general population can be used to better understand changes in participation with policy. Also, contingent behavior questions can increase the cost-effectiveness of data collection. A revealed preference survey will often collect only one data point (e.g., number of trips within the past year). Contingent behavior questions can supplement the single revealed preference data point with one or more contingent behavior data points. More information from each respondent can lead to increased statistical precision of environmental benefit estimates.

John C. Whitehead

See also: Averting Behavior; Choice Experiments; Contingent Valuation; Nonmarket Valuation; Travel Cost Method

Further Reading

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Contingent Valuation

The contingent valuation method (CVM) is a stated preference, survey-based approach to the valuation of amenities and recreational and other behaviors related to environment and natural resources. The CVM is useful for estimating benefits and costs for environmental and natural resource policy analysis and benefit–cost analysis involving nonmarket goods and services. The CVM has been used for major policy analyses associated with the U.S. Clean Water Act, the U.S. Clean Air Act, and the Natural Resource Damage Assessment associated with the Exxon *Valdez* oil spill.

The CVM is one of the most flexible valuation approaches available to policy analysts. The foundation of the CVM approach is a version of the stylized value-elicitation question, "How much are you willing to pay for X?" CVM questions are posed as a hypothetical scenario. 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. The only constraint that application of the CVM imposes is that a realistic valuation scenario must be constructed around payment and delivery of the change in environmental quality. Policy analysis often requires valuation beyond the observable range of behavior. The CVM introduces the flexibility to value wide ranges of quality changes. 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.

Beyond flexibility, the CVM offers advantages over revealed preference methods in the types of values that can be measured. Willingness to pay is the total value of a policy change and can be decomposed into use and passive use values.

The CVM can be used 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, changes in the neighborhood of residence, or through changes in one's own health.

The components of a contingent valuation scenario include a description of the resource or policy context, a description of the policy or proposed change in resource allocation that will be valued, a payment vehicle and a payment rule. The description of the proposed policy should make explicit exactly what is being valued. A concrete scenario description allows each respondent to understand what good or service would be obtained in exchange for payment. Scenario descriptions must include the baseline level of environmental quality or natural resource allocation and changes to this baseline. These descriptions must be nonpersuasive and neutral.

The payment vehicle and payment rule are closely related. Payment vehicles are the way that respondents would actually pay for the change in resource allocation. Typical payment vehicles include increases in utility bills, increased taxes, increases in prices of related goods, user fees, and donations to special funds. The payment vehicle must be realistic, believable, and neutral. The payment rule makes explicit under what conditions the policy will be implemented. For quasi-public goods for which use is excludable, the payment rule is understood as payment of a fee for service or access. Respondents have little incentive to misrepresent their preferences. Payment rules for public goods are more complex. The payment rule for voluntary contributions is that if donations exceed the program costs then the program will be recommended for implementation. In this case respondents have at least a weak incentive to tell the truth. Since subsequent payment is not enforceable, people who want the policy tend to overstate their willingness to pay. The payment rule with a referendum is majority rule. If 50 percent or more of respondents vote for the policy then it will be recommended for implementation. In combination with an involuntary tax payment vehicle and if the survey is considered consequential there is little incentive for respondents to misrepresent their preferences. A consequential survey is one that has a nonzero probability of influencing policymakers.

Many early CVM applications asked the open-ended willingness to pay question. In practice, this question format is relatively difficult to answer, and respondents may adopt simple valuation strategies or anchor responses. The payment card question asks an open-ended question but provides dollar interval response categories from which respondents indicate the amount that most accurately reflects their maximum willingness to pay. This approach is prone to range bias. If another response category is included the average willingness to pay may change.

The earliest version of the closed-ended question was iterative bidding where everyone in the sample was asked for their willingness to pay a starting dollar amount. If the respondent answered "yes" they would be asked the question again

with a higher dollar amount. These questions would continue until the respondent answered "no." If the respondent answered "no" they would be asked the question again with a lower dollar amount until the respondent answered "yes." One problem with iterative bidding is starting point bias where the magnitude of the starting dollar amount influenced final willingness to pay

The dichotomous choice question (often called referendum style in the context of a referendum payment rule) is similar to an iterative bidding question but the starting point is varied across survey respondents and only a single question is asked. The advantage of the dichotomous choice question is that a single valuation question is relatively easy to answer. The major disadvantage is that the answers reveal only whether each respondent is willing to pay is above or below the dollar amount threshold and sophisticated statistical techniques are necessary to estimate the population distribution of willingness to pay.

Since the CVM is based on responses to hypothetical valuation questions, there have been concerns about the accuracy of value estimates. Accuracy of a measure of a theoretical construct (e.g., willingness to pay) is comprised of validity and reliability. Validity is the extent to which a valuation method generates a measure that is unbiased, that is, provides an estimate centered around the true value, if it were known. Reliability is the extent to which a valuation method consistently generates the same measure. While reliability can often be demonstrated through repetition and replication, validity is more difficult to demonstrate when valuing nonmarket goods and services. By their nature, the true value of nonmarket goods and services are unknown. A valid method for estimating these values is thus attempting to provide an unbiased estimate around an unknown and unobservable quantity. It is important that CVM studies demonstrate some degree of both validity and reliability.

Critics of CVM point to the hypothetical nature of the questions, the ability of practitioners to influence results through question format, statistical manipulation, and the often conflicting results on tests of validity as evidence of the inadmissibility of CVM-derived values into policy analysis.

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See also: Benefit–Cost Analysis; Choice Experiments; Contingent Behavior; Experimental Methods and Valuation; Exxon *Valdez* Oil Spill; NOAA Panel on Contingent Valuation; Nonmarket Valuation; Passive Use Value; Welfare

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Corporate Average Fuel Economy

Following the energy crisis of 1973, the U.S. Congress established Corporate Average Fuel Efficiency (CAFE) standards via the U.S. Energy Policy and Conservation Act of 1975 (PL94-163). The National Highway Traffic Safety Administration (NHTSA) was given the authority to determine the average standards for fuel efficiency that U.S. car and light-duty truck (pick-up trucks, minivans, sport utility vehicles up to 8,500 lb gross vehicle weight) manufacturers must meet based on four statutory criteria: (1) technological feasibility; (2) economic practicability; (3) the effect of other federal standards upon fuel economy; and (4) the need for the nation to conserve energy. The intent was to reduce fossil fuel (petroleum) consumption of cars and light trucks by increasing their fuel efficiency.

The CAFE regulations have been updated in response to new congressional laws that broaden U.S. Environmental Protection Agency's (EPA) authority to regulate greenhouse gases (GHGs). EPA was given authority to regulate GHG emissions after the Supreme Court's 2007 *Massachusetts et al. versus the EPA* decision that GHGs are air pollutants covered by the Clean Air Act (549 US 497). Following this decision, in 2009 the EPA administrator signed two findings: (1) the endangerment finding stating that the administrator had determined that the current and projected concentrations of GHGs threaten public health and welfare and (2) the combined emissions of these GHGs from new motor vehicles and new motor vehicle engines contribute to the GHG pollution. Because the primary method to reduce GHGs from vehicles is through improvements in fuel economy, EPA's authority to regulate GHGs is closely related to NHTSA's regulation of vehicle fuel economy. The transportation sector, as a whole, was responsible for 27 percent U.S. GHG (31% CO_2) emissions in 2010. The on-road sector (cars, motorcycles, trucks, and buses) makes up 84 percent of this total.

The EPA and NHTSA now develop harmonized fuel economy and GHG standards. Thus, CAFE regulations, which had an initial justification and focus on energy security and fuel savings, are coordinated with standards for nonfuel economy GHG emissions from such additional factors as air conditional coolants (hydrofluorocarbons) and efficiency factors.