Countervailing Power and Dynamic Efficiency*

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July 2007

Abstract

This paper studies the impact of buyer power on dynamic efficiency. For this purpose we consider a bargaining model in which buyer power arises endogenously from size and may impact on a supplier's incentives to invest in lower marginal cost. We challenge the view frequently expressed in policy circles that the exercise of buyer power stifles suppliers' incentives. Instead, we find that the presence of larger buyers keeps a supplier more on his toes in inducing him to improve the competitiveness of his offering relative to these buyers' alternative options.

Keywords: Buyer Power; Countervailing Power; Dynamic Efficiency.

*Roman Inderst acknowledges financial support from the ESRC grant on "Buyer Power in Retailing." The first draft of this paper circulated under the title "How Stronger Buyers Spur Upstream Innovation"(CEPR DP 5365). We thank Helmut Bester, Stephane Caprice, Paul Dobson, and participants at various seminars and conferences (2006 IIO in Boston; 2006 EARIE in Amsterdam; 2006 WZB in Berlin; 2006 INRA/IDEI in Toulouse) for helpful comments.

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1 Introduction

The study of how market structure affects dynamic efficiency has received much attention both in academic writing and antitrust policy, primarily with respect to the impact that market power can have on incentives to invest and innovate. This paper deals, instead, with the exercise of power in vertical relations and how this affects dynamic efficiency. Its main purpose is to inform the policy discussion on the exercise of buyer power,which is of increasing concern to antitrust authorities.

Retailing, in particular in fast-moving consumer goods, provides a prominent example. There, the formation of ever larger multinational retailers and the spread of ever larger store formats has increasingly shifted bargaining power to these retailers. As has been documented in numerous recent policy reports, this has put suppliers under increasing pressure.[1] At the European level, some of the recent retail mergers where buyer power played an important role are Rewe/Meinl, Kesko/Tuko, and Carrefour/Promodes.[2] In the UK, buyer power played a key role in the various recent investigations into the national grocery retail market.[3] Buyer power continues to play a key role in the ongoing inquiry.[4] Also, the case of the UK is of particular interest as, similar to Australia, concerns of buyer power have lead to the introduction of a "Code of Practice" that the country's key retailers have to follow in their dealing with suppliers.[5]

This paper isolates one of the concerns that is frequently raised in relation to the exercise of buyer power, namely that it stifles suppliers' incentives to invest and innovate.[6] We analyze this assertion in a model of bilateral bargaining that allows to explicitly relate investment incentives

[1] See, for instance, "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" (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).

[2] Case no IV/M.1221, Case no IV/M.784, and Case no IV/M.1684, respectively.

[3] See, for instance, Competition Commission (2003) on the acquisition of Safeway.

[4] See http://www.competition-commission.org.uk/inquiries/ref2006/grocery/index.htm.

[5] The experience in the UK and Europe is discussed in detail in Dobson (2002, 2005). Across the Atlantic, the Antitrust Law Journal has recently dedicated a special issue to this topic (Volume 2 in 2005).

[6] Explicitly, the FTC's 2001 report expresses the concern that when facing increasingly powerful buyers, "suppliers respond by under-investing in innovation or production" (FTC, 2001, p. 57). Likewise, in Euopean Commission (1999, p. 4) it is suggested that when facing powerful buyers, suppliers may "reduce investment in new products or product improvements, advertising and brand building". As a final example for a different industry, Pitofsky (1997) expresses similar concerns for the US health industry.

to buyer power. The model also derives from first principles how buyer power relates to size and, thereby, to changes in the downstream market structure that suppliers face.

In our model, larger buyers obtain better terms of trade such that following an increase in retail concentration a supplier's total profits are lower. From a hold-up perspective, it could thus be indeed reasoned that this should stifle suppliers' incentives.[7] This observation has been recently formalized in Chen (2004) as well as Battigalli, Fumagalli, and Polo (2006).[8] Our results will be markedly different: The formation of larger and consequently more powerful buyers will keep a supplier on his toes and increase incentives to invest.

Our focus is on *marginal* incentives, for which a supplier's total profits are, as we find, not informative enough. Moreover, while Chen (2004) explores an exogenous shift in a buyer's bargaining power, which allows the buyer to extract a higher (constant) fraction of any incremental profits, we study an exogenous shift in size. We find that if buyer power derives from an increase in size, then a more powerful buyer may extract a larger share of joint total profits but less of incremental profits, which in turn determine a supplier's marginal incentives.[9] Moreover, in difference to Battigalli, Fumagalli, and Polo (2006) our analysis focuses on how a buyer's outside option in negotiations is affected by the interplay of size and a supplier's investment. As we explore below in detail, such a focus on outside options seems to be particularly justified in the presence of already large and powerful buyers.[10]

In our model, we isolate several effects that all support the view that the exercise of bargaining power by large buyers can actually *increase* a supplier's incentives. What is crucial for this result to hold is both the focus on buyers' outside options in negotiations as well as the fact that buyers compete in the downstream (retail) market.[11] The role of downstream competition

[7] We restrict attention to investments where incentives can not be adequately provided through contractual means. 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.

[8] 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 Fumagalli and Motta 2007).

[9] It may be reasonable, though, to presume that other sources of buyer power (e.g., related to financial strength or reputation) could be more adequately formalized as an exogenous change in the sharing rule as in Chen (2004).

[10] As Battigalli, Fumagalli, and Polo (2006) as well as Chen (2004) focus on investment in quality, it remains to be analyzed how the outcome from our modelling approach would compare to theirs in a similar setting. This might provide a fruitful avenue for future research.

[11] This represents a key difference to the approach taken in Inderst and Wey (2003, 2007) and Vieira-Montez (2005), where buyers do not compete while buyer power derives from the presence of convex costs or capacity

derives from the fact that for any given buyer the value of his alternative supply option is lower as the supplier can produce more efficiently. This in turn follows as after a reduction of the supplier's own marginal cost a buyer's rivals that still purchase from the supplier can do so at lower marginal prices and thus become more competitive in the retail market.[12] This negative impact on a buyer's outside option then increases a supplier's incentives to further reduce own marginal cost. Importantly, we find that this effect becomes stronger as there are fewer but larger buyers.

In addition, if we employ a bargaining solution that satisfies the well-known "outside option principle", then there are additional effects at work that further increase a supplier's incentives as there are fewer but larger buyers.[13] Intuitively, this holds as under the "outside option principle" the value of a buyer's outside option only affects the outcome of negotiations if the respective outside option is sufficiently attractive, which in our model will be the case if a buyer is sufficiently large. Once a buyer's outside option binds, this entails two differences. First, under the "outside option principle" the large buyer's payoff is then entirely determined by the value of his outside option, which in turn implies that the supplier can pocket all incremental profits from a marginal reduction in costs. This further increases the supplier's incentives.[14] Moreover, once a buyer become sufficiently large such that its outside option starts to bind, then also the previously discussed effect kicks in, namely that the supplier's incentives are further increased as any reduction in the supplier's marginal cost undermines the value of the large buyer's outside option. In sum, under a bargaining solution that satisfies the "outside option principle", several effects now work in the same direction, namely towards an increase of the supplier's incentives if there are fewer but larger buyers.

In line with the growing interest in antitrust, more recently the academic literature on

constraints. More formally, in this case larger buyers obtain a discount as they negotiate less "at the margin," where incremental costs are highest. (This follows Chipty and Snyder 1999 and is further extended in Smith and Thanassoulis 2006 through introducing uncertainty). In the presence of larger buyers a supplier has less incentives to reduce capacity or, more generally, to make his cost function "more convex" so as to extract a larger share of profits.

[12] Such a strategy to undermine the value of buyers' outside options is also considered in Caprice (2006).

[13] We discuss the application of the "outside option principle" in more detail further below. (On this principle see Binmore et al. 1986.)

[14] This insight is also used in DeMeza and Lockwood (1998) and Chiu (1998). There are, however, several important 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.

buyer power has made further progress (see, for instance, the survey in Inderst and Mazzarotto, 2006). Our model of buyer power further develops the approach pioneered by Katz (1987), which provides a particularly parsimonious treatment of buyer power from first principles. Here, larger buyers have a more attractive outside option as they can distribute over more units any fixed costs that arise from searching and choosing an alternative source of supply. Our analysis also focuses on the long-run implications of the exercise of buyer power and thus abstracts from any short-run implications on retail prices that would arise, in particular, under linear contracts (cf. Dobson and Waterson 1997 and von Ungern-Sternberg 1996).[15] As the short-run implications are known to depend crucially on the type of considered contract, it could be thought that the consideration of dynamic efficiencies provides more robust predictions. Our analysis and results provide, however, some warning against a too naive assessment. In particular, we show that it is premature to conclude from a reduction in suppliers' overall profits that their incentives to invest and innovate are lower.

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 an identical production function that transforms one unit of the input into one unit of the output.[16]

There are $N \geq 2$ independent markets. In each market two competing firms are active. The $2N$ downstream firms are owned by a number $I \geq 2$ of intermediaries, to which we simply refer to as buyers. A given buyer i, where $1 \leq i \leq I$, owns n^i firms in separate markets. This rules

[15] More recently, Chen (2003) has extended this setting by using linear contracts only with respect to a market fringe while allowing for non-linear contracts with the large buyer.

[16] This description would fit the retailing industry. Given symmetry of production functions, though, this specification is not important for our results.

out standard monopolization effects. It also allows us to treat all N markets symmetrically, regardless of the number and size of buyers. After presenting our main results, we comment more on these assumptions in the light of a particular application, namely retailing.

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 $\widehat{q}$, the first firm's revenues are given by $R(q, \widehat{q}) := qP(q+\widehat{q})$, where $P(\cdot)$ denotes the inverse demand function. The supplier has constant marginal costs of production $c \geq 0$. It is convenient to assume that P is twice continuously differentiable where positive. 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.[17]

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 symmetric quantities, 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 Stages of the Model

There are three 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 i are up for renewal. Alternatively, our model may capture the introduction of a new product.[18] At the final stage, downstream firms compete in the N local markets.

[17] See, for instance, Vives (1999).

[18] This could also justify why there is currently only a single (incumbent) supplier. Note, however, that our main insights are easily extended to the case where different buyers currently purchase from different suppliers.

Turning to a description of the first stage, it is convenient to suppose that originally the supplier has constant marginal cost $\overline{c} > 0$. The supplier can now choose at costs $K_S(\Delta_S)$ a reduction of marginal cost by $\Delta_S \geq 0$ such that ultimately $c = \overline{c} - \Delta_S$, where $0 \leq \Delta_S \leq \overline{c}$. We stipulate that K_S is strictly increasing and satisfies $K_S(0) = 0$. It is also convenient to assume that K_S 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 $t^i(q) = \tau^i + qw^i$. The use of two-part tariffs deserves some comments. First, with two-part tariffs we can abstract from well-known issues related to double-marginalization. Second, in the set of non-linear tariffs the further restriction to two-part tariffs is relatively innocuous. As will become clear in what follows, our unique equilibrium with two-part tariffs would also be an equilibrium if we allowed for more general menus $t^i(q)$. In this respect, the two-part tariffs should also not be interpreted too literally. Though in equilibrium the buyer will make a fixed lump-sum transfer τ^i to the supplier, this does not suggest that we should necessarily observe such transfers in practice.[19] 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 may follow Katz (1987) and suppose that after disagreement buyers have the option to integrate backwards. When integrating backwards, a buyer must incur the fixed costs $F \geq 0$. The attractiveness of the buyer's new supply option depends on the resources that the buyer spends at this stage. A given buyer i that integrates backwards also controls its (new) marginal cost c^i_{Out}. Again, it is convenient to suppose that without any investment we have that $c^i_{Out} = \overline{c}_{Out}$, while with expenditures $K_B(\Delta^i_B)$ these costs can be reduced to $c^i_{Out} = \overline{c}_{Out} - \Delta^i_B$, where $0 \leq \Delta^i_B \leq \overline{c}_{Out}$. We specify that $K_B(0) = 0$, while K_B is twice continuously differentiable with $K_B'(0) = 0$ and $K_B'(\Delta^i_B) \to \infty$ for $\Delta^i_B \to \overline{c}_{Out}$.

While interpreting the alternative supply option as backward integration is convenient, we need only that generating the alternative supply option involves a certain amount of fixed costs,

[19] It is well-known that retailers sometimes charge suppliers up-front transfers in the form of slotting fees.

i.e., $F + K_B$ in the chosen setting.[20] These could also be incurred through searching for a new source of supply. Likewise, these costs may arise when reorganizing the purchasing and distribution system. Finally, some of these costs may also arise at a newly chosen 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.[21] We employ the axiomatic Nash bargaining solution.[22]

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. Recall first that contracts can specify a fixed fee τ^i. This allows to fully disentangle the issue of maximizing joint profits from that of how to share the realized surplus. Next, 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 buyer i. If a mutually beneficial agreement with buyer i is feasible, it is thus 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

[20] Note that while K_B clearly depends on the investment, it is still independent of the subsequently produced quantity. Without changing results we could, however, also introduce another, variable component.

[21] 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.

[22] A different approach, building on the Shapley value, has been used, for instance, in Inderst and Wey (2003) or deFontenay and Gans (2005). Both papers also endogenize the use of the Shapley value. (The approach in Inderst and Wey 2003 is further extended in deFontenay and Gans 2006).

Schwartz (1994), or O'Brien and Shaffer (1994).[23] In these papers, the supplier typically makes simultaneous offers to all downstream firms.[24] 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 "passive beliefs." Passive beliefs specify that when receiving an unanticipated offer a firm believes that the supplier did not simultaneously adjust its offer to other firms. Our specification that the supplier negotiates through I agents has the same implications.

By Lemma 1, the supplier's total profit is equal to the sum of all agreed fixed transfers τ^i. One implication of this is that an individual agreement does not affect the supplier's profits from all other potential agreements. If all other negotiations are successful, an agreement with buyer i, which controls n^i firms, then generates the joint profits[25]

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

where we substituted the respective equilibrium quantities q_S. Suppose now first that buyer i would cease to operate when negotiations break down. (For instance, the fixed costs F from integrating backwards could be too high.) According to the general Nash bargaining solution, τ^i would then be determined by the requirement that the profits of buyer i are equal to some fraction $0 \leq \rho^i \leq 1$ of the joint profits (1).

We choose not to model a change in buyer power through an exogenous variation in ρ^i. This follows from the fact that we are primarily interested in the role of a buyer's size. To our knowledge, there does not exist a formal argument for how size would affect ρ^i (e.g., through affecting a buyer's discount factor in an underlying non-cooperative model of bargaining). Remaining agnostic about the sharing rules ρ^i, we thus stipulate that buyers and the supplier have equal bargaining power such that ρ^i is equal to one half for i.[26]

If one half of the joint profits (1) already exceeds the value of the respective buyer's alternative

[23] We follow these papers in assuming that contractual ways to achieve the monopoly outcome (e.g., by granting exclusivity) are not credible or not feasible, e.g., as they would constitute a non-permissible vertical restraint.

[24] A notable exception is O'Brien and Shaffer (1994), who adopt an axiomatic Nash bargaining approach.

[25] 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 such mutually beneficial renegotiations.

[26] 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 ρ (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.

supply option, the threat to take up this option 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 value of the buyer's alternative supply option fully determines the buyer's payoff from the negotiation. In what follows, we first employ the "outside option principle," which will allow for a richer set of effects. In Appendix B we set up and solve a non-cooperative bargaining model in the spirit of Binmore, Rubinstein, and Wolinksy (1989) and provide a foundation for the chosen solution concept in our model. Moreover, in Section 4 we analyze our model under a solution concept where the "outside option principle" does not apply and show that our results still hold.

The value of the outside option of buyer i, which we denote by V^i_{Out}, is now derived as follows. When choosing the alternative supply option, the buyer can also decide on the amount $K_B(\Delta^i_B)$ that it wants to invest in order to reduce its own future marginal cost from $\overline{c}_{Out}$ down to $c^i_{Out} = \overline{c}_{Out} - \Delta^i_B$. Working backwards, if buyer i decides to integrate backwards then the maximum profits from this strategy are equal to[27]

$$v^i_{Out} := \max_{\Delta^i_B} \left\{ n^i \max_q \left[R(q, q_S) - (\overline{c}_{Out} - \Delta^i_B) q \right] - K_B(\Delta^i_B) - F \right\}. \tag{2}$$

As there is always the option not to be active any longer, the outside option of buyer i has thus the value $V^i_{Out} = \max\{0, v^i_{Out}\}$. To ensure that there is indeed scope for a mutually beneficial agreement with all buyers, we make the following assumption.[28]

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

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 i specifies $w^i = c$, while*

[27] We already use that in equilibrium negotiations with all other buyers will be successful. Recall also that buyers' respective own marginal costs are mutually observable.

[28] Assumption 2 is stronger than needed as it will have to hold only "sufficiently close" to the equilibrium choice 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 $\overline{c}_{Out}$ (in comparison to $\overline{c}$) and on K_B (in comparison to K_S) that ensure that Assumption 2 holds.

the agreed fixed transfer τ^i *is determined as follows. If*

$$\frac{1}{2}n^i[R(q_S, q_S) - q_S c] \geq v^i_{Out}, \tag{3}$$

then τ^i *satisfies*

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

Otherwise, we have that

$$\tau^i = n^i\,[R(q_S, q_S) - q_S c] - v^i_{Out}. \tag{5}$$

In what follows, we refer to the case where condition (3) does not hold, i.e., where τ^i is determined by equation (5), as the case where the outside option of buyer i *binds.*

Note finally that the chosen bargaining solution allows the supplier to discriminate between different buyers. In the present setting, discriminatory pricing arises due to the different values of buyers' outside options, which in turn depend on buyers' different size.

3 Analysis

3.1 Buyer Size and Outside Options

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. This would be the case if the option to switch to an alternative source of supply is unattractive as already the associated lump-sum costs, F, are sufficiently high. Note next that the average price that buyer i pays in equilibrium 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 τ^i from equation (4) in case no buyer's outside option binds the average purchasing price of some buyer 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 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 N independent markets. The size of individual buyers starts 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 firms n^i that a buyer controls. We next provide an intuition for this result.

When making use of its alternative supply option (e.g., through backward integration), a buyer incurs two types of costs: F and the additional investment costs $K_B(\Delta_B^i)$, which depend on the (optimally) chosen level of cost reduction Δ_B^i. The larger n^i, the larger is the total quantity over which the buyer can distribute these costs. As a consequence, the value of a buyer's outside option increases more than proportionally with n^i, i.e., v_{Out}^i/n^i is strictly increasing in n^i, implying ultimately that the buyer's average purchasing price is lower. More formally, substituting τ^i from (5) in Proposition 1 into the average price μ^i as given by (6), we can confirm from

$$\mu^i = P(2q_S) - \frac{v_{Out}^i}{n^i q_S}$$

that μ^i is then indeed strictly decreasing in n^i if this holds for the ratio v_{Out}^i/n^i.

At this point, it is also useful to note that as a buyer controls more firms, the buyer will invest more in order to reduce its own marginal cost c_{Out}^i.

Lemma 2. *Holding the supplier's marginal cost c constant, a buyer's size has the following impact on the value of the buyer's outside option V_{Out}^i and thereby on the respective bargaining outcome. Unless the outside option does not bind for any size $n^i \leq N$, there exists a threshold $1 \leq \widehat{n} \leq N$ such that for all buyers with size $n^i < \widehat{n}$ the outside option is not binding, while it is binding for all buyers with size $n^i \geq \widehat{n}$. Moreover, for all $n^i < \widehat{n}$ the average purchasing price μ^i is identical, while μ^i is strictly decreasing in n^i if $n^i \geq \widehat{n}$.*

Proof. See Appendix A.

3.2 Supplier's Incentives

We turn now to the first stage of our model, where the supplier invests in a reduction of own marginal cost. Recall that as the supplier sells at a constant marginal price that is equal to marginal cost c, the supplier's profit is then just equal to the sum of all fixed transfers τ^i. Consequently, the supplier optimally chooses its marginal cost $c = \bar{c} - \Delta_S$ so as to maximize the *ex-ante* profit

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

where the transfers τ^i are determined by equations (4) or (5), respectively. It is now easily checked (and verified in the following proofs) that U is continuous and almost everywhere differentiable in Δ_S. To analyze the supplier's incentives, define thus the derivative $m := dU/d\Delta_S$ at all points where U is differentiable.

We make now the following additional assumption.[29]

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

Assumption 3 ensures that total Cournot profits are decreasing in marginal cost c.

Suppose now first that for some choice of c the outside option does not bind for any buyer. Then the supplier's incentives to (marginally) decrease c would be determined by the derivative[30]

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

Here, we make use of Proposition 1 and of the fact that there are $2N$ downstream firms. Recall also that $K_S(\Delta_S)$ represents the investment that is needed to reduce marginal cost from $\bar{c}$ to $c = \bar{c} - \Delta_S$. Moreover, if all buyers' outside options do not bind, then the supplier can just extract one half all all incremental profits. Finally, note that from Assumption 3 we have that $\frac{d}{dc} \left[R(q_S, q_S) - cq_S \right] < 0$ such that a reduction of c indeed increases total industry profits.

How do incentives change if, instead, the outside option of some buyer, say buyer i, binds? We can isolate three effects that all point in the same direction, namely towards an *increase* in the derivative m and thus to higher incentives for the supplier.[31]

First, as the outcome of negotiations with buyer i is now fully pinned down by the value of the buyer's outside option, following a reduction of c 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

[29] Vives (1999, p. 105) provides sufficient conditions on the demand function for Assumption 3 to hold.

[30] The minus sign in front of the first term of the right-hand side of equality (8) follows from $dc/d\Delta_S = -1$.

[31] All effects are derived formally in the proof of Lemma 3 in Appendix A.

outside option there is no longer a hold-up problem between the supplier and buyer i, at least not for marginal changes in Δ_S.[32] Second, once the outside option of buyer i binds there is an additional effect through which the supplier's incentives to reduce c increase. We find that a reduction in the supplier's marginal cost reduces the value of a buyer's outside option and, thereby, increases the supplier's profit in case the buyer's outside option binds. To see this, note that in each of the n^i markets in which firms controlled by buyer i are active the supplier also sells to competing firms. The lower the supplier's marginal cost, the more competitive are these rivals, which reduces a buyer's profits if this buyer chooses an alternative supply option.

Importantly, which is our third observation, the previous effect becomes stronger if there are fewer but larger buyers, even if the outside option of *all* buyers binds. More formally, the size of the (negative) effect that a reduction of c has on a buyer's outside option payoff v^i_{Out} increases more than proportionally with the buyer's size n^i. Consequently, if we merge a subset I' of buyers, then this strictly increases the supplier's incentives. The intuition for this result is somewhat more involved and explored next.

The argument builds again on the insight that a reduction of c makes all other buyers more competitive, inducing them to choose a strictly higher quantity at each of the N markets. Recall now that a larger buyer intuitively chooses a lower value of c^i_{Out} after disagreement, implying that he will produce a larger quantity in each of the n^i markets in which the buyer is active. This implies that following disagreement a larger buyer will also tend to lose relatively more compared to smaller buyers if rivals increase their quantity and thereby lower prices following a reduction of their marginal purchasing price, which is equal to c.

Summing up, in our model and under the presently analyzed bargaining solution there are various effects at work that all work in the same direction, namely towards an increase in the supplier's incentives if there are fewer but larger buyers. Note now that for the preceding arguments we scaled up the size of one buyer i. To keep the size of the total industry constant, this requires to simultaneously scale down the size of another buyer. In what follows, in order to keep the size of the whole market constant we focus on mergers between buyers.[33]

[32] 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^i_{Out} both change continuously in c, the outside option of B^i stays binding after a small change in Δ_S.

[33] It should be recalled that we only consider market structures where neither of the N independent markets is monopolized.

Lemma 3. *Take some level of the supplier's marginal cost c and consider the marginal incentives for the supplier to further decrease c, which are given by the derivative m. Following a merger of any of the I independent buyers, m increases, which holds also strictly whenever the outside option of the newly formed, large buyer binds.*

Proof. See Appendix A.

3.3 Equilibrium Analysis

With Lemma 3 at hands, the following result follows now immediately by applying standard comparative statics results.[34]

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

Note that we do not need for Proposition 2 that there is a unique optimal choice of the cost reduction Δ_S, leading to some $c = \overline{c} - \Delta_S$. If there is a multiplicity of equilibrium choices, then Proposition 2 applies to the respective optimal sets.[35]

Proposition 2 is the main result of this paper. An application of Proposition 2 could be to retailing, where a larger retailer is formed through the merger of two or more smaller retail chains. The resulting average purchasing price μ^i of a larger chain is then fully pinned down by the chain's attractive alternative supply option. From the perspective of the supplier, this leaves no room for haggling over a higher price. In contrast, with small chains there is scope for negotiations. Lemma 3 and Proposition 2 show that the formation of larger retail chains can actually spur upstream investment to reduce marginal costs, even though the supplier's total profits are clearly lower.

Some of the simplifying assumptions that we made in order to focus our analysis on the novel results in this paper seem also to be particularly suitable to retailing. There, markets are indeed often locally segmented. Though there may be different competing chains, in a

[34] See, for instance, Vives (1999).

[35] There are essentially two reasons for why the formation of a larger buyer does not always lead to a strictly lower value of c. First, the outside option of the newly formed larger buyer may not be binding over the relevant range of c. Second, even if this is the case such that m increases over the relevant range, then the optimal c may still be unchanged as it lies on a kink of the supplier's profits U. (U is differentiable everywhere with the exception of points at which the outside option of one buyer starts to bind.)

given local market consumers may only choose between few different outlets.[36] If two chains operating in different local markets merge, the merger will thus have no immediate implications for downstream competition. In addition, in case there is some overlap, it is relatively easy for antitrust authorities to impose adequate structural remedies by forcing the divestiture of outlets in the affected markets.

If the exercise of buyer power leads to lower marginal costs and thus higher quantities in each of the N markets, consumer surplus is unambiguously higher. We study next the effect on total welfare. Suppose first that the outside option does not bind for any buyer. The resulting hold-up problem with any of the I buyers reduces the supplier's incentives, inducing a choice of Δ_S that lies below the level that would maximize total industry profits (net of the respective investment costs). This is, however, already strictly below the level at which welfare would be maximized. Hence, by increasing the supplier's incentives total welfare can be improved.

Consider next the opposite extreme where all outside options bind, making the supplier the residual claimant when (marginally) increasing joint profits. In this case, the equilibrium choice of Δ_S will be strictly above the level that would maximize total industry profits. This follows as a further increase in Δ_S is still beneficial for the supplier given that it erodes the value of buyers' outside options and thus allows the supplier to extract a higher share of joint profits.

In principle, in the latter case the supplier's incentives may thus become too high, implying that Δ_S lies even above the level at which welfare would be maximized. We next illustrate this, as well as our previous general calculations, with the help of a linear example.

3.4 Linear Example

To illustrate the working of our model, we now suppose that each market is characterized by a linear inverse demand $P(q) = a - bq$, which is derived from the utility function of a representative consumer. Given marginal cost c, the symmetric Cournot quantities are $q_S = \frac{a-c}{3b}$. As the wholesale price equals marginal cost, this yields per-firm profits $R(q_S, q_S) - q_S c = b\left(\frac{a-c}{3b}\right)^2$.

A marginal reduction of c increases social welfare (i.e., the sum of producer surplus and

[36] In retailing, in particular in the "one-stop-shopping" segment of super- or hypermarkets, the assumption of a tight local oligopoly (and, in particular, of no further entry) is also often realistic given local planning restrictions. In addition, for many goods or services the local market may also often not support more than a very limited number of competing shops.

consumer surplus) by

$$\frac{8N}{9b}(a-c). \tag{9}$$

Likewise, from differentiating total industry profits we have

$$\frac{4N}{9b}(a-c), \tag{10}$$

which is clearly always strictly lower than (9). If no outside option binds, then the supplier's incentives are given by one half of (10) and are thus clearly too low from the perspective of welfare maximization. (Note that when applying a consumer standard any $c > 0$ is "too low".)

Suppose now that the outside option of some buyer i binds. According to our previous analysis, this entails two differences. First, the supplier receives the full incremental profits from its dealing with buyer i, instead of only one half. Second, the supplier's incentives are additionally increased through the impact of c on the outside option of buyer i, i.e., through the derivative $-dv^i_{Out}/dc$. Likewise, if all buyers' outside options bind, then the additional effect is given by $-\sum_{i\in I} dv^i_{Out}/dc$.

To calculate these expressions, we have to substitute into v^i_{Out} the optimal choice of the respective marginal cost of buyer i following disagreement, namely c^i_{Out}. To determine this value, we specify that following disagreement a reduction of the buyer's marginal cost from $\overline{c}_{Out}$ to $c^i_{Out} = \overline{c}_{Out} - \Delta^i_B$ comes at quadratic costs $K_B(\Delta^i_B) = \gamma_B(\Delta^i_B)^2/2$. Moreover, we stipulate that

$$\gamma_B > \frac{1}{\overline{c}_{Out}}\frac{N}{6b}(2a+c), \tag{11}$$

which ensures that there is always a unique interior solution $0 < c^i_{Out} < \overline{c}_{Out}$, regardless of a buyer's size. Calculating profits if buyer i has marginal cost c^i_{Out}, we thus have that

$$v^i_{Out} = \max_{c^i_{Out}}\left[n^i\left(\frac{2a+c-3c^i_{Out}}{6b}\right)^2 - \frac{\gamma_B}{2}(\overline{c}_{Out}-c^i_{Out})^2\right] - F, \tag{12}$$

which from (11) yields a unique interior solution

$$c^i_{Out} = \frac{6b\gamma_B\overline{c}^i_{Out} - n^i(2a+c)}{6b\gamma_B - 3n^i}. \tag{13}$$

From (12) we then have that

$$\frac{dv^i_{Out}}{dc} = -n^i\left(\frac{2a+c-3c^i_{Out}}{18b}\right), \tag{14}$$

where again c^i_{Out} is given by (13).

In the extreme case where all buyers' outside options bind, we thus have that the supplier's marginal benefits of reducing c are given by the sum of (10) plus $-\sum_{i\in I} dv^i_{Out}/dc$ from(14). If we stipulate in addition quadratic investment costs K_S, then it is possible to calculate explicitly the resulting equilibrium choice for c and compare this with the first-best benchmark. It is then straightforward to find examples where the supplier's incentives become inefficiently high. Hence, in the linear-quadratic case we get the stark result that far from stifling a supplier's incentives the formation of larger buyers may actually increase too much the supplier's incentives to reduce marginal cost.[37]

4 Discussion and Robustness

4.1 Impact of a Merger on Other Buyers

So far we have only analyzed how the formation of a larger buyer affects the supplier's profits and thereby the supplier's incentives. Holding c constant, unless the merged buyer's outside option does not bind, the supplier's profits decrease. This holds still if the supplier optimally adjusts c following the merger.[38] Next, if c remains constant, then the merger will be unambiguously profitable for the larger buyer. Interestingly, this may, however, no longer be the case once we take into account the supplier's optimal adjustment of c. Naturally, buyers would, however, only merge if this was profitable. What remains to be analyzed is how the formation of a larger buyer affects all other buyers, i.e., those buyers that remain outside the merger.

In policy discussions, in particular in the area of retailing, it is sometimes argued that other buyers may be *negatively* affected by the formation of a larger and more powerful buyer. In our model, we specified that contracts are sufficiently complex to avoid problems of double-marginalization. An implication of this is that regardless of a buyer's size, each buyer can still procure at the same *marginal* purchasing price c. While a larger buyer can thus procure at better *average* terms, this does not give the buyer an advantage in the downstream market.

[37] For instance, it is easily checked that the following specification generates such a case. Suppose that each buyer controls N outlets and that the respective (symmetric) outside option binds. Furthermore, take $a = b = 1$, $\overline{c} = \overline{c}_{Out} = 0.5$, and $\gamma_B = \gamma_S = 10$, while supposing that N is not too high such that (11) is still satisfied.

[38] Formally, this follows as c is optimally chosen both before and after the merger.

Consequently, in our model it is only in the long run that other buyers are affected by a merger, namely through a possible reduction in the supplier's marginal cost. The exercise of buyer power has then quite surprising implications for other buyers. Small buyers that do not have a sufficiently valuable outside option benefit from a merger as they can extract in their negotiations a fraction of the additional profits that are created by a reduction in c. In contrast, other large buyers may be hurt as a reduction in c reduces the value of their binding outside option.

Proposition 3. *The formation of a larger buyer can never hurt a small buyer whose outside option does not bind, while the small buyer strictly benefits if the merger induces the supplier to invest strictly more in a reduction of marginal cost. On the other hand, a large buyer that remains outside the merger may be negatively affected as the value of its binding outside option decreases in case the supplier has lower marginal cost.*

Proof. See Appendix A.

The result that the exercise of buyer power may in the long run be beneficial for small buyers, who essentially free ride on the supplier's higher incentives, comes, however, with some important caveats.

First, our analysis focuses on incremental changes on the upstream market, namely the reduction of the chosen supplier's marginal cost. As noted above, what matters for the supplier's incentives is consequently not the absolute level of profits but, instead, only how the formation of a larger buyer affects the supplier' incremental profits from a reduction in marginal cost. For other decisions such as, for instance, whether to introduce a new product or whether to stay in the market or to exit, the supplier's total profits should, however, be more relevant. The spill-over that a merger can have on other buyers via this channel may then be quite different from that of Proposition 3. In addition, given that all buyers obtain the same marginal purchasing price in equilibrium, irrespective of their size, in the present model there is no scope to analyze how differential buyer power affects a buyer's competitive position vis-a-vis its downstream rivals.

4.2 Bargaining without the "Outside Option Principle"

In this Section, we argue that our results hold also if we choose a solution concept to the bargaining problem for which the "outside option principle" does not apply. Following Binmore, Rubinstein, and Wolinksy (1989) we could adjust the non-cooperative game in Appendix B to allow for risk-of-breakdown in order to ensure that the value of buyers' outside options matters even if they are too small to represent credible threats. This gives rise to the axiomatic Nash bargaining solution in which incremental profits are always calculated net of the respective disagreement payoffs.

With the modified solution concept, the supplier and each of the buyers now always split the respective net surplus according to a fixed sharing rule, which we again choose to be one half. From our previous results, we thus have immediately that

$$\tau^i = \frac{1}{2}\left[n^i\left[R(q_S, q_S) - q_S c\right] - V^i_{Out}\right],$$

implying that the supplier's incentives are always determined by the derivative[39]

$$\frac{d}{d\Delta_S}\sum_{i\in I}\tau^i = -N\frac{d}{dc}\left[R(q_S, q_S) - q_S c\right] + \frac{1}{2}\sum_{i\in I}\frac{d}{dc}V^i_{Out}. \tag{15}$$

Recall now that we previously decomposed Lemma 3, which states how incentives depend on the concentration of buyers, into several effects. Importantly, we showed there that a reduction of c disproportionately affects a larger buyer's outside option. That is, if I' denotes the set of merging buyers we have that the pre-merger value $\sum_{i\in I}\frac{d}{dc}V^i_{Out}$ is strictly lower than the post-merger value for the single, larger buyer. Consequently, from (15) under the modified bargaining solution a concentration of buyers still always increases incentives.

Proposition 4. *The key results, namely Lemma 3 and Proposition 2, continue to hold under Nash bargaining without the "outside option principle."*

4.3 Heterogeneous Goods

So far we assumed that buyers compete in homogenous goods. We show now that this assumption can be relaxed without affecting our results. We thus specify that if one firm in a given market

[39] To avoid any confusion, recall from Assumption 3 that $\frac{d}{dc}\left[R(q_S, q_S) - q_S c\right] < 0$ while also $\frac{d}{dc}V^i_{Out} > 0$ given that changes in c only affect rivals' costs if buyer i breaks off negotiations.

chooses quantity q and the other firm quantity $\widehat{q}$, then the price for the first firm's goods is given by $P(q, \widehat{q})$. We denote the respective partial derivatives by P_1 and P_2. The following Assumption extends Assumption 1 to the case with heterogeneous goods.

Assumption 1'. *If goods are not perfect substitutes, then whenever $P(q, \widehat{q})$ is positive it holds that $P_1(q, \widehat{q}) < \min\{0, -qP_{11}(q, \widehat{q})/2\}$ and that $P_2(q, \widehat{q}) < \min\{0, -qP_{12}(q, \widehat{q})\}$.*

With Assumption 1', we can show that all of our effects are still present. This gives then rise to the following result.

Proposition 5. *If goods are heterogeneous, then all results still hold.*

Proof. See Appendix A.

4.4 Negotiations in the Presence of Inside Options

The bargaining literature makes a distinction between "outside options", which are triggered by permanent disagreement, and "inside options", which are triggered during negotiations. Applied to our setting, a buyer's inside option would thus be to temporarily purchase a substitute for the supplier's input. In what follows, we extend the analysis in this direction to show that all our results are robust.

For this purpose, suppose that any buyer has the inside option to produce at costs $c_{In} > \overline{c}$. 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 before one of the parties makes use of its inside option, there is no issue of credibility. To calculate the additional surplus that is generated by an agreement, the value of each party's inside option is thus subtracted from the respective joint profits. With the symmetric Nash solution, each party's payoff is then equal to the value of its inside option plus one half of this incremental surplus - provided, of course, these payoffs are not lower than the values of the respective outside options.

In Appendix B we incorporate buyers' inside options in a non-cooperative 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 nor the inferior supplier would at this stage have incentives to sink resources so as to make this option more attractive.

The payoff that buyer i obtains from its inside option is given by

$$V_{In}^i := n^i \max_q \left[R(q, q_S) - qc_{In}\right], \tag{16}$$

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 6. *Suppose that buyers have in addition the "inside option" to purchase at costs $c_{In} > c$. Then under the symmetric Nash bargaining solution there is an agreement in all bilateral negotiations, where $w^i = c$ and where τ^i satisfies the following requirements. If*

$$\frac{1}{2}\left[n^i[R(q_S, q_S) - cq_S] + V_{In}^i\right] \geq V_{Out}^i, \tag{17}$$

then τ^i satisfies

$$\tau^i = \frac{1}{2}n^i[R(q_S, q_S) - q_S c] - \frac{1}{2}V_{In}^i. \tag{18}$$

Otherwise, we have that

$$\tau^i = n^i\left[R(q_S, q_S) - q_S c\right] - V_{Out}^i. \tag{19}$$

It then follows immediately from inspection of the payoffs in Proposition 6 that all our results continue to hold, once we substitute these payoffs instead of those from Proposition 1.

5 Conclusion

We showed how the presence of larger buyers can make it more profitable for a supplier to reduce marginal cost. This result stands in stark contrast to an often expressed view whereby the exercise of buyer power would stifle 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 cost 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. In addition, a supplier could also 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 become less profitable if other firms sell the supplier's superior product. We leave a formal analysis of such investment incentives to future 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 outlets 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^i_{Out}. Denote the set of optimal choices for Δ^i_B by D^i_B. If following disagreement it is not optimal for buyer i to remain active, it is uniquely optimal to set $\Delta^i_B = 0$ such that $v^i_{Out} = -F/n^i$.[40] Otherwise, we have from the properties of K_B that all $\Delta^i_B \in D^i_B$ satisfy $\Delta^i_B > 0$ and $0 < \Delta^i_B < \overline{c}_{Out}$ and, given the smoothness of the Cournot game and differentiability of K_B, that all $\Delta^i_B \in D^i_B$ are determined by the respective first-order conditions. Note next that we can treat n^i as a continuous variable as all expressions in v^i_{Out} are also defined for real values n^i. From the envelope theorem, v^i_{Out} is then strictly increasing and strictly convex in n^i.

In light of future results, it is also helpful to show now that the set D^i_B is strictly increasing in n^i, provided that n^i is sufficiently large such that the buyer optimally chooses to be active

[40] Note that v^i_{Out} is calculated irrespective of whether vertical integration is more profitable than staying inactive or not.

after disagreement ($n^i \geq \widehat{n}$). 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 Δ_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 Δ_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 merge by $\widehat{I}$. Suppose that before the merger, the outside option was binding for buyers in the set $\widehat{I}' \subseteq \widehat{I}$ and not binding for the buyers in the complementary set $\widehat{I}/\widehat{I}'$. We denote the total number of firms controlled by the merged buyer by $\widehat{n} = \sum_{i \in \widehat{I}} n^i$. Note next that from Lemma 1 and Proposition 1 negotiations with all buyers $i \in I/\widehat{I}$ are not affected by the merger. Hence, to analyze how the supplier's investment incentives are affected by the merger, we only have to compare the derivative of $\sum_{i \in \widehat{I}} \tau^i$ with respect to Δ_S, which sums up the respective fixed transfers of the merging buyers before the merger, with the derivative of the *single* transfer that is subsequently paid by the merged buyer, which we denote by $\widehat{\tau}_S$ (in a slight abuse of notation). Likewise, we denote the merged buyer's outside option by $\widehat{v}_{Out}$.

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 $i \in \widehat{I}$ before the merger. Consequently, we have from Proposition 1 that[41]

$$\frac{d}{d\Delta_S} \sum_{i \in \widehat{I}} \tau^i = \frac{d}{d\Delta_S} \widehat{\tau}_S = -\frac{1}{2} \widehat{n} \frac{d}{dc} \left[R(q_S, q_S) - cq_S\right]. \tag{20}$$

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 $i \in \widehat{I}$. 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 Δ_B^i that are chosen by buyer i after disagreement.) From Assumption 1, we further have that for given Δ_B^i (and given q_S) there is a unique corresponding optimal quantity $q^i > 0$ that buyer i chooses at all of its controlled n^i firms. If the set D_B^i is not

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

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 with respect to Δ_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.[42] By equation (2), 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 outside option is binding that

$$\frac{d}{d\Delta_S}\widehat{\tau}_S = -\widehat{n}\frac{d}{dc}\left[R(q_S, q_S) - cq_S\right] + \frac{d\widehat{v}_{Out}}{dq_S}\frac{dq_S}{dc}. \tag{21}$$

Summing up the pre-merger fixed fees of the firms participating in the merger and noting that the outside option was already binding for the subset of firms $\widehat{I}'$, we obtain the derivative

$$\begin{aligned} \frac{d}{d\Delta_S}\sum_{i\in\widehat{I}}\tau^i &= \sum_{i\in\widehat{I}'}\left[-n^i\frac{d}{dc}\left[R(q_S, q_S) - cq_S\right] + \frac{dv_{Out}^i}{dq_S}\frac{dq_S}{dc}\right] \\ &\quad -\frac{1}{2}\left(\sum_{i\in\widehat{I}/\widehat{I}'} n^i\right)\frac{d}{dc}\left[R(q_S, q_S) - cq_S\right]. \end{aligned} \tag{22}$$

We want to show that (21) is strictly larger than (22), or formally, that $d\widehat{\tau}_S/d\Delta_S > d\left(\sum_{i\in\widehat{I}}\tau^i\right)/d\Delta_S$ which we can rewrite as

$$\frac{1}{2}\sum_{i\in\widehat{I}/\widehat{I}'} n^i\left(-\frac{d}{dc}\left[R(q_S, q_S) - cq_S\right]\right) + \left(\frac{d\widehat{v}_{Out}}{dq_S} - \sum_{i\in\widehat{I}'}\frac{dv_{Out}^i}{dq_S}\right)\frac{dq_S}{dc} > 0. \tag{23}$$

It is now easily checked that our assertion is true. To see this, note first that by Assumption 3 we have that $d\left[R(q_S, q_S) - cq_S\right]/dc < 0$. Hence, the first term of the inequality (23) is strictly

[42] Precisely, v_{Out}^i is continuously differentiable whenever Q^i is singular.

positive. Next, observe that $dv^i_{Out}/dq_S < 0$ for all $i \in \widehat{I}$ and that also $d\widehat{v}_{Out}/dq_S < 0$.[43] Thus, the second term of inequality (23) is strictly positive if

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

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

$$q^i P'(q_S + q^i) > \widehat{q} P'(q_S + \widehat{q}). \tag{24}$$

To see that (24) holds, note first that the expression $qP'(q_S + q) < 0$ is by Assumption 1 strictly decreasing in q.[44] 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 Proposition 3. 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 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^i_{Out} is non-increasing in c (it is strictly decreasing whenever $v^i_{Out} \geq 0$), it follows from (3) that the outside option is also not binding at $\widehat{\Delta}_S$. Given that the payoff of buyer i is equal to $[R(q_S, q_S) - cq_S]/2$ from (4), buyer i is by Assumption 3 strictly better off after the merger if this lowers marginal costs, while otherwise buyer i is not affected. Suppose next that the outside option of buyer i binds at $\widehat{\Delta}_S$. By the same argument as before, the outside option of buyer i is then also binding at $\widetilde{\Delta}_S$. As v^i_{Out} is now strictly decreasing in Δ_S given that $V^i_{Out} = v^i_{Out} > 0$, buyer i is now strictly worse off after the merger if this lowers marginal costs. **Q.E.D.**

Proof of Proposition 5. To show that our results from the homogeneous case extend, we need only to show that v^i_{Out} is strictly increasing in c and that the respective derivative increases again more than proportionally with n^i. For this, note that now

$$\frac{dv^i_{Out}}{dc} = n^i q^i P_2(q^i, q_S) \frac{dq_S}{dc},$$

[43] 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.

[44] To be precise, note that differentiating $qP'(q_S + q)$ with respect to 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.

where we denote again by q^i the quantity chosen by buyer i after a breakdown of negotiations. We use now that from Assumption 1' we still have that $dq_S/dc < 0$, while by the arguments in Lemma 3 a higher n^i will lead to a strictly lower c^i_{Out} and thus a strictly higher q^i. It thus remains to show that $q^i P_2(q^i, q_S)$ is strictly decreasing in q^i, which by the same argument as in Lemma 3 holds again by Assumption 1'. **Q.E.D.**

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 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 $\tau^i + qw^i$.[45]

The model incorporates both inside and outside options. In a period h where no agreement has been reached between buyer i and the supplier but where also no side has yet walked away

[45] 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 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.

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, buyer i can instantaneously rely on a supply at marginal cost c^i_{Out}, but has to incur the respective (discounted) costs $F + K_B(\Delta^i_B)$.[46] We still define V^i_{In} as in (16), though this is now in flow terms. On the other hand, the outside option of backward integration is stated as the discounted value of the future stream of payoffs :

$$v^i_{Out} := \max_{\Delta^i_B} \left\{ \frac{1}{r} n^i \max_q \left[R(q, q_S) - (\overline{c}_{Out} - \Delta^i_B) q \right] - K_B(\Delta^i_B) - F \right\}. \tag{25}$$

In what follows, we focus on equilibria where all negotiations lead to immediate agreement.[47] The net surplus in each bilateral negotiation is again $n^i[R(q_S, q_S) - cq_S] - V^i_{In}$, 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 τ^i for each buyer i, that is unless τ^i is determined by the binding outside option.

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

$$\frac{1}{2} \left[n^i \left[R(q_S, q_S) - cq_S \right] + V^i_{In} \right] \frac{1}{r} \geq V^i_{Out}, \tag{26}$$

then τ^i satisfies

$$\tau^i = \frac{1}{2} n^i [R(q_S, q_S) - q_S c] - \frac{1}{2} V^i_{In}. \tag{27}$$

Otherwise, we have that

$$\tau^i = n \left[{}^i R(q_S, q_S) - q_S c \right] - r V^i_{Out}. \tag{28}$$

Proof. Given that we focus on equilibria without delay, in a bilateral negotiation with buyer 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 buyer i has no implication for the supplier's payoff from all other buyers B^j. Consequently, we can consider the negotiations with buyer i in isolation, which in turn allows us to draw on results from standard bilateral alternating-offer bargaining.[48]

[46] It is straightforward to incorporate some fixed real time $Z > 0$ that it could take to build up own production facilities.

[47] The equilibrium without delay is not the unique sequential equilibrium. In particular, under 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 through repeated interaction.

[48] See Rubinstein (1982) for the seminal paper on the open-horizon alternating-offer game.

There is a unique (subgame perfect) pair of offers that are made whenever it is the turn of buyer 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 τ_B^i and that offered by the supplier by τ_S^i. The respective 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 τ_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 (16)). Hence, τ_B^i and τ_S^i are determined by the two indifference conditions

$$\begin{aligned} \frac{1}{r} n^i \left[R(q_S, q_S) - c q_S - \tau_S^i \right] &= \frac{1 - e^{-rz}}{r} V_{In}^i + \frac{e^{-rz}}{r} n^i \left[R(q_S, q_S) - c q_S - \tau_B^i \right], \\ \frac{1}{r} \tau_B^i &= \frac{e^{-rz}}{r} \tau_S^i, \end{aligned}$$

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 τ^i is given by (27). Finally, if τ_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 (28).[49] **Q.E.D.**

It is now easily checked that after discounting flows (by dividing through r), (26)-(28) transform into (17)-(19) and vice versa.

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[49] 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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