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THE CENTER FOR THE STUDY
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Working Paper #0067

Buyer Groups as Strategic Commitments

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Abstract

Buyer cooperatives, buyer alliances, and horizontal mergers are often perceived as attempts to increase buyer power. While prior theoretical and empirical work has emphasized that buyer size can increase buyer surplus, I show that even a small group of buyers with heterogeneous preferences can increase price competition among rival sellers by forming a buyer group and committing to buy exclusively from a single seller. The benefit to consumers from this commitment is the same as the benefit from committing to buy from the lowest price firm when they in fact prefer one firm's product. Finally, I suggest that buyer groups may be effective strategic commitments even when the agreement is potentially reversible.

1. Introduction

Firms often form purchasing alliances in order to obtain lower prices from suppliers. Sometimes these are formal long-term relationships, typically organized as co-operatives. For example, independent retail grocers have long used co-operatives for this purpose (the most well known is the Independent Grocer's Association or IGA).¹ In other instances alliances are formed for a single purchase. Recently four airlines, Air Canada, Luftansa, SAS, and Australian Airlines, all members of the Star Alliance (a code-sharing airline network), joined together for the purpose of purchasing aircraft.² Cable television franchises also form buyer groups to negotiate with content providers. And finally, prescription benefit managers, such as Medco, negotiate lower pharmaceutical prices on behalf of the members of Health Maintenance Organizations (HMOs) and Preferred Provider Organizations (PPOs) by auctioning off the right to be on the HMO or PPO's drug formularies (preferred prescription drug lists).³ The motive for buyer groups may be increased bargaining power associated with size, as has been widely suggested, but in reality buyer groups tend to form when buyers face multiple suppliers and when they form they make a point of committing to concentrate their orders with a

¹ Similarly Ace Hardware, TruServ, and Do It Best are three large co-operatives whose members are all retail hardware stores. In addition to negotiating better prices from suppliers, these co-operatives also provide important marketing services, presumably at lower cost than is available to individual retailers.

² These four airlines have agreed to buy over 100 planes in a single model aircraft, either Airbus' A318, Boeing's 717, Embraer's 170, Bombardier's CRJ700, or Bombardier's CRJ900. It is estimated that the total order will be as much as \$4.5 billion. Stated reasons for the purchasing alliance are economies of scale in production and buyer economies (inventory pooling).

³ Consumers who join PPOs benefit from lower prices for these medications that in turn lower the cost of the PPO, but their choice of drugs is restricted. As importantly, the doctors' are restricted by these formularies when they choose which drugs to prescribe (except when alternatives are medically necessary).

single supplier. This paper offers an alternative theory of buyer groups that emphasizes composition rather than size as the central strategic component.

In this paper I analyze the strategic value of buyer groups and their commitments to purchase exclusively from a single seller. Initially, I suppose that buyers can contractually bind themselves to each other and commit to bundle their purchases and to buy exclusively from a single seller. These strategic buyer groups subsequently act to maximize the group's joint surplus. I show that appropriately designed buyer groups make their members better off by increasing price competition.

This result follows from two insights. First, buyers are strictly better off if they can strategically commit to buy on the basis of price alone. Specifically, in a duopoly model every buyer is better off imitating a buyer who is indifferent between the available products and makes its purchase decision based solely on price. The cost of this commitment is that the buyer may purchase his or her less preferred product, however this is always smaller than the benefit, which is an increase in price competition.

Second, forming a strategic buyer group is a way for diverse buyers to commit to jointly act like consumers whose purchase decision is based solely on price. Specifically, strategic buyer groups purchase decisions are the same as those of the mean group member, so by choosing the composition appropriately, every member of the group is committing themselves to buy on the basis of price alone.

Of course, buyers can make themselves even better off if they are free to make any strategic commitments. Part of the appeal of focusing on buyer groups as strategic commitments is that the formation of a buyer group is an easy, practical, and potential very credible commitment. The credibility of the commitment may derive from the number of buyers and the transactions costs of renegotiation a contract with many

participants. This argument is the commonly used to argue that corporate debt acts as a strategic commitment: the debt holders are too dispersed to actively renegotiate.⁴

While buyer groups may be more credible than other commitments, I also argue that they may be an effective commitment even when they are not more credible. This is true in the sense that there are multiple equilibrium at it is at least plausible that announcing a exclusive purchase agreement may cause firms to coordinate on a less favorable equilibrium, especially when the reversibility of the commitment is uncertain.

Previous work on buyer power has emphasized bargaining power and information rents. In a single seller/single buyer environment, the sources of buyer power are the bargaining game timing, private information, and outside options. First, buyer power depends on the timing of the parties offers. For example, the buyer's surplus rises when a monopoly seller loses the ability to make a take-it-or-leave-it offer. Second, buyer power often increases when buyers have private information (and conversely decreases when sellers have private information) (see Maskin and Riley, 1984). Conditional on trade, privately informed individuals generally capture information rents. Third, buyer power increases when buyers have stronger outside options.

In a multiple buyer environment, buyers may be able to increase their buyer power by forming groups. This is true whenever the total gains from trade with the group exceed the sum of the individual gains from trade with each of the group's members (see Horn and Wolinsky, 1988; Stole and Zwiebel, 1996b; Chipty and Snyder, 1999; Chae and Heidhues 1999a, 1999b; Inderst and Wey, 2001,2003). In other words, while individuals can only capture a share of the marginal surplus they create, groups can capture a share of the inframarginal surplus created by their members. This inframarginal surplus is higher

⁴ See for example Perotti and Spier (1993) and Hart and Moore (1995).

when the seller has decreasing returns to scale in production and when there are positive consumption externalities.^{5 6}

In a multiple seller/multiple buyer setting, buyer surplus may depend on sellers' abilities to tacitly coordinate on price. Snyder (1996, 1998) showed that the ability to tacitly coordinate falls with buyer size.

Three papers have empirically looked at the impact of buyer size on buyer surplus (or price). These are Chipty (1995), Sorenson (2001), and Ellison and Snyder (2001). In addition, Moore and Newman (1993); Grabowski (1988); Dranove (1989); and Grabowski, Schweitzer, and Shiota (1992) have looked at the impact of drug formularies on price. All of these papers find evidence of a positive relationship between buyer size and buyer surplus. Only Ellison and Snyder (2001) look at the role of competition on the buyer size premium, and they find that buyer size is most valuable when buyers face more than one seller. Their result is consistent with theory presented here (as well as with Snyder, 1996, 1998).

This paper is closely related to O'Brien and Shaffer (1997). They show that a monopsony retailer is better off when he can commit to purchase exclusively from either of two suppliers. The vertical chains profits are maximized when the retailer purchases both suppliers output, however the commitment to purchase exclusively intensifies price competition and justifies the inefficiency. As in this paper, they show that this outcome is an equilibrium of the pricing game even in the absence of the commitment, but the

⁵ This is also true when the seller has capacity constraints and buyers have heterogeneous valuations. The seller's outside option when negotiating with an individual is the willingness to pay of the highest valuation excluded buyer, however when negotiating with a buyer of size n , the outside option is the willingness to pay of the next n individuals, which by construction must be lower (see Inderst and Wey, 2003).

⁶ Another issue is whether the seller makes uniform or discriminatory price offers (i.e., buyers' price quotes are common or buyer specific). A monopoly seller's surplus is increased when it makes discriminatory offers (decreasing buyer power). However the opposite may be true when there are multiple competing sellers (for example see Corts, 1998).

commitment causes it to be the unique outcome. This paper goes beyond theirs by analyzing how buyer groups can be formed to exploit the commitment opportunity suggested by O'Brien and Shaffer.

Another related paper is Matutes and Regibeau (1988). Although they study firm commitments as opposed to buyer commitments, they argue that rival sellers of complementary products can soften price competition by making their products compatible with each other's products. In a differentiated product model with two firms each producing two complementary products, firms are reluctant to adopt a strategy of bundling their products because this has the effect of changing consumers who have a strict preference for Product 1 from Firm A and for Product 2 from Firm B (and similarly those who have a strict preference for Product 2 from Firm A and for Product 1 from Firm B) into consumers who are indifferent between the two firms' bundles. However, in my paper it is the buyers, not the firms, who are deciding whether or not to bundle purchases in order to increase price competition. The problems are also mathematically distinct because Matutes and Regibeau's firms consider uniform rather than discriminatory prices.

The paper is organized as follows. First I present a simple numerical example. Then I present the basic model, a two firm, differentiated product, heterogeneous buyer, complete information model in which firms have constant returns to scale and make take-it-or-leave-it offers to individual buyers. I show that in equilibrium buyers form groups and that these buyer groups create value regardless of their size. I show that buyer groups' strategic commitments are valuable because they increase price competition among the firms even though they lead to ex post inefficient trade. I then relax the commitment assumption and argue buyer groups may increase buyers' profits even when the exclusive purchase agreement is renegotiable. I finish with a brief discussion of four other extensions of the model and some concluding remarks.

2. A Numerical Example

Suppose Firm A and Firm B each have constant unit costs of \$1. Suppose Buyer 1 values one unit of Firm A's output at \$3 and one unit of Firm B's output at \$2 (and derives no value from additional units of either firm's output). Conversely, suppose Buyer 2 values one unit of Firm A's output at \$2 and one unit of Firm B's output at \$3. In the absence of a buyer agreement, assume the firms simultaneously make separate take-it-or-leave-it price offers to each of the two individual buyers and the buyers subsequently choose the product that maximizes their surplus. In equilibrium Firm A offers to sell one unit at a price of \$2 to Buyer 1 and a second unit to Buyer 2 for \$1, Firm B offers to sell to Buyer 2 for \$2 and to Buyer 1 for \$1. In response to these offers Buyer 1 buys from Firm A and Buyer 2 buys from Firm B. Each firm's profits are \$1 and each consumer's surplus is \$1.

If the two buyers merge and commit to purchase their output exclusively from either Firm A or Firm B, then the equilibrium prices fall. Because the two buyers are now constrained to consume the same product variety, they collectively value two units from Firm A at \$3 and two units from Firm B at \$3. In equilibrium the prices are \$2 for two units of output from each firm, and the buyers mix between buying from Firm A and Firm B. Each firm's profits are \$0 and each consumer's surplus is \$1.50 (assuming consumer mix 50/50). The consumers are strictly better off, but \$1 of total surplus has been destroyed.

This example illustrates the first fundamental insight of the paper. Buyers can use exclusive purchase contracts that are commonly adopted by buyer groups as a device to increase price competition between sellers. However the cost is that some ex post surplus

⁷ If the firms' offers can be arbitrary non-linear schedules of its sales, or more generally, the sales of both firms, then this game has other Nash equilibria as well. However the equilibrium described here is the only one that satisfies the refinement proposed by Bernheim and Whinston (1986) and is the one that yields the highest profit for the sellers (see also O'Brien and Shaffer, 1997 and Sections 7 and 8 below).

is destroyed because in equilibrium buyers mix between suppliers even though they may have strict preferences.

I revisit this example in Section 7 of the paper.

3. The Model

I consider a simple product differentiation model with two firms, A and B, and a continuum of buyers whose valuations for a single unit of the good, v_A and v_B , are described by the cumulative distribution function $F(v_A, v_B)$. I assume that the firms have complete information about the buyers' preferences. I also assume that the distribution is symmetric, or $F(v_A, v_B) = F(v_B, v_A)$, which implies $E[v_A - v_B] = 0$. Finally, I assume the firms have constant marginal cost of production c and that the support of F is bounded above c , that is $v_A > c$ and $v_B > c$ for all buyers.

It is convenient to describe buyers by their relative valuations of the goods. I will refer to $v_A - v_B$ as a buyer's preference type. Buyers with positive types all prefer good A to good B at equal prices, and buyers with negative types all prefer good A to good B at equal prices. Given the available prices individual buyers choose whether to buy from Firm A or B so as to maximize his or her ex post consumer surplus.

I assume that buyer groups are groups of buyers that have agreed to bundle their purchases and buy exclusively from either Firm A or Firm B. To differentiate from a buyer group that makes no strategic commitment, I refer to this as a strategic buyer group. Not that even strategic buyer groups choose whether to buy from Firm A or B so as to maximize the entire group's ex post consumer surplus, though the group can divide this surplus in any way it wishes. Since this means the group's decision is optimal ex post, the only strategic commitment that buyer groups can make is the commitment to buy exclusively from one firm.

I consider the following three-stage game:

- 1) Buyer Group Formation Stage: A planner assigns each buyer to a buyer group so as to maximize aggregate consumer surplus. Buyers use contractually binding agreements to form buyer groups and commit to purchase exclusively from a single seller.
- 2) Pricing Stage: Sellers simultaneously make a single take-it-or-leave-it price offers to each unassigned buyer and to each buyer group.⁸
- 3) Purchasing Stage: Individual consumers and buyer groups simultaneously make their purchase decisions. Each buyer group purchases from the supplier whose price offer maximizes the group's aggregate consumer surplus.

The assumption of a planner in Stage 1 is for convenience. It would be more appropriate to consider an extensive form coalition formation game, however these games are complex and often have multiple equilibria (see for example Aumann and Myerson, 1988, Ray and Vohra, 1997 and 1999, and Yi, 1997). However as a consequence, the model only describes the potential for buyer groups to increase consumer surplus. Much of this potential might not be realized in practice.

This is the basic timing. However I vary the timing in several ways. In Section 5, I analyze a game with much simpler Stage 1 commitments. In Section 7, I generalize the pricing stage to allow menu auctions, and in Sections 7 and 8, I relax the assumption that the exclusive purchase agreement is irreversible.

⁸ I assume throughout the paper that offers to groups of buyers other than the groups formed by the social planner are not feasible.

4. Equilibrium Pricing without Strategic Buyer Groups

Without strategic buyer groups, the Nash equilibrium pricing and purchasing decisions in Stages 2 and 3 of the game are easily characterized.

Proposition 1: *The equilibrium price offers made to a buyer with valuations v_A and v_B are $\max\{c, c + v_A - v_B\}$ from Firm A and $\max\{c, c + v_B - v_A\}$ from Firm B. In equilibrium, the buyer purchases from Firm A if $v_A > v_B$ and purchases from Firm B if $v_B > v_A$. When $v_A = v_B$, both firms' prices are c and the buyer mixes between purchasing from Firm A and Firm B,*

Proof: The losing firm's offer is c , otherwise either it could lower its price and win a profitable sale or the winning firm could raise its price and still win the sale. The buyer must be indifferent between the two prices or the winning firm could increase its profit. Therefore if $v_A > v_B$, Firm A is the winning firm, Firm B's price is c , Firm A's price is $c + v_A - v_B$, and the buyer captures surplus $v_B - c$. Similarly if $v_B > v_A$, Firm B is the winning firm, Firm A's price is c , Firm B's price is $c + v_B - v_A$, and the buyer captures surplus $v_A - c$. If $v_A = v_B$, the buyer mixes between purchasing from Firm A and Firm B, and both offer the good for c . So the price paid by the buyer is $c + |v_A - v_B|$ and the buyer's surplus is $s(v_A, v_B) = \min\{v_A, v_B\} - c$, or equivalently, $v_B - c$ when $v_A \geq v_B$ and $v_A - c$ otherwise.

In equilibrium each firm extracts a rent from each consumer equal to the added value it creates relative to the rival firm. Firms make zero profits from consumers who are indifferent between the two firms, but extract a loyalty rent from consumers who prefer their product.

5. Equilibrium Pricing with Strategic Commitments

Before considering strategic buyer groups, I first consider other Stage 1 strategic commitments buyers might make. Ideally a buyer would like to extract the entire surplus from the firm. So if a buyer could, it would make a take-it-or-leave-it offer to the firm whose product he or she prefers. Alternatively, he or she could commit to accept the firm's offer if-and-only-if it is equal to marginal cost. Of course, these commitments are not sequentially rational. For example, if the buyer commits to buy only at marginal cost, and the firms' each offered to sell at their cost plus a dollar, then the buyer has an incentive to renege on its commitment and buy at that price.

Another commitment that a buyer could make is to purchase from the lowest priced firm, regardless of his or her preferences. Priceline.com is an online travel agent that offers "Name Your Own Price" deals with this feature. Priceline.com's service allows consumers to commit to buy from the airline (or hotel) in a particular market that meets their price. Travelers commit to making a purchase, at a price of their choosing, from the lowest price carrier regardless of who it turns out to be (they also bear some risk associated with travel time and location). By slowly raising their price (a practice that is limited by priceline.com because only one price can be submitted per day), buyers can in principle commit to buy from the lowest priced firm.

Proposition 2 establishes that such commitments are profitable for buyers even though they are ex post inefficient. When $v_A = v_B$, the buyer is indifferent over making the commitment because the firms set price equal to marginal cost in either case.

Proposition 2: *Committing to buy from the lowest priced firm before firms set their prices increases price competition and makes every buyer better off (strictly better off if $v_A \neq v_B$). Firms set price equal to marginal cost and the buyer's surplus increases from $s(v_A, v_B) = \min\{v_A, v_B\} - c$ to $s_p(v_A, v_B) = (1/2)(v_A + v_B) - c$.*

Proof: The commitment clearly causes the firms to price at marginal cost. At any other prices, the higher priced firm has an incentive to undercut the other firm or the lower priced firm has an incentive to raise its price. So the buyer's surplus is

$$s_p(v_A, v_B) = (1/2)(v_A + v_B) - c$$

which is strictly greater than

$$s(v_A, v_B) = \min\{v_A - c, v_B - c\}$$

unless $v_A = v_B$, in which case they are the same.

6. Equilibrium with Strategic Buyer Groups

Rather than model coalition formation using an extensive form game, I assume that a coalition planner can design the coalition structure to maximize all consumers total ex post surplus subject to individual participation constraints. Consumers may be assigned to at most one coalition and some consumers may not be assigned at all. I refer to this set of coalitions and assignments as the coalition structure.

The participation constraint specifies that each buyer must be better off in the coalition to which he or she is assigned than on his or her own. The outside option is to not join a group and receive the price offers given in Proposition 1 (these price offers are independent of the coalition structure of other buyers).

Let $g_n(v_A, v_B)$ denote the distribution of the product valuations of the members of buyer group n . The mean preference type of the group, which I denote x_n and define to be the group's type, is

$$x_n = \frac{\iint (v_A - v_B) g_n(v_A, v_B) dv_A dv_B}{\iint g_n(v_A, v_B) dv_A dv_B}.$$

A great deal of intuition comes from considering what happens when every buyer is assigned to a single, universal group. Remember the winning supplier gets to sell to

every buyer in the group and the distribution is symmetric, so the total gains from trade for the group are the same at each firm, i.e.,

$$\iint v_A f(v_A, v_B) dv_A dv_B = \iint v_B f(v_A, v_B) dv_A dv_B.$$

So the group will always buy from the firm that offers the lower price. That is the group behaves as if it is a single buyer with the same valuation for each firm's product. So the unique equilibrium in the price stage is marginal cost pricing, $p_A = p_B = c$.

The effect of the group's type on equilibrium pricing is stated more generally in Lemma 3:

Lemma 3: *A coalition with mean valuations \bar{v}_A and \bar{v}_B behaves exactly as an individual with valuations \bar{v}_A and \bar{v}_B , and, in equilibrium, the firms' price offers to the coalition are the same as to an individual with the same valuations (i.e., the same as in Proposition 1).*

Lemma 3, with Proposition 1, clearly implies that the type of buyer group that induces the most competition among the firms is a group of type 0. More importantly, in conjunction with Proposition 2, Lemma 3 implies that the participation constraint is always satisfied for coalitions of type 0. Furthermore, the participation constraint is satisfied not only for the group, but also for each individual, so it is never necessary to use transfer payments to create a type 0 coalition.

I now want to show that only type 0 coalitions will form. Lemma 4 is an intermediate step in this argument:

Lemma 4: *A merger between two coalitions strictly increases total consumer surplus if the coalitions would have otherwise purchased from different firms and has no effect on total consumer surplus if the coalitions would have otherwise purchased from the same firm.*

Proof: Suppose there exists two groups, one of which has mean valuations v_A^1 and v_B^1 and the second of which has mean valuations v_A^2 and v_B^2 . These unmerged groups capture surplus $\min\{v_A^1 - c, v_B^1 - c\}$ and $\min\{v_A^2 - c, v_B^2 - c\}$ respectively. If the groups merge, the new group's mean valuations are $v_A^3 = \alpha v_A^1 + (1 - \alpha)v_A^2$ and $v_B^3 = \alpha v_B^1 + (1 - \alpha)v_B^2$, where $\alpha = n^1 / (n^1 + n^2)$ is the fraction of the combined group who were members of group 1. It follows that the combined group would capture surplus equal to $\min\{v_A^3 - c, v_B^3 - c\}$. Suppose $v_A^1 > v_B^1$ and $v_A^2 > v_B^2$ so both groups would purchase from A. (A similar argument holds when $v_B^1 > v_A^1$ and $v_B^2 > v_A^2$). Then the merged group purchases from A and their surplus is

$$(v_B^3 - c) = \alpha(v_B^1 - c) + (1 - \alpha)(v_B^2 - c)$$

and so

$$\min\{v_A^3 - c, v_B^3 - c\} = \alpha \min\{v_A^1 - c, v_B^1 - c\} + (1 - \alpha) \min\{v_A^2 - c, v_B^2 - c\},$$

that is, the merged group's total surplus is equal to the sum of the total surplus the two groups earned on their own. Suppose instead that $v_A^1 > v_B^1$ and $v_B^2 > v_A^2$, so group 1 purchase from Firm A and group 2 purchases from Firm B (a similar argument holds when $v_B^1 > v_A^1$ and $v_A^2 > v_B^2$). Then the merged group's surplus if they buy from Firm A is

$$(v_A^3 - c) = \alpha(v_A^1 - c) + (1 - \alpha)(v_A^2 - c) > \alpha(v_B^1 - c) + (1 - \alpha)(v_A^2 - c)$$

and their surplus if the buy from Firm B is

$$(v_B^3 - c) = \alpha(v_B^1 - c) + (1 - \alpha)(v_B^2 - c) > \alpha(v_B^1 - c) + (1 - \alpha)(v_A^2 - c)$$

so

$$\min\{v_A^3 - c, v_B^3 - c\} > \alpha \min\{v_A^1 - c, v_B^1 - c\} + (1 - \alpha) \min\{v_A^2 - c, v_B^2 - c\},$$

that is, the merged group captures greater total consumer surplus than the separate groups.

It follows from Lemma 4 that the consumer surplus is increased when every group with a non-zero type is merged with a group whose type has the opposite sign. If a positive type group exists in equilibrium, then by symmetry a negative type group must exist as well, but the groups could merge and increase consumer surplus, so only type 0 groups exist.

Proposition 5 is the main result of the paper.

Proposition 5: *An equilibrium coalition structure is one in which every buyer joins a group and every group is of type 0. Given an equilibrium coalition structure the firms' offer a price equal to marginal cost to each group, the firms' profits are zero, and each buyer's surplus is $s_p(v_A, v_B) = (1/2)(v_A + v_B) - c$.*

Proof: Lemma 4 establishes that a coalition structure in which every buyer joins a group and every group is of type 0 maximizes consumer surplus. All other coalition structures either have groups of opposite signs or individuals that were not members of groups and by Lemma 4 these structures are dominated: groups with types of the opposite sign can increase their surplus by merging and, if some buyers aren't in groups, they can be put into groups without lowering total consumer surplus and then merged with other groups to increase surplus. Finally by Proposition 2, groups of type 0 satisfy every individual's participation constraint. So the coalition structures that maximize consumer surplus also maximize consumer surplus subject to the participation constraints.

Proposition 5 is the first of the two main results in the paper. It shows that composition, and not size, may be the key attribute of a buyer group that generates additional buyer surplus.

However it is clear that forming a type 0 buyer group is not the only strategic commitment that increases buyer surplus, and more importantly, it is not even the most profitable one for buyers. So why use buyer groups at all?

There are several plausible answers. First, buyer groups can be large networks of diverse agents who find it very inconvenient to negotiate with one another. Hence a buyer group may be able to commit not to renegotiate terms of an agreement much more easily than an individual. This argument has been used to justify the assumption that a firm's debt terms are irreversible when debt instruments are widely held (see for example Perotti and Spier, 1993, and Hart and Moore, 1995).

The second is an equilibrium selection argument. In the next section I show that the equilibrium outcome characterized in Proposition 5 is an equilibrium of the game even without the exclusive purchase agreement. I argue that it is possible that forming a buyer group and announcing an exclusive purchase agreement is profitable even when both are fully reversible.

7. Strategic Effects Without Commitment: Numerical Example Revisited

The above analysis emphasizes the role of the exclusive purchase agreement in creating a strategic advantage for the buyer groups. However, I now argue that buyer groups have can the same strategic effect even if they do not make an exclusive purchase commitment or, equivalently, the exclusive purchase agreement is fully reversible. Specifically, in a menu auction (see Bernheim and Whinston, 1986) in which the sellers

specify a different price for every possible allocation, this equilibrium is one of several that arise when buyers do not sign an exclusive purchase agreement.

To see this, consider the numerical example in Section 2. In a menu auction this example has many Nash equilibrium. Table 1 shows three of these equilibria, labeled (i), (ii), and (iii), of a game in which buyers can, and do, form buyer groups, but cannot sign an exclusive purchase agreement. Equilibrium (i) is essentially the Nash equilibrium that we have already described. The firms offer to sell their first unit at a price of \$2 and their second unit at a price of \$1. In terms of a menu auction they are offering to sell at \$2 when each firm supplies one unit and at \$3 (for two units) when they are the exclusive supplier. Note that this is an equilibrium because neither firm can increase its profit by offering a lower price for the right to sell two units. Such an offer would be accepted, but yield lower profits.

In equilibrium (ii) the firms each offer a price of \$2 in the event they are the exclusive supplier, and, as in equilibrium (i), they offer a price of \$2 in the event each firm supplies a single unit. The merged buyer mixes between buying both units from Firm A and both units from Firm B. Note that neither firm can profitably deviate from this equilibrium by raising their offer to be the exclusive supplier. If either firm tries to sell to just one buyer, the offer will be rejected because the price of obtaining just one unit from the other firm is relatively high and the price of obtaining two units from the other firm is relatively low. Only a coordinated deviation by both firms can increase the firms' profits.

Equilibrium	(i)	(ii)	(iii)
<u>A's Price</u>			
0 units (0, 1, or 2 from B)	0	0	0
1 unit (0 or 1 from B)	2	2	1.5
2 units (0 from B)	3	2	2
<u>B's Price</u>			
0 units (0, 1, or 2 from B)	0	0	0
1 unit (0 or 1 from B)	2	2	1.5
2 units (0 from B)	3	2	2
<u>Equilibrium Allocation</u>			
Firm A	1 unit	2 units with probability 1/2 0 units with probability 1/2	1 unit
Firm B	1 unit	2 units with probability 1/2 0 units with probability 1/2	1 unit
<u>Net Profit</u>			
Firm A	1	0	0.5
Firm B	1	0	0.5

Table 1: Three Menu Auction/Non-Linear Pricing Equilibria

In equilibrium (iii) the firms each offer a price of \$2 in the event they are the exclusive supplier, but they instead offer a price of \$1.50 in the event each firm supplies a single unit.⁹ In this equilibrium the buyer purchases efficiently ex post. Note that the buyers are indifferent between this equilibrium and equilibrium (ii), but firms strictly prefer equilibrium (iii).

⁹ In this equilibrium the firms are dividing \$1 of surplus symmetrically. There are a continuum of related equilibrium in which the \$1 surplus is divided arbitrarily between the firms.

Each of these equilibria may arise when firms use menu auctions, i.e., announce general price schedules as a function of equilibrium allocation. Since the price schedules in these equilibria depend only on the sales volume (the prices are the same across all allocations with the same level of sales) all three of these equilibria also exist when firms are limited to traditional non-linear price schedules. Equilibria (i) and (iii) correspond to the “two good” equilibria and equilibrium (ii) corresponds to the “one good” equilibria described by O’Brien and Shaffer (1997) in their analysis of non-linear pricing when multiple suppliers face a monopsony buyer with preferences for variety. They prove that the buyer weakly prefers all one-good equilibria to all two-good equilibria, and the firms weakly prefer all two-good equilibria to all one-good equilibria, and conclude, counter intuitively, that foreclosure benefits buyers. This is consistent with the payoffs described here.

What happens when the exclusive purchase commitment may be reversible? The equilibria in Table 1 are also equilibria of the game in which an exclusive purchase agreement is signed in Stage 1, but is fully renegotiable in Stage 3. The presence of an exclusive purchase agreement does not formally change the set of equilibria as long as the agreement is fully renegotiable. However, it could still have an impact through equilibrium selection. In particular, Equilibrium (ii) is unthinkable in the absence of an agreement, but might be better described as a costly mistake if an exclusive purchase agreement were signed.

While it is interesting to note the multiplicity of equilibria, and the potential for exclusive purchase agreements to alter the equilibrium selection, it remains the case that equilibrium (i) is appealing because it is the equilibrium that yields highest profits, and is focal in the sense that it describes the strategies firms choose in the absence of an strategic agreement. The outcome in equilibrium (i) is also the unique equilibrium outcome of the game that satisfies the Truthful Nash Equilibrium refinement that was proposed by Bernheim and Whinston (1986). Under Bernheim and Whinston’s

refinement, the exclusive purchase commitment makes the buyers strictly better off since it switches the equilibrium outcome from (i) to (ii). Under this refinement, introducing menu auctions does not materially change the analysis.

8. Strategic Effects With a Little Commitment: Renegotiation of the Exclusive Purchase Agreement

If there is any positive chance that the agreement will hold, then the game gets even more interesting. I assume firms announce their prices before buyers learn whether it is feasible to renegotiate their agreement. In this case, the strategies in equilibrium (i) no longer constitute an equilibrium of the game. This is because each firm could increase its profits by charging a lower group price and winning the group sale with probability one. But such a price cut would induce consumers to buy at the group price even when the commitment was reversible.

Table 2 shows some equilibria that can arise when the agreement is partially reversible. Equilibrium (iv), like equilibrium (ii) in Table 1, describes the equilibrium in which firms' expectations are that the agreement will never be renegotiated. Neither firm can unilateral induce the buyers to renegotiate their agreement when it is feasible to do so, so a coordination failure occurs. Equilibrium (v), like equilibrium (iii), describes the case in which firms coordinate their individual offers sufficiently to allow renegotiation to occur whenever it is feasible, but are not able coordinate on their most profitable group offers. In this case buyers capture the full value of their commitment, even though it is reversible and renegotiated on the equilibrium path. These two equilibria arise for any positive probability of reversibility.

Equilibrium	(iv)	(v)	(vi)
<u>A's Price</u>			
0 units (0, 1, or 2 from B)	0	0	0
1 unit (0 or 1 from B)	2	1.5	1.9
2 units (0 from B)	2	2	2.8
<u>B's Price</u>			
0 units (0, 1, or 2 from B)	0	0	0
1 unit (0 or 1 from B)	2	1.5	1.9
2 units (0 from B)	2	2	2.8
<u>Equilibrium Allocation When the Commitment is Irreversible</u>			
Firm A	2 w/ prob. 1/2 0 w/ prob. 1/2	2 w/ prob. 1/2 0 w/ prob. 1/2	2 w/ prob. 1/2 0 w/ prob. 1/2
Firm B	2 w/ prob. 1/2 0 w/ prob. 1/2	2 w/ prob. 1/2 0 w/ prob. 1/2	2 w/ prob. 1/2 0 w/ prob. 1/2
<u>Equilibrium Allocation When the Commitment is Reversible</u>			
Firm A	2 w/ prob. 1/2 0 w/ prob. 1/2	1 unit	1 unit
Firm B	2 w/ prob. 1/2 0 w/ prob. 1/2	1 unit	1 unit
<u>Net Profit</u>			
Firm A	0	0.5	0.8
Firm B	0	0.5	0.8

Table 2: Menu Auction Equilibria with Partial Reversibility

What is the best the firms can do? If the probability that the commitment is irreversible is 20%, then the highest possible joint profits for the firms is 0.8 (equal to $1.9 - 1.0$, or 0.9 with probability 0.8 and $2.8 - 2$, or 0.8 with probability 0.10). One such equilibrium is Equilibrium (vi). In this equilibrium, buyer groups are indifferent between the group offer and the individual offers, but the firm strictly prefers to sell at its

individual prices. The difference is just high enough to prevent the firms from wanting to cut their group price (doubling the probability of sale (earning .8) when the commitment is irreversible (20%) is offset by the drop in profits, .9 to .8, when it is not (80%).

However, I would suggest that there is nothing focal about Equilibrium (vi). That is, there is little reason to believe that firms have at hand a coordinating device that would allow them to coordinate on one of the equilibria that maximize joint profits. While in general, firms' maximum joint profits fall continuously from 2 to 0 as the probability of reversibility falls from 1 to 0, there is a sense in which the coordination problem increases severely, and discontinuously, as this probability falls below 1.

9. Generalizations and Extensions

There are several ways in which I have simplified the model for my convenience, and that of the reader, and it is worthwhile discussing some of the many ways the model could be generalized.

General Governance Structures

I assumed above that buyer groups always maximized group surplus. If groups could commit to any governance structure, then they could clearly do even better. For example a group of positive type buyers could commit to let a buyer with type $+\varepsilon$ make their purchase decision and a group of all negative type buyers could commit to let a buyer of type $-\varepsilon$ make their purchase decision. In this way the purchase decisions are ex post efficient and almost the entire seller surplus is extracted. The problem with these alternative governance structures is that they are not renegotiation proof. The assumption that buyer groups always maximize group surplus is equivalent to assuming renegotiation proof governance structures.

Transfers

I did not need to assume that transfer payments were feasible, however, without transfer payments Proposition 5 becomes very sensitive to the assumption that the buyer coalitions formed are exactly type 0. In particular, a coalition of type $+\varepsilon$ or $-\varepsilon$ would capture almost as much surplus as a type 0 group, but without transfers the individual participation constraints would not be satisfied. For example, a coalition of type $\varepsilon > 0$ would buy from Firm A at a price $c + \varepsilon$, but buyers in the coalition for whom $v_B > v_A$ would rather buy as an individual from Firm B and get surplus $v_A - c$ then stay in the group where they would pay $c + \varepsilon$ for good A yielding surplus $v_A - c - \varepsilon$. In other words, the individual's participation constraint is discontinuous in his group type. For example, for consumers for whom $v_A > v_B$ the participation constraint is slack and continuous in the group's type as long as the group's type is positive; is slack, but discontinuous at zero; and fails to hold but is continuous in group type as long as the group's type is negative.

This discontinuity in the participation constraint could be eliminated in several ways besides using offsetting transfer payments. First, if firms had a small amount of private information about their cost, then Firm A may still win the group's contract even if the type is negative. As long as the probability of each firm winning is continuous in the group's type, every buyer's participation constraint would be continuous in the group's type and every buyer's participation constraint would hold for all group types in a neighborhood of 0.

Second, if consumers faced a small correlated preference shock after they formed coalitions, but before firms set prices, then again Firm A may supply a group of type $-\varepsilon$ in equilibrium. Third, if consumer's didn't precisely know the preferences of other buyers, then their participation constraint would be satisfied as long as there was a reasonable expectation of the group's type being near zero, either positive or negative. However, if consumers don't observe each others' valuations than it is not reasonable to

assume that firms do, and a full treatment of this case is beyond the scope of the paper, but it is briefly discussed in the next section.

Symmetry

The result that every buyer joins a type zero group depends on the population of buyer's having a mean type of zero, which followed from the symmetry assumption. If the distribution of buyers were asymmetric, then an equilibrium coalition structure would be any set of type 0 coalitions and set of residual individuals such that $\text{sgn}[v_A - v_B]$ is the same for all of the individual buyers (which implies it is impossible to form any additional type 0 coalitions).

Proposition 6: *Without transfer payments when the distribution is asymmetric, an equilibrium coalition structure is one in which either every positive-type buyer or every negative-type buyer (only one of these is feasible) joins a type 0 group and all the groups are type 0 groups.*

This is clear because only type 0 groups satisfy the individual participation constraints. However, with transfer payments many more coalition structures are possible. In particular, the universal coalition structure is an equilibrium coalition structure.

I now briefly discuss three other potential extensions of the model.

Inefficient Trade

I assumed that buyer's valuations always exceeded sellers' costs so that trade between any buyer and any seller increased surplus. Suppose instead that some buyers only gained from trade with one of the sellers. For example, suppose that in my numerical example Buyer 1 values Firm A's output at 3 and Firm B's output at 1/2 and Buyer 2 values Firm B's output at 3 and Firm A's output at 1/2. These buyers still have an incentive to form groups. If Buyer 1 and 2 formed a group in equilibrium they would

pay \$2 for 2 units and capture consumer surplus of 1.5. Yet as individual buyers, they capture 0 surplus. So in a more general, but still symmetric, model all buyers whose expected valuation for the firms' products exceeds the firms' costs will join a buyer group and the others will purchase as individuals.

n Firms

When there are more than two firms, the surplus created by coalitions may be smaller. For example, in the case where buyers have identically and independently distributed valuations for three goods, a coalition of every buyer would be indifferent between all three products and induce marginal cost pricing. However the surplus buyers capture in the group, equal to

$$\frac{v_A + v_B + v_C}{3} - c$$

may be smaller than surplus they get from purchasing individually, which, for example, is equal to

$$\max\{v_B - c, v_C - c\}$$

when $v_A = \max\{v_A, v_B, v_C\}$. So in particular the surplus is clearly smaller when

$$v_A = v_B > v_C.$$

However, instead of forming buyer groups that are indifferent among all three products, it is more natural, and in fact optimal, for buyer groups to be designed to induce rivalry between just two suppliers. In equilibrium three different types of coalitions could form, one indifferent between products A and B, one indifferent between products A and C, and one indifferent between products B and C. Each consumer joins the group that maximizes its consumer surplus given this coalition structure, namely the group that plays off his highest valuation good against its second highest valuation good. This argument generalizes to N firms as long as the valuations are independently distributed.

Uniform Pricing

I have assumed that each buyer is quoted a buyer-specific price. When firms are required to set uniform prices (perhaps because of laws prohibiting price discrimination) then the impact of coalitions on pricing is dramatically changed. However it is still the case that assigning every buyer to a type 0 coalition leads to marginal cost pricing and maximizes consumer surplus. However under uniform pricing, when one small type 0 coalition forms the equilibrium uniform price is essentially unchanged. Furthermore, since the beneficial effect of coalition formation is enjoyed whether or not buyers are in the coalition, individuals prefer to free ride on other buyers coalitions rather than form their own. It seems likely that in any reasonable game with a coalition formation stage, the unique equilibrium outcome in this game is that coalitions never form.

An alternative specification uniform pricing game assumes individuals are offered a common uniform price and groups are offered a group specific price. This game has the property that everyone is better off forming a group than buying individually, even if they are the only one in the group! Hence I speculate that all buyers will form groups of type zero in this model, at least when the distribution of buyers is uniform. However the analysis of this game is complicated by the fact that the pricing game has a mixed-strategy equilibrium for some coalition structures since a unique pure strategy price equilibrium exists only when regularity conditions on the distribution of buyers are satisfied. However given arbitrary coalitions, it is clear that these conditions will be violated.

Incomplete Information

When buyers types are privately observed two things change. First, individuals can no longer be distinguished so individual pricing becomes uniform. Second, coalitions still want to be perceived as being of type 0, but given this perception they have an incentive to bias their membership towards one firm or the other and always buy

from that firm. This effect totally undermines the commitment value of coalitions. However there is still one way for buyers to commit to being in a type zero groups; form a universal coalition with every buyer. I speculate that this is the unique equilibrium of the incomplete information game (it clearly is an equilibrium) when the distribution of buyers is uniform. However this is difficult to prove because the pricing subgame does not in general have a pure strategy equilibrium for arbitrary coalition structures.

10. Conclusion

I have shown that carefully constructed buyers groups that can commit to purchase from only one seller can capture greater surplus than any of their members could on their own. The group creates power by grouping buyers with heterogeneous preferences together to create a single buyer who is indifferent over all other product characteristics besides price. This induces sellers to price more aggressively, and while some members of the group end up consuming the product they value less, the expected benefit of increased price competition exceeds the expected cost of consuming the wrong product.

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