Using Prospect Theory to Better Understand the Impact of Uncertainty on Real Estate Negotiations

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Abstract:

Economic experiments are used in this study to evaluate the impact of uncertainty on negotiations involving the assembly of land for real estate development. Consistent with the tenets of prospect theory, the results suggest landowners act to mitigate risk, as opposed to maximize gain, when the duration of negotiations are undefined and they face disadvantageous fallback positions in the event they do not reach an agreement to sell their properties. The experiments contribute to the study of behavioral economics by offering further evidence of psychological biases that can encourage individuals to act in ways that are inconsistent with neoclassical economic theory.

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Land aggregation; real estate negotiations; strategic holdout; economic experiments; prospect theory

JEL Codes:

R1, R14, R33

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Introduction

Prospect theory, as described in the seminal work of Kahneman and Tversky (1979), has been widely used by behavioral economists to explain decision-making in the presence of uncertainty. It offers an alternative to utility theory and argues that individuals bring psychological biases to negotiations that encourage them to act in ways that are not economically rational in a neoclassical sense (Paraschiv and Chenavaz, 2011). The theoretical paradigm assumes individuals base their decisions on anticipated gains or losses around subjectively defined reference points, rather than on absolute gains or losses in wealth, while demonstrating greater sensitivity to the prospect of relative losses in comparison to relative gains (Barberis, 2012). Loss aversion may therefore help explain the negotiating behavior of parties participating in a variety of different markets, including the real estate market where price negotiation is a common practice.

The economic experiments presented in this paper test the loss aversion premise of prospect theory by considering whether uncertainty in the duration of negotiations with a prospective real estate developer effects the behavior of landowners faced with different fallback positions. This is an important question because many studies in the extant real estate literature rely on experimental designs where negotiations to buy or sell land take place over a defined number of rounds known to all parties, and where sellers are unaffected by proposed real estate development projects in the event they decide not to voluntarily participate in an assemblage. A more realistic scenario would include the possibility of a landowner being left to face an uncertain fallback position as a result of being excluded from a land assemblage.[1]

[1] Studying the impact of uncertainty on real estate negotiations in the manner described is in some ways analogous to the body of research examining price discounts cash buyers are able to obtain from real estate sellers by reducing the risk of transactions not closing. See Jauregui et al., 2017; Chinloy et al., 2017; Tidwell et al., 2018.

In this study, subjects play the role of the owner of the last parcel of land needed to complete an assemblage. They negotiate with a computerized "developer" programmed to make offers pursuant to an algorithm until a purchase agreement is reached or the predetermined number of rounds in the negotiation come to an end. To incorporate uncertainty and alternative fallback positions into the analysis, all of the "landowners" are exposed to two groups of four experimental treatments during the negotiation process. The total number of offers the developer is willing to make before terminating negotiations is known to each landowner in the first group and unknown in the second. Concurrently, each treatment within these groups exposes landowners to different fallback positions related to assigned reservation values that are advantageous or disadvantageous.

The fallback positions are designed to represent realistic scenarios in which the value of a landowner's property could exceed or fall short of its reservation value. A landowner who is excluded from a land assemblage is exposed to either positive or negative externalities generated by the adjacent development. In a more limited number of instances, there is also the possibility of a landowner receiving less for his or her property than the reservation value if a government entity participates in the land assemblage to advance a public purpose and exercises its power of eminent domain. These scenarios are presented to provide context and to introduce the likelihood of economic losses and gains in the event a land aggregation fails.

Consistent with the loss aversion premise of prospect theory, the experimental results suggest landowners accept lower offers and capture less of the surplus created by proposed real estate development projects when there is uncertainty in the number of offers forthcoming and when faced with the possibility of a disadvantageous fallback position in the event they do not voluntarily agree to sell their properties. Concurrently, uncertainty in the number of forthcoming offers is not found to have a significant impact when fallback positions are potentially advantageous. These findings provide some evidence that the threat of negotiations ending abruptly should be taken into account in experimental studies of land aggregation, particularly those that expose landowners to the prospect of economic loses in the event they do not participate. They also highlight the complexity of the negotiation process and the need to account for the bargaining strength and position of the parties involved in land aggregation exercises.

Literature Review

Each parcel of land has a unique geographic location that provides the owner with a degree of power when negotiating with prospective buyers (Plassmann and Tideman, 2010). Landowners attempt to leverage this power to maximize profits when their parcels are needed to complete a proposed real estate development project (Strange, 1995; Miceli, 2011). This type of behavior is referred to as a strategic holdout. It has been argued that such behavior creates obstacles to economically efficient land aggregation in the absence of mitigating factors (Cadigan et al., 2009; Collins and Isaac, 2012). Some government entities have responded to the problem by using eminent domain and other sovereign powers to aid in the land assembly process, which has naturally led to questions about the appropriateness of such interventions as a means of addressing a potential market failure (Miceli and Segerson, 2007; Sridhar and Mandyam, 2013).

To some degree, real estate developers can address the threat of strategic holdout by using contractual mechanisms such as options or purchase and sale agreements that are contingent upon the successful acquisition of all parcels of land needed to complete a proposed project. These tools are useful because they limit a developer's financial commitment to a transaction until it is relatively clear that they will be able to move forward, thereby reducing the amount of leverage garnered by potential holdouts (Miceli and Segerson, 2012a; 2012b). However, there are economic and pragmatic reasons why contingent contracting is not always the optimal solution. Several studies have shown that there are market settings where developers may actually obtain greater benefits from guaranteed payment contracting because it allows land to be acquired at a price low enough to accept the risk of a land aggregation task ultimately failing (Collins and Isaac, 2012; Zillante et al., 2014; Swope et al., 2014). There are also scenarios where time constraints and/or market demands warrant the use of rather simple contractual terms to appease landowners and expedite the land aggregation process (Miceli and Segerson, 2012a).

Exploring the prevalence of strategic holdout using data derived from market transactions is a challenging task due in part to the inability to control for the motivations of landowners and real estate developers involved in the negotiations (Cadigan et al., 2011). For example, some landowners may act strategically to capture a greater portion of the developer's projected profits, while others may simply be reluctant to sell their land because the subjective value they place on it is higher than other market participants (Zillante et al., 2014). Because the latter behavior represents a rational attempt to maximize utility, scholars are left with the challenge of differentiating between strategic holdouts and sincere holdouts when evaluating whether government intervention is needed to promote market efficiency (Swope et al., 2014).

Economic experiments offer a method for overcoming data limitations when examining the severity of strategic holdout in land aggregation (Cadigan et al., 2009). Scholars utilizing this methodology typically assign research participants roles as either landowners or real estate developers and then observe their negotiations in a controlled laboratory environment where the motivations of the parties are clearly defined. This approach generates granular data about negotiating behavior and can be used to control for the subjective value landowners and developers place on individual properties, which is often unobservable in market transactions (Collins and

Isaac, 2012). These benefits, among others, have encouraged extensive use of economic experiments to study the process through which land is assembled (Tanaka, 2007).

Diverse experimental structures involve a combination of settings where negotiations may take place in one or more periods; one or more landowners may be involved; subjective land values may be disclosed or undisclosed; landowners may act sincerely or strategically; offers made to individual landowners may be contingent or non-contingent on successful land aggregation; offers may be sequential or simultaneous; developers or landowners may initiate the negotiations; and delay costs may or may not be taken into account (Cadigan et al., 2009; Collins and Isaac, 2012; Swope et al., 2011; Parente and Winn, 2012; Shupp et al., 2013; Swope et al., 2014). There are also experiments that examine the effectiveness of alternative policy tools and contractual mechanisms expected to limit strategic holdout in different situations (Duke and Bromley, 2009; Kitchens and Roomets, 2015; Zillante et al. 2014).

Although existing studies differ in many ways, most rely on an experimental design where negotiations between landowners and real estate developers occur over a defined number of rounds known to all parties. This structure eliminates the possibility of a developer walking away from the negotiations unexpectedly and leaving landowners with no chance of participating. Landowners have an incentive to act strategically in this type of setting because they gain additional information about the value the developer places on their property in each round of negotiation without being exposed to additional risk (Menezes and Pitchford, 2004). The benefits derived from such an approach are, however, tempered when there is uncertainty regarding the number of offers forthcoming from the developer. There are also theoretical reasons to believe landowners' fallback positions may affect their willingness to act as strategic holdouts when faced with this type of asymmetric information. In fact, it could be argued that controlling for a landowner's fallback position in such a setting is essential to studying negotiation strategies.

Behavioral economists have turned to prospect theory, as described in Kahneman and Tversky (1979), to better understand decision-making in the presence of uncertainty. Prospect theory posits that individuals are influenced by psychological biases when they engage in negotiations that may encourage them to act in a manner inconsistent with neoclassical economic theory (Paraschiv and Chenavaz, 2011). More specifically, gains and losses relative to subjectively defined reference points are believed to influence decisions more so than absolute gains or losses, with individuals displaying greater sensitivity to the prospect of relative economic losses (Barberis, 2012).

Loss aversion is but one of many psychological phenomena receiving an increasing amount of attention in the real estate literature (Seiler, 2014). In fact, behavioral real estate has emerged as a field of study in its own right, dedicated to the exploration of how individuals participating in various types of real estate transactions make decisions (Diaz, 1990; 1997; Black et al., 2003). Much of the existing work in this area focuses on heuristics and biases that prevent fully rational decision-making as described in traditional economic or financial models (Gallimore et al., 2000). Examples include anchoring, confirmation, and feedback heuristics, as well as endowment and familiarity biases, that have all been shown to influence the value ascribed to properties by real estate practitioners and students in experimental settings (Gallimore and Wolverton, 1997; Diaz et al., 1999; Hansz & Diaz, 2001; Seiler and Seiler, 2010; Freybote et al., 2014; Salzman et al., 2017).

A presumption of loss aversion can be found in many behavioral real estate studies. One application involves efforts to explain why residential real estate developers are reluctant to embrace untested building practices or build in untested markets (Mohamed, 2006; Bowman et al., 2012; Magliocca et al., 2014). A second focuses on residential and commercial property owners' tendency to overprice their properties during periods of weak demand, thereby experiencing longer times on market, in an effort to avoid nominal losses (Genesove and Mayer, 1997; 2001; Anenberg, 2011; Bokhari and Geltner, 2011). A void in the extant real estate literature is an application of prospect theory to the study of land aggregation when landowners face uncertainty in the duration of negotiations. If the theory holds, the prospect of economic losses should discourage strategic holdout to a greater degree than it is encouraged by the prospect of economic gains.

Using the loss aversion premise of prospect theory as a lens through which to examine the impact of uncertainty in the land aggregation process is particularly relevant to the study of urban revitalization because both advantageous and disadvantageous fallback positions are posited to be in play for landowners. Should the owner of a non-essential parcel of land be excluded from an assemblage, the value of his or her property may increase or decrease as a result of any urban revitalization project that takes place nearby. For example, positive externalities may arise from the delivery of amenities to the area or from the removal of disamenities, whereas negative externalities may result from increased congestion or heightened demand for neighborhood resources (Uitermark and Loopmans, 2013; Lee et al., 2016). These countervailing forces suggest the impact of urban revitalization on surrounding property values is often ambiguous and context specific, as evidenced by a number of existing empirical studies (Ding et al., 2000; Ooi and Le, 2013; Chau and Wong, 2014; Mesthrige and Poon, 2015).

Should an urban revitalization project have a public purpose, there is also the possibility of a government entity participating in the land aggregation process via eminent domain. This is a legitimate threat because municipalities interested in promoting economic development have increasingly turned to their sovereign powers to transform urban areas in ways that are perceived to be conducive to the attraction of private sector capital (Sagalyn, 2007; Immergluck, 2009). Despite constitutional safeguards requiring the payment of just compensation in the event of a taking, many landowners appear to fear receiving less for their properties than their reservation value or even the prevailing market value (Guidry and Quang Do, 1998; Garnett, 2006). Several empirical studies indicate these fears are not completely misplaced, as inadequate appraisal techniques, data limitations, and regulation-induced biases have been shown to contribute to systematic over and undervaluation in condemnation cases (Clauretie et al., 2004; Aycock and Black, 2008; Chang, 2010; 2011). These threats may expose landowners to uncertain fallback positions if they do not voluntarily agree to sell their properties to accommodate development.

Experimental Design

Within the context of a land aggregation task, the economic experiments presented in this paper test the loss aversion premise of prospect theory by considering whether uncertainty in the number of offers forthcoming from a developer has a greater impact on the behavior of landowners facing economic losses in the event they do not voluntarily agree to sell their land in comparison to landowners facing economic gains. Economic loses (gains) are defined as receiving less (more) compensation at the end of the experiment than the reservation value randomly drawn by a landowner at the beginning of the experiment. To the extent the loss aversion premise holds, landowners are anticipated to accept offers more quickly, accept lower offers, and capture a smaller amount of the developer's surplus when there is uncertainty in the duration of negotiations and economic losses are a possibility. The opposite may not hold true when economic gains are a possibility.

In the experiments, human participants act as the owner of the last parcel of land needed to complete an assemblage, while the role of the developer is computerized. Landowners have a reservation value for their properties known only to them, drawn from a range of values U[800, 1500]. Developers have a value on the landowner's parcel known to them, but not to the landowner, drawn from a range of values U[1200, 1900]. Landowners are not informed of the distribution of developer values. All landowners participate in eight decision-making treatments intended to better understand their behavior across a variety of land aggregation settings.

Landowners receive offers to purchase their properties from the computerized developer, which are made in accordance with an algorithm described later in this section. While the landowners are not told the specific algorithm, each is told new offers depend upon the maximum amount the developer is willing to pay for the land, past rejected offers, and the number of rounds remaining in the negotiations. They are also told that offers, while generally increasing across negotiating rounds, do at times decrease.[2] All landowners are additionally given the ability to make a counteroffer. If the counteroffer is below the developer's current offer or next offer, it will be accepted. The only advantage landowners derive from submitting counteroffers is to speed up the negotiation process. An abundance of counteroffers also serves as evidence that the experiments are structured in a manner providing the participants with the feeling they are engaging in actual negotiations.

There are a total of eight treatments in the experiment, comprised of two groups of four. In the first group of treatments, each landowner knows with certainty that five offers will be made

[2] If offers always increase, or at a minimum never decrease, over time participants should always be willing to wait until the last round before accepting or rejecting the offer when the number of negotiating rounds is known. The potential for an offer to decrease introduces some uncertainty in fixed round negotiations. It also captures real world settings where a developer can potentially structure a deal around a holdout parcel.

by the developer to purchase his or her property unless an agreement is reached earlier. In the second group of treatments, landowners only know that they have an equal probability of receiving between one and nine offers. For ease of exposition, the treatments in which the landowners know at most five offers are forthcoming are denoted as "known ending" or "known", and those in which the ending is randomly determined are denoted as "unknown ending" or "unknown". When landowners move through the unknown ending treatments, they are told the developer is aware of the maximum number of offers that can be made and that this information is taken into account when determining the amount of each offer. Thus, the developer has more information than the landowners about the time or number of negotiating rounds available to complete a deal.[3]

Payoffs are set at the agreed upon sale price in all eight of the treatments described in the event an offer or counteroffer is accepted irrespective of whether the number of offers forthcoming from the developer is known or unknown. The four treatments in each of these two groups also expose landowners to different fallback positions. This allows examination of whether uncertainty in the duration of negotiations has a more pronounced impact on the behavior of landowners facing economic losses than it does when they face economic gains, as prospect theory suggests. Economic loses (gains) are defined as receiving less (more) compensation at the end of the experiment than the landowner's reservation value drawn at the beginning of the experiment. The experimental set-up allows for a comparison of acceptance rates, sale prices, and surplus captured by a landowner across all eight of the treatments to which he or she is exposed, as well as pairwise comparisons across the four treatments included in the known and unknown ending groups.

[3] This is also consistent with real world settings where the developer often steers the negotiations.

The four experimental treatments included in both the known and unknown ending groups are referred to as: *Basic*, Eminent Domain (*EmDom*), Positive Externality (*PosEx*), and Negative Externality (*NegEx*). In the *Basic* treatment, landowners receive their reservation values as payoffs if they do not reach an agreement with the developer. In *EmDom*, landowners receive a payoff equal to their reservation values or an eminent domain price of 900, with the latter occurring 75% of the time. In *PosEx*, landowners are informed that development has a 50% probability of occurring irrespective of whether they agree to sell their property. This treatment generates positive externalities increasing reservation values, and hence landowner payoffs, by 20% in the event the project moves forward without the purchase of the landowner's property. *NegEx* is identical to PosEx except that landowners excluded from the assemblage receive payoffs 20% below their reservation values in the event development occurs.

These four variants expose landowners to the prospect of economic gains and economic loses above and below their defined reservation values, which serve as reference points allowing for a test of the loss aversion premise of prospect theory. There is debate in the literature about buyers' and sellers' reference points and whether they change over the course of negotiations, which make the selection of these points context specific and subject to experimenter discretion (Kristensen and Gaerling, 1997; Paraschiv and Chenavaz, 2011). A static reference point was selected as the most appropriate means of measuring gains and losses in these experimental settings because it conforms to previous research. There is also little reason to believe participants have preexisting aspirations, knowledge, or normative expectations influencing reference points in this case (Paraschiv and Chenavaz, 2011).

The algorithm used to generate offers from the computerized developer is:

$$Offer_t = \begin{cases} \min(land) + (D - \min(land)) * p * U[0,1] - 100 * U[0,1] & t = 1 \\ Offer_{t-1} + (D - Offer_{t-1}) * p * U[0,1] - 100 * U[0,1] & t > 1 \end{cases}$$

(1)

where min(land) is the minimum land value a landowner can have; ***D*** is the value of the land to the developer; and ***p*** is a parameter reflecting the negotiating strength or position of the developer. The parameter ***p*** depends upon how many offers have been made and the experimental treatment. It also reflects stronger negotiating power in that the rank ordering of ***p***, ceteris paribus, from strongest to weakest negotiating power is: *EmDom*, *NegEx*, *Basic*, *and PosEx*.[4] The offers made by the developer across these treatments are not strictly hierarchical, as landowners simply have a heightened probability of receiving higher or lower payouts in each. Equation (1) states that offers begin with the minimum land value (800 in the experimental set up), and increase by some fraction (p) of the remaining available surplus between the developer's value and the last rejected offer (or the minimum land value if it is the first offer). The surplus term is also multiplied by a random number between U[0,1] to allow for variation in the offers. The final term, -100*U[0,1], is included so that offers are not always increasing. Offers that always increase would make it transparent that participants should wait until the last offer before accepting.

Figure 1 shows the average simulated offer paths by treatment for each period for 1,000 random draws of developer values. While the average simulated offer paths increase over time, as one might expect in a negotiation, about 15%-20% of the offers decrease in comparison to the prior offer. Offers in *EmDom* are also the lowest on average, while offers in *PosEx* are highest. Note that even the largest average offer in the fifth period is still below the maximum land value. This result occurs for two reasons. First, the developer does not know the landowners' values and

[4] Appendix A contains the exact values for p for all treatments and possible number of rounds. For the treatments when the landowner knows there are 5 rounds, the values of p are the same as those in the setting when the landowner does not know there are 5 rounds, but the developer does.

cannot simply pay some small amount above that value. And second, a profit-maximizing developer who has not committed nonrefundable money to the project will not find it optimal to offer the entire surplus to the landowner in the final period.[5]

INSERT FIGURE 1 HERE

As a matter of procedure, instructions are provided as handouts and read aloud to all participants.[6] In each session, landowners first progress through all eight treatments in the same order without the opportunity for compensation. The goal of the unpaid sessions is to familiarize participants with the structure of the experiments and the algorithm used to create offers. Landowners are made aware of the potential payouts and do not have to calculate them. Negotiations with the developer initially occur in the *Basic*, *EmDom*, *PosEx*, and *NegEx* treatments with the known ending. These four variants are then repeated in the unknown ending setting. Verbal announcements are made between treatments to explain how the experimental settings differ. After completing an unpaid set of treatments, participants repeat the exercise in its entirety at their own pace for payment. Reminder screens appear between treatments during the paid rounds to remind landowners of the experimental setting they are about to enter. Relevant information for a particular treatment is also displayed on the screen when landowners accept offers or make counteroffers to the developer. The compensation received by participants is determined by randomly selecting a payoff from one of the eight completed treatments.

Pop-up messages occur in all treatments if a participant is making a decision that might lead to a relative loss. For example, these messages appear after an acceptance decision when an offer is accepted below the landowner's reservation value. Similarly, they appear when a submitted

[5]See Zillante et al. (2014) for an example of a theoretical model in which this holds.
[6]A copy of the instructions provided to the experiment participants, along with screenshots of the interface used for the negotiation exercises, are included in Appendix B.

counteroffer is below the current offer made by the developer. Landowners can move forward with a decision that results in a relative loss in all cases, but the goal of the pop-up messages is to minimize errors associated with typos or misunderstandings.

A total of 73 students, predominately undergraduates, participated in the experimental sessions on the campus of a large state university. All experiments were conducted using Z-tree software (Fischbacher, 2007) and lasted approximately 30 minutes, on average. Participants earned $17, on average, including a $5 show-up fee for engaging in the experiment. The variable component of the payments received by the students was directly tied to the sale price they received for their land at the end of the negotiation exercise, or their reservation value in the event a sale agreement was not reached, to simulate incentives that exist in land sale transactions.

Caution must be exercised when using students as experimental subjects in negotiation exercises testing prospect theory because market experience has been shown to attenuate endowment effects in select instances (List, 2003). This concern is addressed in our study in a number of ways. This study is part of a much larger set of experiments which includes over 60 real estate professionals to assess whether they approach stylized land negotiations differently than students. When assigned the role of a "land seller," practitioners and students were found to behave in a similar manner, accepting offers of similar size and with similar frequency across various experimental structures and treatments. The most notable difference was the speed at which practitioners and students completed negotiation exercises, with practitioners consistently taking more time to accept or reject offers, only to end at the same place. These findings encouraged our team to conduct the remainder of the hold-out experiments with students to expedite data collection efforts and reduce cost.

Following the work of scholars such as Isaac et al. (2016), Kitchen and Roomets (2015), Parente and Winn (2012), and Cadigan et al. (2011), among many others, the experiments presented in this paper were also structured in a manner that did not require student subjects to take into account complex financial arrangements, legal issues, or market conditions when deciding whether or not to sell their land. They were simply asked to accept or reject an offer with the knowledge that another offer may or may not be coming and that they may receive more or less than their reservation value at the end of the exercise if they do not voluntarily agree to sell. Furthermore, the student subjects were not given the ability to negotiate any terms of sale other than price, which rendered in-depth knowledge of real estate contracts less relevant in the context of the negotiations.

The simplicity of the experiments presented in this paper is very much by design to focus on whether specific and narrowly tailored treatments encourage or discourage strategic holdout. Financially incentivized students are deemed to be appropriate subjects because even if they possessed extensive negotiating skills and market knowledge honed over years in the real estate industry, they would not be able to take advantage of it in this particular setting, which presumably contributed to the similarity in results across practitioners and students in the pilot study. Relying on data derived from student experiments is not anticipated to be inherently problematic in the absence of compelling evidence to the contrary (Druckman and Kam, 2009). It also allows for testing of whether behavioral bias is sufficient by itself to induce the hypothesized results.

Theoretical Model

This section presents a theoretical model supporting the proposition that uncertainty in the number of offers forthcoming should have a greater impact on landowners' behavior in settings where their fallback position exposes them to the threat of economic losses than it does in settings where there are possible economic gains. Consider a scenario where an individual is playing the role of a landowner with a computerized algorithm playing the role of the developer. Note that the algorithm only engages in "strategic" behavior when a landowner submits a counteroffer below the algorithm's next offer, and its "strategy" is limited to accepting that offer. Thus, the offers of the algorithm are not affected by any cheap talk behavior on the part of the landowner, nor are they affected by any thoughts about the relative strength or weakness of the landowner relative to the algorithm itself. Thus, the "game" being played by the two parties is really an individual decision-making task by the landowner. Based on the tasks participants face in the experiment, the theoretical model is constructed by choosing between a sure payoff and a gamble.

Knowing the potential distribution of offer paths faced, under what conditions should the landowner accept an offer prior to the last offer? Risk-neutral landowners should wait until the final offer in all experimental treatments when the number of negotiating rounds is certain because offers are increasing across rounds on average and the final offer should be the highest in such a setting. However, the dynamics change when uncertainty is introduced into the model and landowners must deal with the possibility of negotiations ending abruptly without warning.

Consider a setting in which the landowner is uncertain as to whether the current offer is the last offer. Let V be the landowner's reservation value[7] and $Offer_t$ be the current offer at time t, with $N \geq t$ the maximum number of offers and $t=1,...,N$. Let α_t be the probability of continuation at time t, so that $1-\alpha_t$ is the probability that time period t is the last time period in which a landowner

[7] The theory is developed based upon the Basic treatment. For the *EmDom*, *PosEx*, and *NegEx* settings the gamble can be substituted for V.

will receive an offer. The landowner either accepts or rejects the current offer. If $Offer_t$ is rejected, the landowner will either receive V or another offer.

Future offers are based upon the current offer, so that $E[Offer_{t+1}]=Offer_t+E[Z]$, where Z is a random variable. While the distribution of Z includes negative values, the expectation of Z is positive. Under risk-neutrality, the landowner will accept the current offer if:

$$Offer_t \geq (1-\alpha_t)V + \alpha_t\left(Offer_t + \frac{\sum_{i=1}^{N-t} iE[Z]}{N-t}\right) \quad (2)$$

The right-hand side of the equation is the weighted average of the landowner's reservation value, which is received if the current offer is the final offer and it is rejected, and the expectation of future offers that may be received if bargaining continues. The term in brackets is constructed using $Offer_{t+1}=Offer_t + E[Z]$ for all t.

Isolating $\sum_{i=1}^{N-t} iE[Z]$ on the right-hand side yields:

$$\frac{(N-t)(1-\alpha_t)(Offer_t-V)}{\alpha_t} \geq \sum_{i=1}^{N-t} iE[Z] \quad (3)$$

Given the structure of the experiment, $\alpha_t = \frac{N-t}{N-t+1}$. Substituting and simplifying yields:

$$Offer_t - V \geq \sum_{i=1}^{N-t} iE[Z] \quad (4)$$

If the landowners know the simulated offer algorithm, then E[Z]=105. Given the expected offer paths, on average, a risk neutral landowner with the lowest possible value, 800, in the *Basic* setting should wait until the sixth period to accept an offer. Note that this result assumes landowners know the offer algorithm. Introducing loss aversion into the model, whereby individuals suffer more disutility from a loss than they receive in utility from an identical sized gain, should accelerate the acceptance of offers and reduce landowner payoffs holding all other factors constant. And while the skewed distribution and magnitude of gains in the experiment at hand creates an environment where only very loss averse individuals would not wait until the last period to accept an offer, the model supports the applicability of prospect theory to the study of land aggregation when landowners face different fallback positions in the event negotiations fail.

Experimental Results

Very similar acceptance rates and average payoffs exist within information conditions across the unpaid and paid experiments. However, the average surplus, measured as the payoff minus the reservation value, is much larger in the paid experiments. The data analysis presented in this section, therefore, focuses on the results when participants are paid. Figure 2 shows the average payoffs to landowners in each of the eight treatments. The four treatments on the left represent the known ending treatments, while the four on the right represent the unknown ending treatments. Acceptance rates, payoffs and surplus are initially compared across treatments, followed by an econometric analysis examining the conditional effects treatments have on acceptance decisions.

Acceptance Rates

Figure 2 shows the percentage of landowners who accept an offer in each stage. The bars are segmented into those who accepted an offer from the developer and those who submitted an accepted counteroffer. Acceptance rates across the eight treatments range from 78% in *NegEx* of the known offer group to 44% in *EmDom* of the unknown offer group. Few differences emerge in acceptance rates across the four treatments in the known offer group. These findings, interpreted in conjunction with the payoff data, suggest the incentive for landowners to accept offers to avoid eminent domain is limited by the developer making weaker offers because there is a possibility of the assemblage being completed without landowner consent.

T-tests show that unconditional acceptance rates between the known and unknown offer groups are different in *EmDom*, *PosEx* and *NegEx*. In each of these variants, an unknown number of forthcoming offers reduces the probability of acceptance at the 5% level. No statistically significant differences are observed between the known and unknown offer groups in the *Basic* variant. Although prospect theory might suggest greater willingness on the part of landowners to accept offers when they are exposed to asymmetric information, and fallback positions have the possibility of being below reservation property values, the results indicate other considerations have an impact. Uncertainty in the duration of the negotiations appears to have a downward effect on acceptance rates when any complicating factors are involved in the decision-making processes, irrespective of whether landowners stand to experience nominal economic gains or losses in the event they do not voluntarily agree to sell their property to the developer. Pairwise comparisons across groups show this is especially true in *EmDom* and *PosEx* where landowners much more frequently reject offers above their reservation property values when the number of offers forthcoming is unknown. These results suggest landowners exhibit anchoring behavior relative to their reservation values and fail to fully account for alternative fallback positions. They are also indicative of ambiguity aversion where landowners make decisions to manage the ambiguity surrounding the structure of the algorithm dictating the evolution of developer offers.

INSERT FIGURE 2 HERE

Payoffs

As shown in Figure 3, the payoff rankings across the four variants of the experiment are the same in the known and unknown ending treatments. Landowners receive the highest payoffs in *PosEx* and *Basic*, respectively, followed by *NegEx* and *EmDom*. These rankings confirm expectations regarding the order of payoffs in light of the risks landowners face in the event an agreement is not reached with the developer. Kruskal-Wallis tests comparing the average payoffs within a given group and between variants additionally demonstrate that at least one average payoff differs across the variants in both the known and unknown offer groups at a significance level of 1%. The results demonstrate that more advantageous fallback positions tend to increase the bargaining power of landowners participating in land aggregation tasks. While this result is unsurprising, it is beneficial to confirm some basic results in laboratory experiments to ensure there is some minimal level of consistency with basic economic principles.

INSERT FIGURE 3 HERE

Pairwise comparisons are next made between the known and unknown settings for each of the four variants to determine if landowners in the same variant of the experiment achieved different payoffs depending upon whether or not they had knowledge of the number of forthcoming offers. T-tests demonstrate that average payoffs are not different at statistically significant levels across the groups in *Basic* or *PosEx*. However, differences are statistically significant at the 5% level in the *NegEx* and at the 10% level in *EmDom*. Wilcoxon-Mann-Whitney U-tests yield results similar to the t-tests, with differences in *NegEx* and *EmDom* statistically significant at the 2% and 5% levels, respectively.

These results suggest landowners are less willing or able to negotiate for higher sale prices in an environment where they face information asymmetries and the risk of receiving less for their properties than their reservation values due to eminent domain or negative externalities. Because the possibility of economic losses influences landowner behavior more than the possibility of economic gains, the findings are consistent with the loss aversion premise of prospect theory.

Surplus

Figure 4 shows landowners' payoffs relative to their randomly drawn reservation values, which is effectively a measure of the developer's surplus they are able to capture. Participants receive payoffs approximately 4% below their reservation values in *EmDom* under the known ending setting and 8% below their reservation values in the unknown ending setting. Participants in *NegEx* of the unknown ending setting are the only others to receive payoffs below their reservation values, losing roughly 3%. Those participating in the known and unknown variants settings of *PosEx* receive payoffs exceeding their reservation values by slightly more than 10%, but less than the 20% premium available in the experiment. This suggests landowners capture only a portion of rents associated with positive externalities. Once again, the observed results are consistent with prospect theory and indicate loss aversion influences behavior. Landowners' goals appear to shift from profit maximization to loss mitigation when uncertainty is introduced into the negotiations, which serves to exacerbate landowner losses and reduce landowner gains.

INSERT FIGURE 4 HERE

Econometric Analysis

The observed differences in both payoffs and surplus across experimental treatments provide some evidence of loss aversion among landowners involved in land aggregation tasks when uncertainty in the number of offers forthcoming from a developer is introduced. However, a more complicated story emerges with regards to the probability of an offer being accepted in a given round. Table 1 presents the results of four econometric models with a dichotomous dependent variable measuring whether or not a participant accepted an offer (or had a counteroffer accepted). The value of the dependent variable is set to 1 if the participant accepted an offer and 0 if an offer was rejected. Only rounds in which an offer is made are included in the models.

The independent variables include the offer made in the round, the surplus associated with the offer, binary variables for the treatments with *Basic* excluded as the reference category, and interactions between the treatment binary variables and the surplus measure.

INSERT TABLE 1 HERE

Probit models are used given the binary nature of the dependent variable, and a linear probability model is estimated on the full set of independent variables as a robustness check. A random effects model is chosen over a fixed effects model. To gauge consistency of the estimates when adding sets of variables, a probit model with only the offer and surplus variables is estimated first, followed by the inclusion of treatment binary variables, and finally the interaction variables between the binaries and the surplus. Estimates for the offer, surplus, and interaction terms are scaled to show the impact of changing the offer or surplus by 100 units (cents).

Predictably, the results show larger offers and surplus increase the likelihood of an offer being accepted in any given round. The binary variables yield more interesting outcomes. In the model including interaction terms, the signs of the *EmDom*, *EmDomUk*, *NegEx*, and *NegExUk* binaries are all positive, with the coefficient estimate of the binaries for *EmDom* and *NegExUk* significant at the 1% level. The coefficient estimates for the *PosEx* and *PosExUk* binaries are negative and significant at the 1% level. These results suggest that when compared to *Basic*, conditional on the offer and surplus in the round, participants exhibit risk mitigating behavior and are more likely to accept the offer in *EmDom* and *NegEx*, whereas they are less likely to accept an offer in the *PosEx* treatment where they are guaranteed a payout equal to or greater than their reservation value. Moreover, the coefficient estimates for all of the interaction terms are positive, and all are significant at least at the 5% level, except for the *PosEx* interaction. These results suggest increases in surplus make participants more likely to accept offers in these other treatments when compared to *Basic*. Nonetheless, they provide little evidence that uncertainty in the number of offers forthcoming from the developer alone affects whether a given offer is accepted.

Conclusions

The economic experiments presented in this paper represent an initial application of prospect theory to land aggregation by assessing whether uncertainty in the number of offers forthcoming from a developer has a more profound effect on the behavior of landowners facing economic losses than it does on the behavior of those facing economic gains The results support this proposition by demonstrating that landowners' payoffs and surplus are lower when these parties have disadvantageous fallback positions and do not know the number of rounds over which they have to reach an agreement with a developer before a land aggregation task fails. Both outcomes indicate information asymmetries discourage strategic holdout in such situations.

The findings contribute to the study of behavioral economics on a number of levels. First, they offer further evidence that psychological biases can encourage individuals to act in ways that are inconsistent with neoclassical economic theory. Second, they illustrate the importance of incorporating uncertainty in the duration of negotiations into economic experiments involving purchase and sale transactions, irrespective of whether those transactions involve land aggregation or some other type of proposed acquisition. Third, they highlight the need to consider alternative fallback positions when examining the negotiation process.

Moving forward, opportunities exist to build upon the work presented in this paper by conducting experiments that require participants to engage in more dynamic negotiation activities. This can be accomplished in a number of ways, such as the inclusion of multiple landowners in a land aggregation task or by assigning an experimental subject to the role of the developer instead of utilizing an algorithmic process to determine offers made across rounds. Taking these steps is likely to yield new information about prospect theory's relevance to the study of land aggregation and the pervasiveness of strategic holdout in real estate markets. It may also offer new insights into the impact of heuristics on the behavior of different parties involved in real estate negotiations.

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Figure 1. Simulated offer paths for the four treatments when the number of potential offers is known to be a maximum of 5

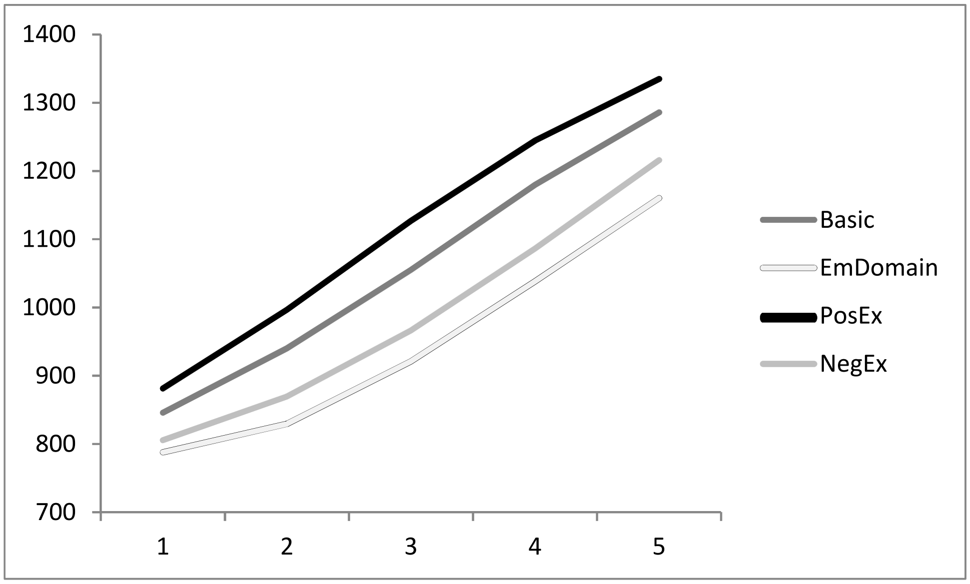


Figure 2. Acceptance rates, by treatment, broken into acceptances of the developer's offer and counteroffers accepted by the developer

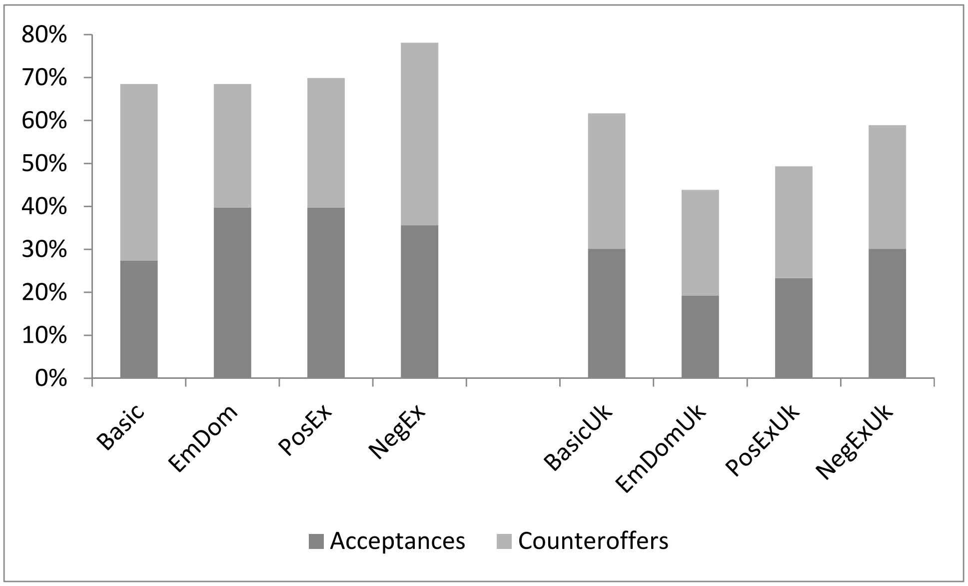


Figure 3. Average landowner payoffs by treatment

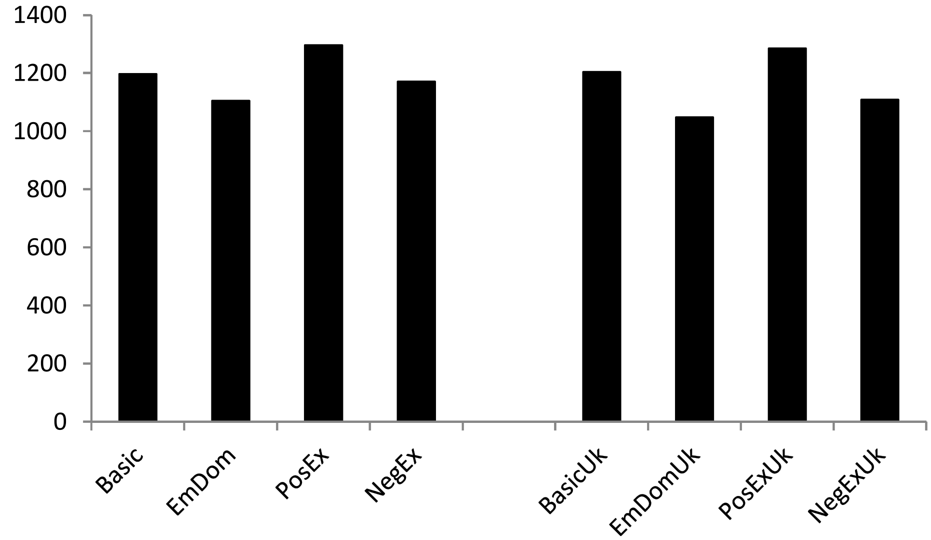


Figure 4. Landowner payoff as a percentage of reservation value, by treatment

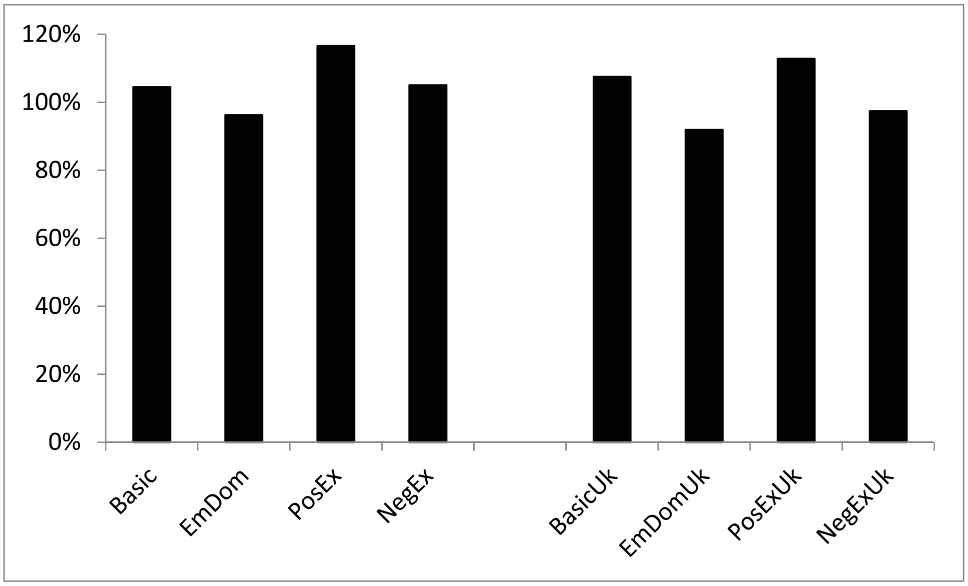


Table 1. Estimates from Random Effects Probit and Linear Probability Models*

	Probit	Probit	Probit	Linear Prob
Offer	0.153^{***}	0.182^{***}	0.186^{***}	0.042^{***}
Surplus	0.307^{***}	0.338^{***}	0.198^{***}	0.026^{***}
EmDom		0.327^{**}	0.433^{***}	0.116^{***}
PosEx		-0.494^{***}	-0.418^{***}	-0.034
NegEx		0.060	0.070	0.047^{*}
BasicUk		-0.025	-0.012	0.047
EmDomUk		0.180	0.231	0.038
PosExUk		-0.491^{**}	-0.479^{**}	-0.042
NegExUk		0.302^{*}	0.428^{***}	0.104^{***}
EmDom*Surplus			0.259^{***}	0.028^{***}
PosEx*Surplus			0.090	0.010
NegEx*Surplus			0.190^{***}	0.027^{***}
BasicUk*Surplus			0.174^{**}	0.021^{**}
EmDomUk*Surplus			0.184^{*}	0.005
PosExUk*Surplus			0.157^{*}	0.004
NegExUk*Surplus			0.284^{***}	0.026^{***}
Constant	-2.490^{***}	-2.784^{***}	-2.842^{***}	-0.227^{***}

** The dependent variable is whether the participant accepted an offer in the round. The offer, surplus, and surplus interaction terms have been scaled up by 100 to reflect changes in 100 units of surplus rather than 1 unit of surplus. The asterisks ***, **, and * represent the 1%, 5%, and 10% level of significance, respectively.*

Appendix A. Values for *p* for all Treatments and Possible Number of Rounds

The tables below show the values of the parameter *p* for all treatments. The rows represent the maximum number of offers, while the columns represent the offer number for that number of offers. For instance, row 5, column 4 in the Basic treatment shows that *p*=0.7, which means that a maximum of 70% of the remaining surplus would be offered with the 4th offer when there are 5 potential offers.

Basic	1	2	3	4	5	6	7	8	9
1	0.55								
2	0.475	0.625							
3	0.4	0.55	0.7						
4	0.325	0.475	0.625	0.775					
5	0.25	0.4	0.55	0.7	0.85				
6	0.175	0.325	0.475	0.625	0.775	0.925			
7	0.1	0.25	0.4	0.55	0.7	0.85	0.99		
8	0.025	0.175	0.325	0.475	0.625	0.775	0.925	0.99	
9	0.01	0.1	0.25	0.4	0.55	0.7	0.85	0.925	0.99

EmDom	1	2	3	4	5	6	7	8	9
1	0.4								
2	0.325	0.475							
3	0.25	0.4	0.55						
4	0.175	0.325	0.475	0.625					
5	0.1	0.25	0.4	0.55	0.7				
6	0.025	0.175	0.325	0.475	0.625	0.775			
7	0.0175	0.1	0.25	0.4	0.55	0.7	0.85		
8	0.01	0.025	0.175	0.325	0.475	0.625	0.775	0.925	
9	0.005	0.01	0.1	0.25	0.4	0.55	0.7	0.85	0.925

PosEx	1	2	3	4	5	6	7	8	9
1	0.65								
2	0.575	0.725							
3	0.5	0.65	0.8						
4	0.425	0.575	0.725	0.875					
5	0.35	0.5	0.65	0.8	0.95				
6	0.275	0.425	0.575	0.725	0.875	0.99			
7	0.2	0.35	0.5	0.65	0.8	0.95	0.99		
8	0.125	0.275	0.425	0.575	0.725	0.875	0.925	0.99	
9	0.05	0.2	0.35	0.5	0.65	0.8	0.95	0.975	0.99

NegEx	1	2	3	4	5	6	7	8	9
1	0.45								
2	0.375	0.525							
3	0.3	0.45	0.6						
4	0.225	0.375	0.525	0.675					
5	0.15	0.3	0.45	0.6	0.75				
6	0.075	0.225	0.375	0.525	0.675	0.825			
7	0.05	0.15	0.3	0.45	0.6	0.75	0.9		
8	0.025	0.075	0.225	0.375	0.525	0.675	0.825	0.975	
9	0.01	0.05	0.15	0.3	0.45	0.6	0.75	0.9	0.975

Appendix B. Experiment Instructions and Screenshots of the Interface for Negotiation Exercises

Land Aggregation Instructions

Thank you for participating in today's experiment. I will read aloud from this script to ensure that all sessions of this experiment receive the same information. However, if you have any questions please do not hesitate to ask me or one of the other monitors. At this time I ask that you refrain from talking to any of the other participants.

In this study each of you will be a landowner who owns a piece of land that a developer is attempting to purchase. Your piece of land is the last one that the developer needs to finish a development project.

This experiment is an individual decision-making task, meaning that your decisions will not have any effect on other participants' decisions or payments.

The basic decision task

There are 8 stages to this study. While there are important differences between the stages that will be described momentarily, all stages have the same underlying decision task. You own a piece of land worth a certain amount, call it **V**, to you. A computerized developer will make an offer for your piece of land. You will be able to accept or reject the offer. If you reject the offer you will be able to make a counteroffer, and the computerized developer will send you a new offer. The number of offers you will receive from the computerized developer will depend on the stage.

What does the computer use to determine its offer to you? For each stage and participant the computer has a randomly drawn value. The computer uses this randomly drawn value, the number of remaining rounds, and past offers made to you to determine the new offer. Note: If you submit a counteroffer that is below the computer's next offer, the computer will accept your counteroffer, so choose your counteroffers carefully.

How is my payoff calculated?

There are 8 stages to this study and there will be a payoff associated with each stage, and one of these payoffs will be randomly chosen to be your payoff for the study, and this amount will be added to your $5 show-up payment. How the payoffs for each stage will be determined will be described momentarily.

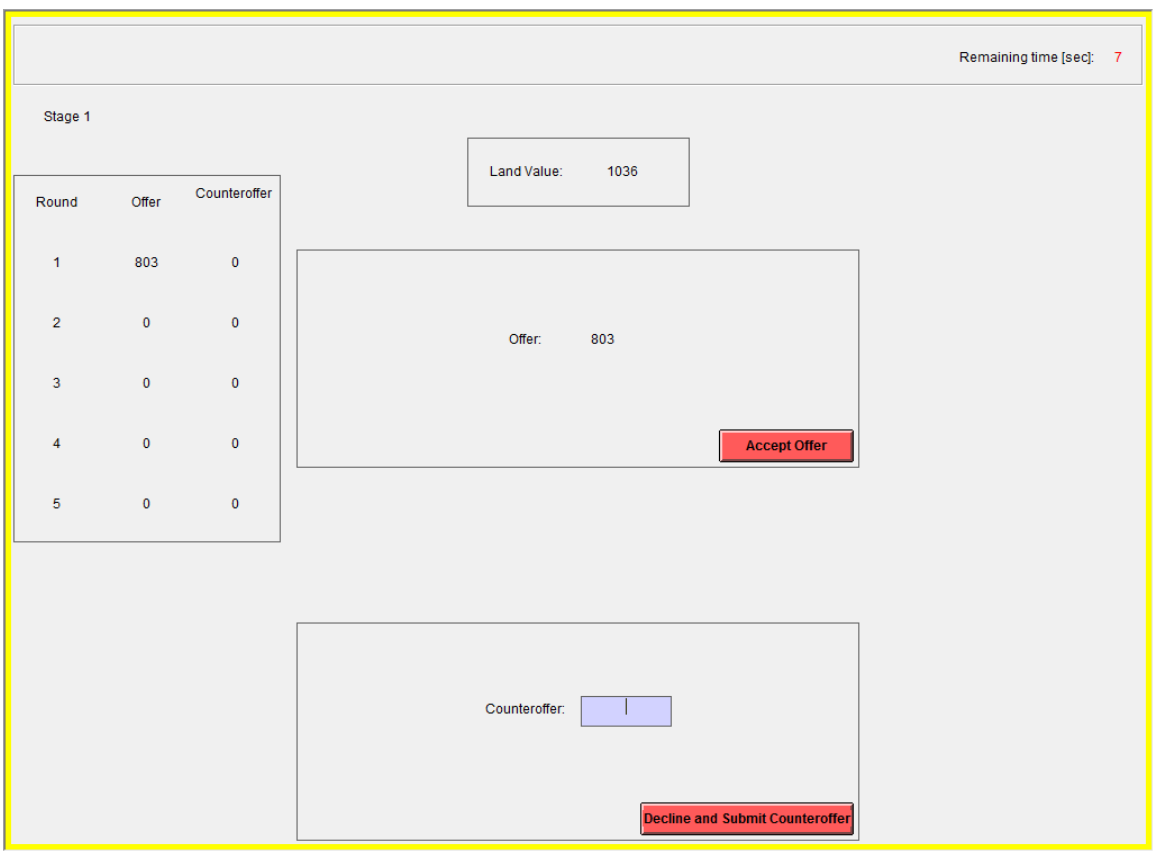
Stage 1: Standard stage

In this stage you are a landowner. Each landowner has a land value. If no offer from the developer is accepted by the landowner, then the landowner receives a payment equal to his or her land value, which in this example is 1036. Please note that all values are denominated in cents, so that a value of 1036 is \$10.36. If an offer is accepted, then your payoff is equal to the accepted offer.

The current offer from the computerized developer appears in the middle of the screen. In this example the offer is 803. To accept this offer press the "Accept Offer" button. If you do not want to accept this offer you can press the "Decline and Submit Counteroffer" button below. IMPORTANT: To submit a counteroffer you need to first enter a counteroffer in the box and then press the button. Recall that if your counteroffer is below the developer's next offer to you then the developer will accept that counteroffer.

If you decline the current offer a new offer will appear in the center of the screen. It is up to you to determine whether or not you accept an offer. In Stage 1 you will receive a maximum of 5 offers, assuming you do not accept an offer before the 5th offer. The left hand side of the screen shows the current offer as well as the past offers and counteroffers. If you decline an offer but choose not to submit a counteroffer it will appear as a zero in the box on the left.

At times you may press the buttons and pop-up buttons will appear. These buttons typically inform you that (1) you are choosing to accept an offer below your land value, which you can do but in this stage will cause you to receive a lower payoff, (2) you are submitting a counteroffer below the current offer and that this counteroffer will be accepted and you would do better by accepting the current offer, or (3) that you are submitting a counteroffer below your land value.

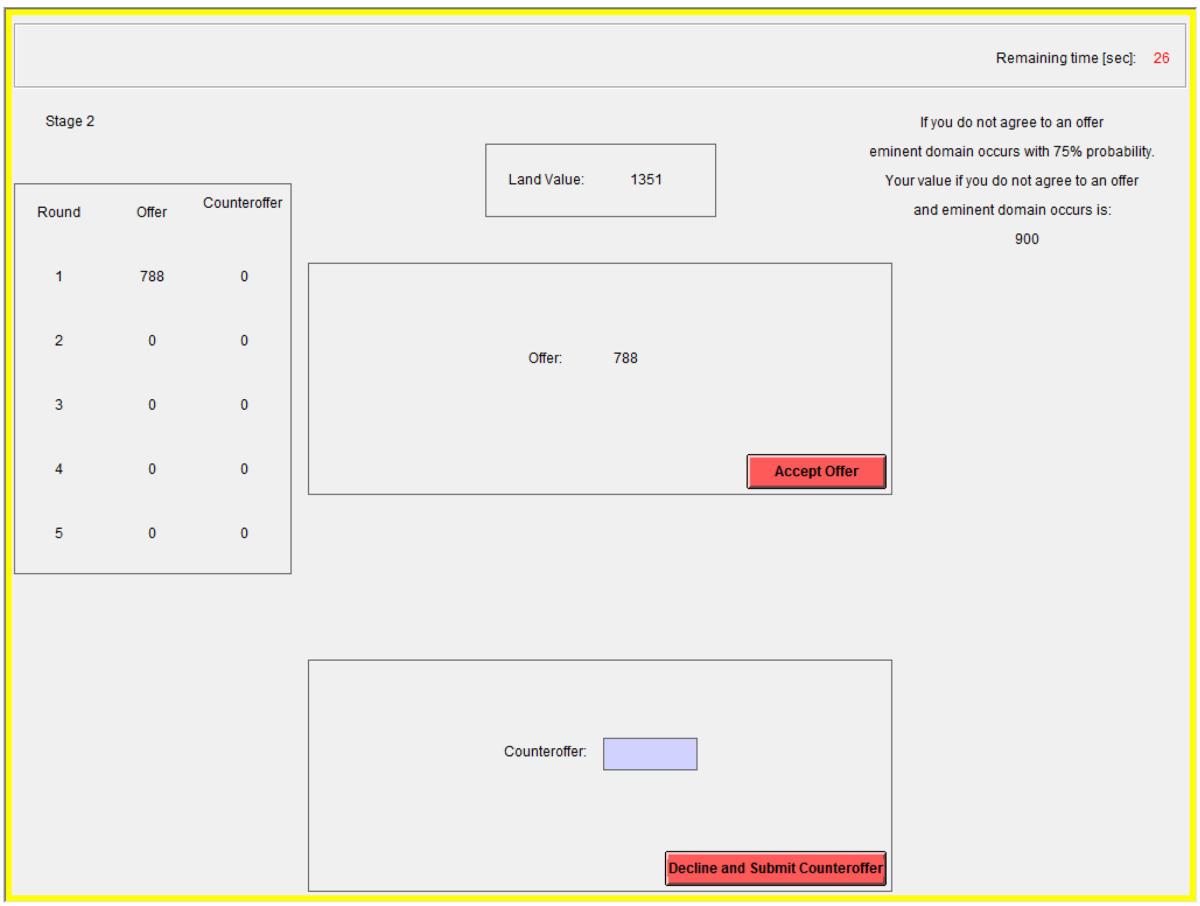


Stage 2: Eminent domain stage

The offer and counteroffer procedure for stage 2 is exactly like that for Stage 1. The main difference between Stage 1 and Stage 2 is that if, after 5 offers, you do not accept an offer from the developer, then there is a possibility that the developer can use eminent domain to acquire your land. Eminent domain means that the developer obtains your land for the eminent domain price, which is 900. Eminent domain does not occur with certainty, but there is a 75% chance that it will occur. There is a reminder in the upper right hand corner of the screen.

Example: Suppose you do not agree to an offer with the developer. Then there is a 75% chance that you receive a payoff of 900, and a 25% chance that you receive a payoff of your land value (1351 in this example). If you agree to an offer with the developer there is no uncertainty about your payoff for this stage – your payoff will be the offer you accepted. The same is true if you make a counteroffer that is accepted by the developer – your payoff will be the counteroffer you submitted.

Please note that any pop up messages that occur in this stage relate to your land value, and the message may not be true regarding the eminent domain value (900). Whether or not you continue to accept an offer or submit a counteroffer is a decision you will need to make.

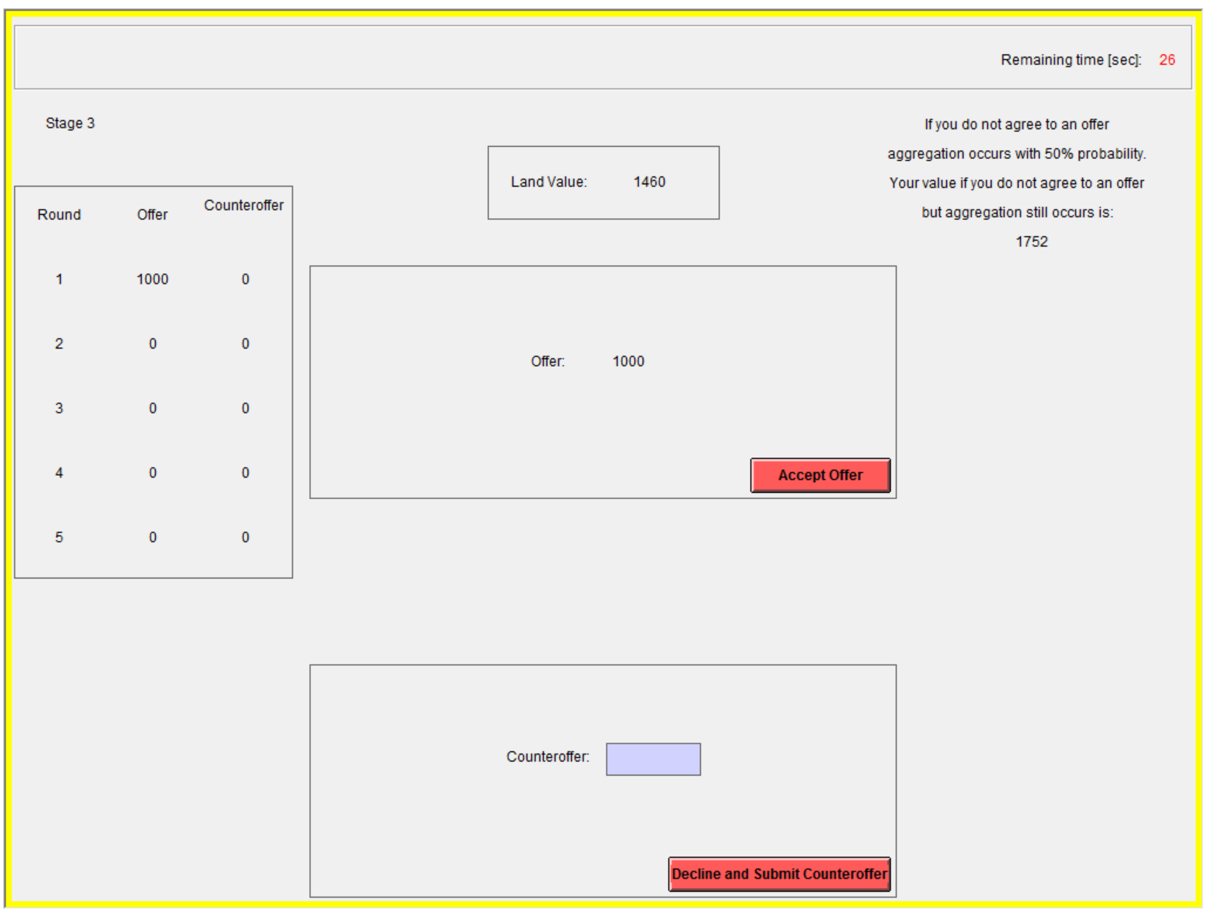


Stage 3: Positive externality stage

The offer and counteroffer procedure for stage 3 is exactly like that for Stage 1. The main difference between Stage 1 and Stage 3 is that if, after 5 offers, you do not accept an offer from the developer, then there is a possibility that development occurs without your parcel. In this stage it is as if the developer is developing something which you enjoy or benefits you (for example a park, assuming you enjoy parks), thus increasing the value of your land to you. The value of your land always increases by 20%, and you can see this value in the upper right hand corner of the screen. In this example your land value is 1460 if you keep your land and development does not occur, and 1752 if you keep your land and development does occur. There is a 50% chance that development occurs.

Example: Suppose you do not agree to an offer with the developer. Then there is a 50% chance that development occurs and you receive a payoff of 1752, and a 50% chance that development does not occur and you receive a payoff of your land value (1460 in this example). So in this stage the lowest payoff you can receive if you do not agree to an offer is your land value. If you agree to an offer with the developer there is no uncertainty about your payoff for this stage – your payoff will be the offer you accepted. The same is true if you make a counteroffer that is accepted by the developer – your payoff will be the counteroffer you submitted.

Please note that any pop up messages that occur in this stage relate to your original land value, and the message may not be true regarding your adjusted land value should development occur (1752 in this example). Whether or not you continue to accept an offer or submit a counteroffer is a decision you will need to make.

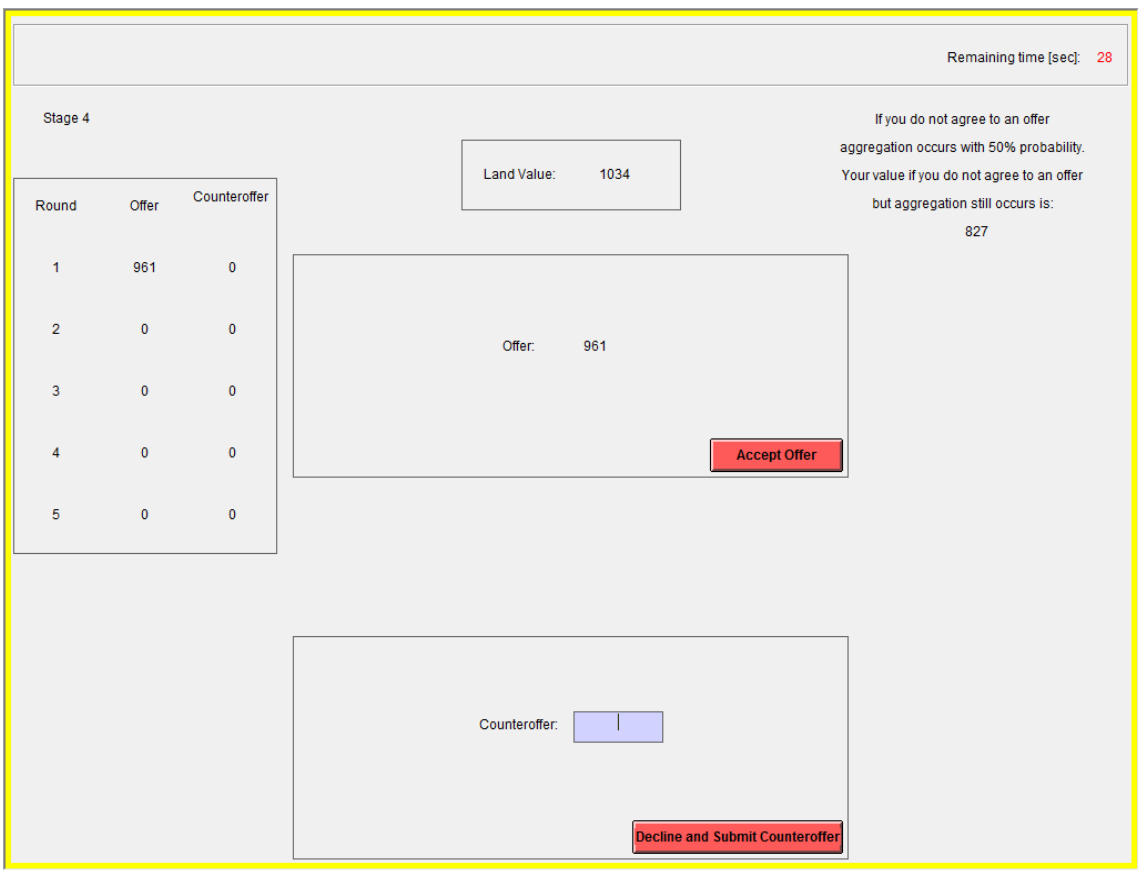


Stage 4: Negative externality stage

The offer and counteroffer procedure for stage 4 is exactly like that for Stage 1. The main difference between Stage 1 and Stage 4 is that if, after 5 offers, you do not accept an offer from the developer, then there is a possibility that development occurs without your parcel. In this stage it is as if the developer is developing something which you dislike (for example a toxic waste dump, assuming you do not enjoy toxic waste dumps), thus decreasing the value of your land to you. The value of your land always decreases by 20%, and you can see this value in the upper right hand corner of the screen. In this example your land value is 1034 if you keep your land and development does not occur, and 827 if you keep your land and development does occur. There is a 50% chance that development occurs.

Example: Suppose you do not agree to an offer with the developer. Then there is a 50% chance that development occurs and you receive a payoff of 827, and a 50% chance that development does not occur and you receive a payoff of your land value (1034 in this example). So in this stage the lowest payoff you can receive if you do not agree to an offer is if development occurs (827). If you agree to an offer with the developer there is no uncertainty about your payoff for this stage – your payoff will be the offer you accepted. The same is true if you make a counteroffer that is accepted by the developer – your payoff will be the counteroffer you submitted.

Please note that any pop up messages that occur in this stage relate to your original land value, and the message may not be true regarding your adjusted land value should development occur (827 in this example). Whether or not you continue to accept an offer or submit a counteroffer is a decision you will need to make.



Stages 5-8

Stages 5-8 correspond directly to stages 1-4. That is, stage 5 is another standard stage, stage 6 is another eminent domain stage, stage 7 is another positive externality stage, and stage 8 is another negative externality stage. Again, the offer and counteroffer processes are the same as in the early stages.

What is the difference between stages 1-4 and 5-8?

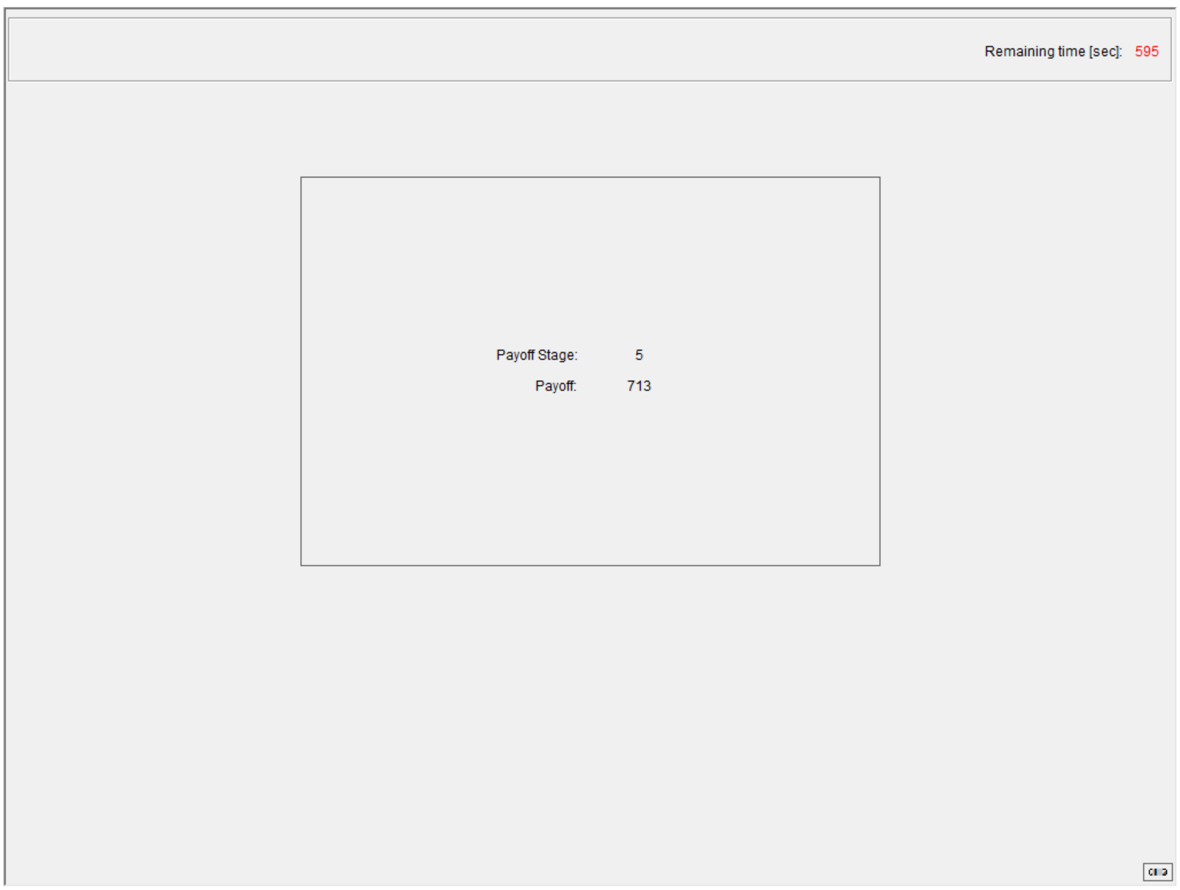
In stages 1-4 you knew that the 5th offer would be the last offer that you received. In stages 5-8 the number of offers made is randomly determined. You will receive at least 1 offer but you will receive at most 9 offers. There is an equal probability (1/9) that the maximum number of offers you will receive within each stage is a number 1-9. So there is a 1/9 probability that you will receive 1 offer, a 1/9 probability that you will receive 2 offers, etc.

Note: The number of offers you receive in round 5 does not affect the number of offers you receive in rounds 6, 7, or 8. The same is true for the randomly chosen number of offers in rounds 6, 7, and 8 – they do not influence the maximum number of rounds in any of the other rounds. While there are 9 potential offers listed in the box on the left hand side of the screen, you will not necessarily receive 9 offers.

In any of these stages, if you accept an offer (or if your counteroffer is accepted), then your payoff for that stage is equal to the accepted offer. If you do not accept an offer, then your payoff is determined depending on the stage. In stage 5 your payoff would be your land value. In stage 6 your payoff would either be your land value or the eminent domain value. In stages 7 and 8 your payoff would either be your land value if development occurs or your land value if development does not occur.

Final notes:

1. We will first do one set (all 8 stages) as unpaid practice. Everyone will move through the stages at the same time.
2. When the paid portion of the session begins I will start the program and you will move through the stages at your own pace. There will be reminder screens in between the stages to remind you what stage you are entering.
3. After the 8th stage appears in the final rounds there will be a screen that shows all of your payoffs for each round. One of these payoffs will be randomly chosen as your payoff for the session and this amount will be added to your $5 show up payment. When you press continue there will be a screen with the payoff stage number that was randomly selected and the payoff amount (see the example screen below). When you see this stage please raise your hand and wait until I acknowledge you. I will come around and write in your payoff amount and pay you at that time. Once you have received your payment the session is over (for you) and you may quietly exit the room.



(NOTE: Once the practice stage has begun, when participants begin to see the second or third offer in the Basic stage note that "While offers generally increase, there is some probability that the next offer will be less than the previous offer, as some of you may have already seen.")