Strategic bidding in a private value experimental auction with positive and negative bids

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Abstract:

We treat a difference in initial bids for two private goods as an endogenous "induced" value. Results from follow up auctions eliciting positive or negative bids to exchange one good for the other suggest that positive WTP bids are demand revealing while subjects tended to overbid (in absolute value) negative WTA values. Controlling for risk attitude in WTA bids is shown to partially explain the WTA overbidding. WTA bids tended to be lower in a random n^{th} price auction compared to those elicited in a 5^{th} price auction.

Keywords

Experimental Auction, Negative Bids, Strategic Bidding

1. Introduction

Due to their having a mix of perceived benefits and risks, goods such as irradiated or genetically modified foods are valued positively by some consumers and negatively by others. Researchers often elicit values for such goods using laboratory experimental auctions. Those auctions typically elicit either a willingness to pay (WTP) or a willingness to accept (WTA) value, and rarely allow negative bids which would facilitate simultaneous elicitation of both WTP and WTA (Lusk and Shogren, 2007). Instead, when faced with the likelihood of negative valuations, researchers typically truncate bids at zero, or separate participants based on preference and elicit WTP to upgrade to a preferred alternative (Fox et al., 1998).

Allowing negative bids in an experimental auction would permit full revelation of the demand curve. However, Dickenson and Bailey (2002) pointed to a potential drawback of allowing negative bids – i.e., subjects may bid strategically instead of revealing their true valuation. Their concern was motivated by results from induced value experiments reported by Shogren et al. (2002) and later by Parkhurst et al. (2004) showing that subjects with negative values tended to overbid (not reveal the full extent of the negative valuation) in a 2^{nd} price auction. In the same study, results from a random n^{th} price auction were less precise but did not reveal the same tendency to overbid negative values (Parkhurst et al., 2004).

In this paper, we investigate participants' bidding behavior when negative bids are allowed for privately valued goods in an experimental auction. We focus on two questions: i) whether subjects with negative values tend to bid strategically – either overbidding (as found by Parkhurst *et al.*) or underbidding (i.e., demanding excess compensation) in an effort to enhancing earnings, and b) the performance of random n^{th} and 5^{th} price auctions when negative bids are allowed. Any tendency to either under- or over-bid a negative value would

be important to recognize should practitioners begin to routinely allow negative bids in their experiments. We find that a) WTP bids are demand revealing, b) subjects tend to underbid WTA values, c) controlling for risk attitude partially explains the bias in WTA bids, and d) negative values from random n^{th} auctions tend to be below those from 5^{th} price auctions.

2. Experimental design

Participants were graduate and undergraduate students at Kansas State University, recruited via e-mail solicitation or from an undergraduate class. They were told they would be paid $5 and receive a pizza meal. A total of five sessions were held, each with ten participants. Two sessions used a 5^{th} price auction, two used a random n^{th} price auction, and one session used both auctions. The experiment thus provided 30 observations for each auction mechanism.

On arrival, participants signed a consent form, received the $5 payment, were provided with an ID number, and completed a short questionnaire.[1] In stage 1, participants examined two products – a 10oz package of Trail Mix (TM) and a 6oz package of Dried Fruit (DF). They were then asked to indicate a preference - i.e., I prefer the Trail Mix; I prefer the Dried Fruit; I like them both equally well. Participants were then told that they would participate in a 2^{nd} price auction for both products. A practice auction using a small candy bar was used to demonstrate the auction mechanism and to emphasize that the exercise was not hypothetical. At the end of the practice auction, the winning bidder obtained the candy bar and paid, in cash, an amount equal to the 2^{nd} highest bid. Participants then bid for the packages of TM and DF in a "full bidding approach" with bids for both items were submitted simultaneously

[1] Instructions are available from the corresponding author.

(Corrigan and Rousu, 2006). To avoid a wealth effect, participants were told that only one of the two auctions, selected by coin toss, would be binding. They were informed that the binding auction and winning bidder would be selected at the conclusion of the experiment.

In stage 2, participants were told that they would participate in a number of "endowment" auctions in which they would bid either a positive WTP or a negative WTA to exchange one good for another. Only one of these auctions (the number of auctions was not revealed) would be binding, and there would be N winning bidders each paying an amount equal to the $N+1^{st}$ bid. In sessions using the 5^{th} price auction, N=4 was revealed prior to bidding. In sessions using the random n^{th} auction participants were told that N would be a randomly drawn number between 1 and 8, determined after the bidding. An instruction sheet illustrated how the auction would work in a scenario with seven subjects bidding to exchange an oven mitt for a coffee mug. In that scenario, three people preferred the coffee mug (and bid positive WTP for the exchange), one was indifferent (and bid zero), and three preferred the oven mitt (and bid negative WTA for the exchange). Positive, zero, and negative bids were illustrated as points along a line. With N=4 winning bidders, the result was 4 bidders making the exchange and getting paid the amount of the (negative) 5^{th} highest bid to do so. To ensure that subjects understood the mechanism, they were asked a series of questions about the scenario – e.g., what would happen if N=2, etc. To further familiarize them with the auction, another practice auction (also binding) was conducted using candy bars.

We then conducted Auction A, in which participants were endowed with a package of DF and could bid to exchange it for a package of TM. On the bid sheet, participants were asked to write "the most I am willing to pay" for the exchange or "the minimum I would accept" to make the exchange, and were further instructed to mark their bid along a line. The monitor checked bid sheets for consistency between the written bid amount and the location of the

marked bid on the line and sought clarification from the subject in the event of any discrepancy. After bids were collected, participants handed back the DF and proceeded to Auction B in which the endowment was reversed, i.e., the endowment was TM and participants bid to exchange it for DF.[2]

In our analysis, we will treat the bid differential from the initial bids for the two products as if it were an induced value – i.e., in the same way Parkhurst *et al.* (2004) and others treat resale values provided to auction participants. Thus, performance of the subsequent endowment auctions will be assessed in terms of how well elicited bids for upgrades or downgrades reflect the initial bid differential between the same two products.

3. Experimental results

After checking the data for consistency between initial bids and stated preferences, bids from three subjects (all from the session using both auction types) were discarded for inconsistency i.e., stating a preference for good A, but simultaneously submitting a larger bid for good B. Table 1 summarizes the bids for the remaining 27 observations on each auction.

Table 1. Stage 1 and Stage 2 bids by auction type

Auction type		Stage 1		Stage 2	
		Bid for TM	Bid for DF	DF→TM	TM→DF
5th price	Mean	1.58	1.47	0.03	-0.54
(N=27)	Median	1.25	1.00	0.1	-0.6
	St. Dev.	1.04	1.19	1.09	1.70
Random nth	Mean	1.74	1.62	-0.35	-0.28
(N=27)	Median	1.8	1.5	0.00	0.00
	St. Dev.	1.13	1.33	1.65	2.00

Stage 1 bids are slightly higher for Trail Mix (TM) than for Dried Fruit (DF) but the

[2] Two additional rounds, C and D, were conducted in the session that used both auction types.

difference is not significant ($t(53) = 0.79$, $p = 0.43$). Stage 1 bids imply expected average bids for the Stage 2 DF→TM exchange of \$0.11 and \$0.12 in the 5th price and random nth auctions. The observed averages are lower, but not significantly so, at \$0.03 and -\$0.35 respectively. Likewise, the observed averages for the opposite TM→DF exchange (-\$0.54 and \$-0.28) are below the expected values of -\$0.11 and -\$0.12, but again differences are not significant.

Comparing Stage 2 bids in the 5th price and random nth auctions reveals no clear pattern. The average bid for the DF→TM exchange is higher in the 5th price auction, while the average bid for the opposite TM→DF exchange is highest in the random nth auction. Bid variance is higher in the random nth auctions, but again, differences are not statistically significant.

We now re-categorize Stage 2 bids as either WTP or WTA values according to the preference revealed in Stage 1.[3] In table 2, "Upgrade WTP" represents WTP to exchange to the preferred alternative (whether DF or TM), and, similarly, "Downgrade WTA" represents the negative WTP for an exchange toward the less preferred alternative. The "Induced Premium" is the premium for the preferred alternative revealed in Stage 1.

Table 2. Induced premium, Upgrade WTP, and Downgrade WTA values, by auction type

Auction type		Induced Premium (Stage 1)	Upgrade WTP	Downgrade WTA
5th price	Mean	0.69	0.74	-1.25
(N=27)	Median	0.50	0.50	-1.00
	St. Dev.	0.71	0.85	1.22
Random nth	Mean	0.93	0.95	-1.61
(N=26)	Median	0.75	0.75	-1.30
	St. Dev.	0.77	1.16	1.49

[3] One subject indicated equal preference for TM and DF, bid equal amounts for both products, and bid zero WTP and WTA amounts in Stage 2. Because the Stage 2 bids could not be categorized as either WTP or WTA, the individual's bids were dropped from this analysis.

Table 2 values suggest that upgrade WTP is similar to the Stage 1 induced premium, while downgrade WTA values exceed (in absolute value) the Stage 1 premium. We test the hypothesis of demand revealing bidding behavior in the Stage 2 auctions using the following structure:

(1) $WTP_i\ (WTA_i) = \alpha + \beta * IP_i + \varepsilon_i$

where $WTP_i\ (WTA_i)$ is the Stage 2 bid to upgrade (downgrade), and IP_i is the induced premium from Stage 1. Stage 2 bids are demand revealing if $\alpha=0$ and $\beta=1$ for WTP, *and* $\alpha=0$ and $\beta=-1$ for WTA. The estimated WTP/WTA equations for each auction, with standard errors in parentheses, are:

5th Price:	WTP_i =	0.19 (0.17) +	0.81*IP_i (0.18)	(W = 0.64; p = 0.53)
	WTA_i =	-0.75 (0.31) -	0.73*IP_i (0.32)	(W = 3.73; p = 0.038)
Random N:	WTP_i =	0.11 (0.29) +	0.91*IP_i (0.24)	(W = 0.08; p = 0.92)
	WTA_i =	-0.36 (0.33) -	1.35*IP_i (0.28)	(W = 5.98; p = 0.008)

The Wald test values (W) test the joint hypothesis $\alpha=0$ and $\beta=1/-1$ and indicate that, for both WTP auctions, the hypothesis of demand revealing bidding cannot be rejected. For both WTA auctions however, demand revealing bidding is rejected. WTA coefficient estimates indicate that participants demand more compensation to surrender the preferred good in exchange for the less preferred good than they are willing to pay for the opposite exchange. Divergence between elicited WTP and WTA is common in experimental valuation and is

consistent with an endowment effect (Kahneman and Tversky, 1979).[4]

We now explore whether the subject's attitude to risk may have a role in explaining the WTA-WTP divergence. From table 2 we see that in the 5th price auction, WTA bids exceed their WTP counterparts by 0.51 on average (WTP=0.74, WTA = -1.25), while in the random nth treatment the difference was 0.66. Since the endowment effect posits the idea that losses are weighted more heavily than gains in the utility function, it seems possible that the weighting applied to losses may be correlated with an individual's risk attitude. Thus, individuals who are more risk averse may be more inclined to exaggerate a WTA bid (i.e., demand more compensation) to reduce the possibility of losing a preferred good. Our questionnaire elicited risk attitude by asking respondents the degree to which they disagreed/agreed with the statement "*I am cautious in trying new and different things*." Responses were on a Likert scale from 1 (strongly disagree) to 5(strongly agree), with higher values indicate higher risk aversion. The variable had a mean of 2.85 and st.dev. 0.91. Regressing the WTA-WTP divergence on risk attitude provided the following estimates:

$$5^{th}\text{ Price:}\quad |WTA\text{-}WTP|_i = \underset{(0.72)}{0.02} + \underset{(0.22)}{0.16}*Risk_i$$

$$\text{Random N:}\quad |WTA\text{-}WTP|_i = \underset{(0.91)}{-0.06} + \underset{(0.33)}{0.27}*Risk_i$$

In both models, the coefficient on risk attitude is positive (as hypothesized) but not statistically significant. While risk attitude may influence the magnitude of the WTA-WTP divergence, the evidence in this sample is not convincing.

[4] Shogren et al. (1994) however, demonstrated convergence of WTP and WTA with repeated market experience for goods with close substitutes.

The final objective is to compare performance of the 5th price and random nth price auctions. For subjects with large positive or negative values, Parkhurst *et al*. (2004) found that subjects in a 2nd price auction tended to overbid while bids in the random nth auction were unbiased. We investigate the hypothesis of similar behavior across auction mechanisms using:

(2) $WTP_i\ (WTA_i) = \alpha_1 + \beta_1 * IP_i + \alpha_2 * RandomN + \beta_2 * IP * RandomN + \varepsilon_i$

where *RandomN* is a dummy variable for bids elicited in a random nth auction, and *IP*RandomN* an interaction term. Bidding behavior is similar in both auctions if α_2 and β_2 are both zero. The estimated equations are:

WTP_i = 0.19 + 0.81**IP*i – 0.07**RandomN* + 0.09 IP**RandomN* (W = 0.05; p = 0.95)
(0.21) (0.22) (0.33) (0.31)

WTA_i = -0.75 - 0.73**IP*i + 0.39**RandomN* - 0.63 IP**RandomN* (W = 1.16; p = 0.32)
(0.30) (0.31) (0.46) (0.42)

Wald tests for the joint hypothesis fails to reject similar bidding behavior in the two auction mechanisms for both positive (WTP) and negative (WTA) values. However, while the estimated α_2 and β_2 coefficients are both close to zero in the WTP equation, they are of considerably greater magnitude in the WTA equation. Figures 1 and 2 plot WTP and WTA bids against the stage 1 induced premium. Figure 2 shows that WTA bids elicited with the random nth auction are everywhere below the induced premium, and that divergence from both the induced premium and 5th price auction values increases with the induced premium.

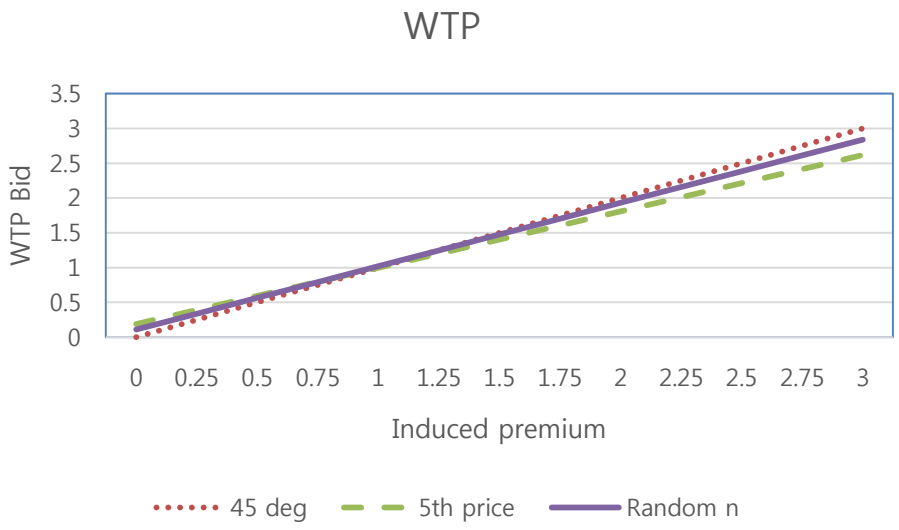

Figure 1: WTP bids vs Induced Premium

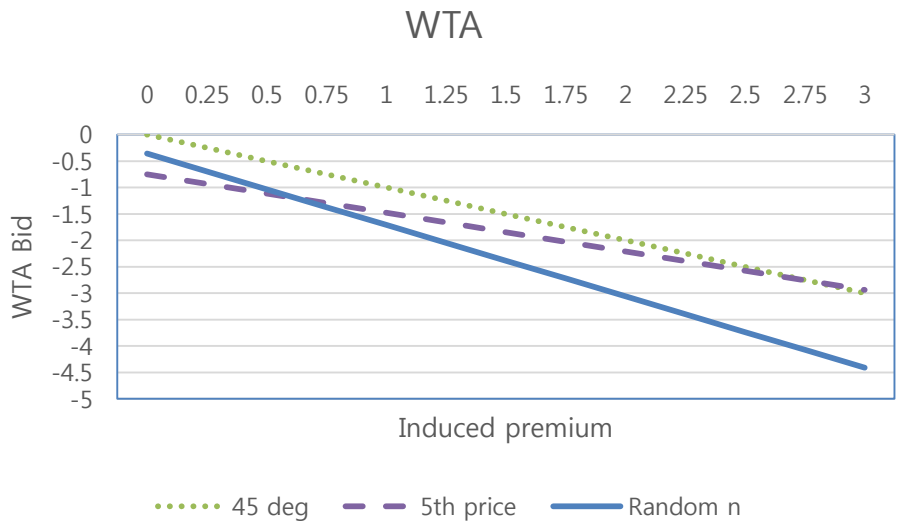

Figure 2: WTA bids vs Induced Premium

4. Conclusions

Valuation studies often deal with goods for which some subjects hold positive value, others negative. In that context, experimental auctions that permit simultaneous elicitation of

positive and negative values have advantages over other approaches such as truncation at zero, or screening and separating subjects based on preferences. Permitting negative bids allows for a more complete revelation of the demand curve, but may also introduce incentives for strategic bidding for subjects seeking a financial gain. Using an approach that treats a difference in initial bids for two private goods as an (endogenous) induced value, we show that the option to submit a negative bid did not compromise accurate revelation of positive WTP values in either a 5^{th} price or random n^{th} auction mechanism.

As in many studies, we find evidence of a WTP/WTA divergence, with WTA exceeding (in absolute value) the WTP for the opposite exchange of goods. The hypothesis that the negative WTA bids accurately revealed induced value was rejected. Controlling for the subject's risk attitude was shown to partially explain the overbidding of WTA. The random n^{th} and 5^{th} price auctions performed similarly in eliciting WTP values; with negative values, however, the tendency to overbid (in absolute value) was more pronounced with the random n^{th} price mechanism. Our findings are in contrast with those of Parkhurst *et al.* (2004) who reported demand revealing bidding in a repeated trial random n^{th} auction for both positive and negative induced values. We find no reason to discourage practitioners from allowing simultaneous positive/negative bidding in valuation experiments, but our results suggest that negative bids will reflect the commonly found WTP/WTA disparity, and that it may be more pronounced in a random n^{th} auction.

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