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## Who's Holding Out? An Experimental Study of the Benefits and Burdens of Eminent Domain

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## Who's Holding Out?

### An Experimental Study of the Benefits and Burdens of Eminent Domain<sup>\*</sup>

By Abel M. Winn *and* Matthew W. McCarter

#### Abstract

Eminent domain is widely considered a necessary tool to avoid seller holdout and ensure efficient land assembly. We conduct a series of laboratory experiments that challenge this conventional wisdom. We find that when there is no competition and no eminent domain, land assembly suffers from costly delay and failed assembly, resulting in participants losing 18.1% of the available surplus. Much of this delay is due to low offers from the buyers rather than strategic holdout among sellers. Introducing weak competition in the form of a less valuable substitute parcel of land reduces delay by 35.7% and virtually eliminates assembly failure, so that only 11.5% of the surplus is lost. When buyers can exercise eminent domain the participants lose 18.6% of the surplus. This loss comes from spending money to influence the fair market price and forcing sellers to sell even when they value the property more than the buyer.

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## **I. Introduction**

Most economists consider seller holdout an inevitable and intractable problem that prevents efficient land assembly (Calabresi and Malamed 1972, Bittlingmayer 1988, Cohen 1991, Epstein 1992, 1993 and Menezes and Pitchford 2004) and provides strong justification for eminent domain (Allen 2000, Miceli and Sirmans 2007, Rose 2011). Suppose, for example that two landowners with adjoining property each value their own parcel at \$100,000 and a buyer wishes to acquire both parcels. The development that the buyer wishes to undertake is such that both parcels are necessary to his plans. His maximum willingness-to-pay (WTP) is \$0 for either one of the parcels but \$250,000 for the pair. This may lead to inefficient assembly because each seller is effectively a monopolist: the refusal of either to sell would thwart the buyer's development. Consequently, both sellers are in a position to hold out for a large share of the surplus. Strategic holdout can lead to a protracted bargaining process causing costly delay in land assembly, or even its outright failure. This is especially likely if the negotiating parties face uncertainty about one another's valuations for the land (Shupp, et al. 2013).

The holdout problem in land assembly is a special case of social dilemma termed the tragedy of the anticommons (Heller 1998, Buchanan and Yoon 2000, Fennell 2004). An anticommons is a property regime in which multiple agents have the unilateral right to prevent the use of a resource. Examples include water rights transfers (Corbin 2011), assembling pharmaceutical patents (Heller and Eisenberg 1998) and assembling contiguous blocks of the broadcast spectrum (Hazlett 2008, 2014). In each case, too many agents with veto power can hinder a resource's use and reduce economic efficiency.

In the case of land assembly, eminent domain allows the buyer to eliminate delay and ensure successful assembly by forcing a recalcitrant landowner to sell her property. However, it is

important to face the fact that eminent domain may cause its own inefficiencies from two sources: inefficient assembly and influence costs. Inefficient assembly occurs where the sum of the fragmented owners' value for their land exceeds the value of the buyer but they are forced to sell through eminent domain. As Munch (1976) points out, the danger of under-assembly through market mechanisms is mirrored by the danger of over-assembly through eminent domain (see also O'Flaherty, 1994; Miceli and Segerson, 2007; Shavell, 2010).

The threat of inefficient assembly is not idle speculation. In the case of *Kelo v. New London* the Supreme Court upheld the transfer of private land to a private developer. The main beneficiary was to be Pfizer, Inc., which would receive a \$300 million research center. The case was decided in 2005 and seven families were evicted from their property, their houses demolished or moved offsite. Yet the development group never managed to raise financing and gave up the project in 2008. Pfizer left the city of New London the following year. As of 2014 the land where Ms. Kelo and her six neighbors lived remained an undeveloped field.

Eminent domain also imposes influence costs in determining the "fair market value" of the land; i.e., the price that is to be paid to the owner. This price is determined through a legal process in which both the buyer and seller(s) must, at the very least, obtain counsel and pay for separate and independent appraisals of the property. Both sides improve their chances of a favorable price by expending more resources on the legal process relative to their opponent.

The result of the legal process is that a substantial fraction of surplus may be expended through attempts to influence the final price. In 2013, for instance, the city of Modesto, California used eminent domain proceedings to purchase a strip of property from one resident for \$120,000. The city spent \$180,000 in legal fees (Valine 2013). Moreover, more than two decades of experimental work has shown that participants in contest settings (like a court battle) frequently

overspend relative to their Nash Equilibrium strategies. For a survey of the literature, see Dechenaux, Kovenock and Sheremeta (2012).

There are a number of experimental studies of land assembly that demonstrate that seller holdout does occur and can be costly. (We provide an overview of these results in the following section.) This has led some investigators to suggest that eminent domain may be a necessary tool for efficient land aggregation (Swope, et al. 2011, Cadigan, et al. 2011). However, to date there has been no experimental comparison of efficiency under a regime of eminent domain versus secure property. In this paper we provide such a comparison and find that eminent domain is not efficiency enhancing. The reduction in delay and assembly failure is slightly more than offset by inefficient assembly and influence costs. Participants captured 81.9% of the available surplus when buyers had no alternative to assembly and no recourse to eminent domain. They captured 81.4% of the available surplus when buyers could exercise eminent domain and the fair market price was determined by a contest in which both parties could improve his probability of winning by expending more resources. In another treatment we prevented the buyer from exercising eminent domain but allowed him to buy a less valuable substitute parcel of land instead of assembling parcels from the two primary sellers. Introducing this weak form of competition increased average efficiency to 88.5%.

Interestingly, we find that buyers “hold out” more frequently than sellers. In the baseline treatment with secure property and no competition the sellers rejected a profitable offer in 22.6% of cases, while 60% of buyers’ final offers were too low compared to the profit-maximizing offer. In the treatment with weak competition 22.2% of final offers were too low and sellers rejected profitable offers in only 6.7% of cases. This strategic holdout rate of 6.7% is not statistically

different from the holdout rate of 4.3% when the buyer could exercise eminent domain. Thus, weak competition was as effective at breaking up seller holdout as eminent domain.

## **II. Previous Experiments in Land Assembly**

Several laboratory studies examine the holdout problem, but none of them incorporate the sources of inefficiency for eminent domain. In the laboratory environments the land is always more valuable under assembled ownership and there are no influence costs. The most relevant studies are those by Cadigan, et al. (2009, 2011), Swope, et al. (2011), Cadigan, Schmitt and Swope (forthcoming), Parente and Winn (2012), Shupp, et al. (2013) and Zillante, Read and Schwarz (2014). Two findings are both salient and consistent across studies.

First, the holdout problem is real, although failure to assemble land is infrequent so long as the parties can negotiate through multiple periods. There is a strong tendency for sellers to demand more than the value of their property, and this strategy tends to be profitable (see, e.g., Cadigan, et al., 2009, Swope, et al., 2011, and Cadigan Schmitt and Swope, forthcoming). Indeed, even non-binding requests from sellers tend to raise the price they are ultimately offered (Zillante, Read and Schwarz 2014). Consequently, negotiations tend to drag on for multiple negotiation periods, even when delay is costly. Failure rates in multi-period negotiation treatments in these studies range from 0% to 41.4%, with an average of 8.7%. However, it is important to note that in all of these studies except for Zillante, Read and Schwarz (2014) the sellers were modelled as having a cost for selling their input rather than a value for keeping it. Consequently, the only way for sellers to earn money in most experiments was to hold out for high prices. Moreover, Zillante, Read and Schwarz (2014) study land assembly without delay costs, so there was little reason for their sellers not to hold out.

Second, competition among landowners is effective in combating seller holdout. Cadigan, et al. (2011) conducted experiments in which the assembler negotiated with three landowners but needed only two parcels. Negotiation lasted for a maximum of 10 periods, but delay cost participants 10% of their earnings per period. Out of 64 groups none failed to assemble the necessary parcels and negotiation took an average of 1.85 periods. Parente and Winn (2012) also conducted experiments in which the assembler (represented by the software) needed two parcels and faced three landowners. Their experiments were single-period ultimatum games, with participants randomly re-grouped 60 times. Out of 768 cases where assembly failure was possible, it occurred only 6 times, for a success rate of 99.2%.

### **III. Theoretical Model**

#### *A. Overview*

We model an environment in which the buyer negotiates with two owners (the sellers) through a finitely repeated process of offers and responses. The buyer makes simultaneous independent offers to the sellers, who may accept or reject them.

Each seller  $i$  has a private valuation for his own parcel of  $v_i$ , which is drawn (with replacement) from a uniform distribution with support  $[a, b]$  and mean  $m$ . The buyer's WTP for either of the parcels alone is zero, but his WTP for the pair of them is  $V$ , which is drawn from a uniform distribution with support  $[A, B]$  and mean  $M$ . We assume that  $M > 2m$ , and  $A < 2b$ , so that assembly is efficient on average but is inefficient with non-zero probability. Agents know their own valuation but only the distribution(s) from which their counterparts' valuations are drawn.

Negotiation lasts up to  $T$  periods, which is common knowledge. In each period the buyer offers a bid,  $\beta_i$ , to each seller who has not yet agreed to sell her input. Sellers can only accept or reject an offer; they cannot make a counteroffer. The bids are contingent: if only one seller has accepted an offer by the end of period  $T$  the buyer is not obligated to purchase her parcel.

Prolonged negotiation is costly. Following Cadigan, et al. (2009) we model the costs of delay as a penalty assessed against all agents' payoffs. Specifically, if both sellers have accepted an offer by period  $t$ , then all payoffs are multiplied by  $1 - \delta(t - 1)$  where  $\delta \in (0,1]$ . Thus, if both sellers accept their offers in period 1 there is no cost of delay, while the cost is nonzero and monotonically increasing in all subsequent periods.

We now consider this general negotiation environment in three conditions. In the first the buyer's only profit opportunity is to purchase the parcels from the sellers without recourse to eminent domain. In the second condition the buyer can purchase a substitute parcel of land instead of assembling the fragmented parcels. The substitute is not as valuable to the buyer as the fragmented parcels, however, so that the competitive pressure on the sellers is weak. In the third condition the buyer may invoke eminent domain and the fair market value is determined by a Tullock Contest. A high or low price can result from the contest, and a contestant's probability of achieving his preferred price is proportional to the amount of money he spends in the contest.

### *B. Secure Property*

We begin by considering the simplest case in which  $T = 1$ . In this case there is no incentive for sellers to strategically hold out, and they should accept any offer  $\beta_i \geq v_i$ . Since the  $v_i$  are drawn from the same distribution the buyer has no reason to submit different offers to the two sellers, and so in equilibrium  $\beta_1 = \beta_2$ . Thus, we omit the subscripts in the following analysis.

The buyer will attempt to maximize his expected profit,  $\pi$ , which is a function of his value and offers:

$$E(\pi) = (V - 2\beta) \left( \frac{\beta - a}{b - a} \right)^2 \tag{1}$$

The first term in (1) is the profit earned by the buyer if both sellers accept and the second term is the probability that his offers exceed both of the sellers' values. The first order condition is:

$$-2 \left( \frac{\beta - a}{b - a} \right)^2 + 2(V - 2\beta) \left( \frac{1}{b - a} \right) \left( \frac{\beta - a}{b - a} \right) = 0 \tag{2}$$

Solving (2) for  $\beta$  yields the equilibrium offer function:

$$\beta^* = \frac{V + a}{3} \tag{3}$$

(Note that if  $V < 2a$  then  $\beta^* < a$ , which would ensure that the sellers reject their offers. We therefore focus on the case where  $V \geq 2a$ , and set  $A = 2a$  in our experiments.)

Once we extend the number of bargaining periods to two or more it becomes difficult to succinctly model buyer behavior after the first period because his best strategy will depend on his beliefs about the sellers. Suppose one or both sellers reject their offers in period one. If the buyer believes that the sellers would only reject an offer that is below their value then in the second period he will incorporate any accepted offer into the first term of equation (1), substitute the first period  $\beta^*$  for  $a$  in its second term and solve for the new equilibrium offer. If he believes that the

first period offers exceeded the sellers' values but they are holding out strategically, then he will not change his offers in the second period. A third possibility is that the buyer places a non-zero probability on the sellers rejecting strategically, in which case he will revise his second period offer(s) upward, but by a smaller amount than if he believed them to be sincere.

In their turn, the sellers' behavior will depend on their beliefs about the buyers' beliefs. If they believe him to think they are strategic, then strategic holdout will not be profitable because it will incur the delay cost  $\delta$  without increasing the buyer's offers in period two. If they believe him to think they will only reject sincerely – i.e., reject offers below their values – they will hold out in period one so long as the difference in equilibrium offers is greater than  $\delta v_i$ .

The multiplicity of equilibria implies that we cannot predict behavior in our experiments beyond period one with any confidence without knowing the beliefs of the agents. However, earlier empirical work by Zillante, Read and Schwarz (2014) and Shupp, et al. (2013) suggests that offers will rise over time. For the current study we will use the equilibrium offer function as a benchmark for buyer offers in the first period.

### *C. Secure Property with a Substitute Parcel*

Now suppose the buyer faces the two sellers as above, but also has the option of buying a substitute parcel of land. For clarity, in this section we will refer to the two fragmented parcels as the “primary parcels” and their owners as the “primary sellers.” We will refer to the owner of the substitute parcel as the “alternative seller.” The buyer's WTP for the substitute parcel is  $\theta V$ , where  $\theta \in (0,1)$  and  $V$  is his WTP for the two primary parcels, as above. The substitute parcel is of no additional value to the buyer if he purchases both of the primary parcels. He wishes either to assemble the primary parcels or to purchase the substitute parcel, but not both.

The alternative seller has a valuation for his parcel,  $v_a$ , that is drawn from the uniform distribution  $[2\theta a, 2\theta b]$  with mean  $2\theta m$ . Notice that the expected surplus from assembling the primary parcels is  $M - 2m$ , while the expected surplus from buying the substitute parcel is  $\theta(M - 2m)$ , so purchasing the substitute parcel will not be socially optimal on average.

We again begin with the simple one-period model. We assume that negotiation proceeds as follows. First, the buyer makes his offers to the primary sellers as above. If one or both of them reject his offer, the buyer then submits an offer to the alternative seller. If he is forced to make an offer to the alternative seller, his alternative profit,  $\pi_a$ , will be a function of his WTP for the substitute parcel and his offer to the alternative seller,  $\beta_a$ . The expected profit function is therefore:

$$E(\pi_a) = (\theta V - \beta_a) \left( \frac{\beta_a - 2\theta a}{2\theta(b - a)} \right) \tag{4}$$

The first order condition to maximize (4) is given by:

$$-\left( \frac{\beta_a - 2\theta a}{2\theta(b - a)} \right) + (\theta V - \beta_a) \left( \frac{1}{2\theta(b - a)} \right) = 0 \tag{5}$$

Solving for  $\beta_a$  yields the equilibrium alternative bid function:

$$\beta_a^* = \frac{\theta(V + 2a)}{2} \tag{6}$$

Substituting (6) into (4) gives us the expected profit in equilibrium:

$$E(\pi_a^*) = \frac{\theta \left( \frac{V - 2a}{2} \right)^2}{2(b - a)} \quad (7)$$

Given that failing to assemble the primary parcels will still generate an expected profit of  $E(\pi_a^*)$ , the buyer's expected profit when he is making an offer to the primary sellers is now:

$$E(\pi) = (V - 2\beta) \left( \frac{\beta - a}{b - a} \right)^2 + E(\pi_a^*) \left( 1 - \left( \frac{\beta - a}{b - a} \right)^2 \right) \quad (8)$$

Equation (8) yields the first order condition:

$$-2 \left( \frac{\beta - a}{b - a} \right)^2 + 2(V - 2\beta) \left( \frac{1}{b - a} \right) \left( \frac{\beta - a}{b - a} \right) - 2E(\pi_a^*) \left( \frac{1}{b - a} \right) \left( \frac{\beta - a}{b - a} \right) = 0 \quad (9)$$

We may then solve for  $\beta$  to find the equilibrium offer function:

$$\beta^* = \frac{V + a - E(\pi_a^*)}{3} \quad (10)$$

Notice that a comparison of the equilibrium offer functions (3) and (10) implies that the presence of the alternative seller diminishes the buyer's equilibrium offers to the primary sellers so long as there is an expected profit from dealing with the alternative seller.

Allowing for multiple periods causes equilibrium behavior to become ambiguous for the reasons discussed in the previous section. Failure to assemble the primary parcels or to buy the

substitute parcel will lead the buyer to increase his offers in the subsequent period if he believes the sellers to be sincere or to submit the same offers if he believes them to be strategic. A seller's decision to hold out will depend in part on her beliefs about the buyer's beliefs. However, it is also clear that holdout becomes more risky in this environment because it runs the risk that the buyer will commit to a contract with the competing party (or parties). Consequently, we would expect to see less seller holdout in this environment.

#### *D. Eminent Domain*

Now consider a case where the buyer may invoke eminent domain on a seller who has rejected his offer. We assume that there is a prevailing market price for parcels of land, and that the price is consistent with the competitive equilibrium. This prevailing price is equal to  $a$ , the lower bound of a seller's valuation, because if a seller valued his property at less than the prevailing market price he would have sold it already. However, if the buyer invokes eminent domain the "fair market price" is decided through litigation, so that the price he pays will be influenced by the resources each side expends on the legal process. Let  $P_m \in \{a - \epsilon, a, a + \epsilon\}$  represent the fair market price and  $S_b$  and  $S_s$  represent the amounts that the buyer and seller spend in an attempt to win the contest, where each defines winning as receiving the most favorable price.

If  $S_b = S_s = 0$  then  $P_m = a$ . That is, there is a cooperative outcome in which neither competes in the contest and the fair market price is equal to the prevailing market price for parcels. If one or both contestants spends an amount greater than zero the probability that the buyer wins the contest is given by:

$$p = \frac{S_b}{S_b + S_s}$$

(11)

The seller's probability of winning is determined by an analogous function. Winning is certain if one side spends a non-zero sum in the contest while the other does not, so the cooperative outcome is not a Nash Equilibrium. Notice that the litigation process effectively offers the buyer and seller a prize equal to  $2\epsilon$ , the difference between the high and low values that  $P_m$  can take. We may therefore analyze the legal process as a simple Tullock Contest.

The buyer's expected profit from competing in the contest,  $E(\pi_c)$  is given by:

$$E(\pi_c) = 2\epsilon \left( \frac{S_b}{S_b + S_s} \right) - S_b \quad (12)$$

The first order condition of equation (12) is therefore:

$$\frac{2\epsilon S_s}{(S_b + S_s)^2} - 1 = 0 \quad (13)$$

Solving for  $S_b$  gives us the buyer's best response function:

$$S_b = \sqrt{2\epsilon S_s} - S_s \quad (14)$$

Because the buyer and seller are symmetrical in their valuation of the prize and their ability to influence the outcome of the contest the seller's best response function is symmetrical to the buyer's:

$$S_s = \sqrt{2\epsilon S_b} - S_b$$

(15)

Solving equations (14) and (15) simultaneously and accounting for the symmetry of the contestants' spending in the Nash Equilibrium we find that:

$$S_b^* = S_s^* = \frac{\epsilon}{2}$$

(16)

Thus, in equilibrium the buyer and seller will expend, in total, half of the difference between the minimum and maximum values of the fair market price. Because both contestants spend an equal amount in equilibrium the expected  $P_m$  is equal to the prevailing market price,  $a$ .

Of course, the influence costs of a court battle will act as a deterrent to invoking eminent domain in the first place. The buyer knows that if he takes the seller to court the seller's expected profit will be equal to the expected price she will receive minus the amount she spends in court costs. When calculating his optimal bid, then, the buyer will offer the sellers an amount that will leave them indifferent between accepting his offer and going to court:

$$\beta^* = a - \frac{\epsilon}{2}$$

(17)

Notice that although the litigation process offers sellers the opportunity to increase the price they are paid it is actually the buyer who benefits from the existence of the litigation process. This result would be reversed if it were the sellers who made offers to the buyer.

## IV. Experimental Design

### A. Treatments and Procedures

We conducted experiments in three separate treatment conditions with the characteristics described in the previous section. To keep the participants' decisions based on their own profit calculations and not on their personal feelings about land assembly and eminent domain, we described the decision space as neutrally as possible. We called the parcels of land "inputs" that the buyer wished to purchase. We referred to a "forced sale" rather than eminent domain or condemnation, and a "contest" rather than a litigation process. Participants made their decisions through an electronic computer interface. The three treatments proceeded as follows:

1. *Baseline*: Buyers and sellers saw a matrix of two squares labeled (1) and (2), which represented the sellers' inputs. In the first negotiating period the buyer submitted simultaneous private offers to both sellers. Each seller saw her offer in her square of the matrix and indicated her decision by clicking one of two buttons labelled "accept" and "reject." Once a seller had accepted an offer negotiations for her input ceased at the price she had agreed to. If at least one seller had rejected her offer the negotiation went on to the next period. **All participants in a group incurred a delay cost of 5% of their earnings every time a period ended without successful assembly.** Contracts were contingent; the buyer only paid a seller the agreed price if both sellers accepted an offer.
2. *Competition*: Negotiation proceeded as in the *Baseline* treatment, except that in addition to the two sellers of fragmented inputs (called the primary sellers in this treatment), there was an alternative seller offering a substitute input. The substitute input was displayed on participants' screens as a rectangle to the right of the matrix representing the primary inputs. In each period the buyer first made offers to the primary sellers. If he failed to

purchase both primary inputs he then made an offer to the alternative seller. If she accepted his offer then negotiation concluded without further attempts to assemble the primary inputs. If she rejected it then negotiation proceeded to the next period. The delay cost for the period was only incurred if the alternative seller rejected her offer. Contracts were contingent, as above.

3. *Eminent Domain*: Negotiation proceeded as in the *Baseline* treatment except that after the sellers had responded to their offers the buyer had the option of forcing any seller who had rejected his offer to sell to him. This was done by clicking a button labelled “Force Sale” next to a seller’s input. If a buyer forced a sale then both he and the seller entered an amount to spend and the price was determined according to a Tullock Contest, as described in the previous section. Neither the buyer nor the seller were allowed to spend so much in the contest that they could make negative earnings. The most the seller was allowed to spend was equal to the low price that could result from the contest. The most that the buyer was allowed to spend was calculated based on his value for the matrix of inputs and any price he had already agreed to or other contest he was in. This maximum was calculated so that even if the buyer had to pay the high price in the contest his total expenditures would not exceed his value. The buyer could exercise his option to force a sale in any period. The buyer could not force a sale on a seller who had accepted his offer. The delay cost was incurred at the end of a period only if at least one seller rejected her offer and the buyer chose not to force her to sell. A buyer did not have to pay for either input if he did not acquire both, even if he had forced a seller to sell.

Negotiations in all treatments were strictly private. Sellers never saw one another’s offers, nor were they informed whether another seller had accepted her offer except when the buyer was

successful in assembling the primary inputs or purchasing the alternative input. In the *Eminent Domain* treatment sellers did not know if the other seller in their group had been forced to sell. When competing in a contest neither the buyer nor the seller were told how much their opponent had spent.

We recruited 150 undergraduate and graduate students at a university in the American Southwest. The participants came from a pool of approximately 2,000 who had signed up in advance to participate in economic experiments. Each participant participated in only one treatment. We paid them \$7 for attending in addition to earnings that they received from their decisions in the experiment. The average decision-based earnings were \$16.22. Each experimental session lasted between 30 and 60 minutes, including time for instructions.

Participants were seated in at desks separated by privacy dividers. At each desk was a half-page summary of the rules of the experiment as well as important parameter information, such as the distributions from which values would be drawn. An experimenter read the instructions aloud from a script. A screen at the front of the lab was used to display various features of the user interface. At predetermined locations in the script the experimenter paused and asked the participants if they had questions and answered any that were forthcoming.

Each experimental session consisted of three rounds. Each round was a separate negotiation. Participants took the same role in every round, but were matched into different groups for each round. To keep the negotiations independent across rounds we re-matched the participants so that they were never grouped with any of the same counterparts more than once. This prevented participants from rewarding or punishing one another for their decisions in prior rounds. The number of rounds and uniqueness of each round's grouping was common knowledge. After the

third round the computer software randomly chose one of the rounds for each participant. The participant was paid according to his earnings in that round's negotiation.

To facilitate unique groups we conducted the *Baseline* and *Eminent Domain* treatments in sessions with nine participants organized into three groups – three buyers and six sellers. This allowed us to obtain nine observations from each session. For the *Competition* treatment every session used twenty participants organized into five groups – five buyers, ten primary sellers and five alternative sellers. This allowed us to obtain fifteen observations per session. We conducted five sessions of the *Baseline* and *Eminent Domain* treatments and three sessions of the *Competition* treatment, giving us 45 negotiations for each treatment. (See Table 1.)

**[Table 1 Here]**

#### *B. Parameters and Theoretical Predictions*

The parameters of the experiment are provided in Table 2. All values, offers and influence costs were described in terms of points. Sellers earned their input values even if they did not sell, while buyers only received payment if they assembled both parcels. For this reason we varied the exchange rate between points and dollars by role. Buyers received \$1.00 for every two points, primary sellers \$1.00 for every four points and alternative sellers \$1.00 for every seven points due to their higher average input value. Exchange rates were kept private, though participants knew that their counterpart's exchange rates may be different from their own.

**[Table 2 Here]**

The primary seller's values (in points) were drawn from the distribution [50,100], and the buyer's value was drawn from the distribution [100,250]. The expected surplus per negotiation was 25 points and the sum of the primary sellers' values would exceed the buyer's value in

approximately one third of negotiations. In the *Competition* treatment the alternative seller's value was drawn from the distribution [80,160]. The buyer's value for the substitute parcel was always 80% of his value for the two primary parcels. These parameters meant that when there was positive surplus available with both the primary sellers and the alternative seller, assembling the primary parcels would generate more surplus in about 60% of cases.

Negotiation proceeded for five periods. The costs of delay were described to the participants in terms of a "multiplier," which was displayed on their computer screens. In the first period the multiplier was 100% and it fell by five percentage points in each subsequent period. Participants' earnings from a round were multiplied by the multiplier to determine how many of the points they had earned in the round would actually be paid to them in cash. If assembly (or substitute purchase) had not occurred by the end of period five the multiplier was 75%.

In the *Eminent Domain* treatment the prevailing market price was 50, the lower bound of the primary sellers' value distribution. We allowed the outcome of the contest to change the price by  $\pm 20\%$ . This range of prices is conservative. Munch (1976) found that eminent domain prices ranged from 28% below her estimate of market value to more than 100% above it. If the buyer won the contest the input sold for 40 points, if the seller won the price was 60 points, and if both spent nothing in the contest the price was 50 points. Consequently, the buyer and seller were competing for a prize worth 20 points and each should spend five points to win it.

Based on the theoretical model in Section III and the parameters presented here we formulated a set of predictions, which are displayed in Table 3. We use these predictions as our reference point in analyzing the results of the experiment. We expect the buyer's average opening offer in the *Baseline* treatment to be 75 points. This is because the expected buyer value is 175 and the lower bound of the sellers' value distribution is 50, implying an equilibrium offer of

$(175 + 50)/3 = 75$ . When there is an alternative seller the buyer's expected profit of negotiating with the alternative seller is 11.25 points. By equation (10) we subtract one third of this profit from the *Baseline* equilibrium offer. Because offers had to be whole numbers in our experiments we expect the average opening offer in the *Competition* treatment to be 71.

**[Table 3 Here]**

In the *Eminent Domain* treatment we expect the buyer to offer the expected fair market price (50 points) minus the seller's contest cost (five points). This yields an equilibrium offer of 45. Sellers should accept these offers, so that the rate of forced sales should be 0%. Moreover, in the *Eminent Domain* treatment we expect the buyers to successfully assemble the inputs in every negotiation. This means that the buyers should achieve assembly in 100% of negotiations in which it is efficient. However, we also expect the buyers never to leave the inputs in the sellers' possession when fragmented ownership is efficient. We predict no delay in the *Eminent Domain* treatment because the buyers should be capable of assembling the inputs in the first period.

For the *Baseline* and *Competition* treatments predicting assembly and delay depend on seller holdout, for which we have no formal model. We formulated our predictions by simulating 10,000 negotiations of each treatment with the simplifying assumption that sellers do not strategically reject their offers and this is known to the buyers. This provides a best-case benchmark against which to compare actual outcomes in the *Baseline* and *Competition* treatments. In the *Baseline* simulations the buyers bought both inputs in 89% of the cases where assembly was efficient while sellers retained possession in 100% of the cases where fragmentation was efficient. For calculating delay we coded a negotiation where sellers retained possession of their inputs as lasting six periods. Negotiations in the *Baseline* simulations lasted an average of 3.4 periods for all negotiations and 2.1 periods for negotiations where assembly would be efficient.

In the *Competition* simulations the buyers only achieved efficient assembly in 60% of negotiations, but this is because they sometimes successfully negotiated with the alternative seller when there was more available surplus with the primary sellers, or vice versa. If we consider how often the buyers made a purchase with positive surplus the rate increases to 92%. The sellers retained possession in 100% of cases where fragmented ownership was efficient. Across all negotiations it took an average of 2.7 periods to reach an agreement. In those negotiations where assembly was efficient negotiation took an average of only 1.7 periods.

## V. Experimental Results

### A. Buyer offers

In Figure 1, we present the average first offer and average final offer by treatment. It is clear that buyers who could not exercise eminent domain tended to submit offers that were below the equilibrium predictions. In the *Baseline* treatment the average first period offer was 58.6, which is 21.9% below the profit-maximizing offer of 75. This is not due to a small number of outliers. Of the 45 first offers in the *Baseline* treatment, 38 (84.4%) were below the optimal offer given the buyer's value. We compared the first period offers to their predicted values with a Wilcoxon sign rank test. The unit of analysis was the average of a buyer's two offers in the first period of the round. We can reject the null hypothesis that first period offers in the *Baseline* treatment were no different from the equilibrium with high confidence ( $p < 0.001$ ).

[Figure 1 Here]

The *Baseline* offers did increase in subsequent periods, but remained overly conservative. The average final offer in the *Baseline* treatment was 69.5. Sixty percent of these final offers were below the equilibrium prediction. A Mann-Whitney test comparing a buyer's final average offer

of the round with his first offer indicates that the difference is significantly different ( $p < 0.001$ ). However, a Wilcoxon sign rank test shows that even by the end of negotiations the typical buyer in the *Baseline* offered the sellers less than would have been optimal in the first period ( $p = 0.002$ ).

The pattern was similar in the *Competition* treatment, but not as pronounced as the *Baseline*. The average buyer's value was 168 points, which implied an average first offer of 68.5. Buyers' offers were 64.4 on average, or approximately 6% below equilibrium. The difference between optimal and observed offers is marginally statistically significant (Wilcoxon,  $p = 0.052$ ) but rather small in economic significance. The average final offer in the *Competition* treatment was 70.1, which is not statistically different than the predicted first-period offer (Wilcoxon,  $p = 0.592$ ). Overall, 42.2% of first offers and 22.2% of final offers were below equilibrium in the *Competition* treatment.

Notice that introducing competition among the sellers was predicted to reduce buyers' offers by four points. Instead the buyers increased their offers by an average of almost 10 points. Mann-Whitney tests do not find the distributions of first or final offers to be statistically different between the *Baseline* and *Competition* treatments ( $p = 0.263$  and  $p = 0.765$ ). However, we also compared offers in these treatments by performing chi-squared tests of the frequency of offering less than the equilibrium prediction. Buyers in the *Baseline* were more likely to offer less than the equilibrium in both their first and final offers ( $p < 0.001$  in both cases). Our results suggest that the presence of an imperfect substitute encourages more generous offers from the buyer. In the *Baseline* treatment buyers may have made low offers in an effort to avoid overpaying one of the sellers and thereby constraining their ability to make an adequate offer to the other. This was less of a concern in the *Competition* treatment because even if the buyer found himself unable to make

a sufficiently high offer to one of the primary sellers he might still negotiate a contract with the alternative seller.

While offers under secure property tended to be too low, offers under eminent domain were higher than predicted. The average first offer was 56 in the *Eminent Domain* treatment. This is 24.4% higher than the equilibrium offer of 45, and a Wilcoxon sign rank test indicates a statistical difference between average first offer and the equilibrium offer ( $p < 0.001$ ). Thus the buyers did not fully exploit the strength of their bargaining position. In fact, the first-period offers in the *Eminent Domain* treatment were not statistically lower than those in the *Baseline* treatment (Mann-Whitney test,  $p = 0.238$ ).

### *B. Strategic holdout*

To analyze strategic holdout, we found the highest offer that a seller rejected in a round and subtracted her input value from it. Where this normalized highest rejected offer is greater than zero we consider the seller to have withheld her input strategically. The cumulative distributions of the normalized highest rejected offers are shown in Figure 2. A vertical line at the value of zero separates the shares of each distribution that represent strategic rejections from sincere rejections.

**[Figure 2 Here]**

Holdout was not very common in any of the treatments, although it occurred most frequently in the *Baseline* treatment. Sellers in the *Baseline* strategically rejected the buyer's offer in 22.6% of cases. Notice that this is substantially less than the percentage of buyers in the same treatment who made offers that were lower than the equilibrium. Sixty percent of the buyers' final offers were below equilibrium. If we consider these low offers to be buyer holdout, then holdout was 2.7 times as common among buyers as it was among sellers. Buyers also tended to hold out

for larger amounts than the sellers in the *Baseline*. In the cases where sellers strategically rejected the average difference between the offer and their values was 8.4 points. In the buyer's final offers that were below equilibrium the average difference was 15.3 points. Our findings run counter to the conventional wisdom that sellers are primarily responsible for the difficulties of land assembly.

When they were facing a competitor the primary sellers strategically rejected far fewer offers, but held out for higher amounts when they did reject them. In 6.7% of cases, a primary seller's highest rejected offer exceeded her value, a 70.4% reduction compared to the *Baseline*. A chi-square analysis confirms that holdout was statistically less frequent in the *Competition* treatment compared to the *Baseline* treatment ( $p = 0.013$ ). This reduction in strategic holdout is especially impressive when compared to the *Eminent Domain* treatment. Sellers in the *Eminent Domain* treatment rejected profitable offers in 4.3% of cases. A chi-square test shows that the holdout rates are statistically indistinguishable between the *Eminent Domain* and *Competition* treatments ( $p = 0.609$ ). That is, introducing a weak form of competition was as effective at discouraging seller holdout as was eminent domain.

On average, the strategically rejected offers were 23.8 points above the seller's value in the *Competition* treatment. This is almost three times as large as the average holdout in the *Baseline*. The difference is only marginally statistically significant (Mann-Whitney,  $p = 0.078$ ), but this is likely due to the fact that there we have only four observations from the *Competition* treatment. The magnitude of holdout was similarly large in the *Eminent Domain* treatment. The average strategic rejection was for an offer 19.5 points above her value. It is not entirely clear why sellers would reject such favorable offers, although we suspect that they were due to confusion or simple error. There were two cases of strategic holdout in the *Eminent Domain* treatment, and both occurred in the first round.

### *C. Efficiency*

We measured the participants' ability to create surplus with two metrics. The first metric – which we will call basic efficiency – is the amount of surplus achieved in the negotiation divided by the maximum surplus that could have been achieved. Notice that the sellers received their values (minus delay costs) if assembly failed, so it was impossible for basic efficiency to equal zero. Some minimum amount of surplus was guaranteed. Thus, we use an additional metric, which we will call normalized efficiency, equal to the difference between the achieved surplus and minimum surplus divided by the difference between the maximum and minimum surpluses. The advantage of the basic efficiency metric is that it is sensitive to how much surplus was at risk in a given negotiation. Yet the normalized efficiency metric is useful because it reflects the percentage of the at-risk surplus that was captured through negotiation.

Basic efficiency and normalized efficiency are shown in Table 4. We compared both metrics across treatments with pair-wise Mann-Whitney tests. The z-statistics from those tests are displayed in Table 5. All comparisons are statistically different, with two exceptions. First, the basic efficiencies in the *Baseline* and *Eminent Domain* treatments are 81.9% and 81.4%, which are not statistically different ( $p = 0.971$ ). That is, eminent domain did not result in a net surplus gain. Second, the normalized efficiencies in the *Competition* and *Eminent Domain* treatments are 64.9% and 69.4%. The difference is not statistically significant ( $p = 0.498$ ). Consequently, an imperfect substitute allowed participants to capture as much of the at-risk surplus as eminent domain.

**[Table 4 and Table 5 Here]**

In Table 6 we provide complete information regarding the number of points that could have been earned in each treatment, along with how many points were earned and the number of points

that were lost due to the various sources of inefficiency. In the *Baseline* participants failed to capture a total of 1,498 points, or 18.1% of the available surplus. The overwhelming majority of these (82.6%) were lost due to delay. The average length of all negotiations in the *Baseline* was 4.2 periods. For those cases where assembly was efficient the average negotiation required 3.75 periods. These average durations are longer than the results of our simulations, which predicted all negotiations to take an average of 3.4 periods and those with positive surplus from assembly to last an average of 2.7 periods. Wilcoxon sign rank tests indicate that there are statistical differences in duration between the simulated and actual negotiations ( $p < 0.01$  in both cases). However, it is important to note that sellers do not bear sole responsibility for delay, as less than a quarter of them rejected an offer that exceeded their values and more than half of buyers' final offers were below equilibrium.

**[Table 6 Here]**

There were 32 negotiations in the *Baseline* with a positive surplus available from assembly. The buyer achieved assembly in 23 of them. This is a 71.8% assembly rate, which is less than the 89% from our simulations. However, in four of the failed negotiations there was no seller holdout. If offers had been high enough for sellers to accept in these negotiations the assembly rate would have been 84.4%. In total, 225 points were lost in the *Baseline* due to assembly failure. The loss to assembly failure accounts for 15% of the points lost in that treatment, and resulted in an efficiency loss of 2.7%.

Contrary to our predictions, inefficient land assembly did occur in the *Baseline*. One third of negotiations where the sum of the sellers' values exceeded the buyer's values ended in a successful purchase. This is because sellers "caved in" by accepting offers below their values in 52.9% of cases, most likely to avoid delay costs. However, the differences in buyer versus seller

values tended to be small in these cases. Only 36 points were lost due inefficient assembly. This is 2.4% of all points lost in the *Baseline* and 0.4% of the available surplus.

Participants were able to capture a higher share of the surplus in the *Competition* treatment. Normalized efficiency was 64.9% in the *Competition* treatment compared to 46% in the *Baseline*. This means that the presence of a substitute parcel improved participants' ability to capture the at-risk surplus by 41.1%. This was primarily due to a reduction in delay. The average duration was 2.7 periods for all negotiations and 2.1 for those where there was positive surplus available from a contract. Wilcoxon sign rank tests indicate that these were not statistically different than our predicted averages of 2.1 and 1.7 ( $p > 0.2$  in both cases). As a result, participants lost 8.1% of the available surplus due to delay in the *Competition* treatment compared to 15% in the *Baseline*.

Inefficient assembly failure was negligible in the *Competition* treatment. The buyer failed to make a purchase in only one of the 32 negotiations with positive surplus available. Surprisingly, seller cave-in resulted in nine contracts in which the buyers valued the inputs less than the sellers. This represents 38.1% of the negotiations where negative-surplus assembly was possible. Still, these contracts eliminated only 169 points of surplus, or 1.2% of the points available.

In negotiations where there were positive gains from trade the buyer purchased the parcel(s) that generated the higher surplus 65.6% of the time. This is modestly better than our prediction of 60% based on simulated negotiations. Moreover, the buyer made a purchase in 93.8% of negotiations where there were gains from trade, compared to our prediction of 92%. For each negotiation where the buyer's purchase generated less surplus than if he had negotiated an agreement with the other seller(s), we calculated the difference in surplus between the two possible contracts. This allows us to determine the opportunity cost in efficiency from purchasing the

wrong input(s). The total opportunity cost was 304 points, which is 2.2% of the available surplus in the *Competition* treatment.

As noted above, basic efficiency was 81.4% in the *Eminent Domain* treatment, which is not statistically different than in the *Baseline*. Normalized efficiency in the *Eminent Domain* treatment was 69.4%, which is a 50.9% increase compared to the *Baseline* normalized efficiency of 46%. This difference is statistically significant (Mann-Whitney,  $p = 0.002$ ). However, normalized efficiency is a more forgiving metric for the *Eminent Domain* treatment than the other treatments. This is because the buyer and sellers could theoretically spend almost all of the surplus in the price contest, resulting in a lower minimum surplus. Thus, relatively high normalized efficiencies could be obtained in the *Eminent Domain* treatment so long as the negotiating parties did not spend most of the available surplus in the contest.

Delay and failed assembly did not substantially affect basic efficiency in the *Eminent Domain* treatment. Only two negotiations failed to result in assembly because the buyer could not afford to force both sellers to sell. In both of these negotiations the sellers valued their inputs more than the seller, so no points were lost from assembly failure. The average duration was 1.4 periods for all negotiations and 1.2 periods for negotiations with gains from trade. As a result, only 157 points (1.9% of available surplus) were lost due to delay.

However, spending in the price contest was more than 200% higher than predicted. In theory the buyer and seller should both spend five points. In fact, buyers spent an average of 15.7 points and sellers an average of 15.9 points. These high averages were due in part to very high spending by a few participants. However, median spending was 10 points for both buyers and sellers; 100% higher than equilibrium. Wilcoxon sign rank tests find that spending was statistically

higher than equilibrium for buyers and sellers ( $p < 0.01$  for both roles). This is consistent with prior studies on spending in Tullock Contests (see Dechenaux, Kovenock and Sheremeta, 2012)

Theoretically, sellers should accept any offer of 45 points or higher, and the average first offer in the *Eminent Domain* treatment was 56 points. Consequently, we would expect litigation to be infrequent, but that was not the case. The buyer invoked eminent domain against at least one seller in 44.4% of negotiations and against both sellers in 11.1% of negotiations. As a result, participants spent 1,149 points trying to determine the fair market price. This accounts for 73.9% of all points lost in the *Eminent Domain* treatment and 13.7% of the maximum available surplus. Notice that this is almost the same amount of surplus that was lost due to delay in the *Baseline*. Thus, what eminent domain gave through faster negotiation it took through influence costs.

## **VI. General Discussion**

### *A. Implications for Land Assembly and Eminent Domain*

The current findings push our understanding about eminent domain and collective action in three ways. First, we find that – contrary to the conventional wisdom – seller holdout is not very common, nor is it for very large sums, even when the buyer has no alternative to assembly or recourse to eminent domain. Rather, in our experiments it is primarily the buyers who hold out for an outsized share of the surplus by making offers that are below the profit maximizing level. It seems a perverse response under such circumstances to give a buyer the right to cut short the bargaining process and force the sale of property.

Second, eminent domain did not enhance the efficiency of negotiated outcomes. The surplus that was saved by avoiding delay was spent in litigation costs. One possible policy response would be to curtail or eliminate the degree to which litigants can influence the price of condemned property. Yet such a policy would run directly counter to democratic principles of due

process, and it would also open landowners to predatory behavior on the part of government officials. An alternative policy response would be to place a high burden on the party invoking eminent domain to demonstrate that gain in surplus from assembling the properties is very large. Eminent domain ought not to be invoked to achieve modest improvements in land use due to the risk that influence costs will meet or exceed the gains from trade.

Third, we find that even weak competition is sufficient to break down seller holdout and improve economic efficiency. When our buyers had an outside option to assembling the primary sellers' parcels, seller holdout was not statistically higher than when the buyers could force a sale. Having an available substitute also increased the buyers' offers relative to the theoretical equilibrium. As a result of an available substitute, the duration of negotiations fell by 35.7% overall (from 4.2 periods to 2.7 periods) and almost no surplus was lost due to assembly failure. Comparing weak competition to eminent domain with a litigation process, participants captured 8 percentage points more of the maximum available surplus under competition and a statistically indistinguishable share of the at-risk surplus.

The result that weak competition helps to navigate seller holdout strengthens the findings of Cadigan et al. (2011) and Parente and Winn (2012) that competition among sellers makes land assembly quite easy. Notice that in their studies the sellers competed with perfect substitutes, while in the present study the buyer incurred a 20% loss in value from buying the alternative parcel. A straightforward implication for policy is that eminent domain should be restricted to cases where the assembling agent has no viable alternative to assembling a single set of properties. An example would be the construction of a road through a mountain range with a single pass. If the land along that pass is owned by multiple parties then eminent domain may be necessary to prevent strategic holdout from thwarting efficient assembly. But suppose there is a second pass that is less suitable

for a road, perhaps because it is further from the existing infrastructure or takes a more circuitous route through the mountains. In this case eminent domain is less likely to be justified because an element of competition has been introduced which will break down seller holdout.

### *B. Implications for the Social Dilemma of the Tragedy of the Anticommons*

Our study also contributes to social dilemma research more broadly in that land assembly is a special case of the tragedy of the anti-commons (Van Lange, et al. 2013). The well-researched tragedy of the commons is a property rights problem where agents possess usage rights but no exclusion rights (Hardin 1968) to a shared resource. In contrast, the tragedy of the anti-commons is a property rights problem where agents possess exclusion rights regardless if they possess usage rights to the resource (Heller 1998).

Social dilemma research in law conjectures that without a superordinate authority invoking eminent domain the tragedy of the anti-commons is inevitable because voluntary agreements of land assembly “rarely work in America and elsewhere in the world” (Heller 2008, p. 113). Indeed, placing a superordinate authority over shared resources has long been endorsed as a way (sometimes the only way [Hardin 1968]) to navigate social dilemmas (Kollock 1998). This conjecture focuses on the negative externalities of seller holdout but overlooks the externalities of the proposed solution.

We complement existing social dilemma research in two ways. First we show that solutions to social dilemmas can have their own externalities (e.g., spending resources to invoke eminent domain). When the buyers exercised eminent domain, the participants lost 18.6% of the surplus. The loss came from attempting to influence the fair market price and forcing sellers to sell even when they valued the property more than the buyer. Before invoking a solution to a

social dilemma, policy makers would benefit from answering Hardin's (1985) question "And then what?"

Second, we relax the assumption in the social dilemma sciences that resource management is a closed system rather than an open system. Traditionally social dilemma researchers have assumed that agents are closed off from outside alternatives; e.g., there is only one configuration of land amenable to development or one set of patents that will permit a suitable pharmaceutical treatment. Simon (1996) reminds us that there are often substitutes for and more efficient ways to utilize resources. Taking an open system approach to the tragedy of the anti-commons, as we have done with land assembly, introduces a substitute to superordinate authority. In our experiments this resulted in the highest level of economic efficiency, with just 11.5% of the surplus lost.

### *C. Limitations and Future Research Directions*

Our study does have some important limitations. Cadigan, et al. (2011) have demonstrated that delay is exacerbated and assembly failure more common with a larger numbers of sellers. We did not vary the number of sellers, so we cannot measure how the degree of fragmentation interacts with the results reported here. Future research may benefit from examining whether the number of sellers makes land assembly more challenging, especially if sellers are allowed to form coalitions against prospective buyers. Additionally, there were no externalities from assembly in our experiments, which may encourage seller holdout (O'Flaherty 1994). Future scholarship may benefit from examining whether the knowledge of positive versus negative externalities to those directly involved in the land assembly impact seller holdouts.

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Table 1. Sessions and observations by treatment

Treatment	Sessions	Groups per Session	Negotiations
Baseline	5	3	45
Competition	3	5	45
Eminent Domain	5	3	45
Total	13	--	135

Table 2. Experimental parameters

Parameter	Value
Buyer exchange rate	\$1.00 = 2 points
Primary seller exchange rate	\$1.00 = 4 points
Alternative seller exchange rate	\$1.00 = 7 points
Distribution of primary sellers' values, $[a,b]$	[50,100]
Distribution of buyer's value, $[A,B]$	[100,250]
Value multiplier, $\theta$	0.8
Distribution of alternative seller's value, $[2\theta a, 2\theta b]$	[80,160]
Negotiating periods, $T$	5
Delay cost, $\delta$	0.05
Set of fair market prices in contest, $P_m \in \{a - \epsilon, a, a + \epsilon\}$	{40,50,60}

Table 3. Theoretical predictions from our theoretical model and simulated negotiations

	Baseline	Competition	Eminent Domain
Average opening offer	75	71	45
Efficient assembly rate	89%	60%	100%
Efficient fragmentation rate	100%	100%	0%
Average number of periods in all rounds	3.4	2.7	1
Average number of periods when assembly produces surplus	2.1	1.7	1
Percent of sales forced	--	--	0%
Buyer's contest spending	--	--	5
Seller's contest spending	--	--	5

Table 4. Average basic and normalized efficiency in each treatment

	Baseline	Competition	Eminent Domain
Basic Efficiency	81.9%	88.5%	81.4%
Normalized Efficiency	46.0%	64.9%	69.4%

Table 5. Mann-Whitney statistics from pairwise comparisons of basic and normalized efficiency

Panel A – Comparison of Basic Efficiency			
	Baseline	Competition	Eminent Domain
Baseline			
Competition	-2.52*		
Eminent Domain	0.04	2.01*	
Panel B – Comparison of Normalized Efficiency			
	Baseline	Competition	Eminent Domain
Baseline			
Competition	-2.45*		
Eminent Domain	-3.11**	-0.68	

\* Significant at 5%, \*\* Significant at 1%, \*\*\* Significant at 0.1%

Table 6. The loss from delay in the *Baseline* Treatment is similar to the loss from contest spending in the *Contest* Treatment

	Baseline	Competition	Eminent Domain
Points Available	8,254	13,816	8,370
Points Achieved	6,756	12,227	6,815
	(81.9%)	(88.5%)	(81.4%)
<b>Loss from delay</b>	<b>1,237</b>	1,114	157
	<b>(15.0%)</b>	(8.1%)	(1.9%)
Loss from failed assembly	225	2	0
	(2.7%)	(0.0%)	(0.0%)
Loss from inefficient assembly	36	169	249
	(0.4%)	(1.2%)	(3.0%)
Opportunity cost of inefficient assembly	--	304	--
		(2.2%)	
<b>Loss from contest spending</b>	--	--	<b>1,149</b>
			<b>(13.7%)</b>
Total Loss	1,498	1,589	1,555
	(18.1%)	(11.5%)	(18.6%)

Note: Key findings **bolded**.

Figure 1. Buyers' average first and final offers

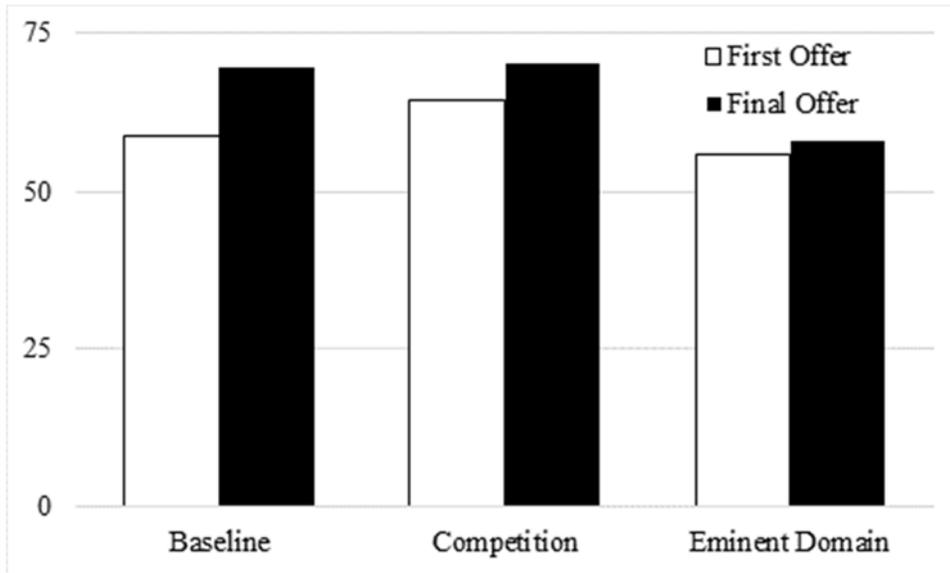


Figure 2. Difference between highest rejected offer and seller's value

