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RESEARCH ARTICLE

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Second chance offers versus sequential auctions: theory and behavior

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Abstract Second chance offers in online marketplaces involve a seller conducting an auction for a single object and then using information from the auction to offer a losing bidder a take-it-or-leave-it price for another unit. We theoretically and experimentally investigate this practice and compare it to two sequential auctions. We show that the equilibrium bidding strategy in the second chance offer mechanism only exists in mixed strategies, and we observe that this mechanism generates more profit for the auctioneer than two sequential auctions. We also observe virtually no rejections of profitable offers in the ultimatum bargaining stage.

Keywords Ascending auctions · Ultimatum games · Mixed strategies · Experimental economics

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1 Introduction

Online marketplaces evolve as sellers find new ways to sell their products because they are always looking for new approaches that would increase their profits.[1] Sellers have begun combining bargaining offers with the standard auctions as a

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[1] See Bajari and Hortacsu (2003) and Lucking-Reiley (2000) for extensive surveys.

way of selling multiple units.[2] Some on-line marketplaces facilitate a version of this behavior allowing sellers to make what are called second chance offers to non-winning bidders.[3]

We are interested in analyzing how such a mechanism would work rather than investigating the practice specific to some site such as e-Bay because our ultimate interest in this mechanism extends beyond these consumer-to-consumer electronic auctions. Consequently we examine a generalized version of a second chance offer mechanism consisting of a second price or ascending clock auction followed by an ultimatum game played between the seller and the price setting losing bidder. One reason that seller may value the second chance offer mechanism is that if bidders naively bid their true value in the auction stage, the seller can exploit this information in the bargaining stage to obtain perfect price discrimination. The empirical question is whether bidders who are aware of the post-auction bargaining stage will alter their bidding strategy by enough so as to reduce the usefulness of the information gained during the bargaining stage, thereby impairing the revenue generating abilities of the mechanism. If not, it is possible that the use of this mechanism could be expanded well beyond e-Bay.

We begin our approach to analyzing this problem by characterizing the theoretical behavior in a two-stage game consisting of a second price or English clock auction in stage one and an ultimatum bargaining game in stage two played between the seller and the highest losing bidder. The purpose for this analysis is to serve as a foundation upon which to analyze the data from the experiments. The theoretical analysis shows that there exist no pure strategy equilibria for this game, at least for non-degenerate value distributions. Equilibria do exist in mixed strategies, but they are infeasible to solve for when bidders can have more than a few possible values. These equilibria are inefficient, which means we cannot apply the standard revenue equivalence theorem to argue that expected revenue should be the same between this hybrid institution and more traditional auction mechanisms.

We then conduct a controlled laboratory experiment to observe how bidders behave when faced with such a mechanism and how sellers in turn interpret the bids and make offers. As a side benefit of the experiment, the second chance offer mechanism allows us to observe behavior in ultimatum games that are almost fully contextualized into a market setting to determine if this has an impact on behavior. We also compare the revenue generation capabilities of the second chance offer mechanism with a sequential ascending auction institution without a reserve price. We chose the sequential ascending auction for comparison because it is the default alternative choice of a seller in a market such as e-Bay. We do not allow sellers to set reserve prices in these auctions as might be suggested by standard optimal auction theory. While e-Bay sellers can set reserve prices, the evidence in Bryan et al. (2005) suggests that they do so relatively rarely. Furthermore, Levin and Smith

[2] An e-mail example of such an offer is available upon request.

[3] According to e-Bay's rules, for example, second chance offers can be made when the original item goes unsold, when the original winning bidder fails to complete the transaction or when the seller has a second item. We are concerned with only the last case. E-Bay's complete rules concerning second chance offers can be found here, http://pages.ebay.com/help/sell/second_chance_offer.html. There is also a common variant (technically not allowed by most sites) that involves using the on-line auctions as a means of gaining information for conducting off-market trades which is a practice sometimes referred to as "fee avoidance" since the seller avoids paying the fee to the electronic auction site facilitating the transaction.

(1994) show the optimal auction involves no reserve price or entry fee in environments such as e-Bay when there are multiple sellers and entry is endogenous. The intuition behind this result is that all things being equal, bidders prefer the auction with the lower reserve price, and so sellers face a quasi-Bertrand game in attracting bidders to their auction. We note that the second chance offer mechanism provides an alternate way to engage in supply restriction that underlies the traditional optimal auction design but it may be less likely to decrease participation. The supply restriction will only be effective in raising revenue though if bidders in the first round do not attenuate their bids by too much in an attempt to get a lower offer in the second round such that overall revenue falls.

We will present our results from these experiments in a series of seven findings. The key findings are that the auction/bargaining hybrid institution turns out to generate significantly more profits for the seller than the sequential English auction while delivering approximately the same efficiency. The behavior of the participants on both sides of this auction/bargaining hybrid institution will turn out to match relatively well with the general characteristics of the theoretical predictions. A finding of particular interest and importance is that our results will show very strong evidence to support the subgame perfect prediction in the ultimatum game on the part of the responders as they accept all offers yielding non-negative surplus, with only a very few exceptions.

The most closely related paper to ours is Goeree (2003), which investigates second price auctions in an environment in which bidders expect to engage in post-auction strategic interactions among themselves. In his environment buyers typically wish to signal their value or cost through their bidding behavior which leads to the existence of pure strategy equilibria. The key difference is that in our environment, bidders wish to hide their value from the seller and do not want to signal it, resulting in a mixed strategy outcome. There are two other recent papers that find mixed strategies as the only equilibria of auctions, Rapoport and Amaldoss (2004) and Haile (2003). The first is in the context of all-pay auctions with discrete bids while the second deals with auctions followed by re-sale markets.[4]

The idea of the second chance offer mechanism is similar to the methodology proposed in Segal (2003) for using auctions to allow a monopolist facing unknown demand to gather information about the distribution of buyer values in setting prices. Segal's mechanism allows the monopolist to use information on the bids of other buyers to set the price offer to each specific buyer. This ensures incentive compatibility since a bidder's bid does not effect his own price. In the second chance offer mechanism the seller also obtains value information in the first stage to set prices in a later stage, but incentive compatibility is not retained since the seller can use the buyer's bid during the negotiation phase. Though similar, the two mechanisms are intended for different uses. The Segal mechanism is best suited to cases in which a seller wishes to sell a large number of items to a large number of buyers but initially has little information on the nature of the demand (i.e., a concert promoter selling concert tickets for a new band). The second chance offer

[4] Zeithammer (2004) and Roth and Ockenfels (2002) examine bidding behavior in formats more specifically based on e-Bay auctions. Since we are interested in the second chance offer mechanism in a more general setting we abstract away from these details. Also, Ivanova-Stenzel and Kröger (2004) investigate an e-Bay mechanism that involves a take it or leave it offer stage prior to an auction stage but that mechanism only involves a single unit.

mechanism is suited better to cases in which the seller wishes to sell a small number of items to a small group of buyers and therefore could not appeal to the large numbers requirements of the Segal mechanism.

Engelbrecht-Wiggans and Katok (2004) investigate an alternative approach to combining auctions and negotiations first proposed in Engelbrecht-Wiggans (1996) in which some of the units in a multi-unit auction can be pre-sold to buyers at a price to be determined by a subsequent auction. This mechanism was designed for procurement to combine the benefits of an auction mechanism in yielding low prices along with the benefits of a negotiation system that allows for enduring relationships with suppliers. The second chance offer mechanism represents an alternative means of accomplishing such a goal. The second chance offer mechanism is able to achieve such strong revenue results because it leads to strong bidder competition in an auction phase for the right to get into the bargaining phase. In the bargaining phase considerations other than just price could be brought in while the buyer benefits from the information revealed in the auction phase. This would involve substantial changes in the exact nature of the mechanism which are beyond the scope of this paper to deal with, but the principles demonstrated in this paper could be readily applied in such a context.

The outline of paper is as follows. Section 2 describes the two institutions in more detail and presents the theoretical analysis of both. Section 3 provides an overview of the design of the experiments used for this study, and the results are reported in Section 4. We briefly conclude with Section 5.

2 Theory

2.1 English-Ultimatum game

The auction/bargaining institution is a two-stage game. The first stage is a second price or ascending clock auction for a single unit, and the second stage is an ultimatum bargaining game in which the seller offers a take-it-or-leave-it price to the price-setting (losing) bidder for the sale of a second unit. We will refer to this as the English-Ultimatum (EU) game. We choose to model the bargaining phase as a simple ultimatum game in part because its strategic simplicity allows a more tractable theoretical analysis and experimental implementation. We also find it to be a reasonable starting point for examining an auction/bargaining hybrid institution. The key incentive effect of adding the bargaining stage at the end of the auction is that it discourages bidders from revealing their value and the important theoretical and empirical question is whether or not this disincentive to value reveal damages the quality of the information the auctioneer receives from the auction phase. The ultimatum game structure delivers the maximum incentive against value revelation so our analysis serves as a strong test of the degree to which the disincentive does or does not diminish the information value in the bids.

In our theoretical analysis we first consider the case of two risk neutral bidders and then explain how the results generalize to cases in which agents might be risk averse and in which there are more bidders than objects. All bidders are assumed to demand only a single unit. In the first stage, the two bidders are bidding to win the auction and the losing bidder then goes on to play an ultimatum game with the seller. For convenience we assume that the values for the bidders are independently and privately drawn from a commonly known distribution, $F(\cdot)$, on the range $[\underline{v},\ \bar{v}]$. We also assume that the seller has some cost r for the object and therefore the lowest permissible bid in the auction is $w = \max(\underline{v}, r) < \bar{v}$.

This game can be solved for a weak Perfect Bayes Nash equilibrium (wPBNE). A wPBNE requires that decisions at all decision nodes be optimal in expected utility given the beliefs of the players and that those beliefs be constructed using Bayesian updating in conjunction with the equilibrium strategy profile where possible. Pure strategy equilibria of this game will come in three possible forms: separating, pooling or partial-pooling. In a separating equilibrium, bidders with different values will bid different amounts for the first unit using a one-to-one mapping between values and bids (these bids need not be true value though). In equilibrium the seller would be able to invert the strategy of the bidders and determine the exact value of the losing bidder from the auction based upon the closing price. In a pooling equilibrium, all bidders regardless of value would place exactly the same bid. This means that at the close of the auction, the seller would be unable to update his beliefs in regard to the value of the losing bidder and must therefore use only the base value distribution to form his beliefs. A partial pooling equilibrium would involve some bidders pooling on the same bid with others separating themselves out.

We can use a backward induction argument to describe how such an equilibrium might be found. In the last decision node, the bidder who receives the offer of the seller must accept any profitable offer. At the previous decision node, the seller has observed the bid of the losing bidder but not the losing bidder's value. The seller then makes an ultimatum price offer to the bidder based upon his beliefs about the bidder's value. Moving back to the auction stage, bidders incorporate the knowledge of what is expected to happen in the second stage into their bidding strategy. We present two propositions ruling out broad classes of possible equilibria.[5]

Proposition 1 *There exists no pure strategy separating equilibrium of this game.*

The fundamental reason for this is that bidders with all values above the minimum would prefer to bid as if they had the lowest value to get a lower second chance offer. While pure strategy separating equilibria of this game will not exist, at least for non-degenerate value distributions (i.e., cases where $\bar{v} = \underline{v}$), it remains possible for a pooling equilibrium to exist. Our next proposition deals with this case.

Proposition 2 *There exists no pooling pure strategy equilibrium of this game so long as the optimal offer of the seller contingent upon no information on the buyers value is greater than the minimum possible price, or* $\arg\max_q (q-r)(1-F(q)) > w$.

With all bidders pooling on one bid, the ultimatum offer will be above that so each bidder would prefer to deviate from the pooling bid to edge out their competitor in the first stage. The lack of existence of a pooling equilibrium does not depend on the risk attitudes of the bidders or the value distribution. The proof does allow for the possibility that a pooling equilibrium could exist in the presence of an extremely risk averse seller or if r were very far below $\underline{v}$ as either case can drive q^*,

[5] Full proofs of both propositions are available in a working version of the paper available from the authors upon request.

the optimal ultimatum game offer, down to w, the minimum possible bid, making bidders indifferent between pooling on a bid of w and deviating. A partial pooling equilibrium, in which all bidders with value of z or greater bid z while all bidders with values less than z bid their value, will also fail to exist. The reason is that, just as in the pure separating case, all bidders would prefer to deviate by bidding the lowest allowable bid. The conclusion is that the only equilibria that will exist in this game must involve the bidders bidding according to a mixed strategy.

Seller strategies will also involve at least partially mixed strategies. Determining the strategies of both bidders and the seller is complicated by the fact that given any mixed strategy profile for the bidders, there may exist some cutoff offer $\bar{q}$ such that any offers $q > \overline{q}$ are strictly dominated. Let $\phi(q|p)$ represent the probability that an offer of q is accepted conditioned on the fact that the closing price was p and the bidders were bidding according to a proposed mixed strategy. This cutoff offer is found by determining if there exists a $\bar{q}$ such that $(\bar{q} - r) > \phi(q|p)(q - r)$ for all $q \in (\bar{q}, \bar{v}]$. The intuition behind this cutoff is that at low auction close prices the seller will find it worthwhile to forego some sales to increase the price on the completed sales which they will accomplish by asking for a price above the auction close price. At some point though, the auction price is high enough that given the (perhaps low) probability of offers above that point being accepted, there is no offer higher than the auction close price that would raise revenue enough to compensate for the possibility of foregoing an already highly profitable sale. This complicates solving for the equilibrium strategies because bidders should never be expected to place a bid above the level of $\bar{q}$ but $\bar{q}$ is determined by their strategy profile.

The general structure of a seller's equilibrium strategy is that they will mix over possible offers in the range $[p, \bar{q}]$ for auctions in equilibrium that close at prices less than or equal to $\bar{q}$ while for any auctions out of equilibrium that close at prices above $\bar{q}$, the seller's offer will just be equal to the auction close price. A seller must mix over offers when an auction closes at a price $p < \bar{q}$ because if they established a strategy that delivered a deterministic offer as a function of an auction closing price, this would either lead to the seller foregoing too many trades by setting a very high price or a lower price would induce bidders with high values to place deterministic low bids in order to receive the low offer. The reason the latter could not be an equilibrium is that it would lead to a pure strategy pooling equilibrium and we have already shown that such an equilibrium cannot exist. Consequently, the equilibrium strategy profile of the seller must be set in order to make the bidders indifferent between placing all bids over the range $[w, \min(\bar{q}, v)]$.

As an illustrative example, we will construct the full equilibrium for a simple case in which the value distribution consists of bidders being equally likely to receive a value of 1 or 2 and the seller possesses $r = 0.5$. We will restrict the closing auction prices to be either 1 or 2. A full equilibrium must consist of a bid function, $b^*(v)$, indicating what bidders will bid for either possible value, and then an offer function, $q^*(p)$, indicating what offer a seller would make for any closing price. It is quite easy to see that $b^*(1) = 1$ and that $q^*(2) = 2$. To find the rest of the equilibrium, we will let the probability with which a bidder with a value of 2 bids 1 be equal to α and the probability with which he bids 2 be $1 - \alpha$. For the seller we will let the probability of making an offer of 1 conditional upon seeing a close price of 1 be equal to β and the probability of offering 2 be $1 - \beta$. It is easiest to find α first. $\alpha$is the value that makes the expected utility of the seller for offering a price of 1 equal to the expected utility of offering a price of 2 conditional on observing a price of 1. Solving this equation yields $\alpha = 0.5$. The value for β is set by finding the value that makes the bidder with a value of 2 indifferent between bidding 1 and 2 given that we already have $\alpha = 0.5$. Solving this equation yields $\beta = 0.6$. We will refer back to this example for use as a comparison reference in Section 2.3.

While it is somewhat tractable to extend this equilibrium analysis to slightly larger value distributions, it is not tractable for an empirically interesting environment that could be used for an experiment. Expanding this analysis to $n > 2$ is even less tractable. Based upon our formal arguments above and on plausible extensions, we can make the following theoretical conjectures for observed behavior in these games:

1. When $n = 2$ bidders drop out of the stage one auctions below their values in a non-deterministic manner.
2. For cases with $n > 2$, bidders still typically drop out below their value in stage one auctions, but bids are closer to value revelation as n increases.
3. At low auction close prices, sellers make offers greater than the closing auction price in a non-deterministic manner. Therefore, we conjecture a low correlation between offers and auction closing prices at low levels of auction closing prices. At higher auction prices, sellers make an offer equal to the closing auction price.
4. Bidders receiving the second chance offer always accept profitable offers.
5. The mechanism results in inefficient allocations as sometimes sellers will make second round offers above the value of the relevant bidder and when $n > 2$ since bids are based on mixed strategies, the bidders with the first and second highest values are not always the two highest bidders.

The only aspect of those predictions not previously explained is the predicted increase in value revelation as n increases. The reason for the change is that with $n > 2$ there will be competition to receive the second unit offer. While bidders will still bid according to mixed strategies to keep from perfectly signaling their value to the seller, the additional competition will force bidders to bid on average closer to their value. In order to derive an exact model of behavior when $n > 2$ we have to specify the information available to bidders regarding when competitors drop out. If the bidders are allowed to see when other bidders drop out in an English auction, then all bidders will initially plan to stay in the auction until the price reaches their value. Once there are only two bidders left, they will revert back to the $n = 2$ environment described above with w being determined by the drop out point of the third highest bidder. This will lead quite naturally to greater value revelation as n increases. A more reasonable assumption for field applications is that bidders will not observe the drop-out points of others except for the price-setting drop-out. This would require a more complicated structure where bidders estimate the maximum willingness to bid of the third highest bidder contingent upon the observed bids and their own value being first or second highest and then the bidders would mix over the possible bids above that level. While much more complicated to solve, the result should still be an increase in value revelation as n rises.

Of course due to the complexity of these equilibria there should be little expectation that bidders will find a mixed strategy equilibrium much less play according to it. This is due in part to the general problems that have been observed with players using mixed strategies [see chapter 3 of Camerer (2003) for an overview], but is worsened due to the exceedingly complex nature of even finding the mixed strategy in this game. It is, however, reasonable to hypothesize that intentional decision making on the part of the subjects would lead to behavior consistent with the general predictions made above.

We can also imagine an alternative benchmark hypothesis for a very simple way bidders might behave. Specifically, bidders may not execute the strategic interactions outlined above by engaging in value revelation on the first unit. The result would lead to first unit revenue equal to the second highest bidder value. If bidders do this, the optimal response by the seller, and perhaps a reasonable heuristic at any rate, would be to make the second unit offer at about the level of the first unit transaction price. Any risk aversion on the part of sellers also pushes their optimal offers closer to the unit 1 transaction price. The effect of risk aversion on bidder behavior is uncertain, but it would likely lead to bidders coming closer to value revelation.

2.2 English–English game

We will consider sequential English auctions (EE) as a benchmark comparison with the revenue generation and efficiency properties of the EU game. Since there are only two units to be allocated by sequential auctions, a 2-bidder case is uninteresting. Hence, with the EE institution we only conduct sessions with 4 bidders. There is a well defined equilibrium for this game assuming risk neutral bidders originally developed in Milgrom and Weber (2000). Regardless of the number of bidders, buyers should bid their value in the second stage and the result will be that the bidder with the second highest value will pay a price equal to the third highest value. In the first stage, the bids depend on the number of bidders and with the number equal to 4 and with values distributed uniformly on the range of $[\underline{v},\ \bar{v}]$, bidders will submit bids equal to $\underline{v} + \frac{2}{3}(v - \underline{v})$ as that will equalize the prices across the two rounds on average. This equilibrium is based upon the arbitrage prospects between winning in the first and second rounds which leads to a prediction that the price should be equal in expectation across units. Since the bid function is monotonically increasing in v, the auctions should be perfectly efficient.

The risk neutral equilibrium prediction has not always fared well in at least sealed bid first price auction experiments [see Kagel (1995) for a survey] and we can imagine a few alternatives. The easiest alternative would involve the bidders not realizing the strategic implications of the sequential structure and bidding as if both units were unrelated ascending auctions. This would result in value revelation on both items. We will call this the naive model and the predictions are that the unit 1 price will be equal to the second highest bidder value while the unit 2 price will still be equal to the third highest bidder value.

Alternatively, bidders may realize the strategic nature of the institution but be risk averse. Risk aversion is not a factor in standard ascending auctions and therefore the bids for the second unit should not change. An argument similar to that in Goeree et al. (2003) can be adapted to this simpler sequential auction environment to show that risk averse bidders will bid higher on the first unit than risk neutral bidders. By bidding higher on the first unit, risk averse bidders expect to achieve a smaller yet more certain surplus on the first item which is a tradeoff they are willing to make. They will bid up to the point that their expected utility from winning the first unit is equal to their expected utility of winning the second unit. With risk averse bidders this will not necessarily be the point at which the expected prices are equal and will generally be at a point at which the expected price for the first unit is higher than the expected price for the second.

2.3 Comparison of institutions

A general comparison of the two institutions' theoretical expected revenues is not feasible, but there are a few things that can be said. First, even under the assumption of risk neutral bidders the standard multiple unit revenue equivalence theorem (RET) does not apply. One of the general conditions for the RET to apply is that both institutions are efficient or have the same assignment rule.[6] As noted above, the EE institution is perfectly efficient in equilibrium but the EU institution is not. Thus the assignment rules differ between the mechanisms and the RET does not apply.

We can compare expected outcomes for the simple example environment we derived the EU equilibrium for above. This was the case in which bidders could only have two values $\{1, 2\}$ and seller cost was equal to 0.5. Using the equilibrium strategies derived in Section 2.1, the expected revenue in the EU mechanism is 2 which breaks down as 1.0625 from the first unit and 0.9375 from the second. The first unit revenue is only slightly above 1 because there are very few expected realizations of a price of 2. On the second unit, there will be more prices of 2 realized but there will also be a number of transactions not completed when the seller offers a price of 2 and the bidder has a value of 1. The expected revenue in the EE institution is also 2 assuming that the winning bidder of each item is forced to submit at least a bid of 1 to win leading to revenue of 1 on both items. The fact that revenue is the same under both institutions in this example is not an indication that the RET holds. The RET goes farther than just equivalent revenue to require that expected utilities to all participants is the same across institutions. Due to the existence of the unsold items in the EU mechanism, this cannot be the case. The equality of revenue in this example is mere coincidence.

The fact that revenue is equal might indicate that the two institutions would be equally preferred by sellers. That, however, overlooks the actual profit of the seller. If we look at the expected profit to the seller we can establish a clear preference. The expected profit from the EE institution would be 0.5 on both items since the seller is assumed to have a cost of 0.5 and the objects sell at a price of 1. In the EU institution, the expected profit is 0.5625 on both items for a total expected profit of 1.125 for the EU compared to 1 for the EE. This indicates that the seller is better off with the EU. There are two reasons for the increased profit. First is the slight increase in price on first unit sales. The second is that while the revenue in EU is slightly lower than in the EE on the second unit, sales of the second unit occur in the EU mechanism only 75% of the time in expectation compared to 100% for the EE. This means that seller costs are 25% lower in the EU than the EE while revenue is only 6.25% lower.

[6] See Krishna (2002) for a summary and discussion of the RET.

3 Experimental designs and procedures

Our experiment consists of three treatments: a 2-bidder EU treatment, a 4-bidder EU treatment, and a 4-bidder EE treatment. A session of the 2-bidder EU treatment comprised of twelve subjects. As previously mentioned, we did not conduct any experimental sessions with a 2-bidder EE treatment because the theoretical bid predictions in that case are degenerate and uninteresting – both bidders should drop out immediately. Consequently, we conduct the 2-bidder EU treatment to allow for a test of that mechanism in the simplest environment and then use the 4-bidder environment to test the EE versus the EU institution.

As a means of familiarizing the subjects with the properties of an English clock auction, each subject first participated as a bidder in a series of four 2-bidder English clock auctions for a single unit. The computer served as the auctioneer. Bidder values were drawn from the uniform distribution on the range $[\underline{v},\ \bar{v}]$ where $\underline{v} = 100¢$ and $\bar{v} = 400¢$, The value of the seller for the object was given by $r = 100$ where ¢ denotes US cents. The starting price for each auction was $r = 100¢$ and increased by $\delta = 1¢$ every 300 ms.[7] The bidder who clicked the "Do Not Buy" button set the price on the clock at the moment the button was clicked, and the remaining bidder who did not click purchased the unit at that price. In each round of the experiment, the bidders were randomly paired from the set of twelve subjects as a mitigating control for repeated interactions with the same counterpart bidder. The subjects were given the information on the value distribution. As a control for variation across the six pairs of bidders, all bidder 1's in each pair received the same random draw in an auction, and likewise for bidder 2's. Across sessions, each type of bidder (1 or 2) received the same random value for their type in the auction.

After these four single unit auctions, the subjects were then given instructions on the EU institution, eight of them as bidders and four of them as sellers. We defined a round as an English auction for a single unit after which "the seller will make an offer to sell a second unit to the buyer who last exited the auction (and so did not buy)." The buyer who received the price offer could either click "Buy" or "Do not Buy". Again, bidders of the same type received the same randomly drawn value in a round, and across sessions, all bidders of the same type received the same random value in round t. We continued to use the parameters: $\underline{v} = 100¢$, $\bar{v} = 400¢$, $r = 100¢$. Each round, the eight bidders were randomly repaired and assigned to be potential buyers from one of the four sellers and then assigned to one of the two bidder types. The bidders were informed that the sellers were other subjects in the experiment. The subjects were paid their earnings from the four single unit auctions and twenty rounds of the EU game. Sellers earned on average 17.51$ and buyers 17.53$.

A session in the 4-bidder EU treatment included ten subjects, and except for the differences noted below, this treatment was conducted just as in the 2-bidder treatment described above. Eight of the subjects first participated as a bidder in a series of four 4-bidder English clock auctions for a single unit, and the remaining two as bidders in 2-bidder auctions. The computer again was the auctioneer. Due to the increased competition, we increased the saliency for the 4-bidder auctions by

[7] If the clock price were to reach the maximum price of $\bar{v} = 400$, then the unit would be randomly awarded to one of the bidders at a price of 400; however, this never occurred in any auction.

setting $\underline{v} = 100¢$ and $\bar{v} = 600¢$ with bidder valuations still drawn from a uniform distribution on this range. Again, after these four auctions the subjects were then given instructions on the EU institution, with the group of eight remaining as bidders and other two subjects becoming sellers. For $\underline{v} = 100¢$ and $\bar{v} = 600¢$, the expected profit for sellers over 20 rounds is \$100 if $r = 100¢$, so we reduced the average payout to the sellers by US\$20 by setting $r = 200¢$ (the mean of the minimum order statistic for the buyers' values). The starting price for each auction was 100¢ and increased by $\delta = 1¢$ every 180 ms.[8] The subjects were again given full information on the range and distribution of possible values. Both bidder *i*'s for *i* = 1, 2, 3, 4 received the same random draw in a round, and across sessions, each bidder-type *i* received the same random value for their type in round *t*. Sellers earned on average \$45.98 and buyers \$9.38.

The 4-bidder EE treatment maintains all of the features of the 4-bidder EU treatment except that (a) the second unit in a round was sold via a second, identically-conducted English clock auction to the losing bidders of the first unit and (b) a session only included eight subjects as bidders. We did not include human sellers because the seller plays a perfectly passive role as an auctioneer (with a considerable cash payoff). The bidders were informed that the computer was serving as the seller in the experiment.[9] The buyers earned on average \$11.40.

We conducted a total of 12 laboratory sessions, four in each treatment, plus one pilot session in the 2-bidder EU treatment with only six subjects (two sellers and four buyers). Each session lasted no longer than 90 min using subjects recruited from undergraduate classes. No subject had any prior experience in any one-sided laboratory auctions, but many had participated in other types of experiments. In each session subjects were randomly assigned a role as a buyer or seller and were seated at visually-isolated computer terminals. In addition to the payoffs reported above, the subjects were paid US\$5 for showing up on time and received their total payments in private at the conclusion of the session.

4 Results

4.1 Aggregate results

Table 1 contains the summary statistics of the revenue and efficiency in the different treatments. The efficiency measure used in the table is percent of possible surplus achieved where the surplus is the difference between the bidder's value and seller's costs. Examining these data reveal several indications about individual behavior though. In the 2-bidder case, bidders in the auction stage seem to be dropping out well below their value in a potential attempt to get a better offer on the second unit (average price 126.62, average second highest value 189) while the bidders in the 4-bidder EU treatment did not seem to shade their bids by much at all under their true values (average price 356.90, average second highest value 358). Likewise in

[8] Notice that the longest the auction would last is constant at 90 s across the 2- and 4-bidder treatments.

[9] We note that bidders could possibly behave differently with computer auctioneers in the EE case than with human auctioneers in the EU case. The auctioneers in the EE case are completely passive, i.e., there is no opportunity for human auctioneers to incur goodwill or acts of negative reciprocity on the part of the bidders based upon any actions.

Table 1 Average revenue and efficiency

	Rounds		Unit 1		Total	Unit 2	
			Efficiency	Revenue	Efficiency	Revenue	Offer
2-Bidder EU	1–20	Avg.	0.89	142.72	0.94	114.61	164.43
$v \sim U[100, 400]$		St. Dev.	0.23	46.75	0.15	79.71	51.40
2- Bidder EU	11–20	Avg.	0.88	126.62	0.93	96.50	154.13
$v \sim U[100, 400]$		St. Dev.	0.23	30.37	0.18	73.64	43.60
4-Bidder EU	1–20	Avg.	0.97	348.70	0.91	235.64	326.23
$v \sim U[100, 600]$		St. Dev.	0.09	113.36	0.17	172.04	95.32
4-Bidder EE	1–11,13–20	Avg.	0.92	334.86	0.93	282.39	–
$v \sim U[100, 600]$		St. Dev.	0.17	102.01	0.17	101.70	–
4-Bidder EU	11, 13–20	Avg.	0.98	356.90	0.93	271.32	335.14
$v \sim U[100, 600]$		St. Dev.	0.06	115.12	0.15	159.97	102.18
4-Bidder EE	11, 13–20	Avg.	0.94	334.80	0.96	273.09	–
$v \sim U[100, 600]$		St. Dev.	0.13	100.33	0.11	100.19	–

In round 12 the random values are 112, 169, 131, and 211. In the EE treatment, since the computer sells the second unit at a loss greater than the surplus generated from the first unit, efficiency is not defined. In the EU treatment, the buyer simply rejects a seller's offer greater than $r = 200$, but for the sake of parsimony, we omit round 12 when looking at the second half of rounds in this treatment as well

the 4-bidder EE treatment, bidders do not seem to be shading their bids by as much as predicted as both the first unit and the overall revenue is above the theoretical benchmark (first unit revenue 334.8, second unit revenue 273.09, equilibrium prediction of 270 for both).

4.2 Panel results

We use several linear mixed effects models to gain more careful insight and quantify our findings. We index sessions by $j = 1, \ldots, 8$, and subjects within each session by $i = 1, \ldots, 8$, and rounds by $t = 1, \ldots, 20$. For tests comparing the EU and EE institutions, we employ a linear mixed effects model to explain the price of the first unit. The primary treatment effect, EE_i, is one for an EE session and zero otherwise. We also include a dummy variable for rounds 1–10, $\mathrm{FirstHalf}_t$. To control for the across-round variation of values, we include deviations of the relevant kth highest value from their theoretical expected values, denoted by v_k. When conducting regressions for first unit prices, we index by random subject effect by the losing bidder while in the second unit regressions we index by seller, as these are the two relevant decision makers for setting those prices. We also accommodate heteroskedastic errors by session and incorporate two- and three-term interaction effects for the explanatory variables.

4.2.1 English-Ultimatum versus English–English institution

We first consider the revenue/profit generation of the two mechanisms. Table 2 contains the results of the key regression on comparing the seller profits in the two mechanisms. It reports the estimates of a linear mixed effects model for the unit 1 prices, unit 2 prices and overall profits. This leads to our first finding:

Table 2 Estimates of the linear mixed-effects model: English-Ultimatum versus English–English

	Unit 1 price		Unit 2 price		Seller profit	
	Estimate	p-Value	Estimate	p-Value	Estimate	p-Value
μ	384.02	<0.0001	362.22	<0.0001	308.40	<0.0001
EE	−33.85	0.0223	−60.15	0.0024	−63.26	0.0114
v_2	0.96	<0.0001	0.83	<0.0001	1.62	<0.0001
v_3	0.02	0.7480	−0.03	0.6613	−0.05	0.7219
EE × v_2	−0.32	0.0005	−0.81	<0.0001	−1.02	<0.0001
EE × v_3	0.11	0.2908	1.01	<0.0001	1.15	<0.0001
FirstHalf	−12.88	0.0657	−19.87	0.0100	−31.88	0.0326
FirstHalf × EE	32.88	0.0045	26.97	0.0042	63.65	0.0010
FirstHalf × v_2	−0.26	0.0038	−0.37	0.0002	−0.57	0.0028
FirstHalf × v_3	0.18	0.0718	0.32	0.0047	0.62	0.0043
FirstHalf × EE × v_2	0.34	0.0208	0.44	0.0003	0.84	0.0006
FirstHalf × EE × v_3	−0.23	0.1740	−0.40	0.0039	−0.88	0.0017
		320 Obs.		320Obs.		320 Obs.

Finding 1 *Sellers earn higher profits with the EU institution than with the EE institution.*

The rightmost columns of Table 2 report that the sellers earn on average $\hat{\mu} =$ 308¢ each round in the EU treatment, but EE sellers receive $-\hat{\beta}_{\text{EE}} = 63.26$¢ less than that ($p$-value = 0.0114). That indicates that seller profit in the EE mechanism is about 20% less than their profit in the EU mechanism. This establishes a base preference on the part of the sellers for the EU mechanism.

The other columns of Table 2 indicate why the EU mechanism is more profitable. Seller prices are slightly higher for both first and second units in the EU (first unit EE prices are $-\hat{\beta}_{\text{EE}} = 34$¢ or 8.8% less than EU prices, on second units EE prices are $-\hat{\beta}_{\text{EE}} = 60.22$¢ or 16.6% lower than EU). The rest of the difference is due to the fact that only 67% of the second unit transactions occurred in the 4-bidder EU sessions.

One important point about these observations is that they do not reduce the total surplus from the EE benchmark. The estimate of an EU dummy variable from an unreported linear mixed effects model is insignificant (p-value = 0.2470). This forms our second finding:

Finding 2 *The total surplus realized by the buyers and sellers is equivalent across EU and EE institutions, which means that higher EU prices are direct transfers from buyers to sellers with no statistically significant loss in overall efficiency.*

This finding might be quite surprising due to the number of unsuccessful second unit transactions under the EU mechanism. The reason for the result is that, as shown in Table 1 before, the first unit efficiency in the EU mechanism is quite high and indeed much higher than the efficiency in the theoretically perfectly efficient EE mechanism. Bidders in the EU mechanism are bidding aggressively leading to the more efficient allocations in the completed transactions making up for the efficiency/surplus lost from the failed transactions.

This difference in first unit bidding behavior is made concrete in our next finding:

Finding 3 *Considering bids for the first unit, bidders in the English-Ultimatum institution bid closer to their true values than bidders in the English–English institution.*

Figure 1 plots the drop out bids on the first unit of the three losing bidders against their values for both institutions in the 4-bidder treatments. For low values, there appears to be little difference between how the buyers bid, but for the high values, the ones most likely to be price setting, buyers in the English–English treatment under reveal more often and to greater extent than buyers in the English-Ultimatum treatment. To assess this quantitatively, we estimate a linear mixed effects model for bids, Bid_{ijt}, as a function of value (Value_{it}), EE_j, and FirstHalf_t. We include random effects for both session j and subject i in session j in the intercept and in the slope of Value_{it}. As before, we also accommodate heteroskedastic errors by session.

Table 3 reports that EU bidders reveal 88% ($\hat{\beta}_V = 0.88$, p-value < 0.0001) of their values in the English auction for the first unit. EE buyers bid 72% of their value ($\hat{\beta}_V + \hat{\beta}_{\text{VEE}} = 0.88 - 0.16 = 0.72$, p-value $= 0.0363$). While this estimate is close to the theoretical prediction of 0.67, it is not an indication that an average bidder bid in a manner consistent with the theoretical prediction. As Figure 1 shows, many of the bidders were essentially value revealing while there was a smaller group of bidders who were bidding substantially under the theoretical prediction. This broad range in individual behavior leads to a large variance of the aggregate estimate; the 95% confidence interval is (0.61, 0.83). As seen in the aggregate revenue tests above, the overbidding relative to the theoretical prediction is significant enough

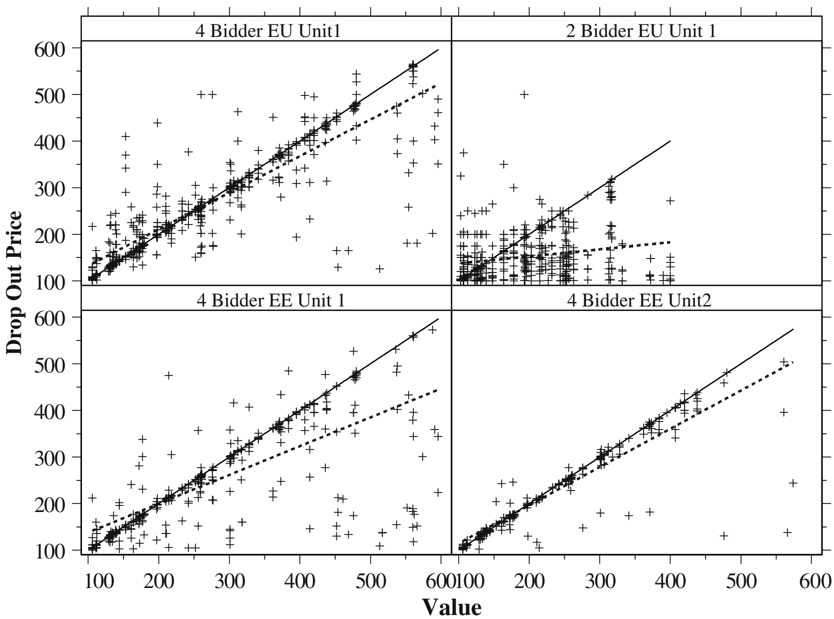

Fig. 1 Scatterplots of drop out prices against value

Table 3 Estimates of the linear mixed-effects model for bidding

	First unit		Second unit (EE only)	
	Estimate	p-Value	Estimate	p-Value
μ	25.83	0.0197	14.70	0.0630
Value	0.88	<0.0001	0.91	<0.0001
EE	22.40	0.2178		
Value × EE	−0.16	0.0363		
FirstHalf	16.04	0.0848	12.79	0.1012
FirstHalf × Value	−0.06	0.0536	−0.05	0.0821
FirstHalf × EE	−4.82	0.7410		
FirstHalf × Value × EE	−0.04	0.4061		
		960 Obs.		320 Obs.

to lead to revenue above the predicted level even when including random effects for sessions and subjects ($\beta_{V,j}$ and $\beta_{V,i}$).

This aggressive unit 1 bidding in the EU mechanism is driving the profit differential in the two formats. Not only does this lead to higher prices on the first unit sold, but the information revealed to the seller assists him in increasing profits on the second item as well. The reason for the different behavior is also clear. In the EE mechanism, bidders realize that if they do not bid aggressivley on the first unit, they still have a chance to bid on the second. Thus, if some bidders see that first unit prices are too high, they wait for the second unit auction by dropping out at very low prices in the EE treatment. In the EU mechanism, bidders cannot refrain from bidding on the first unit because they have to be either the highest or second highest bidder to have a chance at winning an item. The primary effect of only allowing the second highest bidder into the second stage appears to be increased competition in the first stage.

4.2.2 English-Ultimatum institution

In addition to looking at the cross institution comparison, there are a number of interesting behavioral issues that can be observed through more careful examination of the EU institution alone.

Finding 4 *Bidders in the 2-bidder treatment strategically shade their bids on the first unit throughout the session, whereas bidders in the 4-bidder treatment strategically shade their first unit bids in the early rounds and then approach full value revelation in later rounds.*

Table 4 reports the estimates for the model of unit 1 prices and unit 2 offers, and Figure 1 contains scatterplots of first unit bids for the 4- and 2-bidder EU treatments. In the 2-bidder treatment, the results indicate that the only statistically significant determinant of unit 1 prices is the value of the second highest bidder, but the coefficient on this variable is 0.40 and not 1 as it might be for a standard single unit clock auction. Since the coefficient is much less than 1, this indicates that bidders are dropping out well below their values. The dummy variable for the first half of the experiment and the interaction term with v_2 are both insignificant indicating a relative lack of an experience effect in these results.

Table 4 Estimates of the linear mixed-effects model for English-ultimatum prices

	Two-bidder treatment				Four-bidder treatment			
	Unit 1 price		Unit 2 offer		Unit 1 price		Unit 2 offer	
	Estimate	p-Value	Estimate	p-Value	Estimate	p-Value	Estimate	p-Value
μ	151.17	<0.0001	66.82	<0.0001	384.05	<0.0001	54.14	0.1267
v_2	0.40	<0.0001	0.06	0.1725	0.96	<0.0001	0.05	0.5593
Unit 1 price	–	–	0.67	<0.0001	–	–	0.80	<0.0001
v_3	–	–	–	–	0.02	0.7582	−0.05	0.2590
FirstHalf	3.10	0.3775	6.41	0.5776	−13.10	0.0620	21.31	0.6146
FirstHalf × v_2	0.01	0.7906	−0.05	0.3488	−0.26	0.0041	−0.03	0.7904
FirstHalf × Unit 1 price	–	–	−0.02	0.8088	–	–	−0.07	0.5512
FirstHalf × v_3	–		–	–	0.18	0.0723	0.12	0.0805

The results for the 4-bidder EU treatment are a little different. First, the dummy for the first half of the experiment is borderline significant, but the interaction between this variable and the deviation between the expected and actual second highest value is significant indicating that bidders alter their bidding behavior over the course of the experiment. In the early rounds, the buyers bid on average 70% of their value in the auction ($\hat{\beta}_2 + \hat{\beta}_{F2}$ =0.96 − 0.26 = 0.70) but in the later rounds raise their bids to 96% ($\hat{\beta}_2 = 0.96$) of their value. The coefficients involving v_3 suggest why the bidders' behavior changes. In the first half of the rounds, the third highest value explains 20% of the price ($\hat{\beta}_3 + \hat{\beta}_{F3} = 0.02 + 0.18 = 0.20$), which means that this bidder is crowding out the second highest bidder and receiving the ultimatum offer from the seller for the second unit. As the buyers bid more aggressively in the latter half of rounds, the third highest value has little effect on the auction price ($\hat{\beta}_3 = 0.02$). This comparative static result is precisely what should be expected in regard to the change in bidding behavior due to an increase in n as discussed before. It is also a direct demonstration of the effect of the EU mechanism on creating intense competition for that first unit when there are $n > 2$ bidders.[10]

Finding 5 *Auction prices are the best predictors of ultimatum offers.*

Table 4 shows that in both the 4- and 2-bidder EU treatments, the only significant variables in the regressions to explain the second unit offer are the constant term and the unit 1 price. The indication is that seller offers have a certain lower bound but beyond that, the offers are strongly influenced by the price. Most importantly, the effect on the offers of the price dominates any effect from the value of the bidder being bargained with.

[10] Earlier we noted a potential confound of our results due to the fact that bidders might behave differently when faced with human rather than computer auctioneers. A standard hypothesis might be that subjects would prefer to give humans their money rather than the computer (i.e., the experimenter) and so we should see higher bids in the EU than the EE. This is what we observe in the 4-bidder experiments. If, however, this potential confound explained the result, we should also expect near value revelation in the 2-bidder EU case and we do not. We see bidders dropping out very far below their value and not evidencing any interest in giving the human auctioneer their money.

While making offers at the level of the auction close price seems to match with the theoretical prediction, it may appear suboptimal behavior given the observed bidder behavior and because sellers are making offers so close to the auction price all of the time (and hence not closer to the value of the bidder). Since we do not have a precise version of the equilibrium strategy for the sellers, we cannot compare the observed behavior directly to it. However, we can compare the observed seller offers to what might be called an ex-post best response offer to the true empirical distribution of bids, i.e., the profit-maximizing offer for the actual distributions of bidder values given the auction price.

Finding 6 *Sellers use an apparent rule of thumb in making offers, which is to offer the second unit at about the same price as the first unit. This is a best response when first unit auctions end at prices above a certain level but not at lower levels.*

Due to the sparse nature of the data, we construct bins of auction prices and then form a distribution of the values for the price-setting bidders given the bin.[11] It is then possible to solve the optimization problem of finding the offer that maximizes the sellers expected profit. This assumes (a) that buyers will accept any offer less than their value (which the data supports) and (b) that the distribution of bidder values is given by the empirical distribution.

The general pattern of the ex-post optimal offers matches quite well with the pattern predicted in our theoretical discussion. With two bidders, we find that for prices above 150, the ex-post optimal offer is at about the level of the auction close price and sellers make offers quite close to that level. When the auction ends at prices between 100 and 150, the ex-post optimal offer would have been substantially above the auction closing price but sellers on average make offers substantially less than this optimal benchmark. Over this range, the sellers are making offers \$0.50–\$1.00 below the optimal offer and this is costing them 40% of their possible surplus. This represents a substantial loss of surplus for the sellers because 66% of the auctions end at prices in this range.

In the 4-bidder treatment, we find that the prices are less concentrated at the lower end. The sizes of the bins we present are different because there are so few observations below 200 and above 500. The sellers make offers reasonably close to the best response for auctions prices in the range 200–500 (save 251–300). However, the sellers forego an expected value of almost 30¢ for the lowest auction prices and 70¢ for the highest. In contrast to the 2-bidder cases the number of auctions ending at the low prices leading to a large surplus loss account for only 12.5% of the total number of auctions.

Overall it appears that sellers are making offers approximately in the manner predicted by the sophisticated model of behavior. Their only substantial deviation from the predicted behavior is that in the 2-bidder treatment the sellers do not quite ask for high enough prices when the first unit closes at a low level. This could be rationalized as due to risk aversion because risk aversion does have the effect of lowering the asking price in the second stage, but it is more plausible to conclude that sellers are applying an almost optimal rule of thumb a little more broadly than they should.

Our final finding concerns the responder behavior in the ultimatum stage:

[11] In the interest of brevity, the table of these data has been omitted but is available upon request.

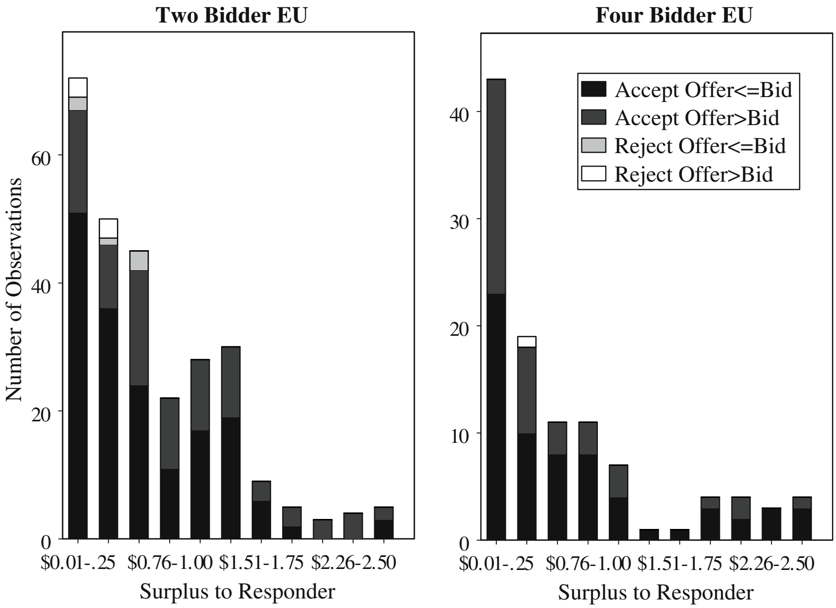

Fig. 2 Ultimatum offers in EU treatment

Finding 7 *There are virtually no offers of positive surplus to bidders that are rejected. Many offers are accepted that yield surplus of less than $0.10 to the bidder.*

In contrast to standard ultimatum game results[12] in which responders reject offers of low surplus with regularity, we see virtually no such rejections of positive surplus here. In the 2-bidder treatment, there were 273 offers made for a price less than or equal to the value of the bidder and only 12 (or 4.4%) were rejected. In the 4-bidder treatment, 111 offers were made at prices less than or equal to the bidder's value and only 4 (or 3.6%) were rejected. Moreover, three of those rejected were at prices precisely equal to bidder's value, leaving only a single profitable offer rejected (0.9%).

These results are highlighted in Figure 2, stacked histograms displaying the number of times bidders accepted and rejected offers made at various surplus levels. Included in these histograms are the number of offers that were made above the level of the unit 1 auction price and therefore above the level of the bid of the responder. These should have been the cases most likely to trigger some form of negative response (i.e., a rejection) from the responder. If a buyer has bid $2.00, then that buyer should have little objection to accepting an offer at $2.00 regardless of the amount of surplus it would lead to. If a bidder has placed a bid of $1.25 and they receive an offer of $2.00, this represents a direct attempt by the proposer to decrease the surplus of the responder and that might well trigger a negatively

[12] See, e.g., Forsythe et al. (1994), Guth et al. (1982), Guth and Tietz (1990), Hoffman et al. (1994), Roth (1995) and Thaler (1988). Another related paper is Croson (1996) which finds proposers make smaller offers to responders when the responder has no information on the size of the pie. In our experiment, neither the proposer nor the responder know the size of the pie.

reciprocal response. Figure 2 illustrates that even offers of this nature do not seem to trigger many rejections. In the 4-bidder treatment there were 41 offers above the bid but below the value of the responder and only 1 was rejected. In the 2-bidder treatment 93 such offers were made, only six were rejected. It does not appear then that these offers were any more likely to be rejected than offers at or below the bid price.

This is quite a striking result. One treatment in Hoffman et al. (1994) is a "Buy–Sell" treatment that specifically describes the experiment context as a market in which a seller offers a take-it-or-leave-it price to the buyer who can either "buy" or "not buy" at that price. They find rejections of \$2 and \$3 of surplus are still persistent (10.4% of all offers). In our design with the ultimatum game embedded into a naturally occurring market environment such rejections virtually disappear, even for much lower amounts of surplus offered. There are several possible explanations. One reason for the lack of rejections may be that they disappear naturally when the market context is even more explicitly experienced by the subjects through the related auction stage. This would be in contrast to a more neutrally framed bargaining only setting or cases that just label subjects as buyers and sellers but do not make the market setting truly tangible through a familiar market institution. A second possibility is that when the responder knows that the proposer is uncertain of the pie size, the proposer is able to "hide" behind the excuse that he does not know the responder's value and therefore only "accidentally" offered such a low surplus. Since the responder knows the proposer does not know the responder's value, the responder might be more forgiving of offers leading to low surplus as it is unclear whether the proposer is truly attempting to minimize the responder's surplus or just trying to equalize the surplus.

5 Conclusion

In this paper we compare the revenue generation of a second chance offer mechanism to a standard sequential auction. The results show that the second chance offer mechanism leads to higher profits to sellers. The key to the increase in profit is that this auction/bargaining hybrid substantially increases competition on the first unit because only the top two bidders have a chance at winning a unit. This contrasts with a sequential auction in which it is possible for a bidder to refrain from bidding on the first unit and still win the second, thereby reducing the intensity of the competition in the first stage. This competition in the first stage also serves to transmit to the seller more accurate information on the value of the bidder with whom he will be bargaining in the second stage, which in turn allows him to earn a larger profit on the second unit.

While the revenue ranking result is important from a mechanism design standpoint, our results in regard to the ultimatum game have implications beyond just the design of electronic markets. Our results represent a clear departure from other ultimatum game studies in the behavior of the responders as we observed practically no rejections of non-negative surplus even when the surplus offered was a few pennies and the proposer appeared to be quite aggressively raising his own welfare at the expense of the responder. While there are other interpretations of these results that our experiments were not capable of rejecting, it is our interpretation that this difference in behavior is due to the triggering of market oriented behavior by setting the ultimatum game in close relation to a natural market context with which the subjects are familiar, i.e., an ascending auction. These results could therefore imply that issues of fairness that have been found in numerous laboratory studies may not be important in market contexts. Our results are not conclusive in this regard but they do suggest that there is reason to question an extrapolation of some results found in non-market settings into market settings.

The practical implication of our results is that sellers in on-line auctions should be able to run an ascending or second price auction to gather information about the underlying demand curve and then use that information to make price discriminating offers to non-winning bidders even though this may cause bidders not to completely value reveal in the ascending auction. Our results further suggest that there should be implications for using this mechanism beyond electronic markets. A firm wishing to procure a large amount of a particular type of item might well be able to use a mechanism related to this second chance offer mechanism in which they first run an auction for some portion of the total desired quantity as a means of gathering data on the cost structures of providers and then use that information in negotiations with losing providers or perhaps even with others who did not participate (if cost structures are affiliated across firms). The overall implication of our results is that it does seem to be possible for an auctioneer to exploit the information obtained in a second price/ascending auction well beyond what was previously understood. That leads to a wealth of possible applications and further avenues of investigation of how the information could be used.

One interesting extension of our results, to more accurately apply what we have learned to auctions on e-Bay, would be to endogenize the second auction with a new group of bidders with new value draws and include as a seller's decision the choice to either make an ultimatum offer or conduct a second auction. Our design maintains the same group of bidders for both units, which underestimates the revenue generation of the sequential auction. Our results indicate that if a seller receives a "high" price (which means he had at least two high value draws), he can exploit the second one through a second chance offer. A "high" price is a price greater than the expected price from running a second auction with new value draws. But if the seller gets a "low" price initially, then our results indicate that he is probably better off listing a new auction and getting a new set of value draws (depending upon his aversion to risk).

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References

Bajari, P., Hortacsu, A.: Cyberspace auctions and pricing issues: a review of empirical findings. In: Jones D.C. (ed.) New Economy Handbook, pp. 163–211. San Diego, CA: Academic Press (2003)

Bryan, D., Prasad, N., Reeves, D., Reiley, D.: Pennies from eBay: the determinants of price in online auctions. University of Arizona Working Paper (2005)

Camerer, C.: Behavioral game theory: Experiments in Strategic Interaction. Princeton, NJ: Princeton University Press 2003

Croson, R.: Information in ultimatum games: an experimental study. J Econ Behav Organ **30**, 197–212 (1996)

Engelbrecht-Wiggans, R.: Auctions with noncompetitive sales. Games Econ Behav **16**, 54–64 (1996)

Engelbrecht-Wiggans, R., Katok, E.: E-sourcing in procurement: theory and behavior in reverse auctions with non-competitive contracts. Penn State Working Paper (2004)

Forsythe R., Horowitz, J.L., Savin, N.E., Sefton, M.: Fairness in simple bargaining experiments. Games Econ Behav **6**, 347–369 (1994)

Goeree, J. K.: Bidding for the future: signaling in auctions with an aftermarket. J Econ Theory **108**, 345–364 (2003)

Goeree, J.K., Plott, C.R., Wooders, J.: Bidders' choice auctions: raising revenues through the right to choose. California Institute of Technology Working Paper (2003)

Guth, W., Schmittberger, R., Schwarze, B.: An experimental analysis of ultimatum bargaining. J Econ Behav Organ **3**, 367–388 (1982)

Guth, W., Tietz, R.: Ultimatum bargaining behavior: a survey and comparison of experimental results. J Econ Psychol **11**, 417–449 (1990)

Haile, P.A.: Auctions with private uncertainty and resale opportunities. J Econ Theory **108**, 82–110 (2003)

Hoffman, E., McCabe, K., Shachat, K., Smith, V.L.: Preferences, property rights, and anonymity in bargaining games. Games Econ Behav **7**, 346–380 (1994)

Ivanova-Stenzel, R., Kröger, S.: Behavior in a combined institution: auctions with a pre-negotiation stage. University of Arizona Working Paper (2004)

Kagel, J.H.: Auctions: a survey of experimental research. In: Kagel, J.H., Roth, A.E. (eds.) The Handbook of Experimental Economics, pp. 501–557. Princeton, NJ: Princeton University Press 1995

Krishna, V.: Auction Theory. San Diego, CA: Academic 2002

Levin, D., Smith, J.L.: Equilibrium in auctions with entry. Am Econ Rev **84**, 585–599 (1994)

Lucking-Reiley, D.: Auctions on the internet: what's being auctioned and how? J Indus Econ **48**, 227–52 (2000)

Milgrom, P.R., Weber, R.J.: A theory of auctions and competitive bidding, II. In: Klemperer, P. (ed.) The Economic Theory of Auctions, pp. 179–194. Cheltenham, UK: Edward Elgar Press (2000)

Rapoport, A., Amaldoss, W.: Mixed strategy play in single-stage first-price all-pay auctions with symmetric players. J Econ Behav Organ **54**, 585–607 (2004)

Roth, A.E.: Bargaining experiments. In: Kagel, J.H., Roth A.E. (eds.) The Handbook of Experimental Economics, pp. 253–348. Princeton, NJ: Princeton University Press 1995

Roth, A.E., Ockenfels, A.: Last-minute bidding and the rules for ending second-price auctions: Evidence from eBay and Amazon auctions on the Internet. Am Econ Rev **92**, 1093–1103 (2002)

Segal, I.: Optimal pricing mechanisms with unknown demand. Am Econ Rev **93**, 509–529 (2003)

Thaler, R.: Anamolies: the ultimatum game. J Econ Perspect **2**, 195–206 (1988)

Zeithammer, R.: Forward-looking bidders in online auctions. University of Chicago Working Paper (2004)