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Surveys

Adequate responsiveness to scope in contingent valuation ☆

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ABSTRACT

The standard test for scope sensitivity in contingent valuation studies determines whether the response to changes in scope is statistically significant; it does not address whether the magnitude of response is appropriate given the specified changes in scope. We examine contingent valuation studies that implemented scope tests to determine what they imply about the adequacy of response to scope. We find that in the vast majority of studies, the magnitude of response cannot be assessed. Only three studies permit such an assessment: Samples and Hollyer (1990), Diamond et al. (1993) and Chapman et al. (2009). The first two papers find that responses to their surveys did not vary adequately with scope. The third study passed the standard scope test, but we show that the magnitude of response in this study is inadequate by straightforward methods of assessment and cannot be explained by diminishing marginal utility or substitution. More research is needed on this issue, including wider application of adding-up tests on incremental parts, as well as the development of other methods that permit an assessment of the magnitude of response or other tests of rationality.

1. Introduction

Contingent valuation (CV) is a survey method designed to elicit information about respondents' willingness to pay (WTP) for environmental goods; see Carson and Hanneman (2005), e.g., for a review. A central question in the debate about CV is the issue of scope: whether the results from CV studies vary as required for economic rationality with the quantity, extent, or, more generally, the scope of the environmental good. Several early studies, including Kahneman and Knetsch (1992), Diamond et al. (1993), and Boyle et al. (1994), found, in their applications, that CV does not satisfy this criterion. However, as emphasized by, e.g., Carson (1997), these studies' results can constitute evidence of a problem in the design of these particular CV studies rather than in the CV method itself.

In response to this and other issues related to CV, the National Oceanic and Atmospheric Administration (NOAA) convened an expert panel to investigate and make recommendations regarding the use of CV methods for environmental damage assessment. The panel developed a list of guidelines for CV studies (Arrow et al., 1993) and stated that "…the burden of proof of reliability must rest on the survey designers. They must show through pretesting or other experiments that their survey does not suffer from the problems that these guidelines are intended to avoid. Specifically, if a CV survey suffered from any of the following maladies, we would judge its findings 'unreliable'." Among the list that followed is "Inadequate responsiveness to the scope of the environmental insult."

Since the issuance of the NOAA panel guidelines, it has become fairly standard practice for CV studies to perform a scope test by specifying a reduced level of the environmental good[1] and soliciting WTP information for both the reduced and original levels. If the results for the two levels are statistically different in the expected direction, the study is said to have passed the scope test. To our knowledge, 109 CV studies, cited below, have conducted scope tests of this form on environmental goods.

This type of scope test does not address the NOAA panel's concern. The NOAA panel described the potential malady as "inadequate responsiveness to the scope of the environmental insult." The standard test examines whether there is any statistically significant response to scope, not whether the amount of responsiveness is adequate.[2] Passing the tests does not imply that response is adequate, only that it is not zero. And since there are rational reasons for a small response to scope, such as diminishing marginal utility and substitution, failing the test does not indicate that the estimated response is inadequate. Some other information or tests are needed to address the issue.

In order to determine what the literature has said about adequacy of response to scope, we examined all the CV studies that we have

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[1] Or a raised level of the good. We use "reduced" for linguistic convenience.
[2] Some members of the NOAA panel even stated (Arrow et al., 1994) that a statistically significant response is not what they meant in their guideline to test for an "adequate" response.

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been able to find that address scope empirically. In the following section, we discuss the implications of these studies in relation to adequacy of response, finding that practically none of them provides information about adequacy. In Section 3, we describe the only study that passed the standard scope test and also permits an evaluation of adequacy of response to scope. We show that the response to scope in this study is greatly inadequate under straightforward methods of assessment. In the final section, we discuss implications for future work.

2. Review of Previous Studies with Scope Tests

To evaluate the extent to which implemented scope tests allow an assessment of adequacy, we undertook an extensive literature review of empirical scope studies. To find these studies, we used standard research strategies such as internet key word searches, on-line databases of nonmarket valuation studies,[3] and reference lists in published studies and in textbooks on contingent valuation. We made an effort to include unpublished study reports as well as published papers in peer-reviewed journals and books.

We applied several criteria for including studies in our detailed review for adequacy. For example, we focused only on studies that are consistent with a traditional CV approach. Studies based on a choice experiment design are not included. Because our interest is in the use of scope tests in natural resource damage assessments, we focused on studies that evaluate commodities that are natural resource services. Studies based on market goods or services, or health states independent of environmental changes, are not included. Additionally, we included studies that may not have been designed explicitly to test for scope effects if other researchers could interpret the design as a scope test.[4] Earlier, unpublished studies are included if they contain scope tests that are different from a subsequent published version.[5] Studies that include a re-analysis of earlier data and report scope test results that differ from the original results are also included.[6] Table 1 contains 109 studies that meet these criteria and form the group of studies on which our detailed review for adequacy is based.[7]

For nearly all of the studies in Table 1, the authors report on the results of more than one scope test. For example, some authors evaluate sensitivity to scope based on both parametric and non-parametric criteria for the same data (e.g., Berrens et al., 2000). Others consider more than two levels of a good (e.g., Whitehead and Cherry, 2007). Some scope studies report on scope tests for different surveys conducted on different commodities (e.g., Kahneman and Knetsch, 1992). In light of the multiple tests within a study, the third column of Table 1 summarizes the results of each study's scope tests. "Pass" and "Fail" mean that all tests reported by the authors demonstrated sensitivity and insensitivity to scope, respectively. "Mixed" means that some of the tests passed while others did not.

We examined all the studies in Table 1 to determine what, if anything, they reveal about adequacy of response to scope. Amazingly, there is little information to be obtained. In most studies, the original and reduced environmental goods that are specified for the scope test differ in ways that prevent an assessment of the magnitude of response. For example, Berrens et al. (2000) find that the average value of saving one fish species in one river is $57 while the value of saving 11 fish species in four rivers is $74, which might appear to be inadequate response (i.e., "look fishy") but might also be the result of highly diminishing marginal utility of saving fish. Similarly, Carson et al. (1994a) find that the value of saving two fish species over a period of fifteen years is worth $30 on average, while the value of saving two bird and two fish species for fifty years is $56; the low value for the extra species and years might reflect substitution across species and/or diminishing marginal utility.[8] The design of the scope tests in these studies makes it impossible to find that the response to scope is inadequate, which means that the studies do not provide information on whether the response is adequate.[9] By the scientific method, a hypothesis can be tested only with a method that has a theoretical possibility of rejecting it.

Eighteen studies (marked as such in Table 1) have designs that allow testing of an adding-up criterion within CV. The concept of an adding-up test, as suggested by Diamond et al. (1993), is based on a definitional identity that must hold for preferences to be meaningful. In particular, consider two environmental goods A and B, where B is specified as being incremental to A (that is, B is provided as an extra benefit once A is already provided). By definition, WTP for A plus WTP for B is equal to the WTP for A and B combined. This identity provides a test that is implemented as follows: A CV study is conducted for A, for B (stated explicitly as being incremental to A), and for A and B combined. Then the hypothesis is tested of whether the sum of the first two WTPs is equal to the third. The issue of adequacy is addressed by this procedure, since the response to scope is inadequate if the sum of the parts exceeds the whole.

The adding-up test is only applicable when the parts are specified incrementally. Several authors, e.g., Nunes and Schokkaert (2003), point out that, due to diminishing marginal utility and/or substitution, economically rational values of non-incremental parts need not sum to the value of their combination. This result implies that neither failing nor passing an adding-up test on non-incremental parts is informative about adequacy of response: (1) Failing an adding-up test on non-incremental parts does not indicate that responses are inadequate, since rational values need not sum as tested. The impossibility of rejecting adequacy means that adequacy is not actually being tested. (2) Passing an adding-up test with non-incremental parts does not indicate that response to scope is adequate, for the following reason. If the sum of the true values of the non-incremental parts differs from the true value of their combination, as is rationally possible, then a finding that the sum of CV values for the parts equals the CV value of the whole indicates that the CV responses are incorrect. Since we do

[3] Environmental Valuation Reference Inventory at http://www.environment.nsw.gov.au/publications/evri.htm; National Ocean Economics Program at http://www.oceaneconomics.org/nonmarket/; Social Sciences Citation Index at http://thomsonreuters.com/products_services/science/science_products/a-z/social_sciences_citation_index/; Econlit at http://www.aeaweb.org/econlit/index.php; Lexis-Nexis at http://www.lexisnexis.com/hottopics/lnacademic/?; IDEAS at http://ideas.repec.org.

[4] See McClelland et al. (1992) as an example.

[5] For example, Desvousges et al. (1992) report on results from a separate dataset that Boyle et al. (1994) do not include in the published version.

[6] For example, Giraud et al. (1999) report original results and Poe et al. (2005) later re-analyze the same data.

[7] Although the NOAA panel was explicit in its recommendation for using split-sample or external scope tests, the literature includes many examples of internal scope tests. Thus, we include both in this table. We do not, however, include meta-analyses of previous scope studies, such as those of Smith and Osborne (1996) and Ojea and Loureiro (2011), since doing so would constitute a form of double-counting.

[8] Several other reasons (in addition to diminishing marginal utility and substitution) have been proposed to explain small scope response and scope test failures. For example: Amiran and Hagan (2010) show that directionally bounded utility functions can imply a vanishingly small response to scope in specific parts of consumption space. Bateman et al. (2004) demonstrate that scope test failures may be attributed to the lack of advance notice of the entire valuation task. Powe and Bateman (2004) indicate that some scope test failures occur when respondents perceive that the provision of the higher level of the commodities is unrealistic. Heberlein et al. (2005) hypothesize that psychological and emotional beliefs held by respondents can explain some scope test failures.

[9] Bateman (2011) expresses the same concern when he states (p. 326) that testing for response to changes in scope "has a major flaw in that we have no clear prior expectation about what a 'correct' answer should be. … All outcomes are eminently feasible." Bateman's suggestions for addressing this issue enter our "Discussion" section below.

Table 1
CV studies that test for scope sensitivity (P = Pass, F = Fail, M = Mixed, NR = Not Reported, X = Yes).

Authors (publication year)	Result of scope test	Adding up design	Incremental adding up design	Result of adding up test	Possible to assess adequacy	Result of adequacy assessment
Ahearn et al. (2006)	M					
Alvarez-Farizo et al. (1999)	P	X		F		
Araña and León (2008)	M					
Bandara and Tisdell (2005)	M					
Banzhaf et al. (2006)	P					
Bateman et al. (2008)	M	X		F		
Bateman et al. (2005)	M					
Bateman et al. (2004)	M					
Bell et al. (2009)	P					
Bennett et al. (1998)	M					
Bergstrom et al. (1985)	P					
Berrens et al. (2000)	P					
Berrens et al. (1996)	P					
Binger et al. (1995)	P	X	X	NR		
Bliem and Getzner (2008)	F					
Blomquist and Whitehead (1998)	M					
Bowker and Didychuk (1994)	P					
Boyle et al. (1994)	F					
Boyle et al. (1993)	M					
Brookshire et al. (1983)	M					
Brown and Duffield (1995)	M					
Brown et al. (1995)	M					
Carson (1997)	P					
Carson and Mitchell (2006)	P					
Carson et al. (1994a)	P					
Carson et al. (1994b)	M					
Carson et al. (1990)	NR					
Chapman et al. (2009)	P				X	F
Chestnut and Rowe (1990)	M					
Chilton and Hutchinson (2003)	NR					
Choe et al. (1996)	M					
Christie (2001)	M	X		F		
Colombo et al. (2006)	P					
Cooper et al. (2004)	P					
Day and Mourato (1998)	P					
Desvousges et al. (1992)	F					
Diamond et al. (1993)	M	X	X	M	X	M
Douglas and Taylor (1999)	M					
Duffield and Neher (1991)	M					
DuPont (2003)	M					
Eom and Larson (2006)	P					
Fischhoff et al. (1993)	F					
Gerrans (1994)	F					
Giraud et al. (1999)	M					
Goodman et al. (1998)	M					
Halstead et al. (2004)	P					
Hanemann (2005)	P					
Hanemann et al. (1991)	P					
Hanley and Kristom (2002)	F					
Hanley et al. (2003)	F					
Heberlein et al. (2005)	M					
Hite et al. (2002)	P					
Hoevenagel (1996)	P	X		NR		
Holmes et al. (2004)	M					
Huang et al. (1997)	P					
Kahneman (1986)	NR					
Kahneman and Ritov (1994)	M					
Kahneman and Knetsch (1992)	M					
Kemp and Maxwell (1993)	M					
Krieger (1994)	P					
Le Goffe (1995)	F					
Loomis and Ekstrand (1997)	P					
Loomis and González-Cabán (1998)	P	X		NR		
Loomis and Larson (1994)	P					
Loomis et al. (2009)	P					
Loomis et al. (1993)	M					
Macmillan and Duff (1998)	P	X		F		

(continued on next page)

Table 1 (*continued*)

Authors (publication year)	Result of scope test	Adding up design	Incremental adding up design	Result of adding up test	Possible to assess adequacy	Result of adequacy assessment
Macmillan et al. (1996)	M					
Magnussen (1992)	M					
McClelland et al. (1992)	M					
McDaniels et al. (2003)	P					
McFadden (1994)	F					
Navrud (1989)	M					
Nielsen and Kjaer (2011)	P					
Nunes and Schokkaert (2003)	M	X		M		
Ojea and Loureiro (2009)	F					
Poe et al. (2005)	P					
Pope and Jones (1990)	M					
Pouta (2005)	M					
Powe and Bateman (2004)	M	X		F		
Ready et al. (1997)	P					
Riddel and Loomis (1998)	P	X		NR		
Roberts et al. (1985)	P					
Rollins and Lyke (1998)	M	X		NR		
Romer et al. (1998)	M					
Rowe et al. (1992)	M					
Samples and Hollyer (1990)	F	X	X	F	X	F
Schkade and Payne (1994)	F					
Schulze et al. (1998)	M					
Smith et al. (2005)	M					
Smith et al. (1997)	P					
Stanley (2005)	P					
Stevens et al. (1997)	F					
Stevens et al. (1995)	P	X		F		
Streever et al. (1998)	F	X		NR		
Svedsäter (2000)	F					
Tanguay et al. (1993)	NR					
Veisten et al. (2004)	M	X		F		
Walsh et al. (1984)	P					
Welsh et al. (1995)	M					
White et al. (1997)	M	X		F		
Whitehead (1992)	P					
Whitehead and Cherry (2007)	M					
Whitehead and Finney (2003)	F					
Whitehead et al. (2009)	F					
Whitehead et al. (1998)	P					
Whittington et al. (1997)	M					
Wilson (2000)	M					
Wu (1993)	NR	X		F		

not know the true values, we cannot know whether passing an adding-up test on non-incremental parts indicates that CV is accurate or inaccurate.[10]

Unfortunately, of the eighteen studies that have used adding-up designs, only three specified the parts as increments: Samples and Hollyer (1990), Diamond et al. (1993), and Binger et al. (1995).[11,12] Of these three, only the first two give results of their adding-up tests. Binger et al. focus on other issues related to consistency of responses and, while their design would allow a type of adding-up test on incremental parts, they did not perform this test or report the information needed for us to perform it.

We have found only three studies that allow an assessment of the adequacy of response to scope: the two studies with incremental adding-up tests, i.e., Samples and Hollyer (1990) and Diamond et al. (1993), plus a recent study by Chapman et al. (2009) that did not implement an adding-up test but nevertheless, as we describe below, permits an assessment of adequacy. Samples and Hollyer found that the sum of estimated values for incremental parts greatly exceeded the estimated value of the combination of parts, which implies inadequate responsiveness to scope. They did not test the difference statistically but concluded without the test that the adding-up property was not met. Diamond et al. concluded, based on the mixed results of their various scope and adding-up tests,

[10] Smith (1997) argues that adding-up tests, even on incremental parts, are problematic if the separated parts are not considered by the respondent to be perfect substitutes for their respective components of the whole. Of course, if the increments are not the same as the components of the whole, then the design does not actually provide an incremental adding up test. His comment is important to keep in mind when designing surveys that implement this test. It also highlights the potential difficulty in designing an adding up test, in which environmental benefits are described as being incremental to other benefits. Diamond (1996) points out that if environmental goods provided in one way (e.g., through a program) are not perfect substitutes for the same goods provided in another way (e.g., though nature), then the difference in WTP based on method of provision does not constitute a part of damages. Hanemann (1994) argues otherwise, that any factor is a permissible element of consumers' utility.

[11] Even Diamond et al. did not specify parts that were exactly incremental. They estimated the WTP to not develop certain named wilderness areas. For their adding up test, the number of wilderness areas already saved from development was raised incrementally when asking about WTP not to develop an additional named area. However, the respondent was not told the names of the areas that were already saved. Hanemann (1994, footnote 29) criticizes the lack of site identification in Diamond et al., though without explicitly linking the concept to the issue of increments.

[12] There is also an issue of income effects even with incremental parts. A person's WTP for B as an increment over A can differ depending on whether, or how much, the person had to pay for A, since the payment reduces the person's remaining income. However, in the context of environmental goods where WTP for each increment is likely to have a small impact on the person's effective income for the next increment, it is doubtful that the difference matters for evaluating the increments (Diamond, 1996).

that the response to scope in their CV was not consistent with economic preferences. Chapman et al. applied a scope test, which was passed, and did not explicitly address the issue of adequacy of response; however, the design of their scope test, unlike those of other studies, permits such an assessment. We discuss the findings of this study in the next section.

3. Analysis of the Chapman et al. Study

We discuss this study in greater detail than might seem needed for the sake of our conclusions for two reasons. First, according to Chapman et al. (2009), the study meets most of the NOAA Panel criteria and is incentive-compatible and consequential (as defined by Carson and Groves, 2007). Moreover, the researchers spent nearly two years developing the questionnaires through a series of focus groups, one-on-one interviews, pretests, and pilot studies. Secondly, the complexity of the relationship between the study's programs is difficult to summarize briefly.

The study's scope test involves three incremental parts, as illustrated in Fig. 1:

A. Speed recovery of specified rivers[13] by 40 years (starting in 10 years)
B. Speed recovery of a specified lake by 10 years (starting in 50 years), conditional on A already being obtained
C. Speed recovery of the same lake by another 30 years (starting in 20 years), conditional on A and B already being obtained.

Their base program consists of A, B, and C combined and was found to be valued at $184 per household. Their scope program consists of B (with its conditioning on A explicitly stated to respondents) and was found to be valued at $138. The responses passed the scope test, in that the hypothesis of no difference was rejected. However, the magnitude of response is demonstrably inadequate. By the standard calculation of present value, B is worth at most one-quarter of B and C combined. However, it is estimated at 75% of A, B, and C combined. Any positive discount rate and any positive value for A make the difference even greater.

The adding-up identity can be used in this study, since the parts are specified as increments to each other. In particular: if the value of A, B, and C combined is $184, and the value of B is $138, then the combined value of A and C is $46. This result constitutes an actual violation of the scope criterion: Parts A and C provide more service than B in each dimension: more types of resources (the rivers and the lake versus just the lake), more years of service (40 years of additional service for the rivers and 30 years for the lake versus 10 years for the lake), and a closer time period (recovery occurring 10 years in the future for the rivers and 20 years in the future for the lake versus 50 years in the future for the lake). Yet these two parts are found by the study to be valued less than part B—a third as much.[14]

As stated above, most CV studies' results cannot be evaluated since their base and scope programs are specified such that any difference in WTP can reflect diminishing marginal utility and/or substitution. However, these factors cannot explain the results in Chapman et al. A salient feature of their design is that the scope program is incremental to some of the benefits provided in the base program. In particular, the base program includes 40 years of faster recovery of the rivers (part A). In the scope scenario, this faster river recovery is said to occur without a program, and so the respondent obtains this environmental benefit without the scope program. The scope program provides 10 years of faster lake recovery as an increment to the river recovery (i.e., part B). Diminishing marginal utility might cause B to be worth less than A, since B is incremental to A. But, instead, the study finds that B is worth more than A (and even more than A and C combined). Similarly, substitution between lakes and rivers might cause the lake recovery to be less valuable after the rivers have already recovered. But the study found the opposite: the lake recovery is more valuable than the river recovery to which it is a possible substitute and was already provided. Train (2012) discusses the study in more detail, considering various alternative concepts of diminishing marginal utility, and concluding that none can rationalize the study's results.

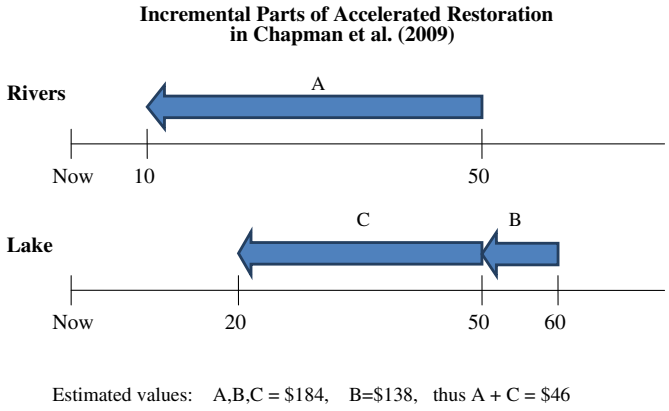

Fig. 1. Incremental parts of accelerated restoration in Chapman et al. (2009).

4. Discussion

What can we conclude from all this? One thing seems clear to us. The NOAA Panel was concerned with the possibility of "inadequate responsiveness to the scope of the environmental insult." The standard scope test does not address this concern, since it tests for statistical significance rather than adequacy of magnitude. In nearly all past applications of the test, the design of the study does not permit an evaluation of adequacy. And in the one study that permits such an evaluation while passing the standard scope test, the response to scope is demonstrably inadequate—which shows that the standard scope test does not provide a reliable indication of adequacy.

Carson and Groves (2007) describe a CV elicitation method that is intended to induce truthful responses, by offering a single referendum with a binding payment that the respondent votes for or against. Of the scope studies described in Table 1, only two studies have implemented this method (Carson et al., 1994a[15]; Chapman et al., 2009), both of which pass their scope tests. However, we have shown above that response to scope in Chapman et al. is demonstratively inadequate, while adequacy cannot be assessed in Carson et al. Four other studies have utilized the design but have included "I don't know" as a third option to the referendum question. Carson and Groves indicate that the consequential vote question must be a "binary discrete choice question" (p. 184) and that "no response format that allows more than two alternatives can be incentive-compatible" (p. 187). However, an "I don't know" option might not constitute the type of third alternative about which Carson and Groves were concerned. In any case, two of these four studies passed their scope tests (Hite et al., 2002; Whitehead et al., 1998), one failed (Whitehead and Finney, 2003), one obtained mixed results (Pouta, 2005), and none assessed the adequacy of response.

[13] For linguistic convenience, we use "rivers" to denote "river and creeks," which is the term used in the study.

[14] The hypothesis that the combined value of the A and C equals or exceeds the value of the B can be rejected at a confidence level of over 99.9%, using the confidence intervals reported on page 7-5 of Chapman et al.

[15] Carson et al. actually used double-bounded referendum questions in their survey, rather than a single referendum. However, they only used the answer to the first question in their analysis. Under the concept that the first question was answered the same as if the second question had not been asked, their study can be considered to follow the recommendations of Carson and Groves.

There are several tests that can be used to assess the adequacy of response in CV studies. Diamond et al.'s (1993) incremental adding-up test can be applied in most CV studies, by expanding the split-sample design to include several increments that together constitute the whole. For example, Chapman et al. used a split-sample design for a base program that speeds recovery of rivers and a lake by 40 years each (parts A, B, and C combined, for the incremental parts described above) and a scope program that provides ten years of speedier lake recovery conditional on 40 years of faster river recovery (part B). An adding up test could be performed by expanding the split samples to include the two other incremental parts: a program that speeds recovery of the rivers by 40 years without improving the lake (part A) and a program that speeds recovery of the lake by 30 years taking as given the 40 years of faster river recovery and the 10 years of faster lake recovery (part C).

Diamond (1996) suggests a test based on the second derivatives of utility, which has never to our knowledge been implemented but is feasible and informative about adequacy. In particular, let $WTP_1(x) = U(b+x) - U(b)$ be the willingness to pay for an increase by x of an environmental good from some base amount b, with utility U scaled in dollars,[16] and let $WTP_2(x) = U(b) - U(b-x)$ be the willingness to pay to prevent a decrease by x from the base amount. Diminishing marginal utility from the environmental good implies that $WTP_1(x)$ rises less than proportionately in x and, importantly, that $WTP_2(x)$ rises more than proportionately in x. More generally, whatever shape the utility function takes, $WTP_1(x)$ and $WTP_2(x)$ have oppositely signed second derivatives in any region of the utility function. CV studies can be developed to test whether responses adhere to this property when programs are described as providing improvements or avoiding losses.[17] Importantly, warm glow can be expected to cause both measures of WTP to rise less than proportionately, which means that the test would be able to distinguish warm glow from responses that reflect utility-based preferences.

Bateman (2011) examines whether "in the absence of clear understanding of a good, stated preferences are malleable and hence can be manipulated by changes in the questionnaire design." He reports that, using choice experiments, the estimated willingness to pay for margarine made with palm oil from "tiger friendly" plantations rises significantly when respondents are shown a picture of tiger cubs. Similar tests can be adapted to CV studies. The researcher must be able to identify changes in the questionnaire design that are indeed irrelevant. For example, adding a photo of murky water is not irrelevant to a program that increases clarity, since water quality is difficult to describe in words. However, different questionnaire designs that are equally informative can serve as the basis for testing malleability.

With these other tests available, the question arises of whether to continue to use the scope test at all. Heberlein et al. (2005) propose that the standard scope test should perhaps be abandoned for efficacy and cost-effectiveness reasons. Their argument is that numerous cognitive and attitudinal factors can induce a lack of scope response and even "negative scope," by which respondents give a smaller value to a larger environmental good. These factors are important to investigate from a scientific perspective, in order to understand how respondents process information and respond to CV questions. Indeed, there must be *some* explanation for any observed response, and discovering the various causes is useful. Our analysis confirms Heberlein et al.'s suggestion that the standard scope test is not very informative, but the implication we draw is different, namely, that some other form of evidence of adequate response to scope is needed in order to inform the practical uses to which the damage assessments are usually applied. In this regard, our conclusion more closely follows Bateman (2011), who argues that standard scope tests are uninformative and recommends more extensive testing of the reliability of CV and stated-preference methods in general.

[16] Diamond extends the analysis to include income effects, which our scaling of utility in dollars does not include.

[17] Note that this issue is different from whether willingness to pay equals willingness to accept. Stated in terms of *WTP* and *WTA* for gains and losses, Diamond's test is whether *WTA* rises more than proportionately in the loss whenever *WTP* rises less than proportionately in the gain, and vice versa.

5. Conclusion

Our examination of the literature indicates that environmental economics as a field has barely addressed the issue of adequate response, despite the large number of studies on scope in CV. The reason for this lacuna might be historical: Early studies (cited above) claimed to have found no statistically significant response to scope in CV. The showing of no significance prompted investigations of (i) whether statistically significant responses are obtained in other settings and by other designs and (ii) whether there are explanations for a lack of significance. The second line informs our understanding of what adequate responses might be under various circumstances. But this second line negates the relevance of the first line to an extent that seems not to have been recognized. The relevant issue is not whether CV passes a scope test but whether CV evidences adequate response to scope—whatever that might be.

To remedy this situation, CV practitioners need to specify and implement procedures that assess the adequacy of response in their studies. Some procedures are discussed above, including the adding-up test on incremental parts. Important directions for future work include more applications of these tests and the development of other methods to assess adequacy of response.

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