5. Environmental Valuation

Objectives

After studying this chapter you should be in a position to:

- explain the various types of non-market values associated with environmental goods and services;
- explain various techniques for estimating non-market values;
- explain the limitations of these techniques; and
- implement the travel cost method.

5.1 Introduction

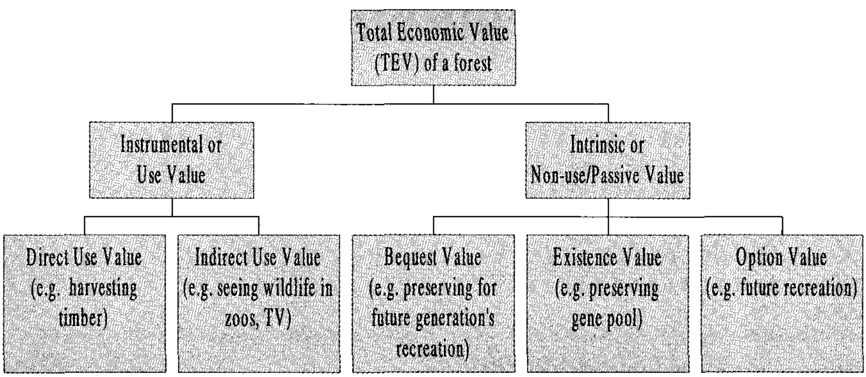
The proper valuation of non-market environmental commodities has significant policy implications. In the past such commodities have been assigned zero or low values due to difficulties involved in assigning economic values. Failure to properly account for the values of some environmental resources has resulted in decisions that have had negative implications for the environment and the society. Environmental valuation is also important in the event of natural disasters, either man-made or naturally occurring. A recent example is the Exxon Valdez oil spill in Alaska. In a landmark case the United States Supreme Court ruled that the people of Alaska should be compensated for their loss of livelihood and recreation as a result of the accident. As most of the lost benefits were non-market in nature, conventional market techniques could not be used.

This chapter begins with a description of the types of non-market values associated with a given environmental resource. The chapter then proceeds to describe a range of techniques for valuing non-market environmental commodities. A summary of the main points is provided at the end.

5.2 Types of Economic Values

Whenever we think of a resource, say a forest, the value that immediately comes to mind is the utility that we derive from direct uses (e.g., timber harvesting, and recreation). However, there is a range of values that is associated with a natural resource such as a forest. The **total economic value** (TEV) of a natural resource can be divided into two broad categories: **instrumental** or **use value**, and **intrinsic** or **non-use** (or **passive use**) **value** (Figure 5.1). Use values, which are most commonly known, refer to the capacity of a good or service to satisfy our needs or preferences. Use values can be further divided into **direct value** and **indirect use value**.

Figure 5.1 A taxonomy of economic values



Direct use values consist of **consumptive uses** such as timber harvesting and **non-consumptive uses** such as camping, hiking and birdwatching. Indirect use values include environmental services such as maintenance of the hydrological system, climatic stabilization (e.g., carbon fixing) and soil stabilization.

Intrinsic or non-use values, as the name suggests, are inherent in the good. That is, the satisfaction we derive from the good is not related to its consumption, *per se*. Non-use or passive use values comprise **existence value, bequest value** and **option value**.

Existence value arises from the benefit an individual derives from knowing that a resource exists or will continue to exist regardless of the fact that they have never seen or used the resource, or intend to see or use it in the future. A good example of the significance of non-use value is the international outcry over the whaling issue. There are many people who have never seen a whale or plan to see one, but are nevertheless willing to pay significant sums of money to ensure that whales are not hunted to extinction.

Bequest values arise from the benefits that individuals derive from knowing that a resource will be available for their children and children's children. Option value is a little more complex. Option value may be defined as the amount of money an individual is willing to pay, at the current time, to ensure that a resource is available in the future, should they decide to use it. To the extent that option value is the expected value of future use of the resource, it may also be classified as a form of use value.

A related type of option value is **quasi-option value** (Arrow and Fisher, 1974; Fisher and Hanemann, 1987). Suppose there is a choice between conservation and development. However, the development option will result in an irreversible change. In this case, quasi-option value is the value of information that results after a decision has been made to develop or conserve at the present time. For example, if a cure for a fatal disease were to be found after the conservation decision has been made, then quasi option value would clearly be positive. It must be noted that quasi-option value cannot be summed with option value because it measures a different concept.

Use values can be readily measured by market prices or other means and are well accounted for in decision-making processes. However, as indicated earlier, non-use values are problematic because they are not traded and therefore cannot be valued by market prices. Empirical research suggests that non-use values can be a significant component of total economic value. Table 5.1 reports estimates of use and non-use values for wildlife in Alberta, Canada. The preservation (i.e., non-use) benefits of wildlife were estimated to be C$67.7 million per annum out of a total economic value of C$185.2 million per annum in 1987 dollars. In this case non-use benefits were at least one-third of TEV. Thus, failure to consider such benefits, whether quantitatively or qualitatively, in the decision-making calculus could lead to gross underestimation of the contribution of wildlife to total social welfare.

We discuss below a range of techniques for obtaining non-market values of environmental resources.

Table 5.1 Estimates of the economic value of wildlife in Alberta, Canada

Type of value	Mean values C$/capita/p.a.	Number of participants	Annual values (1987 C$mil.)	In perpetuity (C$ mil. p.a.)
Preservation Benefits	80.9	836,125	67.7	1354
Hunting				
Waterfowl	171.8	59,730	10.3	206
Other birds	130.0	84,827	11.0	220
Small mammals	119.1	56,738	6.8	136
Large mammals	211.1	118,207	24.9	498
All hunting	165.9		53.0	1060
Non-Consumptive Use	163.0	395,873	64.5	1290
Total Economic Value			185.2	3704

Source: Adamowicz, Asafu-Adjaye, Boxall and Phillips (1991).

5.3 Non-Market Valuation Methods

Non-market valuation methods can be broadly classified into two categories: **revealed preference (RP)** models, **stated** (or **expressed) preference (SP)** models, and combined SP and RP models. Revealed preference approaches make use of individuals' behaviour in actual or simulated markets to infer the value of an environmental good or service. For example, the value of a wilderness area may be inferred by expenditures that recreationists incur to travel to the area. The value of, say, noise pollution may be inferred by analysing the value of residential property near an airport. These methods are also referred to as indirect or surrogate market approaches.

Examples of RP methods include:

- Travel Cost Method (TCM)
- Hedonic Pricing Method (HPM)
- Cost (or Expenditure) Methods, and

- Benefit Transfer Methods

Stated preference methods attempt to elicit environmental values directly from respondents using survey techniques, hence the alternative name of 'direct approach'. As will be explained below, these methods are flexible and can be applied to a wider range of environmental goods and services than RP methods. Furthermore, SP methods can be used to estimate total economic value (i.e., use and non-use values), whereas RP methods can be used to estimate only use values. Stated Preference methods do have some drawbacks and these are discussed below.

5.3.1 Stated Preference Models

Stated preference models can be further classified into three types: contingent valuation method (CVM), conjoint analysis, and choice modelling. In this section we first consider the CVM and then go on to discuss conjoint analysis and choice modelling.

The Contingent Valuation Method

The CVM uses interview techniques to ask individuals to place values on environmental goods or services. The term 'contingent' in CVM suggests that it is contingent on simulating a hypothetical market for the good in question. The most common approach in the CVM is to ask individuals the maximum amount of money they are willing to pay to use or preserve the given good or service. Alternatively, the respondents could be asked the maximum amount of money they are **willing to accept in compensation** (WTA) to forgo the given environmental good or service. Theoretically, these two measures should be equivalent. However, empirical studies have indicated that WTA estimates exceed WTP estimates.[29] Typical steps in a CVM procedure are as follows:

1. Set up the hypothetical market;
2. Obtain the bids;
3. Estimate mean WTP and/or WTA; and

[29] Critics of the CVM assert that this is an indication of the lack of validity of the method. However, recent research indicates that the divergence should be expected on both economic and psychological grounds. Individuals may feel the cost of a loss more intensely than the benefit of a gain.

4. Estimate bid curves

Setting up the hypothetical market

The first step is to establish a reason for a good or service where there is no current payment. Suppose there is a government proposal to mine, say, a wilderness area. Assuming few people actually visit the area, the analyst would describe the area and the impacts of the proposed project on the environment. Pictorial aids could also be used in setting up this hypothetical market (not applicable to a telephone interview).

Obtaining the bids

The second step is to decide on a suitable 'bid vehicle'. This is the method by which the WTP or WTA bids would be elicited. Possible bid vehicles could include income taxes, property taxes, utility bills, entry fees, and payments into a trust fund.

Methods used to obtain the bids include face-to-face interviews, telephone interviews or postal surveys. A face-to-face interview allows more scope in presenting the hypothetical market and clarifying respondent concerns. However, it is the most expensive method because interviewers have to be paid. The telephone interview and postal survey offer less flexibility, in declining order

Methods of obtaining bids include the following:

- **Bidding games**: respondents are offered progressively higher bids until they reach their maximum WTP.
- **Payment card**: a range of values is provided on a card and the respondent is requested to choose one.
- **Open-ended questions**: respondents are asked to report their maximum WTP.
- **Close ended questions**: there are at least three variants:
  (i) **Dichotomous choice (referendum)**: a single amount is offered and respondents are asked to provide a 'Yes' or 'No' answer, also referred to as the 'take it or leave it' approach;
  (ii) **Double-bounded referendum**: respondents who answer 'no' to the first amount are offered a lower amount, and those who answer 'yes' are offered a higher amount; and
  (iii) **Trichotomous choice**: respondents are offered three choices to the payment—'yes', 'no' and 'indifferent'.

An important requirement of using the CVM is that the respondents must be reminded of their budget constraints when eliciting their bids. The dichotomous choice (or referendum) format (Bishop and Heberlein, 1979) is considered to be the state-of-the-art in CVM methodology. A National Oceanic and Atmospheric Administration (NOAA) panel of economic experts, chaired by Kenneth Arrow and Robert Solow, recommended the referendum format over the open-ended format (NOAA, 1993). The double-bounded referendum (Hanneman, 1985) and trichotomous choice (Ready *et al.*, 1995) are relatively more recent variants of this approach.

Estimating mean WTP and/or WTA

For the first three bid elicitation approaches the mean and median WTP can be found from the individual bids. Mean and median bids for the close-ended referendum bids are more difficult to obtain. Analytical methods such as probit, logit and random utility models can be used to obtain estimates.

Estimating the bid (demand) curves

Bid (or demand) curves could be estimated at this stage to validate the WTP results and to estimate aggregate WTP. The bid curve is estimated by regressing WTP against relevant socioeconomic variables, and checking to see whether the signs conform to theory. For example, the following demand function could be estimated:

$$WTP_i = f(A_i, E_i, Y_i, M_i) \tag{5.1}$$

where A is age; E is educational level; Y is income level and M is a variable for membership of an environmental organisation. Based on economic theory, we would expect Y to be positively related to WTP.

The total value of the good or service can be estimated by multiplying the mean WTP by the number of households (if the sampling unit used was the household).

Choice Experiments

Choice experiment approaches include **conjoint analysis**[30] and **choice modelling** (CM). Conjoint analysis is further divided into **contingent ranking, contingent rating** and **paired comparison.**

Conjoint analysis

A major difference between CVM and conjoint analysis is that in the former respondents are required to evaluate only one or sometimes two alternatives. On the other hand, the latter requires them to evaluate several alternatives separately. In contingent rating, respondents are requested to rate their preferences for several alternatives on, say, a ten-point scale. They are presented with a set of attributes associated with each alternative. The respondents' ratings are then regressed against the attributes. The marginal rate of substitution between a given attribute and its price provides an estimate of the 'value' of the attribute. This is referred to as the **'part-worth'** of the attribute. Summing all the part-worths provides an estimate of a respondent's WTP for an aggregate change in the environmental good or service. In contingent ranking, respondents are required to rank all the alternatives from least preferred to most preferred. The analysis of contingent ranking data is similar to that of contingent rating. The rankings can be converted to a ratings scale and analysed with multiple regression techniques, or other estimation methods such as logit or probit analysis can be used.

A weakness of both contingent rating and contingent ranking is that they do not provide the respondent with an opportunity to reject the good. The only way they allow opposition is by registering a low rating or ranking. In that sense these methods are considered to be unconditional or relative measures of WTP and could be understated.

In the paired comparison approach, respondents are presented with successive sets of two choices and asked to rate the difference between them on a scale (usually, a 5-point scale). A form of paired comparison is adaptive conjoint analysis where the pairs are generated with the aid of a computer. Like the previous two methods, the data from the paired comparison can be analysed using **multiple regression**, **logit** or **probit models** to provide

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[30] Conjoint analysis is a popular technique in marketing research. It has only recently been adapted for valuing environmental goods and services.

estimates of a respondent's WTP for an aggregate change in the environmental good or service.

Choice modelling

Choice modelling was developed by Jordan Louviere and was initially used in the field of marketing to analyse consumer choices (Louviere and Woodworth, 1982). Since then, a few studies have used the method to value environmental goods and services.[31] In this approach, respondents are presented with a series of alternatives, with each containing three or more resource use options. Usually, each alternative is defined by a number of attributes. For example, in a CM study of preserving a wilderness area the attributes could be the following: numbers of rare species present; ease of access to the area, size of area and cost to households (Box 5.1). These attributes would then be varied across the various alternatives. The respondents are then required to choose their most preferred alternative. Estimates of respondents' WTP are obtained by estimating a multinomial logit model.

Choice modelling is relatively more versatile than the other SP methods. It can be used to value multiple sites or multiple use alternatives. Unlike conjoint analysis, CM can be used to provide conditional or absolute measures of WTP provided a 'choose neither' option is included among the alternatives.

The main disadvantage of choice modelling is that complex survey designs are required. The number of choice sets can be large, which tends to lengthen interview times.

Biases associated with stated preference models

Stated preference models have some distinct advantages. Most are straightforward to apply and do not require any theoretical assumptions compared to revealed preference approaches. The only assumption is that the individual is able to value the good or service and will truthfully report his or her valuation. Furthermore, at the present time, methods such as CVM and choice modelling are the only ones that can be used to estimate non-use or passive use values.

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[31] See applications by Adamowicz *et al.* (1994) for valuing water-based recreation and by Morrison *et al.* (1998) for valuing wetlands.

Box 5.1 Choice modelling application in the Desert Uplands, Central Queensland

Choice modelling was used to estimate the economic value of preventing the loss of endangered species in the Desert Uplands region of central Queensland (Blamey *et al.*, 1997). The aims of the study were: (i) to apply and develop the choice modelling technique; and (ii) to provide estimates of the economic value of preventing endangered species loss to assist resource management decision-making. The first objective was to enable a test of choice modelling as an alternative to the CVM given the problems associated with the latter. With regards to the second objective, land clearing is a major problem in the area, and there was a need to assess the trade-offs involved with alternative land uses.

The preliminary results suggest that the loss of endangered species was valued at A$11 per species by Brisbane residents aged under 30 years of age and $14 per species by Brisbane residents aged under 60 years of age.

Source: Blamey *et al.* (1997).

In spite of (or maybe due to) their simplicity, stated preference methods are subject to a number of biases. These include: (i) **hypothetical bias**; (ii) **embedding effect**; (iii) **strategic bias**; (iv) **bid vehicle bias**; (v) **starting point bias**; (vi) **information bias**; (vii) **part-whole bias**; and (viii) **non-response bias**.

These biases are briefly discussed below.

(1) Hypothetical bias: the major assumption in the CVM is that the amount of money people say they are willing to pay corresponds to the individual valuations of the good or service in question. The CVM has been criticised for the fact that respondents do not actually have to pay their stated amounts. Therefore, it has been suggested that the hypothetical nature of the exercise might induce people to 'free ride', that is, understate their true WTP. However, in a series of experiments in which hypothetical WTP has been compared to actual WTP, hypothetical bias has not been found to be significant.

(2) Embedding effect: embedding effect (Kahneman and Knetsch, 1992) is said to occur when an individual's WTP is lower when it is valued as part of a more inclusive good or service, rather than on its own. It has been suggested that embedding effect occurs because people are seeking a 'feel good' or 'warm glow' associated with contributing to a 'good' cause. Some researchers attribute embedding to the existence of substitutes. That is, people will reduce their WTP if they are aware of substitutes. Embedding effect is minimised in CM because it allows explicit inclusion of substitutes.

(3) Strategic bias: strategic bias occurs when a person deliberately overstates (or understates) his or her true bid in order to influence the outcome. For example, some people who strongly support a proposed development may report a zero WTP for conservation even when they have a positive WTP. Other SP methods may not suffer from the same level of strategic bias as CVM because they do not require respondents to state their bids.

(4) Bid vehicle bias: as noted above, the CVM depends on a 'vehicle', that is, a means by which the stated hypothetical amounts would be collected. An individual who dislikes a particular kind of vehicle (e.g., higher taxes) may understate his or her WTP. In some areas, respondents might be dissatisfied with the way their government is using their taxes and therefore such a vehicle might invoke a negative response. A solution to this problem is to use a 'neutral' vehicle. For example, for preservation values, a useful vehicle could be donations to a trust fund to be administered by an independent non-governmental organisation. Vehicle bias is present in CVM and contingent ranking. There is a question mark on the presence of vehicle bias in contingent rating, paired comparison and CM because these methods emphasise multiple attributes which place less emphasis on payment.

(5) Starting point bias: some CVM bid elicitation formats (payment card and bidding game) 'start' off with a certain amount. The stated amount may induce bias in the sense that it may be misinterpreted by the respondent as a cue for an 'appropriate' range of WTP. There is not much empirical evidence about the extent of this type of bias. However, it may be minimised by extensive pretests of the survey instrument.

(6) Information bias: because a CVM is conducted by creating hypothetical scenarios, this scenario must be conveyed to the respondent by providing information. The quantity, quality and sequencing of this information can influence the bids. Insufficient information will make it difficult for the respondent to properly value the given good if he or she has no prior knowledge of it. On the other hand, too much information would be a definite source of bias. One way of minimising this kind of bias is to provide enough information to model the real context of the valuation exercise.

(7) Part-whole bias: there is concern that if people are asked to value one part of a given asset (e.g., all wildlife) and then subsequently asked to value a part of it (e.g., a given species) the response may be similar. It has been suggested that this problem arises from the way people allocate their personal budget, first dividing their income amongst broad consumption categories, and then allocating to sub-categories of goods. The solution to this problem is to remind them of their budget constraints and to restrict valuation to whole goods rather than parts of the good.

(8) Non-response bias: this type of bias is associated with surveys, in general. Some people cannot be bothered to participate in surveys. Often, it is those with particular interests in the subject who are likely to respond. In such cases, it may be argued that the sample is not representative of the population. Non-response bias can be minimised if questions are easier to answer. In this regard, it has been suggested that the CM format may be easier than, say, the CVM. Mackenzie (1993) reported that only 1.4 percent of respondents in a CM survey refused to answer rating questions.

Summary of stated preference methods

Stated preference methods are relatively straightforward approaches for eliciting individuals' valuations of non-market environmental goods and services. They require few theoretical assumptions. For example, the only assumption implicit in the use of the CVM is that respondents have an idea of their personal preferences and are willing to truthfully report their willingness-to-pay. However, the validity and reliability of estimates obtained using these methods may be questioned due to inherent biases.

Most of these biases are associated with the CVM, in particular. These include hypothetical, part-whole, strategic, vehicle, starting point and non-response bias. The other SP approaches are less prone to certain types of biases. Recent research, however, suggests that following certain best practice procedures in survey design can minimise most of these biases. At the present time, CVM and CM are the only techniques that can be used to value non-use values.

5.3.2 Revealed Preference Models

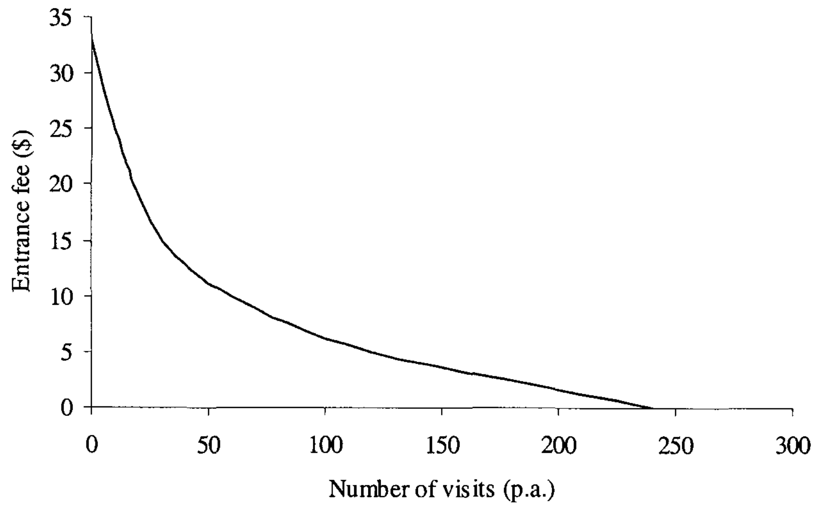
Revealed Preference models include the travel cost method, the hedonic price method, market value or cost methods and the benefit transfer method

Travel Cost Method (TCM)

The concept of using travel costs to value recreation was first proposed by Hotelling in 1949 and formalised by Clawson (1959). However, Davis (1963) was the first to apply the method in a study of the value of recreation in Maine forests. The basic assumptions underlying the TCM are that (i) the costs an individual incurs in visiting a recreational site reflect the person's valuation of that site, and (ii) individuals will react to an increase in entry fees in the same way as they would react to an increase in travel costs. That is, at some high level of entry fee (or cost of travel) no one would visit the site because it would be too expensive. By asking visitors questions relating to where they have travelled from and the costs they have incurred, and relating this information to the number of visits they make per annum, a demand curve can be generated for the recreational site under question. This curve will be downward sloping in the sense that travel cost will be inversely related to number of visits (Figure 5.2). That is, those living near the site will make more visits per annum compared to those living far away.

There are two forms of the travel cost method: the **zonal travel cost method** (ZTCM) and the **individual travel cost method** (ITCM). In the zonal travel cost approach (e.g., see Smith and Kaoru, 1990), concentric zones are defined around each site such that the cost of travel from all points in a given zone is approximately constant. Visitors to the site are grouped according to their zone of origin. By comparing the cost of coming from a zone with the number of people who come from it and the population of the zone, one can plot a point for each zone. A curve can then be fitted to all the points to generate the demand curve from which a measure of consumers surplus can be obtained.

Figure 5.2 Demand curve for the travel cost method



A trip-generating function for the ZTCM can be specified as:

$$V_h/N_h = f(C_h, X_h) \qquad (5.2)$$

where: V_h = number of visits from zone h
N_h = population of zone h
C_h = travel cost from zone h
X_h = a vector of socioeconomic variables that explain changes in V

The ITCM uses the number of visits per annum made by an individual, rather than zonal visits, as the basis for generating the demand curve. The trip-generating function for the ITCM can be stated as follows:

$$V_i = f(C_i, X_i) \qquad (5.3)$$

where: V_i = number of visits made by individual i to the site
C_i = cost of a visit by individual i to the site

X_i = socioeconomic factors affecting individual i's visits to the site

By integrating the area under the demand curve, an ITCM estimate of the individual's consumer surplus can be obtained. This figure is then multiplied by the number of visitors per annum to obtain the aggregate benefits.

Recently, variations of the travel cost model have been developed. These include the combined TCM and CVM model (discussed in more detail later), the random utility model (RUM), the **hedonic travel cost model**, and the **multi-site travel cost model**. The RUM (Ward and Loomis, 1986) first models the visitor's decision on whether or not to participate in the recreation activity, followed by the decisions on the number of visits. Econometric techniques such as probit, tobit and and logit models are used to estimate these two decisions independently. The hedonic travel cost model (Bockstael *et al.*, 1991) identifies separate characteristics of the recreation experience and the price that people are WTP for each. The first stage of the procedure involves regressing the respondents' travel costs on measures of quality characteristics at the site. A separate demand curve for each characteristic is then developed. The multi-site travel cost model (Ward and Beal, 2000) attempts to account for all relevant substitute sites within the region. Visitation data from multiple sites that have different levels of the site quality variable of interest are used and the model predicts demand for each site.

Table 5.2 reports travel cost estimates for various protected areas in Queensland. Beal (1995) estimated a value of A$2.50 per person per visit for trips to the Carnarvon Gorge National Park, but Hundloe *et al.* (1990) estimated relatively higher values of A$15.70–32.63 per visit to Fraser Island. Scoccimarro (1992) estimated the value of recreation in the Green Mountains, Lamington National Park, to range from A$8.09–9.23 per visitor per day. Much higher estimates of A$362 per visit and A$49 per visit, respectively, for Hinchinbrook Island (Stoekl, 1994) and the Wet Tropics World Heritage Area (Driml, 1996) have been made.

Limitations of the TCM

As indicated above the main underlying assumption of the TCM is that the value of a recreational site corresponds to the costs that the respondent incurs in undertaking the recreational experience. A distinct advantage of the TCM is that it is based on real rather than hypothetical data and as such can provide true values. It is based on the simplified assumption that the recreational value of a place is directly related to travel costs incurred in getting there.

Table 5.2 Travel cost estimates of protected areas in Queensland

Site	Study	Average willingness-to-pay
Carnarvon Gorge National Park	Beal (1995)	A$2.50 per person
Fraser Island	Hundloe *et al.* (1990)	A$15.70–32.63 per visit
Green Mountains, Lamington National Park	Scoccimarro (1992)	A$8.09–9.23 per visitor day
Hinchinbrook Island	Stoekl (1994)	A$362 per visit
Wet Tropics World Heritage Area	Driml (1996)	A$49 per visit (domestic tourists)

However, the TCM suffers from the following limitations.

(1) The TCM is suited to estimating the value of particular sites or locations and is unsuited for measuring other kinds of goods or services. For example, TCM cannot be used to value non-use or passive use values. This is because it is based on the travel costs of users of a given recreational site. Non-users, who may have significant values for the same site are excluded from the sample.

(2) Multiple destinations: a problem arises about the appropriate allocation of costs among multipurpose journeys. The allocation of such costs could be arbitrary and there is currently no consensus on how to do this. A variety of ways of dealing with this issue has been suggested in the literature. One approach is to omit multiple-destination visitors and consider only single-site visitors. The other is to ask the respondents to allocate a proportion of the total travel cost to the given site.

(3) Visits to certain sites could be seasonal and therefore the survey results could be biased unless it is conducted over a long period.

(4) Travel costs: the assumption that travel costs reflect recreational value may not always be true. For example, people who live near the site may

incur zero or minimal travel costs but may nevertheless have high values.

(5) Time and other factors: the TCM assumes that travel costs (e.g., fuel costs) are the major determinants of the value of a recreational site. However, other factors could affect the demand for recreation. For example, travel time is an opportunity cost because the time spent travelling is not available for other pursuits. Time should therefore be considered as a cost.[32] However, there is no consensus as to how time should be accounted for in TCM. In some studies, a certain proportion of the wage rate is multiplied by travel time to provide an estimate of the opportunity cost of time. However, the choice of the weight is quite arbitrary and open to question.

(6) Welfare estimates computed from the TCM may differ depending on the variables and functional form used to estimate the relationship between demand for visits and the cost of travel.[33]

Summary of TCM

To summarise, the travel cost method is a useful method for valuing the recreational benefits of a site. However, it is a restrictive method in the sense that it can only be used to measure site-specific recreational value. There are also some problems in actually deriving benefit estimates. These relate to the issues of the cost of travel time and substitute sites.

The Hedonic Price Method

The **hedonic price method** (HPM) derives values for an environmental good or service by using information from the market price of close substitutes. It is based on Lancaster's consumption theory which assumes that a good or service provides a bundle of characteristics or attributes (Lancaster, 1966). Suppose the government wishes to value the disutility generated by aircraft noise in a given location. It could do so by analysing variations in house prices as one moves away from the flight path of aircraft. Take the example of two houses with the same facilities (e.g., number of

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[32] If a person enjoys, say, views of the countryside while travelling, or simply enjoys travelling then, of course, this should be considered a benefit.

[33] This problem also applies to the hedonic price method.

bedrooms, bathrooms, and swimming pool). One is directly under the flight path and the other is quite a distance away. It is expected that the house under the flight path will be cheaper and the price difference may be attributable to the value of the noise pollution.

Hedonic price models attempt to explain individuals' willingness-to-pay in terms of a set of attributes and characteristics of the good. For example, the price a potential homebuyer is willing to pay for a house depends on the location of the property, number of rooms, access to amenities (e.g., schools and transport), the environmental quality and the person's income. The hedonic price equation may therefore be expressed as

$$\text{Price of house} = f(\text{location, number of rooms, access to amenities, income of buyer, environmental quality}) \quad (5.4)$$

where environmental quality is proxied by aircraft noise measured in decibels.

Data are collected on each of the five variables for a reasonable sample of houses. Equation (5.4) is then estimated using multiple regression techniques. We would expect house prices to be positively related to the number of rooms, positively related to the degree of access to amenities (e.g., shops, schools, entertainment), positively related to income and negatively related to environmental quality (aircraft noise in decibels). The monetary value for a one-unit change in noise level can be found by differentiating this function with respect to environmental quality, or alternatively, by finding it from a plot of the function (Figure 5.3).

Table 5.3 presents HPM estimates for the value of traffic noise in the U.S. The results reported represent coefficients of the hedonic price function for various American cities. They measure the percentage fall in house prices due to a one-decibel increase in noise levels. The monetary value of noise is the coefficient multiplied by the average house price in the area. For example,

$$\text{Monetary value for a one decibel decrease in noise in North Virginia} = 0.15 \times (\text{average house price in North Virginia})/100 \quad (5.5)$$

Figure 5.3 Effect of aircraft noise on house prices

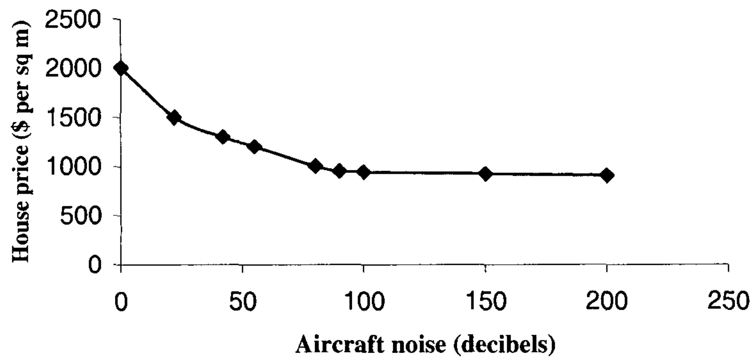

Table 5.3 Impact of traffic noise on house prices in the U.S.

Area of U.S.	Percent fall in house price due to a 1 decibel increase in noise level
North Virginia	0.15
Tidewater	0.14
North Springfield	0.18–0.50
Tourism	0.54
Washington, D.C.	0.88
Kingsgate	0.48
North King County	0.40
Spokane	0.08
Chicago	0.65

Source: Nelson (1982).

Summary of the HPM

The HPM is suited to the estimation of the characteristics of goods and services. However, it also has some limitations. As is the case for the TCM, welfare estimates computed from the HPM are sensitive to the choice of functional form and the variables included in the model. The HPM is susceptible to the problem of multicollinearity, which refers to a high degree of correlation amongst the explanatory variables in the hedonic price function.

A major assumption is that, given income constraints, people are free to select the characteristics of houses that satisfy their preferences and that the price they are willing to pay takes account of these factors. However, house prices can also be affected by external factors such as taxes and interest rates, which are not accounted for in the hedonic price equation.

Market Value Method

Market value approaches make use of observed market prices for environmental goods and services. Based on our classification of TEV above, it can be seen that this approach can only be used to value environmental goods and services that have established markets. These are commodities which have:

- direct uses: e.g., plantation timber, commercial fisheries, tourism;
- some indirect uses: e.g., the value of water from protected watersheds; and
- some option values: e.g., gene research, forest conservation.

Market value methods attempt to find a link between a proposed environmental change and the market value of the corresponding goods and services. A common approach is to use changes in productivity of the good or service. For example, the direct impacts of an environmental change on human health can be estimated as a change in income. The assumption here is that sickness reduces one's ability to earn income.

The advantages of the market value method are:

(1) It is relatively simple and straightforward;
(2) It relies on actual market values; and
(3) It has some relation to measured output.

The disadvantages are:

(1) It is limited in the types of values that it can capture;
(2) It can be difficult to define the physical flows over time;
(3) In some cases, the links between the environmental change and the market good or service may not be obvious.

Market Cost Method

In general, market-cost methods measure the cost of achieving a particular objective. Examples include restoring certain environmental services and avoiding land degradation. These methods focus on the cost of prevention or rectifying environmental damage and the cost of replacing environmental services. Most often, these costs are estimated from market prices, including the costs of labour and materials used in the particular activity.

There are a number of variations of the market cost method. These include the following: (1) change in cost; (2) replacement cost; and (3) defensive expenditures. The basic assumption of cost methods is that the value of a good is equal to some multiple of the cost of producing it.

(1) **Change in cost method:** suppose a proposed project may change the cost of a good or service. If the project causes a decrease in the cost of the good or service, this can be interpreted as a gain in benefits, that is, a cost saving. On the other hand if the project results in an increase in costs, this may be taken to be a loss of benefits. Take the example of a project that involves the construction of a water supply system. In this case a major benefit is the cost savings to households from not having to buy water from water vendors or transport water over long distances.

(2) **Replacement cost method:** assumes that the value of an existing good or service is the cost of replacing it. For example, if a storm damages roads, buildings and transmission lines then an estimate of the damage done is the cost of replacing these structures. However, in this case, the replacement cost must be considered as the minimum value of the benefits derived from these goods. This is because we need to add on the consumer surplus that people derive from utilising the good or service. A variation of replacement cost is **mitigation cost**. Mitigation cost is an estimate of the cost of restoring a damaged environmental good to its former condition. This approach could be useful where the damage is minor. Obviously, it is of limited use where the damage is either irreversible or total restoration is impossible.

(3) **Defensive-expenditure method:** in this approach the net benefit of a particular project intervention is the amount of money people are willing

to spend to either mitigate or avoid the impacts.[27] A good example is a community which does not have good drinking water. In this case, the benefits of introducing a water treatment plant include the amount of money people spend to boil or treat their water for cooking or drinking purposes.

Limitations of market and cost methods

The market and cost methods are easy to apply and can provide useful measures of net benefits. People can easily understand the use of monetary units. However, a major limitation is that they do not measure benefits that are determined from the interaction between the demand for and supply of environmental goods. As such, they only capture a portion of total benefits (e.g., they exclude non-use benefits). Where there is a high degree of non-market benefits or costs, market values may provide only minimum estimates of opportunity costs or forgone benefits.

Benefit Transfer Method

The benefit transfer method is another alternative for obtaining non-market values. This approach has been applied to value the impact of improved water quality on recreation values and public health (Kask and Shogren, 1994) and to lake recreation (Parsons and Kealy, 1994). It involves 'transferring' values that have been estimated for a similar good or service from another location to the current location. The approach is useful because surveys are expensive and, in addition to money, there could be a time constraint.

Economists are divided on the validity of the benefit transfer method. For this method to be meaningful, the following conditions must hold:

- The goods (or services) in both sites should have roughly similar characteristics;
- The population in both areas should be similar; and
- The values in the first study should not have been estimated a long time ago because preferences change over time.

Three tests have been suggested to determine the accuracy of benefit transfer (Box 5.1). The aims of these tests are to determine the convergent validity

[34] See Hufschmidt *et al.* (1993) for a good discussion of applications in developing countries.

(i.e., statistical validity) of benefit transfer and the extent of any bias. The first test involves comparing the benefit transfer values with primary data values obtained from the policy site. If the benefit transfer estimates are not statistically different from the primary data value estimates from the policy site, then it may be concluded that the benefit transfer values are valid. The extent of bias is given by the deviation between the two estimates.

The second test involves determining whether different populations have the same preferences for the same non-market good, after controlling for differences in socioeconomic characteristics such as income and education levels. The third type of benefit transfer test is to determine whether transfers are stable over time.[35] Many studies have concluded that value estimates remain relatively stable over a few years.

Morrison *et al.* (1998) investigated the suitability of using choice modelling estimates for benefit transfers both across different populations and across different wetlands in northern New South Wales, Australia. In general, the weight of the evidence appeared to be against the convergent validity of both transfers across sites and across populations. However, they found that transfers across sites tended to be less problematic compared to transfers across population.

5.3.3 Combined Stated and Revealed Preference Models

In the past, SP and RP models have been viewed as substitute valuation methodologies. Some researchers (e.g., Carson *et al.* 1996) have attempted to test the validity of one of the approaches by making comparisons of welfare estimates derived from both models. However, since each approach is subject to criticism, including a variety of biases and statistical estimation problems, it is not clear that such a validation strategy is effective. Cameron (1992) made the innovative suggestion that, rather than treating, say, the CVM and TCM as competing methods, the two approaches could be successfully combined to estimate welfare measures. Since information from two sources are being combined to estimate a given set of parameters, the combined model should be estimated more precisely than separate models.

Catherine Kling analysed the gains from combining TCM and CVM data using simulation experiments (Kling, 1997). She found that there were definite gains in precision from combining models and there also appeared to be gains in reduced bias. The parameter estimates from the combined model

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[35] See, for example, studies by Reiling *et. al* (1990) and Teisl *et. al* (1994).

results are generally more efficient because information on the same set of underlying preferences is used to construct the estimates.

The advantages of combing RP and Sp methods can be summarised as follows:

(1) With a combined approach, researchers can afford to work with smaller samples since each person in the sample generates more than one observation;
(2) The combined approach results in improved statistical efficiency as indicated above; and
(3) The combined approach allows us to test for the consistency of SP and RP representation of individuals' preferences.

There are, however, some disadvantages of the combined approach. These are:

(1) The combined models are statistically complex and harder to implement;
(2) The combined approach does not work in all situations. For example, there must be a RP technique that fits the problem;
(3) In practical terms, there is limited experience in using this approach to analyse environmental issues; and
(4) Using the combined approach implies asking more survey questions. This could reduce the response rates, increase protests, and reduce the overall quality of the responses.

5.4 Summary

In this chapter various methods for estimating non-market values were introduced. The methods discussed were the SP methods (contingent valuation method, conjoint analysis, and choice modelling), RP methods (travel cost method, hedonic price method, the market value method and the market cost method), as well as combined SP and RP methods.

There is no single technique that is superior to the others. The choice of a particular technique depends on the particular resource valuation problem at hand. For example, if one wanted to estimate non-use or passive benefits, the CVM (or choice modelling) would be the technique of choice. If one wanted to estimate the recreation benefits of a particular resource, say, a national park, TCM would be a suitable choice. It was stated that there are gains in precision from combining SP and RP models and there also appeared to be gains in reduced bias. However, the combined models are complex and difficult to implement. Furthermore there is limited experience in the use of such models.

The application of these valuation techniques is important for decision making insofar as they take into account the unpriced or underpriced outcomes of proposed policies or projects. Although these techniques are not perfect, the inclusion of non-market values in the decision-making calculus helps to clarify the trade-offs and allows the decision makers to make better informed policy choices.

Key Terms and Concepts

benefit transfer method
bequest value
bid vehicle bias
bidding games
change in cost
choice experiment
choice modelling
combined revealed preference and stated preference
consumptive uses
contingent ranking
contingent rating
contingent valuation method
dichotomous choice (referendum)
direct value
double-bounded referendum
option value
paired comparison
part-whole bias
passive use
payment card
probit model
embedding effect
existence value
hedonic price method
hedonic travel cost model
hypothetical bias
indirect use value
information bias
instrumental (use) value,
intrinsic (non-user) value
logit model
market cost method
mitigation cost
multi-site travel cost model
non-consumptive uses
non-response bias
open-ended question
revealed preference
starting point bias
stated (or expressed) preference
strategic bias
total economic value
travel cost model

quasi-option value
random utility model
replacement cost
trichotomous choice
willing to accept in compensation

Review Questions

1. List the different kinds of values associated with a marsh.

2. List some of the possible values associated with soil conservation.

3. Discuss the main differences between revealed preference and stated preference methods.

4. List and explain the biases associated with the stated preference approach.

5. Select a natural environment in your area. Develop a willingness-to-pay question to estimate the value of this natural environment. Suggest a way to check the validity of the responses.

6. Compare and contrast the contingent valuation method and choice modelling.

7. State any advantages and disadvantages of cost methods.

Exercises

1. The following table provides estimates of average house prices in the northern and southern areas of a city before and after a tollway was constructed near the northside.

	House price ($'000)		Number of houses
Area	Before	After	
Southside	150	210	15,000
Northside	150	100	10,000

Calculate the following:

a. Determine the value of houses in both locations after construction of the tollway.
b. Overall, is there a net gain/loss? How much is it?

2. A survey of 200 visitors to a national park gave the following results:

Total visit cost ($)	Number of visits per person per annum
140	0
120	1
80	3
60	4
30	6
20	7
16	10

a. Draw a demand curve for visits to the park as a function of the price, i.e., the travel cost.
b. The survey results indicate that 50,000 people living in the area surrounding the park take, on average, five visits to the park a year. Calculate the consumer surplus for a single visit to the park for the average person.
c. Calculate the total consumer surplus for an average visit.
d. Calculate the aggregate consumer surplus per annum for the national park.

3. The construction of a new irrigation system in a town is expected to benefit small-scale farmers living in and around the area. It is hypothesised that the development will lead to an increase in farm prices in the area. However, to benefit, a farmer must pay for the cost of constructing a pipeline to his or her property. A hedonic price model was estimated as follows:

$$\text{Farm price} = 500000 + 30\text{AREA} - 100\text{DIST} + 2000\text{IRIG}$$

where:

AREA = farm size (ha);
DIST = distance (in km) from the main distribution channel; and

IRRIG = dummy variable, where 1 = construction of irrigation scheme goes ahead; 0 = construction does not go ahead.

Given that the average farm size is 200 ha and is 15 km from the main distribution channel, calculate the following:

a. The average farm price if the project does not go ahead.
b. The average farm price if the project goes ahead.
c. The change in average farm price if the project goes ahead.

4. Data collected for possible admission fees to a zoo and corresponding number of visits are as follows:

Admission fee ($)	Total number of visits per day
0	8,000
1	6,000
2	4,000
3	2,000
4	0

a. Calculate the loss in consumer's surplus if entrance fees were to be increased from the current $1 to $3 per visit.

5. Suggest possible valuation methods for assessing the following:
a. Recreational fishing.
b. Water treatment and wastewater services.
c. Cyclone damage.
d. High voltage transmission lines.
e. Flood control programs.
f. Tourism and recreation
g. Loss of mangrove swamps.
h. Health effects of air pollution.
i. Creating artificial wetlands.
j. Stopping logging in World Heritage listed areas.
k. Improvement in waterway vegetation.

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