ECONOMIC ANALYSIS GROUP

DISCUSSION PAPER

Ordered Bargaining

by

Alexander Raskovich*

EAG 06-10   September 2006

EAG Discussion Papers are the primary vehicle used to disseminate research from economists in the Economic Analysis Group (EAG) of the Antitrust Division. These papers are intended to inform interested individuals and institutions of EAG's research program and to stimulate comment and criticism on economic issues related to antitrust policy and regulation. The analysis and conclusions expressed herein are solely those of the authors and do not represent the views of the United States Department of Justice.

Information on the EAG research program and discussion paper series may be obtained from Russell Pittman, Director of Economic Research, Economic Analysis Group, Antitrust Division, U.S. Department of Justice, BICN 10-000, Washington, DC 20530, or by e-mail at russell.pittman@usdoj.gov. Comments on specific papers may be addressed directly to the authors at the same mailing address or at their e-mail address.

Recent EAG Discussion Paper titles are listed at the end of the paper. To obtain a complete list of titles or to request single copies of individual papers, please write to Janet Ficco at the above mailing address or at janet.ficco@usdoj.gov or call (202) 307-3779. Beginning with papers issued in 1999, copies of individual papers are also available from the Social Science Research Network at www.ssrn.com.

* Economist, Antitrust Division, U.S. Department of Justice. The views expressed are solely my own and not those of the U.S. Department of Justice. I thank Patrick Greenlee and Glen Weyl for helpful discussions and comments.

Abstract

When buyers choose the order in which they bargain with suppliers of known characteristics, prices are determined jointly by bargaining power and competitive intensity (the outside option to bargain with rival suppliers). Bargaining power becomes less important to the outcome as competition intensifies; prices fall to marginal cost in the limit. With positive visit costs and weak competition, some buyer power is necessary for trade. Incomplete buyer power may lead to inefficient choice of bargaining order. The robustness of ordered bargaining to the possibility of price posting and auctions, and welfare properties of these alternative pricing institutions are also explored.

JEL codes: C72, C78, D43, D61, L13, L40

1. Introduction

Analyses of competition have consumer choice at their heart. Competition authorities recognize that consumers often have well-specified preferences over *suppliers*. The analysis of market definition, for example, typically turns on some determination of consumers' preferences over suppliers, or at least the distribution of such preferences in the consumer population.[1] In contrast, the formal literatures on search theory and on competitive bargaining often assume that consumers have preferences only over seller *characteristics*. In such models, consumers are frequently assumed to know only the distribution of characteristics in the seller population, but not the character of any particular seller.[2] Thus buyers are frequently modeled either as searching randomly, or as being randomly paired with sellers by some exogenous matching process. Although uncertainty is an important feature of many markets, consumers often have familiarity with suppliers and can rank them in order of preference.

While consumer choice is central, consumers are commonly treated as passive price-takers. Suppliers are typically portrayed as choosing which prices to post or (in case a buyer organizes an auction) which prices to bid. The key role played by bargaining in determining prices in many markets has gained broader recognition recently, and the development of models of buyer power is on the rise.[3] Nonetheless, bargaining has remained the poor stepchild of competition analysis, largely unintegrated into the family of competition models commonly used to analyze mergers and business practices.

---

[1] See for example the Horizontal Merger Guidelines, U.S. Department of Justice and the Federal Trade Commission, April 2, 1992 (revised: April 8, 1997).

[2] Papers on directed or ordered search are exceptions to this (see e.g. Perry and Wigderson, 1986; Stahl, 1996; Acemoglu and Shimer, 1999; Corbae et al, 2003; Arbatskaya, 2005).

[3] A very partial listing: Horn and Wolinsky (1988), Dobson and Waterson (1997), Chipty and Snyder (1999), Inderst and Wey (2003) and Raskovich (2003). See also Normann et al (2005) and Engle-Warnick and Ruffle (2005) for experimental tests of buyer power.

This paper develops a model of *ordered bargaining*, wherein buyers choose the order in which they bargain with suppliers of known characteristics. This is a departure from the common assumption in the literature on competitive bargaining[4] that meetings between traders are generated randomly by a matching process. In describing one such process, De Fraja and Sakovics (2001) draw an apt analogy with chemistry: buyers and sellers are akin to reactive atoms that bond with some probability upon being shaken in a beaker. While this characterization may be appropriate in some settings, it is inappropriate where buyers take the initiative in choosing among suppliers whose positions (in both physical and product space) are reasonably stable and known.

The ordered bargaining model developed here is a static model with a finite number of suppliers who face no effective capacity constraints. This economic setting is common in studies of industrial organization. The competitive bargaining literature, however, focuses on large economies with a continuum of atomistic buyers and sellers. This formulation has helped to make tractable the study of steady states in dynamic settings with continuous inflows and outflows of traders. But the focus on atomistic agents has tended to obscure the potential relevance of bargaining to the classic issues of concentration and market structure in industrial organization.

The ordered bargaining model offers a number of intuitively appealing features. It exploits the idea of "competition as outside option." The option of bargaining with rival suppliers is key to determining a buyer's expected price in the model. While the

[4] Among others, Jackson and Palfrey (1998) use this term to describe the literature. In business circles, however, the term has the colloquial meaning of "hard" bargaining. Papers in the competitive bargaining literature are too numerous to list exhaustively. Among the early papers in this vein are Rubinstein and Wolinsky (1985), Gale (1986), Bester (1988) and Binmore and Herrerro (1988); see Osborne and Rubinstein (1990) for a survey. More recent papers include Jackson and Palfrey (1998) and De Fraja and Sakovics (2001).

importance of outside options to bargaining outcomes has long been recognized, outside options have typically been treated as exogenously given. According to the well-known "outside option principle,"[5] an outside option is either irrelevant to the bargaining outcome, when the option is weak, or else completely overshadows internal factors (such as the relative patience of the parties) to determine the bargaining outcome, when the outside option is strong. In the ordered bargaining model, by contrast, the strength of the outside option is determined endogenously, by the nature of the market, the buyer's choice of bargaining order, and the state of play (e.g., whether earlier offers have been rejected).

The broader the set of suppliers with whom a buyer could bargain, and the greater the ease with which a buyer could switch bargaining partners (e.g., less differentiation among suppliers; lower costs of visiting them), the stronger is the buyer's outside option. Stronger outside-option competition lowers the expected price the buyer faces in subgame perfect equilibrium of the ordered bargaining game. Outside-option competition and buyer bargaining power both contribute to lowering expected prices. Bargaining power wanes in significance, however, as outside-option competition intensifies. In the limit as the number of suppliers grows without bound and as trading frictions decline to zero, expected prices fall to marginal cost. This result contrasts with the typical finding in the competitive bargaining literature, that equilibria diverge from the perfectly competitive outcome even in the limit as frictions vanish.

The ordered bargaining model offers a framework for studying the competitive effects of mergers and business practices in markets where prices are determined by bilateral bargaining. The model illustrates that, as in other market settings, a loss of

[5] See the seminal paper by Binmore et al (1989).

(outside-option) competition tends to raise prices in ordered bargaining markets. The model offers insights into how the costs of initiating bargaining ("visit costs") and heterogeneity among suppliers affects competitive intensity, as measured by the value of the buyer's outside option to bargain with rival suppliers.

The remainder of the paper is organized as follows. Section 2 lays out the economic setting. Section 3 derives the unique subgame perfect equilibrium of the general game and explores the efficiency of equilibrium. Section 4 treats two special cases, one with identical players and one with a particular structure of symmetric differentiation, to illustrate how competitive intensity affects bargaining outcomes. Section 5 augments the ordered bargaining game by introducing the possibility that suppliers can post prices and buyers can organize auctions for their business. Circumstances under which posted prices or auctions emerge in the new equilibrium are then explored, as are welfare implications of the alternative pricing institutions. Section 6 discusses some implications of the preceding results and concludes.

2. Economic Setting

All players have full information and the structure of the game is common knowledge. There is some number (possibly a continuum) of buyers and $n \geq 1$ suppliers indexed by $j = 1, 2, \ldots, n$. It will become apparent that the number of buyers is immaterial to the analysis, which is carried out at the level of an individual buyer. Throughout this section and the next, the superscript i indicates a variable associated with buyer i, while subscripts (always) indicate suppliers. In Section 4, superscript i is dropped to avoid confusion; it should be understood, however, that the analysis is always carried out with respect to a given buyer.

Each buyer i has unit demand, valuing the good of supplier j at $v_j^i \geq 0$. Suppliers can provide their goods without capacity limits. The cost to supplier j of serving buyer i is $c_j^i \geq 0$. Both buyers and suppliers are risk-neutral, acting noncooperatively to maximize their respective expected payoffs from the game. Time proceeds in n discrete periods, indexed by $t = 1, 2, \ldots, n$. There is no time discounting.

In period 1, buyer i can visit any supplier j at cost $s_j^i \geq 0$ to engage in bilateral bargaining. Bargaining takes the simple form that one party chosen at random makes a take-it-or-leave-it offer to the other. If buyer i visits supplier j, the buyer is chosen to be the proposer with probability $\alpha^i \in [0,1]$, the seller with probability $1-\alpha^i$. If an offer p is accepted in period t, trade ensues and the game ends for the buyer. In this case buyer i earns a payoff [6] of $v_j^i - s_j^i - p$ and supplier j earns $p - c_j^i$ on the given sale. The supplier remains in the game to serve other customers. If the offer is rejected, the opportunity for trade between i and j is foreclosed. Let Ω_t^i be the set of suppliers that buyer i has visited prior to period t, the bargaining with each having ended in a rejected offer. Then in period t buyer i can visit a supplier k at cost s_k^i to engage in bargaining only if $k \notin \Omega_t^i$.

3. Equilibrium

The subgame perfect equilibrium of the game with respect to any buyer i can be found by backward induction. Without loss of generality, index suppliers in the order in which a given buyer i would choose to visit them. Let u_j^i denote buyer i's expected

[6] Gross of any earlier visit costs that have been sunk. In subgame perfect equilibrium of the full information game, no buyer visits more than one supplier.

payoff from the game when evaluated just prior to the buyer's decision on whether to visit supplier j, given that bargaining with the first $j-1$ suppliers has ended in rejected offers. Consider the last period, $t=n$. If previous visits, to suppliers $1, 2, \ldots, n-1$, all ended in rejected offers, buyer i's expected payoff in period n would be

$$u_n^i = \max\left\{0, \alpha^i (v_n^i - c_n^i) - s_n^i\right\}. \qquad (1)$$

If $v_n^i < c_n^i$, there clearly is no scope for trade, in which case buyer i will forego visiting supplier n and thus $u_n^i = 0$. If instead $v_n^i \geq c_n^i$, then in visiting supplier n in the final period buyer i would obtain expected surplus of $\alpha^i (v_n^i - c_n^i) - s_n^i$. This is because buyer i would offer price c_n^i if chosen as proposer, supplier n would offer price v_n^i if chosen, and each of these proposals would be accepted by the other party. To effect this trade, buyer i would face the cost s_n^i of visiting supplier n.

Now consider buyer i's bargaining in an earlier period $t = j < n$, with supplier j. Once again, if chosen as proposer buyer i would offer price c_j^i and supplier j would accept. The supplier's optimal offer, on the other hand, depends on the alternative bargaining partners to whom the buyer could turn. Supplier j's optimal offer to buyer i would be $v_j^i - u_{j+1}^i$, where $u_{j+1}^i \geq 0$ represents the value to buyer i of the outside option of visiting supplier $j+1$. Supplier j's offer leaves buyer i indifferent between accepting and pursuing the outside option. Thus buyer i's expected payoff, evaluated just prior to the buyer's decision on whether to visit supplier j, is given by

$$u_j^i = \max\left\{0, \alpha^i (v_j^i - c_j^i) - s_j^i\right\} + (1-\alpha^i) u_{j+1}^i, \qquad \text{for } 1 \leq j \leq n-1. \qquad (2)$$

Proposition 1 (Bargaining Order). *Assume* $\alpha^i \in (0,1)$ *and let subscripts index suppliers in the order in which a given buyer* i *would choose to visit them. This ordering is such that, for any suppliers* j *and* k *, if* $\alpha^i (v_j^i - c_j^i) - s_j^i > \alpha^i (v_k^i - c_k^i) - s_k^i$ *, then* $j < k$ *.*

Proof. Starting with the candidate ordering, any other arrangement can be constructed by a series of operations in which adjacent suppliers switch places, moving lower-ranked suppliers higher up in the new order. It suffices to show that each such transposition of adjacent suppliers would reduce buyer i 's expected payoff from the game. Equation (2) can be expanded to

$$u_j^i = \alpha^i (v_j^i - c_j^i) - s_j^i + (1-\alpha^i)[\alpha^i (v_{j+1}^i - c_{j+1}^i) - s_{j+1}^i] + (1-\alpha^i)^2 u_{j+2}^i .$$

Note that switching the places of suppliers j and $j+1$ would leave the value of the next outside option u_{j+2}^i unchanged. The result then follows immediateley. □

Proposition 1 states that buyer i would visit suppliers in descending order of the expected net surplus the buyer would obtain from one-shot bargaining with them. Intuitively, any other ordering would lower the buyer's expected payoff, because in any period it is better to bargain with the highest net-surplus supplier than to use that supplier as an outside option in bargaining with a lower net-surplus supplier.

Buyer i 's expected payoff evaluated at the outset of the game, u_1^i, can be derived recursively using equations (1) and (2). Note that if $\alpha^i (v_n^i - c_n^i) - s_n^i \geq 0$, then likewise $\alpha^i (v_j^i - c_j^i) - s_j^i \geq 0$ for every supplier $j < n$, according to Proposition 1. In this case

$$u_1^i = \sum_{k=0}^{n-1} (1-\alpha^i)^k [\alpha^i (v_{k+1}^i - c_{k+1}^i) - s_{k+1}^i] . \qquad (3)$$

Proposition 2 (Equilibrium). *There is a unique subgame perfect equilibrium to the ordered bargaining game with regard to trade with a given buyer* i*, as follows:*

(i) *If* $u_1^i < 0$*, the buyer visits no supplier.*

(ii) *If* $u_1^i \geq 0$*, the buyer visits supplier 1 and buys this supplier's good at price* c_1^i*, if the buyer is chosen to propose, or buys at price* $v_1^i - u_2^i$ *otherwise.*

Proof. Follows immediately from the foregoing development. □

Proposition 2 describes equilibrium with respect to a given buyer i. The market-wide equilibrium is simply the union of outcomes for all buyers. This equilibrium will typically involve dispersion in expected prices if buyers vary in their bargaining powers, valuation of goods, costs of being served, or visit costs. As will become apparent, price dispersion tends to narrow as outside-option competition intensifies.

Proposition 3 (Efficiency).

(i) *If* $\alpha^i = 1$*, equilibrium is efficient with respect to buyer* i*'s trade.*

(ii) *If* $\alpha^i < 1$ *and* $s_j^i = s^i > 0$ *for every supplier* j*, equilibrium trade realized with buyer* i *is efficient, but the efficient trade may go unrealized.*

(iii) *If* $\alpha^i < 1$ *and visit costs vary across suppliers, an inefficient trade may be realized in equilibrium.*

Proof. Proof of part (i): The total surplus that would be generated by trade between buyer i and any supplier j is $v_j^i - c_j^i - s_j^i$. Given $\alpha^i = 1$,

$$v_1^i - c_1^i - s_1^i \geq v_j^i - c_j^i - s_j^i \qquad \text{for every supplier } j \neq 1, \tag{4}$$

by Proposition 1. By Proposition 2, buyer i will trade with supplier 1 in case the left-hand side of (4) is nonnegative; otherwise buyer i will forgo trade. Proof of part (ii):

$$\alpha^i (v_1^i - c_1^i) - s^i \geq \alpha^i (v_j^i - c_j^i) - s^i \qquad \text{for every supplier } j \neq 1, \tag{5}$$

by Proposition 1, and so $v_1^i - c_1^i - s^i \geq v_j^i - c_j^i - s^i$. Thus buyer i will trade with supplier 1 if the left-hand side of (5) is nonnegative. If trade occurs, clearly it will be efficient; however note that buyer i will not undertake the efficient (or any other) trade if α^i is so small that the buyer's expected share in surplus ex post fails to cover the cost of the visit.

Proof of part (iii): With heterogeneous visit costs,

$$\alpha^i (v_1^i - c_1^i) - s_1^i \geq \alpha^i (v_j^i - c_j^i) - s_j^i \qquad \text{for every supplier } j \neq 1, \tag{6}$$

by Proposition 1. Buyer i will trade with supplier 1 if the left-hand side of (6) is nonnegative, even if condition (4) is violated. □

Inefficiency can occur when $\alpha^i < 1$ because buyer i bears the full cost of visiting a supplier but captures only a fraction of the ex post surplus. Efficient trade may thus be frustrated by the buyer's unwillingness to undertake the cost of visiting any supplier. The buyer may also undertake inefficient trade, forsaking trade that would yield higher joint surplus in order to economize on the private cost of the visit. The inefficiencies of ordered bargaining are taken up again in the discussion of posted pricing and auctions as alternative pricing institutions in Section 5.

Define the expected (net) price facing buyer i at the outset of the game as

$$p_1^i = v_1^i - s_1^i - u_1^i. \tag{7}$$

A key question of interest is how this price depends on the buyer's bargaining power and on "competitive intensity," as measured by the strength of the buyer's outside option. This is explored in the next section for two special cases.

4. Two Examples

This section treats two special cases of the ordered bargaining game: (1) identical players and (2) a particular structure of symmetrically differentiated goods.

4.1 Identical Players

Suppose all buyers are identical, as are all suppliers. Every buyer values every good at v and suppliers have common marginal cost c, normalized to $(c,v)=(0,1)$. All buyers have bargaining power α and the cost of visiting any supplier is s. In this case, equation (1) simplifies to $u_n = \max\{0, \alpha - s\}$.

Note that if $\alpha < s$ then by recursion $u_1 = 0$, $p_1 = 1$, and no buyer visits any supplier in equilibrium. This is a generalization of Diamond's (1971) paradoxical result: When prices are (always) chosen by sellers and are unobservable to buyers prior to a costly visit, the unique equilibrium is for sellers to set the monopoly price and for no buyer to visit any seller.[7] Diamond's (1971) result holds for any strictly positive visit cost, however small (given $\alpha = 0$). The result holds more generally whenever buyers choose prices with positive probability α but search costs are sufficiently high, $s > \alpha$. Note that this result does not depend on the number of suppliers, n. If $\alpha > s$, on the other hand, buyers face a below-monopoly expected price ($p_1 < 1$) and earn positive expected payoff ($u_1 > 0$) from playing the game. In this case, competition in the sense of n does affect the expected market price.

For $\alpha \geq s$, equation (3) simplifies to

$$u_1 = (\alpha - s)\sum_{k=0}^{n-1}(1-\alpha)^k \ . \qquad (8)$$

[7] See Davis and Holt (1996) for an experimental test of the Diamond (1971) paradox.

Note from equation (8) that the smaller is s (closer to zero), the greater the buyer's share in the joint surplus from trade with supplier 1. This effect has two components. First, the actual cost of visiting supplier 1 declines with s. This corresponds to the first term in the series expansion on the right-hand side of equation (8): $(\alpha - s)(1-\alpha)^0$, or simply $\alpha - s$. Second, the buyer's outside option of visiting suppliers $2, \ldots, n$ is strengthened by a reduction in visit costs. This corresponds to remaining terms in the series in (8).

Evaluated at the outset of the game, the buyer's outside option of visiting supplier j, in jth order, is $(\alpha - s)(1-\alpha)^{j-1}$. The aggregate value of the outside option is the sum of these individual values, as indicated in equation (8). Thus the aggregate value of the outside option cumulates with n, but at a diminishing rate. For example if $\alpha = \frac{1}{2}$, the successive terms $(1-\alpha)^k$ for $k > 0$ on the right-hand side of equation (8) are $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \ldots$ Note also that the terms in the series drop off more rapidly for larger α: Greater buyer power implies a smaller boost to expected buyer surplus u_1 from an increase in competition in the sense of n. This is because a power buyer is already capturing a large share of the joint surplus, apart from any outside-option competition. For $\alpha \in (0,1)$, the series on the right-hand side of equation (8) converges to $1/\alpha$ as $n \to \infty$. Thus, for $0 \le s < \alpha < 1$,

$$\lim_{n\to\infty} u_1 = 1 - \frac{s}{\alpha} \, . \tag{9}$$

By equations (7) and (9),

$$\lim_{n\to\infty} p_1 = \left(\frac{1-\alpha}{\alpha}\right) s \, . \tag{10}$$

The limit price in equation (10) falls to zero (marginal cost) as s falls to zero. That is, the market outcome becomes perfectly competitive in the limit as the number of suppliers grows without bound and as visit cost "frictions" vanish. This result runs counter to earlier work on competitive bargaining, which has generally found that market equilibria diverge from the perfectly competitive outcome even in the limit.

The result also diverges from the classic Bertrand-Nash model of price setting with identical suppliers and zero visit costs, in which the equilibrium price equals marginal cost for any number of suppliers $n \geq 2$. This has potential implications for the competitive analysis of horizontal merger in industries characterized by homogeneous suppliers. The posted-price Bertrand-Nash model implies that (absent efficiencies) a three-to-two merger would have no effect on price. In contrast, the ordered bargaining model suggests the effect might be substantial. For example if $\alpha = \frac{1}{2}$, the expected price would double, from $\frac{1}{16}$ to $\frac{1}{8}$, with a change from $n = 3$ to $n = 2$.[8]

4.2 Symmetric Differentiation

To highlight the role of product differentiation, assume now that the cost of visiting any supplier is zero, suppliers have common marginal cost of zero, and buyers have common bargaining power α. Suppose that any given buyer values suppliers' goods according to a power function of the supplier's ranking. In particular (dropping superscript i to avoid clutter), let $v_1 = 1$, $v_2 = \delta$, $v_3 = \delta^2$, and generally $v_j = \delta^{j-1}$, where $\delta \in [0,1]$. To fix ideas, consider $n!$ buyer types, each distinguished by a unique permutation in ranking the n suppliers. Differentiation is symmetric in the sense that every supplier has ranking j, $j = 1,2,\ldots,n$, for the proportion $1/n$ of the buyer

[8] Here the merger is assumed to simply reduce the number of bargaining opportunities by one.

population. Maintaining the full information setting, suppliers know their rankings with respect to every buyer.

In this example, the analogues to equations (1) and (2) are

$$u_n = \alpha \delta^{n-1}, \tag{11}$$

and

$$u_j = \alpha \delta^{j-1} + (1-\alpha) u_{j+1}, \qquad \text{for } 1 \le j \le n-1. \tag{12}$$

The buyer would offer a price of zero if chosen as proposer, supplier j would offer a price of $\delta^{j-1} - u_{j+1}$ if chosen, and each of these offers would be accepted by the other party. By recursion, a buyer's expected payoff from playing the game is

$$u_1 = \alpha \sum_{k=0}^{n-1} [\delta(1-\alpha)]^k . \tag{13}$$

The higher is δ (closer to one), the less differentiated are suppliers' goods from any given buyer's perspective. Note that a buyer's share in joint surplus increases with δ, given that the buyer's outside option is strengthened thereby. If $\delta \in (0,1)$, a buyer's share in joint surplus also grows with n, at a diminishing rate. For example if $\delta = \frac{4}{5}$ and $\alpha = \frac{1}{2}$, the terms $k > 0$ in the series expansion in equation (13) are $\frac{2}{5}, \frac{4}{25}, \frac{8}{125}, \ldots$ The smaller is δ, the more rapid the drop-off in these terms.

As the number of suppliers grows without bound, the buyer's expected share in joint surplus in equation (13) converges to

$$\lim_{n\to\infty} u_1 = \frac{\alpha}{1-\delta(1-\alpha)} , \tag{14}$$

and thus the expected price converges to

$$\lim_{n\to\infty} p_1 = \frac{(1-\delta)(1-\alpha)}{1-\delta(1-\alpha)} \ . \qquad (15)$$

Perfect competition and one-shot bargaining are polar extreme cases. For $\delta = 1$, the limit price in equation (15) falls to zero (marginal cost). The outside option is very strong in this case: perfect homogeneity of goods allows buyers in the limit to capture the entire unit joint surplus from trade with supplier 1, by equation (14). At the opposite extreme of $\delta = 0$, the outside option becomes worthless. In this case, supplier 1 has the position of local monopolist, albeit one that must bargain to make the sale. The buyer then captures only α of the joint surplus in the one-shot bargaining game.

5. Alternative Pricing Institutions

This section contributes to the growing literature endogenizing pricing institutions. As shown presently, in some circumstances posted pricing or auctions can supplant the ordered bargaining equilibrium. Issues of key interest are the factors determining which pricing institution emerges in equilibrium, and the welfare consequences of this outcome.[9]

Consider first the traditional conception of price posting in which suppliers publicly announce prices at which they stand ready to serve all comers. Suppose that buyers are identical, as are suppliers. If suppliers can post prices at zero posting cost, clearly the ordered bargaining equilibrium cannot be sustained. In the new equilibrium, all suppliers post the common marginal cost and buyers capture the entire surplus without bargaining. With costly posting, there are two possibilities. If posting costs are prohibitively high, the ordered bargaining equilibrium is preserved. If posting costs are

[9] Papers in this vein include Bester (1993), Wang (1993, 1995), Bulow and Klemperer (1996), Arnold and Lippmann (1998), Neeman and Vulkan (2003) and Raskovich (2006).

small but strictly positive, typically no equilibrium exists. In this case, if multiple suppliers were to post prices, none could recover posting costs given the ensuing fierce competition.

5.1 Targeted Price Posting

Suppose that suppliers can send advertising leaflets to individual buyers at the common cost $\lambda \geq 0$ per leaflet. A buyer that has not received any leaflet embarks on ordered bargaining as before. A buyer that has received a leaflet chooses whether to redeem it or to engage in ordered bargaining. A leaflet is a posted price targeted to a particular buyer.[10] Targeted price posting has commitment power; by assumption, the supplier is legally obligated to sell to the targeted buyer at (no more than) the posted price. In the augmented game, suppliers choose whether to send leaflets in an initial stage. Thereafter, buyers choose which suppliers to visit.

For notational convenience, assume for the moment that buyers have common bargaining power $\alpha \in (0,1)$, although they may differ in other respects. If buyer i visits (at cost s_j^i) the supplier j that sent the leaflet advertising price $\overline{p}_j^{\,i}$, then with probability $1-\alpha$ the buyer faces price $\overline{p}_j^{\,i}$ from the supplier. With probability α, the buyer is chosen as proposer, in which case the buyer proposes price c_j^i and supplier j accepts. Buyer i's expected surplus from redeeming the leaflet is then

$$\overline{u}_j^{\,i} = \alpha(v_j^i - c_j^i) - s_j^i + (1-\alpha)(v_j^i - \overline{p}_j^{\,i})\,. \tag{16}$$

[10] This is similar to the advertising technology in Butters (1977), except that here the leaflet can be directed to a particular buyer with certainty.

Supplier j would send the leaflet only if the recipient would certainly redeem it. Otherwise, the leaflet would represent a pure loss of the leaflet cost λ. Buyer i will redeem the leaflet if and only if the following two conditions (17) are both met:

$$\bar{u}_j^{\,i} \geq u_1^i, \tag{17.1}$$

where u_1^i is the expected surplus from ordered bargaining (given in equation (3)), and

$$\bar{u}_j^{\,i} \geq \bar{u}_k^{\,i} \qquad \text{for every } k \neq j \text{ that may send a leaflet to } i. \tag{17.2}$$

In equilibrium with full information, at most one supplier sends a leaflet to buyer i. The price posted on this leaflet may be constrained, however, by potential leafletting competition. Absent such competition, the posted price $\bar{p}_j^{\,i}$ that maximizes j's profit would satisfy condition (17.1) with strict equality.[11] However, if posting this price would open a profitable leafletting opportunity for another supplier, then j would choose $\bar{p}_j^{\,i}$ to satisfy condition (17.2) with strict equality for the strongest leafletting competitor.

The lowest price that any supplier j could profitably post is implicitly defined by $(1-\alpha)(\bar{p}_j^{\,i} - c_j^{\,i}) - \lambda = 0$, or

$$\bar{p}_j^{\,i} = c_j^i + \frac{\lambda}{1-\alpha} \ . \tag{18}$$

Susbtituting equation (18) into equation (16) yields

$$\bar{u}_j^{\,i} = v_j^i - c_j^i - s_j^i - \lambda \tag{19}$$

as the highest expected surplus that supplier j could profitably promise to buyer i, by posting price $\bar{p}_j^{\,i}$ given in equation (18). This leads immediately to:

---

[11] This assumes $j \neq 1$, of course. Otherwise supplier 1 would do at least as well by playing the ordered bargaining game with buyer i, and strictly better if $\lambda > 0$.

Proposition 4. *Augment the ordered bargaining game by introducing an initial stage of targeted price posting. In the new subgame perfect equilibrium:*

(i) *If a given buyer i receives a posting, it is sent by the supplier whose trade with buyer i would yield the highest joint surplus.*

(ii) *A given buyer i trades with the same supplier as in the equilibrium of the original ordered bargaining game, if this equilibrium was efficient with respect to trade with buyer i. In this case, if posting is costly ($\lambda > 0$) and the supplier sends a posting to buyer i, joint surplus falls.*

Recall from Proposition 3 that the equilibrium of the ordered bargaining game may be inefficient. A given buyer may forgo trade altogether, despite the existence of a known supplier with whom joint surplus would be positive. A buyer may also knowingly choose a trade that yields less than maximal joint surplus, in seeking to maximize private gains from trade. Proposition 4(i) implies that if the equilibrium of the ordered bargaining game is inefficient, targeted price posting may improve the efficiency of trade. Such a posting allows the efficient supplier to propose a split in joint surplus to buyer i that makes them both better off.

Conversely, Proposition 4(ii) states that if the equilibrium of the original ordered bargaining game was already efficient, introducing targeted price posting weakly reduces efficiency. In this case, buyer i may be better off with a posting, but the supplier is worse off and joint surplus falls by the cost λ dissipated in any posting.

The next two subsections each explore a special case of the augmented model, with an eye to factors determining whether targeted price posting emerges in equilibrium.

5.1.1 Identical Players

Consider again the case of identical players discussed in Section 4.1, only augmented now with an initial stage in which suppliers can engage in targeted price posting. Recall from condition (17.1) above that a buyer is willing to redeem a leaflet only if doing so yields expected surplus at least as high as the buyer can obtain from ordered bargaining:[12]

$$\bar{u} - u_1 \geq 0 . \tag{20}$$

The highest expected surplus $\bar{u}$ from redeeming a leaflet that suppliers could profitably promise is the joint surplus from trade minus visit cost s and posting cost λ (equation (19)). Given the other parameters of the model, there is a critical posting cost $\hat{\lambda}$ such that condition (20) does not hold—and therefore targeted price posting does not emerge in equilibrium—for $\lambda > \hat{\lambda}$.

Recall that the expected surplus u_1 from ordered bargaining increases with competitive intensity. This is true in two senses. First, u_1 increases with the number of suppliers, n, which improves the outside option. Second, a reduction in visit costs, s, also improves the outside option to visit other suppliers. All else equal, condition (20) is harder to satisfy the greater the intensity of outside-option competition in ordered bargaining. This result is fairly general, as can be seen by inspecting equation (3).

In the limit as $n \to \infty$, recall (equation (9)) that buyers capture the entire joint surplus from trade less the portion s/α. In this limiting case,

$$u_1 = v - c - \frac{s}{\alpha}, \tag{21}$$

[12] Given identical suppliers, a buyer's ordering of suppliers is of course arbitrary. The subscript 1 in condition (20) simply indicates the buyer's perspective prior to making the first visit.

discarding the normalization $(c,v)=(0,1)$ from Section 4.1 for expositional clarity. By conditions (19), (20) and (21), the critical posting cost is

$$\hat{\lambda}=\left(\frac{1-\alpha}{\alpha}\right)s\ . \tag{22}$$

Thus the critical posting cost $\hat{\lambda}$ decreases as buyer power α grows.[13] Intuitively, greater buyer power means buyers enjoy more surplus from ordered bargaining, making it harder for suppliers to promise equally high surplus through a costly posting.

The welfare consequences of targeted price posting are subtle. Suppose that

$$0<\alpha(v-c)<s<v-c\ . \tag{23}$$

The middle inequality in (23) implies $u_1<0$ by (21). The rightmost inequality in (23) implies potential gains from trade. This situation is akin to the Diamond (1971) paradox: Despite positive joint surplus from trade, no trade occurs in the ordered bargaining equilibrium, because buyer power is too low for buyers to recover the cost of a visit in ex post bargaining. Targeted price posting overcomes this hurdle and facilitates trade in the equilibrium of the augmented game, so long as posting costs are below the critical value.

If $\alpha(v-c)>s\geq 0$, on the other hand, $u_1\geq 0$. In this case, trade does take place in the original ordered bargaining game. Moreover, there is no question of allocative inefficiency given identical players. Targeted price posting then represents a pure waste, if it occurs in equilibrium of the augmented game. Dissipation of total surplus would be greatest if posting costs were just below the critical value $\hat{\lambda}$.

[13] This result also holds for finite n (see equation (8)).

5.1.2 Heterogeneous Visit Costs

Recall from Proposition 3(iii) that in equilibrium of the ordered bargaining game, a buyer may choose a trade that fails to maximize joint surplus, in order to economize on visit costs. The reason is that a buyer bears the full cost of visiting a (distant or inconvenient) supplier, but may capture only a fraction of the joint surplus in ex post bargaining. In this case, by Proposition 4(i), there is scope for targeted price posting to improve allocative efficiency in equilibrium of the augmented game.

To simplify notation, let W_j^i denote the joint surplus from trade between buyer i and supplier j, gross of any visit costs or posting costs: $W_j^i = v_j^i - c_j^i$. Assuming buyer power is not supplier-specific, recall from Proposition 1 that

$$\alpha W_1^i - s_1^i \geq \alpha W_j^i - s_j^i \, . \tag{24}$$

Inequality (24) can be written as

$$W_j^i - W_1^i \leq \frac{s_j^i - s_1^i}{\alpha} \, . \tag{25}$$

According to inequality (25), in order for the joint surplus from trade with supplier j to exceed that with supplier 1 in the ordered bargaining equilibrium, visiting supplier j must be costlier than visiting supplier 1 by a multiplier that decreases as buyer power α grows. For $\alpha = 1$, the buyer completely internalizes the social tradeoff between visit costs and ex post joint surplus, and so always trades with the efficient partner. As α drops below one, a wedge is driven between joint gains and the buyer's private gains, in which case supplier j might find it profitable to send the buyer a targeted price posting.

Note that $W_j^i - W_1^i$ is a high upper bound on posting costs consistent with supplier j sending a leaflet to buyer i. That is, if the cost of sending the leaflet exceeds the incremental social surplus, it clearly cannot be privately profitable for the supplier to do so. Even a somewhat less costly leaflet would be unprofitable in most cases, but investigating this high upper bound offers useful insights. Inspection of inequality (25) suggests that targeted price posting is less likely to emerge the greater is buyer power, the smaller are visit costs generally relative to the ex post gains from trade, and when visit costs tend to rise less than proportionately with ex post gains. All three of these factors tend to diminish the potential allocative distortions of ordered bargaining.

A distinct point is that, as in the identical player setting, targeted price posting is less likely to emerge the more intense is outside-option competition in the ordered bargaining game. The reason is that more intense competition (whether from a larger number of potential bargaining partners or from lower visit costs) yields the buyer more of the joint surplus W_1^i in ordered bargaining. This means that supplier j must promise the buyer a greater share of the joint surplus W_j^i to win the business away from supplier 1, which leaves less surplus to cover the cost of posting.

5.1.3 Auctions

Auctions, like targeted price posting, guarantee that the efficient trading partner wins the buyer's business. To see this, consider again the symmetric differentiation case of Section 4.2. Recall that in this case suppliers have zero costs and a buyer values the good of the jth ranked supplier at δ^{j-1}, where $\delta \in (0,1)$. Suppose the buyer organizes an ascending bid auction, where the bids are amounts of surplus the bidder promises to deliver to the buyer. Supplier 1 will win this auction, at a bid of δ that just edges out supplier 2. Recall that visit costs were assumed to be zero. But if heterogeneous visit costs were incorporated into the example, a buyer might choose an inefficient trading partner in the ordered bargaining equilibrium, in which case an auction (if undertaken by the buyer) would improve allocative efficiency.

Other qualitative results for targeted price posting derived above generally apply to auctions as well: A buyer is less likely to undertake an auction the higher the cost of organizing the auction and the greater the expected surplus obtained from ordered bargaining.

To focus on auctions as an alternative means of extracting surplus from suppliers, assume that auctions can be organized costlessly. In the limit as $n \to \infty$, ordered bargaining yields the buyer more surplus than does an auction in case

$$\frac{(1-\delta)(1-\alpha)}{1-\delta(1-\alpha)} \leq 1-\delta . \tag{26}$$

The right-hand side of inequality (26) is the price at which supplier 1 would win the auction, whereas the left-hand side is the expected price the buyer would pay to supplier 1 in ordered bargaining (from equation (15)). Rearranging terms in (26) yields

$$\delta \leq \frac{\alpha}{1-\alpha} , \tag{27.1}$$

or equivalently

$$\alpha \geq \frac{\delta}{1+\delta} . \tag{27.2}$$

Thus for given buyer power α, ordered bargaining yields a lower price than does an auction if differentiation is sufficiently great (i.e., δ small; condition (27.1)). Intuitively, the more precipitously the value of the good drops in moving from supplier 1 to supplier

2, the more poorly the auction performs, given that bid competition from supplier 2 (alone) constrains the price paid to supplier 1. Alternatively, for given differentiation, ordered bargaining yields a lower price than does an auction if buyer power is sufficiently great (condition (27.2)). Note that $\alpha \geq \frac{1}{2}$ implies ordered bargaining outperforms an auction for any level of differentiation in the limit as $n \to \infty$.

Holding δ fixed, outside-option competition grows weaker the smaller is n, hence auctions become relatively more attractive. For $n = 2$, a buyer obtains expected surplus of $\alpha + (1-\alpha)\alpha\delta$ from ordered bargaining, compared with surplus of δ from an auction. In this case, ordered bargaining yields higher surplus to the buyer than does an auction when

$$\delta \leq \frac{\alpha}{1-\alpha+\alpha^2} . \qquad (28)$$

For example if $\alpha = \frac{1}{2}$, (28) implies $\delta \leq \frac{2}{3}$.

6. Discussion

A sometime expressed belief is that competition and bargaining are distinct and irreconcilable forces acting upon prices. On this view, prices in a market are determined either by competition, or through bargaining—and if through bargaining, then "any outcome is possible in bilateral monopoly." The dichotomy is a false one, however, as this paper has striven to show. Competition, in the guise of the outside option to bargain with rival suppliers, can work in tandem with buyer power to shape market outcomes.

In the general model of of ordered bargaining presented in Sections 2 and 3, the unique subgame perfect equilibrium (with regard to any given buyer's trade) can be computed for an arbitrary specification of valuations, production costs, visit costs and bargaining powers. Section 4 developed some intuition into the workings of the model by exploring two special cases: identical players and a particular structure of symmetric differentiation. The equilibrium expected price is determined in ordered bargaining by both the buyer's power in bargaining with the current supplier as well as the attractiveness of the buyer's outside option to bargain with rival suppliers. The value of the option rises with the number of suppliers, but declines with "frictions" to exercising the option, such as visit costs or product heterogeneity. Large enough frictions render the outside option worthless, resulting in the polar extreme of bilateral monopoly bargaining. At the other extreme, frictionless exercise of the outside option leads to the perfectly competitive outcome in the limit as the number of suppliers grows without bound.

The model offers insights to competition authorities for analyses of mergers or business practices in markets where bilateral bargaining is an important determinant of prices. First and foremost, the model reveals that negotiated prices tend to rise with a reduction in (outside-option) competition, as is the case in other, more familiar contexts.

The model also illustrates, however, that the link between competition and pricing can differ subtly in ordered bargaining as compared with posted price or auction markets. For example, the standard Bertrand-Nash model of posted pricing in homogeneous goods markets predicts that (absent efficiencies) a three-to-two merger of suppliers will have no effect on price. The ordered bargaining model suggests, on the contrary, that the effect of such a merger might be substantial.

Settings in which buyers interact repeatedly with suppliers on the road to securing a deal are frequently analyzed as auction markets. Often, however, the nature of the interaction may better fit the ordered bargaining paradigm. In an auction, the buyer's price is determined (exclusively) by bidding competition between the buyer's top two choices. Thus a merger of suppliers tends to raise the auction price only in case the merging parties are (with some positive probability) the buyer's number one and number two options.[14] In contrast, any merger of suppliers can raise expected prices in ordered bargaining. The lower the ranking of the merging parties in a buyer's preference ordering, the more muted the merger's effect on outside-option competition, but the effect is not necessarily zero even for very low-ranked suppliers.

Given the model's full-information setting, bargaining delay and breakdown are not at issue. Nevertheless, the equilibrium of the ordered bargaining game may be inefficient. This is because buyers fully bear the cost of visiting a supplier, but may capture only a fraction of the joint surplus in ex post bargaining. This is a generalization of Diamond's (1971) fundamental insight. Not only may valuable trade fail to occur in the ordered bargaining equilibrium, but buyers may choose trade that fails to maximize joint surplus. Section 5 discussed how posted pricing and auctions can eliminate these distortions if they emerge in equilibrium of the augmented game. However, if the ordered bargaining equilibrium is efficient to begin with, the emergence of alternative pricing institutions may well introduce new distortions.

The model suggests several areas for future research. It would be interesting to endogenize visit costs, broadly conceived as any cost buyers must sink prior to bargaining with a supplier.[15] A supplier may invest to lower buyers' costs of visiting the supplier, but the incentive to do so could be very inadequate. A reduction in visit costs

[14] See Waehrer and Perry (2003) for an analysis of mergers in an auction setting.

[15] Suppliers also typically must sink some costs prior to bargaining with buyers. Raskovich (2003) shows that a supplier has an incentive to sink as little cost as possible prior to bargaining with a pivotal buyer, suggesting this as an explanation for profit-sharing in the motion picture industry as well as fragmented participation in loan syndicates for project finance.

will spur some buyers at the margin to visit who would not otherwise do so, but the supplier may capture only a fraction of the resulting joint surplus in ex post bargaining. Nor does a supplier internalize any of the benefit a visit-cost-reducing investment confers on inframarginal buyers who would visit the supplier in any case. Collectively, traders have an interest in reducing such frictions. This could lead to the development of privately organized markets.

A market organized by suppliers alone may not have the proper incentives to reduce costs, however. A reduction in the cost of visiting one supplier imposes a negative pecuniary externality on rivals, by sharpening outside-option competition. Thus collectively as well as individually, suppliers may have inadequate incentives to lower individual visit costs.[16] Competition among rival private markets, i.e. competition to form coalitions of traders, may be an important factor in keeping trade frictions low.

Another possible area for future research is endogenizing bargaining power. Investments by individual suppliers to improve their bargaining power could be viewed as a form of wasteful rent-seeking.[17] A supplier may work to build a reputation for hard bargaining, or develop internal controls to bolster commitment to take-it-or-leave-it offers.[18] From the suppliers' perspective, such investments have a public good aspect. Greater bargaining power by one supplier confers a positive pecuniary externality on rivals, by softening outside-option competition. This public goods problem grows more severe the larger the number of suppliers. Conversely, a merger of suppliers tends to

---

[16] Suppliers may also lobby for restrictive hours-of-service regulation. For analyses of such rules and their deregulation, see Ferris (1990), Kosfeld (2002) and Inderst and Irmen (2005).
[17] The analysis is of course symmetric for buyers.
[18] However, Raskovich (2006) shows that suppliers may have a collective interest in weakening individual power to commit to a posted price.

internalize the externality, which may lead all suppliers to undertake more wasteful investment.

References

Acemoglu, D., Shimer, R., 1999. Holdups and efficiency with search frictions. International Economic Review 40, 827-850.

Arbatskaya, M., 2005. Ordered search. RAND Journal of Economics, forthcoming.

Arnold, M.A., Lippmann, S.A., 1998. Posted-prices versus bargaining in markets with asymmetric information. Economic Inquiry 36, 450-457.

Bester, H., 1988. Bargaining, search costs and equilibrium price distributions. Review of Economic Studies 55, 201-214.

Bester, H., 1993. Bargaining versus price competition in markets with quality uncertainty. American Economic Review 83, 278-288.

Binmore, K.G., Herrerro, M.J., 1988. Matching and bargaining in dynamic markets. Review of Economic Studies 55, 17-31.

Binmore, K.G., Shaked, A., Sutton, J., 1989. An outside option experiment. Quarterly Journal of Economics 104, 753-770.

Bulow, J.I., Klemperer, P., 1996. Auctions versus negotiations. American Economic Review 86, 180-194.

Butters, G.R., 1977. Equilibrium distribution of sales and advertising prices. Review of Economic Studies 44, 465-491.

Chipty, T., Snyder, C., 1999. The role of firm size in bilateral bargaining: a study of the cable television industry. Review of Economics and Statistics 81, 326-340.

Corbae, D., Temzelides, T., Wright, R., 2003. Directed matching and monetary exchange. Econometrica 71, 731-756.

Davis, D.D., Holt, C.A., 1996. Consumer search costs and market performance. Economic Inquiry 34, 133-151.

De Fraja, G., Sakovics, J., 2001. Walras retrouve: Decentralized trading mechanisms and the competititve price. Journal of Political Economy 109, 842-863.

Diamond, P.A., 1971. A model of price adjustment. Journal of Economic Theory 3, 156-168.

Dobson, P.W., Waterson, M., 1997. Countervailing power and consumer prices. Economic Journal 107, 418-430.

Engle-Warnick, J., Ruffle, B.J., 2005. Buyer Concentration as a Source of Countervailing Power: Evidence from Experimental Posted-Offer Markets. Mimeo.

Ferris, J.S., 1990. Time, space, and shopping: the regulation of shopping hours. Journal of Law, Economics & Organization 6, 171-187.

Gale, D., 1986. Bargaining and competition, part I: Characterization, part II: Existence. Econometrica 54, 785-806.

Horn, H., Wolinsky, A., 1988. Bilateral monopolies and incentives for mergers. RAND Journal of Economics 19, 408-419.

Inderst, R., Irmen, A., 2005. Shopping hours and price competition. European Economic Review 49, 1105-1124.

Inderst, R., Wey, C., 2003. Market structure, bargaining, and technology choice in bilaterally oligopolistic industries. RAND Journal of Economics 34, 1-19.

Jackson, M.O., Palfrey, T.R., 1998. Efficiency and voluntary implementation in markets with repeated pairwise bargaining. Econometrica 66, 1353-1388.

Kosfeld, M., 2002. Why shops close again: An evolutionary perspective on the deregulation of shopping hours. European Economic Review 46, 51-72.

Neeman, Z., Vulkan, N., 2003. Markets Versus Negotiations: The Predominance of Centralized Markets. Mimeo, Boston University.

Normann, H.T., Ruffle, B.J., Snyder, C.M., 2005. Do Buyer-Size Discounts Depend on the Curvature of the Surplus Function? Experimental Tests of Bargaining Models. http://ssrn.com/abstract=422780 .

Osborne, M., Rubinstein, A., 1990. Bargaining and Markets. San Diego: Academic Press.

Perry, M., Wigderson, A., 1986. Search in a known pattern. Journal of Political Economy 94, 225-230.

Raskovich, A., 2003. Pivotal buyers and bargaining position. Journal of Industrial Economics 51, 405-426.

Raskovich, A., 2006. Competition or collusion? Negotiating discounts off posted prices. International Journal of Industrial Organization, forthcoming.

Rubinstein, A., Wolinsky, A., 1985. Equilibrium in a market with sequential bargaining. Econometrica 53, 1133-1150.

Stahl, D.O., 1996. Oligopolistic pricing with heterogeneous consumer search. International Journal of Industrial Organization 14, 243-268.

Waehrer, K., Perry, M., 2003. The effects of mergers in open-auction markets. RAND Journal of Economics 34, 287-304.

Wang, R., 1993. Auctions versus posted-price selling. American Economic Review 83, 838-851.

Wang, R., 1995. Bargaining versus posted price selling. European Economic Review 39, 1747-1764.