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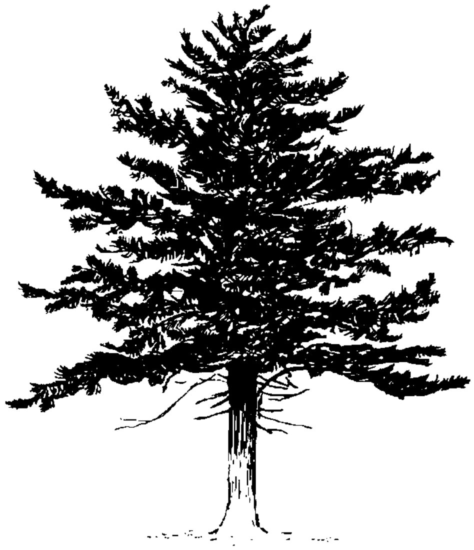

Can Hypothetical Questions Reveal True Values? A Laboratory Comparison of Dichotomous Choice and Open-Ended Contingent Values with Auction Values

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Abstract

Can hypothetical questions reveal true values? An examination of the laboratory experimental literature examining contingent valuation (CV) lends some support for using open ended hypothetical willingness to pay questions. However, experimental studies examining dichotomous choice have found that hypothetical answers overstate demand. Consistent with the experimental literature, published CV studies comparing open-ended to dichotomous choice questions have shown that values from the latter method equal or exceed those of the former in every case. This paper presents a series of experiments employing more than 800 subjects to test this hypothesis for CV and compares the CV results to actual auction values in a single controlled experimental environment.

1. Introduction

Can hypothetical questions reveal true values? This and many aspects of contingent valuation (CV) as a tool for valuing non-market goods are under intense investigation. One fundamental question that remains is: how should a respondent's value be elicited, with a continuous willingness to pay question, such as that provided in an open-ended question (OEQ) format, or with a dichotomous choice question (DCQ) given a stated price? This paper describes a laboratory experiment which compares willingness to pay (WTP) obtained in an actual auction with WTP obtained from both open-ended and dichotomous choice questions, between different subjects, for an insurance policy against a financial hazard with a known probability. Such an experiment is needed because the NOAA panel on CV (Arrow et al., 1993) specifically endorsed the use of dichotomous choice questions.

One of the major discoveries of experimental economics has been that the detailed structure of institutions (including how bids are elicited) matters. In fact, theoretical incentive compatibility does not guarantee that a market institution will actually reveal demand (see, for example, Kagel and Roth, 1995, pp. 506-508). Consistent with this discovery, a review of the CV studies comparing institutions using auction like open-ended values with values obtained from posted offer like institutions using dichotomous choice, reveals that dichotomous choice almost always produces larger value estimates (Schulze et al., 1996). In reviewing the six CV studies that have compared values from OE and DC questions they found that the average study shows that the elicitation methods differ by a factor of 7.0 and that the median study shows a difference of a factor of 1.9. Laboratory experiments, although never directly comparing OE and DC questions, have shown that OE questions can closely approximate auction values (see Coursey et al. 1987, and the study reported in Shogren et al., 1993, and Fox et al., 1994). In contrast, DC questions have consistently led to an overestimate of demand in laboratory experiments (Cummings et al., 1995 and Cummings et al. forthcoming).

The remainder of the paper presents a series of experiments testing this hypothesis in a consistent experimental environment. First, actual bids are obtained from an English auction for an insurance policy protecting the subject against a 0.4 probability of a $10 loss. Second, open-ended hypothetical bids are obtained from a different group of subjects for the same commodity. Third, five different groups of subjects, each group facing a different posted price ($1, $4, $6, $8, and $12), are asked a dichotomous choice question: would they hypothetically purchase the insurance policy? It should be noted that none of the DC laboratory experiments published to date have collected sufficient data at more than one price to allow estimation of WTP.

2. A Summary of the Experimental Literature[1]

The experimental approach potentially allows the experimenter to obtain true values since some auctions have been shown to be demand revealing in experimental tests. Experimental tests of auction mechanisms use induced values (Smith, 1982) where, for example, subjects may buy or sell tickets redeemable at the end of the experiment for the face amount. Since the experimenter knows that a subject's true value for the ticket is the face amount, an auction is perfectly demand revealing if subjects submit offers to buy or sell their tickets for amounts equal to face value. We use the term demand revealing to refer to the actual performance of a mechanism and refer to the theoretical property of demand revelation -- supported by either a dominant strategy or a Nash equilibrium -- as incentive

[1] This section summarizes, in part, an extensive review of the literature presented in Schulze et al. (1996).

compatibility. No known auction is perfectly demand revealing since subjects make errors even if large sums are involved (Smith and Walker, 1993a, 1993b). However, one incentive compatible mechanism, the English auction , is very close to being perfectly demand revealing for all subjects except the winner, even on the first round (Coppinger, et al., 1980; Kagel et al., 1987; Levin et al., 1996). Some theoretically incentive compatible mechanisms, such as the Vickrey auction, require several rounds of experience before they approach individual demand revelation. In fact, although the English and Vickrey auctions are theoretically isomorphic, the English auction performs much better in revealing demand (Kagel and Roth, 1995). Theoretically incentive compatible mechanisms, such as the Groves and Ledyard, Clark, and Tullock public good mechanisms, perform much more poorly than private good auctions and require a large number of rounds before subjects approach demand revelation even at the average or aggregate level. These mechanisms, in spite of their theoretical properties, are not individually demand revealing (Davis and Holt, 1993). In contrast, the English auction is individually demand revealing. To obtain the most precise estimate of the actual value of the insurance policy used in our experiment, based on experimental tests, we employ the English auction. For a summary of the literature on the performance of alternative mechanisms see Davis and Holt (1993) or Kagel and Roth (1995).

A number of experiments have examined OE-CV questions. The first laboratory experiment to test CV against actual auction behavior (Coursey, et al., 1987) used a bitter tasting liquid, sucrose octa acetate, as a proxy for an environmental commodity. Subjects were asked for a hypothetical OE-WTP to avoid a taste experience. After they had tasted the commodity, the same subjects submitted bids to avoid the commodity in a uniform price multiple unit version of the Vickrey auction. Mean hypothetical and actual bids were similar in that the ratio of hypothetical to actual auction bids was equal to one.[2] A substantial number of experiments have followed this general design including studies by Brookshire, et al. (1990), McClelland, et al. (1993), Irwin, et al. (1992), Boyce et al. (1989, 1992), Neill et al. (1994), Shogren et al. (1994), and Fox et al. (1994). Schulze et al. (1996) summarize these studies and conclude that the median experiment shows that hypothetical bids exceed experienced market values by a factor of 1.65. They focus on the median bias because the distribution of experimental results is highly skewed and no one experiment can be viewed as conclusive. For example, focusing only on the WTP for a 16th century map obtained by Neill et al. (1994) would lead one to conclude that hypothetical values had little predictive power since the ratio of hypothetical to actual bids was 9.1. Alternatively, examining the Coursey, et al. (1987) study (ratio of 1.0) or the Fox et al (1994) study (ratios of 1.2 and 1.5), which value unfamiliar commodities (where one might expect a large bias), would lead one to conclude little bias is present. Note that, unlike real world CV studies, large hypothetical values (no matter how unrealistic) have not been trimmed from the experimental data described in these studies.

All of the experimental studies described above relied on OE-WTP questions for eliciting values. Given the endorsement of the referendum approach (which presents respondents with a dichotomous choice question) by the NOAA panel on contingent valuation (Arrow et al., 1993), what do laboratory experiments say about DC questions? The first laboratory experiment to shed light on the reliability of dichotomous choice (Cummings et al., 1995) shows that, for three different commodities (a juicer, chocolate candy, and a calculator), respondents in a hypothetical setting overestimate the frequency with which they would make an actual purchase at the same posted price. Similar results are obtained in a public

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2 This is an average of a range of estimates which are obtained depending on the treatment of one large outlier actual bid. If this bid is included the ratio is 0.7; if it is excluded the ratio is 1.3.

good setting as well (Cummings et al., forthcoming). These studies do not estimate willingness to pay, but suggest that dichotomous choice may produce upward biased estimates of value.

The Cummings et al. papers are only suggestive because they collect sufficient data at only one price to allow statistical testing in both their survey question and actual institution and, as a result, cannot estimate WTP for the commodities they use for comparison. Since, as we show using five prices, hypothetical and actual price elasticities differ, such comparisons may be misleading. In the experiment described in this paper, we extend the work of Cummings et al. in four ways. First, we obtain a full willingness to pay estimate by using five prices to trace out the entire demand curve in the dichotomous choice treatment. Second, we obtain hypothetical WTP using both dichotomous choice and open-ended WTP so that the two techniques can be compared. Third, we use as the commodity an insurance policy with a known expected value. Fourth, we use an English auction to obtain a reliable estimate of actual WTP for the insurance policy.

3. Experimental Design

3.1 English Auction

Two English auction experiment sessions were administered in which bids were recorded from a total of 52 subjects. The English auction was chosen because it is more closely demand revealing than any other mechanism that has been tested. As noted above, the mechanism does not reveal the value of the winning subject. Thus, since we conducted two sessions, we obtained values for 50 of 52 subjects. Subjects were volunteers from undergraduate classes in macro- and microeconomic principles at the University of Colorado at Boulder. Subjects were generally unaware of the concept of expected value and were not trained in it or related concepts. The subjects were seated in a classroom in which the desks were arranged in a circle so that they were in full view of the experimenter and each other. Instructions (see Appendix A) and bidding cards were distributed. The bidding cards had a green side and a yellow side, and both sides had the subject's number recorded on them. After the subjects read the instructions carefully the experimenter gave an oral summary, and administered a practice auction to familiarize the subjects with the auction mechanism.

The auction begins with all subjects holding up their bidding cards with the green side facing the center of the room. The experimenter announces prices, starting at $0.00 and increasing in $0.40 increments. After a price is announced, subjects either keep the green side of the card facing the center of the room, indicating they wish to remain in the auction, or they flip the card so that the yellow side of the card is facing the center of the room, indicating that the current price is the maximum they would be willing to pay. The current price is recorded for subjects showing the yellow side of their cards; these subjects are not allowed to participate further in the auction. The last person whose card's green side is still facing the center of the room gets the auctioned commodity at the last announced price.

After the practice auction each subject was given an initial balance of $80, but was then faced with a 0.4 probability of a $10 loss. One insurance policy against this loss was auctioned in each session. The 0.4 probability was operationalized by placing 40 red chips and 60 white chips in a cloth bag and randomly drawing a chip from the bag. The purchase price was deducted from the balance of the one subject who purchased the insurance policy. After the auction, a volunteer subject drew a chip (with replacement) separately for each subject. If a white chip was drawn, a subject's balance remained unchanged. If a red chip was drawn, a subject's balance decreased by $10. Subsequently, subjects participated in other auctions against different probabilistic losses. The main purpose of these subsequent auctions was to reduce subjects' expected balances to a more reasonable hourly wage rate (about $30). The data for these additional auctions are not reported here.

3.2 Contingent Values

In order to obtain contingent values that were comparable to the values obtained in the English auction , subjects were asked in a survey format to value an insurance policy protecting against a hypothetical risk of a 0.4 probability of a $10 loss. There were two versions of the survey: one used an open-ended question (OEQ, Appendix B), and the other used a single dichotomous choice question (DCQ) for a fixed price (Appendix C contains the DCQ version for a price of $4; other versions were identical except for the price). Different versions of the DCQ survey used prices of $1, $4, $6, $8, and $12.

In the surveys, the risk was described identically to the way it was described in the English auction instructions. Thus, respondents are valuing the same commodity. Specifically, the surveys asked the respondents to imagine that they had an initial balance of $80 and that they faced a one-time loss of $10 with a 0.4 probability. The loss was to occur if one of the 40 red chips out of 100 (red and white chips) was randomly drawn from a cloth bag. The surveys explained that the loss could be avoided through the purchase of an insurance policy. The cost of the insurance policy, which fully protects against the possible $10 loss, was to be deducted from the $80 balance.

The surveys were administered to undergraduate classes in economic principles at the University of Colorado. The subjects were generally unaware of the concept of expected value and were not trained in it or related concepts. These subjects were not recruited for, and did not participate in, the English auction experiment. A total of 766 students were administered contingent value surveys. Following theoretical and empirical expositions of optimal sample design in dichotomous choice contingent valuation (Cooper and Loomis, 1992; Kanninen, 1993) posted prices were concentrated at critical points on the anticipated distribution: close to the expected median value ($4) and at two prices ($1, $8) above and below this value. Given uncertainty in the parameter values, additional "insurance" that the entire distribution was adequately covered was obtained by setting a second tier of posted prices ($6, $12), with fewer observations.[3] Table 1 shows the allocation of subjects across versions and prices.

The CV surveys were administered to each class at the beginning of a normal lecture. The surveys were distributed to the class, and a verbal explanation of the instructions was given. To increase the saliency of the risk, the experimenter demonstrated the risk by drawing poker chips from a bag. The experimenter explained the consequences of drawing a white chip or a red chip, depending on whether one had an insurance policy or not. The students usually completed the survey within 10 minutes.

4. Results

The analysis of estimated WTP values for the insurance policy is divided into two stages. First, we evaluate the English (ENG) Auction results. This experiment involves real monetary transactions and an incentive compatible, demand revealing mechanism, so it provides a reference point for assessing the hypothetical contingent values for the same insurance policy. The OEQ and DCQ contingent values are then compared to this reference auction value and to each other. An additional reference value is provided by the expected value of $4 for the insurance policy. However, departures from risk neutrality might cause bids to deviate from

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3 Although the resulting range is quite wide, it is interesting to note that the highest posted price corresponds closely with Kanninen's "general rule-of-thumb" of limiting bids to within the 85th percentile of the willingness to pay distribution (Kanninen, 1995).

Table 1: Number of Responses to the CV Instruments by Version

OEQ	DCQ					total students
	$1	$4	$6	$8	$12	
345	94	174	31	87	35	766

the expected value of the insurance policies, but such effects are likely to be small for the small stakes used in these experiments.

The top row of Table 2 and the top panel of Figure 1 present summary statistics and the frequency distribution for the English auction .[4] The mode of the English auction distribution approximates the expected value of the insurance policy. If we replace the two missing values for the winners of the two auctions with the next price called (since by remaining in the auction these subjects would be willing to pay at least the next price called), the resulting mean value of $3.66 falls 8% below the expected value of $4.00. This estimated mean may be an underestimate of the true mean which we also approximate later by fitting a cumulative distribution.

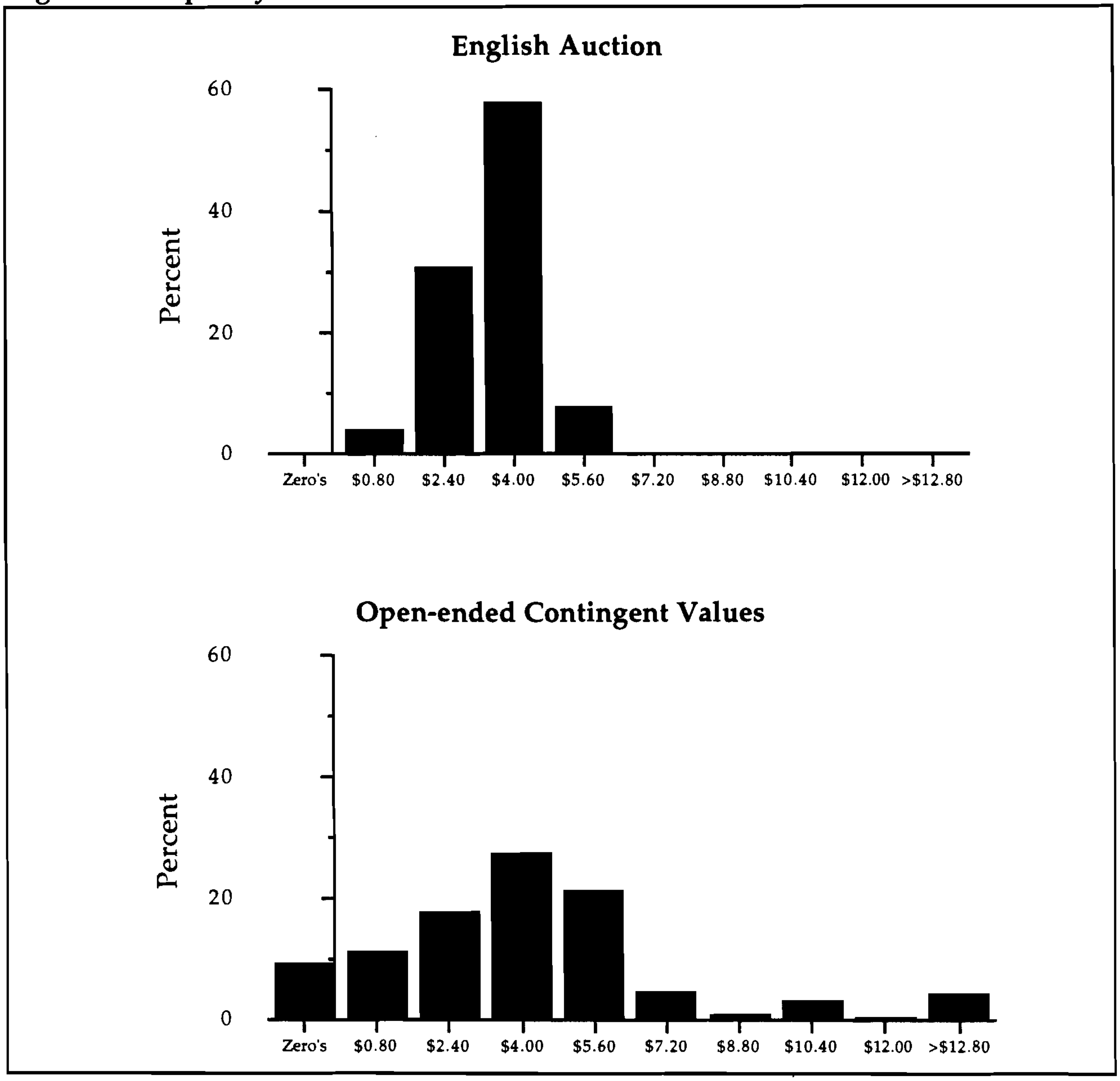
The bottom row of Table 2 and the bottom panel in Figure 1 present the summary statistics and the frequency distribution of the OEQ values. The mean OEQ value of $4.58 is statistically different from $4 ($t(344)=2.00$, $p \cong 0.05$) and exceeds expected values by 14.5%. The large standard deviation is due to a small number of very large bids obtained in the OEQ survey. Two respondents bid $40 and four bid $30 or more. In total, about 5% of the OEQ bids were greater than $10 (the potential loss is only $10), and an additional 9% of the bids were zero. These bids, as is typically done in CV studies, might justifiably be trimmed. By eliminating the

[4] The midpoints on the buckets in Figure 1 were chosen so that they would be consistent with the incremental English auction bids and also so there would be a bucket with a midpoint of EV. The English auction bids are arrayed in $0.40 increments and, as per the instructions, a bid of $0.40 implies a WTP between $0 to $0.40. Therefore, the bucket with the midpoint $0.80 contains English Auction bids of $0.40, $0.80, $1.20 and $1.60; the next bucket labeled $2.40 contains bids of $2.00, $2.40, $2.80 and $3.20.

Table 2: Descriptive Statistics for the English Auction and OEQ-CV Data

	n	Raw Mean ($s)	Std. Dev.
English	52	3.66	1.15
OEQ CV	345	4.58	5.38

Figure 1: Frequency Distributions



outlier bids that were at zero or above $10, the mean bid falls to $3.97 (s = $2.06) which is not significantly different from $4 ($t(296)=-0.25$, $p \cong 0.80$). However, Figure 1 illustrates that the OEQ responses exhibit more variability than the auction values, even if these outliers are ignored. In addition, it is a well known fact in experimental economics that decreasing incentives increases bidding variance (Smith and Walker, 1993a, 1993b). In other words, subject bidding error increases as incentives are decreased.

Table 3 presents the data collected from the DCQ survey. The DCQ data are not in a form that is easily comparable to the distribution of bids obtained from the other methods. Dichotomous choice responses contain far less information than open-ended responses; to make a meaningful comparison, the open-ended responses must be converted to an equivalent dichotomous choice for a given price.

We made a conversion of the OEQ data into equivalent dichotomous choices at the five prices assuming that respondents would have chosen to buy the insurance if the posted price had been less than or equal to their OEQ values. In making the conversion, we wanted to maintain independence in the OEQ data across the prices. Thus each OEQ value was allocated randomly to one of the five prices in a way that produced sample sizes proportional to the DCQ samples for each price. It was apparent, however, that the results were dependent on the random allocation. To get a proportion at each price that was not dependent on a particular allocation, 100 random allocations were used; the average proportions from these 100 allocations are reported in the right half of Table 3. In a simple comparison, each of the DCQ proportions is higher than the average proportions for the OEQ data. Thus, a demand curve estimated from the DCQ data will be entirely to the right of a demand curve estimated from OEQ data.

Table 3: Results from the DCQ Survey and OEQ Conversion to Dichotomous Choices

Price	DCQ		OEQ	
	Total Number of Responses	Proportion that Accepted the Posted Price	Average Number of Observations	Average Proportion that Would have Accepted the Posted Price
$1	94	93.62%	77	88.00%
$4	174	67.82%	143	55.92%
$6	31	32.26%	25	16.12%
$8	87	24.14%	71	8.43%
$12	35	11.43%	29	4.90%

In order to calculate the mean bid from dichotomous choice data a distribution must be assumed and then a maximum likelihood estimation must be made. From this estimation the expected value, or estimated mean WTP, can be calculated. Assuming a logistic distribution, which is widely employed in DCQ analysis, the following logit function is estimated:

$$(1)\quad \text{Probability ("yes")} = \frac{EXP(\alpha + \beta\text{Price})}{1 + EXP(\alpha + \beta\text{Price}).}$$

It is well known that the mean, which equals the median, of this symmetric distribution is given by:

$$(2)\quad \overline{\text{WTP}} = -\frac{\hat{\alpha}}{\hat{\beta}}$$

where $\hat{\alpha}$ and $\hat{\beta}$ are estimated coefficients from Equation (1). Alternatively, under the assumption that only non-negative values should be considered in estimating mean WTP, Hanemann (1989) shows that the expected value of WTP of the logit estimation in Equation 1 is given by:

$$(3)\ \overline{WTP} = \frac{1}{-\hat{\beta}} Ln[1 + EXP(\hat{\alpha})]$$

In the analyses that follow, Equation (2) shall be referred to as the "median" value and Equation (3) will be referred to as the "non-negative mean" (Johansson, et al., 1989; Hanemann, 1989). Approximate distributions of these values can be estimated using bootstrapping techniques (Park, et al., 1991). Cameron (1991) provides an analytical solution for the variance of the point estimate in Equation (2).

The yes/no responses to the dichotomous choice questions were modeled directly, based on the proportions provided in Table 3. For the OEQ data the parameter estimates were averaged over each of the 100 random allocations across the five prices. As we are primarily concerned at this stage with distributional comparisons between the DCQ and the OEQ values, and since the English auction sample is relatively small, no attempt to maintain independence was made in the logit estimations of the ENG data. We simply calculated the proportion of bids that were at or above the threshold prices for all subjects, using each of the 52 bids as threshold values. We do not report the standard errors from these estimates nor do we perform any statistical tests that utilize them. It should be noted, however, that the parameter estimates remain unbiased.

Table 4 presents the estimated logit coefficient for all three experiments. Likelihood ratio tests conducted for the logit equation of the average proportions across the 100 allocations of bid responses rejects the null hypothesis of equality between the DCQ and the OEQ demand equations ($\chi^2(2)=15.11$, $p<0.01$). The specific nature of the deviations was further investigated by pooling the data and using binary variables to identify constant (α) and slope (β) effects: in a model that allows for both an intercept and a slope shift, the binary coefficient for α was not significant ($p \cong 0.76$) but the binary coefficient for β was marginally significant

Table 4: Estimated Logistic Functions

	OEQ-CV	DCQ-CV	ENGLISH
α (S.E.) [Range]	2.6716 (0.3305) [1.9965, 3.4662]	2.6876 (0.2744)	5.3281
β (S.E.) [Range}	-0.6103 (0.0701) [-0.8013, -0.4725]	-0.4771 (0.0501)	-1.3104
χ^2 [Range] n	257.58 [77.39, 476.46] 345	144.97 421	 52

Note: α, β, and S.E. for OEQ are averages of 100 random allocations across the five prices. Ranges are the highest and lowest observations of 100 allocations.

($p \cong 0.08$). This analysis, combined with the likelihood ratio test, would indicate that the DCQ and the OEQ curves diverge for prices above zero.

Figure 2 depicts the fitted logistic demand functions estimated from ENG, OEQ, and DCQ values. Corresponding to the statistical analyses, it is clear that the demand curve derived from the DCQ version is to the right of the demand curve derived from the OEQ version. In comparison, the curve for the English auction approaches a step function, reflecting its tighter distribution around the mean (demand is negligible at prices above the mean bid and large at prices below the mean bid).

Figure 3 depicts probability functions derived from the demand curves for the WTP estimates. Consistent with prior comparisons of real and hypothetical transactions, the distributions from the two estimated hypothetical CV versions (OEQ and DCQ) are much more dispersed than the distributions from the auction

Figure 2: Demand Data and Fitted Logistic Functions

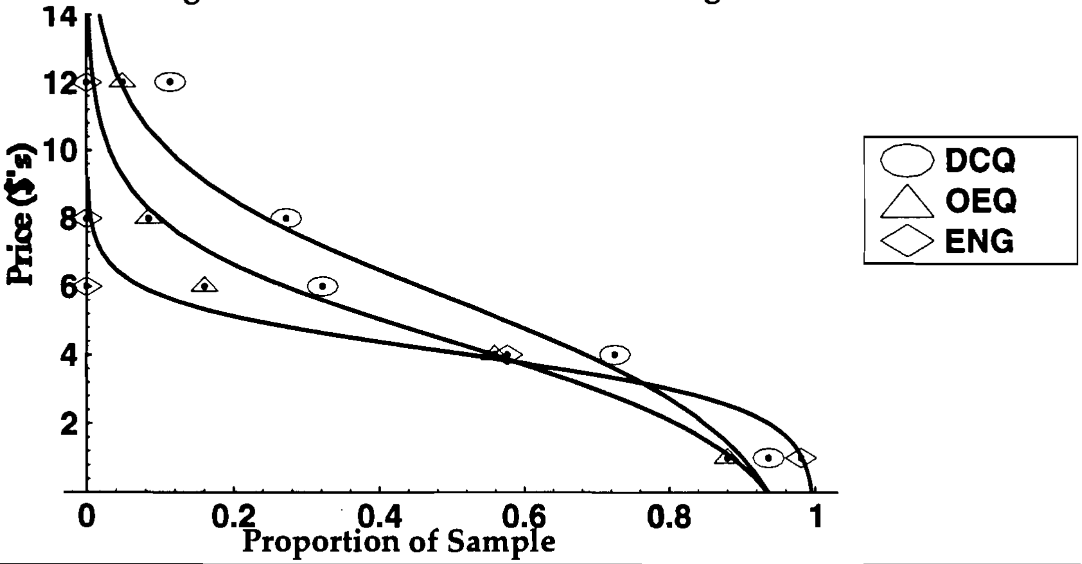
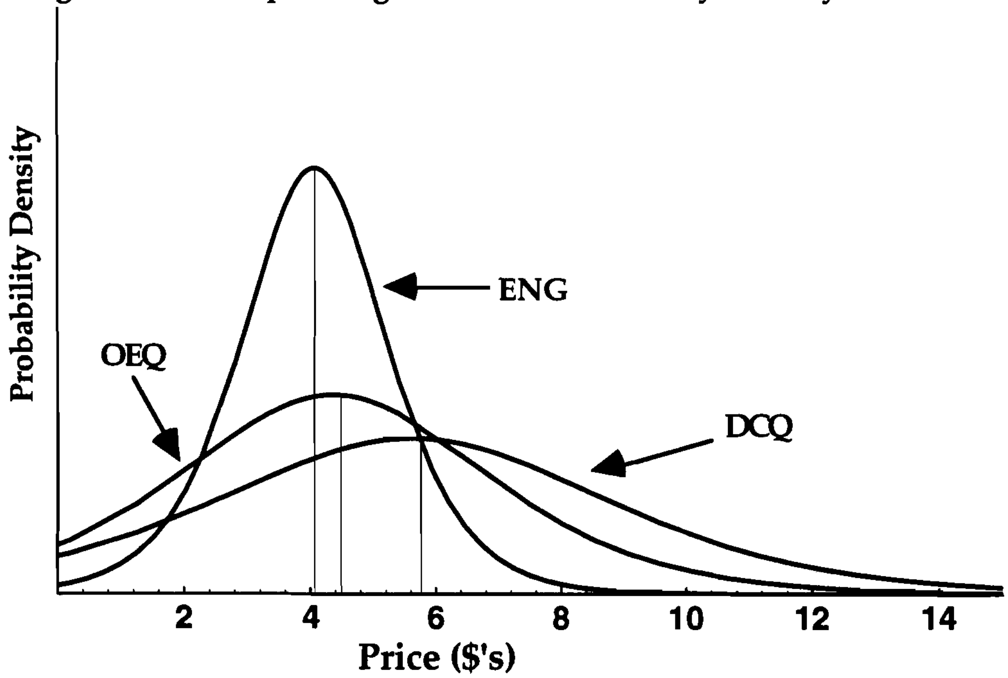


Figure 3: Corresponding Estimated Probability Density Functions



experiment. The estimated "non-negative mean" WTP values provided in Table 5 are shown in Figure 3 as vertical lines. Note also that the predicted mean value for the English auction calculated from the estimated coefficients shown in Table 4 is also shown as a vertical line in Figure 3. This value which is robust to alternative assumptions about the winners' bids is equal to $4.07, very close to the expected value of the insurance policy.[5]

In addition to the point values for median WTP, and non-negative mean WTP derived from the logit parameter estimates for each version of the experiment, Table 5 provides the standard error and 95 percent confidence ranges for the DCQ-CV and OEQ-CV estimates based on 1000 bootstrapped values. An empirical convolutions method detailed in Poe et al. (1994) is used to estimate the distribution of the difference of the simulated mean and median WTP distributions for the

[5] Both sessions of the English auction ended at the same selling price -- $5.20. Since the winners stayed in at $5.20, they would have been willing to pay at least $5.60 (the next price that would have been called had the auction not ended). Two additional treatments of the two winning auction bids were employed to test the robustness of our estimate of mean WTP . First, the two winning bids can be deleted from the logit analysis to provide a lower bound or "min" estimate of WTP in the English auction. As shown in the table below, this estimation has a downward bias on estimated WTP because we have information that the two observations are at least equal to $5.60. Given the tight distribution of bids shown for the English auction in Figure 1, it is reasonable to assume that the subjects would not have bid more than $10 so an upper bound "max" estimate can be obtained by setting these two bids equal to $10. For comparison, the column "mid" shows the results reported above where the two winners' are assigned values of $5.60. Predicted WTP obtained from fitting the cumulative logit distribution is quite robust to these various assumptions, in contrast to the actual mean WTP which shows some sensitivity. The tight distribution of bids in the English auction suggests that mean and median estimates are essentially identical. We use the median estimate in the table below.

	"min"	"mid"	"max"	
alpha	3.6276	5.3281	5.1089	
beta	-.9144	-1.3104	1.2483	
N	50	52	52	
WTP	$3.97	$4.07	$4.09	(predicted mean=alpha/beta)
WTP	$3.58	$3.66	$3.83	(actual mean)

Table 5: Analytical and Simulated Distributions of Median and Mean Values

	Analytical Median	Simulated Median	Simulated Non-negative Mean
OE	4.38	4.38	4.51
(S.E.)	(0.22)	(0.23)	(0.22)
[95% CI]	[3.94, 4.82]	[3.93, 4.83]	[4.09, 4.96]
DC	5.63	5.63	5.77
(S.E.)	(0.26)	(0.26)	(0.26)
[95% CI]	[5.13, 6.14]	[5.13, 6.17]	[5.27, 6.33]

Note: Analytical 'median' values for $-\alpha/\beta$ derived from Cameron (1991). Simulated median for $-\alpha/\beta$ and non-negative means (see text) derived from bootstrapping procedure (Park, Loomis, and Creel, 1991). Simulated point values are averages of 100 simulations.

elicitation formats. Applying this technique, the average difference of DCQ-CV and OEQ-CV distributions across the 100 simulations (each containing 1000 bootstrapped points) was statistically significant ($p \cong 0.0008$) for the median values, and the corresponding difference of the non-negative mean distributions was also significant ($p \cong 0.0009$). That is, under the logistic distributional and other assumptions utilized in this analysis, the median and non-negative mean WTP distributions for the DCQ-CV are significantly different from the same central measures for the OEQ-CV format. The significance level of the difference for either measure never increased above 1 percent in any of the 100 simulations.

While such statistical tests are appropriate, it might be more useful to compare the values that would be used for policy purposes in actual empirical studies. Presumably the objective of such a study would be to report a mean WTP value. In the case of the English auction one could use the raw mean of $3.66 (which falls below EV by 8%) or the predicted mean of $4.07. Similarly, if an OEQ were employed, the raw mean of $4.58 (or a mean with outliers trimmed) would be used. In contrast, the mean DCQ value estimated would be either $5.63 or $5.77, depending on assumptions made about negative WTP values. Regardless of measure used, the 95, and indeed the 99, percent confidence bounds from the DCQ never include the raw mean WTP values derived from the other valuation techniques. Thus, in a case where CV is the only method of obtaining values, this experiment would suggest that an OEQ version would give a relatively accurate measure of WTP that exceeds the expected value ($4) by 14.5%. In contrast, the DCQ method provides mean estimates that lie above the ENG and OEQ means by 54% and 23% respectively and exceed the expected value of $4 by a factor of 41%.

5. Conclusion

Based on the literature summarized in Section 2 and on the experimental results presented in Section 4, it would be difficult to reach any other conclusion than that hypothetical dichotomous choice responses overestimate auction values as well as the expected value for private goods. The experimental results presented here also indicate that open-ended questions have the same direction of bias, but to a lesser extent. Given the conclusion from experimental economics that institutions matter, these results should not be surprising.

In conclusion, this study supports the suspicions raised by previous research that dichotomous choice overestimates values, even in the case of private goods. Open-ended value questions appear to more closely approximate auction values but also overstate values unless outlier bids are trimmed.

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Appendix A: English Auction Instructions

Decision Making Under Uncertainty: Part I

This is an experiment in the economics of decision making. You will have an opportunity to earn CASH through your participation in this experiment. Please follow these instructions carefully and do not hesitate to raise your hand if you have a question. You are part of a group participating in this experiment; however, you will not be permitted to speak with other members of the group during the experiment.

You will be given a starting balance of $80 for the experiment. Any money left at the end of the experiment is yours to keep. Your objective, therefore, is to try to earn as much money as you can. There is a bag full of one hundred (100) poker chips: **40** red ones and 60 white ones. A chip is going to be picked randomly from the bag by a subject in the experiment. If a white chip is drawn then you will keep your $80 and you owe nothing. If a red chip is drawn, however, you will have to pay $10. That is, the loss of $10 will be deducted from your balance.

Rather than taking the chance of the $10 loss, you have the option of purchasing an insurance policy. If you buy the insurance policy then you will not owe the $10 in the event that a red chip is drawn. But, you will have to pay the experimenter, out of your balance, for the insurance policy before the chip is drawn.

Only one person will be able to purchase an insurance policy. The person who purchases the insurance policy, and the price of the policy, will be determined in an auction. The auction will proceed as follows:

Each participant is given a card which is GREEN on one side and YELLOW on the other. (The number shown on each card is used to keep track of the auction results.)

At the beginning of the auction everyone should hold their cards with the GREEN side facing the front of the room.

Then one of the experimenters will start calling out prices: The prices will start at $0.00 and increase in $0.40 increments ($0.00, $0.40, $0.80, $1.20, etc.). Keep holding the GREEN side of the card towards the front of the room as long as you are willing to pay the price called out.

However, as soon as the MAXIMUM price that you are willing to pay is called, and before the next higher price is called, you should turn your card so that the YELLOW side faces the front of the class and hold it up. When you turn your card around to YELLOW you are out of the auction and your card is DEAD. After the number on your card is recorded you will be asked to place DEAD cards down. Put your card down flat on your desk and wait until the current auction is over.

The YELLOW side of the card tells the experimenter that you are NOT willing to buy the insurance policy at any price higher than the one just called. If you show the yellow side of the card before the auction is over it means that you have dropped out and you will not be able to buy the insurance policy (and will not be protected from a $10.00 loss if a red chip is drawn).

The last person holding up a GREEN card gets the insurance policy for the last price called (the price which caused the next to last person to drop out). This participant will then purchase the insurance policy at the last price called (and will be protected from a $10.00 loss if one of the red chips is drawn from the bag).

At the end of the auction, a volunteer subject will draw a chip from the bag individually for each participant. The color of the chip drawn specifically for you will determine whether nothing happens to your balance (white chip) or whether you lose $10.00 (red chip). Each drawing will be independent since after a chip is drawn it will be returned to the bag before the next drawing.

Appendix B: Open-Ended Question CV Survey

Decision Making Under Uncertainty

This is a hypothetical experiment in the economics of decision making under uncertainty. We would like to know how much you would pay for an insurance policy to prevent the chance of a financial loss. Please read the following scenario carefully and do not hesitate to raise your hand if you have a question.

Imagine that you are given a starting balance of $80 for the experiment. (Experiments like this have been conducted for real at C.U.). Any money left at the end of the experiment is yours to keep. Further, imagine that there is a bag full of one hundred (100) poker chips: **40** red ones and 60 white ones. A chip is going to be picked randomly from the bag by a student in the class. If a white chip is drawn then you will keep your $80 and you owe nothing. If a red chip is drawn, however, you will have to pay $10. That is the loss of $10 will be deducted from your balance.

Rather than taking the chance of the $10 loss, you have the option of purchasing an insurance policy. If you buy the insurance policy then you will not owe the $10 in the event that a red chip is drawn. But, you will have to pay the experimenter, out of your balance, for the insurance policy before the chip is drawn.

We would like you to write down the most that you would pay for the insurance against the $10 loss for one draw from the bag. Although this experiment is hypothetical, please think about the problem carefully as if you really were facing this $10 loss if a red chip is drawn.

Given 40 red chips out of 100, the most that I would pay to prevent the chance of the $10.00 loss if a red chip is drawn is:

____________ dollars and ____________ cents .

Appendix C: Dichotomous Choice Question CV Survey (price = $4)

Decision Making Under Uncertainty

This is a hypothetical experiment in the economics of decision making under uncertainty. We would like to know how much you would pay for an insurance policy to prevent the chance of a financial loss. Please read the following scenario carefully and do not hesitate to raise your hand if you have a question.

Imagine that you are given a starting balance of $80 for the experiment. (Experiments like this have been conducted for real at C.U.). Any money left at the end of the experiment is yours to keep. Further, imagine that there is a bag full of one hundred (100) poker chips: **40** red ones and 60 white ones. A chip is going to be picked randomly from the bag by a student in the class. If a white chip is drawn then you will keep your $80 and you owe nothing. If a red chip is drawn, however, you will have to pay $10. That is the loss of $10 will be deducted from your balance.

Rather than taking the chance of the $10 loss, you have the option of purchasing an insurance policy. If you buy the insurance policy then you will not owe the $10 in the event that a red chip is drawn. But, you will have to pay the experimenter, out of your balance, for the insurance policy before the chip is drawn. Although this experiment is hypothetical, please think about the following question carefully as if you really were facing this $10 loss if a red chip is drawn.

Given 40 red chips out of 100, would you be willing to pay $4.00 out of your balance for the insurance policy (circle one please)?

a) Yes, I would pay $4.00

b) No, I would Not pay $4.00

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