde{\Pi} = \max_{q_1, q_2 \geq 0} \left[R(q_1, q_2) + R(q_2, q_1) - C(q_1 + q_2) \right], \tag{1}$$

$$\overline{\Pi} = \max_{q_1 \geq 0, q_2 = 0} \left[R(q_1, q_2) + R(q_2, q_1) - C(q_1 + q_2) \right] = \max_{q \geq 0} \left[R(q, 0) - C(q) \right]. \tag{2}$$

We assume that (1) and (2) have unique solutions (by symmetry, the solution of (1) must have $q_1 = q_2$).

Remark 1 *Under the stated assumptions* $2\overline{\Pi} - \widetilde{\Pi} \geq 0$.

Proof. Let q^* be the solution to problem (1). Then

$$\widetilde{\Pi} = 2R(q^*, q^*) - C(2q^*) \leq 2R(q^*, q^*) - 2C(q^*) \leq$$

$$\leq 2 \left[\max_{q \geq 0} R(q, q^*) - C(q) \right] \leq 2 \left[\max_{q \geq 0} R(q, 0) - C(q) \right] = 2\overline{\Pi},$$

where the first inequality follows from the convexity of $C(\cdot)$ and $C(0) = 0$, and the last inequality follows from the assumption that $R(\cdot, \cdot)$ is weakly decreasing in its second argument.■

[12] Bernheim and Whinston assume that the set of possible choices of the "auctioneer" (P in our case) is finite, whereas in our case it is a continuum. Furthermore, the option of not accepting an offer is not explicitly modeled in their framework. The following version of the negotiation stage can be seen as a special case of their framework: (i) (q_1, q_2) is chosen from a finite grid $G \subset \mathbb{R}^2_+$ containing $(0, 0)$, (ii) P does not have the option of explicitly rejecting offers, but each contract offer $t_i(q_i, q_j)$ has to satisfy the constraint $t_i(0, q_j) = 0$, so that choosing $q_i = 0$ is equivalent to rejecting i's offer. If G is sufficiently fine, such model is essentially equivalent to ours.

[13] By symmetry, it does not matter which retailing outlet is active. Also recall that these quantities depend on X, the given quality of the product.

Following Bernheim and Whinston (1986) we say that an equilibrium is *coalition-proof* if there is no other equilibrium where both retailers obtain a strictly higher profit. The following proposition says that there is a continuum of equilibrium payoff allocations, but in every coalition-proof equilibrium each downstream firm D_i gets its marginal contribution to industry surplus, that is, the difference between maximum industry surplus $\widetilde{\Pi}$ and the maximum surplus $\overline{\Pi}$ obtainable without D_i; the producer P obtains the rest of the maximum industry surplus.

Proposition 1 *In the negotiation stage, (1) the maximum equilibrium payoff of each retailer is* $\Pi_{D_i} = \widetilde{\Pi} - \overline{\Pi}$*, the minimum equilibrium payoff of the producer (gross of sunk costs) is* $\Pi_P = 2\overline{\Pi} - \widetilde{\Pi}$*, and the maximum equilibrium payoff is* $\Pi_P = \overline{\Pi}$*; (2) for each* $\Pi_P \in [2\overline{\Pi} - \widetilde{\Pi}, \overline{\Pi}]$ *there is an "efficient" equilibrium where the producer obtains* Π_P *and each retailer obtains* $\frac{1}{2}(\widetilde{\Pi} - \Pi_P)$*; (3) there is a unique coalition-proof equilibrium allocation where each retailer obtains the marginal contribution* $\widetilde{\Pi} - \overline{\Pi}$ *and the producer obtains* $2\overline{\Pi} - \widetilde{\Pi}$*.*

Proof. A strategy profile in the subgame is given by a pair of contract offers (t_1, t_2) (with $t_i : \mathbf{R}^2_+ \to \mathbf{R}$) and a strategy of the producer that specifies which contracts should be accepted and, for each set of accepted contracts, a pair of quantities (q_1, q_2), where $q_i = 0$ if t_i is rejected. A strategy of the producer is *sequentially rational* if (a) for each set of accepted contracts (q_1, q_2) maximizes P's profit, and (b) P accepts or reject contracts so as to obtain the highest maximum profit. We will only consider sequentially strategies of P and focus on the retailers' incentives.

(1) We first show that $\Pi_{D_i} \leq \widetilde{\Pi} - \overline{\Pi}$ in equilibrium. Consider a strategy profile that yields payoffs Π_P, Π_{D_j} and $\Pi_{D_i} > \widetilde{\Pi} - \overline{\Pi}$. The latter inquality implies that P accepts D_i's offer. By sequential rationality, Π_P is at least as high as the maximum payoff P can achieve by accepting *only* D_i's offer. Since $\Pi_P + \Pi_{D_j} + \Pi_{D_i} \leq \widetilde{\Pi}$, it follows that $\Pi_P + \Pi_{D_j} < \overline{\Pi}$. Therefore D_j can offer an exclusive contract of the form $t'_j(q_j, 0) = R(q_j, 0) - S$ where $\Pi_{D_j} < S < \overline{\Pi} - \Pi_P$. The contract (if accepted) yields payoffs $\Pi'_P = \overline{\Pi} - S > \Pi_P$ and $\Pi'_{D_j} = S > \Pi_{D_j}$. Faced with such an offer, P accepts at most one contract. If only i's contract is accepted, the payoff is at most Π_P. Therefore P would accept D_j's exclusive contract t'_j, which implies that D_j has a profitable deviation.

Next we show that P cannot get less than $2\overline{\Pi} - \widetilde{\Pi}$ in equilibrium. Consider a strategy profile inducing payoffs Π_{D_i}, Π_{D_j}, and $\Pi_P < 2\overline{\Pi} - \widetilde{\Pi}$. Let (wlog) $\Pi_{D_i} \leq \Pi_{D_j}$. Then $\Pi_{D_i} \leq (\widetilde{\Pi} - \Pi_P)/2$. Suppose that D_i offers instead an exclusive contract of the form $t'_i(q_i, 0) = R(q_i, 0) - S$, where $S = \overline{\Pi} - \Pi_P - \varepsilon$. This contract (if accepted) implements the payoffs $\Pi_P + \varepsilon$ for P and $\overline{\Pi} - \Pi_P - \varepsilon$ for D_i. By assumption ε can be chosen so that $0 < \varepsilon < \left[\left(2\overline{\Pi} - \widetilde{\Pi}\right) - \Pi_P\right]/2$. Then P accepts t_i' (otherwise he gets at most Π_P) and it can be checked that $\overline{\Pi} - \Pi_P - \varepsilon > (\widetilde{\Pi} - \Pi_P)/2$; thus D_i has a profitable deviation.

Now consider a strategy profile such that $\Pi_P > \overline{\Pi}$, which implies that P finds it optimal to accept both offers $t_1$and t_2. Then each retailer D_i has a profitable deviation $t_i' \equiv t_i - \varepsilon$, where $0 < \varepsilon < \Pi_P - \overline{\Pi}$. To see this, note that if P accepts t_i' and t_j its payoff is $\Pi_P - \varepsilon > \overline{\Pi}$, and if P rejects t_i' its payoff it at most $\overline{\Pi}$.

(2) Consider the following strategy profile:

$$t_1(q_1, q_2) = \begin{cases} R_1(q_1, q_2) - \frac{1}{2}(\widetilde{\Pi} - \Pi_P), & \text{if } q_2 > 0, \\ R_1(q_1, 0) - (\overline{\Pi} - \Pi_P) & \text{if } q_2 = 0, \end{cases} \tag{3}$$

t_2 is symmetric to t_1, P accepts both contracts, and P is sequentially rational in the choice of (q_1, q_2) for every set of accepted contracts. It can be checked that this is an equilibrium. P is indifferent between accepting both contracts or only one: in both cases the payoff is $\Pi_P \geq 2\overline{\Pi} - \widetilde{\Pi} \geq 0$. In the candidate equilibrium each retailer gets $\frac{1}{2}(\widetilde{\Pi} - \Pi_P) \geq 0$ and cannot obtain more by deviating to an alternative contract t_i'. To see this note that P would accept t_i' only if it gets at least Π_P, which is the payoff of accepting only t_j. If P accepts only t_i' then D_i gets at most $\overline{\Pi} - \Pi_P$. Since $\Pi_P \geq 2\overline{\Pi} - \widetilde{\Pi}$, $\overline{\Pi} - \Pi_P \leq \frac{1}{2}(\widetilde{\Pi} - \Pi_P)$. If P accepts both t_i' and t_j then D_i gets at most $\widetilde{\Pi} - \Pi_P - \frac{1}{2}(\widetilde{\Pi} - \Pi_P) = \frac{1}{2}(\widetilde{\Pi} - \Pi_P)$.

(3) Let $\Pi_P = 2\overline{\Pi} - \widetilde{\Pi}$ in the above equilibrium. Each retailer gets $\frac{1}{2}[\widetilde{\Pi} - (2\overline{\Pi} - \widetilde{\Pi})] = \widetilde{\Pi} - \overline{\Pi}$. By (1), there is no other equilibrium where both retailers get a strictly higher payoff. Therefore this equilibrium is coalition-proof, and every other coalition proof equilibrium is payoff-equivalent to this one.■

The contracts considered in the second part of the proof (eq. (3)) feature a fixed component (slotting allowance) that is contingent on whether the producer also serves the other retailer. Rey *et al* (2006) also consider payment schedules contingent on exclusivity, although they assume that retailers, rather than the producer, choose quantities. They show that allowing for "conditional three-part tariffs" it is possible to attain in equilibrium the industry monopoly profit.

The equilibrium strategy profile put forward in part (3) of the proof above is an example of "truthful equilibrium" in the sense of Bernheim and Whinston (1986), who work in a more abstract framework. Bernheim and Whinston show that all truthful equilibria are efficient and coalition-proof, and that coalition-proof equilibrium payoffs can be implemented by truthful equilibria. A similar result holds for the negotiation stage of our model. The specific structure of our "menu auction" allows us to obtain uniqueness of coalition-proof equilibrium payoffs.[14] The equilibria of part (2) of the proof are efficient and "locally truthful" (Grossman and Helpman, 1994). In these equilibria the producer cannot fully appropriate the gross surplus $\widetilde{\Pi}$ and therefore in the quality choice stage they typically give rise to a form of the hold-up problem, although not as severe as with the marginal-contribution equilibrium payoff selected by the coalition-proofness criterion. From now on we apply the coalition-proofness criterion.

Next we consider a structural specification of the revenue and cost functions, and solve the model backward.

3 Downstream firms's rivalry and quality choice

In this Section we analyze quality choice in various market settings, that are characterized by different levels of rivalry of the downstream firms when bargaining with the producer. The main features of the model are the impact of quality on demand and costs and the channels through which rivalry in the bargaining stage depends on market and technology fundamentals. More specifically, in our setting quality improvements entail sunk costs and enhance consumers' willingness to pay, while the degree of rivalry between retailers depends on final demand substitutability and the steepness of the marginal costs of production.

of the case in which the rivalry between the two downstream firms (retailers) arises on the demand side, since the they operate in the same final market. We describe the model starting from the supply of the product and then moving to the demand for the good distributed by the two retailers.

Producer P supplies a single good, whose baseline quality is X_0. Quality improvements above the baseline level entail sunk costs according to the following expression:

$$I(X - X_0) = (X - X_0)^{\beta} \tag{4}$$

with $\beta > 1$, where X is the chosen quality. Variable costs of production are quadratic:

$$C(q) = \frac{q^2}{2k}. \tag{5}$$

[14] Bergeman and Välimäki (2003) show that, in the context of a common agency game, if there is a unique thruthful equilibrium outcome it coincides with the marginal contribution equilibrium.

where k is a parameter inversely related to decreasing returns to scale. The lower k, the steeper the marginal costs: we shall show later on that this implies a more intense rivalry of the retailers in the bargaining stage, when they compete for the productive resources of the supplier.

Moving to the demand side, the preferences of a representative consumer are described by the following utility function:

$$U(q_1, q_2, y) = X(q_1 + q_2) - \frac{1}{(1+\sigma)}\left[q_1^2 + q_2^2 + \frac{\sigma}{2}(q_1 + q_2)^2\right] + y \tag{6}$$

where q_1 and q_2 are the quantities of the good sold by the two retailers and y is the expenditure in the outside good.[15] It is evident from the expression above that the higher the quality X, the higher the utility from consumption of the good. Moreover, the sales of the good realized by the two retailers (q_1 and q_2) are (horizontally) differentiated, for instance due to different locations of the outlets. From this utility function we can derive the inverse demand functions:

$$p_i = X - \frac{1}{1+\sigma}(2q_i + \sigma(q_1 + q_2))$$

with $i = 1, 2$ and $\sigma \in [0, \infty]$. This latter parameter describes the degree of substitutability of the two retailers. If $\sigma = 0$, they operate in independent markets, i.e. there is no substitution between the two sales. Conversely, if $\sigma \to \infty$, the final consumers view the two goods as perfectly homogeneous. A convenient property of this demand system is that, for given prices and quality, aggregate demand and consumers' surplus do not vary with the degree of substitutability σ. To show this, the demand functions are:

$$q_i = \frac{1}{2}\left[X - p_i(1+\sigma) + \frac{\sigma}{2}(p_1 + p_2)\right]$$

for $i = 1, 2$. Aggregate demand, therefore, is equal to:

$$q_1 + q_2 = X - \frac{1}{2}(p_1 + p_2)$$

and is independent of σ. In other words, for given prices the dimension of the final market (and the consumers' and total surplus) does not depend on the differentiation of the two retailers. The parameter σ, therefore, can be interpreted as a pure measure of the rivalry between the two retailers in the bargaining process with the

[15] This utility function is due to Shubik and Levitan (1980). Demand functions derived from it display some desirable properties (see following discussion).

supplier: when we shall apply Proposition 1 to this model, it will turn out that σ influences only the allocation of surplus between the producer and the retailers, but not total surplus. If $\sigma = 0$, rivalry is nil, while the case $\sigma \to \infty$ corresponds to maximum rivalry of the two retailers.

In order to apply Proposition 1 we now turn to computing total gross profits $\widetilde{\Pi}$ when both retailers are active, and gross profits $\overline{\Pi}$ when only one retailer serves the final market. $\widetilde{\Pi}$ is obtained by solving the following program:

$$\max_{q_1,q_2} \left\{ \left[X - \frac{1}{1+\sigma} \left(2q_1 + \sigma(q_1+q_2)\right) \right] q_1 + \left[X - \frac{1}{1+\sigma} \left(2q_2 + \sigma(q_1+q_2)\right) \right] q_2 - \frac{(q_1+q_2)^2}{2k} \right\}$$

The FOC's :

$$\frac{\partial \Pi}{\partial q_i} = X - \frac{1}{1+\sigma} \left(2q_i + \sigma(q_i+q_j)\right) - \frac{2+\sigma}{1+\sigma} q_i - \frac{\sigma}{1+\sigma} q_j - \frac{q_i+q_j}{k} = 0$$

for $i, j = 1, 2$, $i \neq j$, yield:

$$q_1 = q_2 = \frac{kX}{2(1+2k)}$$
$$\Pi(q_1, q_2) = X^2 \frac{k}{2(1+2k)} \equiv \widetilde{\Pi}$$

Note that $\widetilde{\Pi}$ is increasing in X and in k.

The gross profits when only one retailer is active, $\overline{\Pi}$, is obtained from:

$$\max_{qi} \left\{ \left(X - \frac{1}{1+\sigma} (2q_i + \sigma q_i) \right) q_i - \frac{(q_i)^2}{2k} \right\}$$

The FOC is given by:

$$-\frac{1}{k(\sigma+1)} \left(q_i + 4kq_i + \sigma q_i - Xk - Xk\sigma + 2k\sigma q_i\right) = 0$$

Hence,

$$q_i = \frac{Xk(1+\sigma)}{4k + \sigma + 2k\sigma + 1}$$

and

$$\overline{\Pi} = \frac{1}{2} \frac{X^2 k (\sigma+1)}{4k + \sigma + 2k\sigma + 1}.$$

According to Proposition 1, the producer's profit (gross of the cost of the investment in quality) is given by:

$$
\begin{aligned}
\Pi_P &= 2\overline{\Pi} - \widetilde{\Pi} = 2\left(\frac{1}{2}\frac{X^2 k\,(\sigma+1)}{4k+\sigma+2k\sigma+1}\right) - X^2\frac{k}{4k+2} \\
&= \frac{1}{2}X^2 k \frac{\sigma+2k\sigma+1}{(2k+1)\,(4k+\sigma+2k\sigma+1)} \\
&= \widetilde{\Pi}\cdot\alpha_P
\end{aligned}
$$

where

$$
\alpha_P = \frac{\sigma+2k\sigma+1}{4k+\sigma+2k\sigma+1}
$$

is the producer's share of total profits $\widetilde{\Pi}$. The retailer's profits are:

$$
\begin{aligned}
\Pi_{D_i} &= \widetilde{\Pi} - \overline{\Pi} = X^2\frac{k}{2(1+2k)} - \frac{1}{2}\frac{X^2 k\,(\sigma+1)}{4k+\sigma+2k\sigma+1} \\
&= \widetilde{\Pi}\cdot(1-\alpha_P)/2
\end{aligned}
$$

The producer's share of total profits is increasing in σ and decreasing in k :

$$
\begin{aligned}
\frac{\partial\alpha_p}{\partial\sigma} &= \frac{4k(1+2k)}{(4k+\sigma+2k\sigma+1)^2} > 0 \\
\frac{\partial\alpha_p}{\partial k} &= \frac{-4(\sigma+1)}{(4k+\sigma+2k\sigma+1)^2} < 0.
\end{aligned}
$$

This result allows to understand how the demand substitutability and the steepness of the marginal cost influence the bargaining outcome. Remind that each retailer will obtain in equilibrium, as the outcome of the bargaining process, the incremental profits that are generated by moving from one to two retailers, i.e. its contribution to the creation of the overall profits. Marginal contributions, in turn, depend on both the demand substitutability parameter σ and the decreasing return parameter k.

When the degree of differentiation between the two retailers decreases (i.e. σ increases), the incremental profits generated by each individual retailer fall, reducing the share of total profits that can be kept in equilibrium. In the limit, with perfectly homogeneous retailers ($\sigma \to \infty$), all the surplus is captured by the producer. Notice that the decreasing contribution of each retailer to total profits as demand substitutability increases does not depend on the fact that horizontal rivalry in the final market increases, leading to lower prices and profits: the retailers, in fact, will adopt in any case efficient contracts, as proved in Proposition 1, that maintain the overall profits at the level of the vertically integrated solution. However, when the retailers are more similar (higher σ), each one is less essential in the creation of total profits, and each one can be replaced with minor losses by the rival.

Moving to the supply side rivalry channel, with increasing marginal costs the two retailers compete for the productive resources of the supplier. The marginal cost to produce and sell in one market, in fact, depends on the amount produced and sold in the other market. Hence, if a retailer increases its sales, it causes an increase in the marginal cost incurred to supply the other retailer, and therefore the marginal profits created by this latter. Hence, an expansion in one retailer's sales reduces the other retailer's ability to extract surplus from the producer in the bargaining stage. An increase in k, making the marginal cost flatter, reduces this "congestion" effect in production and therefore reduces the producer's share of total profits. In the limit, with flat marginal costs ($k \longrightarrow \infty$) the supply side rivalry channel vanishes.

We can now consider the optimal choice of quality by the producer in the initial stage:

$$\max_X \left[\alpha_P \widetilde{\Pi}(X) - (X - X_0)^\beta\right]$$

The FOC are given by:

$$\begin{aligned} \frac{\partial \Pi_P}{\partial X} &= \alpha_P \frac{\partial \widetilde{\Pi}(X)}{\partial X} - \beta (X - X_0)^{\beta - 1} = 0 \\ &= X \frac{k}{(2k+1)} \frac{\sigma + 2k\sigma + 1}{(4k + \sigma + 2k\sigma + 1)} - \beta (X - X_0)^{\beta - 1} = 0 \end{aligned} \tag{7}$$

A simple inspection of the maximization program by the producer reveals that, since $\alpha_P < 1$, the supplier will choose a level of quality lower than the one that maximizes total profits: this result reminds the well know hold-up and the associated distortions in the level of investment. The reduction in quality is more severe the lower the share of total profits α_P obtained by the producer, that is the lower the rivalry of retailers in the bargaining process. The following Proposition summarizes this result.

$$\max_{X,k} \left\{ \frac{kX^2}{2(2k+1)} - (X - X_0)^2 - rk \right\}$$

The FOCs are given by:

$$\begin{aligned}\frac{\partial \Pi(X,k)}{\partial X} &= \frac{kX}{2k+1} - 2(X - X_0) = 0\\ \frac{\partial \Pi(X,k)}{\partial k} &= \frac{X^2}{2}\frac{1}{(2k+1)^2} - r = 0\end{aligned}$$

Duopolistic retailers As we proved in the previous section, even in case of a duopoly in the downstream market the producer will be induced (through efficient contracts) to select the output that maximizes the profits of the vertical chain, that now, contrary to the previous case, operates through two retailers rather than one. Moreover, each retailer will obtain in equilibrium, as the outcome of the bargaining process, the incremental profits that are generated by moving from one to two retailers, i.e. its contribution to the creation of the overall profits. At time t_1, for given level of the investment A, the retailers and the producer obtain the following payoffs, sharing the total profits generated by the vertical chain:

$$\begin{aligned}\Pi_{D_i} &= \widetilde{\Pi} - \overline{\Pi} = \frac{(X_0 + A - c)^2}{4(\sigma+2)},\\ \Pi_P &= \widetilde{\Pi} - 2\left(\widetilde{\Pi} - \overline{\Pi}\right) = 2\overline{\Pi} - \widetilde{\Pi} = \frac{(X_0 + A - c)^2\,\sigma}{4\,(\sigma+2)} \geq 0.\end{aligned}$$

In other words, a more fragmented downstream market does not generate more horizontal competition in the final market, with lower prices and higher consumer surplus, but an increase in the vertical rivalry between the two retailers with respect to the producer. Comparing the monopolistic and duopolistic retail market cases, we observe a shift in the distribution of the overall profits to the benefit of the producer, that in the latter situation receives a positive gross profit.

The intensity of rivalry does not only depend on market structure (monopolistic *vs* duopolistic retail market), but also on the degree of substitutability of the two retailers, as captured by parameter σ. Let us define the share of overall profits obtained by each downstream firm as $\alpha_{D_i} = \Pi_{D_i}/\widetilde{\Pi}$ and the corresponding share of the producer as $\alpha_P = \Pi_P/\widetilde{\Pi}$. Substituting the corresponding expressions we obtain respectively $\alpha_{D_i} = \frac{1}{\sigma+2}$ and $\alpha_P = \frac{\sigma}{\sigma+2}$. When the degree of differentiation between the two retailers decreases (i.e. σ increases), the incremental profits generated by each individual retailer fall, reducing the share of total profits that can be kept in equilibrium. In the limit, with perfectly homogeneous retailers ($\sigma \to \infty$), all the surplus is captured by the producer. An opposite pattern arises when σ falls, inducing a higher and higher share captured by the retailers. Hence, different market structures and different substitutability allow us to treat the variation in rivalry and its effects on the allocation of total profits in a continuous way.

We are now in a position to analyze the choice of the investment A at time t_0. The producer anticipates the effects of an investment in quality improvements on its payoff, i.e. $\Pi_P - I(A)$ where $I(A) = A^\beta$ with $\beta > 2$, and it will choose A solving the following problem:

$$\max_{A \geq 0} \left[\frac{(X_0 + A - c)^2 \sigma}{4(\sigma + 2)} - A^\beta \right].$$

Note that a higher quality increases the gross profits and the sunk cost of the investment $I(A)$, while not affecting the share $\alpha_P = \frac{\sigma}{\sigma+2}$ of total profits obtained by the producer.

We can now establish the following result:

Proposition 2 ***(Quality improvements realized through a non recoverable investment.)***
(1) When the retail segment is consolidated or it is separated in two local monopolies ($\sigma = 0$) the producer does not invest and offers the base quality level X_0.
(2) If the retail segment is fragmented and there is substitutability between retailers ($\sigma > 0$), the producer offers a quality higher than the base level X_0. The equilibrium quality is increasing in the degree of substitutability between the retailers, σ.
(3) When $\sigma > 0$, the producer and the consumers are better off under a fragmented retail segment, and their payoffs are increasing in σ.
(4) For low values of σ also retailers are better off when the retail segment is fragmented.

Proof. See Appendix A. ■

The intuition of our results derives from the fact that with two independent retailers and at least some degree of rivalry between them ($\sigma > 0$) the bargaining power of each retailer is weakened and some profits are left to the producer. The hold-up problem is therefore mitigated with respect to the monopoly (or local monopolies - $\sigma = 0$) case and the producer is induced to invest in quality improvement. This effect is enhanced when rivalry between the retailers (σ) increases. Since with efficient contracts the level of output is always at the (integrated) monopoly level, the effect on consumer surplus does not come from reduced prices. However, the improvements in quality benefit consumers, that are better off when there is some rivalry between the retailers.

Instead, in a fragmented structure the impact of an increase in σ on the retailers' aggregate profits is twofold. On the one hand, by increasing rivalry, it reduces the share of the overall profits that is appropriated by the retailers. On the other hand, it strenghtens the incentives of the producer to invest in quality, thereby increasing the overall profits of the vertical chain. It can be shown that under our assumptions on the cost of quality improvements, for low values of σ the second effect prevails.

The following example illustrates the non-monotonic impact of the substitutability parameter σ on retailers' profits.

Example 1 *Let us consider the following values of the relevant parameters:* $\beta = 3$, $X_0 = 1$, $c = 0$. *The optimal investment in quality is given by the first order condition:*

$$\frac{(A+1)\,\sigma}{2\,(\sigma+2)} - 3A^2 = 0$$

that yields $A^* = \frac{\sigma+\sqrt{48\sigma+25\sigma^2}}{12(\sigma+2)}$. *Retailers joint profits are therefore:*

$$\Pi^{*s}_{D_i} = \frac{(1+A^*)^2}{2(\sigma+2)} = \frac{\left(13\sigma+\sqrt{48\sigma+25\sigma^2}+24\right)^2}{288\,(\sigma+2)^3}$$

Figure 1 shows the retailers joint profits as a function of the degree of rivalry σ*, that are characterized by the non monotonic pattern described, and compares it with the profits of a consolidated retail industry.*

In the next section we will show that the results obtained are robust to different specifications of the impact of quality improvements on costs, and of a different channel of rivalry between retailers.

3.1 Intermediate inputs to improve quality

We turn now to the complementary case in which quality improvements can be obtained by using superior intermediate inputs or raw materials, that imply higher marginal costs. The quality of the good is given by:

$$X = X_0 + \sqrt{M}$$

($a = 0$ and $m = 1$ in Eq. (**??**)) and total costs to produce output q are:

$$C(q; M) = (c+M)q.$$

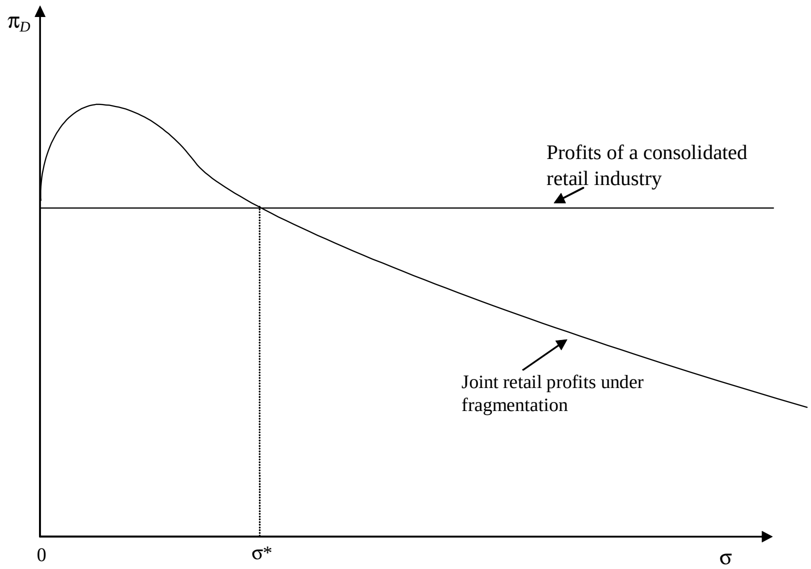

Figure 1: *Retailers' profits as a funtion of σ. Comparison between a consolidated and a fragmented market structure.*

Hence, higher quality implies higher marginal costs, that continue to be flat in quantity.

Given M, and therefore X, the efficient quantities and the associated profit of the vertical chain when both retailers supply the final market are, respectively:

$$q_1^* = q_2^* = \widetilde{q} = \begin{cases} \frac{X_0+\sqrt{M}-c-M}{4} & \text{if } X_0+\sqrt{M}-c-M>0 \\ 0 & \text{otherwise} \end{cases}$$

$$\widetilde{\Pi} = \begin{cases} \frac{\left(X_0+\sqrt{M}-c-M\right)^2}{4} & \text{if } X_0+\sqrt{M}-c-M>0 \\ 0 & \text{otherwise} \end{cases}$$

If, instead, only one retailer serves the final market the corresponding efficient quantities and profits are:

$$\overline{q} = \begin{cases} \frac{(X_0+\sqrt{M}-c-M)(1+\sigma)}{2(2+\sigma)} & \text{if } X_0+\sqrt{M}-c-M>0 \\ 0 & \text{otherwise} \end{cases}$$

$$\overline{\Pi} = \begin{cases} \frac{(X_0+\sqrt{M}-c-M)^2(1+\sigma)}{4(2+\sigma)} & \text{if } X_0+\sqrt{M}-c-M>0 \\ 0 & \text{otherwise} \end{cases}$$

These levels of profits allow us to identify the profits of the producer and retailers as determined by the bargaining process, and to study the choice of the quality level in the first stage. As in the previous section, we compare the equilibrium quality and payoffs in case of a consolidated or fragmented retail segment, and we further argue on the effect of increasing rivalry.

Consolidated retailer Since quality improvements affect only the variable costs and the monopolistic retailer obtains the entire surplus of the vertical chain, at time t_0 the producer is indifferent as to the level of the variable $M \geq 0$. This result is, however, due to the extreme assumption that quality improvements do not entail any sunk investment. We slightly relax this hypothesis, assuming that enhancing quality at any level above X_0 requires a (small) sunk cost. Therefore the producer will select the base level of quality setting $M^* = 0$. Hence, in the case of a consolidated retailer the hold-up problem works as in the previous case.[16]

Fragmented retailers We turn now to the case of a fragmented retail segment where two agents operate. At time t_1, for a given choice of M, the retailers and the producer split the overall profits as follows:

$$\Pi_{D_i} = \widetilde{\Pi} - \overline{\Pi} = \begin{cases} \frac{\left(X_0+\sqrt{M}-c-M\right)^2}{4(\sigma+2)} & \text{if } X_0 + \sqrt{M} - c - M > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$\Pi_P = 2\overline{\Pi} - \widetilde{\Pi} = \begin{cases} \frac{\left(X_0+\sqrt{M}-c-M\right)^2\sigma}{4(\sigma+2)} & \text{if } X_0 + \sqrt{M} - c - M > 0 \\ 0 & \text{otherwise} \end{cases}$$

Hence, at time t_0 the producer chooses M to maximize Π_P. The following Proposition summarises the main findings, which are quite consistent with the one obtained in the previous case, when quality improvements were realized through sunk investments.

Proposition 3 ***(Quality improvements realized through more valuable inputs.)***
(1) When the retail segment is consolidated or it is separated in two local monopolies ($\sigma = 0$) the producer supplies the base quality level ($M^* = 0$).
(2) If the retail segment is fragmented and there is substitutability between retailers ($\sigma > 0$) the producer offers a quality larger than the base level ($M^* = \frac{1}{4}$).

[16] Notice that here we are simply introducing a small sunk cost that is the same for any quality above the base level. In the previous section, instead, the sunk cost was increasing in the level of quality, being determined by investments in R&D or advertising.

(3) When $\sigma > 0$ the producer and the consumers are better off under a fragmented retail segment. The producer's profits are increasing in σ, while consumers' surplus is invariant to σ.
(4) For low values of σ also retailers are better off when the retail segment is fragmented.

Proof. See Appendix A. ■

4 Rivalry of retailers on the supply side

This Section shows that our results extend to the case where rivalry between retailers is indirect, and determined by the existence of increasing marginal cost at the manufacturing stage.

We assume that retailers operate in independent downstream markets. Hence, in each market the inverse demand function (for given quality X) is given by:

$$p_i = X - 2q_i \tag{8}$$

with $i = 1, 2$.

We maintain the same assumptions of Section 3 about the technology of quality improvements: $X = X_0 + aA + m\sqrt{M}$ with $a, m \geq 0$, and the fixed sunk costs are given by $I(A) = A^\beta$ with $\beta > 2$.

However, we now assume that the cost function of the upstream firm exhibits *increasing marginal costs.* Specifically, for given level of M, the total cost to produce output q is given by:

$$C(q; M) = (c + M)q + \frac{\mu}{2}q^2. \tag{9}$$

We assume that $X_0 > c$ and $\mu > 0$.

As the analysis below will clarify, the assumption of increasing marginal costs allows to introduce a form of rivalry between the two retailers even in the presence of downstream markets which are completely independent from the final consumers' perspective.

In what follows we present the main results for the case when quality is improved through R&D or advertising (Section 4.1) and for the case when quality is improved using more expensive inputs (Section 4.2). Since the analysis follows the same logic as in Section 3, the presentation of results will be synthetic.

4.1 Sunk investment to improve quality

When the producer can improve the quality of the good (above the base level) only through the activity A, the quality of the good is given by:

$$X = X_0 + A$$

(obtained setting $a = 1$ and $m = 0$ in expression (**??**)) and the total costs to produce the quantity q amount to:

$$C(q) = cq + \frac{\mu}{2} q^2.$$

The maximum profit of the vertical chain (gross of the sunk investments) when the good is distributed by both retailers (10) and when it is distributed by one retailer (11) are given, respectively, by:

$$\widetilde{\Pi} = \frac{(X_0 + A - c)^2}{2(2 + \mu)} \tag{10}$$

$$\overline{\Pi} = \frac{(X_0 + A - c)^2}{2(4 + \mu)} \tag{11}$$

Consolidated retailer In the negotiation with the supplier, the retail chain obtains the entire profit of the vertical structure . Hence, at time t_0 the supplier decides not to invest ($A^* = 0$) and quality remains at the base level X_0.

Fragmented Retailers As we proved in Section 2.1, when retailing is fragmented, at time t_1 total surplus is shared in the following way (for a given A):

$$\begin{aligned} \Pi_{D_i} &= \widetilde{\Pi} - \overline{\Pi} = \frac{(X_0 + A - c)^2}{(4 + \mu)(2 + \mu)} \\ \Pi_P &= 2\overline{\Pi} - \widetilde{\Pi} = \frac{(X_0 + A - c)^2 \mu}{2(2 + \mu)(\mu + 4)} \end{aligned}$$

Hence, each retailer extracts a share $\alpha_{D_i} = \frac{2}{(4+\mu)}$ of the total surplus from the negotiation with the supplier; the supplier extracts a share $\alpha_P = \frac{\mu}{(4+\mu)}$.

This implies that, when $\mu > 0$, the supplier appropriates a positive share of total surplus, even though retailers operate in independent markets and make "take-it-or-leave-it" offers. This is due to the assumption of *increasing marginal costs* at the production level. The marginal cost to produce and sell in a market depends on the amount produced and sold in the other market. Hence, if a retailer increases sales in its market, it causes an increase in the marginal cost incurred to supply the other market, thereby reducing the other retailer's ability to extract surplus from the producer. Differently stated, the assumption of increasing marginal costs allows to maintain a key feature of the analysis, i.e. the existence of *rivalry between retailers in the negotiation with the supplier.* Therefore, the parameter μ - which measures the slope of the marginal cost function - captures the degree of rivalry between retailers. If $\mu = 0$, marginal costs are constant and there exists no rivalry (neither indirect) between retailers: they entirely absorb the total surplus from the negotiation ($\alpha_{D_i} = 1/2$ and $\alpha_P = 0$). As μ increases, marginal costs become steeper and rivalry between retailers intensifies. Thus, the share of total surplus they appropriate decreases, while the producer's share increases. If $\mu \to \infty$, rivalry between retailers is maximum and the supplier appropriates the entire surplus from the negotiation ($lim_{\mu \to \infty} \alpha_P = 1,\ lim_{\mu \to \infty} \alpha_{D_i} = 0$).

At time t_0, the producer chooses $A \geq 0$ solving the following problem:

$$\max_A \left[\frac{(X_0 + A - c)^2 \mu}{2(\mu + 2)(\mu + 4)} - A^\beta \right]$$

The following Proposition summarizes the main results obtained when rivalry is determined by supply conditions and shows that they are consistent with the ones obtained under demand rivalry.

Proposition 4 ***(Quality improvements realized through a non recoverable investment.)***
(1) When the retail segment is consolidated or it is fragmented and the producer's marginal costs are constant ($\mu = 0$), the producer does not invest and offers the base quality X_0.
(2) When the retail segment is fragmented and the producer's marginal costs are increasing ($\mu > 0$), the producer offers a quality higher than the base level. The equilibrium quantity is increasing in μ if (and only if) μ is sufficiently low.
(3) When $\mu > 0$, the producer and the consumers are better off under a fragmented retail segment.
(4) For low values of μ, also retailers are better off under a fragmented retail segment.

Proof. See Appendix A. ■

Note that in this case the equilibrium quality is not monotonically increasing in μ. The reason is that an increase in μ exerts two effect. On the one hand it intensifies rivalry between retailers and increases the share of total profits appropriated by the supplier, strengthening the incentives to invest. On the other hand, it shifts upward the marginal cost function. This reduces total surplus and weakens the incentives to invest. The former effect is stronger when μ is sufficiently low. The twofold effect played by an increase in μ explains why in this specification of the model the producer and the consumers' equilibrium payoffs are not monotonically increasing in μ. However, when the downstream market is fragmented and there exists some rivalry between the retailers (i.e. $\mu > 0$) both the producer and the consumers are better off with respect to the case of a consolidated retail sector.

Similarly to the previous Section, the effect of an increase in μ on the retailers' aggregate profits is ambiguous in general. For low values of μ the increase of aggregate profits dominates the reduction of the retailers' share, so that also the profits of the retail segment are larger under fragmentation. This is illustrated by the following numerical example.

Example 2 *Let us consider the following values of the relevant parameters:* $\beta = 3$, $X_0 = 1$, $c = 0$. *The optimal investment in quality is given by:*

$$\frac{(A+1)\,\mu}{(4+\mu)\,(\mu+2)} - 3A^2 = 0$$

that, once solves, gives $A^* = \frac{\mu+\sqrt{96\mu+73\mu^2+12\mu^3}}{2(18\mu+3\mu^2+24)}$. *Retailers joint payoff are therefore:*

$$\Pi_D^{*f} = \frac{\left(37\mu + 6\mu^2 + \sqrt{96\mu + 73\mu^2 + 12\mu^3} + 48\right)^2}{18\,(\mu+4)^3\,(\mu+2)^3}$$

Figure 2 shows that retailers joint profits as a function of μ, *that are characterized by the non monotonic pattern discussed above, and compares it with the profits of a consolidated retail sector. Since an increase in* μ *increases marginal costs thereby reducing total surplus, also the profits of the retail segment under a consolidated market structure are decreasing in* μ.

4.2 Intermediate inputs to improve quality

Let us consider the case where quality improvements are achieved by using more valuable inputs. The quality of the good is given by:

$$X = X_0 + \sqrt{M}$$

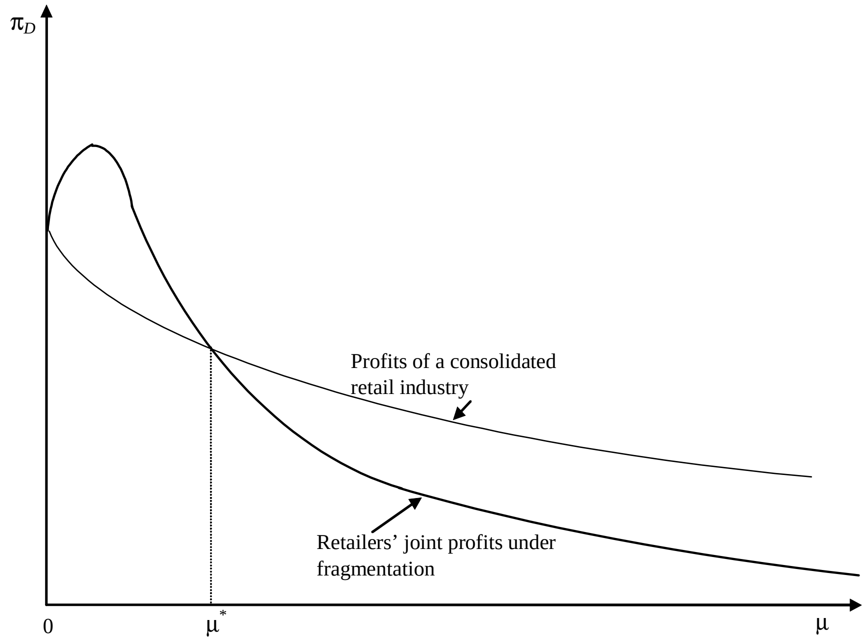

Figure 2: *Retailers' profits as a funtion of μ. Comparison between a consolidated and a fragmented market structure.*

($a = 0$ and $m = 1$ in expression (**??**)) and total costs to produce output q are given by:

$$C(q; M) = (c + M)q + \frac{\mu}{2}q^2.$$

Given M and thus X, the efficient quantities and the associated profits of the vertical chain when the good is distributed by both retailers are given by:

$$q_1^* = q_2^* = \widetilde{q} = \begin{cases} \frac{X_0+\sqrt{M}-c-M}{2(\mu+2)} & \text{if } X_0 + \sqrt{M} - c - M > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$\widetilde{\Pi} = \begin{cases} \frac{\left(X_0+\sqrt{M}-c-M\right)^2}{2(\mu+2)} & \text{if } X_0 + \sqrt{M} - c - M > 0 \\ 0 & \text{otherwise} \end{cases}$$

If one retailer only distributes the good, the efficient quantity and the associated profits amount to:

$$\overline{q} = \begin{cases} \frac{(X_0+\sqrt{M}-c-M)}{(4+\mu)} & \text{if } X_0+\sqrt{M}-c-M>0 \\ 0 & \text{otherwise} \end{cases}$$

$$\overline{\Pi} = \begin{cases} \frac{(X_0+\sqrt{M}-c-M)^2}{2(4+\mu)} & \text{if } X_0+\sqrt{M}-c-M>0 \\ 0 & \text{otherwise} \end{cases}$$

We now study the choice of quality and the equilibrium payoffs under a consolidated and a fragmented retail segment.

Consolidated retailer The analysis is very similar to the one developed in Section 3.1. By assuming that improving quality at any level above X_0 requires a (small) sunk cost, the producer chooses not to improve quality and sets $M^* = 0$.

Fragmented retailers At time t_1, for a given M, the retailers and the producer share total surplus in the following way:

$$\Pi_{D_i} = \begin{cases} \frac{\left(X_0+\sqrt{M}-c-M\right)^2}{(4+\mu)(\mu+2)} & \text{if } X_0+\sqrt{M}-c-M>0 \\ 0 & \text{otherwise} \end{cases}$$

$$\Pi_P = \begin{cases} \frac{\left(X_0+\sqrt{M}-c-M\right)^2\mu}{2(\mu+2)(\mu+4)} & \text{if } X_0+\sqrt{M}-c-M>0 \\ 0 & \text{otherwise} \end{cases}$$

At time t_0 the producer chooses the level of M in order to solve the problem

$$\max_M \Pi_P.$$

We obtain a set of results consistent with the findings of the previous sections, and summarized by the following Proposition:

Proposition 5 ***(Quality improvements realized using more valuable inputs.)***
(1) When the retail segment is consolidated or it is fragmented and the producer's marginal costs are constant ($\mu = 0$), the producer offers the base quality X_0.
(2) When the retail segment is fragmented and the producer's marginal costs are increasing ($\mu > 0$), the producer chooses a quality above the base level ($M^* = 1/4$).
(3) When $\mu > 0$, the producer and the consumers are better off under a fragmented retail segment.

(4) Also retailers are better off under a fragmented retail segment is μ is sufficiently low.

Proof. See Appendix A. ■

Also in this case an increase in μ exerts a twofold effect. On the one hand it increases marginal costs and reduces total surplus. On the other hand is intensifies rivalry among retailers and increases the share appropriated by the producer. When μ is sufficiently low the latter effect prevails so that the producer's payoff is increasing in μ for low values of μ. Instead, both effects are detrimental for the retailers, whose payoff is decreasing in μ.

5 Long-Term Relationship between Producer and Retailers

So far we did not analyze the possibility to mitigate the hold-up problem by means of self-enforcing agreements. In this section we analize a model of repeated interaction between a producer and two retailers preceded by an ex ante quality choice. We adapt and apply a rather general result about the multiplicity of equilibria in repeated agency games[17] to show that under mild assumptions repeated interaction can provide appropriate incentives for ex ante non-contractible investments and that this is consistent with a wide range of distributions of the surplus.

But first we note that, if one is willing to give up coalition-proofness in the "static" setting analyzed in the previous sections, the multiplicity result of Proposition 1 (2) can be used to mitigate the hold-up problem by letting P's continuation equilibrium share of the gross surplus depend on the quality choice. However, by Proposition 1 (1) the upper bound on P's gross surplus in subgame perfect equilibrium is $\overline{\Pi}(X)$, less than the maximum gross surplus $\widetilde{\Pi}(X)$. This implies that it may be impossible to provide the producer with credible and effective incentives inducing the efficient qualitity choice. In particular, the efficient quality choice of the static model, $X^* = \arg\max_{X_0 \geq 0} \widetilde{\Pi}(X) - I(X - X_0)$, is not implementable in subgame perfect equilibrium if $\overline{\Pi}(X^*) - I(X^* - X_0) < 0$, because in this case P is better off choosing X_0 rather than X^*, as X_0 guarantees a non-negative net profit.[18,19]

[17] The techniques are borrowed from Battigalli and Maggi (2004) who in turn adapt arguments from Abreu (1988).

[18] Choosing X_0 the producer incurs no sunk costs and obtains a continuation equilibrum profit larger o equal to $2\overline{\Pi}(X_0) - \widetilde{\Pi}(X_0) \geq 0$.

[19] We note that, in the specific model analyzed in Section 3, X^* can be implemented for a

We consider a dynamic game where first a producer P makes a non contractible quality choice $X \geq X_0$, incurring a sunk cost $I(X - X_0)$, and then it plays repeatedly the sequential game described in Section **??** with retailers D_1 and D_2. The game has infinite horizon and discount factor δ which comprises a fixed conditional probability of termination of the relationship. Thus, letting $\Pi_i(t, X)$ denote the flow payoff of player i at time t given X, the (expected) present discounted values for P and D_i are, respectively,

$$\sum_{t=1}^{\infty} \delta^t \Pi_P(t, X) - I(X - X_0),$$

$$\sum_{t=1}^{\infty} \delta^t \Pi_{D_i}(t, X).$$

We assume that (i) $\widetilde{\Pi}(\cdot)$ and $I(\cdot)$ are increasing and continuous, (ii) $I(0) = 0$, and (iii) the efficient quality choice exists and is unique:

$$X^* = \arg\max_{X \geq X_0} \frac{\delta}{1-\delta} \widetilde{\Pi}(X) - I(X - X_0).$$

We first show that, if the discount factor is high enough, for every quality choice X there is a multiplicity of equilibria of the ensuing infinitely repeated game, which allows to support any division of the surplus. Since the repeated game equilibrium (and the associated payoff distribution) can be selected as a function of X, it is then easy to show that it is possible to induce the efficient quality choice X^* as a subgame perfect equilibrium outcome.

Lemma 1 *If $\delta \geq \frac{1}{2}$, any division of the (gross) surplus $\widetilde{\Pi}(X)$ can be supported by a subgame perfect equilibrium of the repeated sequential game that obtains after the quality choice stage.*

Proof. See Appendix C. ■

The intuition is as follows. Suppose the players want to implement an efficient allocation $(\Pi_P(X), \Pi_{D_1}(X), \Pi_{D_2}(X))$ in each period. This can be achieved by adapting to our sequential setting the "optimal-penal-code" approach of Abreu (1986): whenever a firm deviates from the equilibrium path, or from a punishment path, it triggers an equilibrium punishment phase where it receives its maxmin

wide range of parameters. But, as pointed out in the text, in general one cannot guarantee that the "participation constraint" of P is satisfied at X^*. For example, one can find nonconvex investment cost functions $I(\cdot)$ that make X^* non-implementable due to the violation of this constraint.

payoff (zero). Since the retailers have a first-mover advantage in the stage game, punishing retailers after a deviation may be difficult. We consider strategies that punish retailers by allocating all the surplus to the producer (even if only one of them has deviated). This entails rejection by P of any offer that does not allocate all the surplus $\widetilde{\Pi}(X)$ to P. But with high discounting (δ small) P would also accept offers that give it a small share of the surplus. Suppose that the retailers offers are such that P obtains $\widetilde{\Pi}(X)-\varepsilon$.[20] According to the equilibrium strategies P should reject, yielding zero profits (to all players) in the current period, but making P receive the whole surplus $\widetilde{\Pi}(X)$ in all future periods. On the other hand, if P accepts it will be punished from the next period. Therefore P rejects only if $\frac{\delta}{1-\delta}\widetilde{\Pi}(X) \geq \widetilde{\Pi}(X)-\varepsilon$, where ε can be arbitrarily small. This explains the condition $\delta \geq \frac{1}{2}$.

We can now prove the main result of this section:

Proposition 6 *If $\delta \geq \frac{1}{2}$, for all $\Pi_D \in \left[0, \widetilde{\Pi}(X^*) - \frac{1-\delta}{\delta} I(X^* - X_0)\right)$ there exists a subgame perfect equilibrium of the whole game implementing the efficient quality choice X^* and such that retailers' aggregate istantaneous profit is Π_D.*

Proof. By Lemma 1, for each X and $\Pi_P \in [0, \widetilde{\Pi}(X)]$ there is an equilibrium of the repeated game such that the gross istantaneous profit of P is Π_P and the aggregate istantaneous profit of retailers is $\Pi_D = \Pi_{D_1} + \Pi_{D_2} = (\widetilde{\Pi}(X) - \Pi_P) \geq 0$. Therefore it is possible to implement in equilibrium the following istantaneous gross profit function for P:

$$\Pi_P(X) = \max\{0, \widetilde{\Pi}(X) - \Pi_D\}.$$

Then, in period 0, P chooses quality to solve the problem

$$\max_{X \geq X_0} \left[\Pi_P(X) - \frac{1-\delta}{\delta} I(X - X_0)\right].$$

$\Pi_D < \widetilde{\Pi}(X^*)$ implies (by continuity) that in a neighborhood of X^* the net (long-run average) payoff of P is

$$\Pi_P(X) - \frac{1-\delta}{\delta} I(X - X_0) = \widetilde{\Pi}(X) - \frac{1-\delta}{\delta} I(X - X_0) - \Pi_D$$

[20] For example, on the retailers' punishment path each retailer D_i is supposed to offer the contract $t_i(q_1, q_2) = R_i(q_1, q_2)$, but -say - D_1 may deviate and offer $t_1(q_1, q_2) = R_1(q_1, q_2) - \varepsilon$. The resulting distribution if P accepts (and then chooses (q_1, q_2) optimally) is $(\widetilde{\Pi}(X) - \varepsilon, \varepsilon, 0)$.

and X^* is a local maximum. Since we assume $\Pi_D < \widetilde{\Pi}(X^*) - \frac{1-\delta}{\delta} I(X^* - X_0)$, it follows that X^* yields a strictly positive payoff to P and hence it is also the global maximum.■

We may interpret Proposition 6 as follows. Producer and retailers realize that they can use the multiplicity of subgame perfect equilibria of the repeated game to enforce agreements that maximize the present value of the surplus. How the gains from trade are split depends on the "bargaining power" of the parties before the producer sinks quality-improving investments. Proposition 6 shows that a large set of distributions of the long-run surplus are consistent with implementing the efficient quality choice. The producer can guarantee a non-negative payoff by not investing in quality improvements (recall that $I(0) = 0$). This implies a "participation constraint" that bounds from above the share of the retailers.

6 Concluding Remarks

In this paper we have analyzed the producer-retailer relationship and the effects of buyer power on the incentives of producers to invest in quality improvements. Buyer power of the retailers has been modelled as depending on downstream market concentration and some relevant features of demand and supply that affect retailers' rivalry when dealing with the upstream supplier.

Contrary to most of the literature on this issue we did not adopt a cooperative solution to analyze the negotiation of retailers and producers; rather, we explicitly model a bargaining protocol in a non cooperative setting. The retailer(s) makes a take it or leave it offer to the producer proposing a contract with no a priori restrictions on its form. The equilibrium contracts always entail the implementation of the efficient outcome, i.e. the one that would arise in case of a consolidated vertical chain. Moreover, in equilibrium each retailer appropriates a fraction of total industry profits corresponding to its marginal contribution to total surplus, that is the increase in industry profits when one more retailer is supplied.

When the retail market is a monopoly, therefore, the downstream firm appropriates the entire surplus, being essential to the realization of industry profits. With a duopoly retail market, instead, the profits left to the producer are an increasing function of the rivalry between retailers when negotiating with the upstream supplier. We consider a demand and a supply channel that influence retailers' rivalry.

When the two downstream firms offer a homogeneus sales service, each one is completely substitutable for delivering the goods to the customers and its marginal contribution to industry profits is nil: in this case all the surplus goes to the producer. At the other extreme, when the two retailers operate in completely separated markets (maximum differentiation), each one is responsible for half of the industry profits and the producer receives nothing.

This result provides a new insight on the effect of private labels, i.e. products sold under a retailer's own brand. It is well recognized that the offer of private labels makes a retailer a stronger bargainer when negotiating with a major supplier (national brand producer) by reducing the cost of delisting the national brand. We identify a different channel through which private labels affect this negotiation. A specific feature of private labels is that each retailer has exclusive right over the own product. As a result, the introduction of private labels contributes to differentiate rival retail chains, thereby increasing their marginal contribution and improving their bargaining position with respect to the national brands' manufacturers.

The supply channel, instead, works through decreasing returns in production, that in a sense make the two retailers competing for a scarce input at the production stage. The steeper the marginal costs, the lower the marginal contribution of each retailer to total surplus, because an expansion of a retailer increases the marginal cost for supplying the other, reducing industry profits. The more intense rivalry, again, leads to a higher share of surplus left to the producer.

Once highlighted the features of negotiation on the formation and distribution of industry profits, we consider the effects on the incentives of the producer to invest in quality improvement. Since in our setting quality is non contractible, the interaction of retailers and producer is open to the hold up problem. In fact, the incentive to initially invest in quality improvements depends on the fraction of total profits that in equilibrium is left to the producer. Notice that quality improvements are the only source of an increase in consumers' surplus, since in any equilibrium allocation the efficient solution (vertical integration) is implemented. In other words, more rivalry between retailers does not lead to lower final prices, but makes industry profits higher and consumers better off through an increase in the quality of the good.

We show that an increase in rivalry, by boosting quality improvements and industry profits, may benefit not only consumers and the producer, that gets a larger fraction of profits, but also the retailers, that receive a smaller slice of a much bigger cake.

These results are robust to different ways in which quality can be increased, through fixed inputs (R&D or advertising) or variable inputs (more valuable intermediate inputs), as well as to different upstream market structures (one or two producers).

A Omitted Proofs

Proof of Proposition 2:

When the retail segment is consolidated, quality remains at the base level X_0. The equilibrium payoffs of the different agents are:

$$\Pi_P^{*c} = 0,$$
$$\Pi_D^{*c} = \widetilde{\Pi}(A=0) = \frac{(X_0-c)^2}{4},$$
$$U^{*c} = U(\widetilde{q},\widetilde{q}) - 2\widetilde{q}p(\widetilde{q}) = 2(\widetilde{q})^2 = \frac{(X_0-c)^2}{8}.$$

If $\sigma = 0$ the downstream market is perfectly segmented. This fact and the assumption of constant marginal cost imply that the marginal contribution of each retailer is just half of the inegrated monopoly profit ($\widetilde{\Pi} = 2\overline{\Pi}$), and the two retailers appropriate the entire surplus as in the case of a consolidated market structure. Hence, the producer has no reward from investing in quality and sets $A^* = 0$.

When $\sigma > 0$, the first and second derivatives of the producer's payoff are:

$$\frac{\partial \Pi_P}{\partial A} = \frac{(A+X_0-c)\,\sigma}{2\,(\sigma+2)} - \beta A^{\beta-1}$$
$$\frac{\partial^2 \Pi_P}{\partial^2 A} = \frac{\sigma}{2(\sigma+2)} - \beta\,(\beta-1)\,A^{\beta-2}$$

The second derivative is positive at $A = 0$, strictly decreasing in A (since $\beta > 2$) and tends to $-\infty$ when $A \to \infty$. Moreover, the first derivative is positive at $A = 0$ (since $X_0 > c$) and tends to $-\infty$ when $A \to \infty$. Hence we have a unique internal maximum $A^* = A^*(\sigma) > 0$ where $\frac{\partial \Pi_P}{\partial A} = 0$ and $\frac{\partial^2 \Pi_P}{\partial^2 A} < 0$. By inspection of the first order condition, $\lim_{\sigma \to 0} A^*(\sigma) = 0$. Since $\frac{dA^*}{d\sigma} = -\frac{\partial^2 \Pi_P}{\partial A \partial \sigma} / \frac{\partial^2 \Pi_P}{\partial^2 A}$ and

$$\frac{\partial^2 \Pi_P}{\partial A \partial \sigma} = \frac{A+X_0-c}{(\sigma+2)^2} > 0$$

the investment is increasing in the degree of substitutability between the retailers. The expressions of the producer's profits and of consumers' surplus are obtained by substitution:

$$\begin{aligned}\Pi_P^{*f}(\sigma) &= \frac{(X_0 + A^* - c)\,\sigma}{4(\sigma+2)} - A^{*\beta} > 0 \\ U^{*f}(\sigma) &= \frac{(X_0 + A^* - c)^2}{8}\end{aligned}$$

and the comparative statics with respect to σ immediately follows from $\frac{dA^*}{d\sigma} > 0$.

Let us consider the aggregate profits Π_D^{*f} of the retail segment:

$$\Pi_D^{*f}(\sigma) = \Pi_{D_1}^{*f} + \Pi_{D_2}^{*f} = \frac{2}{2+\sigma}\frac{(X_0 + A^* - c)^2}{4}.$$

Since $A^*(0) = 0$, we have

$$\Pi_D^{*f}(0) = \frac{(X_0 - c)^2}{4} = \Pi_D^{*c},$$

that is, the profits of the retail segment are the same under monopoly (c) and under a duopoly (f) with completely separate submarkets. Next note that $\lim_{\sigma\to 0}\frac{dA^*}{d\sigma} = +\infty$, because $\lim_{\sigma\to 0}\left.\frac{\partial^2\Pi_P}{\partial^2 A}\right|_{A=A^*(\sigma)} = 0$, therefore

$$\lim_{\sigma\to 0}\frac{\partial \Pi_D^{*f}}{\partial\sigma} = \frac{(X_0 - c)}{2+\sigma}\lim_{\sigma\to 0}\frac{dA^*}{d\sigma} = +\infty.$$

Moreover, $\lim_{\sigma\to\infty}\Pi_{D_i}^{*f} = 0$. Hence, the profits of the fragmented downstream segment are increasing in σ and larger than under consolidation when rivalry is very weak (σ small) while when rivalry is very intense the profits vanish.■

Proof of Proposistion 3:

If $\sigma = 0$, i.e. when the final duopoly is composed of two separate monopolistic submarkets, the profits of the producer are nil for any level of quality, and indifference can be broken assuming a small sunk cost to improve quality. Then the producer supplies the base quality level as in the case of a monopolistic retail segment.

When instead $\sigma > 0$, the producer obtains a positive profit and its problem is equivalent to $\max_{M\geq 0}(X_0 + \sqrt{M} - c - M)$ and the.optimal choice is $M^* = \frac{1}{4} > 0$.

The equilibrium profits of the agents are therefore:

$$\begin{aligned}
\Pi_P^{*f} &= \frac{\left(X_0+\frac{1}{4}-c\right)^2\sigma}{4\left(\sigma+2\right)} > 0 = \Pi_P^{*c}, \\
U^{*f} &= \frac{(X_0+\frac{1}{4}-c)^2}{8} > \frac{(X_0-c)^2}{8} = U^{*c}, \\
\Pi_{D_i}^{*f} &= \frac{\left(X_0+\frac{1}{4}-c\right)^2}{4(\sigma+2)} > \frac{(X_0-c)^2}{8} = \Pi_{D_i}^{*c} \quad \text{iff } \sigma < 2\left[\frac{(X_0+\frac{1}{4}-c)^2}{(X_0-c)^2}-1\right].
\end{aligned}$$

■

Proof of Proposition 4:

If $\mu = 0$, i.e. if marginal costs are constant, there exists no rivalry between retailers. As in the case of a consolidated retail segment the supplier does not invest in quality and $A^*(0) = 0$.

If $\mu > 0$, the first and second derivative of the producer's payoff are given by:

$$\begin{aligned}
\frac{\partial \Pi_P}{\partial A} &= \frac{(A+X_0-c)\,\mu}{(4+\mu)\,(\mu+2)} - \beta A^{\beta-1} \\
\frac{\partial^2 \Pi_P}{\partial^2 A} &= \frac{\mu}{(4+\mu)\,(\mu+2)} - \beta\,(\beta-1)\,A^{\beta-2}
\end{aligned}$$

The second derivative is positive at $A = 0$, strictly decreasing in A, and tends to $-\infty$ when $A \to \infty$. Moreover, the first derivative is positive in $A = 0$ and tends to $-\infty$ when $A \to \infty$. Hence, we have a unique internal maximum $A^* > 0$.

Note that $sign\frac{dA^*}{d\mu} = sign\frac{\partial^2 \Pi_P}{\partial A \partial \mu}$ and

$$\frac{\partial^2 \Pi_P}{\partial A \partial \mu} = \frac{(8-\mu^2)\,(A+X_0-c)}{(4+\mu)^2\,(\mu+2)^2} > 0 \text{ iff } \mu \in \left[0, 2\sqrt{2}\right).$$

Moreover, by the envelope theorem,

$$\frac{\partial \Pi_P^{*f}}{\partial \mu} = \frac{(X_0+A^*-c)^2}{2}\left[\frac{8-\mu^2}{(\mu+2)^2\,(\mu+4)^2}\right] > 0 \text{ iff } \mu \in \left[0, 2\sqrt{2}\right).$$

Finally, Π_P^{*f} tends to 0 as $\mu \to \infty$. Even if intense rivalry between retailers allows the supplier to extract the entire surplus from the negotiation, marginal costs are so high that such surplus amounts to 0.

Equilibrium payoff are given by:

$$\begin{aligned}
\Pi_P^{*f} &= \frac{\left(X_0 + A^* - c\right)^2 \mu}{2\left(\mu+2\right)\left(\mu+4\right)} - A^{*\beta} > 0 = \Pi_P^{*c}, \\
\Pi_{D_i}^{*f} &= \frac{\left(X_0 + A^* - c\right)^2}{\left(4+\mu\right)\left(\mu+2\right)}, \\
U^{*f} &= \frac{\left(X_0 + A^* - c\right)^2}{2\left(\mu+2\right)^2} > \frac{\left(X_0 - c\right)^2}{2\left(\mu+2\right)^2} = U^{*c}.
\end{aligned}$$

Note that when $\mu = 0$, the profits of the retail segment are the same under fragmented (f) and consolidated (c) market structure:

$$\Pi_D^{*f}(0) = 2\Pi_{D_i}^{*f}(0) = \frac{\left(X_0 - c\right)^2}{4}.$$

Moreover, since $\lim_{\mu\to 0} \frac{\partial A^*}{\partial \mu} = +\infty$, it is easy to show that $\lim_{\mu\to 0} \frac{\partial \Pi_D^{*f}}{\partial \mu} = +\infty$. Hence, when μ is sufficiently low, the profits of the retail segment are higher under a fragmented market structure.■

Proof of Proposition 5

If $\mu = 0$, i.e. when the producer's marginal costs are constant, $M^* = 0$. When there exists no rivalry between retailers, the outcome is the same under a consolidated and a fragmented market structure.

If $\mu > 0$, the producer's problem is equivalent to solving:

$$\max_M (X_0 + \sqrt{M} - c - M)$$

and the internal maximum is given by:

$$M^* = \frac{1}{4} > 0.$$

The agents' equilibrium profits are given by:

$$\begin{aligned}
\Pi_P^{*f} &= \frac{\left(X_0 + \frac{1}{4} - c\right)^2 \mu}{2\left(\mu+2\right)\left(\mu+4\right)} > 0 = \Pi_P^{*c} \\
\Pi_{D_i}^{*f} &= \frac{\left(X_0 + \frac{1}{4} - c\right)^2}{(4+\mu)(\mu+2)} > \frac{\left(X_0 - c\right)^2}{2(\mu+2)} \quad iff \quad \mu < \frac{8(X_0 - c) + 1}{4(X_0 - c)^2} \\
U^{*f} &= \frac{\left(X_0 + \frac{1}{4} - c\right)^2}{2(\mu+2)^2} > \frac{\left(X_0 - c\right)^2}{2(\mu+2)^2} = U^{*c}
\end{aligned}$$

■

Proof of Lemma 1.

Fix a division of the surplus $(\Pi_P(X), \Pi_{D_1}(X), \Pi_{D_2}(X))$ (with $\Pi_P(X)+\Pi_{D_1}(X)+\Pi_{D_2}(X) = \widetilde{\Pi}(X)$). We construct equilibrium strategies such that in every period the retailers offer contracts implementing $(\Pi_P(X), \Pi_{D_1}(X), \Pi_{D_2}(X))$, P accepts and chooses quantities accordingly. Strategies are represented as automata[21] with three states: the normal state $\mathcal{N}$, the producer's punishment state $\mathcal{P}$, and the retailers' punishment state $\mathcal{D}$. Roughly speaking, in state $\mathcal{N}$ players play subgame perfect equilibrium strategies that implement $(\Pi_P(X), \Pi_{D_1}(X), \Pi_{D_2}(X))$; in state $\mathcal{P}$ players play strategies implementing the lowest subgame perfect equilibrium payoff for P; similarly, in state $\mathcal{D}$ players play strategies implementing the minimum subgame perfect equilibrium payoff for D_1 and D_2. Play starts in the normal state $\mathcal{N}$ and, from any state, play switches to the state punishing deviator i *as soon as* i has deviated.

We describe the candidate equilibrium strategies as finite automata. In state $\mathcal{S} \in \{\mathcal{N}, \mathcal{P}\}$ each retailer D_i is supposed to offer "locally truthful" contracts of the form

$$t_i^{\mathcal{S}}(q_1, q_2) = \begin{cases} R_i(q_1, q_2) - \Pi_{D_i}^{\mathcal{S}}, & \text{if } q_j > 0 \\ R_i(q_1, q_2) - \overline{\Pi}(X), & \text{if } q_j = 0 \end{cases}$$

where $\Pi_{D_i}^{\mathcal{N}} = \Pi_{D_i}(X)$, $\Pi_{D_i}^{\mathcal{P}} = \frac{1}{2}\widetilde{\Pi}(X)$, and P is supposed to accept such offers and choose (q_1, q_2) optimally, yielding the istantaneous payoff distribution $\left(\widetilde{\Pi}(X) - \Pi_{D_1}(X) - \Pi_{D_2}(X), \Pi_{D_1}(X), \Pi_{D_2}(X)\right)$ in state $\mathcal{N}$ and distribution $\left(0, \frac{1}{2}\widetilde{\Pi}(X), \frac{1}{2}\widetilde{\Pi}(X)\right)$ in state $\mathcal{P}$. If a retailer deviates in state $\mathcal{N}$ or $\mathcal{P}$ the transition to state $\mathcal{D}$ is immediate. This means that if the state is $\mathcal{N}$ (or $\mathcal{P}$) when P has to respond, the offered pair of contracts must be $(t_1^{\mathcal{N}}, t_2^{\mathcal{N}})$ (or $(t_1^{\mathcal{P}}, t_2^{\mathcal{P}})$), otherwise the state should be $\mathcal{D}$. On the other hand, if a retailer deviates in state $\mathcal{D}$, the state does not change; therefore any pair of offers (t_1, t_2) can be on the table in state $\mathcal{D}$ when P has to respond. The candidate equilibrium prescribes that in state $\mathcal{D}$ each retailer D_i offers $t_i^{\mathcal{D}}(q_1, q_2) = R_i(q_1, q_2)$, and that P accepts (t_1, t_2) in state $\mathcal{D}$ if and only if it can obtain the whole surplus $\widetilde{\Pi}(X)$. The following table describes the candidate

[21] See, for example, Osborne and Rubinstein (1990).

equilibrum:

State	Pl.	Stage-game strategy	transition
$\mathcal{N}$	D_i	offer $t_i^{\mathcal{N}}(q_1, q_2)$	if D_i deviates, go to $\mathcal{D}$
$\mathcal{N}$	P	accept $t_1^{\mathcal{N}}$ and $t_2^{\mathcal{N}}$, choose (q_1, q_2) optimally	if P deviates, go to $\mathcal{P}$
$\mathcal{P}$	D_i	offer $t_i^{\mathcal{P}}(q_1, q_2)$	if D_i deviates, go to $\mathcal{D}$
$\mathcal{P}$	P	accept $t_1^{\mathcal{P}}$ and $t_2^{\mathcal{P}}$, choose (q_1, q_2) optimally	stay in $\mathcal{P}$
$\mathcal{D}$	D_i	offer $t_i^{\mathcal{P}}(q_1, q_2) = R_i(q_1, q_2)$	stay in $\mathcal{D}$
$\mathcal{D}$	P	accept t_1, t_2 iff $\max_{q_1,q_2} \sum_i t_i(q_1, q_2) - C(q_1 + q_2) \geq \widetilde{\Pi}(X)$	if P deviates, go to $\mathcal{P}$

If no player can profit from one-shot deviations, the one-shot-deviation principle implies these strategies form a subgame perfect equilibrium of the repeated game. We therefore verify that no player can profit from one-shot deviations. If a retailer deviates the state switches immediately to $\mathcal{D}$, P accepts only if it gets at least $\widetilde{\Pi}(X)$, and the continuation value from the following period is zero. Therefore the value of a retailer's deviation is at most zero whereas the value of the equilibrium offer is at least zero.

The candidate equilibrium strategies are defined so that, if P accepts only one contract in state $\mathcal{N}$ and $\mathcal{P}$, it gets zero istantaneous profit and zero continuation payoff. Thus the value of rejecting one contract or both is zero. It follows that in state $\mathcal{P}$ the producer is indifferent because it gets zero whatever it does. In state $\mathcal{N}$ the producer is (weakly or strictly) better off accepting both contracts.

We now consider P's incentives in state $\mathcal{D}$. Clearly P is worse off by rejecting a pair of contracts that yield at least $\widetilde{\Pi}(X)$. If the the offered contracts yield less than $\widetilde{\Pi}(X)$, then the value of acceptance is bounded above by $\widetilde{\Pi}(X)$, whereas the value of rejection is $\frac{\delta}{1-\delta}\widetilde{\Pi}(X)$. Therefore P is better off rejecting (as the candidate equilibrium prescribes) if $\delta \geq \frac{1}{2}$.$\blacksquare$

B Two upstream firms

We now consider a variation of the model where two producers compete in the upstream market selling products of (possibly) different quality. Since this introduces a new source of complexity, we analyze the simpler case where the downstream market is segmented in two (symmetric and) independent submarkets and the downstream firms (retailers) are rival on the supply side only, because they compete for a good produced with increasing marginal costs. We maintain the our basic assumptions about timing and bargaining, with the specification that producers move simultaneously in each stage and retailers make simultaneous take-it-or-leave-it offers to producers.

B.1 Assumptions and notation

Let P^1 and P^2 denote the two producers in the upstream market, and X^i be the quality if the good produced by P^i. There are two independent and symmetric retail markets characterized by a revenue function $R(q_i^1, q_i^2; X^1, X^2)$ where q_i^j denote the quantity of good j (i.e. produced by P^j, of quality X^j) sold on market i. As before, we suppress the dependence of revenues and other variables on quality whenever this causes no confusion. We consider the two cases: (a) a retail chain D operating in both downstream markets, and (b) two independent retailers $D_1$and D_2. We assume for simplicity that higher quality is obtained through a sunk cost investment and does not affect variable costs. Producers are ex ante symmetric with a strictly increasing and convex cost function $C(\cdot)$ such that $C(0) = 0$.

Consistently with the notation used in the previous sections, we let $\widetilde{\Pi}$ the maximum industry surplus (gross of sunk costs), i.e. the gross profit that would be obtained by a monopolist integrated downstream; the maximizing quantities are denoted $\widetilde{q}_i^1$ $(i = 1, 2,\ j = 1, 2)$. By symmetry of the downstream markets $\widetilde{q}_1^j = \widetilde{q}_2^j = \widetilde{q}^j$ $(j = 1, 2)$. Thus:

$$\begin{aligned}\widetilde{\Pi} &= \max_{q_1^1, q_1^2, q_2^1, q_2^2} \left[R(q_1^1, q_1^2) + R(q_2^1, q_2^2) - C(q_1^1 + q_2^1) - C(q_1^2 + q_2^2)\right] \\ &= 2R(\widetilde{q}^1, \widetilde{q}^2) - C(2\widetilde{q}^1) - C(2\widetilde{q}^2).\end{aligned}$$

Similarly, we let $\overline{\Pi} = R(\overline{q}^1, \overline{q}^2) - C(\overline{q}^1) - C(\overline{q}^2)$ denote the maximum surplus obtained when only one downstream market is served (by symmetry, it does not matter which one):

$$\begin{aligned}\overline{\Pi} &= \max_{q_i^1, q_i^2} \left[R(q_i^1, q_i^2) - C(q_i^1) - C(q_i^2)\right] \\ &= R(\overline{q}^1, \overline{q}^2) - C(\overline{q}^1) - C(\overline{q}^2).\end{aligned}$$

As before, we assume that the solutions to these problems are unique, and – to avoid trivialities – non-null.

Recall that the quantities $\widetilde{q}^j$, $\overline{q}^j$ $(j = 1, 2)$ depend on the qualities X^1, X^2. When $X^1 = X^2$, symmetry implies that $\widetilde{q}^1 = \widetilde{q}^2$and $\overline{q}^1 = \overline{q}^2$. We also assume that $X^j > X^{-j}$ implies $\widetilde{q}^j > \widetilde{q}^{-j}$ and $\overline{q}^j > \overline{q}^{-j}$.

Remark 2 *Under the stated assumptions* $2\overline{\Pi} > \widetilde{\Pi} > \overline{\Pi}$.

Proof. By definition, $\widetilde{\Pi} \geq \overline{\Pi}$. The assumption that the maximizations problems have unique and non-null solutions implies that $\widetilde{\Pi} > \overline{\Pi}$. The following is true by definition:

$$\overline{\Pi} \geq R(\widetilde{q}^1, \widetilde{q}^2) - C(\widetilde{q}^1) - C(\widetilde{q}^2).$$

Furthermore, our assumptions on $C(\cdot)$ ($C', C'' > 0$, $C(0) = 0$) imply

$$R(\widetilde{q}^1, \widetilde{q}^2) - C(\widetilde{q}^1) - C(\widetilde{q}^2) > R(\widetilde{q}^1, \widetilde{q}^2) - \frac{1}{2}C(2\widetilde{q}^1) - \frac{1}{2}C(2\widetilde{q}^2) = \frac{1}{2}\widetilde{\Pi}.$$

Therefore $2\overline{\Pi} > \widetilde{\Pi}$. ■

As before, when the downstream markets are served by a retail chain D, D appropriates the industry surplus (for given qualities) and hence producers do not invest in product quality.

We now turn to the negotiation stage with two independent retailers. Since retail markets are separate (no demand rivalry), we may assume wlog that each retailer D_i offers to producer j a menu of contracts $\left[\left(\widetilde{q}^j, \widetilde{r}_i^j\right), \left(\overline{q}^j, \overline{r}_i^j\right)\right]$. The first contract specifies respectively quantity and total payment if j serves both retailers, and the second contract specifies quantity and total payment if j serves only D_i (exclusive contract). Note that for both contracts we consider the efficient quantity obtained by the corresponding maximization problem. Thus retailers compete by offering higher total payments. The equilibrium we obtain would be immune to deviations even with an expanded set of feasible contracts, but we did not fully analyze the set of equilibria in the general case.

We now analyze equilibria where each producer accepts the non-exclusive contracts offered by both retailers, the retailers behave symmetrically and the aggregate payments. We aim at showing that fragmented distribution is more favourable to producers than concentrated distribution. Therefore we focus on equilibria with the lowest aggregate payment to producers.

Proposition 7 *There is a multiplicity of equilibria where producers accept both non-exclusive contracts, retailers behave symmetrically and the aggregate payment to producers is minimal. These equilibria satisfy the following conditions:*[22]

$$\widetilde{r}^1 + \widetilde{r}^2 = \overline{\Pi} - \widetilde{\Pi} + R(\widetilde{q}^1, \widetilde{q}^2),$$

$$\widetilde{r}^j \geq C(2\widetilde{q}^j) - C(\widetilde{q}^j),\ (j = 1, 2),$$

[22] By symmetry, we suppress the retailer index.

$$2\widetilde{r}^j - C(2\widetilde{q}^j) \geq \overline{r}^j - C(\overline{q}^j),\ (j = 1, 2),$$

$$[\widetilde{r}^j - (C(2\widetilde{q}^j) - C(\widetilde{q}^j))] \cdot [(2\widetilde{r}^j - C(2\widetilde{q}^j)) - (\overline{r}^j - C(\overline{q}^j))] = 0.$$

Proof. P^j accepts both non-exclusive contracts if this yields higher profits than accepting an exclusive contract:

$$\widetilde{r}_1^j + \widetilde{r}_2^j - C(2\widetilde{q}^j) \geq \max\left\{0, \widetilde{r}_1^j - C(\widetilde{q}^j), \widetilde{r}_2^j - C(\widetilde{q}^j), \overline{r}_1^j - C(\overline{q}^j), \overline{r}_2^j - C(\overline{q}^j)\right\},\ (j = 1, 2).$$

D_i has no incentive to deviate and offer exclusive contracts that induce both producers to serve (only) him if for all r^1 and r^2 such that $r^1 - C(\overline{q}^1) > \widetilde{r}_1^1 + \widetilde{r}_2^1 - C(2\widetilde{q}^1)$ and $r^2 - C(\overline{q}^2) > \widetilde{r}_1^2 + \widetilde{r}_2^2 - C(2\widetilde{q}^2)$, the following holds:

$$R(\overline{q}^1, \overline{q}^2) - r^1 - r^2 \leq R(\widetilde{q}^1, \widetilde{q}^2) - \widetilde{r}_i^1 - \widetilde{r}_i^2,\ (i = 1, 2). \tag{12}$$

In other words, it is too costly to induce both producers to choose exclusive contracts. This means that (12) must be satisfied also in the limit case $r^j = \widetilde{r}_1^j + \widetilde{r}_2^j - C(2\widetilde{q}^j) + C(\overline{q}^j) \equiv \widehat{r}^j$, that is,

$$R(\overline{q}^1, \overline{q}^2) - \widehat{r}^1 - \widehat{r}^2 \leq R(\widetilde{q}^1, \widetilde{q}^2) - \widetilde{r}_i^1 - \widetilde{r}_i^2,\ (i = 1, 2) \tag{13}$$

(13) is equivalent to

$$\begin{aligned} & R(\overline{q}^1, \overline{q}^2) - \left[\widetilde{r}_1^1 + \widetilde{r}_2^1 - C(2\widetilde{q}^1) + C(\overline{q}^1)\right] - \left[\widetilde{r}_1^2 + \widetilde{r}_2^2 - C(2\widetilde{q}^2) + C(\overline{q}^2)\right] \\ \leq\ & R(\widetilde{q}^1, \widetilde{q}^2) - \widetilde{r}_i^1 - \widetilde{r}_i^2,\ (i = 1, 2). \end{aligned}$$

Simplifying we obtain

$$\widetilde{r}_{-i}^1 + \widetilde{r}_{-i}^2 \geq R(\overline{q}^1, \overline{q}^2) - C(\overline{q}^1) - C(\overline{q}^2) - \left[R(\widetilde{q}^1, \widetilde{q}^2) - C(2\widetilde{q}^1) - C(2\widetilde{q}^2)\right],\ (i = 1, 2). \tag{14}$$

Intuitively, the higher the payment offered by $-i$ the lower is i's incentive to deviate and attract both producers with exclusive contracts.

We reformulate (14) as follows:

$$\widetilde{r}_{-i}^1 + \widetilde{r}_{-i}^2 \geq \overline{\Pi} - \widetilde{\Pi} + R(\widetilde{q}^1, \widetilde{q}^2),\ (i = 1, 2). \tag{15}$$

This condition identifies the minimum aggregate payment to producers, which is attained when (15) holds as an equality.

Assuming symmetry of equilibrium with respect to retailers and summarizing the conditions above we obtain:

$$\widetilde{r}^1 + \widetilde{r}^2 = \overline{\Pi} - \widetilde{\Pi} + R(\widetilde{q}^1, \widetilde{q}^2) \tag{16}$$
$$2\widetilde{r}^1 - C(2\widetilde{q}^1) \geq 0 \tag{17}$$
$$2\widetilde{r}^2 - C(2\widetilde{q}^2) \geq 0 \tag{18}$$
$$\widetilde{r}^1 \geq C(2\widetilde{q}^1) - C(\widetilde{q}^1) \tag{19}$$
$$\widetilde{r}^2 \geq C(2\widetilde{q}^2) - C(\widetilde{q}^2) \tag{20}$$
$$2\widetilde{r}^1 - C(2\widetilde{q}^1) \geq \overline{r}^1 - C(\overline{q}^1) \tag{21}$$
$$2\widetilde{r}^2 - C(2\widetilde{q}^2) \geq \overline{r}^2 - C(\overline{q}^2) \tag{22}$$

(19) and (20) follow from condition $2\widetilde{r}^j - C(2\widetilde{q}^j) \geq \widetilde{r}^j - C(\widetilde{q}^j)$, according to which the profit obtained by each producer by serving both retailers is weakly higher than the profit obtained by accepting the non-exclusive offer of only one producer.

This system of equalities and inequalities has a multiplicity of solutions in the unknowns $(\widetilde{r}^1, \widetilde{r}^2)$. Indeed note that (19) and (20) identify a segment on the line with equation $\widetilde{r}^1 + \widetilde{r}^2 = \overline{\Pi} - \widetilde{\Pi} + R(\widetilde{q}^1, \widetilde{q}^2)$ (not a single point), because the sum of the RHSs of (19) and (20) satisfies

$$C(2\widetilde{q}^1) - C(\widetilde{q}^1) + C(2\widetilde{q}^2) - C(\widetilde{q}^2) < \overline{\Pi} - \widetilde{\Pi} + R(\widetilde{q}^1, \widetilde{q}^2) = \widetilde{r}^1 + \widetilde{r}^2 \tag{23}$$

This can be verified substituting $\overline{\Pi} = R(\overline{q}^1, \overline{q}^2) - C(\overline{q}^1) - C(\overline{q}^2)$ and $\widetilde{\Pi} = 2R(\widetilde{q}^1, \widetilde{q}^2) - C(2\widetilde{q}^1) - C(2\widetilde{q}^2)$ in (23):

$$\begin{aligned} & C(2\widetilde{q}^1) - C(\widetilde{q}^1) + C(2\widetilde{q}^2) - C(\widetilde{q}^2) \\ < \ & R(\overline{q}^1, \overline{q}^2) - C(\overline{q}^1) - C(\overline{q}^2) - \left[2R(\widetilde{q}^1, \widetilde{q}^2) - C(2\widetilde{q}^1) - C(2\widetilde{q}^2)\right] + R(\widetilde{q}^1, \widetilde{q}^2). \end{aligned}$$

Simplifying, we obtain

$$R(\widetilde{q}^1, \widetilde{q}^2) - C(\widetilde{q}^1) - C(\widetilde{q}^2) < R(\overline{q}^1, \overline{q}^2) - C(\overline{q}^1) - C(\overline{q}^2) \equiv \overline{\Pi}.$$

This inequality is necessarily satisfied because our assumptions imply $(\overline{q}^1, \overline{q}^2) \neq (\widetilde{q}^1, \widetilde{q}^2)$, where $(\overline{q}^1, \overline{q}^2)$ is the unique solution to the maximization problem defining $\overline{\Pi}$.

Furthermore (19) and (20) yield

$$2\widetilde{r}^j \geq 2\left[C(2\widetilde{q}^j) - C(\widetilde{q}^j)\right], \ (j = 1, 2).$$

Therefore,

$$2\widetilde{r}^j - C(2\widetilde{q}^j) \geq C(2\widetilde{q}^j) - 2C(\widetilde{q}^j)$$

The assumptions on $C(\cdot)$ imply $C(2\widetilde{q}^j) - 2C(\widetilde{q}^j) > 0$. Thus,

$$2\widetilde{r}^j - C(2\widetilde{q}^j) > 0, \ (j = 1, 2)$$

and each producer obtains a strictly larger profit by serving both retailers rather than not producing at all. Hence (17) and (18) do not bind.

Finally we show that either $\widetilde{r}^j > C(2\widetilde{q}^j) - C(\widetilde{q}^j)$ or $2\widetilde{r}^j - C(2\widetilde{q}^j) > \overline{r}^j - C(\overline{q}^j)$, which determines the equilibrium exclusive contracts, given the equilibrium non exclusive contracts, whenever $(\widetilde{r}^1, \widetilde{r}^2)$ is not an extreme point of the equilibrium segment identified by (16)-(19)-(20). Suppose, by way of contradiction, that $\widetilde{r}^j > C(2\widetilde{q}^j) - C(\widetilde{q}^j)$ and $2\widetilde{r}^j - C(2\widetilde{q}^j) > \overline{r}^j - C(\overline{q}^j)$. Then a retailer would have an incentive to offer to producer P^j a slightly lower payment for the non-exclusive contract because P^j would still be better off accepting such offer rather than accepting only the exclusive or the non-exclusive contract of the other retailer. (This shows that exclusive contracts play an important role even though they are not chosen in equilibrium.)

It can be check that all the menus satisfying the conditions identified above are immune to unilateral deviations.■

B.2 Equilibrium selection in the negotiation stage

If in the investment stage P^1 and P^2 obtain the same quality level, then $\widetilde{q}^1 = \widetilde{q}^2$ and $\overline{q}^1 = \overline{q}^2$. It is then natural to focus on the symmetric equilibrium, letting $\widetilde{r}^1 = \widetilde{r}^2$. We consider a somewhat arbitrary, but plausible, selection rule for the general case that yields $\widetilde{r}^1 = \widetilde{r}^2$ when $\widetilde{q}^1 = \widetilde{q}^2$, that is

$$\frac{\widetilde{r}^1}{\widetilde{r}^2} = \frac{C(2\widetilde{q}^1) - C(\widetilde{q}^1)}{C(2\widetilde{q}^2) - C(\widetilde{q}^2)} \tag{24}$$

If $X^1 = X^2$ then $\widetilde{q}^1 = \widetilde{q}^2 = \widetilde{q}$ and we obtain $\widetilde{r}^1 = \widetilde{r}^2 = \widetilde{r}$, where:

$$\widetilde{r} = \frac{\overline{\Pi} - \widetilde{\Pi} + R(\widetilde{q}, \widetilde{q})}{2}$$

The resulting producers' payoff (gross of sunk costs) is:

$$\Pi_P = 2\widetilde{r} - C(2\widetilde{q}) = \overline{\Pi} - \frac{\widetilde{\Pi}}{2} > 0,$$

and the retailers' payoff is

$$\begin{aligned}\Pi_D &= R(\widetilde{q},\widetilde{q}) - 2\widetilde{r}\\ &= R(\widetilde{q},\widetilde{q}) - \overline{\Pi} + \widetilde{\Pi} - R(\widetilde{q},\widetilde{q})\\ &= \widetilde{\Pi} - \overline{\Pi} > 0.\end{aligned}$$

As before, each retailer appropriates the additional surplus generated by distributing both products also in his own downstream market.

Selection rule (24) has the reasonable property that the higher quality that $X^j > X^k$ implies$\widetilde{r}^j > \widetilde{r}^k$. To see this, note that by assumption $X^j > X^k$ implies$\widetilde{q}^j > \widetilde{q}^k$, and strict convexity of the cost function implies $\frac{d[C(2q)-C(q)]}{dq} = 2C'(2q) - C'(q) > 0$.

Solving the system

$$\begin{cases} \frac{\widetilde{r}^1}{\widetilde{r}^2} = \frac{C(2\widetilde{q}^1)-C(\widetilde{q}^1)}{C(2\widetilde{q}^2)-C(\widetilde{q}^2)} \\ \widetilde{r}^1 + \widetilde{r}^2 = \overline{\Pi} - \widetilde{\Pi} + R(\widetilde{q}^1,\widetilde{q}^2) \end{cases}$$

we obtain:

$$\widetilde{r}^j = \frac{[C(2\widetilde{q}^j) - C(\widetilde{q}^j)]\left[\overline{\Pi}(\overline{q}^1,\overline{q}^2) - \widetilde{\Pi}(\widetilde{q}^1,\widetilde{q}^2) + R(\widetilde{q}^j,\widetilde{q}^k)\right]}{C(2\widetilde{q}^j) - C(\widetilde{q}^j) + C(2\widetilde{q}^k) - C(\widetilde{q}^k)}$$

$(j,k = 1,2,\ j \neq k)$.

B.3 Quality choice with two producers

Recall that all the values obtained above according to selection rule (24) depend on the quality choices X^1 and X^2, although this was not made explicit in the notation. The continuation equilibrium payoff of producer j net of sunk costs is:

$$\Pi_P^j(X^j,X^k) = 2\widetilde{r}^j\left(X^j,X^k\right) - C(2\widetilde{q}^j\left(X^j,X^k\right)) - I(X^j)$$

Without more specific assumptions about cost and demand functions we cannot obtain sharp results about quality choice. In the following statement we rely on very weak reduced form assumptions:

Remark 3 *If the cost and revenue functions are such that*

$$\frac{\partial}{\partial X^j}\left(2\widetilde{r}^j\left(X^j,X_0\right) - C(2\widetilde{q}^j\left(X^j,X_0\right))\right)|_{X^j=X_0} > 0,$$

then in every equilibrium of the two-producer, two-retailer model at least one producer j makes a positive investment in quality, hence aggregate quality $X^1 + X^2$ is higher than in the case of a chain-store retailer.

Comment. The previous result provides a partial characterization of the equilibrium set, but it does not guarantee the existence of a pure strategy equilibrium. Standard assumptions on demand and on the investment cost function $I(\cdot)$ imply that there is an upper bound $\overline{X}$ above which it is impossible to obtain positive profits. The assumptions and selection rule stated above yield continuity of the reduced form function $\Pi_P^j(X^j, X^k)$. This implies existence of a mixed strategy equilibrium.

But in the present context we do not find the mixed equilibrium concept appealing. Quasi-concavity of $\Pi_P^j(\cdot, X^k)$ for each X^k would imply the existence of a pure symmetric equilibrium, but it is not clear how such property can be derived from the fundamentals of the model. Indeed, we conjecture that quasi-concavity can be violated under standard assumptions, because it is plausible that for intermediate values of X^k producer j finds it profitable to differentiate himself with a more extreme quality level. Considering that in a more realistic model producers would also have different research and development technologies, we find asymmetric equilibria quite plausible in this context.

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