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The effect of decision rule and response format on hypothetical bias in contingent valuation

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Introduction

One major critique of the contingent valuation (CV) method of non-market valuation is that responses to CV questions often generate higher willingness to pay (WTP) estimates than comparable actual or simulated market data suggest. This hypothetical bias of the CV method has been consistently observed in previous empirical studies (List and Gallet 2001; Little and Berrens 2003; Murphy et al 2005). Hypothetical bias can only be observed in studies that gather both contingent and actual valuation data and the recent literature has proposed several empirical methods for “correcting” hypothetical bias, either by recalibrating the CV data or the WTP estimates (*e.g.*, Brown et al. 2003, Champ et al. 1997, Norwood 2005, Vossler et al 2003). The results of this research suggest that respondent uncertainty seems to play an important role in the presence of hypothetical bias. Additional studies have proposed a variety of ways for quantifying uncertainty and incorporating this information into the econometric methods used to analyze CV data (*e.g.*, Moore et al. 2010; Le and Mattsson 1995; van Kooten et al. 2001). Despite the growing literature, large gaps in our understanding of these issues remain.

This paper presents the initial results of a valuation experiment designed to explore how individuals respond to hypothetical valuation questions under various survey design options, and how these responses compare to actual valuation decisions. We focus on two specific elements of choice design: the decision rule (donation vs. referendum) and the uncertainty response format (10-point scale vs. probability based scale). Specifically, we compare WTP estimates derived from referenda and from donation-based valuation questions in both actual and hypothetical valuation scenarios. This allows us to test the effect of the decision rule on the magnitude of hypothetical bias. In addition, the hypothetical scenarios included a follow-up question asking respondents to report their certainty regarding their response to the valuation question. This follow-up certainty question used either a 10-point scale (most common in the literature) or a probability based scale to record responses. We use this information to evaluate the

effectiveness of follow-up certainty questions to mitigate hypothetical bias in both referenda and donation scenarios, and to test for differences in the effectiveness of the two response formats.

Methods

The primary objective of our experiment was to evaluate the impact of methodological factors on respondent willingness to pay. We describe the methods in three broad steps. First, we identified an environmental good for which we could elicit preference from undergraduate students. Second, we developed an experimental design and written questionnaire for eliciting preferences under various methodological designs. Third, we administered the questionnaire to a convenience sample of 450 undergraduate students at the University of Georgia (UGA).

Identification of environmental good

Working with the UGA Office of Sustainability, we identified six different sustainability related initiatives being conducted on the University of Georgia campus for which student donations might be useful. Some initiatives were fairly general goals (“Increase recycling”, “Improve wildlife habitat”, “Reduce electricity use”). Others were more specifically targeted at certain actions (“Install water bottle refilling stations”, “Increase the number of sustainability awareness events”). Using a brief written questionnaire, we gathered preliminary information of undergraduate preferences for these varied initiatives. We distributed questionnaires to large introductory courses on campus and asked for voluntary responses and received 100 responses. This initial questionnaire asked students to rank the six initiatives according to which they would most support, identify the program to which they would be most likely to donate, and circle the dollar amount representing the most they would be willing to donate to that program. Offer amounts ranged from \$1 to “more than \$25”.

Based on this preliminary assessment we determined that our final experiment would focus on efforts to improve wildlife habitat on campus. This initiative was most frequently ranked in the top two choices by students, and elicited the highest response by students when

asked how much they would be willing to donate to their top-ranked program. In order to develop the valuation scenario, we narrowed the focus to a specific program we refer to as the Bird Box Program. This program seeks to improve the suitability of campus natural areas for birds through purchase and installation of bird boxes around campus.

Experimental design

Preferences for the birdbox program were elicited via a written questionnaire that was administered during multiple focus groups. We used a written questionnaire in order to maintain consistency across focus groups and treatments and to allow for mixing of treatments within a single group. The questionnaire included a description of the birdbox program, a valuation question, and follow up questions. The description of the birdbox program explained that populations of many bird species have declined in recent years due to the removal of deceased or dying trees in urban forest settings. These trees had provided cavities where the birds can nest. Bird boxes are wooden birdhouses designed to provide specific types of birds a place to nest and help bird populations recover from the loss of their natural habitat. The UGA Office of Sustainability Bird Box Program has a goal to place boxes in many areas across campus, and funds are needed to purchase and install these boxes. Participants were assured that this is a real initiative and funding would come from students. The more money collected, the greater the number of bird boxes that could be installed.

The valuation question was presented as a single dichotomous choice question, with an offer amount of \$5, \$10, or \$15, depending on the treatment group. In order to test the effect of the decision rule and the uncertainty response format on expected WTP and hypothetical bias, we developed an experimental design with 18 treatment groups. A summary of the 18 treatments is shown in Table 1. The treatment groups were defined by the attributes *Decision Rule*,

Consequentiality, Uncertainty Response, and Offer Amount. The actual valuation questions used for each treatment are provided in the appendix.

Table 1. Summary of 18 Experimental Treatments, n = 25 for each treatment.

Decision Rule	Consequentiality	Uncertainty	Offer Amount
Referendum	Actual	-	\$5, \$10, or \$15
	Hypothetical	10-pt. scale	\$5, \$10, or \$15
		Probability-based	\$5, \$10, or \$15
Donation	Actual	-	\$5, \$10, or \$15
	Hypothetical	10-pt. scale	\$5, \$10, or \$15
		Probability-based	\$5, \$10, or \$15

The *Decision Rule* for the CV experiment was either a donation decision or a referendum. In the donation treatments, participants made a private, individual decision to donate or not donate to the bird box program. In the referendum treatments, participants voted in a referendum to determine if everyone in the room would be required to pay money for the bird box program. Individual votes were not made public. If over 50% of participants in each individual referendum voted yes, everyone in the room would have to contribute.

The *Consequentiality* of the treatment was either Actual (i.e., we collected donation money and enforced the results of the referendum) or Hypothetical (we did not, and said we would not, actually collect donations or enforce the vote).

The *Uncertainty Response* followed the valuation question in the hypothetical treatments only. This question asked respondents to self-report the certainty they felt in their answer to the valuation question. The answer format was either a probability scale (i.e., 0% - 100% certain) or a 10-point Scale (i.e., on a scale of 1 – 10).

Following the valuation questions, participants were also asked several follow-up questions related to their certainty regarding willingness to pay, their experience and interests in environmental issues, and other demographic and attitudinal characteristics. These questions were identical for all treatments.

Focus group administration

In order to realistically conduct the actual referenda treatments, it was necessary to elicit preferences in a group setting. However, it was also important to maintain a relatively consistent environment across all treatments and ensure individual decisions were private. With this in mind, we administered the questionnaires through a series of 30 focus groups during July 2012. A total of 450 undergraduate students at the University of Georgia (UGA) were recruited for participation through flyers, announcements during large courses, and via word of mouth. We made efforts to recruit from a variety of subpopulations by hanging flyers in diverse locations (dorms, dining halls, academic buildings and recreation centers, etc.) and making announcements during classes from many departments (biology, chemistry, music, history, economics, etc.). However, the final sample of students does not represent a random sampling of all UGA undergraduates. As our goal was to evaluate the impact of different survey design elements, and not to accurately estimate the population's value for improved bird habitat, a random sampling approach was not necessary and would have proved too costly.

The 30 focus groups were held over a two week period, and included morning, afternoon, evening, weekday, and weekend options. Not all groups included the same number of participants. At times, two groups were held concurrently. Participants were randomly assigned

to one of the 18 treatments. For the actual referenda and actual donation treatments, all participants in the room were given the same methodological treatment, though multiple offer amounts for the actual donation treatment were given in the same session. This was to allow us to collect payment from everyone in the event that the referendum passed, and to collect a donation envelope (empty or not) from everyone with the actual donation treatment. Otherwise, multiple treatments were used during any given session in an extra effort to minimize any group affect.

Each session began by having potential participants affirm that they were current UGA undergraduate students and at least 18 years old. Participants then signed a consent form and were paid \$30 in cash as compensation for their time.¹ Following these administrative tasks, the group leader (one of two PIs for the project) provided a brief statement to provide context for the session. Specifically, that this experiment is part of a research project investigating how people value environmental amenities.

The questionnaire itself was administered in stages. First, participants read the description of the bird box program and answered the valuation question and follow-up certainty question (if a hypothetical treatment). Once all students had answered these questions, the leader directed them to complete the rest of the questionnaire and then remain in their seats. After all questionnaires were complete, the leader collected the questionnaires. For the actual referendum treatments, votes were tallied and result made public. If the referendum passed, the leader collected the appropriate amount from all students. For the actual donation treatments, participants were provided an envelope with their questionnaires. Students who chose to donate placed their donation in their individual envelope as the whole group was leaving, and everyone

¹ Prior to the valuation question, the questionnaire included the following statement: “Before you decide if you will donate (how you will vote), I want to make it clear that the \$30 participation fee that you earned today is your money. You’ve spent your time helping us in our research, and you’ve earned it! You were told that the money is yours, so believe it.”

returned their individual envelope. This procedure was used to minimize the potential for the donation decision to become public during the experiment. Codes were placed on the envelopes and the questionnaires in order to match actual donations with questionnaire responses. For the hypothetical treatments, no votes were tallied and no donations were collected.

Results

There were six methodological treatments in the experiment:

1. Actual Donation (AD)
2. Actual Referendum (AR)
3. Hypothetical Donation with Scaled Uncertainty (HDscale)
4. Hypothetical Donation with Probabilistic Uncertainty (HDprob)
5. Hypothetical Referendum with Scaled Uncertainty (HRscale)
6. Hypothetical Referendum with Probabilistic Uncertainty (HRprob).

There were 75 participants in each of these groups, however four respondents in the HDprob group did not answer the choice question, reducing that treatment group size to a maximum of 71 for most of our analysis. A total of \$160 was collected for the bird box program through this experiment. All of the AR were conducted in groups of 9 – 15 students. One referendum passed, with 11 total participants and a \$5 offer amount. \$80 in donations were collected from the AD group. An additional \$25 was contributed by some participants in the hypothetical groups who elected to make an actual contribution. All of the money collected was forwarded to UGA's Office of Sustainability.

Comparison of Certainty Response Formats

The follow up certainty question asked of all respondents in hypothetical treatment groups to report their certainty in their answer to the valuation question. For the donation group, this was phrased as "How certain are you that you would donate \$x" or "How certain are you that you would NOT donate \$x". For the referendum groups, it was phrased as "How certain are

you that you would actually vote the way you did in an actual referendum?” Responses in the HDscale and HRscale groups were indicated by circling a number on a certainty scale between 1 and 10. For the HDprob and HRprob groups, responses were indicating by circling a probability between 0% and 100%. Actual text of the questions is provided in the appendix.

Table 2 reports the responses to the follow-up certainty question for each of the hypothetical treatment groups. From these results, it appears as though the two answer formats (scale vs. probability) seem to be interpreted similarly by respondents. The mean certainty response for the Donation group was nearly identical (HDprob mean .688, HDscale mean 6.96) and median responses were .7 and 7, respectively. A comparison of the two Referendum groups shows similarities as well.

Table 2. Certainty responses across treatment groups.

Response (Prob)	Response (Scale)	No. of HDprob responses	No. of HDscale responses	No. of HRprob responses	No. of HRscale responses
0	N/A	1	N/A	0	N/A
0.1	1	2	0	0	0
0.2	2	3	0	0	0
0.3	2	4	4	1	3
0.4	4	2	2	1	2
0.5	5	7	12	4	2
0.6	6	7	10	6	6
0.7	7	14	15	14	21
0.8	8	12	15	16	21
0.9	9	7	7	14	11
1	10	14	8	13	9
Mean		0.688	6.96	0.79	7.56
Median		0.7	7	0.8	8
Sample size		73	73	69	75

There is a notable difference in certainty responses between the Donation and Referendum groups. Respondents in the referenda report a higher degree of certainty in their answer to the valuation question, as compared to respondents in the donation groups. Further analysis will explore some of the reasons for this difference. It is also notable that very few respondents report certainty levels below the midpoint on the scale. Less than 10% of HDprob and HRprob respondents reported a certainty less than 50%, and less than 8% of HDscale and HRscale respondents reported a certainty level of less than 5. This mitigates any concerns about the different lower bound of the two response formats (the scale format does not have the equivalent of a 0%).

Table 3. Uncertainty responses by treatment and by valuation decision.

Response (Prob)	Response (Scale)	No. of HDprob responses		No. of HDscale responses		No. of HRprob responses		No. of HRscale responses	
		YES group	NO group	YES group	NO group	YES group	NO group	YES group	NO group
0	N/A	0	1	N/A	N/A	0	0	N/A	N/A
0.1	1	0	2	0	0	0	0	0	0
0.2	2	0	3	0	0	0	0	0	0
0.3	2	2	2	1	3	1	0	0	3
0.4	4	0	2	0	2	1	0	0	2
0.5	5	2	5	1	11	2	2	1	1
0.6	6	5	2	5	5	5	1	3	3
0.7	7	4	10	9	6	10	4	13	8
0.8	8	4	8	6	9	10	6	16	5
0.9	9	2	5	3	4	10	4	5	6
1	10	5	9	4	4	6	7	4	5
Mean		0.764	0.67	7.7	6.64	0.782	0.825	7.79	7.27
Median		0.75	7	7	7	0.8	0.8	8	7
Sample size		24	49	29	44	45	24	42	33

The wording of our follow-up question was such that all respondents answered the same question, regardless of their response to the valuation question. Table 3 compares the certainty levels reported by respondents who answered YES and NO to the valuation question. Across all treatments, the YES respondents report a greater degree of certainty in their valuation response. Both YES and NO referendum respondents report greater certainty than the YES and NO donation respondents, respectively. The NO respondents for the HRprob group are slightly more certain than the NO respondents for the HRscale group (.825 vs. 7.27). Other than this subgroup, the response format does not appear to affect self-reported uncertainty levels in a meaningful way.

Hypothetical bias

Preliminary analysis suggests that hypothetical bias is a concern for both referendum and donation decision rules, though the magnitude of the bias is different under the two treatments. Table 5 reports the percentage of respondents answering YES to the valuation question in the different treatment groups. As expected, the percent of YES respondents decreased as the offer amount increased, holding other variables constant. Also as expected, a greater percentage of participants answered YES to the hypothetical treatments as compared to the actual treatments, all other factors held constant. Somewhat unexpectedly, the percentage of YES respondents was larger for the referendum treatment than for the donation treatment, *ceteris paribus*. The bottom row of Table 5 shows preliminary estimates of expected Willingness to Pay for the bird box program for each treatment. These preliminary estimates were generated using a standard logistic regression with the valuation decision as the dependent variable and the offer amount as the only regressor.

Table 4. Uncertainty responses by treatment and by valuation decision.

	Actual Donation (n = 25)	Hypothetical Donation (n = 46)	Actual Referendum (n = 25)	Hypothetical Referendum (n = 50)
\$5	24%	50%	44%	72%
\$10	20%	36%	28%	52%
\$15	0%	20%	20%	57%
E{WTP}	\$0.74	\$5.24	\$2.61	\$13.15

We also estimated a joint model of WTP by including indicator variables for referendum and hypothetical treatments. The results of this logistic regression are reported in Table 5. The pattern of results is similar to those of the separately estimated models.

Table 5. Joint logit model with indicators. Dependent variable = choice.

	β	se(β)
Constant	-0.7006	0.0001
Offer Amount	-0.1135	0.0008
Referendum (= 1 for referendum; = 0 for donation treatment)	0.9788	-0.0001
Hypothetical (= 1 for hypothetical; = 0 for actual)	1.2001	0.0002
Referendum*Hypothetical	0.0797	-0.0004
E[WTP] for AD treatment	-6.2	
E[WTP] for AR treatment	2.5	
E[WTP] for HD treatment	4.4	
E[WTP] for HR treatment	13.7	

Conclusions

This paper presents the preliminary results of a well-designed multidimensional experiment used to test several hypotheses related to incentive compatibility and hypothetical bias in stated

preference studies. There are many potential applications and extensions of the ideas in this paper and more possibilities are likely to become apparent through presentation and discussion.

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