Contingent Valuation: Theoretical Advances and Empirical Tests since the NOAA Panel

Richard T. Carson

Beyond a simple cost-effectiveness role, and for many policy issues where all the goods or impacts at issue are not readily priced in the market, the relevance of economics depends to a large degree on the ability to use contingent valuation (CV) and other closely related stated preference approaches. The government's use of CV as a tool to place a monetary value on damages from the *Exxon Valdez* oil spill brought forth strong industry objections to the use of CV. In response, the National Oceanic and Atmospheric Administration (NOAA), one of the trustee agencies in the *Exxon Valdez* case, commissioned a blue ribbon panel chaired by Kenneth Arrow and Robert Solow to review the use of CV in natural resource damage assessment proceedings.

The panel's report (Arrow et al.) and transmittal letter to the NOAA general counsel concluded, "CV studies can produce estimates reliable enough to be the starting point for a judicial or administrative determination of natural resource damages—including passive use values." Although the NOAA panel categorically rejected the extreme claims made by some CV critics (e.g., Hausman), it was nonetheless concerned by many of the issues raised and suggested specific recommendations for avoiding particular problems with CV surveys. The panel also suggested that further research on several issues would be desirable.

In this paper, I look at how recent research has clarified our understanding of key theoretical and empirical issues involving CV. Because of space constraints, I concentrate on four key issues: (*a*) implications of the difference between the structure of demand for private and public goods for predictions concerning CV results, (*b*) theoretical predictions and empirical evidence related to whether CV estimates should be and are overestimates of true value, (*c*) whether different CV elicitation formats should result in different estimates, and (*d*) whether CV surveys generally produce estimates that are insensitive to the scope of the good valued.

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Implications of the Structure of Demand for Public Goods

The question of which economic properties the results of CV studies should conform to is of central concern to both CV critics and CV practitioners. The former generally contend that if CV is reliable, willingness to pay (WTP) and willingness to accept (WTA) CV estimates should be fairly close, that income elasticities should generally be fairly large if most environmental amenities are luxury goods, that the value of a good should not usually change much with the order in which it is valued, and that different ways of eliciting CV responses should yield similar estimates. Because CV results do not generally conform to these priors, CV critics argue that CV estimates are likely to be unreliable.

At the time the NOAA panel report was released, a substantial effort was already underway to explore the implications of standard neoclassical economic theory for the structure of demand for public goods. Much of this effort was motivated by CV results (e.g., Bishop and Heberlein), which seem to be counter to what economic theory would predict. Hoehn and Randall (1989) and Hanemann (1991), the two key papers, challenged the conventional wisdom, contained in many books on benefit-cost

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analysis, that the order in which projects were undertaken was of secondary concern and that the divergence between WTP and WTA was likely to be inconsequential. Underlying both papers was effectively a model of quantity-constrained goods where agents did not have control over the quantity of the good they could consume.[1] Pure public goods simply represented one major example of quantity-constrained goods, another one being wartime rationing. Recent experimental papers such as Shogren et al. have supported the framework's relevance.

Work subsequent to the NOAA panel has helped clarify the theoretical insights of the Hoehn and Randall and the Hanemann papers. Hanemann (1997) has expanded his work on WTP-WTA differentials and shows it to be a much more expansive result than initially thought by some who interpreted the original result as implying that only for "unique" goods could WTP and WTA diverge substantially. Carson, Flores, and Hanemann (1995) show that WTP and WTA sequences under typically assumed conditions move in opposite directions, so that WTA for a good valued in any order in a sequence should be larger than WTP for a good valued first in a sequence.[2] Thus, the standard practice of using a WTP estimate for a good valued alone (i.e., first in a sequence) as a surrogate for the desired WTA estimate in a natural resource damage case should underestimate damages, not overestimate damages, as some CV critics had contended. Serious issues do exist with respect to which projects are to be valued and in what order, but it would have been very surprising for CV to be the solution to the agenda control issues that often dominate political discourse. Flores shows that because sequence effects should be proportionate to the inverse of the cross-price elasticity substitution matrix rather than the ordinary matrix of substitution terms, large sequence effects should appear in precisely the cases where CV critics had claimed that small sequence effects should be observed. The reason is that, from a conceptual point of view, substitution in virtual price space (instantaneous WTP or WTA) is substantially different than is substitution in quantity space.

In related work, Flores and Carson show that the income elasticity of demand, on which the standard economic notion of luxury and necessary goods is based, is a substantially different economic measure than the income elasticity of WTP often estimated in CV studies. The income elasticity of WTP is equal to the product of income elasticity of demand, the matrix of substitution terms, and the ratio of disposable to total virtual income (disposable income plus implicit value of available public goods). The last term is always less than one and potentially much less than one, so the income elasticity of WTP is likely to be smaller than the ordinary income elasticity of demand.[3]

Should and Does CV Overestimate?

A common claim of CV critics is that CV estimates are gross overestimates. A small number of papers, such as Neill et al. and Seip and Strand, are usually cited as supporting this contention. A much larger number of empirical papers come to the opposite conclusion. Although it is undoubtably useful to consider the exact techniques underlying particular studies to gain insight into the factors causing convergence or divergence of different estimates, the deeper question is whether there are theoretical conditions under which CV estimates should be unbiased, be biased downward, and be biased upward. It is useful to consider four different situations when considering this issue: (*a*) quasi-public goods, where the effective trade-off is a quality change against a cost change; (*b*) public goods to be provided by means of a coercive payment mechanism, such as an increased tax or utility bill; (*c*) public goods to be provided by means of voluntary contributions; and (*d*) the possible purchase of a private good.

Carson, Groves, and Machina (1997) show in the first two situations that under certain plausible conditions, it is in the strategic interest of respondents to truthfully reveal their pref-

[1] Ironically, Hicks originally proposed four utility consistent monetary welfare measures, two of which were based on the consumer not being able to choose the desired quantity of the good. Most texts on benefit-cost analysis and project evaluation deal almost exclusively with the case of price changes with little indication that substantive differences arise when one is dealing with imposed quantity changes.

[2] Much of the literature using the term *embedding* (e.g., Kahneman and Knetsch) confuses effects related to the sequence order in which a good is valued, which should occur because of changes in income and substitution possibilities, and insensitivity to the scope of the good valued, which generally should not occur. Carson and Mitchell consider the theoretical foundations for the two distinct phenomena.

[3] This result has substantial implications for the conduct of benefit-transfer exercises that apply benefit estimates from developed countries to developing countries where the common practice of scaling the original estimate by the ratio of income in the two countries is appropriate only if the elasticity of WTP is equal to one.

erences.[4] In contrast, in two cases, (*c*) and (*d*), it is possible to show that for a consequential survey question the design of an incentive-compatible survey question is essentially impossible.[5] The general principle underlying this result is a simple and obvious necessary condition: The survey response must provide the possibility of strictly altering the respondent's choice set without strictly expanding or contracting it so that truthful preference revelation is a dominant strategy. The empirical evidence from these four different situations is in general accord with the theoretical predictions: survey-based estimates for public goods with coercive payment mechanisms (Polasky, Gainutdinova, and Kerkvliet) and quasi-public goods (Carson et al. 1996) seem to be approximately equal to or less than estimates from their behavioral counterparts, whereas survey-based estimates from public goods provided with voluntary contributions and potential purchases of private goods are often substantially greater than estimates based on their behavioral counterparts.

The provision of a public good by means of voluntary contributions is particularly troublesome because for actual contributions (as has long been known) there is a strong incentive to free ride and for the survey question to overpledge. Because the free-riding aspect of actual contributions has long been known, it is odd for CV critics such as Diamond and Hausman to raise the comparisons of actual contributions to CV estimates as evidence that CV overestimates. However, what was not known is that a CV question in this context does provide an incentive to overpledge. The only influence that a yes response to the CV question can have is to encourage an actual fund-raising effort. Only if that effort is undertaken does the actual chance to obtain the desired good without paying for it present itself. Thus, for many respondents who desire the good, an optimal strategy is to say yes to the CV survey question and no to the actual fund-raising effort. This suggests that voluntary contribution mechanisms should generally be avoided in CV surveys.[6]

The case of a single private good can be shown to be strategically equivalent to the voluntary contribution on the survey side but incentive compatible on the purchase side in a strictly competitive market. Thus, a single private good, rather than representing the "best" case for a successful CV (as contended by CV critics such as Cummings, Harrison, and Rutström 1995), represents one of the worst cases.[7]

Different Answers from Different Question Formats

It is reasonable to expect two different formats to yield the same answer only if they are strategically and informationally equivalent. Unfortunately, most commonly used CV elicitation formats are not strategically and informationally equivalent. This fact seems to be insufficiently recognized by either CV practitioners or CV critics who find different estimates from different elicitation formats to be disconcerting.

The first formal analysis of the issue appears to be that of Hoehn and Randall (1987), who showed that responses to open-ended questions are likely to be biased downward relative to those of binary discrete-choice questions. Mitchell and Carson extend that analysis and discuss the issue at length. Recent work by Carson et al. (1997) and others, such as Farmer, have shed much more light on the role of the elicitation format.

Although the exact form of the expected influence of the elicitation format can depend on the context in which it is used and the respon-

[4] For example, it has long been known that voting in a binding binary referendum under the usually assumed conditions is incentive compatible in the sense that truthful preference revelation, is the dominant strategy (Farquharson). Replacing the binding nature of the vote with the more general condition that the probability of providing the good increases with the percentage in favor does not change the dominant strategy of truthful preference revelation, and does not change the incentive structure, nor does switching from taking a vote of the population of interest to taking a sample of that population.

[5] Carson et al. (1997) formally define a purely hypothetical survey question as one where the response to the question has no chance of changing the choice set faced by the respondent. They define a consequential survey question as one with a positive probability of altering the choice set (i.e., not a hypothetical question) in a way that could alter the respondent's level of utility. Only for consequential survey questions does economic theory provide predictions concerning respondent behavior. Most CV surveys are intended to be inputs to policy decisions and thus are not hypothetical to the respondent. Further, most of these CV surveys also satisfy the consequential requirement in that they have the potential to influence the provision of goods and/or payment for those goods that agents care about.

[6] In contrast, if majority approval on a survey increases the likelihood that a referendum will be placed on the ballot for a public vote (which is the only way the good can be supplied), then the only consistent responses are yes to both the survey and the referendum or no to both. The rationale is straightforward. If the agent is opposed, then a yes response to the survey increases the likelihood that there will be a vote on the issue, in which case majority approval will force the agent to consume and pay for the good. If the agent is in favor, then lower support on the survey will reduce the likelihood that the vote is held, which is the only way the good can be provided.

[7] Once the strategic incentives in the single-private-good case are grasped, it should not be surprising that the marketing research literature evolved away from the single-good case to the multiple- good case, where it is possible to restore some of the incentives for truthful preference revelation.

dents' beliefs, several general principles emerge from a comprehensive examination of elicitation formats. One of these principles is that even restricting ourselves to situations involving only pure public goods with coercive payment mechanisms and quasi-public goods trade-offs, it is well known from the Gibbard-Satherwaite theorem that all elicitation formats that are not effectively binary discrete-choice questions can be subject to strategic incentives to misrepresent preferences. Thus, one should typically expect to see differences estimates using different elicitation formats.

Optimal response strategies almost always involve conditioning in some way on cost. Binary discrete-choice questions in which stated and expected costs coincide can correctly take this conditioning into account in the econometric estimation. Other elicitation formats, such as open-ended questions, bidding games, and double-bounded discrete-choice questions, typically cannot; thus, one should expect to see some form of "anchoring" behavior, the presence of which should not automatically be taken as evidence in support of the usual psychological explanation that anchoring suggests that respondents do not have well-defined preferences. Usually, optimal conditioning on cost will result in a downward bias in derived estimates, especially if respondents believe that the government is capable of capturing part of any available surplus for unproductive purposes. For open-ended and payment card questions, the optimal strategy for respondents whose WTP for the good is less than the expected cost is to state a WTP of $0. This strategy is surprisingly robust to a wide variety of beliefs about how the government will use the information provided, and the empirical evidence suggests that these two formats tend to yield a large fraction of zeroes (Mitchell and Carson). The strategic nature of these zeros has largely been ignored by labeling them "protest," but protesting by giving $0 and being "unhappy" with various aspects of the plan is likely to be the optimal response for these respondents.

Uncertainty over cost with a public good to be provided by means of a coercive payment mechanism reduces the amount that a risk-adverse honest respondent would be willing to pay: cost uncertainty translates directly into undesirable income uncertainty. An open-ended question, of necessity, invokes cost uncertainty, as it does not state the cost to be paid by the respondent.[8] Cost uncertainty may not be undesirable with a quasi-public (or private) good because the consumer can wait to observe the actual cost and consume more of the good if its price turns out to be low and less of the good if its price turns out to be high.

Insensitivity to the Scope of the Good Being Valued

The empirical claim concerning CV that has received the greatest attention is that CV estimates are not sensitive to the scope of the good being valued. The attention paid to this issue is not surprising. However, the crucial issue to be confronted should not be whether isolated incidents of this phenomenon occur but rather (*a*) does it generally occur, and (*b*) is it avoidable by using more appropriate survey techniques?

Diamond and Hausman have contended (*a*) that the phenomenon generally occurs, (*b*) that most of the empirical tests relevant to this topic had been sponsored by Exxon, and (*c*) that the phenomenon seemed to be robust to a variety of different survey approaches. They and CV critics such as Daniel Kahneman, who first noted the phenomenon, have contended that it cuts across goods with predominantly both direct use and passive use considerations, whereas other CV critics, such as Bill Desvousges, have emphasized that the issue is relevant mainly to studies involving principally passive uses.

Several problems with the claim of scope insensitivity that has been put forward by CV critics are discussed at length in my recent review article on this topic (Carson 1997). First, much of the work sponsored by Exxon does not hold up under closer scrutiny.[9] Second, more than thirty other studies provide split-

[8] Other commonly used elicitation formats, such as the bidding game, payment card, and double-bounded dichtomous choice, induce cost uncertainty by the provision of multiple cost numbers. Even uncertainty centered around the stated cost in a binary discrete-choice question will result in a smaller probability of a risk-adverse consumer agreeing to pay the stated amount than would have been the case if there were no cost uncertainty.

[9] My re-analysis (Carson 1997) of the Exxon scope experiments contained in Hausman reveals a number of substantial problems. For example, a simple linear regression model rejects the scope- insensitivity hypothesis in the Diamond et al. wilderness experiment at $p = 0.01$ using a simple ordinary least squares (OLS) regression, whereas the less powerful Kruskal-Wallis test used in the analysis of the original experiment does not ($p = 0.42$). Dropping two very large outliers in the Schkade and Payne verbal protocol bird experiment results in a rejection of the scope-insensitivity hypothesis. Even the Desvousges et al. shopping mall bird experiment provides a rejection of the scope-insensitivity hypothesis if one uses their trimmed data and the percentage of birds saved as a regressor rather than the absolute number of birds saved.

sample tests for the presence of the phenomenon of scope insensitivity.[10] Almost all reject the hypothesis regardless of whether the goods being valued involved predominantly direct use or passive use. Third, a number of tests performed since the NOAA panel report strongly reject the scope-insensitivity hypothesis (e.g., Carson, Wilks and Imber 1994, Smith and Osborne). Fourth, indirect evidence relevant to the hypothesis, such as that showing a strong correlation between CV and revealed-preference estimates for quasi-public goods (assembled since the NOAA panel report), also suggests rejection of the hypothesis (Carson et al. 1996). Fifth, the ways in which specific, avoidable survey problems can mimic the impression of insensitivity to scope in a CV survey are now better recognized (Carson and Mitchell). Sixth, it has become obvious that problems of insensitivity to scope are concentrated in surveys based on mall intercepts and short telephone interviews and, with significant overlap, in surveys with vague descriptions of the good, the provision mechanism, the payment mechanism, or all of these. Finally, in the one case where it is possible to consistently obtain results that suggest insensitivity to scope in split-sample tests (i.e., valuation of changes in low-probability risks), there is a growing recognition that well-known difficulties that people have dealing with low-probability risk may translate into the appearance of scope insensitivity both in responses to CV questions and to choices made in ordinary markets.

Discussion

Controversy can often be productive when the key issues can be addressed by theoretical or empirical research. This has been the case with many of the issues confronting the use of CV.

Recent work based on neoclassical theory predicts (*a*) that large WTP-WTA differences are likely to be the norm, not the exception; (*b*) that large sequence effects are likely to be frequently observed; and (*c*) that estimated income elasticities of WTP are likely to be on the small side, even for goods that might be considered luxury goods from the usual income elasticity of demand perspective. Although observed empirically, these theoretical predictions are at odds with what many CV critics believe should be the case. This is undoubtably a source of some of the disagreement over the use of CV.[11]

The possibility of strategic behavior was the major early concern of economists considering the use of CV. This concern faded as empirical evidence failed to support the presence of an overwhelming upward strategic bias. The possibility of strategic behavior resulting in a downward bias, which now appears more likely, was largely ignored. Mitchell and Carson's summary of the empirical evidence was taken by many to imply that strategic behavior was not an issue. However, Mitchell and Carson discuss the incentives for misrepresenting preferences at some length and clearly note that it was possible to structure situations in which undesired strategic behavior would occur. However, those situations were not clearly laid out. Most CV studies value public goods using coercive payment mechanisms such as higher taxes, utility bills, or prices, whereas most CV studies regarding quasi-public good trade-offs have used payment mechanisms such as entrance fees or increased travel cost. Public good provision by means of voluntary contributions and the potential purchase of a private good turn out to be situations in which CV would be predicted to have strong incentives for misrepresenting preferences, and the empirical evidence tends to confirm the theoretical prediction. However, behavior of CV in these situations should not be used to make inferences about how CV will work in its more traditional and typical applications.

Should the different formats of CV elicitation produce different estimates? The answer is yes, and the empirical evidence is largely in accord with the theoretical predictions based on a model of respondent behavior that takes into account strategic incentives for preference misrepresentation and uncertainty effects. Should the presence of these effects cause CV practitioners to abandon elicitation formats other than binary discrete-choice questions? The answer here is probably no. The binary discrete-choice format is usually incentive compatible, partly because it does not provide much information. As such, it is more difficult to deal with from an econometric perspective. Further, as Alberini shows, a biased elicitation format

[10] Many of these tests were not formally designed as tests of the scope-insensitivity hypothesis but rather were intended to prevent possible interactions between different scenarios in large studies undertaken for policy purposes.

[11] Even in cases where CV results are at odds with predictions of economic theory, it is usually possible to experimentally demonstrate that the phenomena involved occurs in actual behavior (e.g., Bateman et al.).

may be preferred to the binary discrete-choice format from a mean-square-error perspective. The important interpretive result is that different answers to different formats, if they are in the direction predicted by theory, should not be seen as a source of concern but rather as an indication that respondents are taking the questions put to them seriously.

The issue of scope insensitivity is perhaps the area for which research undertaken in response to the NOAA panel report has provided the clearest answer: Insensitivity to scope is not a major unavoidable problem with CV. This conclusion is based on (*a*) theoretical research that clarified the inapt term "embedding," (*b*) a consideration of the indirect implications of the scope-insensitivity hypothesis, (*c*)re-analysis of the Exxon scope results, (*d*) a summary of the large body of split-sample tests of the scope-insensitivity hypothesis, and (*e*) the implementation of new tests of the hypothesis. Beyond this issue, the interesting research question is: Which aspects of nonmarketed goods do people care the most about? Here there is likely too little empirical work and too much assertion about what people should care about.

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