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Payment Certainty in Discrete Choice Contingent Valuation Responses: Results from a Field Validity Test

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Results from a Field Validity Test[a,b]

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Abstract:

Two methods for calibrating discrete choice contingent valuation responses – the dichotomous choice with follow-up certainty question method of Champ *et al.* (1997) and the multiple bounded method of Welsh and Poe (1998) – are evaluated using data from a field validity comparison of hypothetical and actual participation decisions in a green electricity pricing program. Both calibration methods can produce hypothetical participation levels that closely correspond with actual program participation rates. However, the two methods demonstrate procedural variance as they yield significantly different underlying distributions of willingness to pay.

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I. Introduction

Accumulated evidence from a number of laboratory and field contingent valuation validity studies suggests that discrete choice, take-it-or-leave-it, methods overstate actual willingness to pay (WTP) for private and public goods (e.g., Cummings *et al*., 1995, 1997; Brown *et al*., 1996; Balistreri *et al*., 2001; Champ and Bishop, 2001). Two recent papers offer possible methods for calibrating hypothetical discrete choice responses by considering payment certainty levels reported by respondents. In what we term the "follow-up certainty question" (FCQ) method, Champ *et al.* (1997) ask "yes" dichotomous choice respondents to indicate how certain they are, on a scale from 1 ("very uncertain") to 10 ("very certain"), that they would pay the stated dollar amount if the program were actually offered. Separate WTP functions are estimated for each certainty level. Welsh and Poe (1998) use a "multiple bounded discrete choice" (MBDC) approach that directly incorporates certainty levels through a two-dimensional decision matrix: one dimension specifies dollar amounts that individuals would be required to pay upon implementation of the policy, and the second dimension allows individuals to express their level of voting certainty through "definitely no", "probably no", "not sure", "probably yes" and "definitely yes" response options. A multiple bounded logit model is used to estimate separate WTP functions for each certainty level.

In this paper we use a field validity test of contributions to a green electricity pricing program to further explore these methods and address several validity issues. First, using actual sign-up data as a criterion, we derive "optimal" correction strategies for the two methods. Previous laboratory research on private goods suggests that respondents who are "definitely sure" (Blumenschein, *et al*. 1998) or "probably sure" (Johanesson et al. 1999) of their dichotomous choice responses closely predict actual purchases for private goods. Johannesson, Liljas, and Johansson (1998) find that respondents who were "absolutely sure" of their decision provide a conservative estimate of real purchases. These laboratory results are replicated in public goods contingent valuation field validity research using FCQ methods, suggesting that models that only use "yes" responses with certainty values of "7 and higher" (Ethier *et al.*, 2000), "8 and higher" (Champ and Bishop, 2001) or "10" (Champ *et al.,* 1997) best predict actual contributions. We are the first to provide correction strategies for the MBDC approach.

Second, we examine if the experimental "classroom" results reported in Welsh and Poe can be replicated in the field. In that paper, the authors compare estimated logistic response distributions from dichotomous choice questions and MBDC "not sure" responses and find that they are not statistically different. This suggests that respondents who are uncertain of their values will tend to "yea-say" when asked a single dichotomous choice question, a result that has been replicated elsewhere (e.g. Ready, Navrud, and Dubourg, 2001)

Finally, in an examination of convergent validity, we compare the MBDC and FCQ methods. Specifically, we compare mean WTP, hypothetical participation rates at $6 (the actual offer price for the program), and the underlying WTP distributions estimated from various models based on the two methods, using both parametric and nonparametric estimation techniques. Conceptually the FCQ and MBDC methods offer alternative approaches to account for respondent uncertainty in modeling contingent valuation questions. The primary difference between approaches is that the MBDC framework incorporates the certainty correction directly into the discrete choice decision framework whereas the FCQ method can be regarded as an *ex post* adjustment to the dichotomous choice response. Although these questions seek the same type of information – how certain an individual is that they would actually pay a specified dollar amount – tests of procedural invariance have not been conducted in either the field or the laboratory.

II. Certainty Corrections within the Discrete Choice Framework

The questioning approaches examined in this paper build upon previous research indicating that CV respondents may have a distribution or range of possible WTP values rather than a single point estimate. Here we use the term "certainty" in the same sense as that in Opaluch and Segerson (1989), Dubourg, Jones-Lee and Loomes (1994), and Ready, Whitehead and Blomquist (1995). In this framework, when the referendum dollar threshold falls at or below the lower end of the individual's range of WTP values, then the respondent is likely to be very certain that he or she would vote in favor of the referendum. At very high amounts the respondent might be very certain of voting against the referendum. At intermediate amounts the respondent is less certain of how they actually would vote, with the level of payment certainty being inversely related to the dollar amount.

A. Dichotomous Choice with Follow-up Certainty Question (FCQ)

Response certainty in the FCQ framework is incorporated as follows. Individuals first respond to a standard dichotomous choice (DC) question. For "yes" respondents, a follow-up question is asked:

> *So you think that you <u>would</u> sign up. We would like to know how sure you are of that. On a scale from '1' to '10', where '1' is 'Very <u>Un</u>certain and '10' is 'Very Certain', how certain are you that you would sign up and pay the extra $6 a month if the program were actually offered?*

Respondents are asked to circle a response on the 1 to 10 scale. Modeling of this approach follows well-known DC procedures in which "yes" responses are recoded for each level of certainty and separate WTP functions are estimated. For instance, one can code all responses of, say, 7 and higher as "yes" and all other responses as "no" and then employ standard DC modeling techniques.

B. Multiple Bounded Discrete Choice (MBDC)

The MBDC approach contains elements of, and builds upon, both the Payment Card (PC) and DC approaches widely used in contingent valuation studies. Like the PC format, respondents are presented with an ordered sequence of dollar thresholds. However, rather than circling a single value or interval as an indication of maximum WTP for the referendum, the respondent is given a "polychotomous choice" response option including, say, "Definitely No", "Probably No", "Not Sure", "Probably Yes", and "Definitely Yes". The respondent then chooses a response option at each of the dollar amounts. In this manner, the context of the good-to-cost tradeoff is expanded beyond traditional DC or PC questions by including additional dollar amounts and the likelihood of voting yes, respectively. In some sense, the MBDC model might be thought of as a general framework from which the DC and the PC techniques can be derived as special cases.

Analysis of WTP data collected using the MBDC technique is conducted using a multiple bounded generalization of single and double bounded DC models in which the sequence of proposed dollar values divides the real number line into intervals (Harpman and Welsh, 1999). An individual's response pattern reveals the interval that contains his or her WTP at a given level of certainty. Defining X_{iL} as the maximum amount that the ith individual would vote for, and X_{iU} to be the lowest amount that the ith individual would not vote for, WTP_i lies somewhere in the switching interval $[X_{iL}, X_{iU}]$. Let $F(X_i;\beta)$ denote a statistical distribution function for WTP_i with parameter vector β. The probability that an individual would vote against a specific dollar amount, X_i, is simply $F(X_i;\beta)$. Therefore, the probability that a respondent will vote "yes" at a given dollar amount, X_i, is $1-F(X_i;\beta)$. The probability WTP_i falls between the two price thresholds, X_{iL} and X_{iU}, is $F(X_{iU};\beta) - F(X_{iL};\beta)$, resulting in the following log-likelihood

$$\ln L = \sum_{i=1}^{n} \ln [F(X_{iU};\beta) - F(X_{iL};\beta)] \ .$$

function:

When the respondent says "yes" to every amount, $X_{iU}=\infty$. Likewise, when the respondent says "no" to every amount, $X_{iL}=-\infty$. It should be apparent that the above equation represents the log-likelihood function for discrete choice models in general, including the DC model (Welsh and Poe, 1998). This likelihood function also parallels that used for analysis of interval data from payment cards (Cameron and Huppert, 1989).

Within this framework, WTP functions can be estimated based on any of the voting certainty levels. For example, a "Definitely Yes" model corresponds to modeling the lower end of the switching interval at the highest amount the individual chose the "Definitely Yes" response category and the higher end of the switching interval at the next dollar threshold.

III. Description of Data

Data for this paper is taken from a field validity study that collected actual and hypothetical participation commitments to a green electricity program that would fund investments in renewable energy. In 1995-1996 the Niagara Mohawk Power Corporation

(NMPC), a public utility in New York State, launched Green Choice™, the largest program in the country for the green pricing of electricity (Holt, 1997). NMPC's 1.4 million households were offered the opportunity to fund a green electricity program that would invest in renewable energy projects (e.g., landfill gas reclamation, wind power) as substitutes for traditional energy sources, and a tree planting program. Such green pricing programs have generated substantial interest as utilities come under increasing pressure to provide alternative sources of electricity for customers who prefer environmentally friendly energy sources (Wiser, Bolinger, and Holt, 2000).

Building on the mechanism design recommended by Schulze (1994), NMPC's Green Choice™ provision mechanism incorporated three key features: a provision point, a money back guarantee, and extended benefits if excess funds are collected. NMPC customers had the option of signing up for the program at a fixed cost of $6 per month, paid through a surcharge on their electricity bill. If at least $864,000 (the provision point) is collected in the first year, the program is implemented. NMPC would then plant 50,000 trees and fund a landfill gas project which could replace fossil fuel generated electricity for 1,200 homes. However, if participation were less than $864,000, NMPC would cancel the program and refund all the money that was collected. Any funds collected in excess of the provision point would be applied toward increasing the scope of the program by planting additional trees. The characteristics of the program itself were based on prior market research for NMPC (Wood *et al*., 1994). The improved demand revelation characteristics of the program's funding mechanism relative to the standard voluntary contributions mechanisms used in prior field validity research (e.g., Champ *et al*., 1997) are further discussed in an experimental context in Rondeau *et al*. (1999) and Rose *et al.* (2001). The Rose *et al.* paper provides additional information on the actual NMPC program and participation levels.

In the summer of 1996, a telephone survey was conducted using a random sample of households with listed telephone numbers from the NMPC service territory within Erie County. Participants in the phone survey were offered the opportunity to actually sign up for the program at $6/month, with the charge to appear on their monthly bill. This sign-up now/pay later approach follows standard green pricing methods (Holt, 1997). Furthermore, the phone solicitation corresponded with the “keep it simple” approach adopted by NMPC, which allowed either phone or mail sign-ups. Because of restrictions by the NY public utilities commission, only a single actual sign-up price of $6 per month was allowed.

In the fall of 1996, a mail survey was conducted using the same sample population and involved separate DC and MBDC questionnaires in which respondents were asked – hypothetically – whether they would participate in the GreenChoice™ program. Various dollar values were employed, using established bid design methods. In the DC questionnaire, individuals were asked whether they “would sign up for the program if it cost you $___ per month”, where the dollar amount was randomly assigned across respondents to be 50¢, $1, $2, $4, $6, $9, or $12. If they answered “yes”, they were asked the follow-up certainty question described previously. MBDC respondents were asked if they “would join the Green Choice program if it would cost you these amounts each month”: 10¢, 50¢, $1, $1.50, $2, $3, $4, $6, $9, $12, $20, $45, $95. At each amount, respondents were asked to make a "Definitely No", "Probably No", "Not Sure", "Probably Yes", or "Definitely Yes" response choice. Appendix A provides copies of the phone solicitation and hypothetical valuation questions. Appendix B provides the distributions of responses to the actual choice, DC, and MBDC questions.

Implementation of the survey instruments followed the Dillman Total Design Method (Dillman, 1978). The survey was pretested by administering successive draft versions by phone until respondents clearly understood the instrument. Established multiple contact survey techniques, including a two dollar incentive, were used in all versions with Cornell University as the primary correspondent. A private survey research firm, Hagler Bailly, administered all versions. After adjusting for "list errors" (undeliverables, not NMPC customers, moved out of area, and deceased) adjusted response rates for the hypothetical mail surveys ranged were 66 percent for the MBDC version and 67 percent for the DC with follow up certainty question. The adjusted response rate for the telephone survey was just over 70%. These response rates approximate the 70% response rate guideline established by the NOAA panel report (Arrow *et al*., 1993).

In each survey version, respondents were first screened to establish that they were NMPC customers and to determine their previous knowledge of the GreenChoice™ program. A description of this program followed, with questions to aid the respondents' understanding. The program description followed the NMPC Green Choice™ brochure as closely as possible and emphasized various components of the good (trees and renewable energy) and the provision point mechanism. The description was followed by either an actual choice or CV question, and the survey concluded with demographic questions.

As shown in Table 1, contingency table analyses indicates that the observable demographic characteristics of survey respondents (age, gender, income, completion of a college degree, and whether or not the respondent has contributed to any environmental group in the last two years) are not statistically different across the three sample groups at the 5% significance level.[1] Hence, any procedural variance observed can be attributed to how respondents answer different questions and not to sample selection.

IV. Empirical Results

Logistic response functions for the MBDC and DC responses are reported in the top portion of Table 2. Corresponding estimates for FCQ responses are presented in Table 3. Estimates of participation at \$6 (the cost of actually signing up) and mean WTP estimates for non-negative values, following Hanemann (1984, 1989), are reported for each model. Ninety-five percent confidence intervals for the participation and mean WTP estimates from the parametric models are estimated using the Krinsky and Robb (1986) procedure with 10,000 random draws. In the bottom portion of Tables 2 and 3, nonparametric estimates of participation at \$6 and mean WTP are calculated using Kriström's (1990) approach.[2] Confidence intervals for the nonparametric estimates are obtained by creating 10,000 normally distributed random draws using the mean and variance of the estimates. In the following sub-sections we examine different hypotheses about criterion validity, replicability, and convergent validity, using the participation rates at \$6, mean WTP estimates, and WTP distributions as the measures of interest.

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[1] Age is statistically different across samples at the 10% level. However, when we compare just the MBDC and DC samples, no characteristic is different at the 10% level. Most of the focus in this paper is on analyzing survey responses from these two groups.

[2] We estimate the variance (and subsequently, confidence intervals) based on Haab and McConnell's (1997) derivation of the variance for the Turnbull estimator. That is, we treat the proportion of "yes" responses as random variables. This is contrary to the approach of Boman, Bostedt, and Kriström (1999), that treats the bids as random variables. Formally, using Haab and McConnell's notation, the variance is given by:

$$\sum_{j=1}^{M+1}\left[0.5*c_{j-1}+0.5*c_j\right]^2\left[V(F_j+F_{j-1})\right]-2\sum_{j=1}^{M}\left[0.5*c_{j-1}+0.5*c_j\right]*\left[0.5*c_j+0.5*c_{j+1}\right]*V(F_j)$$

A. Criterion Validity: A Comparison with Actual Participation Decisions

In the telephone survey actual sign-ups were collected, resulting in a participation rate at \$6 of 20.4%. This value serves as a criterion for assessing the predictive power of each method. It should be noted that the actual participation rates used here greatly exceed expected sign-ups for green electricity programs in the field, because our sample is, by necessity, completely aware of the existence of the program. Such 100 percent awareness greatly differs from the limited consumer awareness typically associated with green pricing programs. Also a potential concern is the possible differences between phone and mail elicitation methods. Phone contingent valuation responses were collected as part of a larger research effort (see Ethier *et al.*, 2000) and comparability between hypothetical phone and mail responses suggests that the differences in elicitation formats is not a problem.

Using the 20.4% actual sign-up rate as the reference criterion, we see that the MBDC "probably yes" (parametric: 19.8%; nonparametric: 17.8%) and DC Cert≥7 (parametric: 22.0%; nonparametric: 19.3%) models are the closest predictors of actual sign-ups. To assess significance, a distribution of actual participation was simulated using the binomial distribution, and the convolutions method (Poe, Severance-Lossin, and Welsh, 1994) was employed to compare distributions. These methods indicate that the Pr(yes) at \$6 for the MBDC "probably yes" model are not significantly different from the actual participation rate (parametric (p_p): p=0.903; nonparametric (p_{np}): p=0.539). The DC Cert≥6 (p_p=0.310; p_{np}=0.805), DC Cert≥7 (p_p=0.682; p_{np}=0.789) and DC Cert≥8 (p_p=0.532; p_{np}=0.306) models were also not significantly different from actual participation rates, although the DC Cert≥7 provides the best predictor under both the parametric and nonparametric specifications. All other comparisons of calibrated hypothetical responses with actual responses are significantly different at the 5% level.

B. Replication of Welsh and Poe

In their recent empirical investigation, Welsh and Poe found that DC response patterns corresponded closely with the “not sure” MBDC model, suggesting that individuals who are unsure about their response to a dollar amount would tend to vote “yes” to a DC question. A potential concern about the Welsh and Poe article is that it was conducted in a classroom setting. Here we examine if these results are replicated in the field.

In contrast to the Welsh and Poe study, DC values do not correspond with the MBDC “not sure” model, but instead lie between the point estimates of the “probably yes” and the “not sure” models. Using the convolutions approach, the null hypothesis of identical mean WTP between the “not sure” model and the DC model is rejected for both the parametric and nonparametric specifications ($p_p<0.001$; $p_{np}<0.001$). Equality of mean WTP between the DC and the “probably yes” ($p_p<0.001$; $p_{np}<0.001$) and “definitely yes” ($p_p=0.000$; $p_{np}=0.000$) models is also rejected. The Pr(Yes) at $6 from the DC models are also significantly different from the “definitely yes” ($p_p=0.000$; $p_{np}=0.000$), “probably yes” ($p_p<0.001$; $p_{np}=0.001$), and “not sure” ($p_p<0.001$; $p_{np}=0.487$) model estimates except when the nonparametric DC and “not sure” model values are compared. The correspondence between the nonparametric DC and “not sure” model is coincidental, however, and the empirical cumulative density functions (cdfs) are really very different. Using the Smirnov Test (Conover, 1980), we reject the null hypothesis of identical distributions ($D=0.132$, $p<0.01$). Thus, although our specific results do not concur with those of

Welsh and Poe, the critical message from their article remains: DC response patterns correspond with values that have a relatively low level of voting certainty.

C. Convergent Validity: Comparing Certainty Corrections across Methods

We now compare certainty corrections across the FCQ and MBDC methods. For example, does the "definitely yes" response to the MBDC question format correspond with high levels of certainty in the FCQ, and so on. Table 3 provides the results for the FCQ method. Consistent with expectations, the Pr(yes) at $6 declines as the certainty level increases, and the mean WTP and Pr(yes) at $6 is inversely related to certainty levels. A comparison of these models indicates that the MBDC "definitely yes" model corresponds closely with the DC Cert$\geq$9 model (mean WTP: p_p=0.820, p_{np}=0.532; Pr(yes) at $6: p_p=0.100; p_{np}=0.595). The mean WTP and Pr(yes) at $6 of the MBDC "probably yes" parametric and nonparametric models most closely corresponds with the DC Cert$\geq$7 models (mean WTP: p_p=0.852, p_{np}=0.624; Pr(yes) at $6: p_p=0.468; p_{np}=0.699), and are also not statistically different at the five percent level from the DC Cert$\geq$6 (mean WTP: p_p=0.283, p_{np}=0.562; Pr(yes) at $6: p_p=0.145; p_{np}=0.330) and DC Cert$\geq$8 models (mean WTP: p_p=0.176, p_{np}=0.010; Pr(yes) at $6: p_p=0.527; p_{np}=0.650), except when mean WTP is compared between the "probably yes" and Cert$\geq$8 nonparametric models. As indicated above, the "not sure" model already exceeds the standard DC analysis, and is thus not comparable to any of the corrected measures. In general, the models that are good predictors of the actual participation rate, the "probably yes" model, and the DC Cert>6, DC Cert>7, and DC Cert>8 models, seem to correspond closely with each other.

Even though it appears that there is a close correspondence between MBDC and DC models in terms of their certainty corrected responses, this similarity is mainly coincidental and dependent upon the values (i.e., the non-negative mean WTP and Pr(Yes) at \$6) examined. Using the Smirnov test, the equality of the “definitely yes” and DC Cert$\geq$9 nonparametric distributions is strongly rejected (D_{np}=0.189, p<0.01) even though we found equality between the non-negative mean WTP and Pr(yes) at \$6. Using a Kolmogorov-Smirnov test, the equality of the parametric distributions for these same models is also rejected (D_p=0.214, p<0.01). Equality of distributions is likewise strongly rejected when comparing the “probably yes” model with the DC Cert$\geq$6 (D_p=0.167, p<0.01; D_{np}=0.151, p<0.01), the DC Cert$\geq$7 (D_p=0.151, p<0.01; D_{np}=0.193, p<0.01), and DC Cert$\geq$8 (D_p=0.271, p<0.01; D_{np}=0.281, p<0.01) models.

To further demonstrate the difference in underlying WTP distributions, the top portion of Figure 1 shows the positive domain of the estimated parametric distributions for the multiple bounded models. Figure 2 shows the estimated distributions for the different DC certainty levels. As the certainty levels increase, the DC response functions shift downward and the Pr(yes) at \$0 and other values shift downward dramatically. In general, as the DC certainty level increases the “constant” of the model decreases, while the “slope” is largely unchanged. In contrast it appears that as the certainty level increases within the multiple bounded format, the response function shifts inward and becomes much steeper. The downward effect on the Pr(yes) at \$0 is not as notable, with even the ”definitely yes” model crossing the axis above the 50^{th} percentile. In general, as the MBDC certainty level increases the change in the “constant” is ambiguous, while the “slope” consistently increases. Thus, although both methods seek to measure a certainty-corrected value, it is clear that the response functions they elicit are fundamentally different as the DC correction primarily affects the “constant” and the MBDC correction impacts the “slope”.

As such the equality of certainty corrections with each other and with actual participation at $6 appears to be merely coincidence. This point is demonstrated in Figure 3, which overlays the hypothetical multiple bounded "probably yes' model with the hypothetical DC with certainty of 7 or higher. As depicted, The percentage of "yes" responses is much lower for the DC Cert ≥7 model at low bid amounts than the multiple bounded "probably yes" model. The reverse is true for high dollar amounts. The two functions cross at around $5.23 and the difference between the two distributions is small only for very limited range of bids, including $6.

V. Concluding Remarks

Two methods for calibrating discrete choice contingent valuation responses – the dichotomous choice with follow-up certainty question method of Champ *et al.* (1997) and the multiple bounded method of Welsh and Poe (1998) – are evaluated using data from a field validity comparison of hypothetical and actual participation decisions in a green electricity pricing program. Treating MBDC "probably yes" responses and DC responses with an associated certainty level of 6 and higher, 7 and higher, or 8 and higher to be "yes" responses, lead to hypothetical program participation rates that are not statistically different than actual participation rates. As such, our findings coincide with those of other researchers that find that hypothetical responses tend to overstate WTP, and that appropriate certainty corrections correspond with a moderate to high rate of certainty.

Contrary to Welsh and Poe, our MBDC "not sure" model does not coincide with the DC model. However, we do find that DC responses reflect low levels of certainty if we take the uncertainty expressed in MBDC responses as truth. Hence, while the specific statistical correspondence observed in Welsh and Poe does not apply here, the basic result that DC responses correspond with relatively low levels of payment certainty is replicated.

Further exploration of the various discrete choice models reveals that even though some MBDC models and DC models with certainty corrections are not statistically different in terms of their program participation rate predictions and mean WTP estimates, the underlying WTP distributions are dramatically, and significantly different. This suggests that the underlying behavioral models are fundamentally distinct and the two correction methods do not coincide. Because regulatory restriction prevented the collection of actual program sign-ups at various prices, we are unable to examine how actual contributions vary across price in this research. Based on our results however, it appears that such comparisons offer a critical area of future research.

References:

Arrow, K., R. Solow, E. Leamer, P. Portney, R. Radner, and H. Schuman, 1993. "Report of the NOAA Panel on Contingent Valuation", *Federal Register*, 58(10): 4602-4614.

Balistreri, E., G. McClelland, G. Poe, and W. Schulze, 2001. "Can Hypothetical Questions Reveal True Values? A Laboratory Comparison of Dichotomous Choice and Open-Ended Contingent Values with Auction Values", *Environmental and Resource Economics,* 18: 275-292.

Boman, M., G. Bostedt, and B. Kriström, 1999. "Obtaining Welfare Bounds in Discrete-Response Valuation Studies: A Non-Parametric Approach", *Land Economics*, 75(2):284-294.

Blumenschein, K., M. Johannesson, and G. C. Blomquist, B. Liljas, and R. M. O'Conor, 1998. "Experimental Results on Expressed Certainty and Hypothetical Bias in Contingent Valuation", *Southern Economic Journal*, 65(1): 169-177.

Brown, T. C., P. A. Champ, R. C. Bishop, and D. W. McCollum, 1996. "Which Response Format Reveals the Truth About Donations to a Public Good?", *Land Economics*, 72(2):152-166.

Cameron, T. A. and D. D. Huppert, 1989. "OLS versus ML Estimation of Non-market Resource Values with Payment Card Interval Data", *Journal of Environmental Economics and Management*, 17:230-246.

Champ, P. A., R. C. Bishop, T. C. Brown, and D. W. McCollum, 1997. "Using Donation Mechanisms to Value Non-Use Benefits from Public Goods", *Journal of Environmental Economics and Management*, 33(2):151-163.

Champ, P. A, and R. C. Bishop, 2001. "Donation Payment Mechanisms and Contingent Valuation: An Empirical Study of Hypothetical Bias", *Environmental and Resource Economics*, 19(4): 383-402.

Conover, W. J., 1980. Practical Nonparametric Statistics, 2nd Ed., New York: John Wiley and Sons.

Cummings, R. G., S. Elliott, G. W. Harrison, and J. Murphey, 1997. "Are Hypothetical Referenda Incentive Compatible?", *Journal of Political Economy,* 105(3):609-621.

Cummings, R. G., G. W. Harrison, and E. Rutstrőm, 1995. "Homegrown Values and Hypothetical Surveys: Do Dichotomous Choice Questions Elicit Real Economic Commitments?", *American Economics Review*, 85(1): 260-266.

Dillman, D. A, 1978. Mail and Telephone Surveys: The Total Design Method. New York: John Wiley and Sons.

DuBourg, W.R., M.W. Jones-Lee, and G. Loomes, 1994. "Imprecise Preferences and the WTP-WTA Disparity", *Journal of Risk and Uncertainty*, 9:115-133.

Ethier, R., G. L. Poe, W. D. Schulze, and J. E. Clark, 2000. "A Comparison of Hypothetical Phone and Mail Contingent Valuation Responses for Green Pricing Electricity Programs", *Land Economics*, 76(1):54-67.

Haab, T. C., and K. E. McConnell, 1997. "Referendum Models and Negative Willingness to Pay: Alternative Solutions", *Journal of Environmental Economics and Management*, 32(2):251-70.

Harpman, D. A., and M. P. Welsh, 1999. "Measuring Goodness of Fit for the Double-Bounded logit Model: Comment", *American Journal of Agricultural Economics*, 81(1):235-237.

Hanemann, W. M., 1984. "Welfare Evaluation in Contingent Valuation Experiments with Discrete Responses", *American Journal of Agricultural Economics*, 66(2):332-341.

Hanemann, W. M., 1989. "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses: Reply", *American Journal of Agricultural Economics*, 71(4):1057-1061.

Holt, E. A., 1997. Green Pricing Resource Guide. Gardiner, ME: The Regulatory Assistance Project.

Johannesson, M., G. C. Blomquist, K. Blumenschein, B. Liljas, and T. M. O'Conor, 1999. "Calibrating Hypothetical Willingness to Pay Responses", *Journal of Risk and Uncertainty*, 8:21-32.

Johannesson, M., B. Liljas, and P-O Johansson, 1998. "An experimental Comparison of Dichotomous Choice Contingent Valuation Questions and Real Purchase Decisions", *Applied Economics*, 30:643-47.

Krinsky, I. and A. L. Robb, 1986. "On Approximating the Statistical Properties of Elasticities", *Review of Economics and Statistics*, 68:715-719.

Kriström, B., 1990. "A Non-Parametric Approach to the Estimation of Welfare Measures in Discrete Response Valuation Studies", *Land Economics*, 66(2):135-139.

Opaluch, J. J. and K. Segerson, 1989. "Rational Roots of 'Irrational' Behavior: New Theories of Economic Decision-Making", *Northeastern Journal of Agricultural and Resource Economics* 18(2):81-95.

Poe, G. L., E. K. Severance-Lossin, and M. P. Welsh, 1994. "Measuring the Difference (X-Y) of Simulated Distributions: A Convolutions Approach," *American Journal of Agricultural Economics,* 76(4):904-915.

Ready, R. C., S. Navrud and W. R. Dubourg, 2001. “How Do Respondents with Uncertain Willingness to Pay Answer Contingent Valuation Questions?”, *Land Economics*, 77(3):315-326.

Ready, R. C., J. C. Whitehead, and G. C. Blomquist, 1995. "Contingent Valuation when Respondents are Ambivalent", *Journal of Environmental Economics and Management*, 29(2):181-196.

Rondeau, D., W. D. Schulze, and G. L. Poe, 1999. “Voluntary Revelation of the Demand for Public Goods Using a Provision Point Mechanism”, *Journal of Public Economics*, 72(3):455-470.

Rose, S., J. Clark, G. Poe, D. Rondeau, and W. Schulze, 2001. “The Private Provision of Public Goods: Tests of a Provision Point Mechanism for Funding Green Power Programs.” *Resource and Energy Economics,* forthcoming.

Schulze, W.D., 1994. “Green Pricing: Solutions for the Potential Free Rider Problem.” Paper prepared for Niagara Mohawk Power Corporation.

Welsh, M. P, and G. L. Poe, 1998. “Elicitation Effects in Contingent Valuation: Comparisons to a Multiple Bounded Discrete Choice Approach”, *Journal of Environmental Economics and Management*, 36:170-185.

Wiser, R., M. Bolinger, and E. Holt, 2000. “Customer Choice and Green Power Marketing: A Critical Review and Analysis of Experience to Date.” Proceedings ACEEE 2000 Summer Study on Energy Efficiency in Buildings, Pacific Grove, CA. 2000.

Wood, L. L., W. H. Desvousges, M. V. Bala, F. R. Johnson, R. Iachan, and E. E. Fries, 1994. “Evaluating the Market for ‘Green Products: WTP Results and Market Penetration Forecasts”, *Working Paper #4*, Center for Economics Research, Research Triangle Institute, North Carolina.

Table 1. Comparisons of Respondent Characteristics across Samples

Variable	Chi-Squared (df)	N	Actual Mean	MBDC Mean	DC Mean
Age	31.326[a] (22)	1177	55.66	51.58	52.52
Gender	4.067 (2)	1209	44.37% male	52.31% male	53.53% male
Income	14.980[b] (10)	1107	$41,849	$44,071	$41,188
College Degree	3.439 (2)	1190	45.00%	35.55%	38.41%
Give to Environmental Groups	1.213 (2)	1203	19.15%	19.62%	22.19%

Note: * and ** correspond with 5% and 1% levels of significance respectively. In this case none of the Chi-Squared values are significant at these levels.
[a]Age is a continuous variable, but are converted to the following categories: ≤ 30, 31-35, 36-40, 41-45,…, 76-80, above 80. The upper and lower age categories are wider so that there are enough phone survey responses (≥ 5) in them.
[b]In the survey, income categories are as follows: under $15,000, $15,000 to $30,000, $30,000 to $50,000, $50,000 to $75,000, $75,000 to $100,000, $100,000 to $150,000, $150,000 to $250,000, $25,000 or over. The highest three categories are pooled for the Chi-Squared test, as there are very few phone survey responses in them.

Table 2. Multiple Bounded Model and Dichotomous Choice Models

Model	Multiple Bounded			Dichotomous Choice
	Def. Yes	Prob. Yes	Not Sure	
Parametric Estimation (Logit)				
"Constant" (α)	0.258 (0.117)*	0.866 (0.120)**	0.745 (0.113)**	0.466 (0.115)**
"Slope" (β)	-0.471 (0.036)**	-0.377 (0.026)**	-0.159 (0.011)**	-0.197 (0.022)**
Wald Statistic	166 **	213 **	202**	83**
N	260	260	260	807
Pr (yes) at $6 [95% CI]	0.071 [0.049, 0.104]	0.198 [0.156, 0.248]	0.448 [0.398, 0.500]	0.328 [0.291, 0.367]
Mean WTP [95% CI]	1.76 [1.49, 2.11]	3.23 [2.80, 3.73]	7.14 [6.16, 8.31]	4.83 [4.24, 5.67]
Nonparametric Estimation (Kriström)				
Pr (yes) at $6 [95% CI]	0.082 [0.046, 0.118]	0.178 [0.128, 0.227]	0.338 [0.275, 0.399]	0.307 [0.247, 0.365]
Mean WTP [95% CI]	2.00 [1.79, 2.20]	3.46 [3.17, 3.74]	8.20 [6.68, 9.69]	4.69 [4.19, 5.17]

Note: Standard errors are in parenthesis. * and ** correspond to 5% and 1% significance levels, respectively.

Table 3. Dichotomous Choice with Certainty Corrections

Model	Cert ≥5	Cert ≥6	Cert ≥7	Cert ≥8	Cert ≥9	Cert = 10
Parametric Estimation (Logit)						
"Constant" (α)	0.356 (0.117)**	0.147 (0.118)	-0.014 (0.120)	-0.272 (0.124)*	-0.621 (0.137)**	-0.989 (0.154)**
"Slope" (β)	-0.215 (0.023)**	-0.213 (0.024) **	-0.209 (0.025)**	-0.208 (0.027)**	-0.253 (0.035)**	-0.277 (0.044)**
Wald Statistic	85**	76**	68**	58**	51**	39 **
N	793	793	793	793	793	793
Pr (yes) at $6 [95% CI]	0.282 [0.246, 0.321]	0.244 [0.209, 0.281]	0.220 [0.187, 0.256]	0.180 [0.149, 0.215]	0.106 [0.081, 0.137]	0.066 [0.046, 0.093]
Mean WTP [95% CI]	4.13 [3.61, 4.84]	3.61 [3.13, 4.28]	3.28 [2.82, 3.94]	2.73 [2.31, 3.34]	1.70 [1.42, 2.13]	1.14 [0.92, 1.478]
Nonparametric Estimation (Kriström)						
Pr (yes) at $6 [95% CI]	0.265 [0.207,0.321]	0.215 [0.161, 0.268]	0.193 [0.141, 0.243]	0.161 [0.113, 0.208]	0.101 [0.045, 0.156]	0.067 [0.035, 0.099]
Mean WTP [95% CI]	4.09 [3.63, 4.54]	3.62 [3.17, 4.05]	3.33 [2.90, 3.75]	2.81 [2.41, 3.20]	1.87 [1.54, 2.20]	1.34 [1.09, 1.57]

Note: Standard errors are in parenthesis. * and ** correspond to 5% and 1% significance levels, respectively.

Figure 1: Estimated Multiple Bounded Willingness to Pay Distributions

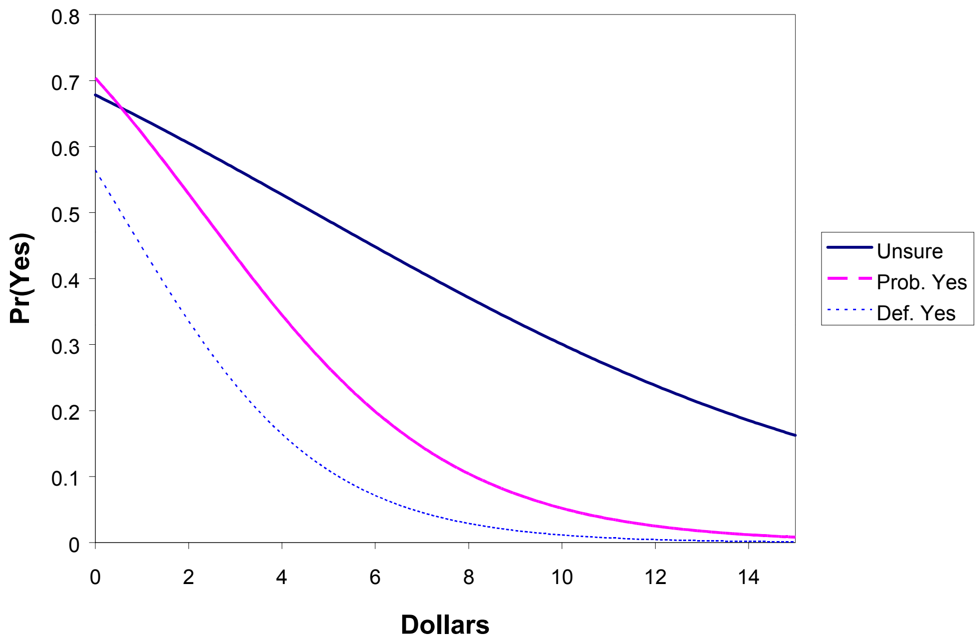


Figure 2: Estimated Dichotomous Choice With Certainty Follow-up Willingness to Pay Distributions

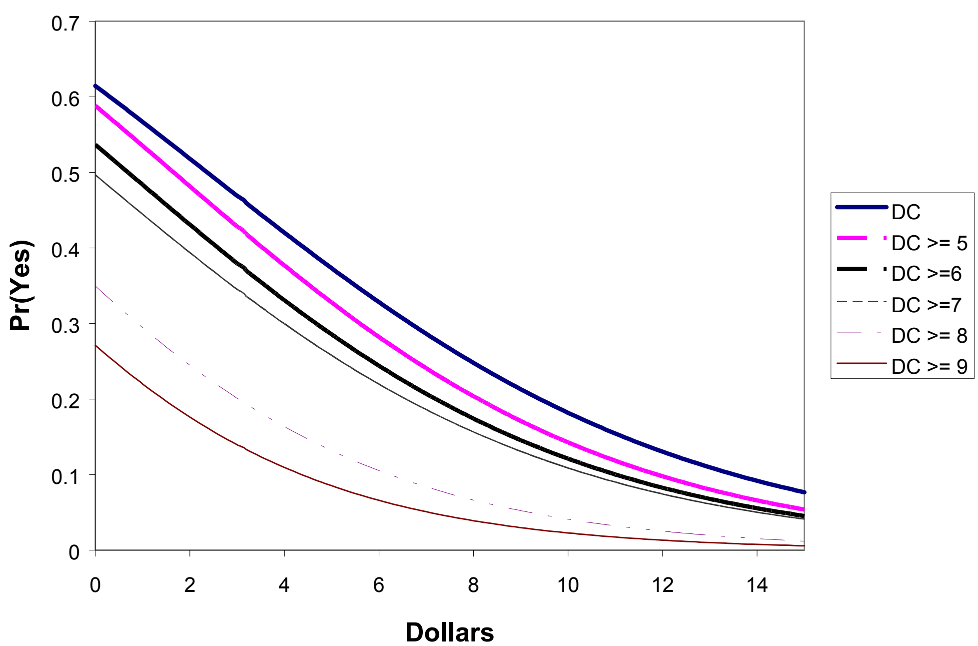
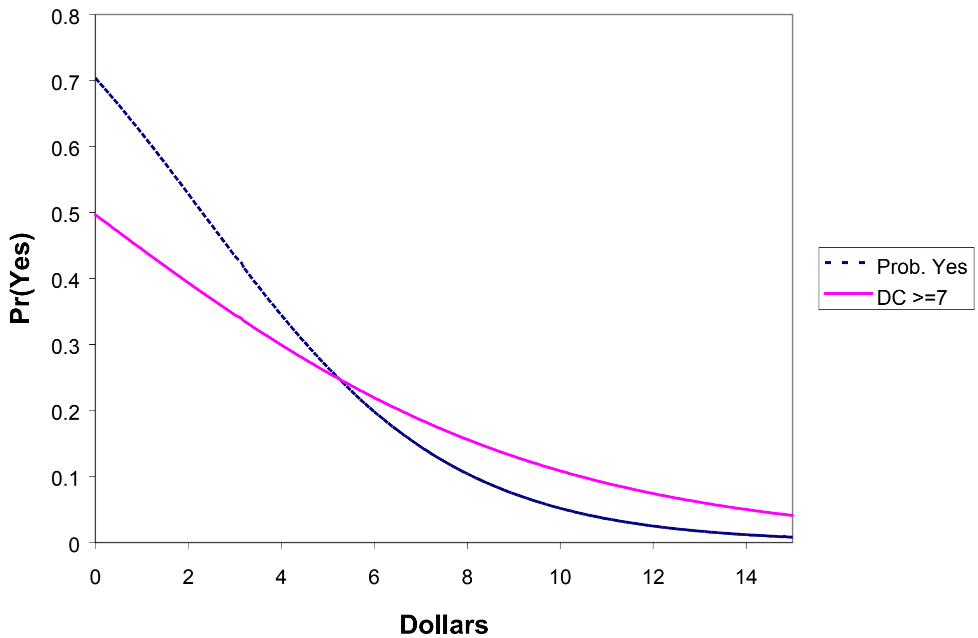


Figure 3: Estimated Prob. Yes Multiple Bounded and DC >=7 Willingness to Pay Distributions



Appendix A: Contingent Valuation Questions:

<u>Actual Sample (Phone):</u>

You may need a moment to consider the next couple of questions. Given your household income and expenses, I'd like you to think about whether or not you would be interested in the Green Choice program. If you decide to sign up, we will send your name to Niagara Mohawk and get you enrolled in the program. All your other answers to this survey will remain confidential.

Does your household want to sign up at a cost of $6 per month?

1. Yes
2. No.

<u>Hypothetical Dichotomous Choice with Follow-Up Choice Question (mail Sample $6)</u>

> Given your household's income and other expenses, we would like you to think about whether or not you would be interested in joining the Green Choice program.

10. Would your household sign up for the program if it cost you $6 <u>per month</u>? *(Please circle ONE response)*

    1 Yes

    2 No --------> *Skip to Question 12 on the next page.*

11. So you think that you <u>would</u> sign up. We would like to know how sure you are of that. On a scale from '1' to '10', where '1' is 'Very <u>Un</u>certain' and '10' 'Very Certain', how certain are you that you would sign up and pay the extra $6 a month if the program were actually offered? *(Please circle ONE response)*

Very Uncertain									Very Certain
1	2	3	4	5	6	7	8	9	10

Hypothetical Multiple Bounded Discrete Choice Question (mail)

Given your household's income and other expenses, we would like you to think about whether or not you would be interested in joining the Green Choice program.

10. Would you join the Green Choice program if it would cost you these amounts each month?

(Please circle ONE letter for EACH dollar amount to show if you would join)

Cost to you per month	Definitely No	Probably No	Not Sure	Probably Yes	Definitely Yes
10¢	A	B	C	D	E
50¢	A	B	C	D	E
$1	A	B	C	D	E
$1.50	A	B	C	D	E
$2	A	B	C	D	E
$3	A	B	C	D	E
$4	A	B	C	D	E
$6	A	B	C	D	E
$9	A	B	C	D	E
$12	A	B	C	D	E
$20	A	B	C	D	E
$45	A	B	C	D	E
$95	A	B	C	D	E

Appendix B: Distribution of Survey Responses

Actual Phone Responses	
Price	% Yes
$6	20.42 (29/142)

Discrete Choice Responses		**Discrete Choice Responses with Certainty Corrections**					
Price	% Yes	% Yes with Cert ≥5	% Yes with Cert ≥6	% Yes with Cert ≥7	% Yes with Cert ≥8	% Yes with Cert ≥9	% Yes with Cert ≥10
$0.50	65.87 (83/126)	62.60 (77/123)	60.16 (74/123)	54.47 (67/123)	48.78 (60/123)	38.21 (47/123)	28.46 (35/123)
$1	63.06 (70/111)	59.26 (64/108)	50.00 (54/108)	47.22 (51/108)	37.04 (40/108)	27.78 (30/108)	21.30 (23/108)
$2	48.33 (58/120)	45.38 (54/119)	41.18 (49/119)	37.82 (45/119)	33.61 (40/119)	23.53 (28/119)	16.81 (20/119)
$4	23.28 (27/116)	19.30 (22/114)	17.54 (20/114)	16.67 (19/114)	13.16 (15/114)	10.53 (12/114)	6.14 (7/114)
$6	38.53 (42/109)	33.94 (37/109)	25.69 (28/109)	22.02 (24/109)	19.27 (21/109)	10.09 (11/109)	7.34 (8/109)
$9	21.90 (23/105)	18.45 (19/103)	16.50 (17/103)	13.59 (14/103)	9.71 (10/103)	5.83 (6/103)	2.91 (3/103)
$12	15.83 (19/120)	11.97 (14/117)	11.11 (13/117)	11.11 (13/117)	9.40 (11/117)	4.27 (5/117)	2.56 (3/117)

Multiple Bounded Discrete Choice Responses			
Price	% Not Sure	% Probably Yes	% Definitely Yes
$0.10	80.66 (196/243)	76.54 (186/243)	60.91 (148/243)
$0.50	80.18 (182/227)	74.45 (169/227)	54.19 (123/227)
$1	74.34 (168/226)	65.93 (149/226)	47.35 (107/226)
$1.50	66.22 (147/222)	52.70 (117/222)	35.14 (78/222)
$2	59.91 (133/222)	45.95 (102/222)	28.83 (64/222)
$3	48.64 (107/220)	33.64 (74/220)	18.18 (40/220)
$4	44.14 (98/222)	27.03 (60/222)	15.77 (35/222)
$6	33.79 (74/219)	17.81 (39/219)	8.22 (18/219)
$9	21.56 (47/218)	11.93 (26/218)	4.59 (10/218)
$12	14.22 (31/218)	5.96 (13/218)	2.29 (5/218)
$20	7.37 (16/217)	1.84 (4/217)	0.92 (2/217)
$45	3.67 (8/218)	0.00 (0/218)	0.00 (0/218)
$95	2.29 (5/218)	0.00 (0/218)	0.00 (0/218)

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