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Hypothetical Bias in Dichotomous Choice Contingent Valuation Studies

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This paper uses a meta-analysis to explore the relationship between hypothetical bias and the price respondents are asked to pay. For public goods, the results clearly indicate a difference in the price elasticity between hypothetical and actual payment conditions. Since the bias increases for larger dollar amounts, any simple guidelines, such as NOAA's "divide by two" rule of thumb, could be misleading. Future attempts to calibrate contingent valuation responses should reflect this price sensitivity.

Keywords: contingent valuation; experiments; hypothetical bias; meta-analysis; stated preference

JEL Classification: C9, Q26, Q28, H41

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This paper uses a meta-analysis to explore the relationship between hypothetical bias and the price respondents are asked to pay. For public goods, the results clearly indicate a difference in the price elasticity between hypothetical and actual payment conditions. Since the bias increases for larger dollar amounts, any simple guidelines, such as NOAA's "divide by two" rule of thumb, could be misleading. Future attempts to calibrate contingent valuation responses should reflect this price sensitivity.

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Introduction

Contingent valuation (CV) surveys request hypothetical payment for the hypothetical provision of a non-market good. There is substantial evidence that these hypothetical values exceed actual payments (Harrison and Rutström, forthcoming; List and Gallet 2001; Murphy, *et al.* 2003). In recognition of this hypothetical bias problem, the NOAA guidelines state that CV value estimates should be halved unless responses can be calibrated (Arrow, *et al.* 1993). This spawned an emphasis on developing calibration techniques to correct for hypothetical bias. Some attempt to elicit unbiased responses, for example by using a cheap talk script (Cummings and Taylor 1999). Others try to calibrate biased responses using statistical bias functions (Blackburn, *et al.* 1994; Mansfield 1998; Hofler and List 2004) or uncertainty adjustments (Champ and Bishop 2001; Poe, *et al.* 2002). However, to our knowledge, no calibration technique explicitly accounts for the possibility that the extent of hypothetical bias may be sensitive to the dollar amounts posed in the survey.

This study uses a meta-analysis of experimental studies that focus on the hypothetical bias problem. Using response rates to dichotomous choice payment questions, we estimate demand functions for hypothetical and actual transactions and find clear evidence that hypothetical bias increases with the amount asked for public goods. Our results suggest that calibration techniques ought to reflect these differences in price elasticities. Moreover, a simple application of the NOAA “divide by 2” guidelines may result in biased value estimates.

Data and Methods

A review of the literature identified 37 dichotomous choice, DC, contingent valuation experiments that reported both hypothetical and actual payments. DC studies were chosen

because this elicitation format is recommended by NOAA and because these were the only studies that tended to report both actual and hypothetical data.¹ The following criteria were then used to identify the studies included in our analysis:

- (1) The hypothetical and actual values had to be elicited from the same DC format. This avoids confounding effects from different elicitation mechanisms with hypothetical bias.
- (2) Willingness-to-accept observations were excluded because very few studies have produced both actual and hypothetical willingness-to-accept values.
- (3) Since we wanted unadjusted hypothetical responses, data derived from ex ante or ex post attempts to reduce hypothetical bias, like use of cheap talk or uncertainty adjustments, were excluded.

Our final data set consists of 99 observations from 15 studies of 16 distinct goods.² Each observation represents the demand for a good under either hypothetical or actual payment conditions. We used the percent of respondents willing to pay each amount asked as the outcome variable and a measure of demand. For example, the Blumenschein, *et al.* 2001 study of willingness to pay for asthma management contributed six observations to our analysis: the percent of respondents answering “yes” when payment for and receipt of the good were hypothetical at \$15, \$40, and \$80; and the percent answering “yes” when payment and receipt were actual at \$15, \$40, and \$80.

Using equation 1, we estimate log demand ($\ln PctYes$ is the natural log of the percent of participants responding “yes”) as a function of both log price ($\ln AmtAsked$ is the natural log of the amount asked) and the interaction of $\ln AmtAsked$ with a dummy variable (Hyp) that equals

¹ A number of other studies report summary statistics and WTP estimation results, but not the data itself.

² Our log specification resulted in the loss of one observation with zero demand. The results were unaffected when we preserved the zero-demand observation by adding a small positive amount to demand for each observation before taking log.

one for a hypothetical payment condition. In order to pool studies that involve different goods with differing underlying valuations, we estimate the demand model with fixed effects for each combination of goods, indexed by i , and payment condition ($j=1$ for hypothetical and 0 for actual).³ As the research design of each study involved experimentally assigned price offers, indexed by k , we do not face the problem of simultaneous determination of price and quantity. An estimate of the quantity-price relationship from observed quantity-price pairs directly measures the price-responsiveness of demand. Thus, we identify the elasticity of demand from within-good, within-condition variation in price. Using this specification, we can distinguish between hypothetical and actual demand for the good at the offered price.

$$\ln PctYes_{ijk} = \alpha_{ij} + \beta \cdot \ln AmtAsked_{ijk} + \delta \cdot \ln AmtAsked_{ijk} \cdot Hyp_{ij} + \varepsilon_{ijk} \quad (1)$$

The log specification allows us to interpret the coefficients as elasticities and provides a direct test of our basic hypothesis: the price elasticity of demand will differ between hypothetical and actual payment scenarios. β is the price elasticity for actual payments, and $\beta + \delta$ is the price elasticity for hypothetical payments; both should be negative. The main variable of interest is δ : the difference in the price elasticity for hypothetical payments relative to actual. Since hypothetical payments are not salient, we expect that the percent “yes” responses will be less sensitive to changes in the amount asked. This implies that δ should be positive and statistically significant.

Estimates of Hypothetical and Actual Demand

There is some evidence of important differences between valuation experiments using public and private goods. List and Gallet 2001 find that the bias is less for private goods, and Murphy, *et al.*

³ With 16 goods and 2 payment conditions, there are 32 groups.

2003 report similar results for some model specifications. Perhaps one of the most intuitively appealing explanations is that if the respondent has a positive value for the good, and if her response to the valuation question may increase the likelihood of the good's provision at little or no cost to her, then it makes sense for her to report an inflated value (Bohm 1984; Harrison and Rutström). Along these lines, it is possible that individuals are merely expressing a positive attitude for the good without necessarily agreeing to contribute towards its provision (Champ and Bishop 2001). While this may help explain the bias in some public good settings, it fails to explain why the bias is also prevalent in experiments with private goods. Both Harrison, *et al.* 2002 and Murphy and Stevens (forthcoming) note that responses to actual payment questions for private goods may be censored by the market price for the good. These conceptual differences in the valuation of public and private goods suggest that it might be inappropriate to pool these data. Therefore, Table 1 reports estimates for equation 1 using only public goods (our primary focus), only private goods, and both goods.

The results in Table 1 strongly support our hypothesis of different price elasticities for public goods. For actual payments, the price elasticity is -0.49 . However, when payments are hypothetical, an elasticity of -0.16 ($= -0.49 + 0.33$) indicates that these “yes” responses are less sensitive to changes in amount asked. For larger dollar amounts, this can have a sizeable impact on bias estimates. Table 2 reports calculations of the estimated average bias for public goods with different amounts asked. In the fixed effects model from equation (1), each combination of good and payment condition has a different intercept (α_{ij}). For the average bias calculations in Table 2, we use the average α_{ij} for each payment condition ($\alpha_{i0} = 4.45$; $\alpha_{i1} = 4.28$). The amounts asked were chosen based on the distribution of these values in our data. It turns out that at the median amount asked (\$9), the NOAA “divide by 2” rule yields a reasonably accurate estimate,


but as the amounts increase, so does the bias. We emphasize these bias estimates are for illustrative purposes and should not be used to calibrate CV results because the individual fixed effects are not included in the calculation.

The evidence for a difference in elasticities with private goods is less compelling: although δ remains positive, the estimate is small (0.09) and no longer significant ($p=0.84$). Note that δ only reflects the difference in elasticity, and alone does not indicate the magnitude of the hypothetical bias. If hypothetical bias is constant across amount asked for good i (as is typically assumed), then the difference in the fixed effects, $\alpha_{i1} - \alpha_{i0}$, would be positive and significant, but δ would not be significant. Hence, although most of these private good studies observe hypothetical bias, the difference tends to be constant across amount asked. This result is consistent with the conjecture that people may be more comfortable valuing goods they commonly purchase and may be less prone to error at the margin (List and Gallet 2001).

Discussion

Our analysis produces two noteworthy results. First, at least with respect to the set of DC public good studies examined here, hypothetical bias appears to be roughly consistent with the NOAA panel recommendation around the median amount asked. Second, and more importantly, there is strong evidence indicating that for public goods, which is the focus of CV studies, hypothetical bias is sensitive to the amount asked. Attempts to calibrate responses in studies that include a range of dollar amounts ought to account for this effect.

One explanation for this is that many individuals may not take hypothetical payments seriously. For example, a recent experiment by Brown, *et al.* 2003 found that decisions by respondents paying real money were quite sensitive to the payment amount while respondents to

an identical, but hypothetical, situation were not. Consequently, hypothetical bias increased over their payment range. Substantial evidence also suggests that experimental subjects often display a sharp increase in risk aversion for increases in actual, but not for hypothetical payments (Holt and Laury 2002). That is, respondents appear much more risk averse for high real payment levels than for similar othetical payment amounts.⁴ Moreover, this relationship may be nonlinear because of the need to account for both increasing relative and decreasing absolute risk aversion with scale (Holt and Laury 2002).

Conclusions

Since a formal theoretical basis for hypothetical bias has not yet been developed, the nature of hypothetical bias, at least in terms of magnitude and functional form, is largely an empirical issue. The analysis presented here indicates that for public goods the magnitude of hypothetical bias is sensitive to the amount asked. This implies that simple guidelines, such as those developed by NOAA, could be misleading in some circumstances. However, additional research is obviously needed. A comprehensive body of knowledge about the process used by individuals responding to CV questions and the factors responsible for hypothetical bias remain unknown. Despite this void, we believe that continued investigation of the behavior and underlying causes of hypothetical bias is an important and useful endeavor.

⁴ Harrison, et al. (2003) show that this effect holds, but is not as strong when task order is controlled for.

Table 1. Price response of hypothetical and actual demand ^a

Variable	Public Goods			Private Goods			All observations		
	Coefficient		Std. Error	Coefficient		Std. Error	Coefficient		Std. Error
Constant (α_{ij})	Unique fixed effect for each combination of good \times payment condition ^b								
lnAmtAsked (β)	-0.49	***	0.06	-1.29	***	0.41	-0.67	***	0.12
lnAmtAsked \times Hyp (δ)	0.33	***	0.08	0.09		0.37	0.24		0.17
N	54			45			99		
F	43.9			18.66			21.08		
Prob>F	0.00			0.00			0.00		
R ²	0.72			0.56			0.39		

^a Dependent variable is the natural log of the percent of “yes” responses. *** denotes significant at 1%.

^b Coefficient estimates are available upon request.

Table 2. Average hypothetical bias for public goods ^a

Amount Asked	Percentile	Bias ^b
\$1.00	Minimum	0.84
\$2.82	10%	1.19
\$4.23	25%	1.35
\$9.00	50%	1.74
\$18.75	75%	2.21
\$30.43	Mean	2.59
\$88.00	90%	3.67
\$288.00	Maximum	5.41

^a Bias is defined as the ratio of estimated hypothetical and actual percent of respondents willing to pay the amount asked. Bias equals one if there is no hypothetical bias and exceeds one if hypothetical bias is present.

^b Values were calculated using the public good coefficient estimates in Table 1. For the constant, we used the average fixed effect for each payment condition ($\alpha_{i0} = 4.45$; $\alpha_{i1} = 4.28$).

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