Endogenous Entry across Auction Formats: Willingness to Pay and Threshold Entry Decisions

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Abstract

We experimentally examine threshold entry decisions in both first-price and English clock auctions with independent private values, when there is an explicit cost of participating in the auction. Bidders privately observe their value and report threshold entry decisions by revealing their maximum willingness to pay (WTP) to enter the auction via a Becker de-Groot Marschak (BDM) mechanism. Every bidder whose revealed WTP exceeds a randomly drawn cost of participation enters the auction and incurs said cost of participation. Bidders are informed of the number of bidders in the auction prior to placing their bids. We find that although revealed WTP is higher than theoretical predictions in both auction formats it is increasing in the bidder's value as predicted by theory. We also find a small revealed preference for first-price auctions. In addition, we find that men have higher WTP for first-price auctions than women, but with no corresponding gender difference in English clock auctions. Most surprisingly, bidders in both auction formats reveal a higher WTP when there are five potential bidders as opposed to three.

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1 Introduction

Much of the auction literature studies the bidding behavior and revenue ranking of auctions with a fixed and exogenous set of bidders who do not face entry or participation costs. However, participating in most auctions is costly. Individuals or firms have an opportunity cost of participating in an auction, and often also an explicit cost of preparing a bid. These costs might influence the entry decisions of potential bidders. By neglecting consideration of these costs and the corresponding entry decision, the bulk of the auction literature has restricted the attention on a sub-game.

It is well known that when there are independent private values, standard auctions generate the same predicted expected revenue, holding the number of bidders constant (see e.g. Myerson [1981] and Heydenreich et al. [2009]). However, if bidders have preferences over auction mechanisms the number of bidders attracted by an available auction will, in part, be determined by the auction format. Since expected revenue is increasing in the number of bidders, the auctioneer's optimal choice of auction mechanism is not irrelevant, but rather depends crucially on the underlying preferences of potential bidders. As Klemperer [2002] notes, "The second major area of concern of practical auction design is to attract bidders, since an auction with too few bidders risks being unprofitable for the auctioneer..." That is, when bidders weigh the cost of entering an auction, the auction mechanism may play a role in their decision, and thus in the number of bidders participating in the auction.

Theorists have informally speculated about the potential ways in which non-pecuniary preferences might influence bidder willingness to participate in various auction formats. For example, Engelbrecht-Wiggans [2001] suggests that oral or ascending auctions may be more attractive for bidders due to lower strategic uncertainty: "Bidders in oral auctions may need or want to spend less effort acquiring and interpreting information than in sealed-bid auctions. Thus, it costs less to participate in oral auctions than in sealed-bid auctions. The lower participation cost makes oral auctions more attractive to bidders. " Klemperer [2002] on the other hand argues that ascending auctions are vulnerable to predatory behavior on the part of bidders, which might depress entry when there are even small participation costs.

This paper experimentally examines endogenous entry thresholds in independent private value auctions in which there is a cost of participation that is common to all potential bidders, and each bidder knows her value prior to her entry decision. We vary auction format between first-price and English clock on a between-subject basis, and vary the size of the pool of potential bidders on a within-subject basis. We employed the Becker deGroot Marschak (BDM) procedure to elicit threshold entry decisions (i.e. maximum willingness to pay to participate in the auction). More precisely, in each auction, potential bidders are privately informed of their value, and then simultaneously report their maximum willingness to pay to enter the auction, without knowing what the participation cost of the auction is. This common participation cost, which is randomly chosen, is then revealed to them. Those who reported a maximum willingness to pay that (weakly) exceeds the chosen participation cost enter the auction and observe the number of bidders who entered before placing their bids. Those who do not enter play tic-tac-toe against a computer in order to mitigate boredom. Given the complexity of using a BDM mechanism to determine participation in an auction, we relied on subjects who had previously participated in an experiment that involved directly choosing to enter or not into an auction (see Aycinena and Rentschler 2011). Since bidder characteristics may play an important role in determining preferences over auction formats, we utilize data on these subjects from their participation in another experiment which measured risk preferences, and preferences for competition. We supplement with data on SAT scores, gender and age.

We find that willingness to pay for both auction formats is increasing in their private value. This is not surprising because the expected profit of bidders is increasing in their value. We also find that revealed willingness to pay systematically exceeds equilibrium predictions and payoffs in both auction formats. This difference exists both when there are three and five potential bidders. Further, this propensity to over-enter does not meaningfully decline over the course of the experiment.

Perhaps our most important result is that bidders are willing to pay more to enter a first-price auction than they are to enter an English clock auction. This is despite the fact that bidder payoffs in English clock auctions are higher than in first-price auctions. This result is mainly driven by men, as men are willing to pay more to enter a first-price auction than are women. No gender difference in willingness to pay exists for English clock auctions.

Our most puzzling result is that, in both auction formats, potential bidders are willing to pay more to enter an auction when there are 5 potential bidders, than when there are only three potential bidders. This is despite that fact that predicted and observed payoffs decrease when the number of potential bidders increases. We also find that risk aversion reduces individuals´ willingness to pay to enter auctions, while competitiveness increases WTP.

The remainder of the paper is organized as follows. Section 2 reviews the existing literature on entry in auctions. Section 3 describes our experimental design. Section 4 provides theoretical predictions. Section 5 contains results. Section 6 concludes.

2 Existing Literature

Early theoretical analysis of endogenous entry has focused on cases where potential bidders observe the common cost of participation, and then decide whether or not to enter. Only after entry do bidders learn their valuation of the good. At this stage bidders also observe the number of bidders who entered the auction. McAfee and McMillan [1987], Levin and Smith [1994] both take this approach for ex ante homogenous and risk neutral bidders in an independent private value framework. Engelbrecht-Wiggans [1993] examines a more general environment in which bidder valuations may be interdependent, but maintains the assumption that bidders only observe their signal upon entering the auction. Smith and Levin [1996] examines the independent private value environment for the case of ex ante homogenous risk averse bidders.

Pevnitskaya [2004] generalizes this approach by allowing for heterogeneous levels of risk aversion, where an individual´s degree of risk aversion is private information. As such, bidders hold private information when making entry decisions, and bidders with a degree of risk aversion above some threshold enter the auction. Palfrey and Pevnitskaya [2008] reports the result of an experiment which demonstrates that bidders with relatively high degrees of risk aversion do self select into a first-price auction.

In a related approach, Li and Zheng [2009] studies procurement auction in which bidders only learn their private cost of supplying the good upon entering, but do not observe the number of actual bidders. This paper then tests the model using data from highway mowing auctions in Texas.

Moreno and Wooders [2011] also examines the case in which bidders learn their private value only after incurring participation costs, but these participation costs are private information and are independently drawn from a common distribution. It is shown that in this environment, a seller wishing to maximize revenue will screen bidders by either their value or their entry cost.

Ye [2004] examines independent private value auctions in which bidders only learn their value after incurring the cost of participation, but allows bidders to also observe signals which provide information about the other bidders´ valuations.

The theoretical literature that is more closely related to our design changes the timing of information revelation in the game slightly. In particular, bidders observe the same commonly known entry cost of participation and their independent private valuation of the good prior to deciding whether or not to enter the auction. As such, their entry decision is contingent on their valuation. Menezes and Monteiro [2000] was, to the best of our knowledge,the first to examine symmetric equilibrium for risk neutral bidders in several auction formats in this environment. Lu [2009] examines optimal auction design when bidders observe their valuations prior to their entry decision, and all bidders have the same opportunity cost of entry.

Much of the attention in this literature has focused on second price auctions, as bidders who enter have a weakly dominant strategy to bid their valuation. Campbell [1998] identifies conditions on the distribution of values which guarantees the existence of asymmetric equilibrium in second price auctions when the participation cost is the same for all potential bidders. Tan and Yilankaya [2006] also examines second price auctions in this environment but allows for asymmetric bidders. Miralles [2008] generalizes the results of Tan and Yilankaya [2006]. Cao and Tian [2008] generalizes these results by allowing heterogeneous but commonly known participation costs.

Cao and Tian [2010] analyzes the case of homogenous and common knowledge participation costs in the context of independent private value first price auctions, and finds conditions on the distribution of values which guarantee the existence of an asymmetric equilibrium, in addition to symmetric equilibrium.

The case in which both bidders valuations and participation costs are both private information has also been studied. Green and Laffont [1984] and Cao and Tian [2009] both investigate this case in second price auctions.

Despite the important theoretical progress that has been made, relatively little empirical or experimental work has been done on entry in auctions. The existing literature largely focuses attention on the case in which bidders only learn their value after they have incurred in their participation cost.

Smith and Levin [2002] experimentally examines the entry decisions of bidders in which the subsequent auction was simulated and the payoff of a bidder that chooses to enter the auction was the expected equilibrium payoff. This is akin to examining the case in which bidders learn their value after entry had occurred. They find support for the equilibrium in which bidders mix between entering or not entering, rather than the equilibrium in which bidders employ pure entry decisions.

Reiley [2005] reports the results of a field experiment in which the reserve price for online sealed-bid auctions for collectible trading cards was varied. He also finds support for the prediction that bidders employ a mixed strategy entry decision. Furthermore, he finds that a reserve price of zero yields more revenue that a reserve price equal to the seller´s valuation, contrary to theory.

Ivanova-Stenzel and Salmon [2004] examines bidder preferences between ascending bid auctions and first-price auctions. Bidders were asked to choose between these two formats every period. In some periods the participation cost was equalized between the two formats, while in others it differed between formats. They find strong preferences for the ascending bid auction, although bidders were not willing to incur a participation cost for ascending bid auctions sufficient to equalize profits between the two formats.

Ivanova-Stenzel and Salmon [2008b] examines the ability of two hypotheses to explain the low willingness to pay for ascending bid auctions. In particular, they examine entry in auctions in which entry is endogenous, but the losing bidders do not pay a participation cost and the winning bidder incurs a "surplus tax" to test the hypothesis that loss aversion may play a role. They also use a second-price sealed-bid auction in place of the ascending bid auction to test the hypothesis that bidders may become impatient for the ascending auction to end. They find that neither of these hypotheses can explain the results of Ivanova-Stenzel and Salmon [2004].

Ivanova-Stenzel and Salmon [2008a] experimentally examines the question of whether first-price auctions of ascending bid auctions will generate more revenue, given that bidders in Ivanova-Stenzel and Salmon [2004] and Ivanova-Stenzel and Salmon [2008b] demonstrate a preference for ascending clock auctions. In particular the two auction formats compete for the same set of potential bidders. They find that bidder preferences for ascending bid auctions restores revenue equivalence between these formats, in contrast to the higher revenue for first-price auctions typically observed when the number of bidders is fixed (see e.g. Kagel and Levin [1993]).

Engelbrecht-Wiggans and Katok [2005] reports the result of a similar experiment but finds that, while bidders seem to prefer the ascending bid auction, the increased number of bidders in the ascending bid auction is not sufficient to drive observed revenue above that of the first-price auction, due to the overbidding in first-price auctions. In what is the closest experimental design to that of this paper, they also report the result of experiments in which potential bidders must choose between participating in either an ascending bid auction or a first-price auction and an outside option. They elicit this choice for a range of possible outside options using a Becker deGroot Marschak (BDM) mechanism. They found no statistically significant difference in the willingness to pay for these two auction formats, despite the fact that bidders earn significantly more in the ascending auction. Their design differs from ours in several important ways. First, bidders in this experiment did not observe their value until after entry had occurred. That is, entry decisions were not able to be conditioned on bidder valuations. Second, in their design, auction format was varied on a within-subject basis, whereas we vary this between subjects.[1]

Ivanova-Stenzel and Salmon [2011] reports experimental results of a design extremely close to that of Ivanova-Stenzel and Salmon [2008a] with one crucial difference: the bidder observes her value before making her entry decision. They find that bidders with low valuations are likely to choose the first-price auction, while bidders with high valuation are likely to choose the ascending clock auction. They also find that revenue and efficiency are equal between the two formats. However, bidder payoffs are higher in the ascending bid auctions. To the best of our knowledge, this is the only other experimental examination of endogenous participation in independent private value auctions in which the bidder observes his value before making an entry decision. Our design differs from theirs in that, rather than being asked to choose between auction formats with a given value, bidders choose whether to participate or not in a given auction format by expressing their willingness to pay the participation cost. Interestingly, we do not find any difference in willingness to pay between the two formats for low or high values.

Ivanova-Stenzel and Salmon [2011] finds that bidders with low valuations self select into first-price auctions and that bidders with high valuations self select into English clock auctions in an environment in which there is no cost of participation for either format. Rather, the bidder must choose which of these two formats to enter. This means that bidders with lower values have a relative preference for first-price auctions and bidders with higher values have a relative preference for English clock, a phenomenon that Ivanova-Stenzel and Salmon [2011] dubs the high/low divide. However, we find that when a bidder has a lower value, or has a higher value, there is no difference in willingness to pay between the two formats. This may be because bidders in our design don't have to participate in an auction and choose the format. Instead they choose whether to incur a cost and participate in an auction or not. That is, when a bidder's choice set includes the possibility of not participating an an auction at all, we find no evidence for the high/low divide.

[1] Aycinena and Renstchler (2011) uses within-subject variation on auction formats to examine bidding behavior in auctions with endogenous entry.

3 Theoretical Predictions

A set of risk neutral players $N \equiv 1, ..., n$ are potential bidders in an auction for a single unit of an indivisible good. The seller's valuation of the good is 0, and this is common knowledge. Each potential bidder $i \in \mathbf{N}$ privately observes her value of the good v_i. Each value is an independently drawn realization of the random variable V, with continuous and differentiable distribution F, with density $f = F'$ and support $[0, v_H]$. After potential bidders privately observe their values, they simultaneously report their respective maximum willingness to pay to enter the auction. The cost of participating in the auction, $c \in [0, c_H]$, is then drawn from a uniform distribution. This cost of participation is common to all potential bidders in the auction and this is common knowledge. Menezes and Monteiro [2000] demonstrates that in equilibrium, bidders employ a cutoff entry strategy. That is, for potential bidder i, if v_i is (weakly) above a cutoff value, denoted as v_c, then she will enter the auction. If $v_i < v_c$, then she will not enter the auction. This equilibrium cutoff strategy is the same in both first-price and English clock auctions and satisfies

$$v_c F(v_c)^{n-1} = c.$$

Note that in our experimental design we use the Becker deGroot Marschak (BDM) mechanism to elicit maximum willingness to pay (WTP_i) for a given value before observing the cost. If potential bidder i's $WTP_i \geq c$, then the bidder enters the auction and pays c. If potential bidder i's $WTP_i < c$, then she does not enter the auction and does not pay c. Having bidders´ participate in the auction if and only if their maximum willingness to pay weakly exceeds c is consistent with equilibrium play. Note that bidders have an incentive to reveal their true maximum willingness to pay. Thus, requiring bidder's to enter their maximum willingness to pay using an incentive compatible mechanism allows us to elicit WTP_i , where in equilibrium

$$WTP_i = v_i F(v_i)^{n-1}.$$

Upon entering the auction, bidders are informed of the number of bidders who entered, $m \leq n$. Bidder i chooses a bid, $b_i \in \mathbb{R}_+$ in an effort to obtain the good. Bidders are not budget-constrained. The vector of bids is $b \equiv b_1, ..., b_m$.

When bidders choose their bids, they know their value and how many other bidders they face. Since, in equilibrium, each bidder employs the same cut-off entry strategy, any bidder who has entered must have a valuation above v_c. Thus, the subsequent auction is just a standard independent private value auction with m bidders in which each valuation is drawn from

$$F(v \mid v \geq v_c) = \frac{F(v_i) - F(v_c)}{1 - F(v_c)}.$$

In an English clock auction, bidders have a weakly dominant strategy to bid their value. As such, their equilibrium bid function is $\rho(v_i) = v_i$. In a first price auction (following Menezes and Monteiro [2000]) the equilibrium bid function is

$$\beta(v_i) = v_i - \left(\frac{1}{(F(v_i) - F(v_c))^{m-1}}\right) \int_{v_c}^{v_i} (F(t) - F(v_c))^{m-1} \, dt.$$

Menezes and Monteiro [2000] finds that first-price and English clock auctions are revenue equivalent when bidders face a common participation cost and learn the number of bidders before placing their bids. This expected revenue, R, is given by

$$R = n(n-1) \int_{v_c}^{v_H} (1 - F(t)) \, tF(t)^{n-2} f(t) \, dt.$$

4 Experimental Design

In each session, fifteen subjects are randomly matched into groups. Each of these groups comprises a set of potential bidders in a single-unit auction. Each subject observes the number of potential bidders. She also observes her valuation of the good, which is an integer between 0 and 100 independently drawn from the discrete uniform distribution. Each bidder then indicates her maximum willingness to pay (WTP_i) to enter the auction, without observing the cost of participating in the auction. This participation cost is an integer between 1 and 30 drawn from the discrete uniform distribution. This was done in order to reduce the prevalence of participation costs so costly as to preclude any participation in a given auction, and to preclude large losses and potential bankruptcy. If a potential bidder's maximum willingness to pay exceeds the participation cost, then she incurs this cost and enters the auction. Otherwise, she does not participate in the auction and instead participates in a pastime intended to alleviate boredom while waiting for the next period to begin.[2]

Reported maximum willingness to pay was restricted to be between 0 and 31. As such, our data is censored. Given our parameters, there are then three relevant regions to consider. In the first of these, a bidder's value is such that the predicted WTP is less than one. This implies that the bidder is not predicted to enter the auction, regardless of c. In the second region, predicted willingness to pay is between 1 and 30 (the bidder is predicted to enter the auction when c is less than the predicted WTP). In the third region a bidder's value is such that predicted willingness to pay is greater than thirty, and the bidder is predicted to always enter the auction, regardless of c.

Subjects who participate in the auction are informed of the number of actual bidders there are in the auction before placing their bids. Once the auction is complete, subjects observe results and move to the next period and are randomly and anonymously re-matched. This process is repeated for a total of forty periods.

[2]This pastime consists of playing tic-tac-toe against the computer. Subjects do not earn money based on their tic-tac-toe results, but they do observe whether they won, tied or lost. Subjects can play multiple games; the only constraint is time. When the auction is complete, all subjects move to the next period at the same time.

We employ a 2×2 design that varies the number of potential bidders in a group within subjects, and varies the auction format between subjects such that bidders in a given session participate in the same auction format throughout the entire session, and the number of potential bidders changes over the course of said session. In particular, we alternate the number of potential bidders in each auction between three and five in ten period blocks. In order to control for order effects, we balance the order in which subjects face these alternative group sizes. That is, in half of our sessions, bidders participate in ten periods with groups of five, then switch to groups of three and then repeat. In the other half of our sessions bidders participate in ten periods with groups of three, then switch to groups of five and then repeat. We vary the auction format between a first-price sealed-bid auction, and an ascending clock or English clock auction on a between-subject basis. This experimental design is summarized in Table 1.

At the end of each period, subjects observe the number of potential bidders who participated in the auction, whether or not they obtained the good, the price that was paid for the good and their profit for the period . In first-price auctions they are also shown all the bids that were placed, ordered from largest to smallest. In English clock auctions subjects are shown the prices at which subjects abandoned the auction. All this information was shown to subjects regardless of whether or not they participated in the auction that period.[3] This was done to homogenize feedback between those who participated in the auction and those who did not.

All sessions were run at the Centro Vernon Smith Economía Experimental at the Universidad Francisco Marroquín. Subjects were undergraduates of said institution recruited using ORSEE (Greiner [2004]). The computer interface was programmed in z-Tree (Fischbacher [2007]). Subjects were seated at computer terminals for the duration of the experiment. These terminals have dividers to prevent subjects from interacting outside of the computer interface. Once seated, subjects were shown video instructions (they were also provided with a hard copy of the instructions). This video contains screen shots of the computer interface in order to familiarize subjects with the environment. Once the video was completed, subjects were asked to complete a short quiz to ensure comprehension. Any remaining questions were then answered in private. At the end of the experiment, subjects completed a post-experimental survey and were paid in private.

Each session lasted for approximately one and a half hours. Subjects were paid a $Q20 \approx US\$2.50$ show-up fee. All other monetary amounts in the experiment were denominated in experimental pesos ($E\$$), which were exchanged for Quetzales at a rate of $E\$7.5 = Q1$. Subjects began the experiment with a starting balance of five hundred experimental pesos to cover incurred entry costs and potential auction losses. The average payoff was $Q102$, with a minimum of $Q47$ and a maximum of $Q167$.

[3] When displaying bids or prices at which subjects abandoned an auction, participant numbers are suppressed. Thus feedback was anonymized.

5 Results

5.1 Willingness to Pay

Bidders reveal higher than predicted threshold entry decisions as measured by their willingness to pay (WTP) to enter auctions. Table 2 reports summary statistics regarding predicted and observed WTP across auction format and across group size. Note that regardless of auction format and group size, average reported WTP is greater than average predicted WTP when predicted WTP is censored to match the choice set of potential bidders.

This over-entry is statistically significant for both first-price and English clock auctions, whether group size is 3 or 5.[4] When bidders report WTP that exceeds theoretical predictions, they express a threshold entry strategy which leads to over-entry in expectation. Thus, we will refer to this phenomenon as over-entry. It is important to note that subjects had previously participated in an experiment with endogenous entry in both of these auction formats, but are still over-entering in this subsequent experiment. Also note that our measure of predicted WTP is truncated to match the decision set faced by potential bidders in the sense that if the true predicted WTP exceeds 31, we replace it with 31, because this is the largest WTP we allowed potential bidders to report.

Figure 1 illustrates this over-entry by plotting predicted WTP in all three regions over a scatter-plot of the data in both auction formats and with both group sizes in the second 20 periods. As the figure illustrates, there is practically no room for under-entry in region 1, and no room for over-entry in region 3. The over entry is most clearly evident in groups of 5, where the vast majority of observations lie above the predicted WTP curve. Note that in region 3 (where all potential bidders are predicted to enter the auction with certainty), that reported WTP such that entry is guaranteed are the most common, regardless of group size or auction format. Similarly, in region 1 (where potential bidders are predicted to not enter the auction with certainty, reported WTP of 0 is very common. In addition, WTP in multiples of 5 seem to be focal; indeed, fully 64.9% of reported WTP are multiples of 5.

In the second 20 periods reported WTP still exceeds theory in first-price auctions when group size is 5 (sign test, $w = 53$, $p < 0.01$), but the difference is no longer statistically significant for groups of 3 (sign test, $w = 33$, *n.s.*).[5] In English clock auctions reported WTP still exceeds theory when group size is 3 (sign test, $w = 39$, $p = 0.0137$) and when group size is 5 (sign test, $w = 51$, $p < 0.01$) in the second 20 periods.

Figure 2 illustrates the difference between reported and predicted WTP over the 40 periods for both auction formats and both group sizes. Note that in

[4]For first-price auctions, sign test $w = 41$ ($p = 0.0031$) with groups of 3 potential bidders and $w = 59$ ($p < 0.01$); for English clock auctions $w = 40$ ($p = 0.0067$) for group size of 3 and $w = 52$ ($p < 0.01$) for groups of 5. The unit of observation is at the individual subject level. If we use session level data as the unit of observations we have 4 observations and the result is still marginally significant ($w = 41$, $p = 0.0625$) except for English clock auctions with groups of 3.

[5]*n.s.* indicates that the test is not significant at conventional levels.

first price auctions the level of over-entry decreases over time. However this decrease is only statistically significant for groups of five (comparing the average individual revealed WTP in the first half of the experiment to the second half; sign test, $w = 35$, $p = 0.0407$). There is no statistically significant decrease in over-entry for English clock auctions, regardless of group size, or in first-price auctions when group size is 3.

In Figure 3, the difference between reported and predicted WTP is illustrated over bidder valuations. Not surprisingly, reported WTP is clearly increasing in potential bidder valuations. In what is perhaps our most surprising result, we find that reported WTP is higher when groups size is 5 than when group size is 3 (Sign test, $w = 7$, $p = 0.0352$).[6] This is surprising because both predicted and observed bidder payoffs are higher when group size is three in both auction formats. Further, this result is still significant when we restrict attention to the second half of the experiment (sign test). We hypothesize that this may be due to a joy of winning that is increasing in the number of people in the respective competition. In particular, it may be that bidders receive some non-pecuniary payoff from winning an auction that is increasing in the number of bidders they face. Alternatively, this could also be explained by a love of beating other people in competition. In other words, it may be that bidders receive some non-pecuniary payoff from beating another other players in a competitive environment. In this sense, winning an auction with more bidders. [not sure what the difference is between this two hypothesis...]

When we compare reported willingness to pay across auction formats, we find that bidders are willing to pay more for first-price auctions than for English clock auctions. This is true when group size is 3 (Robust rank order test, $\acute{U} = 1.586$, $p = 0.056$) and when group size is 5 (Robust rank order test, $\acute{U} = 2.502$, $p = 0.006$).[7] This is of interest because Ivanova-Stenzel and Salmon [2004] finds that bidders have a higher WTP for English clock auctions when they do not observe their value before making their entry decision.[8] Thus our results line up more closely with those of Engelbrecht-Wiggans and Katok [2005], who finds no difference in WTP between first-price and English clock auctions in an environment that closely resembles ours, except that bidders only observe their value after they enter the auction. As mentioned above, subjects in our experiment have previous experience in an experiment involving endogenous entry in auctions where we varied auction format (first-price or English clock) within subjects.

We also test how observed WTP conforms with Nash predictions using a

[6]If we examine this by institution using session level data we have only 4 observations and results are not statistically significant. However, if we use the individual level data, then this result is highly significant for both auction formats, with p-values less than 1%.

[7]The unit of observation for these tests is the average WTP for group size in a given session. Note however, when we restrict attention to the second half of the experiment, this result is no longer significant (Robust rank order test, $\acute{U} = 0.834$, *n.s.*).

[8]Ivanova-Stenzel and Salmon [2008b] and Ivanova-Stenzel and Salmon [2011] both find that bidders will often choose English clock auctions over first price auctions when bidders do not know their valuation prior to entry. Since all else is equal between the two formats in their design, it is not possible to determine if this choice represents a higher WTP.

random effect Tobit specification to control for individual subject effects, and to account for the fact that reported WTP is censored. Our specification is given by

$$WTP_{it} = \beta_0 + \beta_1 \cdot PWTP_{it} \cdot G^3_{it} + \beta_2 \cdot PWTP_{it} \cdot G^5_{it} +$$

$$\beta_3 \cdot G^5_{it} + \beta_4 \cdot FPA_i + \beta_5 \cdot ln\,(t+1) + \beta_6 \cdot O_{it} + \gamma \cdot M_i + \alpha_i + \epsilon_{it}$$

where WTP_{it} is potential bidder i's revealed WTP in period t, $PWTP_{it}$ is bidder i's predicted WTP in equilibrium during period t,[9] G^3_{it} is a dummy indicating that group size is 3, G^5_{it} is a dummy indicating that group size is 5, FPA_i is a dummy indicating that the auction format is a first-price auction, $ln\,(t+1)$ captures learning, O_{it} is a dummy indicating that the order of group size variation was 5 for 10 periods and then switching in 10 period intervals, and M_i is a vector of demographic and other variable such as gender, age, risk attitudes, preferences for competition. Note that if subjects behave on average exactly as predicted by theory, we would expect $\beta_1 = \beta_2 = 1$, and $\beta_0 = \beta_3 = \beta_4 = 0$. The coefficient on β_6 captures any potential order effects and β_5 learning.

Table 3 reports our baseline results. Specification (1) is our basic specification; specification (2) controls for gender and specification (3) for gender and a dummy for males in first-price auctions interaction. In these three specifications we pool the data across all regions. Of interest is that the coefficients on $PWTP_{it}$ are positive and highly significant for both group sizes, regardless of specification. Further, the coefficients for each group size are practically identical and we cannot reject the null that $\beta_1 = \beta_2$. It is important to note that the coefficient, although very close, is actually less than one (we reject both jointly and independently the null that $\beta_1 = 1$ and$\beta_2 = 1$). Given that the constant is also positive and statistically significant, this indicates that bidder's WTP is slightly less responsive to valuation than predicted by theory, and that there is a level effect. This level effect is consistent with the high degree of over-entry we observe. Also regardless of specification, the coefficient on G^5_{it} is highly significant and positive, indicating that WTP is increasing in group size.

Specifications (5) through (8) check the robustness of results by controlling for different regions. Specifically, specifications (5) and (6) focus on regions 1 and 2, dropping region 3, where WTP_{it} is censored from above. Given that we observe over-entry and there is no room for over-entry in this region due to censoring, it makes sense to check whether results hold when we remove this region. Not surprisingly the magnitude of coefficient $PWTP_{it}$ for groups of 3 reduces from 0.95 to 0.85. Surprisingly, the $PWTP_{it}$ coefficient for groups of 5 increases from 0.95 to 1.085. Specifications (7) and (8) focus exclusively on region 2, where the bidder is predicted to enter the auction when predicted WTP_{it} exceeds c. Notice that when we focus exclusively on this region, the magnitude of coefficients β_1 andβ_2 reduce dramatically to 0.671 and 0.696, although we still cannot reject the null that $\beta_1 = \beta_2$. These results suggest that individuals

[9] Recall that in equilibrium predicted willingness to pay is given by$PWTP_i = v_i F\,(v_i)^{n-1}$.

WTP is somewhat less sensitive to the observed value than predicted by theory, although still at a higher level throughout. This can be seen in Figure 3, that shows WTP across different values.

Going back to specifications (2) and (3), note that when we control for auction format, but do not interact auction format with gender, results indicate that WTP is higher for first-price auctions. However, once we control for this interaction, the coefficient on FPA_i is no longer positive, while the interaction of FPA_i and a dummy for males is positive and highly significant. These results suggest that men have higher WTP for first-price auctions than women and men in first-price auctions have higher WTP than men in English-clock auctions. This is consistent with the results of non-parametric tests: between male and female WTP in first price-auctions (Robust rank order test, $\acute{U} = 2.548$, $p = 0.005$.). There is no similar gender difference, for English clock auctions (Robust rank order test, $\acute{U} = -0.774$, $n.s.$). The difference between male WTP across auction formats is only marginally statistically significant using session level (Robust rank order test, $\acute{U} = 1.286$, $p = 0.099$.) Figure 4 illustrates this difference across auction format and group size. Figure 5 contains box plots of WTP across gender, auction format and group size, and contrasts them with predicted WTP.

There are several hypothesis that might explain the higher WTP by males in FPAs. One hypothesis is that this difference may be due to men being less risk averse than women (see Eckel and Grossman [2008] for a meta-analysis of this literature). This difference could also be driven by a relative male preference for competition (hypothesis 2); such a gender difference was shown in Niederle and Vesterlund [2007]. Finally, the higher WTP for first-price auctions for men could also be due to the fact that first-price auctions have higher strategic uncertainty than English clock auctions. If men prefer environments where there is more strategic uncertainty, then they will tend to have higher WTP in FPAs relative to women and relative to other men in ECAs.

We test our first hypothesis looking at a subset (87.5%) of individuals for whom we have risk data collected in an earlier experiment.[10] We don´t find strong support for our risk hypothesis. First, there is no difference in the risk attitudes between the men and women assigned to our first-price auction treatment (Robust rank order test, $\acute{U} = 0.602$, $n.s.$), nor is there difference between males assigned to first-price and English clock auction treatments (Robust rank order test, $\acute{U} = 0.801$, $n.s.$).

Further, Table 4 reports results of our econometric specification which controls for risk preferences. Specification (1) in Table 4 is the same as specification (4) in Table 3, but only for the sub-sample of individuals for whom we have the

[10] This measure of risk is similar to Holt and Laury (2002) except that the safe lottery in each row is replaced by a certain outcome. Thus, each row features a task that is similar to the entry choice of a potential bidder, in which entry is a lottery, and not entering yields a certain payoff (of zero). We also find no difference in risk attitudes between the men and women assigned to our first-price auction sessions when we use a Holt and Laury (2002) measure of risk aversion (Robust rank order, $\acute{U} = 1.103$, $n.s.$). See Appendix B for both of these risk tasks, as they were presented to subjects.

risk data. The results for this sub-sample are very similar in the magnitude of coefficients and statistical significance, with the exception of the dummy for first price auctions (although the interaction of males and first price auctions still holds). In specification (2) we include a dummy for the number of safe choices in the risk preferences elicitation task, in which the safe option was a certain amount. The coefficient is negative and statistically significant. Furthermore, the coefficient for males in first-price auctions reduces in magnitude and is only statistically significant at the 10% level. Although promising, when we check to see how the number of safe choices interacts with auction format, however, it becomes clear that risk attitudes only play a role in determining the WTP for English clock auctions. As such, we conclude that our measure of risk aversion might play a role in the higher WTP exhibited by men, but if so, it plays a minor role.

Hypothesis 2 suggests this difference could also be driven by a relative male preference for competition, if first-price auctions are seen as more competitive. We use data for a subset of our sample (85.8%) on preferences for competition performed in a different experiment and do not find support for this hypothesis.[11] First we test whether there are gender differences in competition for subjects assigned to first-price auction treatment and find only weak evidence for gender difference (Robust rank order test, $\acute{U} = 1.384$, $p = 0.083$). We do not find any difference in competitiveness between males assigned to the first-price auction and the English clock auction treatments (Robust rank order test, $\acute{U} = 0.423$, *n.s.*).

We explore this hypothesis further with regression results that control for preferences for competition, reported in Table 5. Our first specification again is the same as specification (4) in Table 3, but only for the sub-sample of individuals for whom we have data on competitiveness. Overall the results seem to hold for this sub-sample. In specification (2) we control for risk using a method that more closely parallels Holt & Laury (2002), by eliciting choices between two lotteries. Although the coefficient on the number of safe lotteries chosen is not statistically significantly different from 0, controlling for the number of safe lotteries chosen reduces the magnitude on the coefficient on males in first-price auctions from 7.8 to 6.84. In specification (3) we additionally control for the measure on competitiveness. Note that the coefficient is positive and statistically significant, suggesting that individuals who choose 100% of their rewards to come from a tournament are willing to pay on average 6 more than those who choose 100% of their rewards from piece-rate. The magnitude is large, but does not seem to explain well the male effect in first-price auctions, as the magnitude on this coefficient only changes from 6.8 to 5.9. Specifications (4) and (5) split the competitiveness effect between first-price and English-clock auctions, and between men and women correspondingly. Notice in these specifications that competitiveness is correlated with an increased WTP for in English-clock auctions and for women, but the same is not true for first-price auctions or

[11] Our measure of preferences for competition is the weight that a subject places on a tournament payoff rather than a piece-rate payoff when the tournament is between four subjects over a real effort task.

for men. Further, when competitiveness is split these ways, we see only a very small reduction in the male coefficient for first-price auctions (0.36 and 0.23 correspondingly). As such, we conclude that our measure of competitiveness does not explain why men are willing to pay more to participate in a first-price auction than in an English clock auction.

Our final hypothesis is that the higher WTP for first-price auctions for men could also be due to the fact that first-price auctions have higher strategic uncertainty than English-clock auctions. Holding risk preferences (arising from nature) constant, if men prefer environments with strategic uncertainty, perhaps due to greater overconfidence, then this could explain their higher WTP for first-price auctions. Since English-clock auctions have a dominant strategy, this auction format is in some sense very similar to a lottery, that is, it leaves no room for strategic uncertainty. The same is true of first-price auctions if bidders behave as predicted (and know others will too).. However, the fact that bidders must determine how much to shade their bid and that this depends on how they think others will do so (influenced by many factor such as number of bidders, risk attitudes and so on) generates increased strategic uncertainty in first-price auctions relative to ascending or English clock auctions. Engelbrecht-Wiggans [2001] identifies this asymmetry in strategic uncertainty, but argues the increased strategic complexity in first-price auctions relative to English clock auctions may drive bidder preferences for English clock auctions.[12] Our findings suggest that there may instead be a preference for this strategic uncertainty, and that men may prefer it more than women.

5.2 Bidder payoffs and willingness to pay

So far we have been analyzing WTP relative to theoretical predictions of WTP, which depends on ex-ante expected bidder payoffs. However, actual payoffs may differ from ex-ante expected payoffs if the number of bidders who participate in the auction differs from the predicted number of entrants or if participants do not bid as predicted by theory. Table 6 contains summary statistics regarding observed and predicted bidder payoffs, as well as observed WTP. We consider bidder payoffs in the terminal sub-game, without accounting for the incurred participation cost, as this is the relevant comparison to WTP. Figure 6 compares observed bidder payoffs to observed WTP, predicted payoffs, predicted WTP (note that predicted WTP is censored to fit the choice set actually faced by subjects in our experiment), and the predicted payoff that a bidder should expect in the auction conditional on the actual number of bidders entered. It is particularly interesting to compare WTP to payoffs since bidders should not be willing to pay more than expected payoffs in the subsequent auction if they are only concerned with the monetary payoffs. However, we find that bidders earn less than they are willing to pay in first-price auctions with group size 3 (sign test, $w = 45$, $p < 0.01$) and group size 5 (sign test, $w = 51$, $p < 0.01$).

[12] Although Engelbrecht-Wiggans [2001] does not use the term strategic uncertainty, we believe this is consistent with what the paper refers to...

This also holds true for English clock auctions when group size is 3 (sign test, $w = 39$, $p < 0.01$) and when group size is 5 (sign test, $w = 46$, $p < 0.01$). These results indicate that not only are subjects over-entering with respect to theory, but with respect to actual payoffs as well.

In addition we find that bidders earn less than predicted in both first-price auctions (sign test, $w = 54$) and English-clock auctions (sign test, $w = 46$), where predicted bidder payoffs are conditioned on equilibrium play at all information sets in the game. This result is robust to separating the data by group size. This is interesting because bidders also consistently over-enter in both auction formats.

The fact that potential bidders have higher WTP for first-price auctions could be driven by relative payoffs. However, bidders earn more in English-clock auctions when group size is 3 (Robust rank order test,$\acute{U} = 2.502$, $p < 0.01$). This is also true when group size is 5 (Robust rank order test, $\acute{U} = 2.502$, $p < 0.01$).

5.3 Revenue

Table 7 contains summary statistics regarding both observed and predicted auction revenue. Figure 7 compared observed revenue against ex ante predicted revenue (which varies with the cost of participation) and predicted revenue conditional on the number of bidders who actually entered the auction.

Note that when group size is 3, observed revenue is less than predicted by theory, regardless of which measure of predicted revenue is used. This difference is significant for both first-price auctions (Sign test, $w = 4$, $p = 0.0679$) and English clock auctions (sign test, $w = 4$, $p = 0.0679$).[13] When group size is 5, however, observed revenue is greater than ex ante predicted revenue, but less than the revenue predicted by the actual number of entrants. This is driven by the fact that bidders tend to over-enter, but tend to under bid relative to theoretical predictions.[14] There are then two effects driving observed revenue. The first is increased revenue caused by the over-entry, since revenue is increasing in the number of bidders. The second is reduced revenue driven by underbidding of actual entrants. When group size is 3 the underbidding effect dominates, and when group size is 5 the over-entry effect dominates.

We also find that revenue is greater in first-price auctions than in English clock auctions whether the size of the group 3 (Robust rank order test, $\acute{U} = 2.502$, $p < 0.01$) or 5 (Robust rank order test, $\acute{U} = 4.484$, $p < 0.01$). Also, revenue is higher for larger group sizes (i.e. 5 vs. 3), in accordance with theory. This holds for both first-price (sign test, $w = 45$, $p < 0.01$) and English clock auctions (sign test, $w = 44$, $p < 0.01$). The difference however is almost twice what theory predicts. This large difference is driven in part by higher over-entry in auctions with a group size of 5. When group size is 3 it is almost twice (1.96 times) as likely for there to be none or only one entrant -in which case revenue

[13] Session level data is used for these tests.

[14] The observed underbidding may be due to bidders not treating sunk costs as sunk.

for the auction is 0- compared to when the group size is 5.[15]

5.4 Efficiency

In experiments with a fixed set of bidders it is commonly observed that English clock auctions are more efficient than first-price auctions. This is largely due to the fact that English clock auctions have a dominant strategy, and that bidders quickly discover and use this strategy, yielding relatively high levels of efficiency. Because there is no cost of participation, only allocative efficiency need be considered. This measure of allocative efficiency is given by

$$\frac{v_{winner}}{v_{max}}$$

where v_{winner} is the value of the auction winner, and v_{max} is the highest value of the bidders. This measure of allocative efficiency is simply the fraction of total surplus that is actually realized.

When there are participation costs, the measure of efficiency may differ. In particular, the nature of the participation costs must be considered. If the cost of participation is an entry fee which accrues to the auctioneer, then the cost is merely a transfer, and the standard measure of allocative efficiency is applicable. However, if the cost of participation is socially wasteful (such as the cost of traveling to the auction or the cost of preparing a bid), then maximal efficiency is achieved if the bidder with the highest valuation is the only bidder who enters the auction and obtains the good. Note that equilibrium play no longer predicts 100% efficiency in this case. The measure of efficiency that applies to this case is given by

$$\frac{v_{winner} + (n-m)c}{v_{max} + (n-1)c}$$

where n is the number of potential bidders, m is the number of bidders who enter the auction, and c is the (common) cost of participation. The additional term in the numerator is the number of people who do not enter, and the additional term in the denominator is the number of people who do not enter in the social optimum. There are then two effect for efficiency. One is allocative efficiency, and the other is entry efficiency.

It is important to note that equilibrium efficiency may be less than 100%, because any bidder with a valuation above the predicted WTP will enter, even though the social optimum is for only the potential bidder with the highest valuation to enter (provided her valuation is above c). This is in contrast to the case of a fixed set of bidders, where efficiency is always predicted to be 100%.

[15]Although predicted frequency of auctions with one or no bidders does not differ by group size, we find excessive over-entry in auctions with 5 potential bidders, relative to auctions with 3 potential bidders. Put differently, we observe on average 0.11 more bidders than predicted per auction with a group size of 3, vs. 0.87 more bidders than predicted per auction when group size is 5.

Although English clock auctions are more efficient than first-price auctions, the difference is not statistically significant (using averages of session level data as independent observations) when group size is 3 (Robust rank order test, $\acute{U} = 1.206$, *n.s.*) and when group size is 5 (Robust rank order test, 0.504, *n.s.*), when we focus on the allocative efficiency. The same is true for groups of 3 (Robust rank order test, $\acute{U} = -0.776$, *n.s.*) and groups of 5 (Robust rank order test, $\acute{U} = -1.206$, *n.s.*) when we assume that the participation cost is deadweight loss.

We also find that, when we assume that the participation cost is deadweight loss, efficiency is less than predicted for groups of 3 (sign test, $w = 46$, $p < 0.01$) and groups of 5 (sign test, $w = 50$, $p < 0.01$). Similar results hold for English clock auctions. For groups of 3 (sign test, $w = 37$, $p = 0.0337$) and groups of 5 (sign test, $w = 48$, $p < 0.01$) English clock auctions are less efficient than predicted when we assume that the participation cost is a deadweight loss.

6 Conclusion

We experimentally examine threshold entry decisions in independent private value auctions where participation is costly and bidders learn their value before they make their entry decisions. In particular, we elicit WTP using an incentive compatible BDM mechanism. Once each bidder has reported her WTP, a participation cost that is common to all potential bidders is drawn from a uniform distribution. If reported WTP (weakly) exceeds this participation cost then the bidder incurs this cost and enters the auction. Bidders are then told how many bidders there are in the auction and then place their bids.

We vary the auction format between a first-price auction and an English clock auction on a between-subject basis. In addition we vary the size of the pool of potential bidders between 3 and 5, on a within-subject basis.

In accordance with theory, we find that WTP is increasing in bidder valuation. Indeed, revealed WTP is roughly in line with theoretical predictions, plus a constant. For all three regions, revealed WTP is, on average, almost equal to predicted WTP plus a constant. For the region of values where theory predicts the entry decision to depend on the realization of c, we find that WTP increases in value at about 2/3 of what theory predicts. Thus, it seems that WTP increases in value at a lower rate than predicted by theory, but overall it starts from a higher level.

When bidders report WTP in excess of predicted WTP, we say that they are over-entering the auction, because, on average, they will enter the auction more than predicted by theory. The observed over-entry exists in both auction formats, and persists throughout the experiment. This is despite that fact that they are paying more to enter the auction than they earn, on average. This result is consistent with over-entry observed in other experimental environments (see e.g. Camerer and Lovallo, 1999, Fischbacher and Thoni, 2008 and Rapoport et al., 1998).

Our most surprising result is that bidders have a higher WTP for auctions with group size 5, than for auctions with group size 3. This is despite the fact that observed and predicted payoffs are both decreasing in the number of bidders. We argue that this result is consistent with a love of victory that is increasing in the number competitors. In particular, it may be that the utility gained by winning a competition is higher if the winner overcomes more opponents in order to win.

Interestingly, we also find that revealed WTP is higher for first-price auctions than for English clock auctions, although this result is not significant if we restrict attention to the second half of the experiment. This is interesting because Ivanova-Stenzel and Salmon [2004, 2008b, 2011] all find that bidders seem to prefer English clock auctions, although their experimental design is markedly different than ours. Engelbrecht-Wiggans and Katok [2005], which has a design much closer to ours (although bidders only learn their value after entry) does not find any difference in WTP across these two auction formats.

This result seems to be driven by men having a higher WTP for first-price auctions than for English clock auctions. There is no corresponding result for women, and this is not explained by risk preferences or competitiveness -although both of this seem to play a role in observed WTP. (As expected, we also find that measures of risk aversion reduce observed WTP and measures of competitiveness increase WTP.) We speculate this might be due to men, controlling for risk preferences, preferring environments where there is higher strategic uncertainty relative to women. Further research should help to shed light on this finding.

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A Instructions for first-price sessions

Instructions for the first-price auction sessions, translated into English, are below. The original instructions are in Spanish. Instructions for the English clock sessions are available upon request.

SLIDE No.1

Introduction

The following instructions will explain how you can earn money. The amount of money that each participant earns may vary considerably depending on the decisions the participant makes. Participants will interact only through computers. If anyone disobeys the rules, we will terminate the experiment and will ask you to leave without any earnings.

SLIDE No.2

Earnings in the experiment

The amounts in the experiment are denominated in Experimental Pesos (E$). Each participant will start the experiment with a balance of E$500. The profits (or losses) are added (or subtracted) to the balance. At the end of the experiment, we will convert your accumulated balance to Quetzales (Q1 = E$7.5), and we will pay it in cash.

SLIDE No.3

Overview

The experiment will have 40 rounds. In each round, you will participate in an auction for a good or a hobby. At the beginning of each round you will take a decision on whether: 1) you pay the PARTICIPATION FEE, and participate in the auction, or 2) you do not pay anything, and participate in a hobby. If you participate in the auction you can make money if you buy the good. If you participate in the hobby you will not earn (or loose) money.

SLIDE No.4

Value

At the beginning of each round each potential buyer will know her value of the auctioned good, but the potential buyer will not know how much the good is valued by the other potential buyers. The VALUE of the good for each buyer will be between E$0 and E$100, and it will be determined randomly. (All the values between 0 and 100 have the same probability in being designated). The VALUE of each buyer shall be independent from the others; the VALUE is not related (and probably will be different) to the VALUE of the others.

SLIDE No.5

The earnings you can get (if you purchase the good in the auction) depend on its VALUE, the PARTICIPATION FEE, and the Price that is paid for the good. If its VALUE is greater than the Price you pay + the PARTICIPATION FEE, you will earn the difference. VALUE – Price – PARTICIPATION FEE = Profit (or Loss). If the Price you pay is greater than the VALUE, you will lose money. If you do not buy it, you will have to pay the PARTICIPATION FEE.

SLIDE No.6

Participation FEE

The PARTICIPATION FEE is determined randomly between E$1 and E$30 for each round, and it will be the same for all participants. (All the fees between E$1 and E$30 are equally likely to be designated). In each round, all the potential buyers will have: • The same PARTICIPATION FEE, and • Probably a different VALUE.

SLIDE No.7

Participation

Once you have seen its VALUE, and before you know the PARTICIPATION FEE, you will be asked which is the MAXIMUM FEE you would be willing to pay in order to participate in the auction. The MAXIMUM FEE you enter will not affect the PARTICIPATION FEE, as this is determined randomly and it is the same for everyone.

SLIDE No.8

Participation

If the MAXIMUM FEE that you would be willing to pay is less than the PARTICIPATION FEE you will NOT participate in the auction (you will participate in a hobby), and you will pay nothing. If the MAXIMUM FEE that you would be willing to pay is higher or equal to the PARTICIPATION FEE, you will participate in the auction (you will not participate in a hobby), and you will pay the PARTICIPATION FEE.

SLIDE No.9

Participation Example

Suppose you have a value of 50 and the MAXIMUM FEE you would accept to pay to participate is 15. If the PARTICIPATION FEE for that round is 23, you are not willing to pay the PARTICIPATION FEE. Therefore, you will NOT participate in the auction and you will pay nothing. If the PARTICIPATION FEE for that round is 7, you are willing to pay more than the rate. Therefore, you WILL participate in the auction and you will pay the PARTICIPATION FEE (7). Take notice that the MAXIMUM FEE that you would be willing to pay (15) does not affect the PARTICIPATION FEE you pay to participate (7).

SLIDE No.10

Maximum Rate

Note that if you enter as your MAXIMUM FEE an amount less than what you are actually willing to pay, it is possible that you may not participate in the auction, even if you would rather preferred to. For example, suppose that the maximum that you are actually willing to pay to participate is 15: If you indicate a MAXIMUM FEE of 10 and the PARTICIPATION FEE is 12, you do not participate even if you would have rather preferred to pay 12 and participate. If you would have indicated a MAXIMUM FEE of 15, you would have participated and paid 12.

SLIDE No.11

Maximum Rate

On the other hand, if you indicate as your MAXIMUM FEE an amount higher than the maximum that you are really willing to pay, it is possible that you may participate in the auction and pay more than what you were willing to pay. Suppose that the maximum that you are actually willing to pay to participate is 15: If you indicate a MAXIMUM FEE of 20 and the PARTICIPATION FEE is 18, you do participate and pay 18 even if the maximum you were really willing to pay to participate was 15. If you would have indicated a MAXIMUM FEE of 15, you would have not participated and paid 18.

SLIDE No.12

Maximum Rate and Participation

In other words, what you pay to participate in the auction (PARTICIPATION FEE) does not depend on the maximum amount that you are willing to pay (MAXIMUM FEE). Therefore, you should indicate the maximum amount that you are willing to pay as the MAXIMUM FEE, as this will determine whether you participate or not, but will not determine how much you pay to participate in the auction.

SLIDE No.13

Auction

If you participate in the auction you should make a Price Offer. The person that made the highest Offer Price will buy the good. (In case of a tie between two or more bids, the purchaser will be determined randomly). The Price paid by the purchaser will be equal to its Offer. If you are the only participant in the auction, you will buy the good with any offer you make, even with an offer of 0.

SLIDE No.14

Earning of the Auction

The earnings of the buyer is the difference between the VALUE and the Price, minus the PARTICIPATION FEE: VALUE – Price – PARTICIPATION FEE = Earnings. Note that you will make money only if the Price at which you buy the good is lower than (VALUE – PARTICIPATION FEE). Those who do not buy the good pay the PARTICIPATION FEE.

SLIDE No.15

Auction Example

Example: Suppose that your value is 76. If your offer is 61 and the offers of the other participants are 37 and 60, you buy the good and pay the Price (61). Your profit in this round would be: 76 – 61 – PARTICIPATION FEE If your offer is not the highest, you do not buy the good and you pay the PARTICIPATION FEE.

SLIDE No.16

No Participation in the Auction

If you do not participate you will not have earnings or losses, and you will not pay the PARTICIPATION FEE. While the auction is being held, you can automatically make use of a hobby: Tic-tac-toe You will play against the computer and you will win if you can place 3 of the symbols (X) in a straight line (horizontal, vertical or diagonal). Your result in this hobby will not affect your earnings.

SLIDE No.17

Potential Buyers in the Auction

In some rounds, there will be 3 (you and other 2) potential buyers in the auction. In others, there will be 5 (you and other 4) potential buyers. In each round, everyone will know the number of potential buyers in the auction.

SLIDE No.18

Rounds

The experiment will have 40 rounds. In each round, the participants will be randomly reassigned, according to the number of potential buyers. That is, you will NOT be participating with the same people in all rounds.

SLIDE No.19

Summary

The experiment consists in a series of rounds. In each round: (1) You should enter the MAXIMUM FEE that you are willing to pay to participate in the auction. (2) The PARTICIPATION FEE, which is randomly selected, will determine whether you participate or not in the auction: • Participate (and pay the PARTICIPATION FEE) if the MAXIMUM FEE is higher or equal to the PARTICIPATION FEE. • DO NOT Participate (and you do not pay anything) if the MAXIMUM FEE is lower to the PARTICIPATION FEE.

SLIDE No.20

Summary

If you do not participate in the auction, you will not have earnings or losses, and you will not have to pay the PARTICIPATION FEE. If you participate in the auction, you can earn money by buying the good and its VALUE is higher than the Price + PARTICIPATION FEE. Earnings (if you buy the good) = VALUE – Price - PARTICIPATION FEE. If you do not buy the good, you will pay the PARTICIPATION FEE.

B Risk Elicitation Tasks

Parte I

Hoja Para Decisión de Sujeto # ____________________________

	OPCIÓN A	OPCIÓN B		Decisión
1	E$ 28	1: E$ 80	2 3 4 5 6 7 8 9 10: E$ 0	
2	E$ 28	1 2: E$ 80	3 4 5 6 7 8 9 10: E$ 0	
3	E$ 28	1 2 3: E$ 80	4 5 6 7 8 9 10: E$ 0	
4	E$ 28	1 2 3 4: E$ 80	5 6 7 8 9 10: E$ 0	
5	E$ 28	1 2 3 4 5: E$ 80	6 7 8 9 10: E$ 0	
6	E$ 28	1 2 3 4 5 6: E$ 80	7 8 9 10: E$ 0	
7	E$ 28	1 2 3 4 5 6 7: E$ 80	8 9 10: E$ 0	
8	E$ 28	1 2 3 4 5 6 7 8: E$ 80	9 10: E$ 0	
9	E$ 28	1 2 3 4 5 6 7 8 9: E$ 80	10: E$ 0	
10	E$ 28	1 2 3 4 5 6 7 8 9 10: E$ 80		

OPCIÓN A										Fila de Decisión	OPCIÓN B									
55	45	45	45	45	45	45	45	45	45	1	145	0	0	0	0	0	0	0	0	0
55	55	45	45	45	45	45	45	45	45	2	145	145	0	0	0	0	0	0	0	0
55	55	55	45	45	45	45	45	45	45	3	145	145	145	0	0	0	0	0	0	0
55	55	55	55	45	45	45	45	45	45	4	145	145	145	145	0	0	0	0	0	0
55	55	55	55	55	45	45	45	45	45	5	145	145	145	145	145	0	0	0	0	0
55	55	55	55	55	55	45	45	45	45	6	145	145	145	145	145	145	0	0	0	0
55	55	55	55	55	55	55	45	45	45	7	145	145	145	145	145	145	145	0	0	0
55	55	55	55	55	55	55	55	45	45	8	145	145	145	145	145	145	145	145	0	0
55	55	55	55	55	55	55	55	55	45	9	145	145	145	145	145	145	145	145	145	0
55	55	55	55	55	55	55	55	55	55	10	145	145	145	145	145	145	145	145	145	145

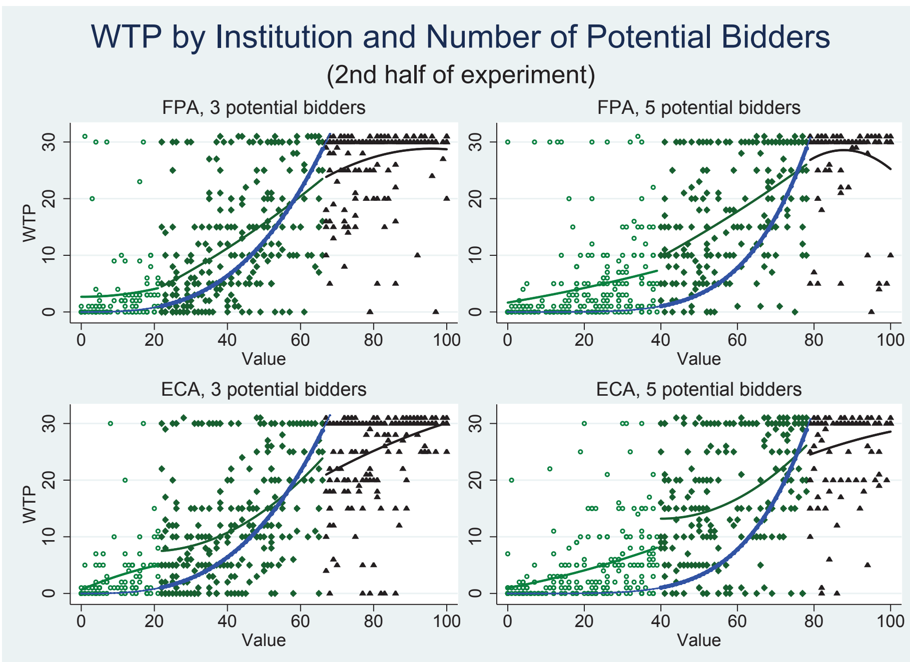

Figure 1: Scatter plots of revealed WTP and the predicted WTP curve

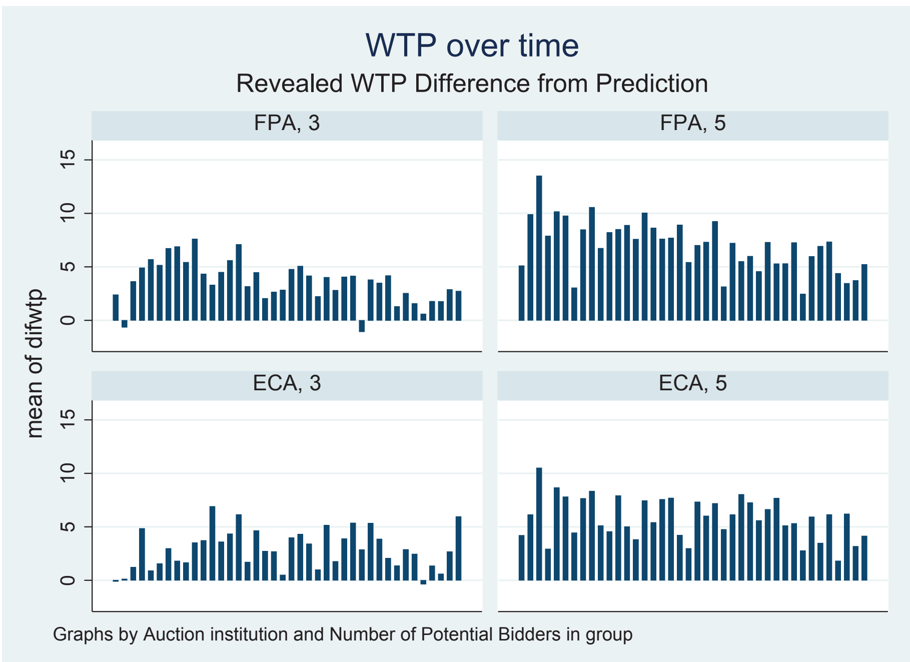

Figure 2: Difference between revealed and predicted WTP over time

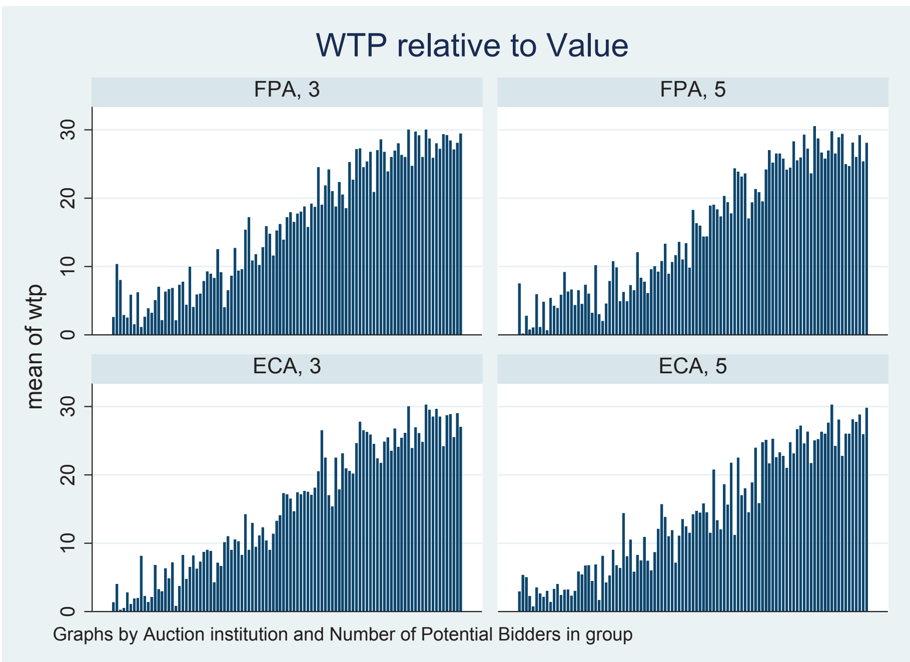

Figure 3: Difference between revealed and predicted WTP over values

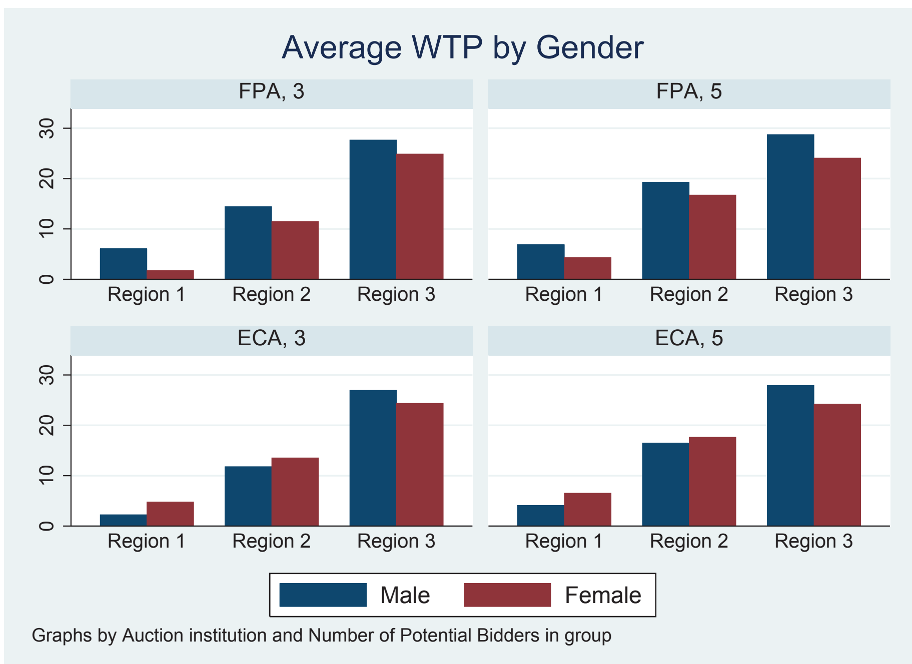

Figure 4: Average willingness to pay by gender in each region

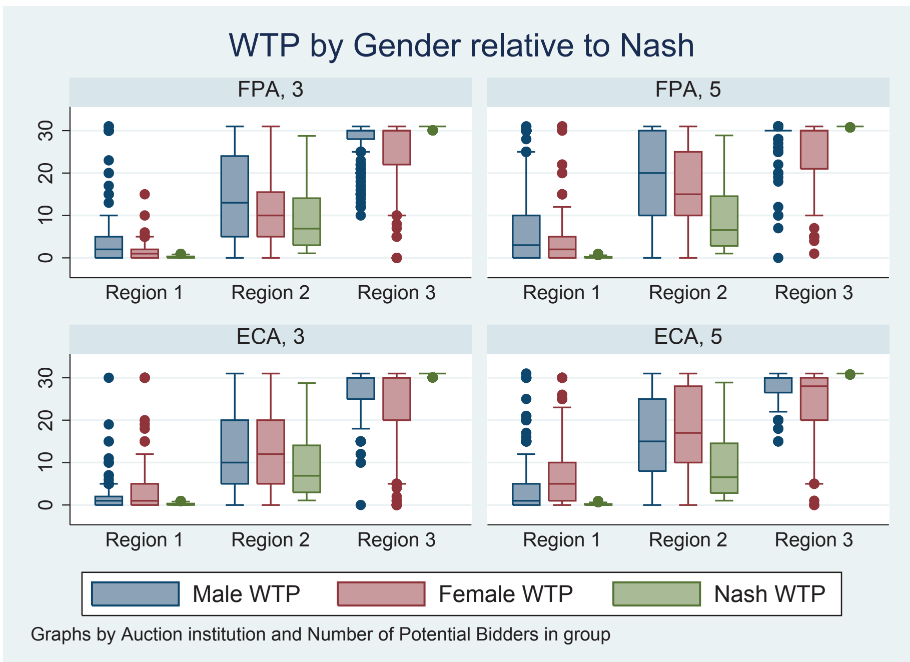

Figure 5: Box plots of willingness to pay by gender relative to Nash predictions

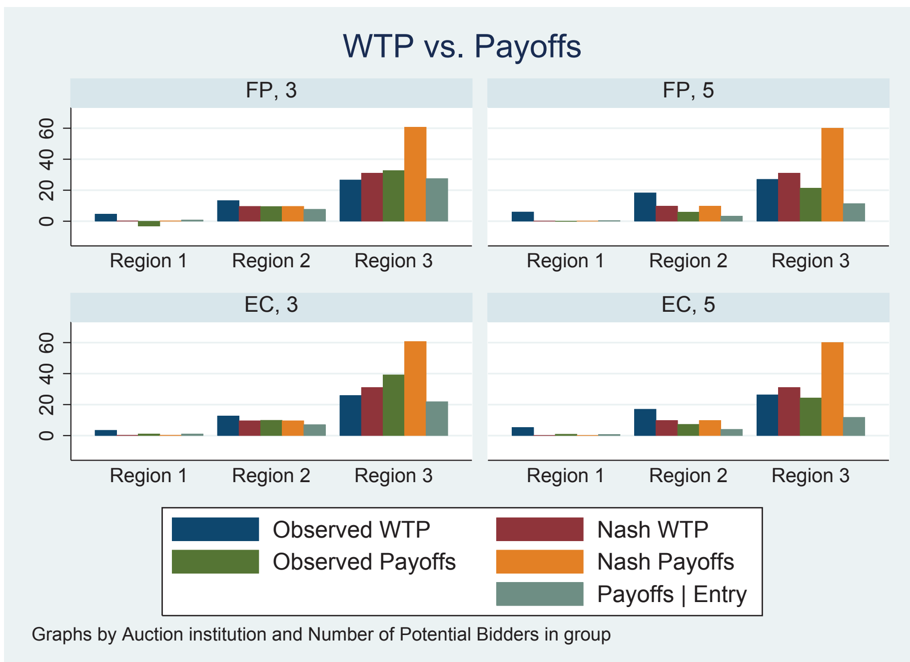

Figure 6: Willingness to pay and bidder payoffs relative to predictions

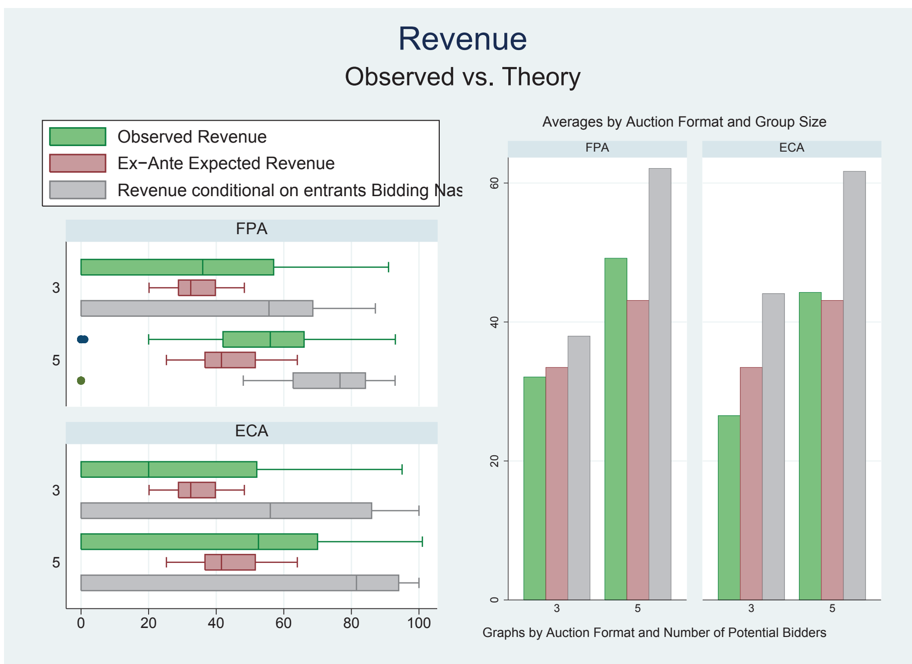

Figure 7: Auction revenue compared to predictions

Table 1: Summary of the experimental design

	Between-subject variation	
	First Price Auction (40 periods)	**English Clock Auctions** (40 periods)
Groups of Potential Bidders: 3 or 5 (within-subject variation)	5353	5353
	3535	3535
	3535	3535
	5353	5353

Table 2: Summary statistics on willingness to pay across group size and auction format

Group Size	Willingness to Pay (WTP)	First Price		English Clock	
		Mean	Std. Dev.	Mean	Std. Dev.
N = 3	Observed WTP [0-31]	16.3	11.8	15.4	11.7
	Predicted WTP (truncated [0-31])	15.2	13.1	15.2	13.1
	Predicted WTP (non-truncated [0-100])	*25.6*	*29.3*	*25.6*	*29.3*
N = 5	Observed WTP [0-31]	15.4	12.0	14.4	11.6
	Predicted WTP (truncated [0-31])	10.7	12.8	10.7	12.8
	Predicted WTP (non-truncated [0-100])	*17.5*	*26.4*	*17.5*	*26.4*

Table 3: Estimated Cutoff Strategies on Entry
Random Effects Tobit (at the individual level)

Dependent Variable: Revealed WTP

	All Regions (1, 2 & 3)				Regions 1 & 2		Region 2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Predicted WTP * Groups of 3	0.95***	0.95***	0.95***	0.95***	0.85***	0.85***	0.67***	0.67***
	[0.02]	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.04]	[0.04]
Predicted WTP * Groups of 5	0.96***	0.96***	0.96***	0.96***	1.09***	1.08***	0.70***	0.70***
	[0.02]	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.04]	[0.04]
Groups of 5 potential bidders	2.97***	2.96***	2.97***	2.96***	2.21***	2.22***	5.82***	5.86***
	[0.43]	[0.43]	[0.43]	[0.43]	[0.41]	[0.41]	[0.64]	[0.63]
First Price Auction	2.53**	2.12*	-3.13**	-3.25*		-3.00*		-4.23*
	[0.87]	[0.85]	[1.14]	[1.62]		[1.47]		[1.86]
Natural log of (Period+1)	-0.04	-0.05	-0.04	-0.04	-1.16***	-1.16***	-0.61*	-0.61*
	[0.20]	[0.20]	[0.20]	[0.20]	[0.22]	[0.22]	[0.28]	[0.28]
Order effects (5353 dummy)	-0.07	-0.14	0.67	0.13	-0.16	-0.48	0.77	1.01
	[0.86]	[0.84]	[1.05]	[1.64]	[0.95]	[1.67]	[1.34]	[2.00]
Male		1.19	-1.02	-2.07		-2.67*		-1.81
		[0.90]	[1.13]	[1.27]		[1.25]		[1.44]
FPA * Male			7.24***	8.28***	3.61**	7.78***	3.51*	6.95***
			[1.94]	[1.66]	[1.21]	[1.99]	[1.76]	[1.93]
Proportion Females in session				3.72		6.37		-2.11
				[7.30]		[8.01]		[9.82]
Age				0.08		0		0
				[0.21]		[0.20]		[0.29]
SAT Verbal				-0.01		-0.02**		-0.03***
				[0.01]		[0.01]		[0.01]
SAT Math				0.01+		0.01		0.01*
				[0.01]		[0.01]		[0.01]
FPA * Female					1.39		-1.35	
					[1.56]		[1.82]	
ECA * Female					2.78*		2.8	
					[1.27]		[2.09]	
Constant	2.73*	2.28*	3.13**	-1.62	4.62***	11.38	6.57***	16.15*
	[1.11]	[1.13]	[1.16]	[6.32]	[1.31]	[7.28]	[1.83]	[7.22]
sigma_u								
_cons	6.57***	6.37***	6.63***	6.67***	7.31***	7.10***	7.65***	7.70***
	[0.32]	[0.33]	[0.36]	[0.38]	[0.44]	[0.44]	[0.53]	[0.51]
sigma_e								
_cons	9.75***	9.75***	9.76***	9.75***	8.82***	8.82***	8.47***	8.44***
	[0.14]	[0.14]	[0.14]	[0.14]	[0.14]	[0.14]	[0.17]	[0.17]
R-squared								
Number of Observations (N)	4800	4800	4800	4800	3408	3408	1980	1980

+ significant at the 10% level (p<0.10), * significant at the 5% level (p<0.05), ** significant at the 5% level (p<0.01), *** significant at the 5% level (p<0.001)

Table 4: Estimated Cutoff Strategies on Entry, controlling for risk preferences
Random Effects Tobit (at the individual level)

Dependent Variable: Revealed WTP

	(1)	(2)	(3)
Predicted WTP * Groups of 3	0.94***	0.94***	0.94***
	[0.02]	[0.02]	[0.02]
Predicted WTP * Groups of 5	0.95***	0.95***	0.95***
	[0.02]	[0.02]	[0.02]
Groups of 5 potential bidders	3.08***	3.06***	3.08***
	[0.45]	[0.45]	[0.45]
First Price Auction	-2.49	-1.42	-3.3
	[1.60]	[1.55]	[3.19]
Natural log of (Period+1)	-0.18	-0.18	-0.18
	[0.21]	[0.21]	[0.21]
Order effects (5353 dummy)	-1.2	-0.31	-0.62
	[1.58]	[1.53]	[1.31]
Male	-1.25	-0.73	-1
	[1.39]	[1.34]	[1.48]
FPA * Male	7.00***	3.14+	5.68**
	[1.74]	[1.83]	[1.94]
Proportion Females in session	8.21	-1.4	7.43
	[6.85]	[7.16]	[7.03]
Age	-0.13	-0.14	0
	[0.31]	[0.31]	[0.21]
SAT Verbal	-0.01+	0	-0.01+
	[0.01]	[0.01]	[0.01]
SAT Math	0.01*	0.01	0.01+
	[0.01]	[0.01]	[0.01]
# of Safe Choices		-0.64*	
		[0.31]	
FPA * # of Safe Choices			-0.34
			[0.42]
ECA * # of Safe Choices			-0.60+
			[0.34]
# of Safe Lotteries			
FPA * # of Safe Lotteries			
ECA * # of Safe Lotteries			
Constant	2.57	5.97	3.53
	[8.75]	[9.57]	[7.51]
sigma_u			
_cons	6.45***	5.94***	6.39***
	[0.41]	[0.36]	[0.42]
sigma_e			
_cons	9.65***	9.66***	9.65***
	[0.15]	[0.15]	[0.15]
R-squared			
Number of Observations (N)	4200	4200	4200

+ significant at the 10% level ($p<0.10$), * significant at the 5% level ($p<0.05$), ** significant at the 5% level ($p<0.01$), *** significant at the 5% level ($p<0.001$)

Table 5: Estimated Cutoff Strategies on Entry, controlling for competitiveness
Random Effects Tobit (at the individual level)

Dependent Variable: Revealed WTP

	(1)	(2)	(3)	(4)	(5)
Predicted WTP * Groups of 3	0.95***	0.95***	0.95***	0.95***	0.95***
	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]
Predicted WTP * Groups of 5	0.98***	0.98***	0.97***	0.98***	0.98***
	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]
Groups of 5 potential bidders	2.84***	2.83***	2.84***	2.81***	2.82***
	[0.46]	[0.46]	[0.46]	[0.46]	[0.46]
First Price Auction	-0.78	-1.69	-0.63	4.48*	-2.62
	[1.69]	[1.55]	[1.49]	[1.89]	[1.96]
Natural log of (Period+1)	0	0	0	0	0
	[0.22]	[0.22]	[0.22]	[0.22]	[0.22]
Order effects (5353 dummy)	-1.77	-0.63	-0.63	-1.11	1.04
	[1.31]	[1.45]	[1.61]	[1.47]	[1.47]
Male	-2.16+	-1.89	-0.34	-0.98	4.78*
	[1.24]	[1.33]	[1.22]	[1.42]	[1.88]
FPA * Male	7.80***	6.84***	5.90***	6.48***	6.61**
	[1.81]	[1.80]	[1.64]	[1.87]	[2.03]
Proportion Females in session	15.50*	11.14	5.75	11.84+	1.41
	[6.91]	[6.98]	[7.15]	[6.52]	[7.21]
Age	-0.11	0.08	0.06	0.03	0.04
	[0.18]	[0.21]	[0.22]	[0.31]	[0.23]
SAT Verbal	-0.01	-0.02*	0	-0.02**	-0.01
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
SAT Math	0.02*	0.02**	0.01	0.02**	0.01
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
Competitiveness			0.06***		
			[0.01]		
# of Safe Lotteries		-0.23	-0.17	0.14	-0.19
		[0.35]	[0.34]	[0.32]	[0.37]
FPA * Competitiveness				0	
				[0.02]	
ECA * Competitiveness				0.10***	
				[0.02]	
Competitiveness * Female					0.13***
					[0.02]
Competitiveness * Male					0
					[0.02]
Constant	-5.65	-5.2	-8.48	-8.5	-4.45
	[7.56]	[8.18]	[7.69]	[9.10]	[8.63]
sigma_u					
_cons	6.52***	6.49***	7.15***	6.76***	6.28***
	[0.39]	[0.39]	[0.45]	[0.43]	[0.45]
sigma_e					
_cons	9.81***	9.80***	9.80***	9.80***	9.80***
	[0.15]	[0.15]	[0.15]	[0.15]	[0.15]
R-squared					
Number of Observations (N)	4120	4120	4120	4120	4120

+ significant at the 10% level (p<0.10), * significant at the 5% level (p<0.05), ** significant at the 5% level (p<0.01), *** significant at the 5% level (p<0.001)

Table 6: Summary statistics of bidder payoffs and observed willingness to pay

Group Size	Observed and Predicted Payoffs, and Predicted WTP	Obs	First Price Auctions		English Clock Auctions	
			Mean	Std. Dev.	Mean	Std. Dev.
N = 3	Profit (all potential bidders)	1200	5.4	21.3	7.4	23.3
	Expected Profit (all potential bidders)	1200	25.6	29.3	25.6	29.3
	Bidder Payoffs (entrants)	679	21.6	29.5	26.1	31.9
	Exante Expcted Bidder Payoffs (entrants)	679	18.2	28.9	15.2	31.3
	Expected Payoffs given number of entrants (entrants)	679	38.7	30.3	39.8	30.5
	Observed WTP (entrants)	679	24.4	7.8	24.3	7.7
N = 5	Profit (all potential bidders)	1200	-0.7	14.4	0.8	16.6
	Expected Profit (all potential bidders)	1200	17.5	26.4	17.5	26.4
	Bidder Payoffs (entrants)	653	10.8	20.7	13.4	25.1
	Exante Expcted Bidder Payoffs (entrants)	653	5.9	18.3	6.8	22.7
	Expected Payoffs given number of entrants (entrants)	653	28.1	29.4	30.0	30.1
	Observed WTP (entrants)	653	24.0	8.3	23.5	8.0

Table 7: Summary statistics of observed and predicted revenue

Group Size	Observed and Predicted Revenue	Obs	First Price Auctions Mean	First Price Auctions Std. Dev.	English Clock Auctions Mean	English Clock Auctions Std. Dev.
	Revenue	400	32.1	28.7	26.5	28.4
N = 3	Ex-ante Expected Revenue	400	33.5	7.7	33.5	7.7
	Expected Revenue, given entrants	400	38.4	33.6	44.5	42.2
	Revenue	240	49.2	25.8	44.3	30.9
N = 5	Ex-ante Expected Revenue	240	43.1	10.5	43.1	10.5
	Expected Revenue, given entrants	240	63.8	31.8	63.5	39.1

Table 8: Observed and predicted efficiency when participation costs are a deadweight loss

Group Size	Observed and Predicted Efficiency	Obs	First Price Auctions Mean	First Price Auctions Std. Dev.	English Clock Auctions Mean	English Clock Auctions Std. Dev.
N = 3	Efficiency	400	71.9%	36.5%	72.8%	33.1%
	Predicted Efficiency	400	76.1%	32.8%	76.1%	32.8%
N = 5	Efficiency	240	62.5%	34.7%	67.4%	30.6%
	Predicted Efficiency	240	77.4%	32.4%	77.4%	32.4%