

Buying up the block: An experimental investigation of capturing economic rents through sequential negotiations

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Abstract

This paper develops and experimentally implements a simple multi-negotiation bargaining game, in which one agent, called the “developer,” must reach agreements with a series of other agents, called “landowners,” in order to implement a value-increasing project. The game has a unique subgame perfect Nash equilibrium under which the surplus from the project is split between the landowner and developer without any dissipation of value. In the actual experiments, however, on average almost half of the value of the project was dissipated. The costs of dissipation fell disproportionately on the developer, who was able to capture less than 5% of the value generated by the project. The results of this experiment call into question the ability of private negotiations between a large number of parties, even in a world without explicit contracting costs, to induce Pareto-optimal allocations of property rights.

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The problem of negotiating a value-increasing agreement between a single large agent and a collection of small agents is salient in a number of economic situations. For example, consider the problem of a real estate developer trying to buy up the landholdings of a large number of small landowners in order to develop a shopping mall. Or consider the many tales told by economists to illustrate market solutions to public goods problems. For example, Pigou (1920) and Coase (1961) discuss the problem of a railroad company attempting to negotiate an agreement over spark emission with small farmers whose fields abut the rail line, or the problem of a polluting factory attempting to negotiate a smoke emission agreement with the citizens living in the vicinity. The large number of consenting parties required in such agreements clearly involves some transaction costs, and such costs may block welfare-improving transactions. However, if we view transaction costs from a fairly narrow perspective as being the physical costs of communication and documenting transactions, then we must recognize that these costs have fallen dramatically with the advent of information technology. This fact has been recognized in the information systems literature (see Shintani and Sycara (2000)), where algorithms have been developed for processing agreements, conditions, and offers from a distributed network of agents at virtually no marginal cost. Another important obstacle to concluding agreements between a single large agent and a collection of small agents is, of course, asymmetric information between the parties. In fact, asymmetric information can engender significant dissipative costs even in simple 1-1 bargaining situations (see for example Grossman and Perry (1986)). However, under conditions of symmetric information and zero transaction costs for bargaining, the standard models yield unique subgame perfect equilibria in which negotiations can be concluded efficiently between all negotiating parties regardless of the number of agents involved.¹ Thus, in a world where information recording and communication is virtually costless, we expect, under symmetric information, that developers, factory owners, and railroads should be able to negotiate surplus-maximizing agreements through simple sequential contracting with all affected parties.

The aim of this paper is to test this conjecture experimentally. In our test, subjects play a sequence of simple bargaining games. In each round of play, one of the subjects acts as a “developer,” sequentially approaching a series of “landowners” to buy their parcels of land. The developer negotiates within the framework of a simple structured bargaining game, offering an unconditional payment to each landowner in exchange for her parcel of land. Unless all parcels are purchased by the developer, the developer’s

¹However “nonstandard” bargaining games can be constructed even in two-player bargaining settings, which have a unique perfect equilibrium that is inefficient. See Furusawa and Wen (1999).

project cannot be implemented. The game is structured to ensure that it has a unique subgame perfect equilibrium under the assumption that all agents are commonly known to be rational expected-value maximizers. We call this solution the “rational Nash solution.” Moreover, because of the very simple dynamic structure of the game, even if common knowledge of rationality is absent, there is little role for “reputation-building” by the agents attempting to signal that their reservation demands exceed rational Nash levels. In fact, even if a developer suffers from the “sunk-cost illusion” and factors sunk costs into his reservation point, the game still has a simple and efficient albeit different solution, a solution we call the “sunk cost solution.” Thus, the game is structured to remove as many impediments as possible to reaching an efficient agreement.

The results of our experiments indicate that, even in the absence of both explicit transaction costs and asymmetric information, there are significant obstacles to negotiating value-increasing agreements. Fully 45% of the negotiations ended before all agreements could be concluded. Thus, because value is created only when agreement was reached by all parties, sequential negotiations dissipated almost half of the available economic surplus. The developer’s payoffs were disproportionally affected by negotiation failure. Landowner payoffs were less affected because frequently negotiations broke down after the developer had already paid off some of the landowners.

The large value losses documented in our experiment were not the result of unusual behavior in the individual negotiations. In fact, the offer and response behavior in the individual negotiations was generally consistent with patterns observed by previous researchers: (a) agreements were usually reached at terms between the rational Nash and equitable division point and (b) offer rejections followed by disadvantageous counter offers were common. Moreover, consistent with the sunk cost bias, both landowners and developers appeared to factor earlier sunk payments into their demands in later negotiations.

Thus, in our experiments, the individual bargaining games between the parties followed patterns consistent with the experimental literature on structured bargaining. Yet, the sequential game frequently produced failure and developer losses. It appears that the cause for this failure rate is analogous to reasons for early experimental failures in sequential games with efficient backward-induction solutions. In backward induction games, the degree to which subjects are willing to rely on common knowledge of the other subject’s rationality is limited. Similarly, in our sequential negotiation game, the degree to which subjects are willing to rely on the rationality of third-parties later in the negotiation sequence is limited. In the context of our game, third-party rationality is crucial to the terms of 1-1 negotiations because the value of the project to the developer early

in negotiations, and thus his reservation offer, depends on the likelihood of dissipative failure in later negotiations. The lack of common knowledge of the developer's beliefs regarding the rationality of the landowners later in the sequence of negotiations makes the developer's true reservation unknown to landowners early in the sequence. Since all negotiations must succeed for any value to be realized from the agreement, if the developer perceives even a small likelihood that a given landowner later in the sequence will be irrationally aggressive in her demands, the developer's expected payoff from completing an early negotiation, and thus his reservation value, will be low. Thus, if a developer is pessimistic about future negotiations and a landowner is optimistic about the developer's success, the landowner's estimate of the developer's reservation demand, which fixes the landowner's demands, will be too high to permit agreement with the developer. Thus, breakdown in early negotiations may occur. In fact, consistent with this logic, we find that offer failure about four times more likely in the first negotiation than in the second, and twice as likely in the second negotiation as in the third and last negotiation.

These results have a number of fairly direct implications both for the design of negotiations and for public policy. First, our results indicate that information technology and a reduced cost of communication, per se, will not permit one to realize the gains from value increasing transactions that require negotiating individual agreements from a large number of dispersed agents. Our results show that using regulation or an eminent domain provision may, in cases where the consent of a large number of disaggregated agents is required, be the most efficient means of capturing economic value and eliminating externalities even in a full-information, zero-transaction-cost world. Second, our analysis provides an alternative rationale for making agreements between a single agent and a large body of counterparties conditional—that is, making the payments to one of the counterparties conditional on other counterparties also accepting the deal. Such conditional offers are common in both real estate and stock purchase transactions. Our results show, that even in cases where setting this condition has no advantage to the buyer under the assumption of common knowledge of rationality, it may still increase buyer profits. By canceling agreements if other parties in the negotiation sequence are obdurate, differing conjectures of the buyer and the given counterparty regarding the reasonableness of other parties are “factored out” of the computation of the developer's reservation price. Given our experimental results, this factoring out should lead to much greater efficiency.

The focus of this paper on the social efficiency of a negotiation game featuring fairly long action paths locates our analysis at the intersection of the experimental research on structured bargaining and the theory of multiagent negotiations. Like the literature

on structured bargaining (e.g., Binmore, Shaked and Sutton (1985) and Ochs and Roth (1989)), we test the predictions of game theoretic models for bargaining games that are explicitly structured to conform to the sequence of play given by the game’s extensive form. Like these authors, we find some predictive power for at least the qualitative predictions of the strategic solutions, and also some evidence of both irrational offer response behavior and the use of normative as opposed to strategic solutions by the agents. However, in contrast to these researchers, we consider negotiations featuring more than two negotiating parties and we consider the sequence of negotiations. Thus, in contrast to these papers, agent conjectures about the rationality and preferences of parties not currently involved in the negotiations are salient. Thus, rather than tracking the standard 1-1 bargaining game theoretical literature, our work tracks the smaller theoretical literature on multiparty sequential bargaining. The point of divergence between these theoretical papers and our experimental study is that the game we consider is actually much simpler than the games analyzed in those papers, which feature more sophisticated institutional/informational environments and thus more subtle solutions. For example, Marx and Shaffer (2004) consider sequential negotiations with breakup fees; Horn and Wolinsky (1988) consider the effect of coalition formation among parties on one side of the negotiations; Noe and Wang (2000) consider the effect of debt restructuring negotiations with one creditor on the bargaining power of other creditors; Cai (2000) considers the effect of allowing agents who fail to reach agreement in one negotiation in a series to negotiate again later, after deals have been concluded with other agents in the series; Noe and Wang (2004) consider optimal strategies in sequential negotiations when the outcomes of earlier negotiations are unknown to parties later in the sequence of negotiations. Our experimental results show that the dissipation that Cai generates from sequence jockeying and Noe and Wang generate from confidentiality is pervasive experimentally even in very simple symmetric information models whose Nash equilibria are unique and efficient.

This paper is organized as follows. Section I specifies and solves the game that will be the focus of our experimental study; Section II describes the laboratory protocols used in the experiment; Section III describes the results of the experiments; concluding remarks and possible extensions are considered in Section IV. The appendix provides a complete desegregated report on the subjects’ actions in the experiment.

I Game design

A *The rules of the game*

A developer is attempting to buy three indivisible and identical parcels of land to complete a development project. Each parcel is owned by a single landowner. We normalize the value of a parcel to the landowner to 0. All three parcels are required to complete the project and, if the project is not completed, the land has no value to the developer. If all three parcels are acquired by the developer, then the value of the project to the developer is 1 dollar. Thus, the three parcels of land are perfect complements and the economic surplus from the project is 1 dollar. The developer can negotiate with each individual landowner only once and only through 1-1 bargaining. These negotiations relate to the size of the monetary payment the developer will make for a landowner's parcel. The developer has complete information regarding past information. The developer is wealth unconstrained in that regardless of payments he has made in the past, he can still make any payment he chooses in current negotiations. Each landowner knows how many negotiations have been concluded before the developer negotiates with her, but does not know the terms at which agreements were reached. As we explain in more detail later, assuming value-maximizing rational behavior on the part of landowners, information on the size of these sunk developer payments has no effect on her optimal strategy. Assuming that common knowledge of rationality is absent, the lack of information regarding previous offers prevents developers from dissipating value in early negotiations to signal toughness in later negotiations.

Each individual 1-1 negotiation is a two-period nonstationary version of an Osborne and Rubinstein (1990) bargaining game, where the delay associated with the rejection of each offer leads to a probability of value dissipation. When value dissipation occurs, the economic value of project falls to zero, terminating all negotiations between the developer and the landowners. Rejection of the first offer (made by the developer) engenders dissipation with probability $\frac{1}{2}$; rejection of the second offer (the counteroffer made by the landowner) engenders dissipation with probability 1. This bargaining model reduces the individual 1-1 negotiation to a simple two-stage process in which the developer makes a first offer, and a landowner makes the final offer.

The specific structure of the model is as follows. First, the developer makes an "offer" to a landowner to buy her land. An *offer* is defined in our analysis as a payment proposed by the developer to a landowner. If the landowner accepts the offer, she receives the offer price and the negotiation with her ends. If she rejects the offer, there is a probability $\frac{1}{2}$ that the value of the project is dissipated. With probability $\frac{1}{2}$, no value dissipation occurs.

In this case, the landowner makes a “counteroffer” to the developer. A *counteroffer* is payment from the developer to the landowner proposed by the landowner. At this point, the developer can accept or reject the counteroffer. If the counteroffer is accepted, the developer acquires the parcel, makes the payment, and the negotiation with the given landowner ends. If the counteroffer is rejected, the value of the project falls to zero with probability 1. Later, we will motivate this design from an experimental perspective. Now, we derive solutions for this game. First, we consider the subgame perfect equilibria of this negotiation game. We call this solution the “rational Nash solution.” Next, we consider a behavioral solution that allows for developers to factor sunk costs into their accept/reject decision. We term this solution the “sunk-cost solution.” A third solution that we consider is a nonstrategic solution under which the four parties, the developer and the three landowners, split the 1.00 surplus of the project equally among themselves. We term this solution the “even-split solution.”

B Solutions to the game

2 Rational Nash

Suppose that all agents are rational risk-neutral expected payoff maximizers. All payouts made by the developer in previous negotiation are sunk, and thus will be ignored in our analysis of subsequent negotiations. Hence, when we refer to “developer payoffs” in a given negotiation, we are not factoring in sunk payments made in previous negotiations. When we want to factor these sunk payments into our analysis, we will use the term “total payoffs.” Our negotiation game has a unique subgame perfect equilibrium, derived by backward induction. Consider first the third and last landowner in the negotiation sequence. To reach the third and last negotiation, the other landowners must have sold to the developer. Thus, the third landowner knows that if she refuses to sell, the developer cannot complete the project. If the landowner makes a counteroffer offer, she can demand any amount less than the full project value 1, with the assurance that her counteroffer will be accepted. An offer more than 1 would certainly be rejected by the developer because accepting such an offer produces a negative payoff to him, and he can receive a payoff of 0 in the last negotiation simply by rejecting the landowner’s counteroffer. Since the landowner receives nothing when her offer is rejected, she will never ask for more than 1. Thus, the landowner must receive 1 in a subgame starting with the landowner making a counteroffer. Hence, when the third landowner rejects a developer offer, with probability $\frac{1}{2}$, the project’s value is dissipated, and with probability $\frac{1}{2}$ the landowner makes a counteroffer of 1, which is accepted by the developer. The expected value to

the last landowner from following the strategy of rejecting the developer's offer is thus $\frac{1}{2}$. Rationality dictates that the third landowner will accept any offer that is greater than $\frac{1}{2}$. The developer's payoff from making an offer that is rejected is zero. Thus, an offer less than $\frac{1}{2}$ will, if it is accepted by the landowner, produce a lower payoff than a rejected offer, and thus such an offer must be rejected. Since the developer always prefers his offer being accepted to being rejected, the developer must, in any subgame perfect equilibrium, make an offer of $\frac{1}{2}$ to the third landowner, and this offer must be accepted.

Hence, regardless of the amount paid to landowners of earlier successful negotiations, the developer knows that he will pay $\frac{1}{2}$ to buy out the third landowner. Meeting the third landowners demands costs the developer $\frac{1}{2}$, leaving $1 - \frac{1}{2} = \frac{1}{2}$ available for division between the developer and the second landowner. We call the value of the project not committed to landowners later in the negotiation sequence the "residual value" of the project. Through the same arguments used for the third negotiation, we can see that in the second negotiation, the landowner can capture one-half of the residual value, i.e., $\frac{1}{2}(1 - \frac{1}{2}) = \frac{1}{4}$. This implies that at the start of the first negotiation the residual value is $1 - \frac{1}{2} - \frac{1}{4} = \frac{1}{4}$. By the same argument again, the first landowner can capture one half of this residual value, or $\frac{1}{8}$. Thus, in any subgame perfect equilibrium, the developer's offer is accepted in each negotiation, and the developer offers $\frac{1}{8}$ to the first landowner, $\frac{1}{4}$ to the second landowner, and $\frac{1}{2}$ to the third landowner. These offers are the lowest offers the landowners will accept. If the developer's offer were to be rejected, the landowner should counter with an offer equal to twice the developer's offer, and the developer should accept a final offer if and only if it is less than or equal to this landowner counteroffer.

2 *Sunk costs*

Based on discussion with students (not the subjects of our experiment) and even some Ph.D. seminar participants, we felt that subjects playing this game might suffer from a sunk-cost bias against accepting offers that produce negative total payoffs. Although, along the subgame perfect equilibrium path, developer payments always sum up to less than the value of the project, the subgame perfect equilibrium sometimes calls for the developer to receive a negative payoff off the equilibrium path. For example, suppose that the game has followed the rational Nash solution in the first and second negotiation, with the developer paying the first landowner $\frac{1}{8}$ and paid the second landowner $\frac{1}{4}$. Consider the subgame starting after a rejected developer offer and nondissipation. Since the payments to the earlier landowners are sunk and the landowner makes an ultimatum offer in the third negotiation, the developer should rationally accept any landowner counteroffer less than 1. However, accepting any counteroffer between $5/8$ and 1 generates a negative total

payoff to the developer (but still a larger payoff than produced by rejecting the offer). Thus, if a developer factors in sunk costs by refusing all counteroffers producing negative total payoffs, then a landowner, even one who realizes that such refusals are irrational, will have to factor the developer's behavioral bias into her counteroffer. Hence, we now consider the equilibrium solution when the developer has a sunk-cost bias, i.e., he will refuse any counteroffer producing a negative total payoff.

In this case, assuming that the developer's sunk cost bias is common knowledge, and otherwise agents are risk-neutral value maximizers, the counteroffer by each landowner must push the developer's payoff to the sunk-cost rejection threshold. Because landowners do not observe the payments made in previous negotiations, their computation of the developer's zero total payoff threshold depends on their beliefs regarding the payments received by other landowners. We concentrate our attention on pure strategy equilibria where each landowner's beliefs regarding the payments to landowners earlier in the negotiation sequence are invariant to the developer's offer to her. Rational expectation requires that the developer's actual earlier offer be the same as the offer conjectured by the landowner. Moreover, for exactly the same reasons as we outlined in the analysis of the rational Nash solution, the developer's offer must equal half of the landowner's counteroffer. Thus, if we let c_i represent the equilibrium counteroffer of landowner i , $i = 1, 2, 3$ and o_i represents the developer's equilibrium offer to landowner i , we see that offers and counteroffers must satisfy the following system of equations:

$$\begin{aligned}\sum_{j \neq i} o_j + c_i &= 1, & i = 1, 2, 3, \\ o_i &= \frac{1}{2} c_i, & i = 1, 2, 3.\end{aligned}$$

This system of equations has a unique solution: $o_i = \frac{1}{4}$, $i = 1, 2, 3$; $c_i = \frac{1}{2}$, $i = 1, 2, 3$. Thus, using the same logic as applied to the rational value maximizing equilibrium, one can show that under the sunk cost solution agents follow the following strategies: the developer's offer is accepted in each negotiation and the developer offers $\frac{1}{4}$ to all landowners. This offer is the lowest offer the landowners will accept. If the developer's offer were to be rejected, the landowner should counter with an offer equal to $\frac{1}{2}$, and the developer should accept a final offer if and only if it is less than or equal to this counteroffer. Landowners believe, regardless of the offer they receive from the developer, that the developer has paid $\frac{1}{4}$ to each landowner with whom he has previously negotiated. Other perfect Bayesian equilibria may exist under the sunk-cost assumption. In these more complex equilibria, landowner beliefs about earlier negotiations are affected by the developer's offer. And for reasons similar to those documented in McAfee and Schwartz (1994), dissipation may occur. However, given symmetry, simplicity, and coincidence

with the even-split solution of our sunk-cost solution, we believe that it is a natural solution when otherwise rational developers suffer from a sunk cost bias that leads them to avoid at all cost accepting offers that produce negative total payoffs.

2 *Even split*

Even more distant from a strategic approach to solving the bargaining game is the even-split solution. We consider this solution for experimental reasons. As long as bargaining game experiments have been performed, “split-the-difference” divisions of gains have exhibited considerable predictive power in laboratory experiments (see for example Roth and Malouf (1979)), even in experiments that set up a strategic bargaining game which has a Nash equilibrium solution inconsistent with the even-split solution (see Binmore et al. (1985)). For this reason, in our empirical analysis we will also use this solution as a bench mark. Under the assumption that agents demand fair payments and make fair offers, with “fair” being defined by the even division of the surplus from the project, we expect the developer’s offer to be accepted in each negotiation and the developer to offer $\frac{1}{4}$ to each landowner. This offer is the lowest offers the landowners will accept. If the developer’s offer were to be rejected, the landowner should counter with an offer equal to $\frac{1}{4}$ and the developer should accept a final offer if and only if it is less than or equal to this counteroffer. Note that the even-split solution and the sunk-cost solution differ only off the equilibrium path.

C *Features of the game design and its solutions*

The experimental design for our multi-negotiation bargaining game was motivated by a desire to abstract away as much as possible from the sources of inefficiency identified in experimental economics in 1-1 bargaining. A number of researchers have shown that experimental subjects have difficulty with multistage backward induction (see, for example, Sefton and Yavas (1996)). For this reason, we made the individual bargaining games as simple as possible, subject to the constraint that the subgame perfect Nash equilibrium game does not assign all the surplus to one of the bargaining parties. Many researchers have also conjectured that limited computational ability of subjects accounts for experimental failures of rational choice models of structured bargaining games (see Johnson, Camerer, Sen and Rymon (2002)). To help alleviate this problem, we designed our game so that the rational Nash equilibrium produces easy-to-compute payoffs (1/8 to the landowner in the first negotiation; 1/4 to the landowner in the second; 1/2 to the landowner in the third negotiation). Having discussed the game with students, we

realized that the sunk cost bias was pervasive among students. Our design features a very simple efficient symmetric solution when agents factor in sunk costs: the developer offers $1/4$ to each landowner and his offer is accepted.

Our design should also attenuate the dissipative losses from reputation formation and signaling. The game played in our experiment is a game of complete and perfect information. Thus, assuming common knowledge among the players that all players will follow rational value-maximizing strategies, there is no incentive for the participants to engage in dissipative reputation formation, i.e., attempt to use proposals or rejections to change the beliefs of the parties with whom they are negotiating. However, the assumption that rationality is common knowledge has proved to be somewhat problematic when applied to experimental subjects. For example, Van Huyck, Rankin and Battalio (2002) find in their experiments that subjects' decisions are typically consistent with their own rationality but subjects frequently make decisions inconsistent with their believing that the other players are rational or inconsistent with their believing that the other players believe that they are rational. This evidence suggests that the assumption of "higher order" knowledge of rationality (see Rubinstein (1989)) seems to be violated by many experimental subjects. Hence, were our efficient solutions to rely on a high order knowledge of rationality, dissipation of value might be attributed simply to the failure of common knowledge. For example, in a experimental game, a rational, value maximizing developer might reject an offer from a landowner even if developer knows he will lose from rejecting the offer because the developer thinks the landowner is unsure of the developer's rationality. In which case, a "crazy" rejection of a pretty good offer might convince the landowner that the developer is irrationally obdurate, willing to reject offers which he feels are "unfairly low" even if rejection is quite costly. Such a belief would encourage the landowner to offer the developer a better deal than the one the landowner would offer the developer were the developer known to be a rational value value maximizing agent.

Our design is fairly robust to this lack of higher order knowledge of rationality. In fact, as long as (a) each landowner knows that her actions do not affect developer's beliefs about his expected payoffs from future negotiations with other landowners, and (b) the landowner knows that the developer is a rational value maximizer, there is no scope for reputation formation in our game design. Because landowners do not observe the play of negotiations with other landowners earlier in the negotiation sequence, there is clearly no role for developers making offers (or rejecting offers) to affect their reputation in later negotiations in the sequence. Next consider the landowners. The expected value-maximizing counteroffer by a rational value maximizing landowner, given the belief that the developer is rational value maximizing, is always equal to the residual value of

the project. This value depends on the play of subsequent negotiations. However, as long as the landowner does not believe that her own actions will affect the developer's beliefs about residual value, (i.e. the expected value to the developer from future negotiations with other landowners) residual value will be invariant to the reject/accept decision the landowner makes. Thus, a landowner's optimal counteroffer is unaffected by the accept/reject strategy followed in response to the developer's offer. Thus, given (a) and (b), there is no role for landowners to reject initial offers for the sake of forming reputations. This implies, for example, that a landowner who assigns positive probability to the developer thinking that she is irrationally obdurate will not try to reject that developer's offer to increase the developer's assessment of the probability of her irrational obduracy and thus increase the counteroffer the developer will accept. Thus, a fairly low order common knowledge assumption is sufficient to sustain our rational Nash equilibrium, levels of common knowledge that are no higher than required to support equilibria in the simplest 2x2 matrix games.

II The design of the experiment

Subjects for the experiment were recruited at a private university on the East Coast from a pool of undergraduate and graduate business students. Potential subjects were told that they had the opportunity to earn money in a research experiment on negotiations and economic decision-making. Each student participated only in one experiment. The likelihood of contact between subjects in different experiments was minimized by recruiting students in different campuses, levels, and programs.

For each experimental session, we recruited 5 participants to play the 4 roles in the experiment, 1 developer and 3 landowners. Five students were recruited to increase the likelihood that at least four students would show up. In 1 out of 3 sessions, all 5 subjects showed up for the experiment. In this case, we appointed one of the students as the experimenter's assistant; this student was paid at an average of all participants' payoff. Two experimenters and one assistant conducted most sessions. In each session, the participants were taken in a classroom and provided with the instruction sheet (see Appendix 1A) and a decision tree (see Appendix 1B). First, the instruction sheet was read aloud. Next, subject questions were answered by the experimenter. One of the 4 participants was designated by lottery to be the developer. The remaining students were designated as landowner 1, 2, or 3. The designation of developer and landowner remained unchanged throughout the experiment.

The participants were told that there would be no verbal discussions between the developer and landowners. All negotiations were conducted in writing on offer sheets

(see Appendix 1C). The experimenter announced that each developer will start with a base payoff of X Francs, which would be augmented or reduced by the payoffs from playing the game. Providing the developers a base payoff was required because the developers net payoff from playing the game could be negative. Landowner payoffs could not be negative, thus landowners received no base allocation. A maximum of 3X Francs was to be distributed to the landowners if all rounds of negotiations were successful. Each experiment session consisted of 20 rounds, but subjects essentially played the game with indefinite end points since they were not told when the game would end. Each session was expected to last approximately one hour or less. Each participant would thus have made about \$20/hr. only if all negotiations had been successful.

All landowners were seated separately in a large classroom, and the developer was seated at front of the room. Every round, the developer first picked a sequence of landowners with whom he/she would negotiate. He then wrote the first offer on a sheet of paper (see Appendix 1C). The offer was handed over to the landowner of his choice, and the landowner was allowed to accept or reject the offer. If she chose to accept, the developer was informed and the game continues. If the landowner rejected the offer, a coin was tossed by the experimenter. If it was correctly called by the landowner, she was allowed to make a counteroffer; otherwise, the game ended. The counteroffer was sent to the developer. If the developer accepted the offer, he made an offer to the next landowner in the sequence, and the game continues. If the earlier landowner accepted the offer, the developer makes his/her offer in the second negotiation to the next landowner in the chosen sequence. The game continues in the same fashion, unless ended by a coin flip after a landowner rejection or by a developer rejection of a landowner counteroffer, until deals were struck with the three landowners. Each landowner kept record of bids and payoff round by round on a landowner's record (see Appendix 1D) and the developer kept record of the sequence of negotiations and all his bids and the counteroffers of the landowners (see Appendix 1E). The overall result of the round was shown to all the landowners at the end of each round, but no information was disseminated to the landowners during the rounds of the game. This circulated information was the same as the information on the developer's record in each round. Each experiment was repeated for 20 rounds, and each experiment session lasted less than one hour. At the end of each session, the payoff was calculated and payment was made to each subject. The average payoff for all negotiation games was \$53 per game (compared to \$80 if all negotiations were successful). Average payoff for developers was \$22.80 and that of landowners was \$10.07. On average, each participant received \$13.25 for less than one hour of their time.

III Results

A *Experiment outcomes*

Table 1 describes the incidence of failure in the negotiations. The most striking result in this table is the large number of failures: 45% of these negotiation games ended in failure. These results are inconsistent with the Coase Theorem and with the predictions of the standard game theoretic models of behavior because, under the unique rational Nash outcome, the likelihood of negotiation failure is zero.

Table 2 continues our investigation by considering the realized payoffs of the players. Total payoffs and the payoffs of each agent are below rational Nash predicted values. The shortfall is particularly pronounced for the developer; his payoff of approximately 0.05 is less than half the theoretically predicted payoff of 0.125. Inspecting agent payoffs conditioned on offer success, we see that the developer's payoff exceeds the theoretically predicted payoff. In fact, his payoff is closer to higher payoff predicted by the sunk-cost and even split solutions. Thus, the very low average payoffs to the developer seem to be the product of frequent breakdown in negotiations rather than excessive payments to landowners. Frequent negotiation failures leading to dissipation in experimental simulation of structured bargaining games which support only efficient subgame perfect equilibria are not uncommon. In fact, our average single negotiation rate of failure (about 16%) is roughly consistent with the literature (see Ochs and Roth (1989)). However, in our multi-negotiation framework, failure has different consequences for agent payoffs than it does in single negotiation games. Because the developer makes payments that are unconditional to the landowners, landowners can receive payoffs and developers can incur costs when the negotiations fail at a later point in the negotiation sequence. However, the developer cannot receive any gain unless all negotiations are successfully completed. Thus, failure has a disproportionately negative effect on the developer. Further, landowners are also affected asymmetrically by failure. Failure at any point in negotiations implies that landowners later in the negotiation sequence will not receive any payments from the developer. Thus, the adverse effect of failure increases the later the landowner is in the sequence of negotiations. These higher failure costs to landowners later in the negotiation sequence perhaps account for the fact that the first landowner has the highest average payoff despite the fact that the rational Nash solution predicts that the payoff to the first landowner is the lowest, and the sunk-cost/even-split solution predicts identical payoffs to all landowners.

Next, we consider the most obvious candidate for producing offer failures: inadequate developer offers. Table 3 provides a summary of the initial offers by developers. From

Table 3, we see that developer offers track the sunk-cost/even split solution much more closely than they do the rational Nash solution. However, as predicted by the rational Nash solution, offers are higher in later negotiations. In the first two negotiations, offers are also significantly less than the sunk-cost/even-split prediction. In the first negotiation, the average offer is 0.211 and the offer equals or exceeds the sunk-cost/even-split offer less than 30% of the time. However, over 80% of the time, the first offer exceeds the Nash predicted offer. In the third and last negotiation, the average is exactly equal to the the sunk-cost/even-split solution, while all offers are below the rational Nash prediction. Note that in the last negotiation, previous negotiations payoffs are sunk, and there are at most two remaining moves for each of the players. Thus, in the very subgame where the predictive failure of the rational Nash solution is most pronounced, the backward induction required to solve the game is the simplest. Thus, a simple failure of backward induction and iterated dominance to predict subject strategies in multistage games, as documented by Ochs and Roth (1989) and McKelvey and Palfrey (1992), cannot completely explain the divergence between the rational Nash predictions and our results. One basic observation, which is most evident from inspecting Figure 1, is that the majority of offers in all rounds are clustered between 0.20 and 0.30. In the first negotiations, nonetheless, many offers fall below this range, and in the last negotiation many are higher.

Having completed our analysis of developer offers, we turn to landowner responses. Our analysis of these responses is initiated in Table 4. In this table, we consider the proportion of offer acceptances and rejections consistent with the predictions of both the Nash and sunk-cost/even-split solutions. In the table, NA represents the proportion of offers that are acceptable for the given solution of the game; PA represents the fraction of offers which should be accepted based on the given solution that are actually accepted; and PR represents the fraction of offers which should be rejected that are actually rejected. Perfect predicted success of the equilibrium requires that both PA and PR equal 1. We see from Table 4 that the sunk-cost/even-split offer is accepted roughly 80% of the time in all rounds. Given that the realized payoffs of the developer are so low (0.046 out of 1.00 surplus), it might seem that developer's could have increased their payoffs by raising their offers at least to the even split level of 0.25. However, it is premature to draw this conclusion from our data. The value of the developers strategy depends on what counteroffers landowners will make after rejecting initial developer offers. If these counteroffers are very aggressive, then even a 20% chance of rejection can lower the value of the game to developers below even the low levels documented in the experiments. Consider, for example, a simple case where there is an 80% chance that each landowner

accepts the sunk-cost/even-split offer of 0.25, and a 20% that the landowner is obdurate, rejecting all offers less than the full surplus. In this case, the expected payoff to the developer from offering 0.25 in all rounds is just 0.024, half of the realized payoff in the experiment.

Next we turn, in Table 5, to considering landowner counteroffers after rejected offers. Each solution to the bargaining game we consider specifies a landowner offer subsequent to an offer rejection. However, in all solutions, this landowner offer is off the equilibrium path. Thus, our first interesting observation is that, contrary to our theoretical predictions, landowner counteroffers are frequently observed, occurring in 24 of the 60 negotiations. The second observation is that such counteroffers are low relative to the preceding developer offer. Because a rejected developer offer triggers a 50% chance of dissipation, any landowner strategy that involves rejecting a given developer offer and countering with an offer that is less than twice the rejected offer is weakly dominated by an otherwise identical strategy of accepting the given offer. We call such rejections and counteroffers “weakly disadvantageous.” We find that, overall, 71% all counteroffers are weakly disadvantageous. As with the developer offers, landowner counteroffers increase with the number of previous negotiations. This increase is consistent with theoretical prediction of the rational Nash solution. However, the magnitude of the increase is much less than predicted. In fact, the average level of the counteroffer is between the sunk-cost prediction and the even-split prediction, with the sunk-cost model having slightly better predictive power in the last two negotiations and the even-split having higher predictive power in the first negotiation. The divergence from the rational Nash prediction is particularly striking in the last negotiation. The subgame starting with the landowner’s offer in the last negotiation is a simple ultimatum game. The mean landowner demand of 0.466 is not only less than the rational value maximizing prediction, 1.00, it is also much less aggressive than the typical ultimatum games offers.² Binmore et al. (1985) also find that embedding an ultimatum game in a larger game can change subject play in the ultimatum game. However, in their case, embedding increases the degree to which subject behavior fits the rational wealth-maximizing strategic model. In our case, embedding the ultimatum game leads to greater deviation from this model.

In the first and second rounds, landowner counteroffers also seem low relative to the payoff landowners should be able to extract given the average payoffs to other landowners. Recall that a developer, even one suffering from a sunk-cost bias, should always accept any offer from the landowner that leaves his total payoff positive. The average payoff to a landowner in any negotiation is less than 0.20. Thus, any demand of 0.60 by the

²See Camerer (2003) for a survey of the results of ultimatum experiments.

landowner in the first negotiation, should be accepted by the developer if he believes that the subsequent pattern of negotiation will produce payoffs to the next two landowners consistent with the average payoffs in the experiment. Yet, landowner demands of 0.60 and above are almost never observed in the experiment. In short, landowner demands seem very moderate, especially when contrasted with their rather aggressive rejection of developer offers. The moderate behavior of the landowners lowers the cost to developers of having their offers rejected, and thus increases developer profits.

Finally, we consider developer responses to landowner counter offers in Table 6, which is structurally identical to Table 4. From the table, we see that in the final round of negotiations all offers were accepted. Because these offers were all less than the sunk cost predicted offer of 0.50, and *a fortiori* less than the rational Nash offer 1.0, it is not possible to determine from the data how developers might have respond to a final offer of say 0.60, which would be close to the typical ultimatum in an ultimatum game played for 1.00 value. Given that such offers were not even attempted, it seems reasonable to conclude that that landowners believe that developers would be unwilling to accept such offers. When we turn to the second negotiation, we see that developers are quite aggressive in rejecting offers of less than 0.50, the optimal rejection threshold in both the sunk cost and rational Nash solutions, rejecting such offers 43% of the time. However, developers were willing to accept landowner demands in excess of the even split solution, as can be seen from the fact that mean accepted landowner demand is 0.390. In the first negotiation, all landowners demand more than the rational Nash solution and less than the sunk cost solution. Landowner offers are accepted 55% of the time, with the mean accepted offer being 0.310 and the mean rejected offer equaling 0.420. In short, developers seem willing to grant the landowners, who possess all the bargaining power when making a counteroffer, payoffs in excess of the even split solution but are unwilling to allow a single landowner to capture more than half of the gains from an agreement.

B Learning by developers

Now we investigate whether developers learned from their past experience. It is natural to focus on the learning of developers because they repeated the decisions of selecting the sequence of landowners to negotiate and making initial offers in every round. The learning of landowners may be difficult to detect because their positions in the negotiation sequence were not the same in the experiment. We consider two aspects of developer learning: making initial offers, and picking the sequence of landowners to negotiate. Initial offers could change over time both in response to simple experience in playing the game and in response to feedback from landowners to developer offers.

With regard to simple experience, we do not observe any consistent patterns of change in developer offers across rounds. To further our understanding of the evolution of offers and counter offers over time, we present, in disaggregated form, a complete round-by-round history of the offers and acceptances of developers and the landowners. This information is presented in Figures 2 and 3. Figure 2 presents the round-by-round history of offers and counter offers, with labels indicating the identity of the developer with whom the landowners negotiate. Figure 3 presents the round-by-round history of offers and counteroffers, with labels indicating whether the offer (or counteroffer) was accepted. As can be seen from Figure 2, most offers cluster in the 0.20–0.30 range, and do not appear either increasing or decreasing over the number of rounds the developers play the game. Rather, experimentation with offers outside the 0.20–0.30 range is most pronounced both in the early and late rounds.

Next, we consider the effect of landowner responses on developer offers. If developers learn from their experience when making initial offers, we might observe that developers increase their offers after having their offers be rejected in the past, and decrease their offers after having their offers be accepted in the past. In Table 7, we compare the difference between two consecutive offers in the same negotiation conditional on whether the previous offer is accepted or not. After an offer is accepted, the developer tends to reduce the offer in the following game, though the reduction was not significant. The average reduction in offers is about 0.015 after acceptance in previous round. After an offer is rejected, the developer increases the offer by about 0.033 in the following game, more than double the reduction after acceptance. This difference is significantly greater than the difference following an accepted offer. The only time that the difference after a rejected offer is not significantly greater is in the third negotiation. The reason may be that the developer has a short memory. The developer does not reach the third negotiation all the time, so two consecutive third negotiations may be several games apart. In this scenario, the developer may forget what happened in the previous third negotiation, and there may be no learning effect. In Panel B, we exclude scenarios when the two consecutive negotiations are more than two games apart. The changes after rejected offers are significantly greater than changes after accepted offers in the third negotiation as well. Thus, the conditional analysis indicates that landowner rejections induce significantly larger developer offers, at least in the early (first and second) negotiations and perhaps in the third and last negotiation.

We then consider the effect of landowner responses to developer learning from a different perspective—through a simple reinforcement learning model (see, for example, Salmon (2001)). We implement reinforcement learning through a specification in which

a log transformation of the developer’s offer is regressed on both the sum of rejected offers and the sum the “complements” of the accepted offer, i.e. 0.50 minus the accepted offer. Reinforcement learning predicts that rejected offers will lead to higher subsequent offers, with the force of reinforcement being proportional to the size of the offer rejected, e.g., a developer offering a landowner 0.49 and having his offer rejected will increase his offer more than a developer offering 0.01 to the landowner and having his offer rejected. Similarly, developer offers should fall in the complement of the accepted offer — e.g., a developer offering 0.01 (which has complement 0.49) and having his offer rejected should lower his offer much more than a developer will who offered 0.49 (which has complement 0.01). Our results, reported in Table 8, are weakly consistent with the reinforcement learning model for offers in the first negotiation, and insignificant for offers in the second and third negotiations. In the first negotiation, the sign of all the regression coefficients is as predicted by the learning model. However, only the coefficient for rejected offers is significant, and even this coefficient is only significant at conventional levels with when there is no control for the fixed effect from the developer’s identity. Once this control is imposed, the p-value for the test that the coefficient is equal to zero increases to 14%. In the second and third negotiations, none of the learning coefficients are significant. Overall, considering both tests for learning and developer offers, there seems to be a weak positive effect of landowner rejections on subsequent developer offers during the first negotiation, and little consistent evidence of learning in subsequent negotiations.

Last, we consider the developers’ choice of the landowner with whom to negotiate first. It is more costly to developers to have the game ended in later negotiations, because payout to landowners in early negotiations is sunk. If developers can classify landowners across games, they may want to move tough landowners (who have rejected offers) to early negotiations and easy landowners (who have accepted offers) to later negotiations. Table 9 shows the distribution of developer’s sequencing choice based on whether the landowner has accepted or rejected an offer in the previous game. The results do not provide much evidence that developer use sequencing to reduce the danger of encountering a tough landholder in later negotiations. In fact, about 50% of the time, developers do not even change the negotiation position of the landowners after the completion of a round of play. Overall goodness of fit tests indicate that there is no statistically significant relation between landowner offer rejections in earlier rounds and the developer’s sequencing of the landowner later rounds.

IV Retrospect and prospect

This paper provides evidence that sequential multiparty negotiations are frequently unable to produce the agreements required to capture the economic surplus from value increasing changes in property rights. These failures manifest in a very simple setting, where individual negotiations conform to standard structured bargaining game designs and the level of common knowledge of rationality required to support the Nash equilibrium solution is quite low. These results raise the question of whether (a) actual sequential multiparty negotiations are prone to failure or (b) more “complex” game forms, ones providing agents less information and/or requiring them to condition their strategies on more variables, might actually smooth out the frictions that make agreement difficult in our simple setting. At first glance, it might seem that making the sequencing of negotiations the confidential information of the developer, and thus forcing landowners to conjecture regarding their position in the negotiation sequence, would lead to even more offer failure. However, as can be seen by using the results in Noe and Wang (2004) under confidentiality, the negotiation game has a symmetric Nash equilibrium that exactly coincides with the even-split solution. In our experiments, we observed a tension between agents’ focus on the even split outcome and their recognition that landowners in later negotiations have more bargaining power. When the sequence of negotiations is private, this tension would vanish, leading to the conjecture that efficiency would increase. In results not reported, we have looked at this extension in a preliminary fashion. We found that, in fact, efficiency is somewhat reduced by making sequencing private information. However the effect of making the negotiation sequence private is fairly marginal.

Another more complex design would be to build conditionally into the payments made by the developer – that is, making the developer payment to each landowner conditional on all landowners agreeing to the buyout. On the one hand, this change in the structure of the game would make a landowner’s payoff from accepting developer offers contingent on the landowner’s conjectures regarding the future play off the game, a dependence not present in our design. On the other hand, contingent payments would “insure” the developer against making sunk payment in early negotiations, only to have the agreement blocked later by an irrationally obdurate landowner. Also, this condition would eliminate the negotiation advantage of landowners later in the sequence of negotiations, which by increasing symmetry, would make the game-theory solution closer to the symmetric division point.

Other changes in the design of the game, such as allowing landowners the option of passing an opportunity to negotiate with the developer, might increase the correspondence between our game and real multiparty negotiations, but we see no strong reason to

believe that such extensions would increase efficiency. In fact, most aspects of real-world negotiations from which we abstract (e.g., private information) would, were they included in our design, only make reaching an efficient agreement more problematic. Thus, our results lead us to believe that behavior biases may well in and of themselves be powerful enough to restrict the multiparty sequential bargaining’s effectiveness in facilitating agreements that capture economic surplus. We think this may account for a number of fairly prominent features of the current institutional economic landscape. In areas obviously related to the problem, such as eminent domain laws, there seem to be many other institutional features of real economies that mitigate the need to negotiate the transfer of property rights via negotiations with a large aggregation of small parties holding complementary rights. For example, it is common for property to be sold without water, mineral or timber rights, with the aforementioned rights retained by a municipality or by the initial development corporation. The water, mineral or timber resources located on a set of small properties exhibit exactly the sort of complementarity in value that we model in this paper. It is difficult to build a mine on Mr. A’s and Mr. C’s property without disturbing the property rights of Mr. B over his intervening plot. Also, assets with complementary value to a new buyer are frequently already held by the same individual because the complementarity they would exhibit to this new buyer are also present in their current use. In short, the difficulty in aggregating complementary assets through simple multiparty “Coasian” negotiations may have a substantial effect on the design of real-world economic institutions.

Appendix 1A

1. General Instructions

You have been selected to participate in an experiment on economic decision making. The experiment consists of several rounds. At the end of each round your payoffs will be calculated. At the end of the experiment, the payoffs in each round will be added up. The sum of your round by round payoffs will determine your payoff from the experiment. Your payoff from the experiment could range from \$0 - \$20.

2. The Game

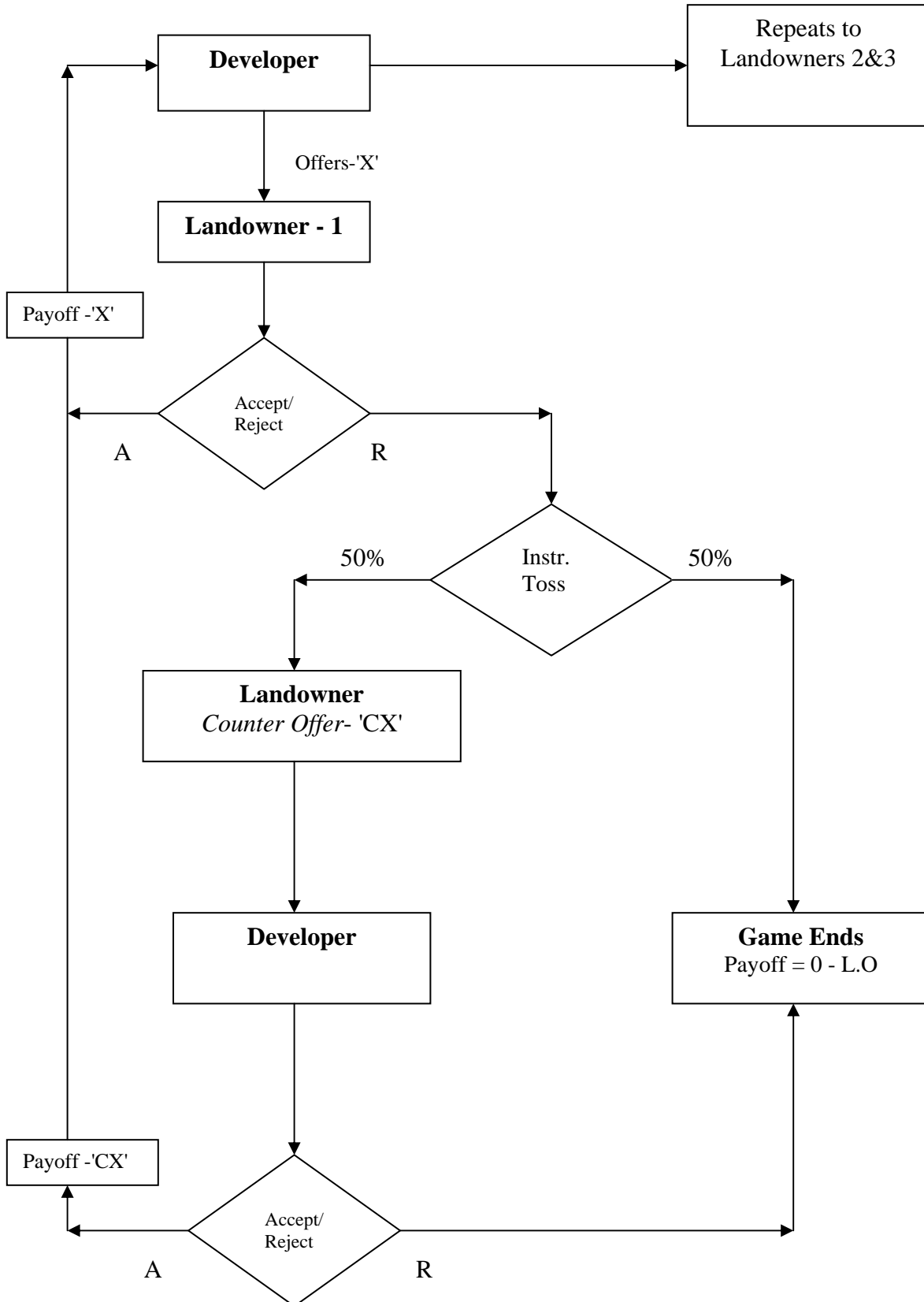
In this experiment, you can be either a developer who wants to develop a commercial property or you can be a land owner who has to sell a piece of land to the developer. Each game consists of one developer and three land owners. The value of the developed property to all agents is equal to Fr. 1. However to develop this property the developer needs to purchase all three plots of land. The value of each plot of land to the land owner is 0. The developer will be purchasing this land from each land owner separately one after another. To buy the land the developer will make an offer to any one landowner Fr. X where x is a fraction. The land owner may accept or reject the offer. If he rejects the first offer from the developer then he/she can make a counteroffer to the developer which developer may accept or reject. If the developer rejects the offer the game ends. Also, every time the land owner makes a counter offer there is a 50% probability that game ends. This is determined by the instructor through a coin flip. If the land owner accepts the first bid of the developer, he/she sends offer to another land owner and the same process repeats till the developer purchases the plots of land from **all** land owners.

Whenever a land owner accepts an offer or the developer accepts a counter offer (provided the game has not ended by the instructor) the payoff for that round to the landowner is the offer or the counteroffer. The developer's payoff is

$$\text{Developer's payoff} = 1 - \text{sum of all payoffs to the land owners.}$$

Note developers payoff can be negative if he fails to buy land from all three land owners after buying land from one or two land owners.

Appendix 1B: Decision Tree



Appendix 1C: Offer Sheet

Round No.	Developer No.	Landowner No.
Offer		Accept/Reject
Counter Offer	Accept/Reject	

Appendix 1D: Landowner's Record

Landowner No. _____						
Round No.	Offer	Accept Reject	Coin Toss Result	Counter Offer	Accept Reject	Payoff
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Appendix 1E: Developer's Record

Developer No. _____																
Round No.	Landowner No. <u>1</u>					Landowner No. <u>2</u>					Landowner No. <u>3</u>					Developer Gain
	Sequence	Offer	Accept Reject	Counter Offer	Accept Reject	Sequence	Offer	Accept Reject	Counter Offer	Accept Reject	Sequence	Offer	Accept Reject	Counter Offer	Accept Reject	
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																

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Table 1: Summary of Negotiation Success

This table presents the number of bilateral negotiations (N), successful ones (N Success), failed ones (N Failure), and percent of failed negotiations (% Failure). N1, N2, and N3 represent the first, second, and third negotiation, respectively.

	N	N Success	N Failure	% Failure
N1	60	48	12	20%
N2	48	36	12	25%
N3	36	33	3	8%
ALL	60	33	27	45%

Table 2: Payoffs

This table presents average payoffs received by the developer and landowners in three negotiations in all games and all successful games. Standard deviations are in paratheses. This table also presents the predicted payoffs in rational value-maximizing equilibrium and sunk-cost/even-split equilibrium.

	All Games	All Successful Games	Rational Equilibrium	Sunk-cost/Even-split Equilibrium
Developer	0.047 (0.226)	0.210 (0.115)	0.125	0.25
Landowner 1	0.190 (0.103)	0.241 (0.043)	0.125	0.25
Landowner 2	0.156 (0.140)	0.262 (0.075)	0.250	0.25
Landowner 3	0.158 (0.161)	0.287 (0.099)	0.500	0.25

Table 3: Initial Offers

This table presents the number (N) and average of initial offers made by the developer. Standard deviations are in paratheses. The table also presents comparison of the initial offers with predicted strategies in rational value-maximizing equilibrium and sunk-cost/even-split equilibrium. For each equilibrium, the table includes the predicted offer (Strategy), the average of absolute errors between initial offers and predicted strategy (AbsErr) and its standard deviation in paratheses, and the percent of initial offers that are acceptable based on the equilibrium (NA). The table also presents the number and percent of initial offers that are between the predicted strategies of two equilibria.

	N	Initial Offer	Rational Strategy	AbsErr	NA	Sunk-cost/Even-split Strategy	AbsErr	NA	In Between N	Percent
N1	60	0.211 (0.051)	0.125	0.093 (0.037)	90%	0.250	0.046 (0.045)	28%	51	85%
N2	48	0.233 (0.051)	0.250	0.042 (0.032)	35%	0.250	0.042 (0.032)	35%	7	15%
N3	36	0.250 (0.043)	0.500	0.250 (0.043)	0%	0.250	0.034 (0.024)	61%	22	61%
ALL	144	0.228 (0.051)		0.115 (0.089)	49%	0.250	0.042 (0.036)	39%	80	56%

Table 4: Acceptance Decision of Initial Offers

This table presents the number (N), average (Mean), and standard deviation (in parentheses) of initial offers that are accepted and rejected. The table also presents the percent of acceptable offers (NA) based on two equilibria, rational value-maximizing equilibrium and sunk-cost equilibrium. In addition, it provides the percent of acceptable offers based on the equilibrium that are accepted (PA), and percent of rejectable offers based on the equilibrium that are rejected (PR).

	Accepted		Rejected		Rational			Sunk-cost/Even-split		
	N	Mean	N	Mean	NA	PA	PR	NA	PA	PR
N1	42	0.227 (0.034)	18	0.174 (0.064)	90%	78%	100%	28%	82%	35%
N2	32	0.243 (0.051)	16	0.212 (0.045)	35%	76%	39%	35%	76%	39%
N3	28	0.255 (0.039)	8	0.231 (0.051)	0%		22%	61%	86%	36%
ALL	102	0.240 (0.042)	42	0.199 (0.058)	49%	77%	36%	39%	82%	36%

Table 5: Analysis of Counteroffers by Landowners

This table presents the number (N), average (Mean), and standard deviation (in paratheses) of counteroffers made by landowners. The table also provides the average absolute errors of counteroffers from equilibrium strategies of rational value-maximizing equilibrium, sunk-cost equilibrium, and even-split equilibrium. The standard deviations of absolute errors are in paratheses. It also presents the percent of counteroffers that are weakly disadvangeous (Disadv. Offers), that is, counteroffers that are less than or equal to two times the initial offers.

	N	Counter	AbsErr			Disadv. Offers
		Offer	Rational	Sunk-cost	Even-split	
N1	11	0.360 (0.079)	0.110 (0.079)	0.140 (0.079)	0.110 (0.079)	55%
N2	8	0.409 (0.089)	0.104 (0.072)	0.104 (0.072)	0.159 (0.089)	88%
N3	5	0.466 (0.144)	0.534 (0.144)	0.114 (0.077)	0.216 (0.144)	80%
ALL	24	0.398 (0.102)	0.196 (0.198)	0.123 (0.075)	0.148 (0.102)	71%

Table 6: Acceptance Decision of the Developer

This table presents the number (N), average (Mean), and standard deviation (in parentheses) of counteroffers that are accepted and rejected. The table also presents the percent of acceptable counteroffers (NA) based on two equilibria, rational equilibrium and sunk-cost equilibrium. In addition, it provides the percent of acceptable offers based on the equilibrium that are accepted (PA), and percent of rejectable offers based on the equilibrium that are rejected (PR).

	Accepted		Rejected		Rational			Sunk-cost/Even-split		
	N	Mean	N	Mean	NA	PA	PR	NA	PA	PR
N1	6	0.310 (0.015)	5	0.420 (0.084)	0%	-	45%	100%	55%	-
N2	4	0.390 (0.099)	4	0.428 (0.088)	88%	57%	100%	88%	57%	100%
N3	5	0.466 (0.144)			100%	100%	-	60%	100%	0%
ALL	15	0.383 (0.113)	9	0.423 (0.080)	50%	75%	50%	88%	62%	33%

Table 7: Ananalysis of Learning by Developers in Making Initial Offers
This table presents the number (N), average (Mean), and standard deviation (Std) of the difference between two initial offers of the same negotiaion of two consecutive games conditional on whether the offer in the last game is accepted. The table also presents t statistics (t-stat) on tests of whether the means of the two subsamples are equal.

Offer Difference between Two Consecutive Games							
	Last offer accepted			Last offer rejected			
	N	Mean	Std	N	Mean	Std	t-stat
Panel A. All							
N1	39	-0.016	0.059	18	0.036	0.059	-3.06
N2	30	-0.014	0.041	15	0.032	0.070	-2.77
N3	26	-0.000	0.046	7	0.029	0.071	-1.30
Panel B. Excluding consecutive games that are more than two games apart							
N2	28	-0.013	0.042	14	0.031	0.072	-2.48
N3	21	-0.004	0.045	6	0.050	0.047	-2.56

Table 8: Regression Ananlysis of Learning by Developers in Making Initial Offers
This table presents regressions of developer initital offers on past experience. The developer initial offers are transformed as $\text{Log}\left[\frac{\text{offer}}{k-\text{offer}}\right]$, where $k = 0.5$. Past experience is summarized by SUMACCEPT, which is the sum of k minus the accepted offers, and SUMREJECT, which is the sum of past rejected offers. T statistics are in paratheses. The Prais-Winsten transformation is employed to adjust autocorrelated errors.

	Dependent Variable= $\text{Log}\left[\frac{\text{offer}}{k-\text{offer}}\right]$					
	Negotiation 1		Negotiation 2		Negotiation 2	
Intercept	-0.462 (-3.67)	-0.290 (-1.56)	-0.228 (-1.57)	0.139 (1.54)	-0.279 (-2.00)	-0.227 (-1.46)
SUMACCEPT	-0.065 (-1.02)	-0.056 (-0.74)	-0.010 (-0.07)	0.042 (0.53)	0.013 (0.12)	0.047 (0.35)
SUMREJECT	0.428 (2.35)	0.350 (1.49)	0.188 (0.62)	0.114 (0.69)	0.809 (1.86)	0.742 (1.43)
I(Developer 2)		-0.438 (-2.78)		-0.715 (-7.18)		-0.026 (-0.12)
I(Developer 3)		-0.001 (-0.01)		-0.423 (-4.16)		-0.150 (-1.46)
R-square	0.088	0.343	0.024	0.549	0.164	0.189

Table 9: Analysis of Learning of Negotiation Sequence by Developers

This table presents the number (N) and percent (Percent) of incidences that the developer moves a landowner to earlier or later negotiations conditional on whether the landowner accepted or rejected an offer in the previous round.

	Offer accepted in last round		Offer rejected in last round	
	N	Percent	N	Percent
Move to later negotiation	27	28.4%	12	29.3%
No change	47	49.5%	22	53.7%
Move to earlier negotiation	21	22.1%	7	17.1%