4 The use of contingent valuation in benefit–cost analysis

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4.1 Introduction

Benefit–cost analysis is policy analysis that identifies whether a government project or policy is efficient by estimating and examining the present value of the net benefits (PVNB) of the policy,

$$PVNB = \sum_{t=0}^{T} \frac{B_t - C_t}{(1+r)^t},$$

where B_t are the social benefits of the policy in time t, C_t are the social costs of the policy in time t, r is the discount rate and T is the number of time periods that define the life of the policy. If the present value of net benefits is positive, then the program yields more gains than losses and the program is more efficient than the status quo. The contingent valuation method (CVM) is a stated preference approach for measuring the benefits, or, in the case of benefits lost, the costs of the policy. The purpose of this chapter is to provide an overview of the role the contingent valuation method plays in benefit–cost analysis.

We begin with a brief discussion about the role of benefit–cost analysis in policy making, the steps of a benefit–cost analysis, and how contingent valuation fits into this framework (see Boardman et al., 2001 and Johansson, 1993 for introductory and advanced treatments). Next, we discuss a range of issues for which the contingent valuation method is an appropriate tool for benefits measurement within the context of benefit–cost analysis. For the rest of this chapter we will consider contingent valuation as an approach to estimate the benefits of the policy, keeping in mind that it can also be used to estimate costs avoided. Then, we discuss some challenging methodological issues in the context of benefit–cost analysis. Aggregation issues are explored. Finally, we offer some conclusions, guidelines, and suggestions for future research that may lead to improvements in the application of contingent valuation in benefit–cost analysis.

4.2 The role of contingent valuation in benefit–cost analysis

Economists tend to think that markets work well most of the time. When we say that markets 'work well' we mean that they efficiently allocate resources. Resources that are allocated efficiently are employed in those uses where the marginal benefits are equal to the marginal costs. Efficiency exists when any further change in resource allocation causes someone to be worse off than before the change. Efficiency means that opportunities for 'win – win' changes no longer exist. When markets allocate resources efficiently within some basic constitutional framework, there is little reason for additional government intervention in an economy, unless the purpose is to make transfers to the advantage of a designated group at the expense of others not in the group. We are ignoring the calls for government intervention that are made by self-serving interest groups who use the power of the government for their own gain.

When markets fail to allocate resources efficiently there is reason to consider government intervention. Examples of government intervention that are considered to correct market failure include the Environmental Protection Agency's Acid Rain Program and the Justice Department's court proceedings against Microsoft. Benefit–cost analysis allows the demonstration of whether government intervention is superior to the existing market (and institutional) outcome in terms of allocative efficiency. Are the social benefits of a specific government intervention greater than the social costs and is the present value of net benefits as large as possible? The purpose of benefit–cost analysis is to inform social decision making and facilitate the more efficient allocation of resources.

The US government must conduct benefit–cost analysis for many policies. While previous presidential administrations required regulatory analysis and review, it was Executive Order 12291 'Federal Regulation' signed by President Reagan in 1981 that first required a regulatory impact analysis to be conducted for every government project with at least a $100 000 cost and that benefit–cost analysis be done whenever permissible by law (Smith, 1984). The executive order remained in effect until President Clinton signed Executive Order 12866 'Regulatory Planning and Review' in 1993. This executive order is similar to the earlier order in that it requires benefit–cost analysis of major regulations where permissible by law. Executive Order 13258 amended and replaced the previous executive order in February 2002 to make administrative changes, but the requirement for benefit–cost analysis still remains in effect during the current administration of President Bush. Another example of mandatory benefit–cost analysis is The Safe Drinking Water Act Amendments of 1996 that require 'cost–benefit analysis and research for new standards'.

A distinguishing characteristic among various benefit–cost studies is the timing of the analysis relative to the government intervention. *Ex ante* benefit–cost analysis is conducted before a government project or policy is implemented to determine expected net benefits. *Ex post* benefit–cost analysis is conducted after the government project or policy is implemented to determine whether the benefits realized exceeded the costs realized. There are several stages in a benefit–cost analysis. First, the benefit–cost analyst must determine standing. Whose benefits and costs count? Second, the scope of the project and various alternatives must be defined. Typically, policy makers make these decisions. Third, the physical impacts of the project must be defined and quantified. Since economists typically are not experts in medicine, ecology, geology, and other relevant disciplines, this task must often be conducted by others. At this stage economists can offer guidance to promote estimating the additional (marginal) effects of the proposed policy rather than average or total effects. The next few stages employ the abilities of the economist. Fourth, the physical impacts must be measured in monetary units such as year 2001 dollars, pesos, yen, or euros. Fifth, monetary values of impacts must be aggregated over the population with standing and those monetary values that accrue in the future must be discounted appropriately. Finally, benefit–cost analysts should perform sensitivity analysis, including various definitions of standing and scope, before making recommendations.

The social impacts of a project or policy include market and non-market impacts. The market impacts can be estimated using changes in market prices and quantities. Revealed preference and stated preference approaches can be used to estimate the monetary values of the non-market benefits. Revealed preference approaches infer non-market policy impacts with data from past individual behavior. The hedonic price method uses housing and labor market location decisions, the travel cost method uses participation, site choice, and frequency of recreation decisions, and the averting behavior method uses purchases of market goods related to the policy to infer non-market policy impacts.

Stated preference methods are implemented with hypothetical questions about future behavior. The CVM is a stated preference valuation method that asks willingness to pay, willingness to accept, or voting questions that directly estimate non-market benefits. The contingent valuation method is called 'contingent' valuation because it uses information on how people say they would behave given certain hypothetical situations, contingent on being in the real situation. Other stated preference methods are contingent behavior and conjoint analysis. Contingent behavior uses hypothetical recreation trips to implement the travel cost method, hypothetical location decisions to implement the hedonic price method or hypothetical purchases of market goods to implement the averting behavior method. Conjoint analysis is an approach where respondents are asked multiple questions about, for example, where they would take a recreation trip and which house or drug treatment they would purchase. The various alternatives offer different bundles of characteristics. Conjoint analysis allows the valuation of the attributes of the good.

While the usual role of the CVM in benefit–cost analysis is to estimate the monetary value of the non-market impacts of a project or policy, decisions made in other parts of the benefit–cost analysis will influence the decisions made in the CVM study. For example, the issue of standing will determine the geographic extent of the sample and aggregation rules. Questions about the scope of the project and various alternatives will influence the range of hypothetical questions that must be presented. The physical impacts of the project must be translated into terms that a survey respondent will understand. The appropriate discount rate will influence whether annual or one-shot willingness to pay questions will be used. Therefore, the economist conducting the CVM study should operate in conjunction with the other scientists on the research team and the public policy decision makers.

4.3 The advantages of the CVM

Compared to the revealed preference methods, the CVM and other stated preference methods clearly have advantages. Relative to the revealed preference methods, stated preference methods are most useful when an *ex ante* benefit–cost analysis must consider policy proposals that are beyond the range of historical experience. The stated preference methods are more flexible than the revealed preference methods, allowing the estimation of the impacts of a wide range of policies. Recently, stated preference data and revealed preference data have been combined to exploit the best characteristics of both. The stated preference data can be 'calibrated' (for example, grounded into reality) by the revealed preference data. The stated preference data can be used to more accurately estimate benefits beyond the range of experience. In addition to flexibility, stated preference methods can be used to estimate non-use values (for example, passive use values) and *ex ante* willingness to pay under demand and supply uncertainty. Before we turn to these issues, we first sketch an economic theory of value in order to place the discussion of the CVM in the appropriate applied welfare economic context.

4.3.1 Theoretical background

Respondents are assumed to answer contingent valuation questions based on the value they place on the policy or programs. To define this value consider a household utility function, $u(x,q)$, that depends on a vector of $i=1, \ldots, m$ consumer goods, $x=[x_1, \ldots, x_m]$, and a vector of $j=1, \ldots, n$ pure and quasi-public goods, $q=[q_1, \ldots, q_n]$. Utility is increasing in x and q and is twice differentiable. The maximization of utility subject to the income constraint, $y = p'x$, yields the indirect utility function, $v(p, q, u)$, where p is a vector of $i = 1, \ldots, m$ market prices. The minimization of expenditures, $p'x$, subject to the utility constraint (at the pre-policy level), $u = u(x, q)$, leads to the expenditure function, $e(p, q, u)$. The expenditure function evaluated at the pre-policy indirect utility is equal to income, y = e(p, q, $v(p, q, y)$).

When faced with a change in the vector of public goods caused by a government project or policy, the willingness to pay for the change is the difference in expenditure functions. If the change in the public good is an increment, $q' > q$, the willingness to pay for the increment arises

$$WTP' = e(p, q, u) - e(p, q', u), \tag{4.1}$$

where *WTP* is willingness to pay. Substitution of the indirect utility function into equation (4.1) yields the compensating surplus function in which willingness to pay is a function of observable variables

$$WTP' = y - e(p, q', v(p, q', y)). \tag{4.2}$$

Since the expenditures necessary to reach the utility level with the increment are less than income, willingness to pay is positive. The corresponding willingness to pay value defined with the indirect utility function is

$$v(p, q, y) = v(p, q', y - WTP'). \tag{4.3}$$

Willingness to pay is the dollar amount that makes the respondent indifferent between the status quo and the increment.

If the change in the public good is a decrement, $q > q''$, the willingness to pay is to avoid the decrement. When the indirect utility function is substituted into the expenditure functions, the compensating surplus function is

$$WTP'' = e(p, q'', v(p, q, y)) - y. \tag{4.4}$$

Since the expenditures necessary to reach the utility level with the decrement are higher than income, willingness to pay is positive. The corresponding willingness to pay value defined with the indirect utility function is

$$v(p, q'', y) = v(p, q, y - WTP). \tag{4.5}$$

Willingness to pay is the dollar amount that makes the respondent indifferent between the status quo and the decrement.

4.3.2 Flexibility

Relative to the revealed preference methods, the contingent valuation method is the most flexible valuation approach available to policy analysts. The travel cost method is largely focused on the valuation of outdoor recreation trips and quality attributes of the sites. The hedonic pricing method is typically limited to analysis of labor, housing, and automobile markets because in other markets data are usually unobtainable for prices and observable characteristics that are useful for public policy analysis. The averting behavior approach is focused mainly on the health effects of air and water quality and safety effects of protection equipment. The other stated preference methods are limited by the necessity of framing the hypothetical question in the appropriate behavioral context.

In the theoretical framework sketched above, revealed preference methods are constrained to quasi-public goods. Quasi-public goods are those for which one or more elements of q is a characteristic of a market good. The Hicksian, or compensated, demand for the $i=1$ market good is

$$\frac{\partial e}{\partial p_1} = x_1^h(p, q, u). \tag{4.6}$$

If q_1 is a quality characteristic of x_1, the demand for x_1 will move in the same direction as the change in q_1

$$\frac{\partial^2 e}{\partial p_1 \partial q_1} = \frac{\partial x_1^h(p, q, u)}{\partial q_1} > 0. \tag{4.7}$$

The use value, UV, for the increase in quality is

$$UV_1' = \int_{q_1}^{q_1'} x_1^h(p, q, u)dq. \tag{4.8}$$

Revealed preference methods require that the demand for the market good be estimated and then the effect of the quasi-public good on the market good must be isolated. If these two empirical conditions are satisfied, the implicit market method can be used to estimate a close approximation to use value, the uncompensated consumer surplus, resulting from the change in the quasi-public good.

In contrast, most any quasi-public good, for which there are implicit markets for comparison, and pure public goods, for which no implicit market exists, are within the domain of CVM applicability. Recently, applications of the CVM have appeared predominately in *Journal of Economic*

Literature category 'Q26: Recreation and the Contingent Valuation Method'. But they have appeared in numerous other *Journal of Economic Literature* subject categories as well. In the theoretical framework above, a CVM application can accommodate just about any pure or quasi-public good defined as characteristics of q. Willingness to pay for characteristics can be expressed as

$$WTP_1 = y - e(p, [q_1', q_2, \ldots, q_n], v(p, q, y)). \tag{4.9}$$

The CVM might present survey respondents the dichotomous choice question: 'Would you be willing to pay \$$t$ for the policy that leads to Δq_1?' (where \$$t$ is a tax price and Δq_1 is the resource change). The only constraint that application of the CVM imposes is that a realistic valuation scenario must be constructed around \$$t$ and the delivery of q_1'.

This flexibility extends to valuation of projects of different scope. Multiple valuation questions can be used to estimate the value of the incremental benefits of a project to determine the scope at which the net benefits are maximized. Split-sample questions might ask about a doubling of the resource change: 'Would you be willing to pay \$$t$ for the policy that leads to $2 \times \Delta q_1$?' Or, follow-up questions might ask about a doubling of the policy change with a δ per cent increase in the tax price: 'Would you be willing to pay \$$t + \delta \times t$ for the policy that leads to $2 \times \Delta q_1$?' Most applications of the implicit market methods are limited to simulated changes in scope and the validity of these simulations for large changes are tenuous due to non-linearities and other complications.

The flexibility of the contingent valuation method is a meaningful advantage only if the willingness to pay estimates are valid. One test of validity is through a valuation comparison study. A comparison study is one in which theoretically similar valuation estimates from two or more methodologies are compared. Estimates that are statistically similar (i.e., overlapping confidence intervals) achieve a type of theoretical validity called convergent validity. The achievement of convergent validity is important for benefit–cost analysis because it increases the confidence in the valuation estimate. With increased confidence, less sensitivity analysis over the valuation estimates is necessary for benefit–cost analysis.

Much research has examined convergent validity of the CVM and implicit market methods. Carson et al. (1996) conduct a meta-analysis of over one hundred studies that compare estimates from the CVM and revealed preference methods. They find that the estimates are positively correlated, suggesting the similarity of value estimates across valuation methodology. They also find that CVM estimates are about 30 per cent lower, on average, than those estimated from revealed preference methods.

Another approach to comparing stated and revealed preference data is joint estimation. As described previously, joint estimation can be used to estimate values beyond the range of historical experience, while grounding the estimates in actual behavior (Cameron, 1992; Adamowicz et al., 1994). For example, in the first joint estimation study, Cameron (1992) estimated the value of recreation trips using revealed preference data over the observed range of trip costs and identified the choke price through information from a CVM question.

There is still much debate over CVM estimates when they cannot be compared to estimates from implicit market methods. The irony in many of these cases is that the CVM is the only approach that can be used to estimate these values for benefit–cost analysis. One example is the estimation of non-use values to which we turn next.

4.3.3 Non-use values

Contingent valuation and conjoint analysis (see, Adamowicz et al., 1998) are the only methods available for measuring the economic value of policy for people who do not experience the changes resulting from policy directly. Direct changes might be experienced through on-site recreation, changes on the job, or changes in the neighborhood of residence, or through changes in one's own health. For some policies, non-use values may exist but their contribution to total value is not substantial. In these cases, revealed preference methods are sufficient. However, for some policies, ignoring the measurement of non-use values would lead to significant errors in policy analysis. For example, the benefits of the Endangered Species Act are dominated by non-use values. In these cases the use of the CVM is necessary. While some might argue that the measurement of non-use values should be included in our 'challenges' section, the potential for estimating non-use values is a strength of the CVM within the context of benefit–cost analysis. The alternative is greater reliance on a less-informed, imperfect political system of decision making.

The total value of a policy change (i.e., willingness to pay) can be decomposed into use and non-use values. For example, suppose that the change in q_1 is realized, while use of the market good related to q_1 is restricted to zero. The non-use value, NUV, of the policy change is

$$\begin{aligned} NUV_1 = {} & e([\bar{p}_1, p_2, \ldots, p_m], [q_1, q_2, \ldots, q_n], v(p, q, y)) \\ & - e([\bar{p}_1, p_2, \ldots, p_m], [q_1', q_2, \ldots, q_n], v(p, q, y)), \end{aligned} \tag{4.10}$$

where $\bar{p}_1$ is the choke price for x_1. It is the price that is just high enough that the individual chooses to consume none of the good even though it is available. Non-use value is the difference in expenditure functions with and without the resource allocation change when use of the resource is zero. Subtraction of NUV from WTP yields the use value of the policy change

$$\begin{aligned} UV_1 = y - e([p_1, p_2, \ldots, p_m], [q'_1, q_2, \ldots, q_n], v(p, q, y)) \\ - e([\bar{p}_1, p_2, \ldots, p_m], [q_1, q_2, \ldots, q_n], v(p, q, y)) \\ + e([\bar{p}_1, p_2, \ldots, p_m], [q'_1, q_2, \ldots, q_n], v(p, q, y)). \end{aligned} \tag{4.11}$$

If, in the absence of policy, the use of the market good is zero, $x_1^h(p_1, q_1, \cdot) = 0$, the use value simplifies to

$$\begin{aligned} UV_1 = e([\bar{p}_1, p_2, \ldots, p_m], [q'_1, q_2, \ldots, q_n], v(p, q, y)) \\ - e([p_1, p_2, \ldots, p_m], [q'_1, q_2, \ldots, q_n], v(p, q, y)). \end{aligned} \tag{4.12}$$

In this simple case, the use value is the willingness to pay for the removal of the choke price with the increment in the resource.

Willingness to pay questions tend to elicit the total economic value. For some benefit–cost analyses, it may be important to empirically decompose the total value into use and non-use values (for example, with issues of standing). The non-use value can be elicited from survey respondents in several ways. The first, and the approach the early CVM literature adopted (Greenley et al., 1981), is with a counterfactual scenario: 'Would you be willing to pay \$$t$ for the policy that leads to Δq_1 even if you are not allowed to consume Δx_1?' Counterfactual questions often are difficult for survey respondents to answer because they are placed in an even more unusual situation than a hypothetical situation. Another early approach asked respondents to divide their total willingness to pay into use and non-use percentages (Walsh et al., 1984). Respondents also find this counterfactual to be difficult.

Another approach is to focus on user groups instead of use and non-use values. The willingness to pay question would elicit total value as usual from current users and current non-users of the resource. Revealed and contingent behavior questions could be used to determine use of the resource with and without the policy. If use of the resource changes with the policy, use values can be estimated and then compared to the total value. The residual between total and use values is an estimate of the non-use value (for example, Huang et al., 1997). Some policies will not affect use of the resource. Then, the entire willingness to pay value is the non-use value.

Estimates of non-use value have drawn criticism because of a concern about theoretical validity. One theoretical validity test that has drawn much attention is the 'scope test'. The scope test is the requirement that non-use values, or willingness to pay for that matter, must be non-decreasing in the quantity or quality of the resource change

$$\frac{\partial NUV}{\partial q_1} = -\frac{\partial e}{\partial q_1} \geq 0. \tag{4.13}$$

While some research has failed to find that non-use values are sensitive to the scope of the policy change (Boyle et al., 1994), others have found sensitivity to scope (for example, Rollins and Lyke, 1998; Whitehead et al., 1998). These results do not imply that all non-use values estimated with the CVM are valid and useful for benefit–cost analysis. These results do imply, however, that in some important policy contexts non-use values estimated with the CVM are valid economic values for benefit–cost analysis. Whether non-use values should be included in the benefit–cost analysis is largely an issue of standing, not methodology (see Rosenthal and Nelson, 1992; Kopp, 1992).

4.3.4 Uncertainty

For policies and projects that involve significant uncertainty, as many do, the appropriate measure of the impacts of policy is an *ex ante* measure. *Ex post* measures of value can incorporate uncertainty by assigning probabilities to different outcomes. The sum of the probability weighted *ex post* willingness to pay amounts from revealed preference methods yields expected surplus. In contrast, the option price is the *ex ante* willingness to pay measured before the uncertainty is resolved. Any willingness to pay estimate elicited from CVM can be interpreted as an option price, regardless of whether the analyst explicitly incorporates uncertainty in the willingness to pay questions or theoretically or empirically models the uncertainty. This is so because contingent valuation respondents will answer willingness to pay questions after considering all of the uncertainties that they are aware of at the time.

In order to define willingness to pay under uncertainty, consider a policy that may yield an outcome of q'_{1a} with a probability of π_a or an outcome of q'_{1b} with a probability of π_b where $q'_{1a} > q'_{1b}$ and $\pi_a + \pi_b = 1$. Note that this is a situation of supply uncertainty. Similar definitions can be constructed for situations involving demand uncertainty (see Cameron and Englin, 1997). Under supply certainty, the corresponding willingness to pay values are WTP'_{1a} and WTP'_{1b}. The expected surplus of the policy is the sure payment regardless of which outcome occurs

$$E[S]_1 = \pi_a WTP'_{1a} + \pi_b WTP'_{1b}. \tag{4.14}$$

The expected surplus is an *ex post* measure of benefits and can be estimated with the revealed preference methods.

The option price, *OP*, is the *ex ante* willingness to pay for the increment before the uncertainty is resolved

$$v(p, q, y) = \pi_a v(p, [q'_{1a}, q_2, \ldots, q_n], y - OP_1) + \pi_b v(p, [q'_{1b}, q_2, \ldots, q_n], y - OP_1). \quad (4.15)$$

It is the amount of money that must be subtracted from income so that the sum of the probability weighted utility functions are equal to utility under the status quo. In the case of supply uncertainty, willingness to pay questions could explicitly describe the various uncertainties before the valuation question is presented. Respondents would then incorporate the uncertainty into their response. Several studies show that respondents recognize the differences in probabilities. For example, Edwards (1988) elicits willingness to pay under various supply probabilities provided by the survey instrument and finds that the option price varies in the expected direction with the probabilities.

Subjective demand probabilities can be directly elicited from respondents before or after the valuation question is presented. Another approach is to estimate demand probabilities from revealed behavior. For example, Cameron and Englin (1997) provide an approach to compare option price and expected surplus estimates by using the demand probabilities of recreational fishing participation and fitted probabilities under different acid rain scenarios. While under certain restrictive conditions it is feasible to estimate the option price with revealed preference methods (Larson and Flacco, 1992; Kling, 1993), the CVM is the only approach that can estimate the option price with variation in demand and supply probabilities.

One problem that might be encountered in benefit–cost analysis under uncertainty is the failure of respondents to understand risk and probabilities. Understanding is especially challenging when probabilities are low. For example, Smith and Desvousges, 1987) elicit values of reductions in the risk of death using CVM and find that, if the willingness to pay estimates are not related to the baseline risk in expected ways, estimates of the values of a statistical life are not plausible. While this is a potential problem, reviews and comparison studies indicate that the CVM estimates of the value of statistical life tend to fall in the range of the estimates from labor market studies (Blomquist, 2001; Viscusi and Aldy, 2003).

4.4 The challenges

Several issues indicate that the contingent valuation method is not a flawless approach to measuring policy impacts for benefit–cost analysis.

These issues include the difference between hypothetical and actual behavior, valuation of long-lived policy, valuation of multi-part policy, and the appropriate property rights.

4.4.1 Hypothetical bias

One of the more troubling empirical results in the CVM literature is the tendency for hypothetical willingness to pay values to overestimate real willingness to pay values in experimental settings (Cummings et al., 1995; Cummings et al., 1997; Blumenschein et al., 1997). In general, respondents in a laboratory market tend to state that they will pay for a good when in fact they will not, or they will actually pay less, when placed in a similar purchase decision. This result has been found in a variety of applications including private goods and public goods.

One simple illustration of a cause for this result is when the ceteris paribus condition does not hold between the actual and hypothetical scenarios. Respondents in the hypothetical scenario may expect that more income or time will be available in the future, and 'the future' is when the hypothetical scenario will occur. Then current income and time constraints are not binding in the survey setting, and hypothetical purchase behavior will be overstated relative to the current time period. Willingness to pay may be based on future expected income, $y+\Delta y$, instead of current income, y

$$WTP' = y + \Delta y - e(p, q', v(p, q, y + \Delta y)). \tag{4.16}$$

The effect of expected income growth on willingness to pay is

$$\frac{\partial WTP'}{\partial \Delta y} = 1 - \frac{\partial e}{\partial v}\frac{\partial v}{\partial \Delta y}. \tag{4.17}$$

Since the inverse of the marginal cost of utility is the marginal utility of income, $(\partial e/\partial v) = \{1/(\partial v/\partial y)\}$, and, if the marginal utility of income is diminishing, $(\partial v/\partial y) > (\partial v/\partial \Delta y)$, the effect of an increase in expected income on willingness to pay is positive for normal goods

$$\frac{\partial WTP'}{\partial \Delta y} = 1 - \frac{\partial v/\partial \Delta y}{\partial v/\partial y} > 0. \tag{4.18}$$

In the real willingness to pay setting, when the growth in expected income is not realized, $\Delta y = 0$, the hypothetical behavior overstates the real behavior. While the divergence in hypothetical and actual willingness to pay has been challenged on empirical and methodological grounds (Smith and Mansfield, 1998; Haab et al., 1999; Smith, 1999), the willingness to pay estimates from the CVM must be considered upper bounds of benefits in the context of benefit–cost analysis unless steps are taken to mitigate hypothetical bias directly.

Research has attempted to empirically discover the source of the overstatement of willingness to pay and question formats that minimize the overstatement. Loomis et al. (1996) and Cummings and Taylor (1999) find that the divergence between hypothetical and actual willingness pay is mitigated or eliminated, respectively, by additional instructions about reporting true willingness to pay. Champ et al. (1997) and Blumenschein et al. (1998, 2001) find that hypothetical willingness to pay is similar to actual willingness to pay when adjusted by respondent certainty about payment. If the benefit category contains significant use values, calibration methods can also be used to adjust hypothetical behavior so that it is grounded in actual behavior.

Another approach to understanding this issue is an investigation of the incentive compatibility of different question formats. Carson et al. (2000) provide theoretical reasons why experimental market results tend to generate the divergence in hypothetical and actual willingness to pay. They argue that scenarios that involve the provision of public goods with a voluntary contribution format and the purchase of private goods should lead to overstatements of hypothetical willingness to pay. Hoehn and Randall (1987) and Carson et al. (2000) conclude that respondents, when considering a public good with individual policy costs and a referendum vote, will tend to truthfully reveal their willingness to pay. These formats too appear to mitigate against the divergence in hypothetical and actual willingness to pay.

4.4.2 Temporal bias

The choice of the appropriate social discount rate can be the most important decision in a benefit–cost analysis for long-lived projects. The same statement could be made about whether the willingness to pay question elicits annual or lump-sum amounts. Most contingent valuation applications elicit annual payments assuming the current period budget constrains the willingness to pay. Aggregation over time is then conducted by multiplying annual payments by the time period of the project after applying a discount rate. The present value of willingness to pay, $PVWTP_1$, is

$$PVWTP_1 = \sum_{t=0}^{T} \frac{WTP^s_{1t}}{(1+r)^t}, \tag{4.19}$$

where WTP^s_{1t} is the annual stated willingness to pay. This approach is problematic, and overstates the present value, if the respondent assumes they would only pay until the project is completely financed (paying their 'fair share'), say, $T=5$, while the analyst aggregates over the life of the project, $T=30$. Willingness to pay questions should explicitly state the time period if the benefit estimates are to be used in benefit–cost analysis.

An alternative is to assume that respondents are constrained by their lifetime wealth and elicit a lump-sum payment: 'Would you be willing to pay $\$t$, this year only as a one time payment, for the policy that leads to Δq_1?' In this case the respondent would apply his or her own rate of time preference to the project and state the present value of willingness to pay. The implicit annual willingness to pay amount is

$$LSWTP_1^s = \sum_{t=0}^{T} \frac{\overline{WTP}_{1t}}{(1+\rho)^t}, \tag{4.20}$$

where $LSWTP_1^s$ is the stated lump-sum willingness to pay, $\overline{WTP}_{1t}$ is the implicit annual willingness to pay of the policy, and ρ is the individual rate of time preference. This approach will tend toward an underestimate of willingness to pay if respondents do not have access to perfect capital markets in which to borrow or have difficulty with discounting.

If the average of the individual rates of time preferences is equal to the social discount rate, the two approaches should yield the same willingness to pay amount, $LSWTP_1^s = PVWTP_1$. However, there is some evidence that respondents answer lump-sum willingness to pay questions with an unrealistically high implicit discount rate. Comparison of lump-sum and annual willingness to pay amounts are used to estimate the rate of time preference. In the extreme case of an infinite rate of time preference, Kahneman and Knetsch (1992) find that a lump-sum payment and a series of five annual payments yield the same willingness to pay values. Stevens et al. (1997) and Stumborg et al. (2001), find that the lump-sum willingness to pay amount is larger than the annual amounts and the implicit discount rate is unrealistically high.

While evidence to the contrary exists, the annual willingness to pay question will generally yield larger estimates of the present value of willingness to pay. Define temporal bias as the upward bias in willingness to pay when annual willingness to pay questions are used when the lump-sum question format and individual rates of time preference are more appropriate. CVM researchers should consider whether lump-sum or annual willingness to pay amounts should be elicited for use in benefit–cost analysis in order to mitigate temporal bias.

4.4.3 Multi-part policy

Few government policies are independent of any other governmental policy. Most policies involve either substitute or complementary relationships with others at either the same or different intergovernmental levels. For example, the protection of coastal water quality is a goal of both state and multiple federal agencies. The Clean Water Act, wetlands protection programs, and fisheries management plans all address coastal water quality. Depending on the ecological relationships, these policies may be substitutes or complements for each other. These relationships complicate the application of the CVM. The resulting problems that may be encountered have been called embedding, part–whole bias, and sequencing and nesting.

For example, consider two related projects that focus on improvement of q_1 and q_2. The willingness to pay for the improvement q'_2 is

$$WTP_2 = y - e(p, [q_1, q'_2, \ldots, q_n], v(p, q, y)). \tag{4.21}$$

The willingness to pay for the improvement $[q'_1, q'_2]$ is

$$WTP_{12} = y - e(p, [q'_1, q'_2, \ldots, q_n], v(p, q, y)). \tag{4.22}$$

Hoehn and Randall (1989) demonstrate theoretically that $WTP_1 + WTP_2 > WTP_{12}$ if $[q'_1, q'_2]$ are substitutes and $WTP_1 + WTP_2 < WTP_{12}$ if $[q'_1, q'_2]$ are complements. If projects q'_1 or q'_2 are valued independently, the willingness to pay amounts may not be different than willingness to pay for joint project, $WTP_1 = WTP_{12}$. Hoehn and Loomis (1993) empirically estimate an upward bias in independently valued substitute projects. This result is troubling if the projects are geographically related; for example, different wilderness areas (McFadden, 1994). Carson and Mitchell (1995) show that this result does not violate the non-satiation axiom of consumer theory if projects $[q'_1, q'_2]$ are perfect substitutes. Also, several applications using a variety of survey methods have found an absence of part–whole bias (Carson and Mitchell, 1995; Whitehead et al., 1998).

A related issue occurs with the sequential valuation of projects. Consider a three-part policy valued in two different sequences $A = [q'_1, q'_2, q'_3]$ and $B = [q'_2, q'_3, q'_1]$. The willingness to pay for q'_1 in sequence A when placed at the beginning of a series of three willingness to pay questions typically will be larger than in sequence B when the question is placed at the end. Independent valuation, in effect valuing at the beginning of a sequence, will always lead to the largest of the possible willingness to pay estimates. This result is expected for the value of public goods estimated with the CVM due to substitution and income effects (Hoehn and Randall, 1989; Carson et al., 1998).

The unanswered question is: If a benefit–cost analysis requires the comparison of the benefits of q'_1 to the costs of q'_1, should the willingness to pay estimate at the beginning, in the middle, or at the end of a valuation sequence be used? This question is not unique to the application of the CVM in benefit–cost analysis. In fact, sequencing effects are common with market goods (Randall and Hoehn, 1996). The answer is likely to depend on the set of policies that is anticipated and their timing.

4.4.4 Appropriate property rights

For many public goods, the implicit property right of the good is held by society or the government; that is, someone other than the respondent. In this case, it is appropriate to ask a willingness to pay question, which is essentially: How much would you give up in order to obtain something that someone else currently owns? The willingness to pay question does not change the implicit property rights of the resource.

For some types of policy the respondent holds the implicit property right. A reallocation of fishing or hunting rights will take a resource away from a group that historically perceives that it owns the right to fish or hunt. In this case, the willingness to pay question essentially asks: How much would you give up in order to avoid losing something that you already own? The willingness to pay question changes the property rights. This complicates the valuation process if the change in the property rights has an effect on the estimated value of the good through, say, protest responses.

Another approach is to ask a willingness to accept question: 'Would you be willing to accept $\$t$ for the decrement Δq?' The willingness to accept question does not alter the implicit property rights. Consider a representative individual who gains utility from a public good (Q) with no good substitutes. The willingness to accept (WTA) the decrement with utility associated with property rights to the unchanged public good and the willingness to pay to avoid the decrement with utility associated with the reduced public good are

$$\begin{aligned} v(Q'', y + WTA) &= v(Q, y) \\ v(Q'', y) &= v(Q, y - WTP). \end{aligned} \tag{4.23}$$

Randall and Stoll (1980) show that, when income effects are small (i.e., small WTA and WTP), willingness to pay and will be a close approximation of willingness to accept. Considering the indifference curves implied by the comparison of the indirect utility functions in $[y, Q]$ space, a sufficient amount of compensation of income (i.e., market goods) would leave the respondent no worse off than before the decrement in the public good. A number of empirical comparisons find, however, that willingness to accept significantly exceeds willingness to pay even with small income effects (e.g., Kahneman et al., 1990).

While the WTA–WTP divergence may be interpreted as an indication that the CVM is unsuitable for benefit–cost analysis under certain circumstances, the divergence can be explained. Hanemann (1991) shows that for a public good with no good substitutes, willingness to accept will exceed willingness to pay because willingness to accept is not income constrained. For a private good, for which there are good substitutes, willingness to accept and willingness to pay will not be different. Shogren et al. (1994) empirically demonstrate these results in a laboratory experiment. Other explanations exist for the WTA–WTP divergence. Carson et al. (1998) show that willingness to accept will be greater than willingness to pay when valued first in a sequence. Kolstad and Guzman (1999) argue that the divergence is due to the costs of information.

Although the WTA–WTP divergence can be theoretically understood, in application the willingness to accept question can be problematic. Willingness to accept questions often generate a large number of values that are not income constrained or with properties that do not conform to consumer theory. Primarily out of convenience, willingness to pay questions have been used when the willingness to accept question is theoretically more appropriate. In the context of benefit–cost analysis, using the willingness to pay to avoid the decrement in place of the willingness to accept question will provide a lower bound on willingness to accept (Carson et al., 1998).

4.5 Other issues

Next to discounting, questions of standing may be the most important to be decided in a benefit–cost analysis. Aggregating an average willingness to pay amount over two million instead of one million people will, obviously, double the aggregate benefits. Two examples highlight the problem. Most CVM applications choose to sample a narrow geographic or political region. If, in fact, the benefits of the project spill over regional boundaries, the narrowness will lead to an underestimate of benefits. Second, CVM survey response rates rarely achieve a level where extrapolation to the population of the sample average willingness to pay amount can be done without considering differences in respondent and non-respondent willingness to pay. Summing the sample average willingness to pay amount over the population, assuming respondent and non-respondent willingness to pay are equal, will tend to upwardly bias aggregate benefits for an improvement.

4.5.1 Geographic extent of the market

The geographic extent of the market may be the most overlooked issue in contingent valuation (Smith, 1993). Most CVM surveys sample local or regional areas such as states. The implicit assumption is that once a household is located on the other side of the border, its willingness to pay is zero.

A more plausible conjecture is that willingness to pay declines with distance from the resource. For example, the price of the recreation trip related to the policy-relevant quasi-public good is an increasing function of distance by construction: $p_1 = d_1 + \phi w(d_1/mph)$, where d_1 is the round trip distance from the resource, $0 > \phi > 1$, w is the wage rate, and mph is miles per hour. The effect of own-price (and distance from the resource) on willingness to pay is

$$\frac{\partial WTP_1}{\partial p_1} = \gamma x_1^m(\cdot, q_1) - x_1^m(\cdot, q_1') \tag{4.24}$$

where $x_1^m(\cdot)$ is the Marshallian demand function. The effect of the own-price on willingness to pay is the difference between Marshallian demands at different quality levels and is negative when $\gamma \to 1$, as expected (Whitehead, 1995).

The geographic extent of the market for the increment in q_1 is the distance such that $WTP_1 = 0$ and $x_1^m(\cdot, q_1) = x_1^m(\cdot, q_1')$. Whitehead et al. (1994) show how the effect of price on willingness to pay will change with the assumptions about the opportunity cost of time in the measurement of the price, and the omission of the prices of substitutes and complements in the empirical willingness to pay function. These results extend to the effects of price on the geographic definition of the market and suggest that the appropriate sample population for a CVM study that is focused on use values is one that includes all users and potential users of the resource. If q_1' is a quality improvement, the population to be sampled should extend beyond the range of current users of the resource to include potential future users with the quality improvement.

For non-use values, the own-price is irrelevant and distance may directly enter the expenditure function. Consider the non-use value for an endangered species of wildlife, say q_4, which is the willingness to pay to avoid the decrement, $q_4'' = 0$

$$\begin{aligned} NUV_4 = {} & e([\cdot, \bar{p}_4], [\cdot, q''_4 = 0], [\cdot, d_4], v(p, q, y)) \\ & - e([\cdot, \bar{p}_4], [\cdot, q_4], [\cdot, d_4], v(p, q, y)). \end{aligned} \tag{4.25}$$

The effect of distance on non-use value is negative

$$\frac{\partial NUV_4}{\partial d_4} = -\frac{\partial e}{\partial d_4} < 0 \tag{4.26}$$

if increasing distance from the resource increases expenditures necessary to reach the given utility. This result is plausible if information about the endangered species generates utility and the information is more costly to obtain the farther from the habitat or if consumers are parochial about species protection. Again, the geographical extent of the market is the distance such that $NUV_4 = 0$. In several empirical tests of this result, Loomis (2000) finds that non-use values decline with distance from the resource. For these public goods the sample should reflect that the geographic extent of the market is beyond *ad hoc* political boundaries.

4.5.2 Response rates and aggregation

Relatively few contingent valuation surveys achieve a response rate sufficient for aggregation over the population without major adjustments. While CVM surveys can achieve high response rates, these have fallen in recent years with the introduction of intensive telemarketing. Telephone survey samples routinely exclude the approximately 5 per cent of the population that do not own telephones or have unlisted numbers. In general, individuals who cannot afford phones may have lower willingness to pay for public goods. The non-response problem can be an even bigger issue with mail surveys, which tend to achieve response rates lower than telephone surveys, all else held constant. The relevant question for benefit–cost analysis is: 'Do survey non-respondents have standing?' Assigning full standing and aggregating over the entire population sampled when only, say, 50 per cent of the sample responded to the survey will lead to an overestimate of benefits if respondent willingness to pay is greater than non-respondent willingness to pay. Denying standing to non-respondents is sure to underestimate aggregate benefits. What value should be assigned to non-respondents?

Several empirical approaches for adjustment of sample average willingness to pay to non-respondents are available (Whitehead et al., 1993; Messonnier et al., 2000). If the sample suffers from non-response bias, the sample average willingness to pay values can be weighted on those observable characteristics for which the bias occurs. If the sample suffers from selection bias, the characteristics for which the bias occurs are unobservable. If demographic and other taste and preference information is available on non-respondents, econometric techniques can be used to adjust the sample average willingness to pay estimates to be representative of the population.

Unfortunately, information on non-respondents is typically not available and benefit–cost analysts are usually left with *ad hoc* adjustment procedures. An extreme adjustment procedure, offered by Mitchell and Carson (1989), is to alternatively assign non-respondents values of 0 per cent and 100 per cent of sample average willingness to pay to provide lower and upper bounds for true willingness to pay. This approach will lead to wide bounds at low response rates with diminishing bound widths as response rates rise (Dalecki, Whitehead, and Blomquist, 1993).

4.6 Conclusions

In this chapter we have argued that the contingent valuation method is a useful approach to estimating benefits or costs (lost benefits) for benefit–cost analysis. Relative to revealed preference methods, the CVM is more flexible, it can be used to estimate non-use values, and *ex ante* willingness to pay under demand and supply uncertainty. In many applications, the CVM is the only methodology that can be used due to the non-existence of related markets, large non-use values, or a significant amount of uncertainty about the outcome of the policy.

Researchers who adopt the CVM for their benefit–cost analysis should be aware of some of the methodological challenges. These include the potential for hypothetical bias, temporal bias, sensitivity of willingness to pay estimates to multi-part policy (i.e., sequencing), and the bias of a reliance on willingness to pay, relative to willingness to accept questions, when the appropriate property rights are held by the respondent. Hoehn and Randall (1987) define a 'satisfactory benefit–cost indicator' as one that does not overstate the present value of net benefits of policy. In other words, the CVM would help identify some, but not all, policies with present value of net benefits greater than zero and never falsely indicate positive present value of net benefits. Our review of the methodological challenges suggests that more methodological research is needed before we can conclude that the CVM estimates of willingness to pay are satisfactory benefit–cost indicators. If willingness to pay estimates suffer from hypothetical bias, temporal bias, or are valued independently, benefits may be overestimated. Willingness to pay estimates in these cases should be considered upper bounds in benefit–cost analysis and sensitivity analysis should be applied.

Increased attention must be paid to aggregation issues. A finely tuned sample average willingness to pay estimate inappropriately extrapolated to the population can swamp other standard problems in benefit–cost analyses. Aggregation issues do not fall under either the categories of advantages of using the CVM or methodological challenges. Aggregation issues are a concern with any benefit estimation methodology. However, the CVM relies on survey research methods that consistently lead to standard sample bias problems. The geographic extent of the market can be determined by sampling a larger geographic area than is typically considered and assessing the effect of own-price and/or distance on willingness to pay. When sample bias is a problem, standard survey research methods can be used to more accurately extrapolate sample average willingness to pay values to the population.

While CVM-derived benefit estimates abound in the literature, relatively few benefit–cost analyses using the CVM are readily available. Publication of more applied studies that place the CVM-derived willingness to pay estimates within the context of the benefit–cost analysis framework would shed some much needed light on the magnitude of the potential problems highlighted here (see, Chambers et al., 1998; Johnson and Whitehead, 2000). Policy relevant CVM research focusing on the parameters of a benefit–cost analysis would go beyond the traditional CVM research of split-sample hypothesis testing and development of new econometric estimators that reduce the variance of willingness to pay. We may find that biased willingness to pay estimates rarely lead to changes in the sign of the present value of net benefits of government policy or programs. If so, concern over statistically significant bias in willingness to pay estimates is less relevant for policy analysis. On the other hand, we may find that statistically significant bias in willingness to pay estimates may be a major concern when the CVM is implemented for benefit–cost analysis. In this case, more methodological research will be needed to make the CVM more useful for benefit–cost analysis.

In the context of the appropriateness of the CVM for natural resource damage assessment, Diamond and Hausman (1994) asked ‘is some number better than no number?’ Extending this question to benefit–cost analysis, we feel the answer is clearly ‘yes’ but ‘with caution’. We feel that ‘some number can be better than no number’ (Blomquist and Whitehead, 1995). The inevitable alternative to the use of the CVM in benefit–cost analysis for many important policy questions is a reliance on the subjective perceptions of decision makers about the benefits of policy or an imperfect political process. For many government projects and policies the CVM is a crucial and necessary component of benefit–cost analysis.

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