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Chapter 2

Valuation of non-market environmental goods and services

Introduction

Environmental goods and services are shown as amenities having impact on an individual's welfare. Some are goods and services in the traditional economic sense, for instance, food, timber, recreation, materials and technology. Such goods and services enter the market place where demand and supply forces determine their price. Markets can be local, national and international. When environmental goods and services are traded, their valuation is done in international prices using the exchange rate of countries involved. Valuation of marketed goods is less complicated because markets reveal information about supply of, and demand for, these goods and services.

Many environmental goods and services, however, lack characteristics of private, tradeable commodities. Examples are coral reefs, sea, beaches, rivers, wetlands, mangroves, watersheds, clean air and freshwater. These goods and services carry with them values which cannot be easily quantified using the formula of the marketplace. This is because both demand and supply are ambiguous. Nature provides these environmental facilities for which production processes remain unknown. Moreover, markets for these amenities are often non-existent. It is only through the users' perceptions that some monetary value can be put on these facilities. We call them non-market environmental resources.

The value of non-market environmental resources is adversely affected due to human intervention and economic activities such as manufacturing, farming, transportation and tourism. So, while valuation of stock and flow of these resources is important, valuation of loss of such resources is equally important. For example, smoke and noise pollution created by automobiles run by fossil fuels degrade the quality of environmental resources. If carbon emissions are traded in the market, it will be less difficult to evaluate decline in environmental quality due to automotive pollution. Strictly speaking, it is not carbon emissions that are traded but a corresponding value of the clean air 'equivalent' that has been lost. The value of this loss can be imputed from the market price of the 'pollution permit' that polluters are willing to pay.

Real world markets for environmental quality are, however, rarely found. Thus, while supply of pollution is spontaneous, demand remains ambiguous. In other words, there is a virtual demand, which is forced upon others. Depending upon the intensity of preferences for clean air, charges may be devised in the form of fees and taxes and levied on polluters. Revenue generated from these charges can be spent on pollution abatement, which is expected to compensate for the loss of clean air. The setting of an optimum charge would require that policy-makers be able to ascertain affected parties' and polluters' preferences for the environment.

Valuation of non-market environmental goods and services constitutes a major area of investigation in environmental and resource economics. This chapter aims at analysing different methods of assigning monetary value to such goods and services. Before attempting to compare different methodologies and case studies along with their limitations, the usefulness of undertaking valuation of these resources is discussed. A case is made as to why there is a need for placing a number on non-use and non-market values of such public goods.

Why place a value on environmental goods and services?

Sustainable development, which would ensure quality of life, requires that depletion, damage and depreciation of the environment be measured. Real and sustainable growth rate calculations would need information on depreciation of physical as well as natural capital. In conventional calculations, only depreciation of physical capital is considered. But it is important to note that the use of the environment in the production or for enjoyment by societies will lead to environmental degradation and thereby depreciate the natural capital. Since the resources emanating from natural capital are used in the production of goods and services, their degradation will eventually limit a country's growth and welfare performance. To put it technically, while an economy produces GDP, the planet produces photosynthetic product (PPP). The latter contributes to the production of GDP. As GDP increases, PPP would tend to depreciate. If depreciation of the PPP is not addressed, GDP growth in the future is likely to be compromised.

Society has limited resources to allocate over projects to meet the objectives of economic growth, poverty alleviation and environmental conservation. These objectives can also be conflicting. For example, construction of dams for irrigation and agricultural development may conflict with the preservation of natural wildlife areas. Valuation of natural resources is vital to show their potential contribution to economic growth and ecological balance. In the absence of such information, environmental objectives will always be undermined by the supremacy of other social and economic objectives.

Valuation of existing environmental resources in the present and in the future (inter-temporal valuation of environmental resources) is important for taking decisions regarding environmental conservation for future generations. Some of these decisions can be highly desirable when it comes to the use of exhaustible natural resources, which cannot be reproduced and therefore must be preserved.

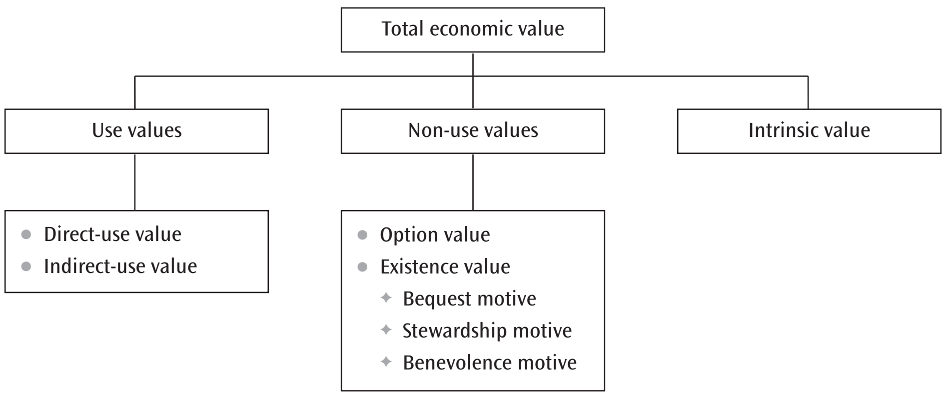
Valuation of environmental goods and services provides information on total and lost values of such resources. This is one of the crucial exercises in environmental accounting. These calculations are further utilised in building green national income accounts following the United Nations System of National Income Accounts (UNSNA), by taking into consideration damages to the environment.

Valuation is also essential to implement the ‘polluter pays’ principle. The essence of this principle is to shift the responsibility of environmental degradation from the government (or general taxpayers) to entities producing the damage. Thus, those who are responsible for pollution should bear the cost of that damage. One such method is to implement a pollution tax. The issue of a tax on international tourists who contribute to environmental degradation during their stay in a tourist destination is discussed in Chapter 10. These tourists pay for the private goods and services but generally it is difficult to tax them for the use of environmental public goods and services (scenery, forests and wetlands, pyramids, pollution created by congestion on the road and sea beaches, etc.). To impose any tax to recover the social cost generated by them, there will be a need to value the damages and calculate the external marginal cost. In other words, implementation of environmental taxes would require valuation of environmental goods and services.

Which values are relevant for environmental governance?

The environment can be a source of welfare to different individuals and in various ways. For instance, a forest can simultaneously provide timber for loggers, ecosystem services for the local community, genetic resources for pharmaceutical companies and also serve as carbon sinks for global carbon dioxide emissions. A taxonomy of different concepts of environmental values relevant for policy analyses is presented in Figure 2.1. Total economic value encompasses direct-use value, indirect-use value, non-use value and intrinsic value. Use values are the more direct and quantifiable environmental values. Examples are products (e.g. edible, ornamental, medicinal and inputs into production process), recreation, research and education (for a good description of different environmental values, see NOAA Coastal Services Centre Website, 2007; Spurgeon, 1998).

Figure 2.1. Concepts of environmental values



Indirect-use values associated with coastal areas include biological support (species and habitat), physical support (coastal defence function), climate modulation, and global life support functions that aid in supporting life on the Earth. These values are extremely difficult to measure and continue to be an area of professional challenge to scientists and economists. In many cases, there is a need for international co-operation and scientific information-sharing among nations.

Non-use values are less direct, less tangible benefits to society and include option and existence values. The option value is the value an individual places on the future use of the resource, for example, benefits a beach would offer during future trips to the coastal area. Existence values include bequest, stewardship and benevolent motives. Bequest value is the satisfaction gained through the ability to endow a natural resource on future generations. The stewardship motive is derived from an altruistic sense of responsibility towards the preservation of the environment and a desire to reduce environmental degradation. The benevolence motive reflects the desire to conserve an environmental resource for potential use by others.

Box 2.1.

Economic value of clean air and water, quality of atmosphere and climate.

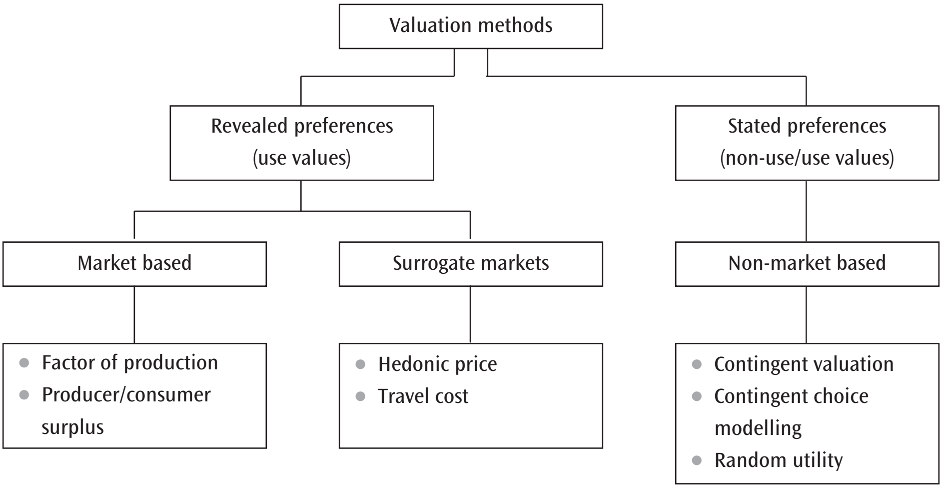
The value of these environmental goods and services can be defined in terms of the opportunity cost that would arise in the absence of such life-supporting natural functions. From this angle, the total economic value of these environmental forces is immeasurably large because extreme degradation of either would result in irreversible and catastrophic damage to the capacity of this planet to support human and other life. Thus, by polluting these natural systems within a limit, an attempt is made to reduce such opportunity costs.

Good examples of existence value are Antarctic glaciers and Amazonian rain forests. As pointed out earlier, if we ask people to contribute some money for the preservation of these environmental assets, there is high probability that many of them would show some willingness to pay, although they may never visit these places. The only justification is that they would need these assets to exist. It is also a good example of intrinsic value of nature that reflects the belief that all living organisms are valuable regardless of the monetary value placed on them by society.

Methods of valuing non-market environmental resources

Economists have devised different techniques to measure the economic value of an environmental asset. Monetary values can be derived based on information collected from individuals benefiting from environmental resources. Individuals will reveal their preference for an environmental good or service either in real or hypothetical market conditions. In market conditions, they reveal their willingness to pay for gains from an environmental resource in actual transactions. In non-market or hypothetical market conditions, they reveal their willingness to pay (WTP) for environmental gains as well as their willingness to accept compensation (WTA) for environmental losses due to degradation. The two methods are also called 'revealed preference method' (market based) and 'stated preference method' (non-market based), respectively (See Figure 2.2).

Figure 2.2. Environmental valuation methods



Market-based methods

- **Factor of production approach**

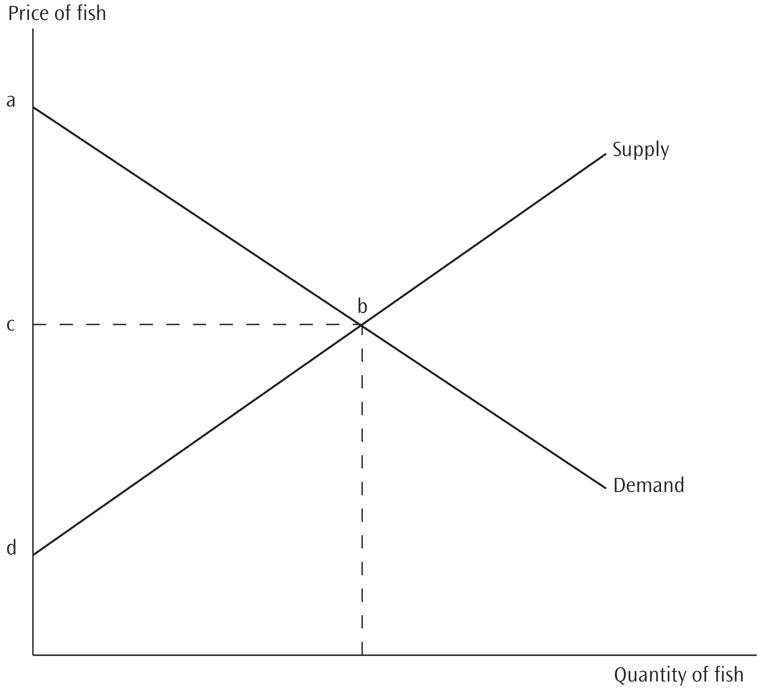
The value of an environmental resource can be monetised based on its value as an input like other material inputs. When a resource has a direct value as a factor of production and it can be obtained from market sources, it may be straightforward to know its value. Similarly, when the impact of environmental degradation on future output using that resource can be measured, the estimated value of the decline in output or higher cost of production can be obtained. This loss would be borne by the producer or the polluter depending on the situation. But this method is applicable to those situations where output can be traded in domestic or international markets.

- **Producer/consumer surplus approach**

When the product using an environmental resource is sold in markets, there is an alternative way to capture the impact of changes in environmental quality and the resultant gain or loss due to that asset. In this method, net economic benefit is calculated by taking into account producer surplus and consumer surplus of a sale. Consumer surplus is the difference between what a customer is willing to pay and what she actually pays. It is represented by area abc in Figure 2.3. On the other hand, producer surplus is the difference between what a producer is paid for fish and what it costs to produce, that is, area bcd in Figure 2.3.

Imagine an open access resource such as a coastal area with a rich fish population. Now the fish biodiversity of the coastal zone declines due to increased tourism and fishing. The degraded fish habitat reduces the rate of fish catch. This will have an impact on producer and consumer surplus. To ascertain the impact of decline in environmental quality on producer and consumer surplus, econometric investigations can be carried out with selected variables and increased fishing (Lipton et al., 1995). The negative impact of fish habitat degradation on total economic value (consumer and producer surplus) would indicate value forgone, which is a measure of economic value of environmental resource.

Figure 2.3. Producer and consumer surplus in the fish market



Surrogate-market methods

In the surrogate-market method, an attempt is made to capture the impact of environmental resources in terms of value created that is capitalised in the values of properties and picnic spots in different geographical regions. The two interesting methods that are used in this approach are hedonic price method (HCM) and travel cost method (TCM).

- **Hedonic price method**

Housing and property markets are typical examples. There is no market for different types of good and bad environmental amenities. But their value is camouflaged in the value of houses and properties. High quality of air and water is supplied by nature. Similarly, polluters supply polluted air and contaminated water. The high and low value of such environmental features cannot be assessed separately. However, since these features are reflected in the value of properties, properly specified hedonic functions can help ascertain values of such environmental resources. Similar houses in two localities with different environmental attributes will fetch two different prices. The difference in housing prices under different environmental features can be used as a measure of the value of environmental resources.

The price of a house close to an airport must be lower than that of another house which is not affected by noise pollution. The price difference can be attributed to noise pollution. If the airport was built after the housing colony, legal property rights may allow for compensation payable to house owners from an airport authority. House owners may, however, get compensation to keep quiet, or accept the noise pollution level to the extent of price difference with respect to houses not affected by this pollution, and the airport continues its operations.

A properly specified hedonic price function can be estimated econometrically in which different environmental qualities can be used as separate arguments to estimate their separate values (see example in Box 2.2).

Box 2.2. Amenity value of an urban forest

Tyrväinen (1997) estimated the effects of urban forests on property prices in Joensuu town, Finland. A hedonic price model was formulated as follows:

$P = f(A_i, L_i, E_i)$

where P represents the price of apartment i, **A** is a vector of apartment characteristics such as size, age and type, **L** is a vector of locality attributes including accessibility to town, school and shops and **E** is a vector of environmental characteristics describing environmental quality in the housing district, namely accessibility to watercourse, recreation areas and relative amount of green spaces. The author estimated the above model using property prices of 1,006 apartments and finds that the variables describing urban forest benefits generally had the *a priori* expected sign and had a positive and significant influence on apartment price. On average, the amount of forested areas in the housing area as well as nearness to watercourses and recreation areas increased apartment prices. Thus, the findings indicate that maintenance of urban forests are capitalised into house prices. The model further enables us to estimate the economic impacts of land use changes in that area.

This information can also be used to know people's willingness to pay for high or low environmental quality. It is important to note that the reliability of such estimates will depend upon the proper specification of hedonic price function, the quality of data that are obtained from market and non-market sources and the method of estimation. Estimates can be sensitive to the method and sample used.

- **Travel-cost method (TCM)**

This method is employed extensively in the literature to place a value on environmental goods and services located at recreational sites and in natural parks (see example in Box 2.3). TCM is suitable to value resources for which significant costs have to be incurred to visit them. Expenditure by different travellers is used as an estimate of willingness to pay for those environmental assets. A central assumption is that of weak complementarity between travel costs to visit a site and utility derived from environmental goods and services at that location. Thus, if people do not visit a site, TCM would attribute a value of zero to environmental assets on the site. In this way, existence value and other non-use values are not captured.

Box 2.3. Measuring economic value of viewing elephants

Brown (1993) used TCM to estimate the benefits of safaris and derived from there the value of viewing elephants that was over and above the travel costs. It was found that viewing elephants was a source of 12.6 per cent of the total value of the trip – equivalent to US$23–27 million. By demonstrating the economic loss associated with declines in elephant population, the results were used to marshal resources necessary to reduce poaching.

Costs of travel comprise distance costs (e.g. petrol and depreciation of vehicle), on-site expenditures and time cost (i.e. opportunity costs of visiting the site). Data on the number of trips made and travel costs are collected by surveying visitors to a recreational site. An implicit demand curve for a recreational site can be generated by examining the relationship between travel costs incurred and total number of trips taken by visitors in different expenditure categories. Once a demand curve is traceable, it will be easy to calculate the consumer surplus and value of that site.

Econometric estimations of trip functions in which cost of travel are arguments can give an idea of the demand for environment (visits to the site) as the cost of travel rises. A well-specified demand curve should, however, also include income and other socio-economic determinants, such as level of education, age and household size. Availability and attributes of substitute sites may also be important, having impact on the frequency of visits. A typical trip generating function (to a recreational site) can be postulated as follows:

> No. of visits = f (cost of travel, income, socio-economic variables determining demand for environmental assets/services, attributes of substitute sites)

Limitations of this approach having impact on the reliability of WTP estimates include multipurpose visits to a site (i.e. enjoying the environment is not the sole reason of visit to a site), choice of functional form, measurement issues (e.g. estimating time cost is difficult), and other econometric problems. Moreover, like the hedonic price method, TCM is unable to estimate non-use values, which can be important for many environmental goods and services. When this is the case, stated preference techniques of valuation are preferred.

Hypothetical-market methods

Optimum allocation of resources to various purposes requires that the external benefits and costs associated with any policy change are adequately taken into account. While market forces facilitate allocation of resources to private goods and services, such allocation mechanisms are generally absent in the case of environmental public goods and services. Public and environmental economists attempt to undertake such tasks by creating market-type conditions to collect requisite data about environmental resources. Such valuation methods are discussed below with their policy implications.

- **Contingent valuation methodology (CVM)**

Contingent valuation of environmental resources is a most popular method involving the use of surveys and interviews to obtain information about monetary values of environmental assets and associated policy changes. It is different from other survey methods where individuals are faced with actual situations. In contingent valuation, respondents are asked to state their preferences in terms of willingness to pay (WTP) for an improvement in quality of the environment or willingness to accept compensation (WTA) for accepting a deterioration. The entire procedure involves the simulation of a hypothetical market situation and solicits individuals to express WTP/WTA, contingent upon the market described to them.

CVM is most suitable for valuing environmental goods and services having non-use values, namely existence value, option value and bequest value. Some of these resources are within the reach of individuals while other environmental assets are valuable for their existence even if they cannot be visited (e.g. Antarctic glaciers). The fundamental assumption is that the value of all goods can be expressed in money-equivalent terms and value is based on goods giving utility to users. Thus, there are three important assumptions: that utility functions exist; that these utility functions can value non-market goods in rank order; and that these value rankings of non-market goods can be empirically identified.

The target population of interest is identified and respondents are randomly selected. A questionnaire is employed as a survey instrument to elicit respondents' willingness to pay for an improvement or willingness to accept a compensation for a decline in environmental quality, WTP or WTA, which are expressed in monetary terms only. Even 'Yes' and 'No' answers are automatically converted into monetary values.

There is an ongoing theoretical debate concerning the use of WTP versus WTA as the most appropriate valuation method for non-market goods (see Venkatachalam, 2004 for an extensive review of the literature). In theory, these two values should converge. However, a large disparity is found to exist with WTA being significantly greater then WTP. This is attributed to the income effect where a respondent's budget constraint becomes binding when she states her WTP whereas it is not binding when accepting compensation. Hanemann (1991) further shows that for some environmental amenities, such as the Grand Canyon, even if income is held constant, absence of close substitutes would cause WTP and WTA to diverge. This is the substitution effect. WTA also often results in unrealistically high bids when interviewees insist that the loss is priceless. Consequently, most CVM practitioners use the lower but more feasible WTP.

The questionnaire to elicit respondents' WTP or WTA can be mailed, directly served to respondents or administered by phone. Bidding questions can take the following forms: open ended, referendum, payment card and bidding game. In an open-ended question, the respondent is asked to state his maximum willingness to pay (MWTP) for the improved quality of the environment. Referendum or dichotomous choice format presents the respondent with a bid choice that she can accept or reject. Payment card is another commonly used alternative in CVM where the respondent has to choose one of the stated bids on the card. The last technique is a bidding game in which bids are offered in sequence so that the respondent's maximum bid is finally known (such as, would you accept $20? If yes, would you accept $30? If the respondent answers no to the last question, then MWTP is inferred to be $20).

The bidding vehicle has to be clearly stated in the questionnaire. It can be a tax or a fee levied by the government, a private body or an NGO; or alternatively, a voluntary contribution to some organisation for preserving nature. The vehicle selected should be generally uncontroversial for a successful CVM. This can be elicited during preliminary research through trials with focus groups. These groups would yield information about respondents' knowledge about the issue studied, their beliefs, and the credibility of the hypothetical scenario presented. The survey questionnaire can be refined using inputs from the pilot survey(s) before a final version is ready for implementation.

The collected data are econometrically treated. WTP/WTA functions are postulated and estimates of mean and median willingness to pay for improvement or willingness to accept compensation for deterioration are obtained. WTP functions are also able to capture the effects of socio-economic factors like income, age, household size, education and rural/urban location. Aggregation of mean WTP would approximate total population values.

Limitations of CVM results for policy analysis

Because CVM relies on the stated preference of individuals rather than actual revealed behaviour, WTP/WTA values generated using this method are often the subjects of controversy. Biases introduced at different stages of the survey or through respondent's strategic behaviour could adversely impact the precision, credibility and reliability of the WTP estimates (Diamond and Hausman, 1994). These biases have to be addressed when designing the survey (see application in Box 2.4; also, Mitchell and Carson, 1989 for a good treatment of this issue and recommendations to improve reliability of CVM results).

Strategic bias can occur where the respondents may believe that their response will be used for some change in policy and they under-estimate or over-estimate their willingness to pay to achieve their desired objective. In other words, the respondent's stated value may have little relation with his/her WTP or WTA. A similar situation arises when respondents feel too good or too bad while thinking of paying for a public good. For instance, a participant may state a high value because he feels a 'warm glow' from expressing concerns about the environment. In this case, since WTP responses reflect general attitudes rather than true economic preferences for the environmental good, the values are likely to be insensitive to scope (Kahnemann and Knetsch, 1992). For example, stated WTP to save 100 turtles is the same as that to save 10,000 turtles.

The hypothetical nature of CVM also poses significant challenges when respondents do not correctly understand the good being valued or cannot accurately state WTP in monetary terms. Information bias arises when respondents have to express their opinion on something about which they do not know enough. Lack of information and misconceptions about environmental quality can result in such biases. Moreover, there are situations when respondents indicate the same willingness to pay for avoiding degradation of whole or part of the environmental asset. That is, they feel concerned about the total damage. This is called the 'embedded effect'.

Box 2.4. An application of CVM to subsidise clean technology in agriculture

Hite et al. (2002) conducted a contingent valuation survey in Mississippi to assess public willingness to pay (WTP) for a subsidy to agricultural producers for the adoption of variable-rate technology (VRT) to reduce agricultural pollution of freshwater. Producers were generally reluctant to adopt this technology given high fixed cost and uncertain impact on profitability.

Methodology

Single price referendum contingent valuation (CV) was used to elicit public willingness to pay a one-time tax to subsidise agricultural producers' cost of purchasing VRT equipment.

To provide a framework for the valuation question, respondents were informed about current water quality in Mississippi.

Versions of the questionnaire assumed 10 per cent and 20 per cent levels of pollution reduction in order to test for scope bias. A 10 per cent reduction suggested by simulation studies was used as a baseline. Respondents at all price levels were randomly assigned 10 per cent and 20 per cent abatement levels and were asked to vote for a bid runoff pair consisting of a one-time tax payment and a runoff reduction percentage (e.g. $50 tax and 10 per cent runoff reduction, $50 and 20 per cent runoff reduction, etc.). The possible answers to the WTP question were 'Yes', 'No' and 'Don't know'.

The referendum prices in the survey were based on estimates of the cost of implementing the VRT adoption programme divided by the number of individual taxpayers ($25, $50, $100 and $150). The authors chose telephone surveys as the administration method following a very low response rate from mail surveys. Pre-test analyses were conducted to evaluate respondents' understanding of questions. The survey sample consisted of 1,024 respondents with a response rate of 79%. The data for the two levels of abatement (10 per cent and 20%) were segmented into two sub-samples.

The exercise passed scope tests: WTP for 20 per cent abatement level was found to be significantly greater than WTP for 10 per cent abatement level. This suggested that the survey was successful in the programme benefits of incremental water quality to respondents. Because of the dichotomous nature of the dependent variable (WTP =1 if answer to bid question is 'Yes' and WTP = 0 if the answer is 'No' or 'Don't know'), a probability model (probit) was specified to obtain estimates of WTP. Control variables in the model include beliefs about the impact of agriculture on water quality and biodiversity, as well as socio-economic and demographic variables. The effective sample was reduced to 762 because of non-response on certain explanatory variables.

Results and policy implications

Results show positive and significant impacts of the following attitudinal factors on WTP for subsidising the pollution reduction technology: beliefs that agricultural practices result in pollution (AG_POL), beliefs that agricultural practices reduce biodiversity (AG_BIO), and that technology can be used to achieve cleaner environment (BLV_TECH). WTP was also found to be higher for people having very important environmental concerns (captured by variable ENV_GOAL). The estimated WTP from the study ranges from $52 million to $122 million. This finding suggests that the subsidy could cover a sizeable proportion of the programme's cost thereby providing incentives to agricultural producers to adopt this precision technology.

Biases due to subjectivity are more prominent when people have to choose between present use and future use of environmental resources. Respondents may distort their willingness to pay for improvements benefiting future generations due to uncertain future. Such biases are generally present when the objective is to generate existence value, option value and bequest value.

Another important bias is introduced when respondents are asked about their preference for payment vehicle. For example, they may be averse to certain taxes and fees, and they may have a preference for local government as against central government. These issues have to be addressed during the pre-testing stages of the questionnaire so as to come up with a vehicle that is acceptable to most people. If vehicle bias is still suspected, different sub-samples may be used and presented with alternative vehicle scenarios but the same bidding amounts. Significant differences in WTP between the samples would imply sensitivity to vehicle scenarios used, rendering the estimates unreliable.

Whittington (1998) argues that a good CV scenario must be designed to appear realistic for respondents to take the 'hypothetical' choice seriously. In practice, the more seriously a respondent considers the choice posed, the less hypothetical the scenario is likely to seem. This is particularly true for goods and services with large use values that are commonly provided by the government such as infrastructure services. Moreover, if different sub-samples are given different hypothetical prices in order to improve the reliability of responses, it may create confusion that differential prices would be charged for the same amount of public services. If this is the case, then the whole purpose of contingent valuation is defeated.

There is another criticism from non-economists, namely sociologists and anthropologists, that researchers extract data from respondents and give them nothing in return. The solution to this problem is not simple. Whether payments to respondents will increase co-operation or improve quality of results is not known. But payments to respondents will definitely complicate the choice of respondents and may hamper smooth administration of survey designs. The issue of payments to subjects is simple in market and business surveys but researchers in the field of public policy and administration generally lack funds for their projects.

To address the methodological challenges of CVM, the NOAA guidelines (Arrow et al., 1993) provide the following suggestions to improve the quality of responses:

- **i** face-to-face interviews are better than other methods;
- **ii** WTP estimates to prevent a future incident are better than WTA for an incident that has already happened;
- **iii** a dichotomous choice referendum is less vulnerable to strategic bidding behaviour than, for example, an open-ended elicitation format;
- **iv** it is preferable to present an accurate and understandable description of the programme or policy under consideration and the associated environmental benefits in each of the two scenarios, that is, with and without the policy;
- **v** an effort should be made to make such a hypothetical exercise resemble as closely as possible an actual market transaction; and
- **vi** a follow-up exercise should be done to ensure that respondents understood the questions and choices well.

Contingent choice and random utility models

When one-shot responses are not sufficient as in CVM and when several alternatives and trade-offs are involved, the contingent choice method (CCM), also known as co-joint analysis, is preferable. Respondents are asked to choose from among different alternatives of environmental goods and services in a simulated or hypothetical market. Each alternative is a package of different environmental characteristics and payments. Thus, choice experiments assign independent values to the individual attributes of an environmental policy or programme. The emphasis on examining the different attributes of a project avoids the possibility of overstating WTP in a simulated market and focuses attention on what really matters to the respondents.

Box 2.5. Contingent choice modelling of community water management

Choice experiments were applied to the assessment of water supply options for the Australian Capital Territory (ACT). The objective of the ACT choice experiment study was to examine community preferences relating to various options for supply water necessary to meet the demands for the area's growing population, while focusing attention on resultant environmental costs (Blamey et al., 1999). The study examined five options, including damming, water recycling, and demand management, and assessed community preferences relative to (a) water availability for household use, (b) water quality, (c) cost of water to household, (d) impact on the aquatic and riparian environment, and (e) maintenance of animal habitat. By examining the attributes associated with water supply options rather than the options themselves, the study was able to avoid 'hot-button' emotional responses to damming and focus on what actually mattered to respondents. Based on the application of the choice experiment approach, a combined demand management/water recycling approach was designated as the preferred option.

Source: http://www.csc.noaa.gov/coastal/economics/envvaluation.htm

In this method, the environment is treated like any other commodity and its value is broken down into many attributes. For example, a coastal area is partitioned into beaches, sea view, fish, crabs, recreation and bird watching and willingness to pay for upgrading the coastal zone can be ascertained by knowing respondents' preferences for these attributes. There are several alternative formats to carry out contingent choice analysis. Contingent ranking requires ranking of alternatives; paired rating involves comparing two alternatives and rating them in terms of strength of preference; and discrete choice involves choosing the most favoured one among all alternatives. Since price is one of the characteristics of the alternatives, the choices are easily converted into a monetary measure of willingness to pay.

It may be noted that derivation of WTP from the data collected through contingent choices is relatively difficult. Discrete choice analysis encompassing sophisticated experimental design techniques and statistical procedures helps to analyse the data and determine WTP. In this way, CCM is a more powerful technique that can be applied to valuing environmental goods irrespective of whether they are marketed or not. But the complexity of this method would increase exponentially when alternatives and trade-offs start multiplying.

Random utility models (RUM) are econometric models that permit the estimation of preferences for different recreational sites with varying characteristics. Consider three beaches with different characteristics in terms of location, water quality, landscape, access, and wash facilities. These characteristics can be transformed into discrete and continuous variables and are used to assess consumer preferences by examining location preferences and the total costs of trips taken. Different sites are surveyed and collected data are utilised in RUM to estimate probability that an individual will visit one site out of three sites based on their characteristics. By varying the quality of those characteristics, an analyst can assess how recreational visitors value changes in environmental quality at particular sites.

The benefit transfer or comparison method
Sometimes when there is little time to conduct a study or when the expenses involved are exorbitant, the results of similar studies in similar locations or cases can be utilised as a quick reference point. The underlying assumption is that costs and benefits and utility functions of affected parties are either similar or comparable. If these assumptions are not satisfied, the estimates may not yield the desired results. Nevertheless, this method may offer some benchmark estimates of the significance and benefits of environmental resources, called 'priors'. These 'priors' can be modified in the light of new information yielding the 'posterior' values of crucial significance for environmental valuation.

Defensive expenditure as an alternative to valuation of damages

Most proposals of environmental accounts, including the system of integrated environmental and economic accounts, suggest that environmental degradation should be measured by obtaining estimates of restoration costs rather than by attempting to quantify the effects of degradation (Harrison, 1993). Feather et al. (1995) discuss the significance of defensive expenditures to prevent or counteract the adverse effects of environmental degradation. Actual defensive or preventive expenditure methods can be employed to measure restoration costs to maintain the environment. The requisite information for environmental preservation can be obtained from budgetary sources when costs are incurred by the public sector and from project files under the management of corporations and private agencies.

It is argued that there will be an element of arbitrariness in the mandated government expenditures since these may reflect built-in biases in government's judgement about the net benefits of restoration. But there can be operational strengths on the implementation front because such expenditures are usually project based and therefore more focused. Examples include beach nourishment, replanting seagrasses, and water purification devices. These projects have the explicit objective of reviving the environmental quality in the affected areas. Estimates of defensive expenditures can be derived from costs of replacement or restoration of total or parts of facilities.

Summing up

What is important to note here is that valuing environmental benefits and costs is not a simple exercise. There are economic, ecological and social dimensions of environmental dynamics, which have local, national and international consequences. Restoration expenditures make the life of decision-makers comfortable because some expenditure levels would emerge out of the budgetary process. But these expenditures should have some relation to benefits that it will generate or will restore benefits that would have been forgone. This simply means that there should be some value against which it is possible to feel bad when we degrade a natural resource.

This chapter has discussed different methods of valuing goods and services that do not enter into markets. In such cases, it is difficult to know the demand and supply processes which play important roles in the determination of prices and values. Researchers use different methods to put a number on the non-market values of environmental goods and services but contingent valuation and contingent choice methodologies are more popular. These are survey techniques which are carried out very scientifically and then collected data are analysed with the help of econometric tools and empirical methodologies.

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