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by

Kurtis Swope
U. S. Naval Academy

Ryan Wielgus
United States Navy

Pamela Schmitt
U. S. Naval Academy

John Cadigan
Gettysburg College

Department of Economics
United States Naval Academy

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An Experimental Study

Kurtis Swope*
U. S. Naval Academy, Department of Economics, 589 McNair Rd, Annapolis, MD 21402, USA, Email: swope@usna.edu , Phone: 00-1-410-293-6892, Fax: 00-1-410-293-6899

Ryan Wielgus
U. S. Navy, Email: ofc96996@usna.edu, Phone: 00-1-301-580-1523

Pamela Schmitt
U. S. Naval Academy, Department of Economics, 589 McNair Rd, Annapolis, MD 21402, USA, Email: pschmitt@usna.edu , Phone: 00-1-410-293-6888

John Cadigan
Gettysburg College, Department of Economics, 300 North Washington Street, Gettysburg, PA 17325, USA, Email: jcadigan@gettysburg.edu, Phone: 00-1-717-337-6667

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Abstract
We use multilateral bargaining experiments to examine how the order of bargaining (simultaneous or sequential) and the nature of contracts (contingent or non-contingent) affect the duration of bargaining, the efficiency of exchange, and the distribution of the surplus in a laboratory land-assembly game with one buyer and two sellers. While theory predicts an earnings advantage for the first seller when contracts are sequential and contingent, and for the second seller when contracts are sequential and non-contingent, we find that when a seller has an earnings advantage in the laboratory, it is the first seller to bargain in the non-contingent contract treatments. This result contradicts conventional wisdom and a common result from the land-assembly literature that it is advantageous to be the last seller to bargain, a so-called "holdout". We also find evidence that sequential bargaining leads to more aggressive seller bargaining and greater bargaining delay than simultaneous bargaining, ceteris paribus, and that non-contingent contracts increase bargaining delay and the likelihood of failed agreements. The majority of sellers indicated a preference for being the first seller to bargain in all sequential bargaining treatments.

Keywords: Land assembly; holdout problem; holdup problem; ultimatum game
JEL classification: C9 ; C7 ; K1 ; J5

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*Corresponding author

1. Introduction

Many economic transactions require universal agreement from multiple parties for a transaction to occur and the economic benefits of the exchange to be realized. Examples include land assembly and other similar problems such as debt and wage renegotiations. Theoretical analysis of these types of bargaining games suggests that the bargaining institution matters. For example, the ordering and nature of the contracts between a potential developer and landowners can play an important role in the efficiency of the bargaining process and the distribution of the surplus. In this paper we use multilateral bargaining experiments to examine how the order of bargaining and the nature of contracts affect the duration of bargaining, the efficiency of exchange, and the distribution of the surplus in a laboratory land-assembly game.

The land-assembly problem refers to the difficulty that a potential land developer may face in trying to assemble multiple properties with dispersed ownership for a large development project. A developer is likely to face both transactions costs and strategic bargaining costs as individual landowners delay agreement in order to obtain as much of the economic surplus as possible. Furthermore, transactions costs and strategic bargaining costs are both likely to increase with the degree of land fragmentation. The land-assembly problem has been linked to inefficient land use and urban sprawl both theoretically (Miceli and Sirmans 2007) and experimentally (Cadigan et al. 2009b).

Developers may seek to reduce potential financial losses from failed exchanges by using contingent contracts. Real estate contracts can be quite complex and involve a variety of different contingences. Of particular relevance to the land-assembly problem is the potential for developers to purchase properties contingent upon acquisition of adjacent parcels necessary to complete the project. Such contingencies can be either direct or indirect. For example, real estate purchase contracts may be contingent upon the developer receiving necessary zoning approval from the city, and the city may make zoning approval contingent upon the developer acquiring all necessary parcels for the project. Thus, the sales of all parcels are indirectly contingent upon each other.

The majority of the theoretical work on land assembly and urban renewal problems assume, either explicitly or implicitly, that contracts are non-contingent (e.g. Miceli and Sirmans 2007; Miceli and Segerson 2007; O'Flaherty 1994; Strange 1995; Eckart 1985). To account for the possibility that a developer may purchase some, but not all, of the desired parcels, these studies typically assume further that the project is either divisible, or that resale is possible at a known market price, typically resulting in a loss to the developer. We adopt the latter assumption in our experimental treatments with non-contingent contracts. Furthermore, the previous theoretical work typically abstracts from the actual bargaining process by assuming either exogenous exchange prices (e.g. Menezes and Pitchford 2004a, 2004b) or a bargaining process that results in predictable exchange prices (Miceli and Sirmans 2007; Miceli and Segerson 2007).

While this body of theoretical work is important for gaining insight into potential problems associated with land development and urban renewal, little empirical evidence exists to support the models' predictions. We are particularly interested in characterizing bargaining behavior, and examining the extent to which behavior changes when the bargaining institution changes. To this end, we use laboratory multilateral bargaining experiments with treatments that include both simultaneous and sequential bargaining as well as both contingent and non-contingent contracts. Use of the laboratory allows us to observe and control buyers' values and sellers' costs, something that is generally not possible in the field. We compare actual bargaining behavior to a set of equilibrium predictions based on payoff-maximizing subjects and complete information. While theory predicts an earnings advantage for the first seller to bargain when contracts are sequential and contingent, and for the second seller when contracts are sequential and non-contingent, we find that when a seller has a statistically significant earnings advantage in the laboratory, it is the first seller to bargain in the non-contingent contract treatments. This earnings advantage appears in both single-period and multi-period sequential bargaining treatments with non-contingent contracts. This outcome contradicts conventional wisdom and a common result from the land-assembly literature that it is advantageous to be the last seller to bargain (i.e. a "holdout"). We also find evidence that sequential bargaining leads to more aggressive seller bargaining and greater bargaining delay than simultaneous bargaining, ceteris paribus, and that non-contingent contracts increase bargaining delay and the likelihood of failed agreements compared to contingent contracts. The majority of sellers indicated a preference for being the first seller to bargain in all sequential bargaining treatments.

The remainder of the paper is organized as follows. Section 2 presents some background on land assembly and two potential sources of inefficiency – the holdout problem and the holdup problem. Section 3 gives the modeling framework that serves as the basis for the laboratory experiments. Section 4 discusses the experimental design and our predictions. Experimental results are given in section 5 followed by concluding remarks in section 6.

2. Background

Although the nature and order of contracts are relevant for other bargaining problems, the most direct application is to land development, which often requires purchasing multiple, adjacent, independently-owned properties. The land-assembly problem is particularly acute for large projects that are indivisible, for all practical purposes. If contingent contracts are used, the exchange requires agreement by all sellers before anyone receives payment. The developer will not be willing to pay more jointly for the properties than the expected development value of the assembled land. However, any seller can realize his unit is essential for the completion of the project and strategically delay the exchange in order to draw the greatest share of the total surplus. Collectively, land owners may demand more than the developer is willing or able to pay, thus threatening the exchange. This problem has been described both as a monopoly problem, whereby each seller has monopoly power over his parcel and can demand a price above marginal cost, and as an externality problem, whereby each seller ignores the impact of his demand on the other participants to the exchange (Miceli and Sirmans 2007). This can result in inefficiencies arising from delay costs or failed exchanges.

Alternatively, with non-contingent contracts, the developer is faced with the prospect of purchasing some properties that can be resold only at a loss if the remaining properties necessary for completion of the project cannot be acquired. Once assembly has begun, remaining sellers can exploit this initial investment by the developer. In this case, a developer may ultimately find it “optimal” to pay more jointly for the properties than the developed value of the assembled land. Predicting this *ex post* exploitation problem, developers may *ex ante* be unwilling to pay anything above market value for initial properties or may hesitate in engaging in sequential land assembly of this kind altogether, again resulting in inefficiently low levels of land development.

The term “holdout problem” has been used variously to describe both the monopoly / externality problem associated with contingent contracts and the sequential purchase problem associated with non-contingent contracts. However, the latter problem is related directly to, and may be more appropriately referred to as, a “holdup problem” (Dawid and MacLeod 2008; Ellingsen and Johannesson 2004a, 2004b; Ellingsen and Robles 2002; Klein, et al. 1978; Williamson 1975), which refers to the general case when an upstream agent must make a costly investment in the first stage of a game that is only of use to a single downstream agent in the second stage. In such cases, a first-period investment can be held up in a second period by the downstream agent in an attempt to extract a greater share of the total surplus generated by the investment. The *ex post* commitment problem inherent in the holdup problem can lead to inefficiently low investment in the first stage of the game. This is exactly the nature of the predicted pattern of behavior in the land-assembly game with non-contingent contracts. Specifically, land owners in the non-contingent contract game may have an incentive to “holdout” in order to become the last remaining seller who can then “holdup” or exploit the buyer’s initial purchases. In contrast, any seller in the contingent contract game can "holdout" in general, if holdout is interpreted to mean demanding a price above cost, thus increasing the likelihood of failed exchanges if all sellers act in a similar fashion. However, sellers cannot exploit any initial purchases made by the developer, and the developer can never find it optimal to pay jointly more than the assembled value of the land, so a "holdup" problem does not exist. In fact, it is possible that holding out in the contingent contract game can be counter-productive, as earlier sellers may demand (and receive) the majority of the surplus (because the buyer faces less risk in offering more), leaving little of the surplus available for the final seller to split with the buyer. Indeed, we demonstrate theoretically that sellers in the sequential contingent contract game have an incentive to bargain early.

It is important to investigate whether bargaining behavior is consistent with the theoretical literature on the holdout and holdup problems. Cadigan et al. (2009a, 2009b) use multilateral bargaining experiments to investigate the holdout problem, where holdout is measured as bargaining delay. Cadigan et al. (2009a) vary the type of institution (buyer offer versus seller demand), number of bargaining periods (one versus ten periods), and examine both costly and costless delay. All of their treatments involved two sellers and contingent contracts. They find evidence of a holdout problem, which is less significant in the presence of delay costs, and that holdout is payoff improving even in the presence of delay costs. They find that when parties can bargain over multiple periods the starting offer to buy is lower and the starting demand to sell is higher than in one-period treatments, but overall efficiency improves. They find that the bargaining institution (which side is making the offers) affects the distribution of the surplus, but has relatively little impact on efficiency. Delay costs reduce holdout, but also result in efficiency losses.

Cadigan et al. (2009b) vary the number of sellers and level of competition among sellers. They find that the buyer's final earnings vary inversely with the number of sellers, ceteris paribus, indicating an incentive to purchase consolidated land. Competition between sellers reduces holdout and the buyer's total purchase price. Therefore, developers may have an incentive to choose projects in areas where land is more consolidated, even if the potential surplus from such projects is lower than similar projects where land is more fragmented. This may result in inefficient land allocation and a bias in favor of urban sprawl, as land tends to be more fragmented in city centers and more consolidated on the outskirts.

Winn and Parenta (2010) compare seller behavior under simultaneous and sequential bargaining in a land-assembly-type experiment where buyers are computerized and the seller's strategy space is limited to two choices that they characterize as *hard bargaining* and *soft bargaining*. Hard bargaining involves making a higher demand relative to soft bargaining. Universal hard bargaining by all sellers leads to a failed exchange with certainty, while universal soft bargaining leads to a successful exchange with certainty. A mix of hard and soft bargaining leads to a successful exchange with some probability less than one. They use a repeated, one-round bargaining stage game with three sellers. Qualitatively similar to our results, Winn and Parenta find evidence of softer bargaining in the simultaneous treatments compared to the sequential treatments.

Ellingsen and Johannesson (2004a) perform a holdup experiment in which a seller may invest a portion of his or her show-up fee in the first period, and in the second period the seller and buyer play a Nash bargaining game over the revenue created if investment occurred. Bargaining occurs with varying levels of communication (none, buyer communication, or seller communication) to examine if investment occurs and the share of the revenues received by each player. They find that communication significantly increases investment. They find that players are not entirely selfish in bargaining; the most frequent outcome was splitting the surplus regardless of which player could communicate. They find, in contrast to theoretical predictions, that seller communication does not completely solve the holdup problem. They suggest that multiple rounds of communication may help eliminate the holdup problem.

Ellingsen and Johannesson (2004b) examine the impact that promises and threats have on the holdup problem again varying communication as in Ellingsen and Johannesson (2004a). Here, the holdup game is similar to a trust game in that the first mover has to forfeit some of his or her show-up fee, which is multiplied, and the second mover is able to split the bargaining pie. It differs from a trust game in that the amount forfeited by the first mover is fixed, the multiple is low, and the second stage is an ultimatum game rather than a dictator game. It differs from the holdup game in Ellingsen and Johannesson (2004a) in that bargaining is no longer done via Nash - the seller can reject the proposed split.[1] Again, they find that communication increases investment and that a large percentage of buyers propose an equal split of the surplus. In addition, they find that promises are more credible than threats. When the bargaining institution is Nash bargaining, as in Ellingsen and Johannesson (2004a), there is less investment with buyer or seller communication but more investment when communication is not available relative to when the bargaining institution is ultimatum bargaining, as in Ellingsen and Johannesson (2004b).

3. Theoretical Modeling Framework

Following Cadigan et al. (2009a, 2009b), the model providing the motivation for the experimental design includes a single risk-neutral agent we call the "buyer." The buyer is interested in purchasing N complementary units of a good, to be used as intermediate inputs in the production of a larger project, from N independent, risk-neutral "sellers" with cost c_i per unit and each with one unit to sell. If N input units are obtained by the buyer, then the project has value V to the buyer. If any input unit is not acquired, the value of the project is zero. The relationship is such that

$$\sum_{i=1}^{N} c_i < V \qquad (1)$$

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

The payoff to the buyer given N input units are obtained is

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

[1] The differences in bargaining games used for splitting the revenues (Nash versus ultimatum bargaining) in Ellingsen and Johannesson (2004a) and (2004b) are implemented to test the theoretical predictions found in Ellingsen and Robles (2002).

where p_i is the price paid for unit i, and each seller i receives a payoff $(p_i - c_i)$.

Given this information, the buyer may use two different contracts. A contingent contract specifies that no party receives their payoff unless all of the required input units have been acquired by the buyer. Conversely, a non-contingent contract does not require all input units to be purchased, and therefore, any seller who sells her unit to the buyer receives a payoff $(p_i - c_i)$ regardless of whether or not the buyer acquires all necessary units. If the buyer fails to acquire all units under non-contingent contracts, then we assume the buyer incurs a (negative) payoff for each purchased unit equal to $(c_i - p_i)$. That is, we assume the buyer can resell units for c_i. Sellers who do not sell to the buyer under either contract form receive a payoff of zero. We suppose that bargaining between the buyer and sellers takes place over multiple periods and there are no delay costs.

4. The Experiment and Predictions

Similar to Cadigan et al. (2009a, 2009b), we use multi-period bargaining experiments. All treatments are conducted using z-Tree software (Fischbacher 2007). We conducted six treatments in a 3x2 design. Three treatments are single-period ultimatum bargaining games, and three treatments are (up to) ten-period bargaining games. Two treatments are simultaneous, and four treatments are sequential; two of the latter treatments have contingent contracts and two treatments have non-contingent contracts.[2] In all treatments there is one buyer and two sellers. We allow the sellers to decide if they wish to be the first mover or not when bargaining is sequential. If both sellers choose to be the first seller (seller A) or the second seller (seller B), roles are randomly determined.[3] The six total treatments are generated by conducting the (1) simultaneous contingent contracts, (2) sequential contingent contracts, and (3)

[2] At the end of the non-contingent treatments, subjects completed a risk preferences survey (Holt and Laury 2002) consisting of a menu of paired lotteries. The purpose of including the paid survey was to reduce the likelihood that any subjects left the experiment with a negative payoff due to losses incurred in the first portion of the experiment.
[3] We considered this addition to the game to be interesting and insightful toward revealing seller behavior and strategy. We wanted to see if the sellers, after understanding the game and developing their strategy, felt there was any advantage assigned to the position in which they bargain with the buyer.

sequential non-contingent contracts institutions with (1) single-period bargaining and (2) multi-period bargaining. In all treatments we have sellers make *demands* and the buyer chooses to accept or reject.[4] In the contingent contract treatments, if the buyer rejects a demand in the single-period treatments (or fails to accept a demand by the tenth period in the multi-period treatments) then all bargaining parties in that group receive a payoff of zero. In the non-contingent contract treatments, if the buyer fails to reach an agreement with the first seller (seller A) then all bargaining parties in that group receive a payoff of zero, but if the buyer fails to reach an agreement with the second seller (seller B), the first seller (seller A) receives a payoff of her accepted demand minus cost, the second seller (seller B) receives a payoff of zero, and the buyer receives a payoff of seller A's cost minus the accepted demand.[5] For all multi-period treatments, if a buyer rejects a demand, the seller is able to make a new demand for up to a maximum of ten demands. Unlike in the multi-period Gneezy et al. (2003) experiments, proposers in our experiment are not constrained to reduce their demands upon a rejection.

Valuations and costs are common knowledge. The buyer's valuation is $V = \$ 90$. 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. Once a buyer accepts a demand from a seller, that seller makes no additional decisions. In the simultaneous treatments, sellers do not observe demands made for other sellers' units, but are informed of the amount of any accepted demand. In the sequential treatments, the second seller (seller B) is informed of the accepted demand, if applicable, and the period in which the acceptance occurred. Subjects are informed of their experimental earnings plus a \$10 show-up fee and paid privately, in cash at the end of the experiment.

Equilibrium predictions

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[4] We chose to examine behavior when sellers are the proposers rather than when buyers are the proposers because the theoretical outcome for buyer offers is invariant to the type of contract. That is, in each case the buyer should offer each seller the seller's cost and, theoretically, no holdout or holdup will occur.

[5] The buyer is able to resell the unit at the seller's cost, which would result in a non-positive payoff assuming the buyer purchases the unit from seller A for a price equal to or in excess of the seller's cost.

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 d_i represent a seller's demand to sell a particular unit. In the multi-seller design used here, this implies:

Proposition 1: When the sellers simultaneously make ultimatum demands with contingent contracts, multiple equilibria exist. The set of equilibria are characterized by $\sum_{i=1}^{N} d_i = V$ and $d_i \geq c_i \; \forall i$.[6]

Proposition 2: When the sellers sequentially make ultimatum demands with contingent contracts, a unique subgame-perfect equilibrium exists. Normalize the ordering of sellers' demands such that seller 1 moves first, followed by seller 2, and so on. Equilibrium demands are such that $d_1 = V - \sum_{i=2}^{N}(c_i)$ and $d_i = c_i \; \forall i \neq 1$. Therefore, $\sum_{i=1}^{N} d_i = V$.

Proposition 3: When the sellers sequentially make ultimatum demands with non-contingent contracts, a unique subgame-perfect equilibrium exists.[7] Normalize the ordering of sellers' demands such that seller 1 moves first, followed by seller 2, and so on. Equilibrium demands are such that $d_N = V - \sum_{i=1}^{N}(c_i)$ and $d_i = c_i \; \forall i \neq N$. Therefore, $\sum_{i=1}^{N} d_i = V$.

Proposition 4: The buyer should accept any set of demands that leaves the buyer with a positive surplus.

Proposition 1 characterizes a Nash-like bargaining outcome from the perspective of sellers, assuming that the buyer would prefer to accept any positive payoff from accepting compared to a zero payoff from rejecting. The sellers should jointly demand virtually the entire surplus, leaving the buyer with the smallest payoff possible. The intuition behind Proposition 2 is that the first seller to make demands has a first-mover advantage. Because an agreement must be reached with all sellers, the first seller can extract the entire surplus, leaving little or none of the surplus to be divided between the buyer

[6] Technically, to ensure acceptance the sellers should leave the buyer with a payoff of ε, which is one cent in the experiment. This is true for all of the protocols examined here.
[7] Note that we ignore the Pareto inferior subgame-perfect equilibrium where the buyer rejects any demand from the first seller. The last seller is better off in the equilibrium in proposition 3 when the exchange takes place.

and remaining sellers. The intuition behind Proposition 3 is that the final seller can exploit the buyer's purchase from the first seller(s). This is consistent with models of endogenous seller ordering (e.g. Miceli and Segerson 2006; Menezes and Pitchford 2004) where there is a disincentive to be the first bargainer because the payoff to the second bargainer is higher in equilibrium. This implies that any offer greater than cost by the first seller(s) should be rejected. If not, *ex post* the final seller can exploit the buyer's investment in any of the previous sellers' units; it is a best response for the final seller to demand the entire surplus because the buyer has already committed to all previous seller(s) and will have a (negative) payoff equal to $\sum_{i=1}^{N}(c_i - p_i)$ if he does not buy from the final seller. The final seller can, therefore, demand up to the value of the project, and accepting the seller's demand will be better for the buyer than rejecting it. Proposition 4 follows from the assumption that a positive payoff is preferred to a zero or negative payoff.

Propositions 1 – 4 are unaffected by multi-period bargaining. The buyer cannot increase his payoff by rejecting a set of demands that leaves him with a non-negative surplus, because there is nothing in the standard game-theoretic predictions of sellers' behavior to indicate that they, in equilibrium, should demand less or offer a greater share of the surplus following a rejected demand. However, as previous studies have demonstrated (e.g. Cadigan et al. 2009a, 2009b), the ability to make multiple bargaining offers and responses has a significant impact on bargaining behavior and outcomes. Therefore, we investigate both single-period ultimatum bargaining as well as multi-period bargaining.

The wealth of research in single-period, ultimatum-type bargaining games has consistently demonstrated that behavior does not conform strictly to the standard predictions based on the simple assumption of maximizing one's monetary self-interest. Here, however, comparison of simultaneous to sequential bargaining, contingent to non-contingent contracts, and single-period to multi-period bargaining may yield important qualitative insight into bargaining behavior, even if such behavior does not conform strictly to the equilibrium predictions described above for reasons that are beyond the scope of our study.[8]

5. Results

Subjects for all treatments were undergraduate student volunteers from Gettysburg College. A total of 525 subjects participated anonymously via computer with approximately 18 subjects per session, 5 sessions per treatment, totaling approximately 90 subjects per treatment for all six treatments.

Table 1 reports the demand and earnings results for the six treatments. The table provides mean first-period demands by sellers, mean first-period earnings for buyers and sellers (had buyers accepted all sellers' first-period demands),[9] and mean final earnings for buyers and sellers. Standard deviations are in parentheses. Table 2 reports the same earnings results from Table 1 as percentages of the available surplus.[10]

[Insert Tables 1 and 2 here]

Similar to Cadigan et al. (2009a, 2009b), and the ultimatum bargaining literature, behavior is not generally consistent with the game-theoretic predictions in the single-period treatments. Specifically, when making demands simultaneously, sellers do not, in general, jointly demand the entire surplus as predicted. [11] The average demand in the single-period simultaneous bargaining treatment is \$41.66 (or 38.9% of the surplus) leaving the buyer with \$6.68 (or 22.3% of the surplus). However, seller A's mean

[8] For example, preferences for fairness and aversion to inequity (e.g. Fehr and Schmidt (1999) and Bolton and Ockenfels (2000)) may also be important determinants of actual bargaining outcomes.

[9] In the sequential games, this is calculated using both seller A's and seller B's first-period demands when seller B had an opportunity to make a demand.

[10] Both Table 1 and Table 2 also present demands, final earnings, and percent of the surplus for "seller A" and "seller B" in the multi-period simultaneous contingent contract treatment. Here, we define "seller A" as the seller whose offer was first accepted, or accepted simultaneously with the other seller's.

[11] Twice, sellers' joint demand in the single-period simultaneous treatment left the buyer with negative surplus (-\$7 and -\$9.99). The buyer rejected both demands in both cases. Four times, sellers' joint demand left the buyer with \$0 or \$0.01 (all demands were \$44.99 or \$45 in these cases). The buyer accepted both demands on two occasions, and rejected one of the demands on two occasions. The remaining set of demands left the buyer with a positive surplus of between \$3 and \$19. On two occasions the buyer rejected one of the demands. In both rejection cases, the set of demands was \$45 and \$40.

demand in the single-period sequential, contingent contract treatment ($43.64, or 45.5% of the surplus) is higher than the mean demand in the simultaneous treatment.[12] This is qualitatively consistent with the prediction that seller A should demand more in sequential bargaining with contingent contracts.[13] However, seller A's mean demand in the single-period sequential, non-contingent contract treatment ($44.11, or 47% of the surplus) is even higher, contrary to the equilibrium prediction.[14]

The pattern of demands in the single-period treatments is similar to first-period demands in the multi-period treatments, except that the initial demands in the latter are much more aggressive. That is, the mean first-period seller demand in the multi-period simultaneous demand treatment was $46.73 (or 55.8% of the surplus), which was actually jointly more than the available surplus. Seller A demanded more in the first-period when demands were sequential and contingent ($48.75, or 62.5%), qualitatively consistent with equilibrium predictions. Again, however, seller A demanded even more ($52.48, or nearly 75% of the surplus) when contracts were non-contingent, which is inconsistent with the equilibrium prediction.

Demands from the single-period simultaneous treatment were, on average, $5.07 lower than in the multi-period simultaneous treatment, and the difference is statistically significant.[15] For sequential contingent contracts, demands from the single-period treatment were, on average, $5.11 ($5.71) lower for

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[12] Comparing demands in the single-period simultaneous and single-period sequential, contingent contract treatments, Mann-Whitney test, one-tailed significance level = 0.13.

[13] The buyer accepted a positive demand of the surplus from seller B on 28 of the 30 occasions in the sequential, contingent contract treatment (rejected demands were $50 and $48). Seller B only once made a demand that left the buyer with a negative surplus (seller A demanded $44.75, seller B demanded $60). The buyer rejected seller B's demand. Five times seller B's demand left the buyer with $0 or $1. The buyer rejected three and accepted one of these demands (earning $0). The remaining seller B demands left the buyer with a positive surplus of between $2 and $17.50. The buyer rejected one of these demands (a $45 demand by seller B that followed a $40 demand by seller A).

[14] The buyer accepted 21 positive demands of the surplus by seller A and rejected 8 in the sequential, non-contingent contract treatment. In only one case did seller B's demand leave the buyer with a negative payoff (seller A demanded $41.99, seller B demanded $55). The buyer accepted this demand. In four cases, seller B's demand left the buyer with $0 or $0.01. The buyer accepted all of these demands. In the remaining 16 cases, seller B's demand left the buyer with a positive surplus of between $2 and $20. The buyer rejected four of these demands, and earned a negative payoff each time.

[15] Using Mann-Whitney Test, two-tailed significance level = 0.000. All statistical comparisons across treatments use Mann-Whitney Tests.

seller A (B) than in the multi-period treatment.[16] For sequential non-contingent contracts, demands from the single-period treatment were, on average, $8.37 ($6.77) lower for seller A (B) than in the multi-period treatment.[17] Consistent with Cadigan et al. (2009a) these differences illustrate how sellers act strategically, taking much more aggressive initial bargaining stances across the board in the multi-period treatments compared to the single-period treatments. The consistency in the pattern of demands across treatments also suggests that sellers bargain more aggressively when they are the first seller to bargain (seller A) in the sequential bargaining treatments compared to the simultaneous bargaining treatments, regardless of the type of contract.

Considering seller behavior over time in the multi-period simultaneous demand treatment, we find no evidence of strategic behavior on the part of remaining sellers. That is, when buyers accept only one of the two demands, theory predicts the remaining seller should change her demand to capture the remaining surplus. This never happened. Buyers accepted demands simultaneously on nine occasions. In the remaining twenty cases, the remaining seller could have increased her demand in response to receiving information on the other seller's accepted demand, but did not.[18]

Does seller B behavior in the sequential bargaining treatments match the strategies given in the equilibrium predictions? And does the type of contract matter? For the multi-period sequential treatment with contingent contracts, five of the 29 seller B's who made offers chose the equilibrium offer in the first period by demanding the remaining surplus. Four sellers made first-period demands that would leave the buyer with a negative surplus. None of these 29 seller B's maintained demands to the final period such that the buyer faced a zero or negative surplus by period 10.[19] For the multi-period treatments with non-contingent contracts, three of the 28 seller B's who made demands chose to "holdup" the buyer. That is,

[16] For seller A, two-tailed significance level = 0.024; for seller B, two-tailed significance level = 0.000.
[17] For seller A, two-tailed significance level = 0.000; for seller B, two-tailed significance level = 0.000.
[18] In almost every case in the multi-period treatments, a seller's demand is the highest in period one, and falling at rates that varied by individual seller. In a very few cases, a seller's demand path had a small "bubble" in the middle bargaining periods.
[19] The smallest surplus available to the buyer by seller B's period 10 was $1.50 in this treatment.

three sellers made a demand that would leave the buyer with a negative surplus. Eight sellers made demands that would leave the buyer with a zero or $0.01 surplus.[20] The buyer faced a negative surplus by period 10 for seller B on only two occasions. While both seller A's and seller B's appear to have bargained more aggressively in the non-contingent contract treatment, there is little concrete evidence that seller B's were able to recognize the "holdup" problem inherent in non-contingent contracts, or at least few seller B's were willing and able to fully exploit the opportunity in the end.

How did buyers respond to these demands? And what were the implications of these demands for bargaining delay, efficiency, and the final distribution of the surplus? Table 3 reports the percent of first-period rejections, the average agreement period,[21] the number of failed agreements, and efficiency (defined as the percentage of the potential economic surplus actually realized) for each treatment. With no delay costs in our treatments, efficiency is equal to the proportion of complete agreements.

[Insert Table 3 here]

Table 4 displays the results of binary logit regression on the buyers' responses for all multi-period treatments, and separate regressions for the three different institutions (simultaneous, sequential contingent, and sequential non-contingent) where the response variable is defined as accept = 1. The pooled regression includes dummy variables for the sequential treatments (the default being the simultaneous treatment) as well as dummy variables for seller A in both the simultaneous and sequential treatments.[22] The other independent variables are the demand and the bargaining period. The table reports marginal effects.

[Insert Table 4 here]

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[20] In only one of these three cases would accepting the demand have yielded a higher payoff to the buyer than rejecting.

[21] For the purpose of comparing average agreement periods, failed agreements are included as period 11 in the calculations. This avoids selection bias that would occur if failed agreement observations were dropped from the calculations.

[22] For the simultaneous treatment, seller A is defined as any seller who, at the time the demand was made, did not have information on the other seller's accepted demand. Seller B, therefore, is any seller who knew the other seller's accepted demand, and was the only remaining seller making a demand in that period.

Table 5 displays the results of a binary logit regression of the buyers' *first-period* responses across all six treatments (again where the response variable is accept = 1) and separately for the three single-period treatments. The independent variables are demand, seller A, the type of contract (contingent vs. non-contingent), and single period. Again, the defaults are seller B, the simultaneous bargaining treatment, and multi-periods. The table reports marginal effects.

[Insert Table 5 here]

A set of demands that would yield a negative payoff occurred twice in the single-period simultaneous treatment,[23] once in the single-period treatment when contracts were contingent,[24] and once when contracts were non-contingent.[25] The vast majority of rejections in each of these single-period treatments were, therefore, positive surplus rejections.

However, in the first period of the multi-period treatments, buyers faced aggressive bargaining demands by sellers, with first-period demands resulting in a negative payoff to the buyer, in many cases, had they accepted all first-period demands. Consequently, 91.7%, 96% and 100% of first-period demands were rejected in the simultaneous, contingent, and non-contingent multi-period treatments, respectively. The regression results in Table 4 indicate that buyers were more likely to accept a demand the lower the demand, the later the period in which the demand occurred, and if the demand came from seller A, particularly in the non-contingent contract treatment. Buyers were less likely to accept a given demand, in general, in the sequential bargaining treatments compared to the simultaneous treatment, and if contracts were non-contingent. Table 5 further illustrates that buyers were much more likely to accept a given first-period demand, ceteris paribus, if it was a single-period ultimatum demand. This indicates that buyers also act strategically by rejecting nearly all early demands in the multi-period treatments.

[23] Joint demands of $99.99, and $97.00 were rejected.
[24] Seller A demanded $44.75 and seller B demanded $60. The buyer rejected seller B's demand. On two other occasions, the joint demand was $90 exactly, and the buyer rejected seller B's demand both times.
[25] Seller A demanded $41.99 and seller B demanded $55. The buyer accepted seller B's demand. On three other occasions, the joint demand was $90 exactly, and the buyer accepted seller B's demand each time.

Interestingly, although sellers act much more aggressively in the early periods of the multi-period treatments, they do soften their demands over time. Figures 1 and 2 give the average demand by period for each of the treatments. The figures show that while initial demands are higher in the multi-period treatments, they tend to fall to the level of average single-period demands by the final periods. Also noteworthy from the two figures is that the average demands of both seller A's and seller B's are higher in all periods of the sequential bargaining treatments compared to the simultaneous bargaining treatment. Figures 1 and 2 do not accurately illustrate how much demands were actually changing, because the lowest demands were being accepted by the buyers. For example, Figures 3 and 4 show the *average cumulative change* in sellers' demands over time, respectively. Therefore, it appears that sellers viewed rejections by the buyers as credible commitments to reject a given demand, and they subsequently reduced their demands considerably.

The results in Tables 1 – 5 also yield some clear patterns with regard to the distribution of the surplus, the amount of bargaining delay, and the efficiency of exchange across treatments. In both the single-period and multi-period treatments, the buyer's mean final earnings are highest in the simultaneous bargaining treatment and lowest in the sequential, non-contingent contract treatment.[26] The reverse is true for seller A's mean final earnings, though seller B's final earnings do not follow the same pattern.[27] Thus, both the buyer's payoff and seller B's payoff appear to be inversely related to seller A's payoff, which makes intuitive sense as the three subjects are ultimately splitting a fixed $30 surplus. However, it is clear that the availability of multiple bargaining periods leads to a Pareto improvement – the mean final earnings of the buyer and both sellers are higher across the board in the multi-period treatments relative to the single-period treatments. This is consistent with the higher rates of agreement and efficiency in the multi-period treatments. Efficiency rates from Table 3 were 76.9%, 76.7% and 58.6% for the single-

[26] Five buyers (17%) in the multi-period non-contingent contract treatment ended with negative earnings.
[27] Seller A has highest mean final earnings in the sequential non-contingent contract treatments, while seller B has the lowest final earnings in this treatment.

period simultaneous, sequential / contingent, and sequential / non-contingent contract treatments, respectively, and 96.7%, 90.0%, and 76.7% for the corresponding multi-period treatments. Although all parties took a more aggressive bargaining stance in the early periods of the multi-period treatments, agreements were reached more often, and all parties benefitted.

Comparing efficiency rates across treatments, again efficiency was highest in the simultaneous treatments both for single-period and multi-period bargaining treatments, and lowest for the sequential, non-contingent contract treatments. The lowest efficiency level overall (58.6%) occurred in the single-period sequential treatment with non-contingent contracts. Interestingly, the efficiency level for the multi-period sequential, non-contingent contract treatment (76.7%) was about equal to the best of the single-period bargaining treatments. Therefore, it is clear that sequential, non-contingent contracts yield the greatest number of failed agreements and the lowest efficiency of the three bargaining institutions investigated here. Although bargaining delay is costless in our treatments, there is also evidence that it took longer for agreements to be reached, on average, in the sequential, non-contingent contract treatments. The average agreement period was 8.33 in this treatment compared to 7.16 and 6.5 for the sequential, contingent and simultaneous bargaining treatments, respectively. Furthermore, the greater delay appears to apply to bargaining with both seller A and seller B, as the average agreement period with seller A was 7.47, and 9.25 with seller B. Both seller types took the most aggressive bargaining stances in this treatment, and the buyers exhibited a greater reluctance to accept a given offer when contracts were non-contingent. These two factors combined explain both the greater bargaining delay in the multi-period treatment and lower efficiency rates in both the single-period and multi-period non-contingent contract treatments.

Finally, is there an advantage to being either seller A or seller B in any of the treatments? And do sellers correctly anticipate such an advantage, when one exists? In each of the sequential bargaining treatments, between 77% and 86% of sellers indicated a preference for being seller A.[28] This preference shows that the majority expected a potential earnings advantage for the first seller to bargain. In the single-period sequential bargaining treatments, seller A had an earnings advantage in *both* treatments, despite the prediction that seller A should earn more when contracts are contingent, and seller B should earn more when contracts are non-contingent.[29] In the multi-period sequential bargaining treatments, seller A had an earnings advantage only in the non-contingent contract treatment ($11.00 compared to $7.84), despite the prediction that seller B should earn more when contracts are non-contingent.[30] However, seller B earned more, on average, than seller A in the contingent contract treatment ($9.33 compared to $10.80), though the difference is not statistically significant at standard levels.[31]

In the multi-period simultaneous bargaining treatment, when agreements were reached with sellers in different periods, we identify "seller A" as the first seller to reach an agreement with the buyer (or when demands were accepted simultaneously), and "seller B" as the last seller. There is some evidence that it was advantageous for sellers to bargain more aggressively. Those sellers that reached agreements later had higher mean final earnings ($8.79 for seller A compared to $10.20 for seller B), and the difference in final earnings is statistically significant.[32] From Table 3, the average agreement period for "seller A's" in the multi-period simultaneous treatment was 5.67, compared to period 8 for "seller B's". Therefore, as in Cadigan et al. (2009a, 2009b), we again have some evidence that aggressive bargaining and "holding out" is payoff improving, though our treatment involved sellers making demands on the buyer, and delay was costless.

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[28] The proportion of sellers choosing to be seller A is not significantly different across the sequential treatments. Using a two-tailed proportions test comparing the contingent contract treatments to the non-contingent contract treatments the percentages of sellers choosing to be seller A are not different; single-period p = 0.540 and multi-period p = 0.539.

[29] The statistical significance of the differences is greatest in the single-period sequential bargaining treatment with non-contingent contracts (Wilcoxon Signed Ranks Test, two-tailed p = 0.162).

[30] The difference in final earnings is statistically significant; using a Wilcoxon Signed Ranks Test, two-tailed p = 0.021.

[31] Using a Wilcoxon Signed Ranks Test, two-tailed p = 0.438.

[32] Wilcoxon Signed Ranks Test, two-tailed p = 0.011.

6. Conclusions

The nature of bargaining and the type of contract used can have potentially important implications for the distribution of the economic surplus, the duration of bargaining, and the overall efficiency of exchange, particularly in bargaining scenarios, such as land assembly, in which unanimous consent is required. While it is difficult to reproduce all salient features of real-world bargaining in the laboratory, analysis of behavior in experimental bargaining games may yield insights into how people bargain in the field, and how behavior and outcomes may be affected by changes in the bargaining institution or environment. In this paper, we reported the results of laboratory multilateral bargaining experiments designed to examine how the order of bargaining (simultaneous or sequential) and the nature of contracts (contingent or non-contingent) affect behavior and outcomes in a land-assembly game with one buyer and two sellers.

While theory predicts an earnings advantage for the first seller when bargaining is sequential and contracts are contingent, and for the second seller when contracts are non-contingent, we find that when a seller has a statistically significant earnings advantage in the laboratory when bargaining is sequential, it is the first seller to bargain under non-contingent contracts. This result contradicts conventional wisdom and a common result from the land-assembly literature that it is advantageous to be the last seller to begin to bargain, a so-called "holdout". We should note, however, that when bargaining simultaneously, those sellers that reached agreements with the buyer in later periods did have higher earnings than those who reached agreements earlier. Thus, it appears that while there is an advantage to bargaining more aggressively, in general, based on our experimental results there is not any clear advantage to being the last seller to *begin* bargaining. This was particularly apparent in the non-contingent contract treatments. Although, theoretically, the final seller can exploit the buyer's initial purchases and extract most of the surplus, the results indicate that the final sellers had lower payoffs than the first sellers in such treatments, and the lowest payoffs, in general, across all the treatments. In contrast, the first seller to bargain in these treatments took a *more* aggressive bargaining stance, contrary to theory, and enjoyed higher payoffs. This approach, however, contributed to lower agreement rates, and lower payoffs for the buyer and subsequent sellers. It is not clear why initial sellers chose to bargain more aggressively rather than less, as theory would predict. Perhaps the first sellers to bargain sequentially recognize, in general, that a successful agreement with them is critical to the exchange regardless of the type of contract and, therefore, bargain more aggressively. And perhaps, under non-contingent contracts, the prospect of a payoff that does not depend on the decisions of the remaining bargaining parties heightens the anticipation of a larger payoff relative to bargaining under contingent contracts. Additional investigation is required to answer these questions. The majority of sellers in all sequential bargaining treatments appear to have anticipated a potential earnings advantage for the first seller by indicating a preference for being the first seller to bargain.

We also find evidence that sequential bargaining leads to greater bargaining delay than simultaneous bargaining, ceteris paribus, and that non-contingent contracts increase bargaining delay and the likelihood of failed agreements. Buyers also had consistently lower average final payoffs when bargaining was sequential and contracts were non-contingent. Therefore, from the perspective of a land developer it appears advantageous to bargain simultaneously with land owners and use contingent exchange contracts, if possible. While the availability of multiple bargaining periods seems to alleviate some of the problems associated with sequential and non-contingent contracts, it does not eliminate them.

References

Bolton, Gary, and Axel Ockenfels. 2000. "ERC: A Theory of Equity, Reciprocity, and Competition." *American Economic Review* 90, 166-193

Cadigan, J., P. Schmitt, R. Shupp, and K. Swope (2009a). "An Experimental Study of the Holdout Problem in a Multilateral Bargaining Game" *Southern Economic Journal*, 76(2) 2009, 444-457.

Cadigan, J., P. Schmitt, R. Shupp, and K. Swope (2009b). "The Holdout Problem and Urban Sprawl: Experimental Evidence" unpublished manuscript.

Coase, Ronald. (1960). "The Problem of Social Cost," *Journal of Law and Economics* **3**, 1- 44.

Dawid, Herbert, W. Bentley MacLeod (2008). "Hold-up and the Evolution of Investment and Bargaining Norms," *Games and Economic Behavior* **62**, 26-52.

Eckart, W. (1985). "On the Land Assembly Problem," *Journal of Urban Economics* **18(3)**, 264 – 378.

Ellingsen, Tore, Magnus Johannesson (2004a). "Is There a Hold-up Problem," *Scand. J. of Economics* **106 (3)**, 475-494.

Ellingsen, Tore, Magnus Johannesson (2004b). "Promises, Threats and Fairness," *The Economic Journal*, **114**, 397–420.

Ellingsen, Tore and Jack Robles (2002). "Does Evolution Solve the Hold-Up Problem?" *Games and Economic Behavior* **39,** 28-53.

Fehr, Ernst, and Klaus Schmidt. 1999. "A Theory of Fairness, Competition, and Cooperation." *Quarterly Journal of Economics* 114(3), 817-868.

Gneezy, U., E. Haruvy, and A. E. Roth. 2003. "Bargaining Under a Deadline: Evidence from the Reverse Ultimatum Game." *Games and Economic Behavior* 45, 347 – 368.

Holt, Charles A., Susan K. Laury (2002). "Risk Aversion and Incentive Effects," *New Developments in Experimental Economics* **2**, 139-50.

Klein, B., R. Crawford, and A. Alchian. (1978). "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process." *Journal of Law and Economics* **21**, 297 – 326.

Lau, Stephanie (2008). "Information and Bargaining in the Hold-up problem," RAND Journal of Economics **39(1),** 266-282.

Menezes, Flavio, Rohan Pitchford (2004a). "A Model of Seller Holdout," *Economic Theory* **24**, 231-253.

Menezes, Flavio, Rohan Pitchford (2004b). "The Land Assembly Problem Revisited," *Regional Science and Urban Economics* **34**, 155-162.

Miceli, T. and K. Segerson. (2007). "A Bargaining Model of Holdout and Takings," *American Law and Economics Review* **9(1)**, 160 – 74.

Miceli, T.J. and C.F. Sirmans. (2007). "The Holdout Problem, Urban Sprawl, and Eminent Domain," *Journal of Housing Economics* **16(3-4)**, 309 – 19.

Nosal, E. (2007). "Private Takings," Federal Reserve Bank of Cleveland, Working Paper: 0713.

O'Flaherty, Brendan (1994). "Land Assembly and Urban Renewal," *Regional Science and Urban Economics* **24**, 287-300.

Schmitz, Patrick W. (2008). "Incomplete Contracts, the Hold-up Problem, and Asymmetric Information," *Economic Letters* **99**, 119-122.

Strange, W.C. (1995). "Information, Holdouts, and Land Assembly," *Journal of Urban Economics* **38(3)**, 317-32.

Tröger, Thomas (2002). "Double Auctions, Ex-Post Participation Constraints, and the Hold-Up Problem" Department of Economics, UC Santa Barbara, University of California at Santa Barbara, Economics Working Paper Series: 1009

Tröger, Thomas (2002). "Why Sunk Costs Matter for Bargaining Outcomes: An Evolutionary Approach," *Journal of Economic Theory*, 102(2), 375-402.

Williamson, O. (1975). Markets and Hierarchies: Analysis and Antitrust Implications, The Free Press, New York.

Winn, A. and M. Parenta. (2010). "Bargaining Behavior in the Anticommons," unpublished manuscript.

Table 1. Demand and earnings results by treatment (standard deviations in parentheses)

Proposer	Treatment	Mean first period demand	Mean buyer first period earnings	Mean seller first period earnings	Mean final buyer earnings	Mean final seller earnings	Number of groups
Seller	Single Period Simultaneous Contingent Contract	$41.66 (4.71)	$6.68 (6.94)	$11.66 (4.71)	$6.94 (6.11)	$8.07 (5.67)	N = 26
Seller	Single Period Sequential Contingent Contract	Seller A $43.64 (5.68) Seller B $40.79 (5.96)	$5.95 (6.43)	Seller A $13.64 (5.68) Seller B $10.79 (5.96)	$5.85 (5.38)	Seller A $9.18 (6.34) Seller B $7.97 (5.85)	N = 30 (77% chose Seller A)
Seller	Single Period Sequential Non-contingent Contract	Seller A $44.11 (9.51) Seller B $41.05 (5.10)	$5.94 (5.79)	Seller A $14.11 (9.51) Seller B $11.05 (5.10)	$2.40 (1.52)	Seller A $ 9.43 (1.43) Seller B $ 6.34 (1.28)	N = 29 (86% chose Seller A)
Seller	Multi-period Simultaneous Contingent Contract	$46.73 (7.62)	$-3.46 (11.06)	$16.73 (7.61)	$10.43 (5.02)	Seller A[33] $8.79 (3.36) Seller B $10.20 (3.30)	N total = 30 N (A) = 39 N (B) = 21
Seller	Multi-period Sequential Contingent Contract	Seller A $48.75 (10.54) Seller B $48.10 (8.91)	$-6.47 (14.78)	Seller A $18.75 (10.54) Seller B $8.10 (8.91)	$6.53 (4.27)	Seller A $9.33 (5.02) Seller B $10.80 (4.83)	N = 30 (83% chose Seller A)
Seller	Multi-period Sequential Non-contingent Contract	Seller A $52.48 (13.06) Seller B $47.82 (8.17)	$-10.02 (17.85)	Seller A $22.48 (13.06) Seller B $17.82 (8.17)	$4.16 (11.25)	Seller A $11.00 (6.72) Seller B $7.84 (5.09)	N = 30 (82% chose Seller A)

[33] In the multi-period simultaneous bargaining treatment, when agreements were reached with sellers in different periods, we identify "seller A" as the first seller to reach an agreement with the buyer (or when demands were accepted simultaneously), and "seller B" as the last seller.

Table 2. Percent of surplus for the first period and final earnings by treatment

Proposer	Treatment	percent first period to the buyer	percent first period to the seller	percent final earnings to the buyer	percent final earnings to the seller	Number of groups
Seller	Single Period Simultaneous Contingent Contract	22.3%	38.9%	23.1%	26.9%	N = 26
Seller	Single Period Sequential Contingent Contract	19.8%	Seller A 45.5% Seller B 35.9%	19.5%	Seller A 30.6% Seller B 26.6%	N = 30 (77% chose Seller A)
Seller	Single Period Sequential Non-contingent Contract	19.8%	Seller A 47.0% Seller B 36.8%	8.0%	Seller A 31.4% Seller B 21.1%	N = 29 (86% chose Seller A)
Seller	Multi-period Simultaneous Contingent Contract	-11.5%	55.8%	34.8%	Seller A 29.3% Seller B 34.0%	N total = 30 N (A) = 39 N (B) = 21
Seller	Multi-period Sequential Contingent Contract	-21.6%	Seller A 62.5% Seller B 60.3%	21.8%	Seller A 31.1% Seller B 36.0%	N = 30 (83% chose Seller A)
Seller	Multi-period Sequential Non-contingent Contract	-33.4%	Seller A 74.9% Seller B 59.4%	13.9%	Seller A 36.7% Seller B 26.1%	N = 30 (82% chose Seller A)

Table 3. Efficiency results by treatment (standard deviations in parentheses)

Proposer	Treatment	Percent of first-period rejections	Average agreement period	Number of failed agreements	Efficiency	Number of groups
Seller	Single Period Simultaneous Contingent Contract	15.4%	NA	6	76.9%	N = 26
Seller	Single Period Sequential Contingent Contract	12.1% (6.7% for seller A, 17.9% for seller B)	NA	7 (2 with seller A, 5 with seller B)	76.7%	N = 30
Seller	Single Period Sequential Non-contingent Contract	34.5% (27.6% for seller A, 19.0% for seller B)	NA	12 (8 with seller A, 4 with seller B)	58.6%	N = 29
Seller	Multi-period Simultaneous Contingent Contract	91.7%	6.5 (5.67 seller A, 8.00 seller B)[34]	1	96.7%	N = 30
Seller	Multi-period Sequential Contingent Contract	96.6% (96.7% for seller A, 96.6% for seller B)	7.37 (6.87 seller A, 7.89 seller B)	3 (1 with seller A, 2 with seller B)	90.0%	N = 30
Seller	Multi-period Sequential Non-contingent Contract	100%	8.33 (7.47 seller A, 9.25 seller B)	7 (2 with seller A, 5 with seller B)	76.7%	N = 30

[34] Here again, "seller A" is defined as any seller whose demand was accepted prior to or simultaneously with the other seller's demand. "Seller B" is any seller whose demand was accepted after the other seller's, or not accepted at all.

Table 4. Logit regression results (marginal effects calculated) for buyers' responses across time for the multi-period treatments (accept=1), standard errors in parentheses.

	All Treatments	Simultaneous Contingent Contract	Sequential Contingent Contract	Sequential Non-contingent Contract
Demand	-0.011*** (0.001)	-0.019*** (0.003)	-0.013*** (0.003)	-.004*** (0.001)
Seller A_SIM (seller A = 1)	0.000 (0.017)	-0.008 (0.020)	—	—
Seller A_SEQ (seller A = 1)	0.037*** (0.015)	—	0.007 (0.015)	0.036*** (0.015)
Period	0.018*** (0.002)	0.015*** (0.004)	0.016*** (0.004)	0.019*** (0.004)
SEQ_Contingent	-0.018 (0.015)	—	—	—
SEQ_Non-contingent	-0.040*** (0.015)	—	—	—
N=	1295	388	431	476
Pseudo R^2 =	0.26	0.28	0.28	0.29

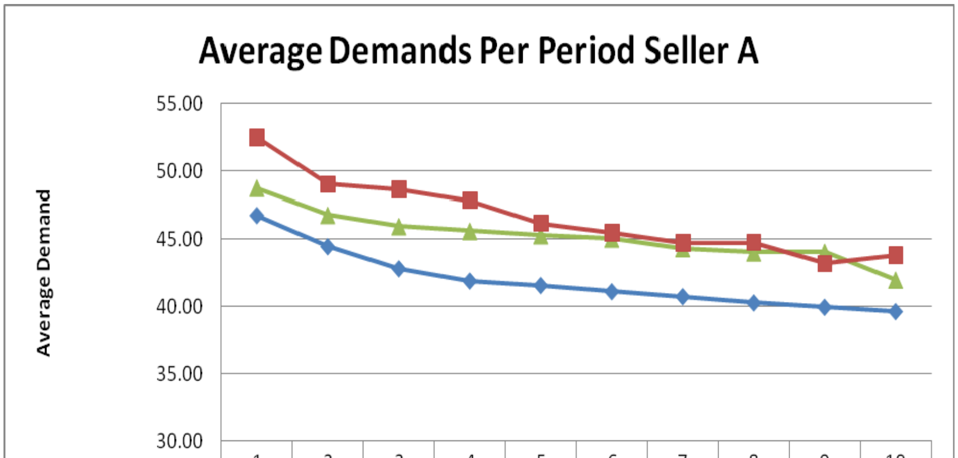
*** Significant at the 1% level

Table 5. Logit regression results (marginal effects calculated) for buyers' first-period responses (accept=1), standard errors in parentheses

	All Treatments	Single-Period Treatments
Demand	-0.024*** (0.006)	-0.012** (0.005)
Seller A_SIM	0.351 (0.220)	—
Seller A_SEQ	0.085 (0.094)	0.055 (0.065)
SEQ_Contingent	0.052 (0.112)	0.020 (0.078)
SEQ_Non-contingent	-0.118 (0.085)	-0.100 (0.092)
Single Period	0.817*** (0.047)	—
N=	337	160
Pseudo R^2 =	0.619	0.071

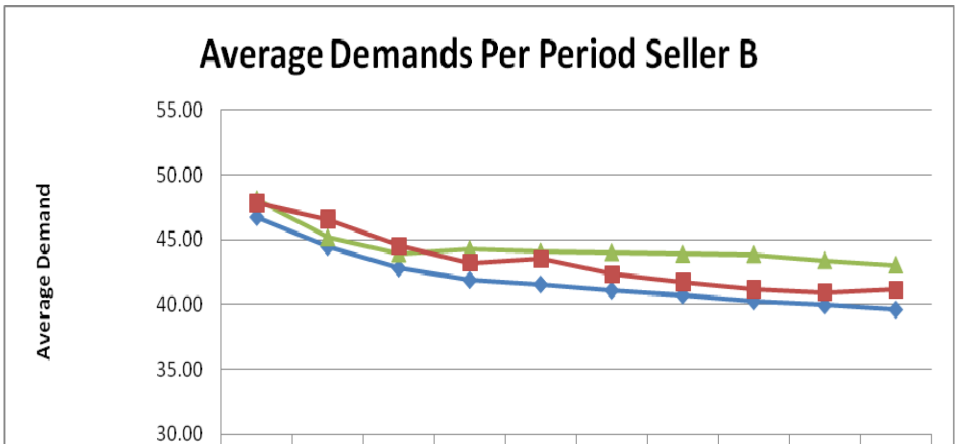
*** Significant at the 1% level ** Significant at the 5% level

Figure 1. Seller A average demand by period in multi-period treatments[35]



	1	2	3	4	5	6	7	8	9	10
simultaneous	46.73	44.44	42.81	41.90	41.56	41.11	40.74	40.28	39.95	39.63
contingent	48.75	46.78	45.95	45.60	45.29	45.04	44.34	44.02	44.06	42.00
non-contingent	52.48	49.03	48.66	47.85	46.18	45.48	44.71	44.76	43.19	43.80

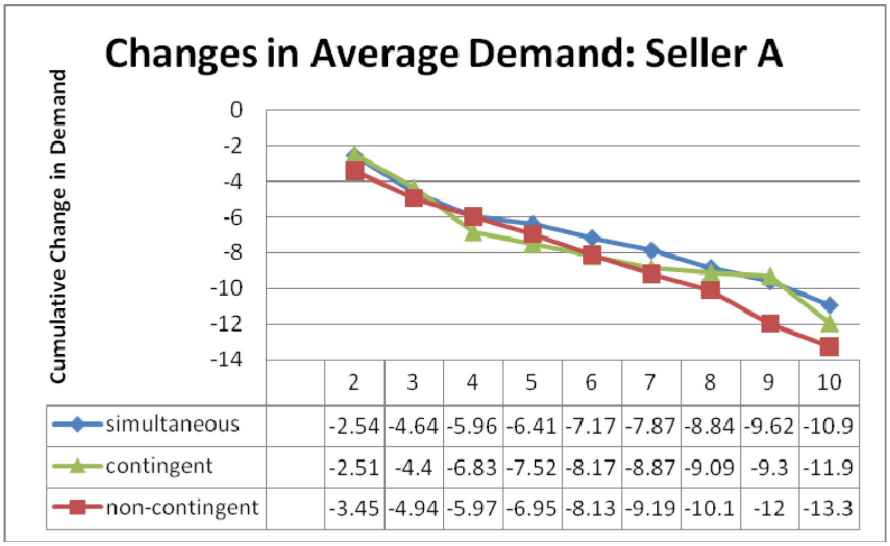
Figure 2. Seller B average demand by period in multi-period treatments[36]



	1	2	3	4	5	6	7	8	9	10
simultaneous	46.73	44.44	42.81	41.90	41.56	41.11	40.74	40.28	39.95	39.63
contingent	48.10	45.14	43.92	44.26	44.05	44.00	43.88	43.86	43.38	43.04
non-contingent	47.82	46.55	44.51	43.21	43.50	42.33	41.71	41.15	40.93	41.13

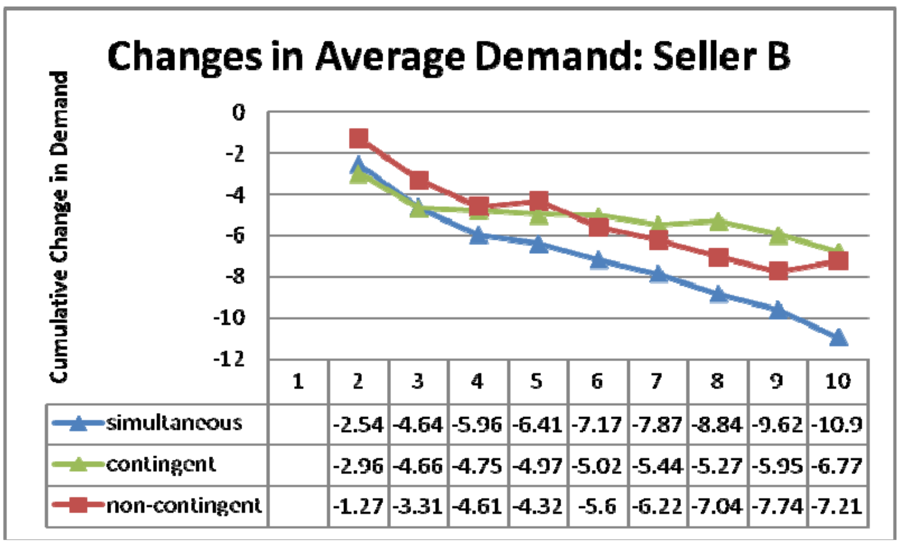
[35] Average demands of all sellers shown for the simultaneous bargaining treatment.
[36] Average demands of all sellers shown for the simultaneous bargaining treatment.

Figure 3. Average cumulative change in seller A's demand by period in multi-period treatments[37]



	2	3	4	5	6	7	8	9	10
simultaneous	-2.54	-4.64	-5.96	-6.41	-7.17	-7.87	-8.84	-9.62	-10.9
contingent	-2.51	-4.4	-6.83	-7.52	-8.17	-8.87	-9.09	-9.3	-11.9
non-contingent	-3.45	-4.94	-5.97	-6.95	-8.13	-9.19	-10.1	-12	-13.3

Figure 4. Average cumulative change in seller B's demand by period in multi-period treatments[38]



	1	2	3	4	5	6	7	8	9	10
simultaneous		-2.54	-4.64	-5.96	-6.41	-7.17	-7.87	-8.84	-9.62	-10.9
contingent		-2.96	-4.66	-4.75	-4.97	-5.02	-5.44	-5.27	-5.95	-6.77
non-contingent		-1.27	-3.31	-4.61	-4.32	-5.6	-6.22	-7.04	-7.74	-7.21

[37] Average demands of all sellers shown for the simultaneous bargaining treatment.
[38] Average demands of all sellers shown for the simultaneous bargaining treatment.