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"Institutions and Information in Multiple-Offer Multilateral Bargaining Games: Theory and Experimental Evidence"

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Abstract

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1. Introduction

Most of the theoretical and experimental literature on bargaining has focus on the bilateral variety. Certainly, many bargaining situations are bilateral, but there are also many circumstances in which more than two parties are involved; for example, firms and input suppliers, developers and land-owners, builders and subcontractors, natural resource usage rights, etc. With multiple parties involved, incentives may be altered and/or interconnected and thus bargaining behavior is quite likely to diverge significantly from the behavioral regularities found in the bilateral bargaining literature. Take for instance, the "holdout problem". Any time there is multi-offer bargaining (bilateral or multilateral), the potential exists for individuals to refuse to negotiate initially, or to strategically delay agreement, in an attempt to capture a greater share of the total surplus created by the potential exchange.

The recent behavior of Chrysler Motors, its creditor's and the worker's as represented by the United Auto Union (UAW) provides a timely potential example of such behavior. Experts have suggested that the creditors, the UAW and Chrysler were playing a game of chicken – waiting to see which would capitulate first – with the threat of bankruptcy as the end-game. For example, the creditors may have been strategically delaying in early rounds of bargaining, hoping that the UAW and Chrysler would agree to debt retirement versus wage reduction terms that were more beneficial to them. It is important to note that the creditors were likely not bargaining as a single unit and that the strategic delay forced by one creditor may have create a negative externality (by potentially forcing a bankruptcy) for other creditors who had already agreed to debt restructuring terms. This added dimension – having more than two bargaining parties – makes the incentives involved with strategic delay or "holding out" more complicated.

Specifically, when the bargaining game is expanded to include more than two players – say a single buyer and two sellers – the incentive for strategic delay still exists, but now the transactions are co-dependent assuming that payoffs to all players are dependant on the buyer coming to agreement with both sellers. Thus, while there may be costly delay in simple bilateral bargaining environments, no holdout externalities of the kind discussed above are present. Additionally, expanding the bargaining game to include multiple sellers or buyers leads to the possibility of costly coordination problems, which, given the presence of externalities, are likely to change negotiation behavior.

As noted earlier, there is relatively little experimental literature investigating multilateral bargaining in general. One example, however, involves the experimental analyses of Coasian bargaining (e.g. Hoffman and Spitzer 1986; Harrison, et al 1987) which included larger groups, but lacked the interdependence of transactions such as that discussed above. More recently, Cadigan, et al. (2008, 2009) begin to examine the potential behavioral effects of multilateral bargaining through a series of multiple offer ultimatum-like bargaining experiments. They begin (2008) by demonstrating that holdout behavior is common and is, on average, a payoff-improving strategy for responders whether they be a seller or a buyer. Specifically, they run several ten-period, three-person (one buyer, two sellers) full information treatments that vary who proposes (seller or buyer) , and whether there is a cost associated with delay. Buyers as proposers earned more than sellers since they faced less of a coordination problem, and delay costs led to more generous buyer offers or seller demands, and less overall holdout.

In their 2009 paper, they extend the analysis by examining the extent to which holdout behavior and efficiency is affected by changes in the number of bargaining parties (group size). Specifically, using the same basic experimental design, they introduce bargaining treatments with extraneous sellers (three instead of two, where the buyer only needs to buy two units – leading to *competition* between sellers) and treatments with four rather than two sellers (a larger bargaining *group size* – where the buyer needs to buy one unit from each seller). As in their first paper, they find that holdout is present and, on average, a payoff-improving strategy in every treatment. They also find that introduction of extraneous sellers, or competition, decreases the number of periods required to reach agreement, thereby increasing efficiency. Additionally, this competition increases the bargaining payoff of buyers relative to sellers, particularly when *sellers* are making take-it-or-leave-it demands to the buyer. Increasing the group size by doubling the number of sellers to four results in significantly greater delay, more failed agreements, and lower overall efficiency all likely due to coordination problems. The authors note that the increase in the deadweight loss in this situation appears to come primarily from the buyers' share of the surplus.

In both of the Cadigan, et al. (2008, 2009) studies, bargaining is one-sided (either buyers always made offers or sellers always made demands – there were no counter-offers/demands) and bargaining takes place under complete information (buyer knows seller values and sellers know buyer's and other seller's values). This paper reports the results of a series of experiments designed to examine the extent to which the multi-offer multilateral bargaining behavior observed in earlier experiments and its resultant efficiency effects are affected by changes to the bargaining institution that allow for counter offers and relax the complete information assumption. Specifically, we introduce two changes to the bargaining institutions used in Cadigan, et al.: 1) we allow counter offers by introducing an *alternating* offer treatment were the buyer and sellers make offers/demands in alternating periods; and 2) we relax the complete information assumption by introducing an *information* treatment were individual buyer and seller valuations are private information. In each of these new treatments (*alternating* and *information*), we maintain the same basic experimental design framework used in Cadigan et al.

Our goal for this paper is to provide further insight into bargaining behavior in multiple offer multilateral bargaining situations by introducing more complexity and perhaps realism to the bargaining institution. In section 2 we describe the basic model that motivates the experimental design. Section 3 describes the experimental treatments in more detail and discusses equilibrium predictions or possible behavioral implications. Experimental results are given in section 4 followed by concluding remarks in section 5.

2. Basic Modeling Framework

Following Menezes and Pitchford (2004b) and Miceli and Segerson (2007), consider a simple model in which a single risk-neutral agent (the "buyer") wishes to purchase N complementary units of a good from N other independent, risk-neutral agents (the "sellers"). The units can be interpreted as intermediate inputs into the production of a large project. Each seller i has one unit for sale and incurs a cost c_i for this unit. The value of the project to the buyer is V if N input units can be acquired, but is zero otherwise. Let the buyer's valuation and the sellers' costs be such that

$$\sum_{i=1}^{N} c_i < V \tag{1}$$

indicating that there is an economic surplus generated by the project.

If N input units can be acquired, the payoff to the buyer is

$$(V - \sum_{i=1}^{N} p_i) \tag{2}$$

where p_i is the price paid for unit i, and each seller i receives a payoff $(p_i - c_i)$. We assume that the buyer is able to write contingent contracts such that all parties receive a payoff of zero if any of the required input units are not purchased. To examine the coordination problems and externalities inherent in many multilateral bargaining situations, we allow for bargaining over several periods. Delay is costly such that payoffs are reduced by a factor δ (where $0 \leq \delta \leq 1$) for each additional period, on average, needed for agreements to be reached. For example, payoffs would be reduced by δ if all agreements were reached in the second period, reduced by 2δ if agreements were reached in the third period, and so on. This is equivalent to assuming that the economic surplus $(V - \sum_{i=1}^{N} c_i)$ shrinks by δ from period to period.

3. Experimental Design

Our experimental design involves a total of six treatments: *Baseline-buyer, Baseline-seller, Alternating-buyer, Alternating-seller, Information-buyer,* and *Information-seller*, where the first two treatments serve as a basis for comparison and come from the previous Cadigan et al. papers (2008, 2009). All treatments were conducted using z-Tree software (Fischbacher 2007) and involve bargaining between one buyer and two sellers, where the buyer must acquire one unit from each seller or no parties capture any of the potential surplus. Within each of the ten periods, all bargaining takes place simultaneously in that all offers and responses are made without knowledge of the other party's offer, demand or response. Once a seller accepts an offer from the buyer, or has an offer accepted by the buyer, that seller makes no additional decisions. At the end of each period, both the buyer and sellers are informed of the outcomes of the period. That is, the buyer and sellers are informed of whether the offers were accepted or rejected. In the case where an offer is accepted, the dollar amount of the accepted offer is revealed to the seller not involved. When an offer is rejected, the dollar amount is not revealed to the other seller. Once the buyer has acquired one unit from each seller, the agreements are complete and the buyers and sellers make no additional decisions for the remaining periods. Additionally, all treatments involve costly delay such that all payoffs are reduced by 10% for each additional period, *on average*, it takes for agreements to be reached. For example, if one buyer is making repeated offers to two sellers, all participants' payoffs are reduced by 5% each time a seller rejects an offer. If both sellers accept in the first period, payoffs are not reduced. If both accept in the second period, all payoffs are reduced by 10%. If one seller accepts in the first period and the other in the third period, payoffs are reduced by 10%, and so on. Thus, coordination problems or strategic delay incur payoff-reducing externality regardless of the decisions of the other subjects. Subjects in all treatments were informed of their experimental earnings (adjusted for any delay costs) at the conclusion of the experiment and were paid this plus a $10 show-up fee in cash, privately.

In the *Baseline* and *Alternating* treatments, valuations and costs are fix and are common knowledge. In these treatments, the buyer's valuation is $V = \$\,90$, while the sellers' costs are symmetric such that $c_1 = c_2 = \$30$. This results in an economic surplus of $30 that may be divided between the three participants. In the *Information* treatments, the exact valuations and cost are not common knowledge. In these treatments, each buyer's valuation and each seller's cost is randomly determined by the software before the first period and is the same for all subsequent periods. Buyer valuations were determined using a uniform distribution between $80 and $100, while seller costs were from a uniform distribution between $20 and $40. The expected surplus is thus the same as in the other treatments ($30), but the actual value can fall between $0 (with a buyer valuation of $80 and two seller costs of $40) and $60 (with a buyer valuation of $100 and two seller costs of $20).[3]

As noted above, each of the treatment types (*Baseline, Alternating* and *Information*) include -*buyer* and -*seller* treatments. Within each treatment type, these treatments differ only in terms of which party is the proposer. For example, in the *Baseline-buyer* treatment, buyers are the proposers and make repeated take-it-or-leave-it offers to buy while in the *Baseline-seller* treatment, sellers are the proposers and make repeated take-it-or-leave-it demands to sell.

Equilibrium/Behavioral Predictions

<u>Baseline Treatments</u>

Assuming complete information and that each agent seeks to maximize his monetary self-interest, the well-known unique subgame perfect Nash equilibrium to the single-period ultimatum game is for the proposer to offer the smallest share of the surplus possible, and for the responder to accept it. Let b_i represent a buyer's offer to buy and d_i represent a seller's demand to sell a particular unit. For the *Baseline-buyer* and *Baseline-seller* treatments discussed above, this implies: 1) when the buyer makes offers to *N* sellers, the buyer offers each seller her cost. That is, $b_i = c_i \quad \forall i$.[4]; 2) when *N* sellers make

[3] It should be noted here that, since the I*nformation* treatments allow for proposers to unknowingly make an offer(s) that responders cannot accept, the software was designed to automatically reject any offer(s) in this case. For example, in the -*buyer* treatment if the buyer made an offer to a seller that they could not accept, the software informed the seller of the offer amount and noted that it was rejected, but the seller made no active decision. The buyer, however, could not determine if a rejection was automatic or otherwise. In the -*seller* treatment, the software was designed to allow the buyer to accept offers up to the point were the residual valuation (*V* minus any accepted offer) was less than any outstanding offer. For example, if the buyer has a value of $83 and both sellers offer $45, the buyer is given the option to reject both or accept one (buyer could choose which seller – important if the offers are not the same) and have the other automatically rejected.

[4] Technically, each seller is indifferent between accepting or rejecting. Therefore, accepting is a weakly dominate strategy and, therefore, constitutes a best-response. One could alternatively assume that $b_i = c_i + \varepsilon$, where ε is the smallest unit of account available. In this case each seller earns a small surplus by accepting. For simplicity, we assume that $\varepsilon \to 0$ in the limit and proceed without the more cumbersome notation.

demands, multiple equilibria exist. The set of equilibria are characterized by $\sum_{i=1}^{N} d_i = V$ and $d_i \geq c_i \; \forall i$;

and 3) responders should accept any offer or set of demands that leaves them with a non-negative surplus.

The first implication is the standard equilibrium prediction for proposer behavior which implies here that the buyer captures all (or nearly all) of the surplus. The second characterizes a Nash-like bargaining outcome from the perspective of sellers, while the third follows from the assumption that a positive payoff is preferred to a zero payoff.

The above equilibrium descriptions are unaffected by the addition of multiple periods and delay costs. Responders cannot increase their payoff by rejecting an offer or set of demands that leaves them with a non-negative surplus, because there is nothing in the standard game-theoretic predictions of proposers to indicate that they, in equilibrium, should offer a greater share of the surplus following a rejected offer or demand.

Alternating Treatments

The *Alternating* treatment uses the ultimatum-like bargaining method introduced in the *baseline* treatments, but instead of the buyer or seller always making the offers, the buyer and sellers take turns. In the first period either the buyer makes an offer-to-buy to each seller or the sellers each make demands-to-sell to the buyer. In the first case, if a seller accepts the buyer's period one offer, then the contingent contract is in place and that seller makes no further decisions. If a seller rejects the buyer's period one offer, no contract is made. In period two the seller(s) who rejected the buyer's offer in the first period get to make an offer-to-sell. The buyer can then accept or reject the offer(s). This alternating offer process continues until both sellers have entered into a contract or until bargaining ends after completion of period 10. A similar sequence of events (except switched) take place when sellers make demands in the first period.

Let S be the surplus available at the start of bargaining such that $S = V - (c_1 + c_2)$. By using backward induction and by making the assumptions needed to allow for a Nash bargaining solution

(Pareto optimality, independence of irrelevant alternatives, symmetry and invariance to linear transformations of utility as in Nash [1950]), the equilibrium for the *Alternating-buyer* treatment is for the sellers to accept the period one buyer offers of $b_1 = .25S + c_1$ and $b_2 = .25S + c_2$. Similarly, the equilibrium for the *Alternating-seller* treatment is for the buyer to accept the period one seller demands of $d_1 = .25S + c_1$ and $d_2 = .25S + c_2$.[5] This implies that in both treatments each seller earns $.25S$ or ¼ of the surplus while the buyer captures half the surplus, $.5S$. Given V=\$90 and $c_1 = c_2 =$ \$30, $b_1 = b_2 = d_1 = d_2$ \$37.50 resulting in a buyer payoff of \$15 and seller payoffs of \$7.50. To show this result for the *Alternating-buyer* treatment, first assume complete information and that each agent seeks to maximize his monetary self-interest, then consider period 10 in which sellers will be making offers-to-sell. Since this is the last period, each seller offers to sell their unit for $.5V - \varepsilon$ or $d_1 = d_2 =$ \$45 – ε, where ε is some small amount. Since the buyer prefers the non-zero payoff of 2ε to zero payoff, he will accept the offers and the sellers will split $.1S - 2\varepsilon$, or $(.1S - 2\varepsilon)/2 \approx$ \$1.50. Note that they split $.1S - 2\varepsilon$, not $S - 2\varepsilon$ since by period 10 costly delay has reduced payouts by 90%. In period 9 it is the buyer that makes the offers and the buyer, knowing that the sellers will each earn $(.1S - 2\varepsilon)/2$ in period 10, will make (and sellers will accept) symmetric offers-to-buy such that both sellers earn $(.1S - 2\varepsilon)/2 + \varepsilon$. The buyer now earns $.2S-(.1S - 2\varepsilon + 2\varepsilon) = .1S =$ \$3.00. In period 8, the sellers will make offers-to-sell such that the buyer will earn slightly more than in period 9, say $.1S + \varepsilon$. Here there are multiple equilibria since any combination of seller offers d_1 and d_2 such that $.3(V - d_1 - d_2) = .1S + \varepsilon$ satisfy the buyer. We assume a cooperative Nash bargaining solution to narrow the equilibria down to the symmetric solution where $d_1 = d_2 \approx$ \$40. In this case the sellers would split the remaining discounted surplus and each receive $(.3S - (.1S + \varepsilon))/2 \approx$ \$3.00. In period 7, it is again the buyer who will make offers such that each seller will receive slightly higher payoffs than they would in period 8. He will make (and sellers will accept) offers-to-buy such that each seller will earn $(.2S - \varepsilon)/2 + \varepsilon$ resulting in the buyer earning $.4S - ((.2S - \varepsilon) + 2\varepsilon) = .2S - \varepsilon$.

[5] Actually, as noted below, the *Alternating-seller* solution involves seller demands that are greater by the smallest unit of account.

This pattern, in which the party making the offer for that period offers the responder(s) slightly more than they would earn as proposer(s) in the next period continues back to period one where the buyer makes symmetric offers-to-buy of $b_1 = b_2 =$ \$37.5. Sellers will accept, and the surplus is split between buyer, seller and seller, 50%, 25% and 25% respectively. The equilibrium prediction for the *Alternating-seller* treatment – as well as the logic behind it – is identical except for the following; 1) the first period demands by sellers must include a slight inducement (some ε) for the buyer to accept in the first period given that the buyer can earn 50% of the surplus in period two[6], and 2) instead of relying on the cooperative Nash bargaining solution beginning in period 8, one must rely on it beginning in period 10. In both cases, it is important to note that without costly delay, backward induction would simply result in the sellers in the *-buyer* treatment or the buyer in the *-seller* treatment capturing the entire surplus (minus some small amount). It is the costly delay, by allowing the proposer in periods 1 through 9 to offer the responder more than they would make as a proposer in the subsequent period that makes it possible for the other player(s) – buyer in the *-buyer* treatment and sellers in the *-seller* treatment – to extract a portion of the surplus.

<u>Information Treatments</u>

For the *Information-buyer, Information-seller* treatments, the equilibrium predictions become much more complex. Recall that in this treatment the buyer valuation (V) and seller costs (c_1 and c_2) are randomly determined using uniform distributions of between \$80 and \$100 and \$20 and \$40 respectively. As in all the other treatments, assume that each agent is risk neutral and seeks to maximize his monetary self-interest. To illustrate the complexities, first consider a single period version of the *Information-buyer* treatment in which the buyer will make simultaneous offers or bids (b_1 and b_2) to the two sellers. He will do so such that they:

$$Max(V - 2b)(b - 20/20)^2,$$

[6] Given that the smallest unit of account is one cent, this might imply that, for example, each seller make demands of \$37.49, leaving the buyer with a combined demand of \$74.98 – this changes the percentage of surplus earned by buyers and sellers to approximately 50.067% and 24.967% respectively.

where the bids are assumed to be symmetric such that $b_1 = b_2 = b$ (since bidding is anonymous there is no reason to expect the buyer to treat the sellers differently). The first term is the buyer payoff if both bids are accepted, while the second term is the joint probability that both sellers accept given that c_1 and c_2 are independently drawn from uniform distributions between \$20 and \$40. Solving the F.O.C. for the optimal bid (b^*) yields:

$$b^* = (V + 20)/3 .$$

Note that b^* is only a function of V. If V= \$100 (highest possible value), then $b_1 = b_2 = b^*$= \$40 which is the highest possible seller cost and guarantees acceptance and a profit of \$20. If V= \$80 (lowest possible value), then $b_1 = b_2 = b^*$= \$33.33 which results in a positive probability (approximately 55%) of rejection, but a maximized expected profit of approximately \$5.92. Thus, all buyer offers will fall in the range of \$33.33 to \$40 with a mean buyer offer of \$36.67.

Similarly, for a single period version of the *Information-seller* treatment the two sellers will solve symmetric maximization problems. Consider seller 1. He will make a demand (d_1) to solve:

$$Max(d_1 - c_1)(100 - d_1 - d_2/20).$$

Again, the first term is the seller payoff if both demands are accepted, while the second term is the probability that the buyer accepts the demands given that V is drawn from a uniform distribution between \$80 and \$100. Solving both seller 1 and 2's maximization problems for the optimal demands (d_1^* and d_2^*) yields best response functions, which when solved jointly yields the following Cournot-Nash solution:

$$d_1^* = (100 - c_2 + 2c_1)/3$$
$$d_2^* = (100 - c_1 + 2c_2)/3$$

Since each seller does not know the other seller's cost, only its distribution, substituting the expected cost for the other player's unknown cost, $E(c_1) = E(c_2)$ = \$30, in each solution yields:

$$d_1^* = (70 + 2c_1)/3$$
$$d_2^* = (70 + 2c_2)/3$$

Note that, for seller 1, if c_1= \$40 (highest possible cost), then d_1^*= \$50. Given that the expected demand of seller 2 is \$43.33, the total expected demand from seller 1's perspective would be \$93.33 yielding an average probability of acceptance of approximately 33.35%. If c_1= \$20 (lowest possible cost), then d_1^*= \$36.67 which gives a total expected demand of \$80 [$d_1^* + E(d_2^*)$=\$36.67+\$43.33] and a probability of acceptance of one. Thus, since seller 2 will behave identically, all seller demands will fall in the range of \$36.67 to \$50 with a mean demand of \$43.33.

Adding multiple periods causes any possibly behavioral or equilibrium predictions to depend heavily on what sellers and buyers believe about other players. To illustrate, consider the single period *Information-buyer* analysis as outlined above and suppose that the buyer makes the predicted offers when V=\$80 ($b_1 = b_2 = b^*$= \$33.33). Given this, the probabilities dictate that approximately 55% of time one or both of the sellers will reject due to a negative payoff. However, with multiple periods, there is now the possibility of not just sincere rejection (rejection due to negative payoffs), but also strategic rejection or delay (rejection of offers that would have resulted in non-negative payoffs in the hopes of a higher payoff in later periods). Suppose the buyer in the single period *Information-buyer* example above *believes* that all sellers are sincere in their responses. He would then interpret a rejection as a signal that that seller has a cost higher than the offer. Upon rejection, the buyer would then rerun the one-period maximization problem (adjusting for the other sellers decision) inserting the revised information about the endpoints of the uniform distribution. In the example, if both sellers reject, the buyer would assume that the costs for the sellers is actually distributed between \$33.33 and \$40, and the new profit maximizing offers would increase by \$4.44 to approximately $b_1 = b_2 = b^*$= \$37.78.

Now, if the *sellers* believe that the *buyer* believes the sellers will behave sincerely, then sellers have an incentive to behave strategically since strategic rejection under these circumstances is profitable. By rejecting the offer (\$33.33) even though the seller has costs that are lower (say \$25), they can receive more in the next period (\$4.44). In our example it would increase the seller payoffs from \$8.33 to \$12.78, which even considering the 10% reduction in payoff due to delay, nets the sellers an additional \$3.17.

Strategic delay by sellers, even given that the buyer is known to interpret rejections sincerely, will eventually encounter diminishing or negative returns. At some point (dependant on V, c_1, c_2 and accepted offers) the increased payoff gleaned from holding out will be overpowered by the cost of delay.

However, why should a buyer believe that seller responses are sincere when it is possible to determine that strategic rejections by sellers are profitable in this scenario? If the buyer *believes* that all sellers behave strategically in their rejection decision and thus always reject, even if the offer would have resulted in a positive payoff. In this case the buyer does not believe he has receive any credible information, does not update his distributional assumptions about the sellers' costs, and, thus, will make the same offer based on the maximization problems above. Most likely, buyers have a probability distribution that places positive probabilities on the presence of both types of sellers, which has been formed through their prior experiences with and current beliefs about the population in question. Similarly, sellers are likely to have probability distributions in place that give positive weights to the existence of both types of buyer – one who believes in sincere responses or one who is suspicious. Clearly, for the *Information-buyer* and *Information-seller* treatments, player beliefs play a significant role in determining behavior.[7] Because these beliefs are unobservable and there are thus no clear theoretical predictions, we hope to identify behavioral regularities or tendencies, and thus make inferences about beliefs, for this type of bargaining situation through our experimental treatments.

The *Baseline* treatments were conducted at Gettysburg College, while the *Information* and *Alternating* treatments were conducted at Michigan State University. Subjects for all treatments were undergraduate volunteers who participated anonymously via computer and were paid a $10 show-up fee plus their experimental earnings privately, in cash, after each experimental session. Five hundred and fifty-eight subjects participated for a total of between 28 and 33 bargaining groups per treatment.

4. Results

Table 1 presents offer, demand, and earnings results from the six treatments. The table gives the mean first period offer or demand, as well as the mean real final payoff for buyers and sellers. These real payoffs are adjusted for delay costs. Additionally, in brackets below the real payoffs, the real payoff as a percentage of the total available surplus is given. This is important, because the total surplus in the information treatments can vary and using percentages allows for more direct comparisons. For holdout analysis, the table also gives the mean buyer and seller earnings that would have resulted had all first period offers or demands been accepted.

[Insert Table 1 here]

Table 2 provides rejection, holdout, and efficiency statistics. Holdout is calculated as the average period in which agreements were reached. If a group failed to reach an agreement (5 out of 153 groups), the average agreement period was set to 11. Efficiency is calculated as the actual total group earnings divided by the maximum possible or original (un-discounted) surplus amount. The surplus amount was $30 per group for the *Baseline* and *Alternating* treatments and, due to random costs and values, between $0 and $60 per group for the *Information* treatment.

[Insert Table 2 here]

Before discussing the specific behavioral changes, relative to the *baseline* treatments, due to reduced information (*information* treatment) or allowing counter-offers/demands (*alternating* treatment), several general observations can be made. First, and not unexpectedly, mean first period offers/demands always favor the proposer (see table 1). That is, when the buyer is the proposer, mean first period offers are fairly low resulting in low mean seller first period earnings and high buyer first period earnings had all offers been accepted. Likewise, when the sellers are the proposers, mean first period demands are fairly high resulting in mean first period earnings that favor the sellers had all offers been accepted. Second, given these starting offers/demands, holdout by responders (first period responders in *alternating*

[7] We do not lay out an illustration involving the *–seller* treatment to conserve space, but similar arguments reach

treatments) significantly increases, on average, their mean real final earnings relative to their mean first period earnings (Mann-Whitney U, p<.05 for all cases). This in combination with the significant percentages of first period rejections across treatments indicates that, consistent with Cadigan, et al. (2008, 2009), holdout is present and a payoff-improving strategy in each of the new treatments. Finally, also consistent with all of Cadigan, et al.'s (2008, 2009) multiple offer (period) experiments, mean real buyer earnings are greater than mean real seller earnings in each of the new treatments, even when the proposer (initial proposer in *alternating* treatments) is the seller. These differences are significant in all but the seller baseline treatment.[8] The consistency of this result across treatments here and in previous work, suggests that the buyer has a consistent advantage in the bargaining process, likely due to the coordination problems encountered by the multiple sellers.

Alternating vs. Baseline Treatments

In this section the behavioral effects of allowing alternating offers/demands is investigated. First, note that the backward induction alternating offer model outlined above does not accurately describe subject behavior. Recall that the equilibrium prediction for the *–buyer* treatment is for the buyer to offer each seller 25% of the total surplus plus cost ($37.50) in the first period and for the sellers to accept. The mean first period offer in the *–buyer* treatment of $36.15 is significantly lower than the predicted offer and 60.6% of offers are rejected.[9] Given the failure of self-interested game-theoretic predictions for bargaining games generally and for the *baseline* treatments (see Cadigen et al.) specifically, the failure here is unsurprising. In fact in the *alternating-buyer* treatment, the mean first period offer (by the buyer) is statistically the same as the mean first period offer in the *baseline-buyer* treatment. Similarly, in the

similar conclusions.

[8] Using percentage of available surplus for the *information* treatments, p<.01 for all treatments except *information – buyer* treatment where p=.172 (all Mann-Whitney U, two-tailed).

[9] One-sample t-test, p=.007 in conjunction with Kolmogorov-Smirnov test for normality

alternating-seller treatment, the mean first period offer (by the seller) is statistically the same as the mean first period offer in the *baseline-seller* treatment.

Further comparisons of the *alternating* treatments to the *baseline* treatments reveals that the results from the *alternating* institution fit neatly between the results of *-buyer* and *-seller baseline* institutions. For example, the mean real final earnings for buyers in the *alternating-buyer* treatment is significantly greater than in the *baseline-seller* treatment, while being no different, statistically, than in the *baseline-buyer* treatment. Similarly, for the sellers in these treatments, the mean real final earnings in the *alternating-buyer* treatment is statistically the same as in the *baseline-seller* treatment, but significantly more than in the *baseline-buyer* treatment. This implies, rather intuitively, that from a final real earnings perspective it is preferable to be the second proposer in an alternating offer environment than to always be a responder. Less intuitively, however, the above also implies that it is no worse (or better) to be the lead proposer in an alternating offer environment, than to be the exclusive proposer in a non-alternating environment. This last result is interesting because, a-priori, one would expect the proposer in a non-alternating environment to earn more given their ability to control the offers.

Table 2 shows that when compared to the baseline treatments the alternating treatments have lower percentages of first-period rejections, lower average agreement periods and higher efficiencies despite a slightly higher number of failed agreements. In fact, the alternating treatments have the highest efficiencies, and lowest average agreement periods and first period rejections of all treatments.[10] These observations along with the discussion above implies that the alternating offer mechanism is not only more efficient, but that the potential efficiency improvement resulting from an institutional move from baseline-buyer to alternating-buyer or baseline-seller to alternating-seller could potentially be a Pareto improvement (i.e., makes baseline responder better off, while leaving the baseline proposer unaffected).

Information vs. Baseline Treatments

[10] For average agreement period comparisons are significant at p<.10 except baseline-buyer. (Mann Whitney U)

Relative to the *baseline* treatments, the *information* treatments essentially increase uncertainty through a reduced level of information. Specifically, the bargaining parties in the *information* treatments only know the range of values or costs faced by her bargaining partners, but not the actual values or costs. This information scenario is probably more representative of the level of information achieved by participants in real-life bargaining situations. For example, when a developer is negotiating with landowners to acquire a specific set of properties, the developer knows the approximate market valuation of each property via transactions for similar property, but does not know the specific reservation price (cost in the experiments here) for each property. Similarly, the landowners may be aware of the general value of the developer's project, but do not know the value to the developer of acquiring their specific property. Our interest here is to determine what effects a reduction of information of this type has on bargaining behavior when the buyer or sellers are the proposer(s) and if these effects are symmetric.

When the buyer is the proposer, reducing the level of information – *baseline-buyer* to *information-buyer* – leads to a reduction in first period offers. First period offers by buyers in the *information-buyer* treatment are significantly lower (Mann-Whitney U, p<.000) than those in the *baseline-buyer* treatment – so low that the mean seller first period earnings are negative ($-.58). It appears that the buyers are trying to take advantage of the potentially lower (down to $20) seller costs, by making lower offers – perhaps figuring that a low initial offer may indicate to the sellers that the buyer has a relatively low value, and spur an acceptance. It is interesting to note that the first period offer of $29.56 is insignificantly different from the mean seller cost of $30. As such this first period behavior by buyers looks more like the game-theoretic prediction for the *baseline-buyer* treatments. However, this buyer tactic appears to lead to a longer time to agreement (shown by the statistically higher average agreement period – see table 2) given that the average seller had no choice but to reject the first period offer. This, in combination with a higher number of failed agreements, leads to lower final real payoffs for both buyer and sellers (Mann-Whitney U, p<.01) and the lowest level of efficiency in any treatment.

When the sellers are the proposers, reducing the level of information – *baseline-seller* to *information-seller* – leads to a reduction in first period seller demands. First period seller demands in the *information-seller* treatment are significantly lower (Mann-Whitney U, p=.037) than those in the *baseline-seller* treatment. Note that this means that the sellers are asking for *less* of the surplus in their initial demand, not more as in the *-buyer* case. Perhaps the sellers are giving up more of the surplus up front because the uncertainty due to the reduced information level confounds the already present coordination problem not face by the buyer when they are the proposer. In any event, this tactic does not appear to help sellers earn more on average given that the mean surplus surrendered in the first period ($42.71-$44.17=$1.46) is essentially the same as the reduction in the mean final seller earnings ($7.80-$6.41=$1.39). However, the higher seller offers do appear to offset any confounding information effects overall given that the percentage of first period rejections, average time to agreement and level of efficiency are all similar to those in the *seller-baseline*.[11]

As seen above, the effect of reduced information in these experiments on initial offers and demands is asymmetric – buyers as proposers ask for *more* of the surplus leading to a reduction in earnings for both buyers and sellers and lower overall efficiency, while sellers as proposers ask for *less* of the surplus which ultimately leads to no change in overall efficiency. Similarly, the effect of reduced information on final real payoffs is also asymmetric. Reducing information always significantly reduces seller mean real final payoffs relative to the appropriate baseline (e.g., $7.24 to $6.61 in the *–buyer* treatments and $7.80 to $6.41 in the *–seller* treatments).[12] In contrast, for buyers, reducing information significantly reduces buyer mean real final earnings in the *–buyer* treatments ($11.12 to $9.30), but significantly <u>increases</u> buyer mean real final earnings in the *–seller* treatments ($9.39 to $13.32).[13] This implies that when information is reduced, buyers go from earning more as the proposer to earning more as the <u>responder</u>. That is, buyers should go from preferring to be proposers in a baseline treatment ($11.12 vs. $9.39, p=.136) to preferring

[11] Difference in average agreement periods for baseline-seller and information-seller treatments are insignificant (Mann-Whitney U, p=.506).
[12] Mann-Whitney U, p<.01 for both.

to be responders in an information treatment ($9.30 vs. $13.32, p=.031).[14] On the other hand, sellers shouldn't care who the proposer is in either type of treatment since the final real payoffs are statistically the same ($6.61 vs. $6.41, p=.732 and $7.24 vs. $7.80, p=.483).[15] In terms of final real earnings the information effect is asymmetric – always a negative to sellers, but sometimes a positive to buyers. In fact, buyers earn the same (statistically) as proposers in the baseline as they do as *responders* in the information treatment. This overall asymmetry suggests that in settings with two sellers and one buyer and this type of reduced level of information that, from an efficiency standpoint, the sellers should make demands. Furthermore, this should not only be the preferred institution in terms of efficiency, but it should be welcomed (by buyers) or unopposed (by sellers).

5. Conclusion

None yet

[13] Mann-Whitney U, p<..01, p=.14 respectively.
[14] Mann-Whitney U tests
[15] Mann-Whitney U tests

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7. Tables

Table 1. Offer/demand and earnings results by treatment (standard deviations in parentheses)

Proposer	Treatment	Mean first period offer/demand	Mean buyer first period earnings	Mean seller first period earnings	Mean real final buyer earnings [% avail Surplus]	Mean real final seller earnings [% avail Surplus]	Number of groups
Buyer	Baseline	$35.82 (2.57)	$18.37 (5.08)	$5.82 (2.57)	$11.12 (5.67) [37.05%]	$7.24 (2.78) [24.14%]	N = 30
Buyer	Alternating	$36.15 (3.90) 66 offers	$17.70 (7.69)	$6.15 (3.85)	$10.75* (3.54) [35.83%]	$7.83* (2.80) [26.1%]	N = 33
Buyer	Information	$29.56 (4.93)	$30.69 (11.43)	$-.58 (7.16)	$9.30* (9.13) [28%]	$6.61* (4.79) [20.9%]	N = 32
Seller	Baseline	$44.17 (6.86)	$1.65 (8.94)	$14.17 (6.86)	$9.39 (4.90) [31.33%]	$7.80 (2.96) [26.01%]	N = 30
Seller	Alternating						
Seller	Information	$42.71 (9.81)	$5.95 (13.89)	$12.65 (9.06)	$13.32* (9.02) [40.61%]	$6.41* (5.34) [20.94%]	N = 28

* Includes group failed agreement payoffs of $0 for buyers and sellers (3 in buyer, 1 in seller)

Table 2. Holdout and efficiency results

Proposer	Treatment	Percent of first-period rejections	Average agreement period	Number of failed agreements	Efficiency	Number of groups
Buyer	Baseline	66.7%	2.47	0	85.3%	N = 30
Buyer	Alternating	60.6%	2.11**	1	88.0%	N = 33
Buyer	Information (Surp=29.53 s.d. =12.01)	84.3%	3.89**	3	69.9%	N = 32
Seller	Baseline	71.7%	2.67	0	83.3%	N = 30
Seller	Alternating					
Seller	Information (Surp=31.25 s.d. =9.60)	71.4%	2.59**	1	82.5%	N = 28

** with fails as period 11 agreement