Buyer Power and Supplier Shirking*

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Abstract

In this paper I show that the formation of larger buyers (and thus an increase in concentration) can have both beneficial and detrimental effects on a supplier's incentives to invest and undertake costly activities so as to ensure quality and sustain sales of his product. The novel effect in my model is that the ensuing reduction in the number of buyers mitigates a "team production" problem with respect to the provision of incentives to the supplier. The countervailing effect arises from a squeeze of the supplier's margin, in the sense of a standard hold-up problem. The trade-off between these two effects depends on the "sharing rule", that is on the role of other determinants of bargaining power, such as buyers' and suppliers' relative financial strength. I relate the theoretical results to recent policy discussions on how the increasing concentration in notably the food retailing industry and the exercise of bargaining power may reduce suppliers' incentives to invest, which could notably increase the likelihood of (more frequent) food scandals.

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1 Introduction

The question whether strong buyers, notably in the food retailing sector, have negative implications for suppliers' incentives to invest and innovate has received much attention over the last decade. This is evident from work carried out for the European Commission, as well as from various sector inquiries, such as in the UK and in Germany.[1] Notably again in relation to food retailing, politicians have expressed their concerns that powerful buyers' attempt to cut their suppliers' margins could even be responsible for recent "food scandals" and related hygienic problems. Intuitively, these concerns seem justified, as such a squeeze of suppliers' profits both undermines their ability to make necessary investments and reduces their incentives to undertake such investments. On the other hand, as the above mentioned reports also show, despite the growing concentration in (food) retailing and abundant evidence of the increasing power of large buyers, there is little evidence of a general reduction in suppliers' investments. This is the starting point for the questions posed in this paper.

I ask what are the various effects that buyers' (notably food retailers') exercise of bargaining power, as arising from greater concentration in the industry, could have on suppliers' incentives to invest and innovate. For this I focus precisely on suppliers' strategies that relate directly to the above mentioned food scandals: Suppliers in my model make non-contractible decisions by which they forego current profits, as these involve higher costs, but ensure that their products remain viable in the market (with higher probability). Hence, the starting point in my model is a moral hazard problem of suppliers. Precisely, with these investments and expenditures suppliers reduce the likelihood that there will be a "serious incidence" that massively reduces sales of their products (notably, down to zero). With this I wish to capture the notion of a "scandal", e.g., as the public suspects that the supplier has not met and will not meet basic safety and hygienic standards.

In my model, the following effects are at work. Indeed, the exercise of buyer power can reduce suppliers' incentives as it leaves suppliers with a smaller share of the total surplus. This is modeled from first principles. Precisely, following notably the approaches in Katz (1987) or Inderst and Valletti (2011), as buyers grow in size, their option to credibly switch to another supplier or to even integrate backwards (that is, to produce a private label) becomes more valuable and credible. This allows the respective buyer(s) to indeed extract a larger share of the total surplus. But there is also a countervailing effect, which to my knowledge is new to

[1] See, e.g., European Commission (1999, 2011), Competition Commission (2000, 2008) for the UK, and Bundeskartellamt (2014) and Markenverbrand (2014) for Germany.

the respective literature: As concentration increases and the number of buyers shrinks, I find that, among buyers, the moral hazard problem with respect to providing incentives to the supplier becomes smaller. In other words, as there are fewer buyers, the extent of a ”team production problem” becomes smaller. These two effects have countervailing implications for how concentration among buyers affects suppliers' incentives and overall efficiency.

I therefore ask as well when one of the two effects becomes stronger. This depends on the so-called ”sharing rule” in bilateral negotiations, which is affected by other determinants of buyer power (such as buyers' own financial strength). When buyers (retailers) are already powerful in this dimension, then further concentration, through which they can exert additional bargaining power (notably by the ”outside option” effect) is beneficial. Otherwise, it is not.

Before moving on to the analysis, I now provide a brief review of the related literature. There are other papers that already deal with the implications of buyer power for suppliers' incentives to invest and innovate. Other contributions in the recent literature have focused more broadly on the interaction of the exercise of buyer power and manufacturer incentives, without however focusing on the moral hazard and ”team production” problem that is at the heart of my analysis. While Battigalli et al. (2007) focus purely on the negative ("hold up") effects, Inderst and Wey (2007, 2011) show how buyer power can boost manufacturer incentives through other channels (see also Montez (2007)). Chen (2013) provides a framework under which incentives of suppliers can become both weaker or stronger.[2] In my model I abstract from so-called channel management issues that relate to the efficient determination of wholesale and retail prices. Other papers, which have focused on linear contracts between suppliers and retailers, have worked out how in such a context, the exercise of buyer power can have implications for efficiency (Dobson and Waterson (1997, 1999) or subsequently Inderst and Valletti (2011)).

The rest of this paper is organized as follows. I first analyze two benchmark cases, where bargaining power is allocated to one of the respective parties. As is common, I model this through a game where one of the two parties can make a take-it-or-leave-it offer. The other party then has only the choice between acceptance and rejection. The second step in the analysis is the consideration of a Nash bargaining framework.

[2]See, for instance, Chen (2007) for a broader discussion of the relevance of buyer power for welfare and efficiency in an antitrust context.

2 Model Framework

2.1 Economic Setting

I consider an industry where B buyers potentially procure an input from the same manufacturer. As the main application is to retailing, buyers are also referred to as retailers. For brevity's sake, B is also the set of buyers. To streamline the exposition, I abstract from retail competition. This allows me to focus fully on the procurement market. As discussed below, I will also abstract from double-marginalization problems, so that the focus indeed lies fully on how the distribution of surplus in the vertical chain affects incentives.

To endow buyers with different size, I specify that each buyer $b \in B$ controls the number m_b of "outlets". As described below, profits will be proportional to m_b. Next to procuring from the considered supplier, to which I also refer to as the manufacturer, buyers have also an alternative supply option. They can access this at fixed costs $K > 0$. For instance, this could represent backward integration (e.g., through the production of private labels). The final ingredient of the model is an investment stage, where the manufacturer can make a non-contractible investment into the quality of the product.

To further fill the gaps in the model, I proceed as follows. First, I lay out the timing of the game. Second, I specify the production technology. Third, I consider contracting. Fourth, I specify how negotiations proceed. Fifth, I introduce the main functional specification that I will apply throughout this paper whenever explicit results shall be obtained.

2.2 Timing

The overall timing of the game is as follows. In $t = 1$ negotiations take place between the B buyers and the manufacturer. In $t = 2$ the manufacturer can make a non-contractible investment that reduces the likelihood with which subsequent sales of his products will be hit by what I call a "bad event" (such as a food poisoning scandal). In $t = 3$ sales take place: Retailers that have contracted with the manufacturer can sell the manufacturer's product, provided no "bad event" occurred, while retailers that did not contract with the manufacturer and have decided to take up the outside option (at cost K) can sell only the alternative product.

The timing of events is motivated as follows. For instance, with food products the respective "investments" and "investment costs" may constitute a manufacturer's decision to keep the temperature sufficiently low, so as to guarantee higher food safety and hygienic standards. The actually chosen temperature level should indeed not be observable to retailers, while the respective savings (along the whole supply chain, from production to distribution at the retailer's gates) may be considerable. In this example, it is also reasonable to assume that the respective action takes place after contracts have been concluded, while this may be different for other types of investments, such as in new product development.

2.3 Production Technology

I specify the following simple production technology for the manufacturer. The manufacturer can influence the likelihood q with which no bad event occurs through exerting expenditures $I(q)$ with $I' > 0$. By assuming that $I'(0) = 0$, $I'' > 0$, and that $I'(q)$ becomes sufficiently large as $q \to 1$, I ensure that there is always an interior solution.

When a bad event occurs, then for simplicity I specify that no sales can be realized. For example, the food is going bad as the result of the outbreak of a bacteria. To subsequently invoke limited liability of the manufacturer, so that no penalties are feasible, I stipulate that the manufacturer goes bankrupt in this case (with zero value of his assets). I come now to the case when there is no such bad event.

For this, recall first that I abstract both from both downstream (retail) competition as well as from double marginalization (as arising from linear, non-efficient contracts in the vertical relationship). In fact, I can thus simply suppress the retail (sales) stage as follows. In case that a retailer obtains the product at the respective marginal costs of production, which I do not need to specify explicitly, I denote the maximum profits that can be realized at a given "outlet" by $\pi > 0$. Hence, π fully summarizes the retail stage. The joint profits that the manufacturer can thus realize with a buyer b that controls m_b outlets are simply $m_b\pi$, once the investment $I(q)$ has been sunk. To streamline the exposition, I set (all other) costs of production equal to zero.

When no contract between a given retailer and the manufacturer was concluded in $t = 1$, the retailer can decide to take up his outside option, if this is profitable. Again, for the purpose of this paper I model this in the most simple way by stipulating that, after incurring the respective costs K, the retailer can then realize the outside option payoff of $0 < \pi_0 < \pi$ per outlet. Summing up, the retailer's reservation value or outside option payoff at $t = 0$ is thus

$$\Pi_b^0 = \max\{0, m_b\pi_0 - K\}.$$

I focus in what follows on the case where K is sufficiently small such that for all considered retailers $\Pi_b^0 > 0$ (i.e., when $\min_{b\in B} m_b = 1$ then $\pi_0 > K$).

One can now think of the following two alternative specifications of the game. They differ as to when retailers can access their outside option. In one alternative, retailers can only access their outside option *instead of* contracting with the manufacturer. In the second alternative, they can still access their outside option when they have contracted with the manufacturer in case there was a bad event, so that the manufacturer's product failed. My key insights survive under both alternatives. In the first alternative, however, it turns out that there are additional effects at work, such as a potential coordination failure among retailers when contracting with the manufacturer. So as to abstract from this, I first focus on the second alternative. However, I also solve for the other alternative whenever this yields additional insights.

2.4 Contracts

The outcome of negotiations between retailer b and the manufacturer, if successful, is an agreement over a fixed payment F_b that the retailer makes in case of success. In case of failure, i.e., when a negative event occurs, no payment is made.

While I presently simply stipulate the respective form of the contract, this is without loss of generality in the following way. As the manufacturer's investment is not contractible, contract can only condition on failure and success. Let now the respective payments be $T_{F,b}$ (for failure) and $T_{S,b}$ (for success). The optimal contract that arises in the game (irrespective of the subsequently chosen bargaining game) is such that $T_{F,b} = 0$ (i.e., the respective payment is reduced to the minimum, given limited liability of the manufacturer). With this at hands, indeed only a single positive payment $F_b = T_{S,b}$ remains.[3] If there is agreement with a (sub-)set of buyers $B' \subseteq B$, the respective sum of all transfers from those buyers is denoted by $F = \sum_{b\in B'} F_b$.

In what follows, I consider three different games how contracts are negotiated. The first two games are standard in the literature and serve as key benchmarks in my analysis. Here, I first consider the case of a buyer take-it-or-leave-it offer (TIOLI-offer) and subsequently that of a manufacturer TIOLI-offer. Finally, I study a more balanced distribution of bargaining power by considering an application of the Nash bargaining solution. This will then connect the

[3] It is straighforward to prove this in the subsequently considered contractual games. Precisely, one can argue to a contradiction and suppose instead that $T_{F,b} > 0$. Then, one considers an adjustment $\Delta T_{F,b} < 0$ and $\Delta T_{S,b} > 0$ so that both parties are indifferent provided that the manufacturer's investment/effort remained unchanged. As the manufacturer's investment/effort however increases, the respective retailer is strictly better off, while this follows also for the manufacturer (precisely, from the envelope theorem, as he optimally adjusts his investment/effort).

results of the two benchmark cases (as corner solutions), while yielding additional comparative implications.

2.5 Functional Specification

In what follows, I frequently use a specific functional choice for the investment cost function. This allows me to obtain explicit results. Here, I specify that $I(q) = \frac{1}{2k}q^2$, where I assume throughout that k is sufficiently small so as to obtain interior solutions in the subsequently considered maximization problems.

The given choice of the investment cost function will turn some of the considered problems into linear-quadratic optimization problems, for which I will obtain explicit solutions. These will allow also for explicit comparative statics results. My general insights however extend beyond this specification.

3 Benchmark 1: Case with Buyer TIOLI-Offer

3.1 Preliminary Analysis

3.1.1 Manufacturer Investment Problem

As is standard, I solve the problem backwards, considering first the manufacturer's investment problem (for given contracts). If there is agreement with a (sub-)set of buyers $B' \subseteq B$, the manufacturer obtains the transfer $F = \sum_{b \in B'} F_b$ if there is no bad event. The manufacturer sets the quality level so as to maximize profits $\Pi_M = qF - I(q)$. The first-order condition is

$$I'(q) = F, \tag{1}$$

which from the properties of $I(q)$ pins down a unique solution, denoted by $\widehat{q}(F)$. With the specification $I(q) = \frac{1}{2k}q^2$ the optimal quality is given by $q = kF$. I summarize the results as follows.

Lemma 1 *For a given sum of transfers F that the manufacturer contracted with buyers, there is a unique optimal choice $q = \widehat{q}(F)$, as given implicitly by (1). This is strictly increasing in F. In the example with quadratic investment costs, it is explicitly characterized as $\widehat{q}(F) = kF$.*

Proof. It remains only to derive the general comparative statics results. This follows immediately from implicit differentiation of (1), from which $d\widehat{q}/dF = I''(\widehat{q}) > 0$. **Q.E.D.**

3.1.2 Individual Buyer Contracting Problem

In the presently considered bargaining game, buyers simultaneously make TIOLI-offers in $t = 1$. As I abstract from all other costs of production, note that the manufacturer surely accepts any offer where $F_b > 0$. Each buyer has now the following maximization problem.

I suppose that buyer b finds it optimal to contract with the manufacturer. This will trivially be the case in equilibrium given that the outside option is not foregone when a bad event occurs. Recall that the outside option yields the payoff $m_b\pi_0 - K$. In case of success the buyer obtains the payoff $m_b\pi - F_b$. Now given anticipated payments F_{-b} of all other buyers, the objective function of buyer b is thus

$$\Pi_b(F_b, F_{-b}) = (m_b\pi_0 - K)\left[1 - \widehat{q}(F_b + F_{-b})\right] + (m_b\pi - F_b)\,\widehat{q}(F_b + F_{-b}),$$

where I split the total receipts of the manufacturer as $F = F_b + F_{-b}$. When interior, the first-order condition is

$$(m_b(\pi - \pi_0) + K - F_b)\widehat{q}' - \widehat{q} = 0. \tag{2}$$

With the quadratic specification, where $\widehat{q}(F) = kF$, this yields

$$m_b(\pi - \pi_0) + K - F_b = F. \tag{3}$$

In this case, I have explicitly that F_b is indeed interior if and only if

$$F_{-b} < m_b(\pi - \pi_0) + K.$$

Before summarizing results, note that buyers' offered payments F_b are strategic substitutes as, when interior, I have that

$$\frac{d^2\Pi_b}{dF_b dF_{-b}} < 0.$$

If buyer b expects all other buyers to provide higher incentives to the manufacturer, then this makes it less profitable for buyer b to provide high incentives himself: The respective cross-derivative is negative. With the preceding derivation I now have immediately the following results:

Lemma 2 *Consider the case with a buyer TIOLI-offer and take buyer b. For given (anticipated) total contracted payments F_{-b} of all other buyers, the optimal level F_b solves the first-order condition (2), in case it is interior. In the example with quadratic investment costs, one obtains* *explicitly*

$$F_b = \max\left\{0, \frac{1}{2}(m_b(\pi - \pi_0) + K - F_{-b})\right\}. \tag{4}$$

Note from (4) that in the linear-quadratic example, buyer b would reduce the payment offered to the manufacturer by, say, 50 Euro if the buyer could expect all other buyers to increase their payments in total by 100 Euro.

3.2 Equilibrium Analysis

I consider here first the case with symmetric buyers. This allows to obtain simpler expressions and also a straightforward comparative analysis, from which I can then obtain the key insights for the presently considered benchmark case. The analysis is then extended to asymmetric buyers.

3.2.1 Case with Symmetric Buyers

I thus assume that $m_b = m \equiv M/B$. In a symmetric equilibrium with $F_b = F/B$, I thus have from Lemma 2 the condition

$$F = M(\pi - \pi_0) + BK - B\frac{\widehat{q}(F)}{\widehat{q}'(F)}. \tag{5}$$

With the chosen functional specification, this can be solved for the equilibrium (sum of) payments

$$F^* = \frac{B}{B+1}\left(\frac{M}{B}(\pi - \pi_0) + K\right), \tag{6}$$

where one then obtains for the equilibrium likelihood of success

$$q^* = kF^* = k\frac{B}{B+1}\left(\frac{M}{B}(\pi - \pi_0) + K\right).$$

This is strictly decreasing in B, and the comparative analysis in B also holds for the general expression (5). This is the core result in the presently analyzed (benchmark) case. The intuition is immediate. As the number of buyers increases, while the size of the total market remains the same, this increases a team-production problem, here in the provision of incentives to the common agent (the manufacturer): Each buyer's choice of F_b does not internalize the (positive) effect that a change in effort has also on all other buyers. Clearly, there is no longer such an externality when from $B = 1$ only a single buyer remains. I next discuss the efficiency implications.

For this I take again first the case with $B = 1$. Also in this case the choice of q^* is *not* first best: First-best effort (q), that is presently from the perspective of industry profits alone, would be obtained if and only if $F = M\pi$, i.e., if and only if the manufacturer himself would internalize all profit implications in the market. But this is clearly not obtained even when $B = 1$: Even a single buyer trades off the maximization of total industry profits with a reduction in the "agency rent" that he leaves to the manufacturer. When there is, in addition, positive consumer surplus in case of success, then also this choice of effort would not be welfare maximizing. To streamline the exposition, in what follows I ignore this additional positive implication of a higher value of q. Hence, in what follows I abstract from consumer surplus.[4] But all insights still survive when an additional consumer surplus term is introduced.

Proposition 1 *Consider the case where symmetric buyers make TIOLI-offers to the manufacturer. Then, in equilibrium all buyers contract with the manufacturer. The likelihood with which the product will be successful, given the manufacturer's equilibrium investment, as well as the resulting welfare are both strictly decreasing in the number of buyers and thus strictly increasing with buyer concentration.*

Proof. I now return to the general specification, using the first-order condition (2), which I write out more explicitly now as a function of total payments F as well as, using symmetry, $F_b = F/B$:

$$(m_b(\pi - \pi_0) + K - F/B)\widehat{q}'(F) - \widehat{q}(F) = 0.$$

From implicit differentiation and using the second-order condition for F_b, from which

$$(m_b(\pi - \pi_0) + K - F_b)\widehat{q}'' - 2\widehat{q}' < 0,$$

I have indeed that $\frac{dF}{dB} < 0$ and thus, from $\widehat{q}' > 0$, the comparative result in B. **Q.E.D.**

3.3 Case with Asymmetric Buyers

While I have so far considered only the case with symmetric buyers, the obtained insights hold more generally. More precisely, I consider now, with asymmetric buyers, again a reduction in the number of buyers, which occurs through a merger of any two buyers b and b'. In fact, it is now more transparent to conduct this analysis with the chosen functional specification.

[4]Formally, this can be justified if a buyer can extract all consumer surplus, which is thus captured in π or π_0, respectively. For instance, this would be the case if the buyer was to "consume" the product rather than resell it. Alternatively, a reselling buyer could be able to practice full price discrimination, if he faced more than one final consumers, thereby again extracting full consumer surplus.

For this I use the first-order condition in (3). I now consider this for each buyer b and sum up over the B first-order conditions. Noting that $\sum_{b=1}^{B} F_b = F$, this yields the expression

$$M(\pi - \pi_0) + BK - F = BF.$$

This shows that, when all payments are indeed interior (as determined by the respective first-order conditions), the only the number of buyers is here of relevance for the totally provided incentives: The equilibrium value F^* is determined in (6) and I thus have, now for this specification the following results:

Proposition 2 *Consider the case where asymmetric buyers make TIOLI-offers to the manufacturer. Then the results of Proposition 1 extend to the case where then number of buyers is reduced through a merger of any two buyers. Precisely, this leads again to an increase in equilibrium investment, a reduction in the likelihood of a bad event, and altogether an increase in welfare.*

3.4 Extension: Coordination Failure of Buyers

3.4.1 Buyer Problem

I consider now the alternative where a buyer that contracts with the manufacturer can no longer access the outside option when a negative event occurs. This yields additional insights. Again, I solve first for an individual buyer's problem. Given that a bad event now yields profits of zero for a buyer, while success still yields $m_b\pi$ (minus the negotiated payment to the manufacturer), the objective function is now

$$\Pi_b(F_b, F_{-b}) = (m_b\pi - F_b)\widehat{q}(F_b + F_{-b}).$$

If interior, the respective first-order condition with respect to F_b is thus

$$(m_b\pi - F_b)\widehat{q}' - \widehat{q} = 0. \tag{7}$$

With the quadratic investment costs and thus $\Pi_b(F_b, F_{-b}, q) = (m_b\pi - F_b)k(F_b + F_{-b})$, this becomes

$$(m_b\pi - F_b) - (F_b + F_{-b}) = 0,$$

so that the optimal choice of F_b is now determined as:

$$F_b = \max\left\{0, \frac{1}{2}(m_b\pi - F_{-b})\right\}. \quad (8)$$

For the alternative specification of moves, I can now summarize results for a buyer's optimal offer to the manufacturer as follows:

Lemma 3 *Consider the case with a buyer TIOLI-offer and take buyer b. Suppose now, however, that the outside option is no longer available when a buyer has contracted with the manufacturer and a bad event occurred. For given (anticipated) total contracted payments F_{-b} of all other buyers, the optimal level F_b solves the first-order condition (7), in case it is interior. In the example with quadratic investment costs, F_b solves (8).*

With the chosen specification, note that $F_b = 0$ holds if and only if the (anticipated) contracted payments of all other buyers together are sufficiently high:

$$F_{-b} < m_b(\pi - \pi_0) + K. \quad (9)$$

Note finally that I have so far assumed that the considered buyer indeed foregoes his outside option and finds it optimal to contract with the manufacturer. Whether and when this is the case will be analyzed next.

3.4.2 Equilibrium Analysis

I consider again the case with the quadratic functional specification. Here, I immediately obtain, if interior, a symmetric equilibrium with

$$q^* = k\pi M \frac{1}{B+1}.$$

But this is now not the only equilibrium. Indeed, I have so far assumed that it is indeed optimal for each (symmetric) buyer to forego the "outside option" in $t = 1$. Recall that in the presently chosen specification this option is no longer available at $t = 2$. Next to paying F_b in case of success, contracting with the manufacturer has thus also the "opportunity cost" of foregoing Π_b^0. In case all buyers are expected to indeed contract with the manufacturer, it is then indeed optimal for each individual buyer to do so if

$$(m_b\pi - F_b)\widehat{q}(F_b + F_{-b}) \geq \Pi_b^0 = \max\{0, m_b\pi_0 - K\}. \quad (10)$$

Substituting the equilibrium values for the chosen functional specification, as well as $m_b\pi_0 > K$, this transforms to the requirement

$$k\pi^2 \left(\frac{M}{B+1}\right)^2 \geq \frac{M}{B}\pi_0 - K. \tag{11}$$

That is, when (11) holds, there is indeed an equilibrium where all buyers contract with the manufacturer. But this condition is not sufficient to ensure that this is the only equilibrium.

To see this, suppose that some buyer b anticipates that all other buyers are *not* contracting with the manufacturer, i.e., the anticipated payments of all other buyers satisfy $F_{-b} = 0$. Substituting now $F = F_b = \frac{1}{2}m_b\pi = \frac{M}{2B}\pi$ from the previously derived conditions and thus $\widehat{q}(F) = k\frac{M}{2B}\pi$, the equivalent condition to (10) now becomes

$$k\pi^2 \left(\frac{M}{2B}\right)^2 \geq \frac{M}{B}\pi_0 - K. \tag{12}$$

This condition is clearly stricter when $B > 1$. Formally, this follows directly from comparing the expression, from which I obtain the condition that $(2B)^2 > (B+1)^2$, which clearly holds for $B > 1$.

In the presently considered alternative, where buyers must forego their outside option when contracting with the manufacturer, there is thus the potential of a coordination failure: When (12) does not hold, while (11) holds, there are two equilibria where either none or all buyers contract with the manufacturer.[5] Such a coordination failure clearly is no longer possible when there is only a single (monopsonistic) buyer. In the presently considered alternative specification there is thus yet *another* reason for why a more concentrated buyer market can increase efficiency: Greater concentration reduces the risk of a coordination failure among buyers in indeed contracting with a common manufacturer (instead of integrating backwards or accessing a "private" alternative supply option). The following summarizes the additional insights obtained for the alternative specification of moves:

Proposition 3 *Consider the case where buyers make TIOLI-offers to the manufacturer. When buyers must forego their outside option when contracting with the manufacturer, then this can give rise to multiple equilibria, including one where no buyer contracts with the manufacturer. With symmetric buyers and the chosen (quadratic) functional specification this is the case when*

[5] With symmetry it is immediate that there are no other equilibria, that is where only some but not all buyers participate.

(12) does not hold while (11) holds. Notably, when there is only a single buyer, such a multiplicity no longer arises.

4 Benchmark 2: Case Manufacturer-TIOLI

4.1 Specification

In this section I stipulate that all contracting power lies with the manufacturer. I do this again by considering a game where now the manufacturer makes TIOLI-offers to all buyers. These offers are made simultaneously. While one can show that this does not affect the subsequent characterization of an equilibrium, in view of the subsequent extension to simultaneous negotiations, where I apply the Nash bargaining solution, I now stipulate that individual offers are only observed by the respective counterparty, but not by any other buyer. To proceed with the analysis, note that once contracts are in place, the analysis at $t = 2$ is clearly as before, i.e., as already captured by the respective first-order condition for q in (1) and thus the respective value $\widehat{q}$.

With each buyer, by optimality for the manufacturer the respective offer will be such that the buyer is indifferent between acceptance and rejection.[6] Take some buyer b with corresponding offer F_b. The buyer's beliefs about all other offers are given by $\widetilde{F}_{-b}$. These affect the buyer's decision whether to accept or reject indirectly as the respective transfers affect the manufacturer's subsequent choice of q, as given by $\widehat{q}(F_b + \widetilde{F}_{-b})$. With this in mind, buyer b will thus accept an offer if the respective expected profits are not below those from taking up his outside option (that is, in $t = 1$). Again, I consider first the case with symmetric buyers.

4.2 Symmetric Buyers

A buyer's participation constraint is given by

$$\widehat{q}(m_b\pi - F_b) + (1 - \widehat{q})(m_b\pi_0 - K) \geq m_b\pi_0 - K, \tag{13}$$

which transforms to

$$m_b\pi - F_b \geq m_b\pi_0 - K.$$

[6] As other offers are not observed by an individual retailer, but as they influence the manufacturer's subsequent choice of q, I have to be careful with the specification of (out-of-equilibrium) beliefs that each buyer has with respect to all other offers. As is common, I assume passive beliefs.

As noted above, by optimality for the manufacturer, in equilibrium (13) will be satisfied with equality. Note that in the presently considered (main) case where a buyer can still take up its outside option when the manufacturer's investment has failed, the maximum feasible F_b is thus independent of the expected investment and thus the expected realization of q. Consequently, it is also independent of the buyer's expectation of all other buyers' (agreed) payments. With symmetry, I can next solve for

$$F_b = m_b(\pi - \pi_0) + K \tag{14}$$

and thus for total payments of

$$F = M(\pi - \pi_0) + KB. \tag{15}$$

Total payments that are received by the manufacturer (and thus also the corresponding choice of q) strictly increase as the number of buyers increases (still for a given number of outlets M, which are then distributed symmetrically over a smaller number of buyers). The intuition for this is immediate and can be gleaned directly from the presence of the term KB in (15). A buyer that contracts with the manufacturer can (conditional on success) save the respective switching costs K (and he can also realize a higher per-outlet profit). The manufacturer can thus extract from each buyer the switching costs K. When there are fewer buyers, so that "per-outlet switching costs" are higher, then F decreases. In contrast, when the concentration among buyers is lower, then F increases.

With symmetric buyers, I have thus obtained a comparative statics result in the number of buyers B that contrasts sharply with that in the case where buyers make TIOLI-offers. Now, when offers are made by the manufacturer, total payments received by the manufacturer (in case of success) increases in B. This implies immediately that also the equilibrium investment ("effort") $\widehat{q}$ is increasing in B (rather than decreasing, as in the case of buyer TIOLI-offers). Or, put differently, when concentration among buyers increases (lower B), this now reduces equilibrium investment and welfare. Given the preceding statements of how welfare changes with $\widehat{q}$, I have thus obtained the following results:

Proposition 4 *Consider the case where the manufacturer makes TIOLI-offers to symmetric buyers. Then, in equilibrium all buyers contract with the manufacturer. The likelihood with which the product will be successful, given the manufacturer's equilibrium investment, as well* *as the resulting welfare are both strictly increasing in the number of buyers and thus strictly decreasing with buyer concentration.*

4.3 Asymmetric Buyers

While I have so far considered only the case with symmetric buyers, the obtained insights hold more generally also in the case where the manufacturer makes TIOLI-offers to all buyers.

Proposition 5 *Consider the case where the manufacturer makes TIOLI-offers to asymmetric buyers. Then the results of Proposition 4 extend to the case where then number of buyers is reduced through a merger of any two buyers. Precisely, this leads again to a decrease in equilibrium investment, an increase in the likelihood of a bad event, and altogether a decrease in welfare.*

Proof. The starting point is again, for each buyer, the respective participation constraint in (13). Again, by optimality for the manufacturer, it will bind for each buyer. Recall also that after a simple transformation, for buyer b it becomes

$$m_b\pi - F_b = m_b\pi_0 - K.$$

I can now sum up the respective (binding) constraints for all buyers B, which yields, in complete analogy to the case with symmetric buyers, the equilibrium condition (15). The assertion then follows from the respective arguments for the case with symmetric buyers. **Q.E.D.**

As already noted with symmetric buyers, the two cases with TIOLI-offers of either the manufacturer or buyers allow me to isolate two countervailing forces: In one case, an increase in buyer concentration leads to higher manufacturer investments and welfare, while in the other case it reduces manufacturer investments and welfare. Before extending the main analysis, I briefly consider again the extension where I change the sequence of moves with respect to buyers' outside option.

4.4 Extension: Alternative where Outside Option is Foregone

I consider now again the case where buyers forego their outside option when they contract with the manufacturer. Though the analysis is then slightly more involved, I show that results still hold.

Here, the respective participation constraint of buyers becomes

$$\widehat{q}(F_b + \widetilde{F}_{-b})(m_b\pi - F_b) \geq m_b\pi_0 - K, \tag{16}$$

where I again make the dependency on beliefs explicit. As noted above, in equilibrium (16) will be satisfied with equality (provided that the manufacturer can make mutually beneficial offers to all buyers; cf. our discussion above as well as subsequently). As in equilibrium $\widetilde{F}_{-b} = F_{-b}$ must hold, when an acceptable offer is made to all buyers, then the respective values F_b must jointly satisfy the equality conditions

$$\widehat{q}(F_b + F_{-b})(m_b\pi - F_b) = m_b\pi_0 - K. \tag{17}$$

In case of symmetry, this transforms to

$$\widehat{q}(F)\frac{1}{B}(M\pi - F) = \frac{M}{B}\pi_0 - K. \tag{18}$$

For the chosen functional specification I further obtain

$$k(F_b + F_{-b})(m_b\pi - F_b) = m_b\pi_0 - K$$

and with symmetry

$$kF\frac{1}{B}(M\pi - F) = \frac{M}{B}\pi_0 - K. \tag{19}$$

It is now convenient to rewrite (19), after multiplying by B, as

$$z(F) = kF(M\pi - F) - (M\pi_0 - BK)\,.$$

Denoting the highest of the two zeros by F^*, which constitutes the unique equilibrium outcome, I then have the following result for the comparative analysis of F^* in B:

$$\frac{dF^*}{dB} = -\frac{\partial z/d\partial B}{\partial z/\partial F^*} = -\frac{(+)}{(-)} > 0.$$

That is, the total payments that are received by the manufacturer (and thus also the corresponding choice of q) again strictly increase as the number of buyers increases (still for a given number of outlets M, which are then distributed symmetrically over a smaller number of buyers). The intuition for this is as in the main specification and the result also extends beyond the chosen functional specification, once one implicitly differentiates (18) and uses again that the optimal value F^* is the lowest solution that solves this condition. I have thus shown the following:

Proposition 6 *Consider the case where the manufcaturer makes TIOLI-offers to all buyers. When buyers must forego their outside option when contracting with the manufacturer, still the comparative results from Proposition 4 hold.*

Finally, note that for the preceding discussion I have ignored the possibility of multiple equilibria, as discussed above. When there is such multiplicity, the present discussion thus focuses on the Pareto dominant choice (with positive payments and positive investment).

5 General Nash Bargaining

5.1 Setting

In this section I extend the preceding analysis. In fact, the now considered model with Nash bargaining nests the previously analyzed two cases of a buyer and a manufacturer TIOLI-offer game. The model that I now employ has been frequently applied in the literature and is sometimes referred to as a "hybrid" or a "bi-form" game (Brandenburger and Stuart 2007), as it combines elements from cooperative (axiomatic) and non-cooperative game theory. Precisely, the bargaining stage in the full game is now represented by an application of the (axiomatic) Nash bargaining solution to each pairwise negotiation between the manufacturer and buyers. One motivation for this, as given by the literature, is that the manufacturer conducts the respective negotiations through "agents".

The application of a bargaining solution concept allows now to bridge the two extreme (TIOLI-offer) cases that I analyzed before. This is done through introducing a weight for each party in the (asymmetric) Nash bargaining solution. A shift in this weight between the two parties is in fact often used in the literature as a representation of a shift in bargaining power. I also conduct such a comparative analysis in what follows. This shift is then supposed to represent any other change in bargaining power that does *not* result from a change in outside options, as in the preceding section (where a merger essentially increased the value of the outside option by ensuring that the respective fixed costs of switching could then be distributed over a larger number of "outlets"). For instance, in line with the respective interpretation in the literature, a larger weight of one party could be linked to greater financial strength and thus patience in negotiations.

5.2 Nash Bargaining Approach

Consider negotiations between the manufacturer and buyer b. The Nash bargaining solution pins down the outcome as follows. First, the outcome is a function of the respective reservation values or outside option payoffs which the agents obtain negotiations break down. I already denoted these for buyer by Π_b^0. For the manufacturer, when negotiating with buyer b, I denote them by $\Pi_{M,b}^0$. Second, I denote the weight given to the buyer by w and that given to the manufacturer by $1-w$. The respective value F_b that is then the outcome of the bilateral negotiation maximizes the so-called Nash product

$$\left(\Pi_b - \Pi_b^0\right)^w \left(\Pi_M - \Pi_{M,b}^0\right)^{1-w}. \tag{20}$$

Before filling in the respective expressions, a few comments are in order. The application of the Nash bargaining solution makes two initial assumptions. First, it must be bilateral efficient to come to an agreement. Second, the so-called bargaining set is convex. Both of these assumptions are satisfied in my case as follows. Notably in the first, main specification of my model, where buyers can still choose their outside option after supplier "failure", it is immediate that bilateral agreement is efficient. Second, in the chosen functional specification convexity of the bargaining set holds. For general specifications, I suppose for convenience that this is also satisfied, noting however that if this was not the case, then in line with the literature one could convexify the bargaining set by appealing to so-called lotteries over contracts. So as not to blur the analysis, I abstract from this possibility. In fact, for the purpose of the present analysis, I will subsequently work mainly with the linear-quadratic specification.

Interestingly, note that the bargaining frontier, that is how utility between two parties is transferred, is not linear in my case even though I allow for lump-sum transfers between the two parties and even though both are risk neutral. This follows however as the respective transfer is ultimately *not* a simple transfer of utility, but is paid only in case of success and thus incentivizes the manufacturer. In this sense, given the underlying moral hazard problem, I have thus no longer a setting with fully "transferable utility". An implication of this is that I can not expect to obtain explicit solutions, even with the chosen linear-quadratic specification.

5.3 Solution and Equilibrium for Symmetric Distribution of Bargaining Power

To now fill the gaps, I determine the respective terms that must be entered into the Nash product in (20). As already noted, with Nash bargaining the issue of analytical tractability arises. In case of a disagreement, the buyer obtains the payoff $\Pi_b^0 = m_b\pi_0 - K$. And so, I obtain for buyer b the difference

$$\begin{aligned}&\Pi_b - \Pi_b^0 \\ &= [\widehat{q}(m_b\pi - F_b) + (1-\widehat{q})(m_b\pi_0 - K)] - [m_b\pi_0 - K] \\ &= \widehat{q}(m_b(\pi - \pi_0) - F_b + K),\end{aligned}$$

where $\widehat{q}$ is a function of F_B and of the payments that buyer b expects that the manufacturer will negotiate (simultaneously) with all other buyers, $\widetilde{F}_{-b}$. Throughout the analysis I characterize an equilibrium where all negotiations are successful, noting that, given bilateral efficiency, no other equilibrium exists. Note that in case of a negotiation break down with buyer b, the manufacturer still contracts with the remaining buyers and thus $\Pi_{M,b}^0 = \widehat{q}(\widetilde{F}_{-b})\widetilde{F}_{-b} - I(\widetilde{F}_{-b})$. For the manufacturer I have, with respect to the bilateral negotiation with buyer b,

$$\begin{aligned}&\Pi_M - \Pi_{M,b}^0 \\ &= \left[\widehat{q}(F_b + \widetilde{F}_{-b})(F_b + \widetilde{F}_{-b}) - I(F_b + \widetilde{F}_{-b})\right] - \left[\widehat{q}(\widetilde{F}_{-b})\widetilde{F}_{-b} - I(\widetilde{F}_{-b})\right].\end{aligned}$$

Again I use here the respective expectations $\widetilde{F}_{-b}$ given simultaneity of the respective bilateral negotiations. Recall the interpretation in terms of bilateral negotiations that are conducted simultaneously by independent agents of the manufacturer. In what follows, where this is convenient, I will suppress the separate notation for expectations. I take now the chosen functional specification, where I have that

$$\Pi_b - \Pi_b^0 = k(F_b + F_{-b})(m_b(\pi - \pi_0) - F_b + K)$$

and that

$$\Pi_M - \Pi_{M,b}^0 = \frac{1}{2}k\left[(F_b + F_{-b})^2 - (F_{-b})^2\right].$$

Thus, in this case the Nash product becomes

$$(k(F_b + F_{-b})(m_b(\pi - \pi_0) - F_b) + K)^w \left(\frac{1}{2}k\left[(F_b + F_{-b})^2 - (F_{-b})^2\right]\right)^{1-w}. \tag{21}$$

Hence, given F_{-b}, F_b is chosen to maximize (21). After neglecting constant multipliers and transforming the respective terms, I thus have the first-order condition

$$\frac{d}{dF_b}\left[((F_b + F_{-b})^w(m_b(\pi - \pi_0) - F_b) + K)^w \left(F_b^2 + 2F_bF_{-b}\right)^{1-w}\right] = 0$$

Proposition 7 *Take now the Nash Bargaining approach with equal weights* $w = 0.5$ *as well as the linear-quadratic specification. When buyers are symmetric, there is an explicit equilibrium characterization where total payments made by buyers are given by*

$$F = [(\pi - \pi_0)M + BK]\,\frac{2B^2 + 2B - 1}{4B^3 + B^2 - B}. \tag{22}$$

Proof. I first simplify expressions using $w = 0.5$. To obtain simpler expressions, note that the Nash Product then becomes

$$((F_b + F_{-b})^{0.5}(m_b(\pi - \pi_0) - F_b + K))^{0.5}(F_b^2 + 2F_bF_{-b})^{0.5}.$$

Differentiation and substitution for $F_{-b} = (B-1)F_b$ in case of symmetry yields the first-order condition that then can be solved to obtain $F = BF_{-b}$, as given in (22). **Q.E.D.**

The solution in (22) yields the intuitive comparative result that F and thereby total incentives for the manufacturer are strictly increasing in buyers' costs of substitution, K. Recall that K only played a role in the benchmark case where the manufacturer made the TIOLI-offer, in which case incentives were higher when K was higher. Unfortunately, already with $w = 0.5$ and the explicit characterization, comparative results with respect to B remain ambiguous (as follows from differentiation of (22)). While my model thus allows to isolate two effects of increasing buyer concentration, one of which is novel to the literature, when I combine the two effects in a model of bilateral Nash bargaining, even with the chosen tractable functional specification it no longer can be said which effect dominates. Still, I would claim that my model and its analysis is useful, notably in the light of the sometimes one-sided policy discussion, as referred to in the Introduction. I have shown that greater buyer concentration can reduce a "team production" problem among buyers in providing manufacturers with incentives, which counteracts any reduction in incentives due to a (standard) hold-up and rent extraction problem, on which the literature has focused.

6 Concluding Remarks

Admittedly, a shortcoming of my analysis is that when I consider a fully fledged Nash Bargaining model, no longer clear-cut results are obtained. While with symmetry and with the chosen functional specification I still obtain an explicit characterization, the comparative statics results are no longer unambiguous. That said, the main objective of my analysis is to shed light on a previously omitted (positive) effect of increasing buyer concentration.

While my analysis clearly relates to policy questions, the presented model is only a first step. Further, future work should seek to embed this into a dynamic game where incentives depend also on future expected sales and profits. This would allow to examine how the dynamics in notably the retailing industry could affect positively or negative suppliers' incentives. In addition, in such a dynamic setting one could study incentives provided by reputation (or the loss of it). In such a more realistic setting one would then be able to draw more robust policy implications. In addition, it is an open question how the introduction of upstream or downstream competition affects the results.

Another important avenue should be to include also retailers' / buyers' incentives to invest and innovate, e.g., in their stores or even in (non-contractible) advertising. The potential free-riding and shirking problem would then become two-sided, still however also with a "common agency" angle.

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