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Consistency and construction in stated WTP for health risk reductions: A novel scope-sensitivity test

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Abstract

A contingent valuation study is conducted to estimate willingness to pay (WTP) for reducing the risks of skin cancer arising from exposure to solar UV light in New Zealand, where skin cancer incidence rates are among the highest in the world. A split sample design contrasts dichotomous choice (DC) with open ended (OE) methods for eliciting WTP responses. We attempt to distinguish theoretically consistent preferences from those which are procedurally variant and constructed. This is achieved both through explicit testing of the influence of available heuristics upon responses and a novel scope sensitivity test. The latter test addresses concerns that survey respondents sometimes fail to understand a specified change in provision. This is achieved by holding the good constant but making its remit vary from just the individual respondent to their entire household. A key feature of this latter test is whether the observed degree of scope sensitivity is not only statistically significant but also conforms to prior expectations. While our OE responses show clear evidence of preference construction, the DC responses pass both forms of testing. We conclude by arguing that the degree of scope sensitivity and its conformity with prior expectations should form a focal criterion for future validity testing.

1. CONSISTENCY VERSUS CONSTRUCTION: THE SCOPE SENSITIVITY TEST

The study presented in this paper concerns a fundamental issue; whether the preferences recorded in contingent valuation (CV) studies¹ of willingness to pay (WTP) for reductions in health risks conform to standard economic-theoretic expectations or whether they are constructed using available heuristics. This is no abstract, purely academic issue. The worldwide rise in the use of economic tools such as cost-benefit analysis (CBA) as a basis for decision-making requires the robust estimation of WTP values for a multitude of private and public goods. To the extent that these estimates are mere procedurally variant constructs, so the results of such analyses are undermined and spurious.

Recent years have seen an increasing number of CV and similar stated preference studies examining individuals' values for reductions in risk exposure. Given the lack of available criterion measures (such as market values²) for such goods, many studies have sought to validate estimates by examining their consistency with expectations derived from standard economic theory (Viscusi and Evans, 1990; Jones-Lee *et al.*, 1993; Baron and Greene, 1996; Jones-Lee and Loomes, 1997; Beattie *et al.*, 1998; Carthy *et al.*, 1999; Eeckhoudt and Hammitt, 2001). Arguably the most common approach to assessing the theoretical consistency of WTP estimates is the 'scope sensitivity' test proposed by Arrow, *et al.*, (1993). This requires that WTP should vary appropriately as the size of the good under consideration changes; put very simply, as the provision change increases so should WTP.

While some studies have demonstrated scope sensitivity (e.g., Carson and Mitchell, 1993; Smith and Osborne, 1996; Carson, 1997; Smith, Zhang and Palmquist, 1999), others have not (e.g., Diamond *et al.* 1993; Boyle *et al.*, 1994; Schkade and Payne, 1994; Beattie *et al.*, 1998; Hammitt and Graham, 1999), while still others show that it is possible to observe scope sensitivity and scope insensitivity within the same study (Loomis, Lockwood and DeLacey, 1993; Rollins and Lyke, 1998; Schulze *et al.*, 1998; Giraud, Loomis and Johnson, 1999; Bateman *et al.*, 2004; Heberlein *et al.*, 2005³). This variety of findings has given ample support to both supporters and critics of CV. In the former camp, advocates such as Carson (1997) and Smith and Osbourne (1996) argue that tests of the statistical significance of scope sensitivity are satisfied in the overwhelming majority of well designed, incentive compatible, studies. Indeed such commentators see scope insensitivity as an indicator of methodological shortcomings within a study. Conversely, critics tend to focus upon the adequacy of the observed degree of scope sensitivity (Fisher, 1996). Here inadequate sensitivity is seen not only as originating from design flaws, but more fundamentally as evidence that survey respondents frequently do not hold well formed, theoretically consistent preferences for the type of goods considered in many CV studies. In such cases it is argued, respondents draw upon rules of thumb and other heuristics to 'construct' preferences (Tversky and Kahneman, 1974; Slovic, 1995; Hoeffler and Ariely, 1999). Such constructed preferences will vary according to the study design employed and available heuristics presented to respondents and therefore are procedurally variant and incompatible with standard economic welfare theory underlying CBA.

The obvious problem facing scope sensitivity tests is to determine in advance what degree of sensitivity is 'adequate' (Fisher, 1996). A complication here is that where marginal WTP diminishes significantly there may not be a simple linear relationship between provision

¹ For basic texts on the CV method see Mitchell and Carson (1989), Bateman and Willis (1999) and Bateman *et al.* (2002).

² Note, however, that even market priced goods are not immune from preference anomalies (see for example, Bateman *et al.*, 1997a,b; Doyle *et al.*, 1999), a result which questions whether any single value can ever be considered a criterion measure.

³ The Heberlein *et al.*, study provides some useful cautions against simplistic interpretations and over-reliance upon scope tests as a sole arbiter of the validity of a CV study.

changes and variation in total WTP. For example, in a recent study concerning WTP for remediating acidification damages in upland lakes, while respondents were WTP a minimum of just over £10 per annum to improve an initial 5 lakes, they were only WTP up to about £30 to improve all 400 lakes in the study area (Bateman *et al.*, forthcoming). This implies a rapidly declining marginal WTP. However, given that we have little theoretical guidance regarding values for changes in such a good, the results of such scope tests are open empirical questions, which effectively provide little illumination regarding the theoretical consistency of estimates⁴. In such cases it is difficult to argue whether an observed level of scope sensitivity is evidence of theoretical consistency or preference construction.

⁴ Bateman *et al.* (forthcoming) present a number of alternative consistency tests.

2. STUDY DESIGN

2.1 Welfare Measures for the Scope Sensitivity Test

In an effort to avoid the impasse surrounding the interpretation of scope sensitivity results, the present study adopts a novel variant of this test, examining a provision change regarding which we have relatively strong theoretical expectations. First, respondents are informed of a specific risk-reduction good. We then employ a split sample design in which one sub-sample states the value of that good to themselves as an individual. By contrast the remaining respondents provide estimates of the same risk reduction but applied to their entire household. Therefore, while the nature of the risk change remains constant, its scope in terms of the number of people affected differs across the two groups. As respondents obviously know their household members, they are aware of the difference in scope. Given the assumption that respondents care about risk changes to others in their household, we have a clear expectation that the change in scope from the individual to the household should generate a substantial change in WTP⁵.

Note that we do not need to assume that the utility gained by the respondent from a personal change in risk is identical to the utility change the same respondent gains from seeing another member of their household enjoy/suffer the same risk change. However, empirical evidence suggests that utility differences will be substantial in the latter case and indeed that, where risk changes impact upon the respondents' children then utility differences can exceed those generated by personal risk changes (Liu *et al.*, 2000; Agee and Crocker, 2001; Dickie and Gerking, 2003; Nastis and Crocker, 2003; Owens and Wiggins, 2003).

A further novel feature of this design is that, in an effort to enhance understanding of the relevant level of scope faced by each respondent it is the respondent themselves who determines whether their response to the initial WTP question refers to individual provision or to household provision. However, in order to provide a check upon the internal consistency of answers, all respondents are subsequently faced with a second WTP question concerning the alternative level of provision. So a respondent who answers the initial WTP question with respect to the benefits received solely by themselves is subsequently asked to state their household WTP. Note that single person households (for whom individual values will equal household values) are omitted from the subsequent analysis⁶.

The study design outlined above delivers four welfare measures. A respondent may initially state their individual WTP (which we denote I_1) followed by their household WTP (denoted H_2). Alternatively, a respondent may initially state their household WTP (H_1) followed by their individual WTP (I_2). Given these measures we can therefore formulate a number of simple hypotheses. First, and most importantly, scope sensitivity requires that $I_1 < H_1$ and $I_2 < H_2$. Second, providing that income constraints do not bind (discussed subsequently), the magnitudes of these differences should be substantial and reflect to an adequate degree the typical household size. Thirdly, consistency would suggest that $I_1 = I_2$ and $H_1 = H_2$. In order to preserve the integrity of the cross sample test, we use a novel questioning format in which respondents themselves implicitly decide (without prompting) whether their first response relates to an individual or household WTP measure. However, while this may prevent respondents 'constructing scope' at the first response, CV advocates would only endorse the expectations of our tests for well designed and incentive compatible studies. As Carson *et al.*

⁵ A potential complication might arise where respondents tap into differing income pools to answer each question, necessitating adjustments. However, subsequent testing failed to find any significant influence of income upon responses, although we recognise that the small sample sizes collected are a concern here.

⁶ Bateman *et al.*, (2005) presents values for all (including single person) households, a redefinition which consequently reduces average WTP estimates below those given in the present paper.

(1999) demonstrate, a major determinant of incentive compatibility concerns the approach used to elicit WTP responses. Investigating the impact of alternate elicitation format (and hence incentive compatibility) upon the scope sensitivity of responses provides a final facet of our study design, to which we now turn.

2.2 Elicitation Methods and Incentive Compatibility

Carson *et al.* (1999) build upon Hoehn and Randall (1987) to make a case in favour of using a single dichotomous choice (DC) question to elicit WTP responses⁷. This case is based upon the incentive compatibility properties of such single responses as set out by the work of Gibbard (1973) and Satterthwaite (1975) establishing the potential incentive compatibility of one-shot referenda. Carson *et al.* (1999) argue that the use of incentive compatible DC elicitation techniques is a vital element in the estimation of theoretically consistent preferences. Conversely, they contend that approaches such as the open-ended (OE) WTP technique are not incentive compatible⁸ and therefore less likely to tap into consistent preferences, being prone to strategies such as free-riding, which Carson *et al.* see as a major cause of the stylized fact that OE studies yield lower WTP values than their DC counterparts⁹.

In summary, Carson *et al.* (1999) argue that WTP estimates derived from DC elicitation techniques are likely to be more theoretically consistent than those obtained from OE approaches, which, by extension, may be relatively more prone to preference construction. This hypothesis can be tested using a further division of our sampling frame, presenting one group of respondents with a DC WTP elicitation format and the remainder with OE questions. Recall that our scope test is constructed such that we have a high expectation that theoretically consistent preferences would reveal demonstrable sensitivity to scope. Given this, if DC questions are more likely to reveal such consistent preferences then we would expect scope sensitivity to be greater within DC than OE responses. We denote the elicitation method from which a given measure was estimated by adding the superscripts DC and OE to the notation previously developed, such that the value given by a respondent answering an initial DC question by stating their household WTP would be denoted H_1^{DC} , while the same measure obtained using an OE question is denoted H_1^{OE} . This interaction of differences in scope, ordering and elicitation method yields a 2x2x2 design giving eight welfare measures (I_1^{DC} , I_2^{DC} , I_1^{OE} , I_2^{OE} , H_1^{DC} , H_2^{DC} , H_1^{OE} and H_2^{OE}). If all respondents provide unbiased estimates of their WTP as based upon theoretically consistent preferences (and therefore undistorted by elicitation effects), then our hypotheses remain essentially as before, that:

- (i) $H_0^1: I_1^{DC} = I_1^{OE} < H_1^{DC} = H_1^{OE}$. This is the typical scope sensitivity test where a statistically significant difference is all that is sought for the test to be considered

⁷ The DC technique presents respondents with the opportunity to purchase a good at a specified price \$X. The take-it-or-leave-it nature of this question delivers the incentive compatibility required by Carson *et al.* (1999). By varying the amount X across respondents we can observe a survival curve of responses and estimate standard welfare measures (for details see Hanemann, 1984 and Hanemann and Kanninen, 1999).

⁸ The OE approach simply asks respondents to state their maximum WTP.

⁹ As an example, see Bateman *et al.* (1995). However, it should be noted that evidence from economic experiments concerning the incentive compatibility of hypothetical single referenda is decidedly mixed. Some studies find convergence of voting responses with those in real consequential referenda while other studies report divergent results (see Cummings *et al.*, 1997; Taylor *et al.*, 2001; Burton *et al.*, 2001). Furthermore, a number of critics argue that the excess of DC WTP over OE WTP is more to do with anchoring or yea-saying within the former than free-riding in the latter (see, for example, Johnson and Schkade, 1989 or Green *et al.*, 1998). An alternative position is given by Ready *et al.* (2001), who argue that DC and OE responses relate to the same preferences, but that DC responses relate to a lower level of payment certainty (i.e. a higher WTP) than do OE responses (lower WTP/higher certainty replies).

satisfied. Here we merely extend this by testing for procedural invariance across elicitation techniques;

- (ii) $H_0^2: (H_1^{DC} / I_1^{DC}) \approx \text{average household size} \approx (H_1^{OE} / I_1^{OE})$. This is a stronger version of the previous test in which we argue that scope sensitivity should not only be statistically significant but should also be of a theoretically 'adequate' degree. The simplification used here is to see whether that degree is roughly linear. While we know this is too strong an assumption for many environmental goods (such as the lakes example cited earlier), it seems reasonable to test whether this holds when a respondent moves from considering just themselves to including other family members;
- (iii) $H_0^3: I_1^{DC} = I_2^{DC} = I_1^{OE} = I_2^{OE}$ and $H_1^{DC} = H_2^{DC} = H_1^{OE} = H_2^{OE}$. This tests for value consistency and procedural invariance across elicitation techniques.

Considering the equality of corresponding measures in H_0^3 , there is reason to argue that this is not in line with theoretical expectations. Carson *et al.* (1999) argue that, even using DC elicitation formats, the incentive compatibility properties of CV questions break down once more than one good is offered in a given contingent market. Furthermore, psychological factors and other anomalies may influence responses that are made in reference to previous questions and responses (Bateman *et al.*, 2001, 2004). Given this, the findings of H_0^3 are essentially an open empirical question.

2.3 Defining the Good and Implementing the Survey

In determining the nature of the risk to be analysed we are faced with a delicate balancing act. If the risk change is trivial then scope sensitivity test will be undermined and yet changes which are too large may involve non-marginal values. Similarly, respondents need to understand the nature of the good in question if we are to have reasonable expectations of scope sensitivity within valuation responses. This problem can be particularly acute in the case of risk-reduction goods. Typically such studies primarily rely upon quantitative (e.g. probabilistic) representations of risk level. However, there is ample evidence that many members of the public find certain types of quantitative information, including probabilities, difficult to accurately understand (e.g. Tversky, *et al.*, 1988). Therefore, instead of attempting to make respondents attend to quantitative information about hypothesised changes in some abstract good, we adopt a 'natural experiment' approach (Rosenzweig and Wolpin, 2000) by considering both a risk and scope sensitivity change which are well understood by the survey population. Considering the risk issue, we focus our study on changes in skin cancer rates within the most at-risk and aware population in the world: New Zealand.

Skin cancers are caused by excessive exposure to solar UV rays with rates being higher for fair-skinned populations (Bentham, 1993). Worldwide incidence rates are highest in Australia and New Zealand where they have been exacerbated by the thinning of stratospheric ozone through emissions of CFC and related ozone depleting gases (*ibid.*). Current incidence rates are more than four times higher in New Zealand than in the UK and more than 10 times higher than for populations at lower latitudes or with predominantly darker skinned populations (Globocan, 2001). However, national information schemes have ensured that awareness of these risks is very high in New Zealand as demonstrated both by specific research (Langford *et al.*, 1998) and the fact that death rates amongst those affected in New Zealand are considerably less than half comparable rates in the UK or other European countries (Globocan, 2001). Skin cancer risks are therefore relatively well understood by the New Zealand population making this an ideal good to investigate the value of changes in risk levels.

A survey questionnaire was designed to exploit this awareness by asking respondents questions concerning their WTP for reductions in skin cancer risk. The full questionnaire considered two modes of risk reduction good: a private good and a public good. The private good questions (which concerned the purchase of a new sunscreen product) were applied not only to New Zealand respondents but also to respondents in various other European countries facing differing background risk levels, the objective being to test the comparability and transferability of resultant valuation (results being presented in Bateman *et al.*, 2005 and Brouwer and Bateman, 2005). However, scope sensitivity tests of the type described in the present paper were only implemented within the public good as valued by our New Zealand sample. This public good hypothesised increases in taxes to fund the international technology transfer scheme proposed under the Montreal Protocol negotiations to end worldwide CFC emissions and thereby reduce skin cancer risks to natural levels by restoring the ozone layer. The corresponding estimated welfare measure is the Hicksian compensating surplus (Hicks, 1943). Scheme details, which specified the payment vehicle and included estimates of the time frame over which the ozone layer could be repaired of this scheme, were presented to respondents through a 'constant information statement' (detailed along with the WTP questionnaire in Brouwer *et al.*, 1999). The questionnaire also collected a variety of attitudinal and behavioural information regarding sun exposure risks together with various questions concerning respondents' socio-economic and personal characteristics. These variables are subsequently used to investigate the determinants of WTP response as well as to investigate the factors, which might lead a respondent, of their own accord, to initially answer such questions on either an individual or household basis.

Following an initial pilot exercise, an eight point bid vector was defined for the DC variant of the public good element of the questionnaire, consisting of the amounts NZ\$20, NZ\$50, NZ\$100, NZ\$200, NZ\$500, NZ\$1000 and NZ\$2000. The main survey was implemented in early 1997 and conducted at various locations in and around Christchurch, on the south Island of New Zealand. Survey locations were diverse including beaches and town centres, the objective being to include a range of perceptions and attitudes toward sun exposure risks. Within these areas a sample of 359 respondents was interviewed using face-to-face survey techniques. Of these, 259 respondents were presented with the DC variant of the questionnaire, the remainder was presented with OE WTP questions. Excluding foreign holiday visitors (for whom the tax vehicle was not binding) and one-person households (for whom the scope test did not apply) reduced these sample sizes to 215 and 89 respectively.

3. RESULTS

3.1 Raw and Univariate Measures of WTP

At the start of the WTP section of the questionnaire all respondents were asked a 'payment principle' (PP) question concerning whether or not they agreed with the principle of paying some additional tax for the public good on offer. This device is in part employed to provide those who reject the contingent market with a ready point of departure from the valuation process. After accounting for legitimate zero bidders and protest bidders based on the reasons why respondents are not willing to pay in principle (see Brouwer *et al.*, 1999 for more details) and excluding those in one person households¹⁰, the total number of observations is 179 and 72 for the DC and OE sample respectively. Table 1 details raw response patterns for both samples, each subdivided according to whether interviewees subsequently stated that they were providing either individual or household WTP.

Examining Table 1 we can see that, while roughly 15% of responses gave zero bids in the OE elicitation format, all respondents asked if they were willing to pay NZ\$20 in the DC formats responded positively. Indeed, echoing previous work we find a general trend towards expressing higher WTP under the DC as opposed to OE format. However, within the DC responses we can see a general trend for higher rates of positive response amongst those providing household WTP responses than those giving individual WTP answers. As the small sample sizes collected are a concern when calculating descriptive statistics, we accordingly focus upon median WTP values as these are generally more stable than mean values (e.g. Boyle *et al.*, 1988; Kriström, 1990). Table 2 compares OE and DC medians, the latter derived from linear logistic models for which medians and means are identical (Langford and Bateman, 1993). Mean and median WTP are inferred from the underlying statistical distribution applying the calculation procedures for binary CV response data first outlined by Hanemann (1984).

¹⁰ There were 21 respondents living in one person households. These were excluded because they obviously could not make a conscious decision to respond on behalf of others in their household.

Table 1: Distribution of Individual and Household responses across WTP amounts and bid levels for the two elicitation formats

NZ\$ Amount ¹	DC (% voting yes)		OE (% stating amount)	
	Individual	Household	Individual	Household
0	-	-	16.0	13.9
2	-	-	1.3	1.4
3	-	-	1.3	-
5	-	-	4.0	-
10	-	-	1.3	4.2
20	100.0	100.0	5.3	2.8
25	-	-	1.3	-
30	-	-	2.7	1.4
40	-	-	-	1.4
50	73.3	92.9	14.7	8.3
52	-	-	2.7	1.4
60	-	-	1.3	1.4
75	-	-	2.7	-
100	100.0	100.0	16.0	15.3
104	-	-	-	4.2
150	90.0	88.9	2.7	4.2
200	40.0	46.2	1.3	5.6
250	56.3	86.7	4.0	2.8
300	-	-	2.7	5.6
400	-	-	2.5	2.8
500	21.7	50.0	2.7	-
520	-	-	-	2.8
600	-	-	2.7	2.8
1000	12.5	34.8	5.3	6.9
1100	-	-	1.3	-
1250	-	-	1.3	-
1500	-	-	1.3	1.4
2000	9.1	22.7	2.7	2.8
3000	4.8	15.0	-	4.2
4000	16.7	21.7	1.3	2.8
Total	-	-	100.0	100.0

Note: 1. **Bold** figures indicate the 11 bid levels used in the DC experiment, across which this sample are distributed in a roughly even manner giving an average of 16 respondents per bid level once protest bidders and single person households are removed. For the OE sample the NZ\$ amount denote the various maximum WTP responses.

The significance of the OE differences reported in Table 2 was tested with the non-parametric Median test (e.g. Newson, 2002) and the significance of the DC results with the help of the Z test (e.g. Greene, 1993). Focussing upon the first response valuations (those emphasised under the incentive compatibility arguments set out by Carson *et al.*, 1999), we reject H_0^1 for our OE responses (we observe no significant difference in the median values of I_1^{OE} and H_1^{OE} at $\alpha = 5\%$). In contrast, the first response values stated under the DC method show statistically significant scope sensitivity. This sensitivity increases when we consider second responses. Therefore, we accept H_0^1 (statistically significant scope sensitivity) for our DC responses. Given the split-sample, the cross respondent nature of these test results provide strong evidence regarding the degree of scope sensitivity engendered by our two elicitation formats.

Table 2 also indicates a marked disparity in the absolute value of OE and DC estimates of WTP. In line with previous studies (e.g. Kriström, 1993; McFadden, 1994; Bateman *et al.*, 1995) we observe that OE values are substantially lower than DC results. The incentive compatibility argument set out previously would mitigate in favour of the latter values¹¹. Such a view is supported by the scope sensitivity results revealed in the table.

Table 2: WTP (NZ\$ p.a.) for skin cancer risk reduction and univariate difference tests

Elicitation format	Median WTP measure						
	H_2		H_1		I_1		I_2
OE	200	>	100	~	100	~	50
DC	1248	>	1155	>	485	>	371

Notes: See text for definition of WTP measures.

Sub-sample sizes are as follows: $n = 82$ for (I_1^{DC}, H_2^{DC}) ; $n = 97$ for (H_1^{DC}, I_2^{DC}) ; $n = 30$ for (I_1^{OE}, H_2^{OE}) ; $n = 42$ for (H_1^{OE}, I_2^{OE}) .

> denotes a significant difference ($p < 0.05$).

~ indicates no significant difference ($p > 0.05$).

Turning to consider H_0^2 , (whether the observed degree of scope sensitivity is consistent with prior expectations), we have to reject this for our OE responses. However, the degree of scope sensitivity exhibited by the DC responses does appear to be in line with expectations. The ratio of household to individual WTP values ranges from 2.4 to 3.4 depending upon whether first or second responses are used. This range embraces the average household size of around three persons suggesting something approaching a linear relationship between WTP and the number of persons affected. Consequently, we also accept H_0^2 for our DC responses.

Figure 1 graphs our WTP results, illustrating the marked contrast between our OE and DC findings. The lack of scope sensitivity in OE results and clear sensitivity in DC gives additional support to the incentive compatibility argument in favour of the latter approach.

¹¹ Although, as discussed previously, the yea-saying, anchoring and response certainty arguments would not.

Figure 1: Consistency and potential construction in scope sensitivity results

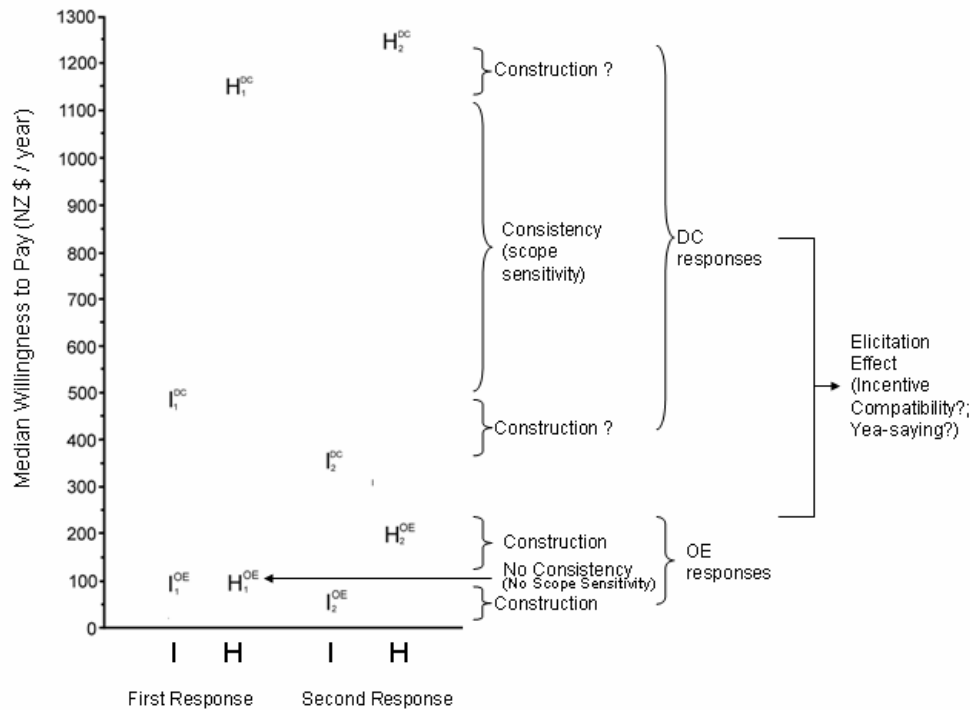


Figure 1 also allows us to readily consider H_0^3 concerning value consistency across first and second responses (i.e. a within respondent test). Here we see, for both elicitation formats, some fanning out of estimates as we move from first to second responses with individual values decreasing and household values rising across these responses. Arguably this could reflect a simple heuristic at work. Respondents giving an initial individual value may use a rule of thumb to ensure that their subsequent household value is sufficiently high relative to that first response. Similarly those initially providing a household value can then appropriately reduce this to construct an individual value.

To permit testing of the ordering effect induced by such an internal consistency heuristic, while at the same time controlling for the variety of factors, which may influence WTP responses, a multivariate regression analysis was conducted for both the individual and household valuations derived from each elicitation method. WTP responses were regressed against economic-theoretic, respondent characteristic, attitudinal and behavioural variables as collected in the course of the interview. This analysis also allowed the examination of various possible heuristics, which might be used by respondents to construct non-standard, procedurally variant preferences. Two such heuristic variables were identified for testing:

- (i) an ordering variable, examining whether, after controlling for all other factors, values for the good varied purely with respect to whether they were elicited from the first or second response given by an interviewee;
- (ii) an anchoring variable examining whether WTP responses for the public good were influenced by interviewees prior responses regarding a private risk-reduction good (collected in an earlier section of the questionnaire).

Table 3: Multivariate regression results for individual and household WTP responses to DC and OE questions

Explanatory variable type	Variable definition	Variable values	DC		OE	
			Individual (I_1^{DC}, I_2^{DC})	Household (H_1^{DC}, H_2^{DC})	Individual (I_1^{OE}, I_2^{OE})	Household (H_1^{OE}, H_2^{OE})
Economic-theoretic	Bid level	7 NZ\$ levels	-0.001 ^{***} (0.0001)	-0.001 ^{***} (0.0002)	-	-
	Income level	NZ\$ 15-100 thousand	0.0001 (0.0001)	0.0001 (0.0002)	0.001 (0.002)	0.002 (0.003)
Respondent characteristics	Respondent sex	0 = male 1 = female	-0.79 [*] (0.47)	-0.83 [*] (0.49)	-255.01 ^{***} (138.97)	-281.32 [*] (168.15)
	Respondent age	1 (youngest) to 7 (oldest)	-0.16 (0.17)	-0.42 ^{**} (0.17)	12.95 (51.78)	-29.28 (62.04)
	Number in household	1 to 8 persons	-0.15 (0.21)	0.08 (0.23)	142.65 [*] (82.82)	114.00 (101.49)
Attitudes and behaviour	Frequency of sunbathing	0 (never) to 2 (often)	-0.26 (0.26)	-0.44 [*] (0.26)	-136.51 (102.09)	-59.08 (127.31)
	Melanoma knowledge	0 = no 1 = yes	-0.001 (0.002)	-0.001 (0.002)	-214.52 (147.98)	-321.65 [*] (172.31)
	Frequency of sunscreen use	0 (never) to 4 (always)	-0.025 (0.14)	-0.04 (0.15)	-35.28 (51.16)	-17.50 (61.39)
Anomaly indicators	Ordering: WTP response order	1 = (I_1, H_2) 0 = (H_1, I_2)	-0.21 (0.75)	-0.40 (0.82)	579.48 [*] (312.07)	714.41 ^{**} (377.54)
	Anchoring: Price of private good	NZ\$ amount	0.0001 (0.0002)	0.0001 (0.0002)	45.75 ^{***} (13.18)	78.86 ^{***} (16.20)
Constant		-	3.33 ^{**} (1.67)	4.26 ^{**} (1.78)	-219.76 (474.72)	-526.14 (560.36)
χ^2			49.8 (0.001)	62.4 (0.001)	22.7 (0.001)	37.5 (0.001)
R ²			0.37	0.43	0.03	0.05
N			159	159	57	56

Notes: ^{*} $p < 0.10$; ^{**} $p < 0.05$; ^{***} $p < 0.01$.

Values in cells are coefficient estimates and, in parentheses, standard errors (except for final row showing χ^2 value and, in parentheses, corresponding p value). Models are untransformed linear (OE) and linear logistic (DC) specifications of WTP responses.

Results from these analyses are presented in Table 3. The OE WTP responses are modelled using Tobit regression in order to account for the censored database and the limited dependent nature of the response variable (e.g. Greene, 1993), while the DC results are based on linear-logistic regression. The Tobit coefficient estimates have been adjusted using the cumulative standard normal distribution function in order to reflect their marginal effects (Halstead *et al.*, 1991). The models are highly significant. The calculated pseudo R-square has to be interpreted with the necessary care (McFadden, 1994).

Considering Table 3, results for the economic-theoretic, respondent characteristic, attitudinal and behavioural variables are unsurprising, conforming to prior expectations and replicating previously observed empirical regularities, except for the non-significance of income. However, the influence of the anomaly indicators is revealing. OE responses for this public good were found to be significantly and positively related to the WTP previously stated by respondents for the private sunscreen good. Although both concern risk reductions, in other respects these goods are highly differentiated and this linkage seems to be based purely upon the frequently observed anchoring bias (Harris *et al.*, 1989; Jacowitz and Kahneman, 1995; Strack and Mussweiler, 1997; Chapman and Johnson, 1999; Epley and Gilovitch, 2001; Ariely, *et al.*, 2003). Similarly, the regression models reveal that the OE responses were significantly impacted by response ordering bias (see also Bateman *et al.*, 2004). However, neither of these anomaly variables prove significant within the DC responses suggesting that the relatively modest degree of fanning out observed between first and second DC responses is not a significant factor once other determinants have been accounted for.

3.2 Determinants of Self-Identification as an Individual or Household Member

As an offshoot of related research into household versus individual decision making (Bateman and Munro, 2005) we undertook an investigation into the factors influencing an interviewee's decision to respond to the initial public good valuation question as either an individual or on behalf of the household. The OE and DC datasets were first combined¹² and a binary dependent variable defined such that 1 denotes an initial household level response and 0 denotes an initial individual level response. A logistic regression model for this variable was then estimated, results being reported in Table 4.

Table 4 shows that the probability of initial self-identification as a member of a household, rather than as an individual, is positively related to the number of children in the household (ranging from 0 to 5 with a mean of 1.2 and median of 1), the age of the respondent (with mean and median in the mid 30's) and to the respondent being a homemaker (or retired, student, or other non-employed person; these groups together representing some 43% of the total sample). Such determinants appear to provide common sense indicators of why respondents self-identify as members of households rather than as individuals.

¹² The OE WTP responses were translated into binary DC WTP responses by randomly assigning DC bid levels to each OE response and subsequently checking whether the stated OE WTP was higher or lower than that randomly assigned bid level. If the OE response equals or is higher than the random bid level, the transformed DC WTP response is given the value 1 ('yes'). Conversely, if the OE response is lower than the bid level, the transformed DC WTP response is given the value 0 ('no').

Table 4: Logistic regression model of the factors influencing interviewees to respond initially as household members (1) rather than as individuals (0)

Variable	B	S.E.	Sig.	Exp(B)
Number of children in the household	.598	.129	.000	1.819
Respondents age in years	.023	.011	.029	1.023
Respondent is homemaker	.589	.282	.037	1.802
Constant	-1.680	.475	.000	.186
χ^2 (p)	30.934 (0.000)			
N	251 (179 DC, 72 OE)			

4. DISCUSSION AND CONCLUSIONS

This paper presents a novel approach to scope sensitivity testing of WTP estimates for a risk-reducing public good. By examining the change in scope inherent in the move between individual and household WTP values we obviate the charge often heard in this type of analysis that respondents do not understand the magnitude of some given risk reduction. We have examined the role of incentive compatibility within such a scope sensitivity test by a split sample design contrasting the DC with the OE elicitation method. While we fully recognise the potential for reinterpretation of findings¹³ and problems caused by sample size constraints, in terms of scope sensitivity it is clear that our OE results definitively fail this test while the DC responses show ample scope sensitivity. Similarly, while OE responses were found to be significantly determined by a number of anomalous and theoretically inconsistent influences, the DC responses appear proof against these factors.

In summary, our OE results fail scope sensitivity tests and exhibit various anomalies resonant of preference construction processes. In contrast, DC responses demonstrate a degree of scope sensitivity which is not only statistically significant but, more importantly, is of a magnitude which conforms to prior expectations. These preferences are also shown to be resistant to the various heuristics affecting the OE responses. Consequently we cannot reject the hypothesis that the DC responses are consistent with standard theory.

In conclusion, this paper argues that, in testing the scope sensitivity of WTP valuations of risk-reductions (or other non-market goods) too much emphasis has been placed upon the 'mere' demonstration of statistically significant changes in values as levels of provision alter. While such tests are clearly necessary they are far from sufficient. For value estimates to be credible and reliable we must also demonstrate the adequacy and theoretical consistency of the observed degree of scope sensitivity. Although the small sample size in this study requires careful interpretation, the present study provides evidence that such consistency may under certain circumstances be observed. In demonstrating this we have also shown that while there are some study designs which are liable to exacerbate tendencies for preference construction, there are others which appear to improve the consistency of estimated measures.

¹³ In particular we would re-emphasise the desirability of controlling for differing income pools, as well as general concerns regarding the interpretation of almost any scope test (Heberlein, et al., 2005) and recent evidence regarding the different decision making strategies adopted by individuals and households (Bateman and Munro, 2005).

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