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Laboratory Testbeds and Non-Market Valuation: The Case of Bidding Behavior in a Second-Price Auction with an Outside Option

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Abstract. Researchers now use the lab to examine the behavioral underpinnings of valuation before the field application which some argue has less experimental control. But lab valuation work raises its own set of concerns when it uses private goods to explore non-market valuation behavior because private goods have substitutes often unaccounted for in the lab. Therefore, the lab as a tool to testbed field valuation work may be limited. Herein we design an induced valuation experiment to explore bidding behavior in a second-price auction with an outside option that is a perfect substitute for the auction commodity. Theory predicts that rational bidders will consider the prices of outside options when formulating bidding strategies, and will reduce their bids whenever their resale value exceeds the price of the outside option. Our results suggest that bidders account for outside options when formulating bids with behavior following comparative static predictions. In addition, we provide evidence concerning hypothetical versus actual behavior with induced values – the data suggesting a hypothetical bias in the level of bids but not in bid shaving.

Key words: bidding behavior, experiments, outside option, valuation

1. Introduction

Laboratory experiments have become a popular tool to explore the behavioral underpinnings in non-market valuation. Researchers use the experimental control of the lab to investigate how people react to design incentives behind valuation questions prior to field application (see Coursey and Schulze 1986). Much of the published experimental validity testing of contingent valuation has occurred in the realm of private goods. Examples include validation of hypothetical survey methods (e.g., Neill et al. 1994; Cummings et al. 1995; Cherry et al. 2003), examination of the WTP/WTA disparity (e.g., Kahneman et al. 1990; Shogren et al. 1994), new product valuation (e.g., Hoffman et al. 1993; Fox et al. 1994, 1995; Roosen et al. 1998), and elicitation of individual discount rates (e.g., Benzion et al. 1989; Harrison et al. 1995). But lab valuation work raises its own set of concerns when it uses private goods to examine non-market valuation behavior because private goods can have substitutes unaccounted for in the laboratory. Consequently, the lab as a tool to testbed field valuation may suffer. If the concerns over uncontrolled incentives in the lab are accurate, laboratory results on observed bidding behavior (e.g., real versus hypothetical valuation) are as open to challenge as the survey work that the lab research criticizes.

Herein we explore whether laboratory valuation work using private goods suffers from a lack of experimental control due to uncontrolled market substitutes acting as an outside option. Our general concern in this study is with experiments designed to elicit individual values for a private good. The problem arises from the observation that lab valuation exercises usually do not explicitly account for the behavioral implications of field substitutes for the lab commodity.[1] A researcher might view the lab auction as producing bids and values for a unique good in a controlled setting, when in fact the bidding behavior reflects the price of an unmeasured outside option. If such a loss of control exists, valuation results from the lab may be less instructive for non-market valuation than previously thought (Harrison 1992; Harrison et al. 1995).

The problem is illustrated with an example. Neill et al. (1994), for instance, use the classic incentive-compatible second-price auction to examine the disparity between hypothetical and real bids for a work of art (Vickrey 1961). Figure 1 shows the demand curve for the art piece, D_V, as the schedule of individual values v_i in the absence of an outside option.

If the artwork is unique, each bidder's dominant strategy is to bid v_i. But if bidders know the artwork is also for sale at a local gallery or local campus bookstore, each high-value bidder's new dominant strategy is to shave his bid downward to the outside option price (assuming zero transactions costs). In effect, the demand curve for the artwork is bent inward due to the introduction of the perfect substitute sold at choke price p_{oo}, yielding the choked demand curve, D_{oo}.[2]

It remains an open question whether bidders actually account for an outside option when bidding in the lab. That is, which demand curve is being observed in the lab, D_V or D_{oo}? Moreover, does the structure of the elicitation mechanism (i.e., real or hypothetical auction) affect which demand curve one observes? The answer matters to the interpretation of bidder behavior. Some observers have suggested that the lab may be capturing D_{oo} when payments are real and D_V when payments are hypothetical (Smith 1994, p. 141). If this holds, the existence of uncontrolled outside options might explain the

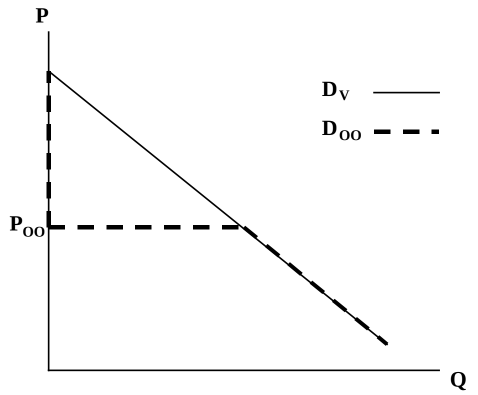

Figure 1. Baseline (D_V) and choked (D_{OO}) demand.

oft-observed gap between hypothetical valuation statements and real economic commitments.

In this paper we design an induced valuation experiment to explore whether bidders in both hypothetical and real second-price auctions consider the existence of outside options when formulating bid strategies. Induced values allow us to control the baseline and choked demand curves, and thereby focus attention on bidding behavior rather than on the elicitation of unobservable private values or perceived outside option prices, or both. Our major results are twofold: (a) bidders consider outside options when formulating bids with behavior following comparative static predictions – a lower outside option price results in lower bids; and (b) bidding behavior in the presence of the outside option is consistent across real and hypothetical auctions, which does not support Smith (1994).

2. Experimental Design and Bidding Behavior

Our experiment used a 2×4 treatment design to test for *bid shaving* in the presence of an outside option. The treatment conditions involved real or hypothetical payments and three uniform outside option prices; \$2, \$4, \$6 or a baseline with no outside option. All other design features were the same across all treatments – 10 bidders and 10 rounds, and in each round a "good" was sold in a Vickrey second-price auction, in which the highest bidder wins and pays the second-highest bidder's bid.[3]

In each round, the monitor assigned each bidder his or her unique induced baseline value for the good, or *induced value* v_i. The induced value is the price at which the bidder could sell the good to the monitor after the auction (see Kagel's overview 1995). We used 10 private induced values to create the induced demand curve D_V – \$8.4, \$7.6, \$7.1, \$6.8, \$6.5, \$5.3, \$3.8, \$2.4, \$1.8,

\$0.9. The resale values were distributed so that each bidder was assigned each value once, i.e., each bidder had a different induced value in each round of bidding. The bidders were neither informed about the other bidders' induced value nor the induced demand curve. The whole demand curve was induced in every round. In addition, an outside option existed that allowed each bidder the opportunity to buy the good in a secondary market at a posted uniform price (either \$2, \$4 or \$6) with no transaction costs.

Instructions for the experiment were read aloud by the experimenter and an informed consent form was handed out to the subjects.[4] The outside option at \$2.00 was described as

> Those that did not have the highest bid in the auction can buy the good from the experimenter for \$2.00 and sell it back to the experimenter for the *resale value*. The difference between the resale value and \$2.00 is their profit. Note that profits can be negative if the *resale value* is less than \$2.00. Use the bid slip to indicate whether you want to buy the good for \$2.00 in the event that you do not have the highest bid in the auction.

Bidders used a bid slip that served three purposes. The bid slip (i) informed the bidder of his induced value; (ii) was the bid mechanism for the auction; and (iii) indicated whether a losing bidder wanted to buy the good in the secondary outside option market. At the end of each round, the monitor collected bid slips, calculated profits for each bidder, recorded the individual results on the bid slip, and returned the slips to the bidders so they could follow the results of their actions. Profits equalled the difference between the induced value and the price the bidder paid for the good, either in the auction or in the secondary market. If a bidder did not purchase the good, her profit was zero for that round. In the real payments sessions, total profits for all 10 sessions were paid to bidders in cash at the end of the experiment. Only the winner saw the two highest bids.[5]

Theory says in a second-price auction without an outside option, a rational bidder's dominant strategy is to bid his induced value v_i (Vickrey 1961). Experimental tests have shown that the second-price auction performs reasonably well in revealing preferences for both induced and non-induced value auctions (see Kagel 1995). With an outside option, however, the bidder's optimal bid strategy b_{i} now depends on whether the price of the outside option p_{oo} exceeds v_i. Rational bidding behavior can be characterized as follows:

$$b_i = \begin{cases} v_i & \text{if } p_{\mathrm{oo}} \geq v_i \\ p_{\mathrm{oo}} & \text{if } p_{\mathrm{oo}} < v_i \end{cases}$$

Holding the baseline demand curve constant, comparative statics suggest as the price of the outside option falls, bids decrease. The outside option can be thought of as a second indirect induced horizontal demand curve for bidders who have a resale value higher than the price of the outside option.[6]

Aggregate baseline demand is computed as the summation of resale values, or \$50.6 per round. Rational bidding behavior in the no outside option baselines yields 100% of the baseline demand. For the \$2 outside option price treatments, rational bidding would produce about 37% of the baseline demand, (8∗\$2 + \$1.8 + \$0.9 = \$18.7 of \$50.6). Similarly, for the \$4 and \$6 treatments, rational bidding yields about 65% of baseline demand (6∗\$4 + 3.8 + 2.4 + \$1.8 + \$0.9 = \$32.9 of \$50.6); and about 87% of baseline demand (5∗\$6 + \$5.3 + \$3.8 + 2.4 + \$1.8 + \$0.9 = \$44.2 of \$50.6).

3. Results

Table I illustrates general bidding behavior by summarizing the observed aggregate behavior by round and treatment.

First, censoring exists in both real and hypothetical markets. The data suggests that subjects, in general, understood the incentives of censoring and were bidding accordingly in both real and hypothetical auctions. As the value of the outside option increases, and correspondingly the incentives to censor decreases, we see less shaving of bids. Strictly rational bidding in treatments A + B + C would result in the elicitation of \$958, or about 63% of the induced demand curve.[7] Adding up the bids in these auctions, we elicit \$1149.9; or about 76% of the induced demand curve and we elicit on average 71% of the treatment without an outside option. In the hypothetical context, 84% (\$1281.8) of the induced demand curve and 57% of the auction without an outside option are elicited. Four bids in the later rounds strongly affect the elicited mean bid in the hypothetical auction without an outside option, \$84, \$35.6, \$43 and \$42.2. This result suggests a potential problem of fatigue in repeated hypothetical auctions. Second, the data shows bidding behavior is consistent with comparative static predictions – as the outside option price decreases, the level of censoring increases.

We now focus our discussion on the bidding behavior at the individual level by estimating the following random effects Tobit model:

$$b_{it} = \alpha + \psi \text{Option}_i + \delta \text{Real}_i + \theta \text{Real} * \text{Option}_i + \phi_t + u_i + \varepsilon_{it}, \quad (1)$$

where b_{it} is the dollar bid of the ith person in trial t; Option$_i$ is a vector of binary variables signifying the outside option available to person i ($p_{\text{oo}} = \$2$, \$4 or \$6; no option, $p_{\text{oo}} = \$0$, baseline omitted); *Real*$_i$ is a single dichotomous variable that equals 1 if the auction was real, 0 otherwise; Real∗Option$_i$ is a vector of interaction variables that captures the relative impact of the real

Table I. Aggregate bidding behavior by treatment and round

Treatment	Real or hypothetical bid	Price of out-side option	Aggregate choked demand	Observed aggregate bids										
				Round										
				1	2	3	4	5	6	7	8	9	10	Total
A	Real	$2	$18.7	$29.4	29.2	25.4	25.1	25.9	30.6	32.1	28.2	29.7	25.2	$280.8
			37%[a]	58.1	57.7	50.2	49.6	51.2	60.5	63.4	55.7	58.7	49.8	55.3
B	Real	$4	$32.9	$38.8	49.0	25.2	47.5	30.3	25.3	28.3	35.4	32.3	34.4	$346.5
			65%	76.7	96.8	49.8	93.4	59.9	50.0	55.9	70.0	63.8	68.0	68.5
C	Real	$6	$44.2	$51.2	49.3	48.0	51.9	55.9	57.9	54.8	48.4	56.6	48.6	$522.6
			87%	101.2	97.4	94.9	102.0	110.5	114.4	108.3	95.7	111.9	96.0	103.3
D	Real	No	$50.6	$45.9	47.3	55.1	58.6	56.6	57.0	54.5	55.8	53.0	55.8	$539.6
			100%	90.7	93.5	109	116	112	112	108	110	105	110	107
E	Hypo	$2	$18.7	$35.7	42.5	38.2	35.1	30.0	28.2	28.0	30.9	27.0	29.8	$325.4
			37%	70.6	84.0	75.5	69.4	59.3	55.7	55.3	61.1	53.4	58.9	64.3
F	Hypo	$4	$32.9	$40.6	42.1	40.4	41.1	37.1	39.6	34.6	37.3	38.3	41.4	$392.5
			65%	80.2	83.2	79.8	81.2	73.3	78.3	68.4	73.7	75.7	81.8	77.6
G	Hypo	$6	$44.2	$38.9	46.8	69.6	46.5	125.2	44.8	51.2	45.1	51.7	44.2	$564
			87%	76.9	92.5	137.5	91.9	247.4	88.5	101.2	89.1	102.2	87.4	111.5
H	Hypo	No	$50.6	$39.8	42.8	49.9	50.9	67.8	132.5	65.2	95.7	99.7	103	$747.3
			100%	78.7	84.6	98.6	100.6	134	261.9	128.9	189.1	197.0	203.6	147.7

[a]Percentage of total baseline demand (baseline demand = $50.6 per round).

outside options available to person i; ϕ_t is a set of $T-1$ dummy variables that capture potential non-linear trial effects (e.g., learning); α is the estimated intercept, u_i are random effects which control for unobservable individual characteristics (e.g., risk aversion), and ε_{it} is the well-behaved error term. The panel framework controls for individual heterogeneity while the Tobit model allows bids to be censored on both ends of the distribution.[8]

Table II presents the estimation results from Equation (1).

Overall, parameter estimates reveal three key findings. First, bidding behavior exhibited a hypothetical bias. People submitted significantly lower bids in real auctions relative to those in hypothetical auctions ($P = 0.057$).

Second, bid shaving exists and increases as the outside option decreases. Estimated coefficients for the outside options ($p_{oo} = \$$) reveal the presence of an outside option significantly lowers bids relative to the no outside option baseline, and show the magnitude of the impact increases as the outside option decreases.

Third, while bidding was subject to hypothetical bias, bid shaving was equally likely to occur in real and hypothetical auctions. Estimated coefficients of the real outside options ($rp_{oo} = \$$) uncover no significant difference in bidding across real and hypothetical auctions once controlling for hypothetical bias. The third finding does not support Smith's (1994) suggestion that the existence of outside options may help explain differences in laboratory behavior when payments are real relative to when payments are hypothetical.[9]

Table II. Panel Tobit estimation results for bid function[a,b]

Variable	Coefficient	*P*-value
Constant	6.83	0.000
Outside option		
$p_{oo} = \$2$	−4.22	0.000
$p_{oo} = \$4$	−3.58	0.001
$p_{oo} = \$6$	−1.83	0.094
Real	−2.08	0.057
Real*Outside option		
$rp_{oo} = \$2$	1.60	0.300
$rp_{oo} = \$4$	1.49	0.336
$rp_{oo} = \$6$	1.60	0.300
$\chi^2(u_i = 0)$	50.39	0.000
N	800	

[a]Dependent variable is the subject's bid (b_i).
[b]Round effects are controlled in the estimation but omitted from the presentation for succinctness; results are available upon request.

4. Concluding Comments

This note evaluates one key issue in the use of laboratory experiments to testbed field non-market valuation exercises: how does an outside option influence bidding behavior in a second-price auction? Using a second-price auction with induced values, the results suggest that people consider outside options when formulating bid strategies, bidders shave their bids toward the price of the outside option. Further, bid shaving persists across both real and hypothetical settings, no significant difference is found. The implications for future non-market valuation research are threefold. First, the results are intriguing as they suggest that bidders can take market incentives seriously, even in a hypothetical setting. Second, previous comparisons of hypothetical and real payments have used "homegrown" instead of induced values. Whether this circumstance would change our results is a question open for empirical tests. Third, bid shaving is a specific case of the more general valuation question on how unobserved private actions (e.g., personal skill in reducing job or environmental risk) can affect revealed preferences for collective policies (see Shogren and Crocker 1991). The results herein support the general idea that uncovering otherwise hidden private actions deserves more attention in non-market valuation work.

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Notes

1. Two exceptions are Coller and Williams (1999) and Harrison et al. (2002), in which the experimenters elicit subject perceptions of the interest rate of alternative field substitutes and then control for these rates in the data analysis. Harrison (1992) and Smith (1994) take field substitutes into account when interpreting experimental data.
2. This exposition is simplified in the sense we do not address the existence of imperfect substitutes or diverse subject perceptions of outside option prices and/or transactions costs. These technical complications do not affect the general implications of the present study, or are they germane to our experimental design, so their discussion is suppressed here.
3. To minimize ending round effects, no information was provided to the subject regarding the number of rounds the experiment would last.

4. Bidders were recruited campus-wide from the student body at the University of Wyoming. Participation was voluntary and not part of their class evaluation. Written instructions were distributed and read aloud. A written quiz followed with a subsequent discussion to ensure bidders understood the dominant strategy of the second-price auction. Each experimental session lasted about an hour and the average bidder earned \$20 in the real auctions alternatively was paid \$20 for participating in a hypothetical one.
5. All the forms including the instructions are available on request.
6. We thank one of the referees for pointing this out.
7. Comparing proportions over all subjects, a total of 190 bidders should censor in all rounds.
8. A Hausman likelihood ratio test reveals that the panel model is the appropriate estimator ($\chi^2 = 50.39$). The model is censored from below at zero given bidders may opt out with a zero bid, and censored from above at the highest bid given bidders may possess some value of winning the auction.
9. For more discussion on the gap between hypothetical and real behavior, see for example Neill et al. (1994), Fox et al. (1998), Frykblom (1997) or Harrison and Rutström (1999).

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