Incentive Incompatibility and Starting-Point Bias in Iterative Valuation Questions: Comment*

David Aadland
Department of Economics and Finance
University of Wyoming
Laramie, WY 82071-3985

Arthur J. Caplan
Department of Economics
Utah State University
3530 Old Main Hill
Logan, UT 84322-3530

ABSTRACT. In a recent study, Whitehead (2002) proposes incentive-incompatibility and starting-point-bias tests for iterative willingness-to-pay questions. We show that if restrictions associated with the nature of starting-point bias are not imposed on the estimation, one obtains inconsistent estimates of the structural parameters and may draw inaccurate conclusions regarding the extent of incentive incompatibility and starting-point bias in contingent-valuation survey data. (JEL Q26, C35)

Incentive Incompatibility and Starting-Point Bias in Iterative Valuation Questions: Comment

David Aadland and Arthur J. Caplan

I. INTRODUCTION

In a recent study, Whitehead (2002) proposes incentive-incompatibility and starting-point-bias tests for iterative dichotomous-choice willingness-to-pay questions. The tests represent a potentially important contribution because they provide a straightforward and relatively simple method to detect and control for two well-documented problems associated with discrete-choice contingent-valuation survey data (Boyle, Bishop and Welsh, 1985; Herriges and Shogren, 1996; Cameron and Quiggin, 1994; Alberini, Kanninen and Carson, 1997). In this note, we show that failure to impose certain restrictions implied by the nature of starting-point bias will lead to inconsistent estimates of the structural parameters. Using a Monte Carlo simulation, we find that failure to impose these restrictions leads to a substantial overestimate of starting-point bias and evidence of incentive incompatibility even when none exists in the actual data. Our theoretical arguments are laid out in Section II and supported with a simple Monte Carlo experiment in Section III. Section IV concludes.

II. THEORETICAL MODEL

Consider the valuation of a public good via a double-bounded dichotomous-choice questionnaire.[1] As in Whitehead (2002) and Herriges and Shogren (1996), assume that respondent i, $i = 1,...,n$, is given an initial bid A_{1i} and answers "yes" if her *true* willingness to pay, WTP_{1i}, is greater than A_{1i} and answers "no" otherwise. Assume the respondent's true willingness to pay is generated according to

$$WTP_{1i} = \beta' X_i + \varepsilon_i, \qquad\qquad [1]$$

where X_i is a vector of explanatory variables observable to the researcher, β is a vector of coefficients, and ε_i is an unobservable i.i.d. normally distributed error term. If the respondent answers "yes" to the initial willingness-to-pay question, then a follow-up bid $A_{2i} > A_{1i}$ is given, otherwise $A_{2i} < A_{1i}$.[2] The respondent's answer to this follow-up question is determined by the WTP function

$$WTP_{2i} = (1 - \gamma)WTP_{1i} + \gamma A_{1i} + \delta. \qquad [2]$$

WTP_{2i} is therefore a weighted average of the true willingness to pay and the opening bid plus a "shift" parameter, δ. Starting-point bias (i.e., "anchoring" to the initial bid) exists if $0 < \gamma < 1$ and does not exist if $\gamma = 0$. Likewise, incentive incompatibility exists(does not exist) if $\delta < 0 (\delta = 0)$.

Whitehead (2002) then proposes an empirical test for starting-point bias and incentive incompatibility by creating a pseudo-panel dataset and estimating the parameters using a random-effects probit model. According to equations [1] and [2], the probability that the ith respondent answers "yes" to the jth question, j = 1,2, is

$$Prob(WTP_{ji} > A_{ji}) = \Phi((\beta'X_i + \beta_\gamma A_{1i} D_j + \beta_\delta D_j - A_{ji} + \lambda_{ji})/\sigma), \qquad [3]$$

where Φ represents the standard normal cumulative density function, σ represents a constant error variance, $D_2 = 1$, $D_1 = 0$, and $\lambda_{ji} = (1 - \beta_A)A_{ji}D_j$. Other than specifying logarithmic willingness to pay, there are two crucial differences between equation [3] and Whitehead's equation [10] – both of which are associated with restrictions related to the nature of the starting-point bias. First, Whitehead omits the λ_{ji} term altogether, which leads to inconsistent estimates of the parameters (Greene 2003, page 679). Second, it must be recognized – based on equation [2] – that the parameters in [3] are interrelated according to

$$\beta_\gamma = \gamma/(1-\gamma), \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad [4a]$$

$$\beta_\delta = (\beta_\gamma\delta)/\gamma, \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad [4b]$$

$$\beta_A = \beta_\gamma/\gamma. \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad [4c]$$

Failure to impose these restrictions leads to inefficient (and if λ_{ji} is omitted, inconsistent) estimates of the structural parameters.[3] We now turn to a Monte Carlo experiment, which serves to support our theoretical arguments.

III. MONTE CARLO EXPERIMENT

Begin by assuming that respondent i's true willingness to pay is given by

$$WTP_{1i} = 5 + 10X_i + \varepsilon_i, \qquad\qquad\qquad\qquad\qquad\qquad\qquad [5]$$

where $\{X_i\}$ are fixed draws from a uniform distribution on the $(0,1)$ interval and $\{\varepsilon_i\}$ are drawn at random from a standard normal distribution. The willingness-to-pay value used for the second valuation question is given by equation [2].

For this experiment, we assume that there is no incentive incompatibility ($\delta = 0$) and a moderate amount of starting-point bias ($\gamma = 0.25$). Based on equations [2] and [5], we then create 500 artificial data sets (n = 1000 each) by drawing 500 independent sequences of $\{\varepsilon_i\}$. The opening bids, A_{1i}, are drawn with equal probability from the set $\{4,5,\ldots,16\}$. This range is approximately two standard deviations above and below the expected willingness-to-pay value of 10. The subsequent bids, A_{2i}, are set equal to $0.5A_{1i}$ if $WTP_{1i} < A_{1i}$ and $2A_{1i}$ otherwise. As in Whitehead (2002), we create pseudo-panel data with a dependent variable equal to one if $WTP_{ji} > A_{ji}$ for j = 1,2 and zero otherwise. The parameters in equation [3] are estimated using a random-effects probit model with the correlation parameter (ρ) for the within-group error

terms set equal to one.[4,5] This restriction on ρ is consistent with the theory presented above

and Whitehead (2002), where the only fundamental error term is the group-specific one (ε_i).

In the third column of Table 1, we report the average parameter estimates across the

500 simulations excluding λ_{ji} and without having imposed the parameter restrictions [4a] –

[4c]. The estimates in the fourth column are based on equation [3] with the parameter

restrictions imposed. The values in brackets are the cutoff values for the 90-percent

confidence intervals across the 500 simulations. Asterisks indicate that the parameter

estimates are statistically different than their corresponding true parameter values.

[Insert Table 1 Here]

Begin by focusing on the third column of Table 1. For four of the model's five

parameters, we reject the null hypothesis that the estimates are equal to their true values at the

90% level. This supports the theoretical argument that the estimated parameters without

imposing the appropriate restrictions are biased and inconsistent. It is interesting to note that

although the true model is designed to be incentive compatible, the maximum likelihood

estimates indicate substantial incentive incompatibility – the shift effect is roughly 30% of the

average willingness to pay. In addition, the average estimate of starting-point bias is

approximately one and a half times its actual value. These biases are the direct result of having

excluded the term λ_{ji} and not having imposed the appropriate restrictions [4a] – [4c].[6]

Interestingly, the biases associated with the parameter estimates do not appear to bias the

overall mean WTP estimate.

The last column of Table 1 reports the estimates including λ_{ji} and with parameter

restrictions [4a] – [4c] imposed. As expected, we fail to reject the null hypotheses that each

parameter estimate is equal to its associated true value. This supports our theoretical argument

that a modified version of Whitehead's model, one that appropriately incorporates restrictions associated with the nature of starting-point bias, provides a consistent method to test and control for starting-point bias and incentive incompatibility. Indeed, failure to impose these restrictions results in biased and inconsistent parameter estimates.

IV. CONCLUSION

The model proposed by Whitehead (2002) provides a convenient and straightforward method to control for incentive compatibility and starting-point bias in a dichotomous-choice iterative WTP question format. However, if the restrictions implied by the structural model are not specifically imposed on the empirical model, inconsistent estimates are obtained for each of the structural parameters. We demonstrate this result with a simple Monte Carlo experiment. We find that the degree of starting-point bias is overstated and that incentive incompatibility arises even when none exists in the actual data. To obtain consistent estimates of incentive compatibility and starting-point bias, it is therefore necessary for researchers to impose the restrictions implied by Whitehead's theoretical model directly in the estimation procedure.

References

Alberini, Anna, Barbara Kanninen and Richard T. Carson. 1997. "Modeling Response Incentive Effects in Dichotomous Choice Contingent Valuation Data." *Land Economics* 73: 309-324.

Boyle, Kevin J., Richard C. Bishop and Michael P. Welsh. 1985. "Starting Point Bias in Contingent Valuation Bidding Games." *Land Economics* 61: 188-194.

Cameron, Trudy Ann and John Quiggin. 1994. "Estimation using Contingent Valuation Data from a 'Dichotomous Choice with Follow-up' Questionnaire." *Journal of Environmental Economics and Management* 27: 218-234.

Greene, William H. 2003. *Econometric Analysis*, 5th Edition. Upper Saddle River, N. J.: Prentice Hall

Herriges, Joseph A. and Jason F. Shogren. 1996. "Starting Point Bias in Dichotomous Choice Valuation with Follow-Up Questioning." *Journal of Environmental Economics and Management* 30: 112-131.

Whitehead, John C. 2002. "Incentive Incompatibility and Starting-Point Bias in Iterative Valuation Questions." *Land Economics* 78 (2): 285-297.

Footnotes

[1] For simplicity, we only consider the double-bounded dichotomous-choice model. Extending the model to allow for multiple dichotomous-choice questions is a straightforward exercise.

[2] Without loss of generality, we assume that $A_{2i} = 2A_{1i}$ when the initial willingness-to-pay question is answered "yes" and $A_{2i} = 0.5A_{1i}$ when answered "no".

[3] An alternative interpretation of the differences between equation [3] and Whitehead's equation [10] is that the model with starting-point bias suffers from within-group heteroscedasticity. To see this, substitute equations [4a] – [4c] into [3], which gives $\text{Prob}(WTP_{1i} > A_{1i}) = \Phi((\beta'X_i - A_{1i})/\sigma)$ and $\text{Prob}(WTP_{2i} > A_{2i}) = \Phi(((1 - \gamma)\beta'X_i + \gamma A_{1i} + \delta - A_{2i})/\sigma^*)$, where $\sigma^* = (1-\gamma)\sigma$. It is especially important to account for this within-group heteroscedasticity when estimating binary-choice models, because unlike standard regression models, it leads to inconsistent estimates of the structural parameters (Greene 2003, page 679).

[4] The "within-group error terms" to which we refer are ε_i and $(1 - \gamma)\varepsilon_i$, the latter being implicit in equation [2].

[5] The log likelihood function for this problem is $\sum_{i=1}^{n}\sum_{s=1}^{4} y_{is} \log(p_{is})$ where s indexes the four regions associated with respondents' answers to the bids A_{1i} and A_{2i}, y_{is} is a indicator variable equal to one if the ith respondent places herself in the sth region, and p_{is} is the probability (given by the bivariate cumulative normal distribution with $\rho=1$) that the ith respondent is in the sth region.

[6] We also performed Monte Carlo experiments with $n = 10,000$. The results are very similar to those reported in Table 1, albeit with smaller confidence intervals, and are available from the authors by request.

9

TABLE 1

MONTE CARLO PARAMETER ESTIMATES (N = 1000)

Parameters	True Values	Without Parameter Restrictions and λ	With Parameter Restrictions and λ
β_0 (Intercept)	5	5.374* [5.139,5.627]	4.990 [4.743,5.253]
β_1 (Slope)	10	9.227* [8.845,9.619]	10.020 [9.582,10.476]
γ (Starting-Point Bias)	0.25	0.358* [0.316,0.401]	0.251 [0.223,0.274]
δ (Incentive Incompatibility)	0	-3.175* [-3.547,-2.812]	0.008 [-0.184,0.180]

σ (Error Standard Deviation)	1	0.926 [0.825,1.019]	0.990 [0.878,1.094]
Mean WTP	10	9.987 [9.839,10.136]	10.000 [9.852,10.149]

Notes: The values in the last two columns are the ensemble averages across 500 independent simulations. The values in brackets are the lower and upper bounds for a 90% confidence interval. A single asterisk denotes a value that is statistically different than the true value at the 90% confidence level.