# Countervailing Power and Upstream Innovation\*

Roman Inderst<sup>†</sup> Christian Wey<sup>‡</sup>

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## Abstract

We challenge the view that the presence of powerful buyers stifles suppliers' incentives to innovate. Following Katz (1987), we model countervailing (or buyer) power as the ability of, in particular, large buyers to substitute away from a given supplier. We employ a bargaining framework and show that the presence of larger and more powerful buyers *increases* incentives to reduce marginal costs, both as the supplier receives a larger fraction of incremental profits and as lower marginal costs make buyers' alternative supply options less valuable. The latter effect is due to downstream competition between buyers and, as we show, is also stronger the larger and thus the more powerful buyers are.

Keywords: Buyer Power; Countervailing Power; Dynamic Efficiency.

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<sup>&</sup>lt;sup>†</sup>Corresponding author: London School of Economics, Department of Economics and Department of Finance, Houghton Street, London WC2A 2AE, UK. E-mail: r.inderst@lse.ac.uk.

<sup>&</sup>lt;sup>‡</sup>Deutsches Institut für Wirtschaftsforschung Berlin (DIW), Technische Universität Berlin, CEPR, London. E-mail: cwey@diw.de.

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# 1 Introduction

Any purely static view of how market structure affects welfare is likely to be misleading. Antitrust authorities are thus well advised to take a more dynamic perspective, as they increasingly do, thereby incorporating firms' incentives to invest and innovate. Traditionally, the focus has been squarely on how competition or the absence of it affect investment incentives. Lately, however, antitrust authorities around the world have become increasingly concerned about the exercise of power in *vertical* relations.

Retailing, in particular in fast-moving consumer goods, provides a prominent example. There, the formation of multinational retail companies and the introduction of ever larger store formats have arguably put increasing pressure on suppliers, as noted by a number of recent policy reports.<sup>1</sup> One key concern is that the exercise of buyer power will stifle suppliers' incentives.<sup>2</sup> As we argue in this paper, the general presumption that buyer power reduces welfare and consumer surplus by stifling suppliers' incentives to invest and innovate has, however, little theoretical support.

The presumption that buyer power reduces incentives seems to rest on the notion that by extracting a larger share of *total* profits, a more powerful buyer can also extract a larger share of the *incremental* profits from any upstream investment, thereby reducing suppliers' incentives.<sup>3</sup> This holds indeed if we assume that a buyer can always extract a fixed fraction of the jointly realized profits and if we account for varying degrees of buyer power by simply scaling this fraction up and down. Though convenient and therefore often used as a modelling tool, to our knowledge there exists, however, no theory that would support such a hard-wired link

<sup>&</sup>lt;sup>1</sup>These include "Buyer Power and its Impact on Competition in the Food Retail Distribution Sector of the European Union" (European Commission, 1999), "Buying Power of Multiproduct Retailers" (Series Roundtables on Competition Policy DAFFE/CLP(99)21, OECD, 1999), "Report on the Federal Trade Commission Workshop on Slotting Allowances and Other Marketing Practices in the Grocery Industry" (FTC 2001), and "Supermarkets: A Report on the Supply of Groceries from Multiple Stores in the United Kingdom" (Competition Commission, 2000).

<sup>&</sup>lt;sup>2</sup>See, for instance, FTC (2001, p. 57), where concerns are raised that facing increasingly powerful buyers "suppliers respond by under-investing in innovation or production". Pitofsky (1997) expresses similar concerns for the health industry. One possible countervailing force, though arguably only applicable to highly concentrated industries, is that the presence of dominant buyers can overcome free-rider problems (as in, for instance, Fumagalli and Motta (2000)).

 $<sup>^{3}</sup>$ We restrict attention to investments where incentives can not be adequately provided through contractual means. Similar to much of the related literature, this may be the case as it is hard to specify the investment ex ante in sufficient detail. Likewise, with a large number of buyers free-rider problems may also limit the extent to which incentives can be provided through multilateral contracts.

between the fraction of surplus that a buyer can extract in negotiations and more fundamental characteristics that would contribute to "buyer power", such as a buyer's size.

We build a model where buyer power arises from first principles. Buyers that compete in a downstream market negotiate with a supplier over bilateral contracts, where we allow for twopart tariffs. Our focus will be on a supplier's incentives to invest in a reduction of marginal costs, which seems like a natural starting point to investigate the dynamic welfare implications of the exercise of buyer power. Buyers have to spend resources in order to generate alternative supply options. Large buyers are able to distribute these costs over a larger number of units. Consequently, in its negotiations with a given supplier a large buyer will have potentially a more attractive and thus also more credible alternative supply option. While for small buyers the option of switching to another source of supply will have no impact at all on their negotiations, for large buyers the opposite can be the case in that the outcome of negotiations is fully pinned down by the value of the buyer's alternative supply option.<sup>4</sup> The latter is good news for the supplier's incentives, even though the supplier's total profits decrease in the presence of fewer but larger buyers.

The supplier's incentives increase for the following reasons. First, even though the presence of larger buyers reduces a supplier's total profits, the supplier ends up receiving a larger fraction of the *incremental* profits that are generated by its investment. Furthermore, by lowering its own marginal costs the supplier reduces the value of buyers' alternative supply options. As these options determine the outcome of negotiations with large buyers, this further increases the supplier's incentives when facing fewer but larger buyer. Note that the latter effect is due to downstream competition between buyers. As lower marginal costs will lead to lower per-unit purchasing costs for all supplied firms, a buyer that chooses to switch to another source of supply will be more at a disadvantage vis-a-vis competing firms the more the supplier has invested to reduce marginal costs. We also find that this effect is stronger if buyers that are already large grow even further (e.g., by taking over smaller buyers).

Our analysis provides some formal underpinning for the view that large buyers can have a beneficial impact on consumer surplus and welfare by basically keeping suppliers "on their

<sup>&</sup>lt;sup>4</sup>In the parlour of bargaining theory, we thus use the well-known "outside option principle." Seminal references for this are Shaked and Sutton (1984) and Binmore, Rubinstein, and Wolinsky (1989). We have more to say on this below.

toes". Our paper does, however, not intend to provide a carte blanche for the creation and exercise of buyer power. Instead, we would like to emphasize the following implications of our results. First, our results show that buyer power need not invariably lead to lower welfare and consumer surplus by stifling upstream investment incentives. Second, on a more conceptual level our contribution shows that it is essential to make precise what is meant by referring to buyer power. In our model, it is buyers' size that translates into more attractive alternative supply options, which then have an impact on how joint profits are shared in negotiations and, thereby, also on a supplier's incentives to invest. Other ways of enhancing buyer power such as private-label goods in retailing or the adoption of specific purchasing techniques (e.g., the use of electronic buying platforms) may well have entirely different implications.

There is a growing literature on buyer power.<sup>5</sup> When dealing with its implications for welfare or consumer surplus, almost all of these papers focus on the short run and analyze how prices on the downstream market change, typically in a model where only linear contracts between up- and downstream firms are feasible.<sup>6</sup> To our knowledge, there are only a few exceptions that consider the (dynamic) implications for investment incentives. Both Chen (2004) and Inderst and Shaffer (forthcoming) consider the impact of buyer mergers on product diversity. In Inderst and Wey (2003, 2004) a merger of buyers may induce suppliers to choose a less convex and potentially welfare improving production technology.<sup>7</sup> In all of these papers, buyer power has different origins than in the current model, where it is linked to buyers' outside option. Our approach follows closely Katz (1987), which deals with the impact of price discrimination on welfare. Other channels to create a link between, in particular, size and buyer power include risk aversion (e.g., Chae and Heidhues (2004), DeGraba (2003)) or collusion among suppliers (Snyder (1996)).

Finally, some of the more general insights on bargaining and incentives are shared with the

<sup>&</sup>lt;sup>5</sup>Snyder (2005) and Inderst and Shaffer (2005) provide recent surveys.

<sup>&</sup>lt;sup>6</sup>Dobson and Waterson (1997) is an early example of models that study countervailing or buyer power under linear contracting. Chen (2003) uses linear contracts only for transactions with a (downstream) market "fringe". Still other papers focus exclusively on distributional issues and derive conditions for when downstream or upstream mergers are beneficial (e.g., Horn and Wolinksy (1988) or Chipty and Snyder (1999)).

<sup>&</sup>lt;sup>7</sup>The intuition is that larger buyers negotiate less "at the margin" of a supplier's strictly convex production technology, which allows a supplier to "roll over" less of its incremental costs at high production volumes when negotiating with fewer but smaller buyers. For a related insight concerning a supplier's choice of capacity see Vieira-Montez (2005). Inderst and Wey (2002) also discuss product innovation, showing that in the presence of larger buyers a supplier may choose a product that generates more demand.

recent literature on the hold-up problem. De Meza and Lockwood (1998) and Chiu (1998) show how results of the theory of ownership change if one adopts a bargaining concept that embodies the logic of the "outside option principle", as we do in the current paper. There are, however, numerous differences between their work and ours. In our model, a supplier negotiates with multiple buyers, which further compete on a downstream market. Also, we study the role of buyers' size and are interested in what impact it has on welfare and consumer surplus by affecting upstream investment incentives.

The rest of the paper is organized as follows. Section 2 presents the model and derives some preliminary results. Section 3 analyzes how the formation of larger and more powerful buyers affects investment incentives. Section 4 discusses and extends these results. Section 5 concludes.

# 2 The Model and Preliminary Analysis

## 2.1 The Industry

We analyze a supplier's incentives to reduce marginal costs. The supplier provides an input to an intermediary industry. Firms in the intermediary industry use the input to produce a homogeneous final good. All firms in the intermediary industry have identical production functions. As in Katz (1987), which considers the case where a monopolistic supplier serves two competing downstream firms, we assume that firms transform one unit of the input into one unit of the output.<sup>8</sup> Also following Katz (1987), we assume that these intermediaries compete in a number of independent markets. We allow for  $N \ge 2$  independent markets, in each of which there are two competing firms active. The 2N downstream firms are owned by a number  $I \ge 2$ of intermediaries, to which we simply refer to as buyers. A given buyer  $B^i$ , where  $1 \le i \le I$ , can only own firms in separate markets.<sup>9</sup> After presenting our results, we comment more on these assumptions in the light of a particular application, namely to retailing.

The number of firms  $n^i$  that  $B^i$  owns will be our measure of the buyer's overall size. As in Katz (1987), larger buyers will be able to extract a better deal from the supplier. Our focus is on

<sup>&</sup>lt;sup>8</sup>Given symmetry of production functions, this specification is not important for our results. A natural example where this specification is reasonable is that of retailing.

<sup>&</sup>lt;sup>9</sup>This rules out standard monopolization effects. It also allows us to treat all N markets symmetrically, regardless of the number and size of buyers. Note also that  $\sum_{i=1}^{I} n^i = 2N$  as there are two competing firms in each of the N (sub-)markets.

analyzing how the presence of more powerful buyers affects the supplier's investment incentives, with buyer power being derived endogenously from buyers' size.

In each independent market, downstream firms offer a homogeneous good and compete in quantities. All N independent markets are symmetric. If in a given market one of the two active firms chooses the quantity q and the other firm the quantity  $\hat{q}$ , the first firm's revenues are given by  $R(q, \hat{q}) := qP(q + \hat{q})$ , where  $P(\cdot)$  denotes the inverse demand. The supplier has constant marginal costs of production  $c \geq 0$ . It is convenient to assume that P is twice continuously differentiable where positive. In line with much of the literature, we assume that standard stability conditions are satisfied and that best responses are downward sloping. With constant marginal costs, this is ensured by the following assumption.<sup>10</sup>

Assumption 1. The inverse demand P that characterizes the downstream markets satisfies  $P' < \min\{0, -qP''\}$  whenever P is positive.

We will find that in equilibrium all buyers are supplied at a constant per-unit price that equals marginal costs c. (We formally introduce supply contracts further below.) Under Assumption 1, the Cournot game where two firms can procure at constant input prices equal to c has a unique equilibrium. In this equilibrium, both firms produce the same quantity, which we denote by  $q_S$ . From our assumptions on differentiability and by Assumption 1, we further have that  $q_S$  is continuously differentiable in c (where  $q_S > 0$ ) with  $dq_S/dc < 0$ .

### 2.2 The Two Stages of the Model

There are two stages in our model. In the first stage, the supplier can choose a non-contractible action to reduce marginal costs. Subsequently, the supplier negotiates simultaneously with all buyers  $i \in I$ . We may think of a situation where the supply contracts for all buyers  $B^i$  are up for renewal. Alternatively, our model may capture the introduction of a new product.<sup>11</sup>

In the first stage, the supplier can choose a reduction of marginal costs  $\Delta_S \geq 0$  such that  $c = \overline{c} - \Delta_S$ , where  $0 \leq \Delta_S \leq \overline{c}$  and  $\overline{c} > 0$ . The associated costs are given by the function  $K_S(\Delta_S)$ , which is strictly increasing and satisfies  $K_S(0) = 0$ . It is convenient to assume that  $K_S$ 

<sup>&</sup>lt;sup>10</sup>See, for instance, Vives (1999).

<sup>&</sup>lt;sup>11</sup>This could also justify why there is only a single (potential) supplier.

is twice continuously differentiable and that its derivative satisfies  $K'_S(0) = 0$  and  $K'_S(\Delta_S) \to \infty$ for  $\Delta_S \to \overline{c}$ . We want to make sure that production is always profitable in equilibrium. A sufficient condition for this is that there exists some q > 0 such that  $P(q) > \overline{c}$ .

Negotiations take place in the second stage of the model. There, buyers and the supplier negotiate over an (only privately observed) two-part tariff of the form  $t^i(q) = \tau^i + qw^i$ . We find the use of non-linear (here, two-part) tariffs natural in a setting where contracts are freely determined in negotiations.<sup>12</sup> Moreover, in equilibrium there will be no incentives to deviate from two-part tariffs. This would, for instance, not be the case if we restricted attention to linear contracts, as it is sometimes done in the literature. Moreover, in many industries the use of (often highly complex) non-linear contracts is indeed pervasive.<sup>13</sup> We postpone a further description of the bargaining game until the next section. The remainder of this section is dedicated to a definition of buyers' alternative supply options.

Though our model allows for a broader interpretation, we closely follow Katz (1987) and specify that after disagreement buyers have the option to integrate backwards. When integrating backwards, a buyer must incur the fixed costs  $F \ge 0.^{14}$  The attractiveness of the buyer's new supply option depends on how much resources the buyer spends. A given buyer  $B^i$  that integrates backwards has control over its (new) marginal costs  $c_{Out}^i$ . By incurring the additional expenditure  $K_B(\Delta_B^i)$ ,  $B^i$  can reduce marginal costs to  $c_{Out}^i = \bar{c}_{Out} - \Delta_B^i$ , where  $0 \le \Delta_B^i \le \bar{c}_{Out}$ and  $\bar{c}_{Out} > 0$ . We specify that  $K_B(0) = 0$ , while  $K_B$  is twice continuously differentiable with  $K'_B(0) = 0$  and  $K'_B(\Delta_B^i) \to \infty$  for  $\Delta_B^i \to \bar{c}_{Out}$ .

 $<sup>^{12}</sup>$ The somewhat opposite case is that where supply contracts are determined in a "market interface" that operates between suppliers and buyers (e.g., an organized commodity exchange). See also Inderst and Shaffer (2005) for a more detailed discussion of the difference between bilateral negotiations and a "market interface" and the implications for the analysis of buyer power.

<sup>&</sup>lt;sup>13</sup>With regards to retailing, this view is supported by the econometric studies of Bonnet, Dubois, and Simioni (2004) for bottled water in France and of Berto Villas-Boas (2004) for yoghurt in the U.S. On the other hand, it could be argued that there is little empirical support for simple two-part tariffs with lump-sum payment to suppliers. Incidentally, the Cournot assumption together with the structure of our bargaining game ensure that our results are relatively robust to a change in contracts, provided the contractual set is sufficiently flexible to allow the parties to overcome double marginalization. In particular, we obtain our results as an equilibrium outcome (though potentially not the unique one) if we allow, for instance, for general continuously differentiable menus  $t^i(q)$  or quantity-forcing contracts prescribing a fixed quantity  $q^i$  together with a total transfer  $t^i$ .

<sup>&</sup>lt;sup>14</sup>More broadly, the investment a buyer must make in order to successfully integrate backwards can also be interpreted as costly search for an alternative supplier.

## 2.3 Negotiations

For the second stage of the model, where supply contracts are determined, we use the following bargaining model. Bargaining proceeds in pairwise negotiations, where the supplier is represented by I different agents, each negotiating with one buyer. All agents of the supplier form rational expectations about the outcome in all other pairwise negotiations, while their objective is to maximize the supplier's payoff. Our approach to the individual pairwise negotiations is axiomatic, though we provide a non-cooperative foundation in Appendix B.<sup>15</sup> We employ the axiomatic Nash bargaining solution.

We need not write down the Nash solution in its generality. Several features of our model ensure that the solution has a very simple characterization. Note first that as contracts can specify a fixed fee  $\tau^i$ , the issue of maximizing (joint) surplus in each bilateral negotiation and that of how to share the surplus are no longer interwined.<sup>16</sup> As firms compete in quantities in each of the N markets and as contracts are not observable, the choice of  $w^i$  does not affect the supplier's payoff with all other buyers but *i*. Therefore, if a mutually beneficial agreement with  $B^i$  is feasible, it is uniquely optimal to set  $w^i = c$ .

**Lemma 1.** The requirement that joint surplus is maximized in each bilateral negotiation implies that  $w^i = c$ .

Lemma 1 is a restatement of a well-known result. The supplier faces a problem of opportunism when dealing with multiple competing buyers. This problem has been analyzed, though with a different focus, in a number of papers, including Hart and Tirole (1990), McAfee and Schwartz (1994), or O'Brien and Shaffer (1994).<sup>17</sup> In these papers, the supplier typically makes simultaneous offers to all downstream firms.<sup>18</sup> Consequently, a downstream firm must form beliefs about the (non-observable) offers that the supplier made to all other firms. The outcome where  $w^i = c$  is obtained under so-called "passive beliefs", which specify that when receiving an

 $<sup>^{15}</sup>$ We use this setting, where the supplier is represented by I agents, also in the non-cooperative game in Appendix B. It should be noted that in the characterized equilibrium the supplier could not profitably "orchestrate" a multilateral deviation by all of its agents.

<sup>&</sup>lt;sup>16</sup>Strictly speaking, we need also risk neutriality to make utility "transferable".

<sup>&</sup>lt;sup>17</sup>We follow these papers in assuming that contractual ways to achieve the monopoly outcome (e.g., the granting of exclusivity) are not credible or not feasible as they would constitute a non-permissible vertical restraint.

<sup>&</sup>lt;sup>18</sup>A notable exception is O'Brien and Shaffer (1994), who adopt an axiomatic Nash bargaining approach.

unanticipated offer a given downstream firm believes that the supplier did not adjust its offers to other firms. Our specification that the supplier negotiates through I agents has the same implication.

By Lemma 1, the supplier's total profits are equal to the sum of all agreed fixed transfers  $\tau^i$ . This also implies that an individual agreement does not affect the supplier's profits from all other potential agreements. Consequently, if all other negotiations are successful, an agreement with buyer  $B^i$ , which controls  $n^i$  firms, generates the joint profits<sup>19</sup>

$$n^{i}\left[R(q_{S}, q_{S}) - q_{S}c\right],\tag{1}$$

where we substituted the respective equilibrium quantities  $q_S$ . Suppose first that  $B^i$  would cease to operate when negotiations break down as the fixed costs F from integrating backwards are too high. According to the general Nash bargaining solution,  $\tau^i$  would then be determined by the requirement that the profits of  $B^i$  are equal to the fraction  $0 \le \rho^i \le 1$  of expression (1) As noted in the Introduction, it is common to model an increase in buyer power by increasing  $\rho^i$ . The shortcoming of this approach is that there is no theory to support this. Non-cooperative models of bargaining - as the one we present in Appendix B - allow to endogenize  $\rho^i$  from primitives such as the two sides' impatience to come to an agreement. We know of no theory that would suggest how a buyer's size should affect, say, its discount factor. Being agnostic about the sharing rules  $\rho^i$ , we stipulate that buyers and the supplier have equal bargaining power such that  $\rho^i$  is equal to one half for all  $B^i$ .<sup>20</sup>

If one half of the joint profits (1) already exceeds what a given buyer would obtain when integrating backwards, the threat to integrate backwards is not credible. This is the key insight of the "outside option principle" in bargaining theory. According to this principle, the buyer's "outside option" only affects negotiations if its value exceeds the payoff that the buyer would realize when negotiating without having such an option. Once the value of the outside option exceeds one half of (1), however, the outside option fully determines the buyer's share of the

<sup>&</sup>lt;sup>19</sup>The axiomatic approach does not allow for renegotiations following an unanticipated disagreement with other buyers. However, with  $w^i = c$  there would clearly be no scope for bilaterally efficient renegotiations.

<sup>&</sup>lt;sup>20</sup>While this makes all expressions simpler, none of our qualitative results depends on the particular choice, that is as long as  $0 < \rho^i < 1$  for all  $B^i$ . However, as we later consider the formation of larger buyers through mergers, it would then fall upon us to specify which value of  $\rho$  (or, in the non-cooperative model of Appendix B, which discount factor) to use for the merged buyer. Again, there is no theory that could guide our choice.

profits (1).<sup>21</sup>

The value of the outside option of  $B^i$ , which we denote by  $V_{Out}^i$ , is now easily derived as follows. When integrating backwards, the buyer can also decide on the amount  $K_B(\Delta_B^i)$ that it wants to invest in order to reduce its own future marginal costs from  $\bar{c}_{Out}$  down to  $c_{Out}^i = \bar{c}_{Out} - \Delta_B^i$ . Given its choice of  $\Delta_B^i$  and the resulting marginal costs  $c_{Out}^i$ ,  $B^i$  then has to decide which quantity to produce and to sell via its  $n_i$  firms. Working backwards, if  $B^i$  decides to integrate backwards then the maximum profits from this strategy are equal to<sup>22</sup>

$$v_{Out}^{i} := \max_{\Delta_B^{i}} \left\{ n^{i} \max_{q} \left[ R(q, q_S) - (\overline{c}_{Out} - \Delta_B^{i})q \right] - K_B(\Delta_B^{i}) - F \right\}.$$
(2)

As there is always the option not to be active any longer, the outside option of  $B^i$  is thus equal to  $V_{Out}^i = \max\{0, v_{Out}^i\}$ . To ensure that there is indeed scope for a mutually beneficial agreement with all buyers, we make the following assumption.<sup>23</sup>

Assumption 2. For all  $c \leq \overline{c}$  (and thus for all feasible  $q_S$ ) and for all  $n_i \leq N$ , it holds that  $v_{Out}^i < n^i [R(q_S, q_S) - q_S c].$ 

Summing up, we have thus arrived at the following results.

**Proposition 1.** Under Assumption 2 and using the symmetric Nash bargaining solution, there is an agreement in all bilateral negotiations. An agreement with buyer  $B^i$  specifies  $w^i = c$ , while the agreed fixed transfer  $\tau^i$  is determined as follows. If

$$\frac{1}{2}n^{i}[R(q_{S}, q_{S}) - q_{S}c] \ge V_{Out}^{i},$$
(3)

then  $\tau^i$  satisfies

$$\tau^{i} = \frac{1}{2}n^{i}[R(q_{S}, q_{S}) - q_{S}c].$$
(4)

<sup>&</sup>lt;sup>21</sup>See also footnote four. Binmore, Rubinstein, and Wolinksy (1989) derive this from a non-cooperative model with alternating offers and impatient players. (See also Appendix B for a related model.) They also show that the outcome would differ if one assumed that frictions arise due to some exogenous probability by which negotiations break down if there is delay. (The "typical" story is that players negotiate on the phone and that the line may get irrevocably interrupted.) This alternative scenario seems not very suitable to describe a setting of inter-firm bargaining with professional negotiators and potentially non-negligible sums at stake.

 $<sup>^{22}</sup>$ We already use that in equilibrium negotiations with all other buyers are successful. Consequently, the chosen output at all other firms equals  $q_s$ .

<sup>&</sup>lt;sup>23</sup>Assumption 2 is stronger than needed as it will have to hold only under the equilibrium choices of c. Invoking the stronger assumption allows, however, to rule out case distinctions when deriving our results. Moreover, while Assumption 2 is not on the primitives, it is straightforward to impose conditions on  $\bar{c}_{Out}$  (in comparison to  $\bar{c}$ ) and on  $K_B$  (in comparison to  $K_S$ ) that ensure that Assumption 2 holds.

Otherwise, we have that

$$\tau^{i} = n^{i} \left[ R(q_{S}, q_{S}) - q_{S}c \right] - V_{Out}^{i}.$$
(5)

In what follows, we refer to the case where (3) does not hold, i.e., where  $\tau^i$  is determined by (5), as the case where the outside option of  $B^i$  binds. Note finally that the chosen bargaining solution allows S to discriminate between different buyers. In the present setting the cause for this discrimination are the different values of buyers' outside options, which in turn derive from buyers' different size.

## 3 Analysis of the Supplier's Incentives

This is the core analysis of our paper. We are interested in how the formation of larger buyers affects the supplier's incentives to reduce production costs in the first stage of the model. As a first step, we ask how the outcome of negotiations change if there are fewer but larger buyers with which the supplier has to negotiate.

Suppose first that for some given choice of c the outside option was not binding for any buyer, which could be the case as high fixed costs F from integrating backwards make this unprofitable regardless of the buyer's size. Note next that the average price that  $B^i$  pays per unit is equal to

$$\mu^i := \frac{\tau^i + n^i q_S c}{n^i q_S},\tag{6}$$

where we make use of  $w^i = c$  from Lemma 1. Substituting for  $\tau^i$  from (4), the average purchasing price of  $B^i$  is then  $\mu^i = [c + P(2q_S)]/2$  and thus independent of its size  $n^i$ . Intuitively, as the outside option does not affect how profits are shared, the buyer receives a fixed fraction, namely one half, of the profits that are realized in each of its  $n^i$  markets. If the outside option does not bind for any buyer, the supplier's overall profits (gross of the initial outlay  $K_S$ ) are thus equal to  $N[R(q_S, q_S) - q_S c]$ , where we use that there are two competing firms in each of the Nindependent markets.

The number and size of buyers start to matter, however, once buyers' outside options become binding. With a binding outside option, the average purchasing price (6) is strictly decreasing in the number of controlled firms  $n^i$ . The intuition for this is as follows. Integrating backwards involves two types of fixed costs: F and the additional investment costs  $K_B(\Delta_B^i)$ , which depend on the (optimally) chosen level of cost reduction  $\Delta_B^i$ . The larger  $n^i$ , the larger the total quantity over which the buyer can distribute these costs. As a consequence, the ratio  $V_{Out}^i/n^i = v_{Out}^i/n^i$ is now strictly increasing in  $n^i$ , which in turn leads to a strictly lower average purchase price. By the same token, the more firms a buyer controls the more likely it will be that it is indeed optimal to integrate backwards after a disagreement with the supplier and the more the buyer will subsequently invest in order to reduce its own marginal costs  $c_{Out}^i$ .<sup>24</sup>

**Lemma 2.** Holding the supplier's marginal cost c constant, a given buyer's size  $n^i$  has the following impact on the buyer's outside option  $V_{Out}^i$  and thereby on the respective bargaining outcome.

i) If after disagreement the buyer weakly prefers to integrate backwards for some  $n^i = n'$ , then the buyer strongly prefers to do so for all  $n^i = n'' > n'$ . Moreover, in case of backward integration the buyer with size  $n^i = n''$  invests strictly more to reduce  $c_{Out}^i$  than if  $n^i = n'$ .

ii) Unless the outside option never binds regardless of the choice  $n^i \leq N$ , there exists a threshold  $1 \leq \hat{n} \leq N$  such that for all  $n < \hat{n}$  the outside option of  $B^i$  is not binding, while it is binding for all  $n \geq \hat{n}$ . Over all  $n^i = n < \hat{n}$  the average purchasing price,  $\mu^i$ , remains constant, while  $\mu^i$  is strictly decreasing in  $n^i$  over all  $n^i \geq \hat{n}$ .

### **Proof.** See Appendix.

We turn now to the first stage of our model. Recall now that the supplier's profits in the second stage of the model are equal to the sum of all fixed transfers  $\tau^i$ . Consequently, the supplier optimally chooses its marginal costs  $c = \overline{c} - \Delta_S$  so as to maximize its net profits

$$U := \sum_{i \in I} \tau^i - K_S(\Delta_S), \tag{7}$$

where the transfers  $\tau^i$  are determined by (4) or (5), respectively. It is now easily checked (and verified in the following proofs) that U is continuous and almost everywhere differentiable in

<sup>&</sup>lt;sup>24</sup>If the optimal  $\Delta_B^i$  is not unique, then assertion i) of Lemma 2 applies to the respective sets: all  $\Delta_B^i$  that are optimal for  $n^i = n''$  are strictly larger than any  $\Delta_B^i$  that is optimal for  $n^i = n' < n''$ . This is made more formal in the proof.

 $\Delta_S$ . To analyze the supplier's incentives, define thus the derivative  $m := dU/d\Delta_S$  at all points where U is differentiable.

It seems intuitive that if it were not for the costs  $K_S$ , the supplier would want to set marginal costs as low as possible. It is, however, well-known that the standard Cournot assumptions that we invoked in Assumption 1 are not sufficient to guarantee this. In what follows, we want to ensure that this intuitive property holds. We thus invoke the following additional assumption.<sup>25</sup>

## Assumption 3. The per-firm Cournot profits $R(q_S, q_S) - cq_S$ are strictly decreasing in c.

If for a given choice of c all buyers' outside options were not binding, the supplier's incentives to (marginally) decrease c would be determined by the derivative

$$m = N \frac{d}{dc} \left[ R(q_S, q_S) - cq_S \right] - K'_S(\Delta_S), \tag{8}$$

where we used Proposition 1 and the fact that there are 2N downstream firms. How do incentives change if, instead, the outside option of some buyer, say buyer  $B^i$ , binds? We can isolate three effects that all point in the same direction, that is towards an *increase* in the derivative m.

First, as the outcome of negotiations with  $B^i$  is now fully pinned down by the buyer's outside option, the supplier can pocket the *full* marginal increase in the respective joint surplus  $n^i[R(q_S, q_S) - cq_S]$ . In other words, with a binding outside option there is no longer a hold-up problem between the supplier and  $B^i$ , at least not for marginal changes in  $\Delta_S$ .<sup>26</sup>

Second, once the outside option of  $B^i$  binds the supplier's incentives are further increased as a reduction in marginal costs reduces the value of the buyer's outside option and, thereby, further increases the supplier's profits. To see this, note that in each of the  $n^i$  markets in which firms controlled by  $B^i$  are active, the supplier still sells to competing firms irrespective of whether there was an agreement with  $B^i$  or not. The lower the supplier's marginal costs, the more competitive are these firms, which reduces the value of the buyer's outside option to integrate backwards instead of purchasing from the supplier.<sup>27</sup> Finally, we find that this effect

<sup>&</sup>lt;sup>25</sup>Vives (1999, p. 105) provides sufficient conditions on the demand function for Assumption 3 to hold.

<sup>&</sup>lt;sup>26</sup>Recall our convention by which the outside option of  $B^i$  is binding if (3) does not hold. Consequently, as  $R(q_S, q_S) - cq_S$  and  $v_{Out}^i$  both change continuously in c, the outside option of  $B^i$  stays binding after a small change in  $\Delta_S$ .

<sup>&</sup>lt;sup>27</sup>Formally, with quantity competition and given Lemma 1, a lower c will translate into a higher quantity  $q_S$  of all firms that compete with  $B^i$ .

is stronger the larger  $B^i$ . The intuition for this is as follows. Recall first from Lemma 2 that a larger buyer will optimally choose a lower value of  $c_{Out}^i$  after disagreement, which in turn makes it optimal to subsequently choose a larger quantity in each of its  $n^i$  markets. If competing firms also choose a large quantity, which will be the case if the supplier's marginal costs c are also low, this reduces the price that  $B^i$  can obtain per unit and will thus hurt  $B^i$  more the larger its output per market.

For the preceding arguments we scaled up the size of one buyer,  $B^i$ . If all other buyers' size was kept constant, we would not only change the size of one buyer but also the scale of the whole market. In what follows, we keep the size of the market constant and only change the number and size of buyers.

**Lemma 3.** Consider for some fixed value  $\Delta_S$  the marginal incentives for the supplier to further increase  $\Delta_S$ , as given by the derivative m (where it exists). Suppose that a subset of the Iindependent buyers are merged into one larger buyer. If the outside option of this new large buyer is binding, then m is strictly higher. Otherwise, m does not change.

**Proof.** See Appendix.

With Lemma 3 at hands, the following result follows now immediately by applying standard comparative statics results.<sup>28</sup>

**Proposition 2.** If there are fewer but larger buyers, then in equilibrium the supplier's marginal costs will never be higher but they may be strictly lower.

Note that we do not need for Proposition 2 that there is a unique optimal  $\Delta_S$  for any given number and size of buyers. Proposition 2 then applies for the optimal sets, as made precise in the proof.

An application of Proposition 2 could be to retailing, where a larger buyer is formed by the merger of two or more smaller retail chains. When dealing with large chains, there is essentially no longer any scope for negotiations: Average purchasing prices  $\mu^i$  are pinned down by the chains' more attractive alternative supply options. Lemma 3 and Proposition 2 show how this can spur upstream investment to reduce marginal costs. Importantly, in retailing some of the

<sup>&</sup>lt;sup>28</sup>See, for instance, Vives (1999).

assumptions we made to focus on the novel aspects of our model may be particularly realistic. In retailing, markets are often locally segmented such that the merger of chains operating in different regions may indeed have no implications for downstream competition. In addition, oftentimes structural remedies are applied that force the divestiture of outlets in those local markets where the merger would seriously reduce the number of competitors.<sup>29</sup> Moreover, the use of two-part tariffs, which implied that there was no double marginalization irrespective of the number and size of buyers, seems also realistic if large retail chains negotiate with equally sophisticated producers of branded goods. In such a setting, the most important (if not the only) implications of the formation and exercise of buyer power may then be indeed how this affects investment incentives and thus efficiency in the long run.

If the exercise of buyer power leads to lower marginal costs and thus higher quantities supplied to each of the N markets, consumer surplus is strictly higher. Proposition 2 is, however, silent about the overall welfare effects. It is straightforward that S invests too little in the reduction of marginal costs if all outside options do not bind. Intuitively, due to the hold-up problem with all buyers the supplier's optimal choice of  $\Delta_S$  then lies below the level that would maximize total industry profits. But this is already below the level at which welfare would be maximized given that a further reduction of marginal costs would increase output and thus reduce deadweight loss. In the opposite extreme where all outside options are binding, there is no longer a hold-up problem, at least not for marginal changes of  $\Delta_S$ . In addition, the supplier has now an incentive to reduce costs even further as this reduces the value of buyers' binding outside options. If the latter effect is not too strong, the formation of larger buyers increases welfare, even if it may reduce total industry profits. However, there is no guarantee that S will not "overshoot" by choosing too low costs in the presence of large buyers.

Finally, we want to analyze how the formation of larger buyers affects other buyers in the industry. Holding c fixed, the size of other buyers has no impact on the negotiations of an individual buyer. Consequently, the formation of larger buyers affects other buyers only via its impact on the supplier's incentives. This observation yields now a somewhat surprising result. Small buyers that do not have a sufficiently valuable outside option benefit as they can extract

<sup>&</sup>lt;sup>29</sup>In retailing, in particular if it comes to super- or hypermarkets, the assumption of a tight local oligopoly (and, in particular, no further entry) is also often realistic given local planning restrictions. For many goods or services the local market may also often not support more than a very limited number of competing shops.

a fraction of the additional joint profits when marginal costs are lower. In contrast, other large buyers may be hurt as this decreases the value of their respective (binding) outside options. To streamline the exposition it is now convenient to assume for the following result that there is a unique optimal choice of  $\Delta_S$  for a given number and size of buyers.

**Corollary 1.** The formation of a larger buyer can never hurt a small buyer for which the outside option does not bind and it will strictly benefit the small buyer if it changes the supplier's incentives. On the other hand, a large buyer may be affected negatively, which is in particular the case if the supplier's incentives change and if subsequently the buyer's outside option binds.

## **Proof.** See Appendix.

Corollary 1 contributes to the ongoing debate whether competing smaller buyers are hurt by the exercise of buyer power through larger buyers. From Corollary 1 quite the opposite can happen in that smaller buyers essentially "free-ride" on the additional incentives that the exercise of buyer power generates for the supplier. It should be noted, however, that in our model the formation of larger buyers does not affect the marginal input price of either smaller or larger buyers. This would be different if contracts were restricted to linear input prices, in which case it is easy to show that larger buyers may end up with lower per-unit input prices and, consequently, a larger share of all markets in which they control firms. As we argued previously, however, for certain settings such as negotiations between retail chains and the manufacturers of branded goods, the assumption of simple linear contracts seems overtly restrictive.

## 4 Discussion

#### Fixed Costs Reductions

We focused our analysis on incentives to reduce marginal costs, which have an implication for output and thus consumer surplus. Consumer surplus is often the standard applied by competition authorities, in particular if it comes to merger specific efficiencies. The analysis where the supplier can invest upfront in a reduction of its fixed costs of operations turns out to be much simpler. If there are at least two buyers, the supplier's fixed costs do *not* affect the joint profits from an agreement as the supplier would anyway have to incur these costs in order to honour its contractual obligation with the other buyer(s). Consequently, as long as there at least two independent buyers the prevailing fixed costs are not affected by the formation of a larger buyer.<sup>30</sup>

#### Outside vs. Inside Options

The bargaining literature makes a distinction between "outside options", which are triggered by permanent disagreement, and so-called "inside options", which provide value to the respective party *while* negotiating. Applied to our setting, a buyer's inside option would thus be to *temporarily* purchase a substitute for the supplier's input at cost  $c_{In} > \overline{c}$ . We may think of this alternative supply option as a market for inferior or higher-cost substitutes. For instance,  $c_{In}$ could be higher as this input is less suitable to buyers' needs and thus requires some additional and costly adjustments.

In an axiomatic approach, the standard way to treat such "inside options" is the following. As negotiations do not have to be cut off irrevocably to allow one of the parties to use its inside option, there is no issue of "credibility". To calculate the additional surplus that is achieved by an agreement, one then subtracts the value of each party's inside option. With the symmetric Nash solution, each party's payoff is then equal to the value of its inside option plus one half of the additional surplus - provided, of course, these payoffs are not lower than the values of the respective outside options. In Appendix B we incorporate buyers' inside option in a noncooperative framework and confirm the subsequent results. Before turning to the formal analysis, it should be noted that all buyers have access to the same inside option. In the non-cooperative model, a buyer that delays an agreement with the (main) supplier expects to reach an agreement in the very next period, implying that neither the buyer itself nor the inferior supplier would have incentives to sink resources. The payoff that  $B^i$  obtains from its inside option is given by

$$V_{In}^{i} := n^{i} \max_{q} \left[ R(q, q_{S}) - qc_{In} \right], \tag{9}$$

where we use again that there is agreement in all other negotiations and that the respective firms choose the quantity  $q_S$ . The following results are then immediate given our previous arguments.

**Proposition 3.** Suppose that buyers have in addition the "inside option" to purchase at costs

<sup>&</sup>lt;sup>30</sup>Given that we abstract from monopolization of the downstream market, our analysis does not cover the case where there only remains one single buyer.

 $c_{In} > c$ . Then under the symmetric Nash bargaining solution there is an agreement in all bilateral negotiations, where  $w^i = c$  and where  $\tau^i$  satisfies the following requirements. If

$$\frac{1}{2} \left[ n^{i} [R(q_{S}, q_{S}) - cq_{S}] + V_{In}^{i} \right] \ge V_{Out}^{i}, \tag{10}$$

then  $\tau^i$  satisfies

$$\tau^{i} = \frac{1}{2}n^{i}[R(q_{S}, q_{S}) - q_{S}c] - \frac{1}{2}V_{In}^{i}.$$
(11)

Otherwise, we have that

$$\tau^{i} = n^{i} \left[ R(q_{S}, q_{S}) - q_{S}c \right] - V_{Out}^{i}.$$
(12)

Note first that holding  $c_{In}$  constant, the introduction of an inside option does not change our results qualitatively. Hence, all our results extend once we use Proposition 3 instead of Proposition 1 to characterize the bargaining equilibrium. Moreover, unless all outside options bind, a more attractive inside option, i.e., a lower  $c_{In}$ , reduces the supplier's payoff. The implications for the supplier's incentives are, however, now somewhat more ambiguous.

We distinguish between three cases. First, if the outside option of  $B^i$  binds after the reduction of  $c_{In}$  it surely binds also for all higher  $c_{In}$ , implying that the reduction of  $c_{In}$  has no effect on the supplier's incentives. At the other extreme, the outside option of  $B^i$  binds neither before nor after the reduction in  $c_{In}$ . In this case, the supplier's incentives to lower marginal costs come from two sources. The supplier obtains one half of the respective incremental profits and, in analogy to the case with a binding outside option, a lower c now reduces the value of the buyer's inside option. Also in analogy to the case with a binding outside option (precisely, in analogy to Lemma 3), the latter effect is stronger the lower  $c_{In}$ . This implies that after a reduction of  $c_{In}$  the supplier's incentives are higher. In the final case, the outside option of  $B^i$  binds before but not after a the reduction in  $c_{In}$ , in which case it is intuitive that the supplier's incentives are lower.

The implications of a more attractive inside option for the supplier's incentives are thus in general ambiguous. Proposition 4 isolates the cases for which we can obtain unambiguous results.

**Proposition 4.** Suppose that buyers have in addition the "inside option" to purchase at costs  $c_{In} > c$ . If the inside option is made more attractive by lowering  $c_{In}$ , then the supplier's marginal

incentives at some given  $\Delta_S$  change as follows. If the outside option of all buyers does not bind before the reduction in  $c_{In}$ , then incentives are strictly higher with a lower  $c_{In}$ . If the outside option of all buyers binds before but not after the reduction in  $c_{In}$ , then the reduction in  $c_{In}$ lowers the supplier's incentives. If the outside option of all buyers binds after the reduction  $c_{In}$ , then incentives are not affected.

**Proof.** See Appendix.

# 5 Conclusion

We showed how the presence of larger buyers can make it more profitable for a supplier to reduce marginal costs. This result stands in stark contrast to an often expressed view whereby the exercise of buyer power stifles suppliers' investment incentives. In a model with bilateral negotiations, a supplier can extract more of the *incremental* profits of a cost reduction if it faces more powerful buyers, though the supplier's total profits decline. Furthermore, the presence of more powerful buyers creates additional incentives to lower marginal costs as this renders buyers' alternative supply options less valuable. The latter effect is due to downstream competition between buyers and, as we show, is also stronger the larger buyers are.

Our analysis focuses on incentives to reduce marginal costs. While we obtained what are arguably strong results for this particular case, we do not claim that our results apply more generally. For instance, a supplier could invest in product quality or in an advertising campaign aimed at increasing consumers' awareness of its product. Again, the presence of more powerful buyers may allow the supplier to extract more of the incremental profits generated from, say, an increase in product quality, while buyers' option to purchase a lower-quality good elsewhere may be much less profitable if other firms still sell the supplier's superior product. We leave a formal analysis of such alternative investments to further work.

Finally, we endogenized buyer power from buyers' size, which in turn generated more valuable alternative supply opportunities. Depending on the particular industry, there may be, however, other sources of buyer power. For instance, customers' loyalty to particular retail shops may make it less likely that they will shop elsewhere if these shops drop a single brand. Alternatively, a retailer may be able to capture some of the revenues that are lost by delisting a supplier's good through selling more of (though possibly inferior) own-label products. It is an open question how buyer power that originates from these alternatives sources could affect suppliers' incentives.

# **Appendix A: Proofs**

**Proof of Lemma 2.** We study first the properties of  $v_{Out}^i$ . These properties will then immediately lead to assertion ii) and the first part of assertion i). To study the properties of  $v_{Out}^i$ , we denote the set of optimal choices for  $\Delta_B^i$  by  $D_B^i$ . If following disagreement it is not optimal for  $B^i$  to remain active, it is uniquely optimal to set  $\Delta_B^i = 0$  such that  $v_{Out}^i = -F/n^i$ .<sup>31</sup> Otherwise, we have from the properties of  $K_B$  that all  $\Delta_B^i \in D_B^i$  satisfy  $\Delta_B^i > 0$  and  $0 < \Delta_B^i < \overline{c}_{Out}$  and, given the smoothness of the Cournot game and differentiability of  $K_B$ , that all  $\Delta_B^i \in D_B^i$  are determined by the respective first-order conditions. Note next that we can treat  $n^i$  as a continuos variable as all expressions in  $v_{Out}^i$  are also defined for real values  $n^i$ . From the envelope theorem,  $v_{Out}^i$  is then strictly increasing and strictly convex in  $n^i$ .

To complete the proof it remains to show that the set  $D_B^i$  is strictly increasing in  $n^i$ , provided that  $n^i$  is sufficiently large such that the buyer optimally chooses to be active after disagreement  $(n^i \ge \hat{n})$ . To see this, observe first that the cross-derivative of

$$n^{i} \max_{q} \left[ R(q, q_{S}) - q(\overline{c}_{Out} - \Delta_{B}^{i}) \right] - K_{B}(\Delta_{B}^{i})$$

with respect to  $\Delta_B^i$  and  $n^i$  is strictly positive. The asserted property of  $D^i$  follows then from standard comparative statics results (see, for instance, Vives (1999)). **Q.E.D.** 

**Proof of Lemma 3.** Here and in what follows, we denote the set of the supplier's optimal choices for  $\Delta_S$  by  $D_S$ . By our assumptions on  $K_S$  and by Assumption 3, we have that  $\Delta_S > 0$  for all  $\Delta_S \in D_S$ . Denote next the subset of buyers that we combine to form a larger buyer by  $\hat{I}$ . Suppose that before this merger, the outside option was binding for buyers in the set  $\hat{I'} \subseteq \hat{I}$  and not binding for the buyers in the complementary set  $\hat{I}/\hat{I'}$ . We denote the total number of firms controlled by the merged buyer by  $\hat{n} = \sum_{i \in \hat{I}} n^i$ . Note next that from Lemma 1 and Proposition 1 negotiations with all buyers  $i \in I/\hat{I}$  are not affected by the formation of a larger buyer out of buyers  $B^i$  with  $i \in \hat{I}$ . Hence, to compare incentives we only have to compare the derivative of

<sup>&</sup>lt;sup>31</sup>Note that  $v_{Out}^i$  is calculated irrespective of whether vertical integration is more profitable than staying inactive or not.

 $\sum_{i\in\hat{I}} \tau^i$  w.r.t.  $\Delta_S$ , which sums up the respective fixed transfers of the merging buyers, with the derivative of the *single* transfer that is subsequently paid by the merged buyer, which we denote by  $\hat{\tau}_S$  (in a slight abuse of notation). Likewise, we denote the merged buyer's outside option by  $\hat{v}_{Out}$ .

We now distinguish between two cases. If the outside option is not binding for the merged buyer, then by Lemma 2 it is also not binding for all  $i \in \hat{I}$  before the merger. Consequently, we have from Proposition 1 that<sup>32</sup>

$$\frac{d}{d\Delta_S} \sum_{i \in \widehat{I}} \tau^i = \frac{d}{d\Delta_S} \widehat{\tau}_S = \frac{1}{2} \widehat{n} \frac{d}{dc} \left[ R(q_S, q_S) - cq_S \right].$$
(13)

Suppose next that the merged buyer's outside option is binding. It is now helpful to introduce some additional notation for this case. For this purpose, take some buyer  $B^i$ . If this buyer's outside option is binding, then we have that  $\Delta_B^i > 0$  for all  $\Delta_B^i \in D_B^i$ . (Recall that  $D_B^i$  denotes the set of optimal values  $\Delta_B^i$  that are chosen by  $B^i$  after disagreement.) From Assumption 1, we further have that for given  $\Delta_B^i$  (and given  $q_S$ ) there is a unique corresponding optimal quantity  $q^i > 0$  that  $B^i$  chooses at all of its controlled  $n^i$  firms. If the set  $D_B^i$  is not singular, we denote the set of corresponding optimal choices of  $q^i$  by  $Q^i$ . We already know from Lemma 2 that  $D_B^i$  is strictly increasing in  $n^i$  - that is, provided the buyer remains active after disagreement as  $n^i$  is sufficiently large. As the cross-derivative of the buyer's disagreement payoff w.r.t.  $\Delta_B^i$ and q is strictly positive, we have from standard comparative statics results (see also Lemma 2) that  $Q^i$  is strictly increasing in  $n^i$ . The finding that  $Q^i$  is strictly increasing in  $n^i$  will be useful later in the proof. Next,  $v_{Out}^i$  is continuous and non-increasing in  $q_S$ , implying that it is almost everywhere continuously differentiable.<sup>33</sup> The derivative is  $dv_{Out}^i/dq_S = n^i q^i P'(q_S + q^i)$ .

Proceeding likewise for the merged buyer, we denote (once more in a slight abuse of notation) the optimal choice of cost reductions after disagreement by  $\widehat{\Delta}_B \in \widehat{D}_B$  and the corresponding optimal (per-firm) quantities by  $\widehat{q} \in \widehat{Q}$ . The resulting payoff for the merged buyer is now  $\widehat{v}_{Out}$ with respective derivative  $d\widehat{v}_{Out}/dq_S = \widehat{n}\widehat{q}P'(q_S + \widehat{q})$ .

Using these results and Proposition 1, we then have for the case where the merged buyer's

<sup>&</sup>lt;sup>32</sup>There is no need to write out the derivative in rectangular brackets, which is  $q_S - \frac{dq_S}{dc} \frac{d}{dq_S} [\pi(q_S, q_S) - cq_S]$ . Note that  $q_S$  is continuously differentiable from our assumptions on the inverse demand P, while  $dq_S/dc < 0$ .

<sup>&</sup>lt;sup>33</sup>Precisely,  $v_{Out}^i$  is continuously differentiable whenever  $Q^i$  is singular.

outside option is binding that

$$\frac{d}{d\Delta_S}\hat{\tau}_S = \hat{n}\frac{d}{dc}\left[R(q_S, q_S) - cq_S\right] - \frac{d\hat{v}_{Out}}{dq_S}\frac{dq_S}{dc}$$
(14)

and

$$\frac{d}{d\Delta_S} \sum_{i \in \widehat{I}} \tau^i = \sum_{i \in \widehat{I'}} \left[ n^i \frac{d}{dc} \left[ R(q_S, q_S) - cq_S \right] - \frac{dv^i_{Out}}{dq_S} \frac{dq_S}{dc} \right] + \left( \sum_{i \in \widehat{I/I'}} n^i \right) \frac{1}{2} \frac{d}{dc} \left[ R(q_S, q_S) - cq_S \right].$$
(15)

We want to show that (14) is strictly higher than (15). To see this, note first that by Assumption 3 we have that  $d[R(q_S, q_S) - cq_S]/dc > 0$ . Next, observe that  $dv_{Out}^i/dq_S < 0$  for all  $i \in \hat{I}$  and that also  $d\hat{v}_{Out}/dq_S < 0.^{34}$  We finally show that for all  $i \in \hat{I}$  it holds that

$$\sum_{i \in \widehat{I}'} \frac{dv_{Out}^i}{dq_S} > \frac{d\widehat{v}_{Out}}{dq_S}$$

which in turn surely holds if we have for all  $i \in \widehat{I}'$  that

$$q^i P'(q_S + q^i) > \hat{q} P'(q_S + \hat{q}).$$

$$\tag{16}$$

To see that (16) holds, note first that the expression  $qP'(q_S + q) < 0$  is by Assumption 1 strictly decreasing in q.<sup>35</sup> The assertion thus follows from our previous observation that  $Q^i$  is strictly increasing in  $n^i$ . This completes the proof of Lemma 3. **Q.E.D.** 

**Proof of Corollary 1.** We denote the supplier's optimal choice before the merger by  $\widetilde{\Delta}_S$  and its choice after the merger by  $\widehat{\Delta}_S$ , where we have  $\widehat{\Delta}_S > \widetilde{\Delta}_S$  if the merger changes the supplier's choice. Suppose first that for the considered buyer  $B^i$  the outside option does not bind at  $\widetilde{\Delta}_S$ . As the joint surplus  $R(q_S, q_S) - cq_S$  is strictly decreasing in c and as  $v_{Out}^i$  is non-increasing in c(it is strictly decreasing whenever  $v_{Out}^i \ge 0$ ), it follows from (3) that the outside option is also not binding at  $\widehat{\Delta}_S$ . Given that the payoff of  $B^i$  is equal to  $[R(q_S, q_S) - cq_S]/2$  from (4),  $B^i$  is by

<sup>&</sup>lt;sup>34</sup>It should be recalled that according to our definition the outside option is binding whenever (3) in Proposition 1 does not hold, implying from continuity that it remains binding also after a marginal adjustment of c and thus of  $q_s$ .

<sup>&</sup>lt;sup>35</sup>To be precise, note that differentiating  $qP'(q_S + q)$  w.r.t. q gives  $qP''(q_S + q) + P'(q_S + q)$ . By P' < 0 (wherever P > 0) this is surely negative if also  $P'' \leq 0$ . For the case where P'' > 0 note that by Assumption 1 we have QP''(Q) + P'(Q) < 0, where  $Q = q_S + q$ , which is a weaker condition.

Assumption 3 strictly better off after the merger if this lowers marginal costs, while otherwise  $B^i$ is not affected. Suppose next that the outside option of  $B^i$  binds at  $\widehat{\Delta}_S$ . By the same argument as before, the outside option of  $B^i$  is then also binding at  $\widetilde{\Delta}_S$ . As  $v_{Out}^i$  is now strictly decreasing in  $\Delta_S$  given that  $V_{Out}^i = v_{Out}^i > 0$ ,  $B^i$  is now strictly worse off after the merger if this lowers marginal costs. **Q.E.D.** 

**Proof of Proposition 4.** Suppose first that the outside option for all buyers does not bind before the reduction in  $c_{In}$ . As  $V_{Ou}^i$  is unaffected by  $c_{In}$  while  $V_{In}^i$  is nondecreasing (and strictly increasing for all  $V_{In}^i > 0$ ), we have from (10) that the outside option for all  $B^i$  does also not bind after the reduction in  $c_{In}$ . As all  $\tau^i$  are then given by (11), we have both before and after the reduction of  $c_{In}$  that

$$m = -N \frac{d[R(q_S, q_S) - q_S c]}{dc} - \frac{1}{2} \sum_{i \in I} \frac{dV_{In}^i}{d\Delta_S},$$
(17)

wherever U is differentiable. Let now  $q^i$  denote the by Assumption 1 unique optimal quantity choice of  $B^i$  under the inside option of purchasing at  $c_{In}$ . Then unless  $q^i = 0$  such that  $dV_{In}^i/d\Delta_S = 0$ , we have from (9) that

$$\frac{dV_{In}^i}{d\Delta_S} = n^i \frac{dq_S}{d\Delta_S} q^i P'(q_S + q^i).$$
(18)

Given (17) and (18), the rest of the argument is then identical to that in Lemma 3.

Suppose next that the outside option for all buyers binds before but not after the reduction in  $c_{In}$ . Consequently, after the reduction in  $c_{In}$  the marginal incentives m are still given by (17), where we can substitute from (18). Before the reduction in  $c_{In}$ , we have that

$$m = -2N \frac{d[R(q_S, q_S) - q_S c]}{dc} - \frac{1}{2} \sum_{i \in I} \frac{dV_{Out}^i}{d\Delta_S}.$$
(19)

Denoting this time by  $q^i$  the optimal quantity choice of  $B^i$  after backward integration and after choosing some  $\Delta_B^i \in D_B^i$ , we have

$$\frac{dV_{Out}^i}{d\Delta_S} = n^i \frac{dq_S}{d\Delta_S} q^i P'(q_S + q^i), \tag{20}$$

which can be substituted into (19). That (19) is strictly larger than (17) follows again from the arguments in Lemma 3. Precisely, we can use that  $d[R(q_S, q_S) - q_S c]/dc < 0$  by Assumption 3 and that  $c_{Out}^i < c_{In}$ , which from  $F \ge 0$  and  $K_B \ge 0$  follows strictly from the assumption that the outside option is binding and thus more attractive than the inside option. Q.E.D.

# 6 Appendix B: A Non-Cooperative Bargaining Model with Outside and Inside Options

We consider an alternating-offer bargaining game with the following features. Time proceeds in equally spaced periods of length z > 0, which are denoted by h = 0, 1, and so on. Buyers and suppliers are eager to avoid delay as they discount payoffs. We could incorporate different sharing rules by letting the supplier and the various buyers  $B^i$  have different interest rates. As discussed in the main text, lacking a theory of how size affects buyers' impatience and thus their respective discount factors, we choose for all players the same interest rate r > 0. Bargaining proceeds pairwise, i.e., between I buyers and the I agents of the supplier. As we will focus on the limit where  $z \to 0$ , it is without consequences that we let the supplier's agents make the first proposal in h = 0.

We now express supply relations as infinite flows of quantities and transfers. This ensures that if there is delay with one buyer, other firms can already start to purchase and sell. Otherwise, i.e., in a model with a one-shot purchase and sale decision, the delay of one buyer would hold up purchases and sales by all other buyers, which seems artificial. Hence, if the supplier produces the constant flow quantity q, then its flow costs are cq. Likewise,  $R(\cdot)$  denotes now the flow of revenues, while a contract specifies the fixed flow of transfers  $\tau^i$  together with the flow  $qw^{i}$ .<sup>36</sup>

The model incorporates both inside and outside options. In a period h where no agreement has been reached between  $B^i$  and the supplier but where also no side has yet walked away from the negotiations, a buyer has the inside option to purchase at the flow costs  $c_{In}$ . If instead the outside option is taken up after disagreement,  $B^i$  can instantaneously rely on a supply at marginal costs  $c_{Out}^i$ , but has to incur the respective (discounted) costs  $F + K_B(\Delta_B^i)$ .<sup>37</sup> We still define  $V_{In}^i$  as in (9), though this is now in flow terms. On the other hand, the outside option of

<sup>&</sup>lt;sup>36</sup>We allow firms in the Cournot game to adjust quantities instantaneously and focus on the competitive (Markov) equilibrium. Results would be unaffected if firms could only adjust quantities each period h or if they had to fix quantities once and for all after deciding which source of supply to use. Off equilibrium, i.e., when there is delay with  $B^i$  or when the two sides have split up unsuccessfully, all firms that are not controlled by  $B^i$  will still choose  $q_S$ . This can be supported by beliefs that attribute any other observable quantity choice (or a change in price) to a temporary deviation by the respective firm and not to final break-up of negotiations between the supplier and the respective buyer.

 $<sup>^{37}</sup>$ It is straightforward to incorporate some fixed real time Z > 0 that it could take to build up own production facilities.

backward integration is stated as the discounted value of the future stream of payoffs :

$$v_{Out}^{i} := \max_{\Delta_{B}^{i}} \left\{ \frac{1}{r} n^{i} \max_{q} \left[ R(q, q_{S}) - (\bar{c}_{Out} - \Delta_{B}^{i})q \right] - K_{B}(\Delta_{B}^{i}) - F \right\}.$$
 (21)

In what follows, we focus on equilibria where all negotiations lead to an immediate agreement.<sup>38</sup> The net surplus in each bilateral negotiation is again  $n^i[R(q_S, q_S) - cq_S] - V_{In}^i$ , though this is now in terms of flows. As  $z \to 0$ , we find that the surplus is split equally given that both sides are equally impatient. This together with  $w^i = c$ , which holds from Lemma 1, pins down  $\tau^i$  for each  $B^i$ , that is unless  $\tau^i$  is determined by the binding outside option.

**Proposition B1.** The non-cooperative bargaining game has a unique equilibrium without delay. All contracts specify  $w^i = c$ , while as  $z \to 0$  all  $\tau^i$  are determined as follows. If

$$\frac{1}{2} \left[ n^{i} \left[ R(q_{S}, q_{S}) - cq_{S} \right] + V_{In}^{i} \right] \frac{1}{r} \ge V_{Out}^{i},$$
(22)

then  $\tau^i$  satisfies

$$\tau^{i} = \frac{1}{2}n^{i}[R(q_{S}, q_{S}) - q_{S}c] - \frac{1}{2}V_{In}^{i}.$$
(23)

Otherwise, we have that

$$\tau^{i} = n \left[ {}^{i} R(q_{S}, q_{S}) - q_{S} c \right] - r V_{Out}^{i}.$$

$$\tag{24}$$

**Proof.** Given that we focus on equilibria without delay, in a bilateral negotiation with  $B^i$  we can take all contracts with buyers  $B^j$  and  $j \neq i$  as given. Also, as already argued for Lemma 1, the agreement with  $B^i$  has no implication for the supplier's payoff from all other buyers  $B^j$ . Consequently, we can consider the negotiations with  $B^i$  in isolation, which in turn allows us to draw on results from standard bilateral alternating-offer bargaining.<sup>39</sup>

There is a unique (subgame perfect) pair of offers that are made whenever it is the turn of  $B^i$ or of the supplier's agent (though, in equilibrium the game will end in h = 0 with the immediate acceptance of the supplier's offer). Both offers are efficient in that they specify  $w^i = c$ . Denote the transfer offered by the buyer by  $\tau_B^i$  and that offered by the supplier by  $\tau_S^i$ . The respective

<sup>&</sup>lt;sup>38</sup>The equilibrium without delay is not the unique sequential equilibrium. In particular, given the repeated interaction firms could collude in the final market, while if we either allowed for also short-term contracts or renegotiations then also the opportunism problem may be overcome or at least mitigated in some equilibria.

<sup>&</sup>lt;sup>39</sup>See Rubinstein (1982) for the seminal paper on the open-horizon alternating-offer game.

offer makes the other side just indifferent between acceptance and rejection. We first ignore the outside option. Then, the buyer's alternative is to rely on its inside option for one (more) period and offer  $\tau_B^i$  in the next period, which the supplier will accept. The buyer's discounted value of using the inside option over a period of time z equals  $(1 - e^{-rz})/r$  times  $V_{In}^i$  (as defined in (9)). Hence,  $\tau_B^i$  and  $\tau_S^i$  are determined by the two indifference conditions

$$\frac{1}{r}n^{i}\left[R(q_{S},q_{S})-cq_{S}-\tau_{S}^{i}\right] = \frac{1-e^{-rz}}{r}V_{In}^{i} + \frac{e^{-rz}}{r}n^{i}\left[R(q_{S},q_{S})-cq_{S}-\tau_{B}^{i}\right],$$
$$\frac{1}{r}\tau_{B}^{i} = \frac{e^{-rz}}{r}\tau_{S}^{i},$$

respectively. Solving out and taking limits for  $z \to 0$  yields  $\tau_B^i \to \tau^i$  and  $\tau_S^i \to \tau^i$ , where  $\tau^i$  is given by (23). Finally, if  $\tau_S^i$  does not match the value of the buyer's outside option, then in the unique equilibrium  $\tau^i = \tau_S^i$  is determined by (24).<sup>40</sup> **Q.E.D.** 

It is now easily checked that after discounting flows (by dividing through r), (22)-(24) transform into (10)-(12) and vice versa.

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 $<sup>^{40}</sup>$ There is no need to take the limit as we specified that a buyer who decides to quit negotiations can take up its outside option immediately.

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