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VALUING SOCIETY AND ENVIRONMENT: ECONOMIC METHODS AND LIMITS

Abstract

Economic measures of environmental change have proven particularly popular in recent years as judged by the expanding literature on the subject. However, the basis of these economic measure in welfare theory has too often been overlooked by those producing numbers. The methods of cost-benefit analysis were designed for analysis of marginal adjustments in prices but are being used for a range of value issues, categories of value and across large time and space scales. This presentation looks at the range of environmental values which have been proposed as being included within environmental CBA and asks how far can we expect to actually measure environmental changes using such methods. This raises questions over some of the current practices with respect to the use of methods such as contingent valuation and the transferability of numbers across different contexts. The basis of economic values on the individual, entailing a specific psychological model, also produces concerns over the meaning and content of social values as described by economists.

Clive Spash

VALUING SOCIAL CONSEQUENCES OF ENVIRONMENTAL CHANGE: ECONOMIC METHODS AND THEIR LIMITS

1. Introduction

This paper provides a survey of methods of valuation in economics as an approach to assessing social welfare resulting from environmental change. In doing so I will:

(a) outline a range of values associated with environmental change;

(b) set out the methods of cost-benefit analysis (CBA) used in empirical work;

(c) explain the main problems associated with those methods; and

(d) recommend the most appropriate method(s) for empirical work to evaluate the monetary benefits and costs.

Section 2 provides an overview of the environmental values and divides these into market, non-market and non-economic values. Section 3 summarises the principal methods for generating estimates of the non-market values and major problems in their application. The techniques discussed are the travel cost method (TCM) in Section 3.1, the production function approach (PFA) in Section 3.2, hedonic pricing (HP) in Section 3.3, and stated preference techniques, mainly the contingent valuation method (CVM), in Section 3.4. The final section summarises the extent to which these valuation methods can be used in the European context to inform the decision making processes. Emphasis throughout is placed upon awareness of the limitations of these methods, which therefore demand prudent use in any policy context.

2. The range of relevant environmental values

Economic assessment, associated with evaluating externalities, can differ from impact assessment under a natural science or engineering approach where physical impacts are central. That is, under the economic approach, emphasis is placed upon the physical impacts only to the extent that they follow a path to specific targets which affect human welfare. Environmental change is then linked to human welfare via characterising the environment as goods and services (which may be broadly defined). Thus, changes in the provision of environmental goods and services form the focus of attention. This means economic value categories relate to what are regarded as relevant welfare generating aspects of the environment in terms of the environmental goods and services provided rather than the source of physical changes, e.g. loss of ecosystems or biodiversity. Another difference between economic values and physical changes is that the expectation of an impact and its psychological effect can be important in terms of economic welfare, even if there is no physical change, as, for example, in the case of nuclear power stations. Economic valuation techniques appeal to human preferences and as a result are influenced by whatever impacts upon those preferences and ignores whatever those preferences fail to take into account.

2.1 Potential impacts on existing markets

Goods and services sold directly to consumers or to firms as inputs to production may be impacted by certain environmental changes. For example, air pollution may impact agricultural crops raising production costs, shifting supply functions and raising prices in the market place. In such cases a market exists where goods and services are traded so that standard economic models of supply and demand in that market can be employed to estimate the economic impacts. Producers may find the costs of supply rise due to pollution and may reflect the cost of additional treatment of inputs or outputs in accordance with governmental or international standards, or the cost of paying others to change their practices. Where environmental quality is reduced, industry reassurances may be insufficient to prevent consumer substitution away from the supplier, thereby reducing demand. In order to capture these effects a market model both consumer and producer welfare surpluses to be estimated.

Pollution from production processes may also reduce the option for use of products which are currently regarded as non-commercial. For example, recreational and tourist opportunities may be temporarily or permanently lost. The impact of lost demand for recreation and tourism would be felt in the local economy if no alternative (perfect) substitute site were available in the area for the activities involved, and a regional substitution effect might occur. The site may have unique characteristics with no opportunities for substitution while others have close market substitutes. Thus, non-commercial harvesting of food can be related to the markets for the commercial substitutes to estimate the value of the product loss. However, in general, recreational activities involve an experience related to the quality of the environment which depends not only upon site characteristics and the availability of substitutes, but also the value gained from participation in the activity. Thus, recreational and tourist activities can involve values beside those costs associated with related markets or identifiable physical aspects of ecosystems. For example, gathering flowers, wild berries or mushrooms may be related to market substitutes but the experience of harvesting is of more central concern to the welfare gained. This means people may incur travel costs in excess of the value of the harvest gathered, as measured by the equivalent commercial product costs, because the experience is valued in itself. If markets are directly related to an activity (e.g. travel costs, entry fees, equipment costs), the opportunity cost can be approximated but not the welfare gained (i.e. consumer surplus). The welfare in terms of surplus would require using a technique which would derive a surrogate demand function for the site's non-market values (e.g. CVM, or TCM as discussed below).

2.2 Non-market values

The activities outlined above tend to result in either direct markets being set up to buy and sell services or goods related to the environment, or in impacts upon uses which are directly related to market activities. However, non-market aspects and non-marketable values are associated with the impacts of environmental changes. These values include a range of goods and services including aesthetics, cultural heritage, health, peace a & quiet and ecosystems functions & biodiversity.

Several attempts have been made by economists to value aesthetics (see Graves 1991). The aesthetic appeal of a given environment or site involves the subjective perception of what is beautiful or stimulates the emotions. The relationships between a person and their physical environment can form an important part of their identity affecting their feelings of personal and/or social worth, self-efficacy, distinctiveness or uniqueness (see e.g. Twigger-Ross and Uzzell 1996). Hence, the concept of 'landscape' and the particular characteristics of different landscapes (such as rugged hills, a gently rolling lowland valley, or a river plain; or birdsong and 'natural' sounds associated with different landscapes) can form an important aspect of people's identification with, or reaction to, a place and their perception of any changes to the status quo. Such aesthetic/landscape appeal could be partially reflected as a characteristic of the local housing market. Thus, sites of great natural beauty may be associated with specialised markets (e.g. retirement homes, tourism and holiday sites). Where such aesthetic qualities are regarded as rare or unique the lack of substitutes will mean aesthetic enjoyment of the location is reflected by the premium placed upon living in the area (which might then be assessed via an HP approach). Studies which attempted to assess aesthetic values by direct questioning of the public (e.g. CVM) have tended to estimate an individual's preference for a specific aspect of aesthetic quality, such as improved visibility due to better air quality or the introduction of specific tree species). Following this reasoning, aesthetic quality would then need to be identified with specific site characteristics by visitors or local residents. Such reductionism may be difficult or impossible to achieve (e.g. relating aesthetics to the type and quantity of individual landscape features). Questions can also be raised as to the relevance of a current aesthetic preference. That is, some landscapes may be regarded as worthy of preservation for the values they encapsulate and therefore should be removed from the vagaries of consumer choice, fashions and fads.

Cultural, historical and archaeological sites can be disturbed or destroyed by land use practices. Cultural values may be associated with geological features, ecosystems (e.g. an ancient woodland) as well as buildings or ruins. The site specific nature of these values can, in theory, allow estimation of their economic benefits (using for example, HP, TCM or CVM), although in practice defining and measuring what is meant by the concepts of culture and history would prove difficult. The importance of a site in public perception can vary greatly from that of an expert, say an archaeologist or historian. Local or regional perception of a site's cultural and historical features may also diverge strongly from national or international opinion (e.g. World Heritage Sites versus local economic interests).

Mortality and morbidity valued in monetary terms has proven highly controversial. In terms of preference based measures of economic welfare loss, the risk perception of individuals is all important, rather than the judgement of scientists, engineers or other experts. As long as the aim is to learn about individual's preferences and willingness to pay or accept then knowledge is required of the individual's view of the trade-off, including subjective risk assessment (see Freeman 1993, Chapter 8). Thus the fact that health and safety hazards have been largely eliminated through tighter regulation of industries may be irrelevant in terms of the

value of the impact that the public perceives. Of course, public preferences based on mistaken beliefs or poor information may be deemed an inappropriate point of reference for policy.

Noise from human activities can prove a substantive impact on well-being. The reaction may be to take ameliorative steps such as installing double glazing in houses and these protection costs could then be used to estimate the damages resulting from noise pollution. However unless the protection is a perfect substitute for the benefits foregone this approach will be an underestimate of the loss. For example, double glazing is only effective as a sound barrier inside a house with the doors and windows closed. A fuller range of economic loss may be reflected in the value of houses and land in the vicinity which could be depressed by the presence of say a busy road so that the externality is capitalised. (In this case HP models might be employed to estimate the damage.)

The functions which ecosystems perform are many and varied. Only a minority of these fall within the framework where they can be bought and sold on markets subject to private ownership. Amongst the most important functions performed by ecosystems are maintenance of climatic stability and nutrient cycles. Biodiversity of ecosystems, genes and species is seen as an important aspect of natural capital and a key to sustainable development. However valuation of biodiversity is complicated by a poorly informed general public and the extent to which people reject market valuation in this area (Spash and Hanley 1995). Direct questioning of the public (e.g. via CVM) may be able to provide some aspects of species value or even ecosystem diversity but is unable to address many of the concerns raised by the need to maintain ecosystems functions and protect biodiversity. Where an identifiable output or service can be related to an ecosystem function and this output or service is connected to a market product the economic value of changes in ecosystem functions may be assessed (i.e. using PFA). Impacts can be complex, highly uncertain or unknown, such as the loss of a site specific species which has never been classified.

2.3 Intrinsic value in Nature

This category of values is by definition outside of the economic calculus to evaluate. The category is mentioned here in order to qualify the discussion over the extent to which economic techniques can achieve a comprehensive valuation of the benefits of the environment. Intrinsic values are related to non-consequentialist and therefore non-utilitarian aspects of the environment. For example, a species may be valued as a food source and because it is beautiful and because of its potential to benefit science, but it may also be valued outside and separately from all these uses or aspects of its nature which create good consequences for humans.

Individuals who conform to economic assumptions regard the world from a perspective where all values can be traded. The ultimate criterion of morality lies in some value (e.g. welfare, utility, happiness) that results from acts. Such theories see only instrumental value in such acts, but intrinsic value in the consequences of these acts. In contrast, deontological ethical theories attribute intrinsic value to features of the act, themselves. This could be apparent as an expression of the rights of animals to welfare or the rights of humans to life. Thus, non-compensatory choices arise and Freeman (1986) has suggested that lexicographic preferences may be taken as a belief in such rights. When preferences are lexicographic, the individual cannot be compensated for the loss of a quantity of one good by increases in the quantity of one or more other goods, no matter how small the former or how large the latter. However this approach reduces the difference between payment offered and compensation demanded to an anomaly within utilitarianism rather than a fundamental difference in philosophical outlook. The refusal to trade becomes particularly relevant when disruption of the environment affects such things as human health, animal welfare and ecosystems functioning and structure. In such cases intrinsic values in non-human animals, plants or ecosystems are recognised by individuals as a serious constraint on economic trade-offs. Studies show a significant proportion of respondents to valuation surveys on biodiversity and wildlife can hold rights based beliefs as their motivation for environmental concern (Stevens *et al.* 1991, Spash 1998a, 1998b, 2000).

3. CBA Methods for social appraisal of environmental change

This section turns to a discussion of the specific methods for monetary valuation of the environment which have been mentioned above. In doing so, the main problems associated with applying these methods to different aspects of the environment are raised. This shows how the idea that environmental damages and improvements might be reflected in monetary terms confronts both theoretical limitations and practical problems.

3.1 Travel cost method

Travel cost method (TCM) is the oldest of the non-market valuation techniques predominantly used in outdoor recreation modelling. The basic method is to place a value on non-market environmental goods by

using the costs of consumption behaviour in related markets. For example, to evaluate recreational fishing, a TCM survey would typically gather information on travel costs, access / fish license fees, on-site expenses, and capital expenditure on fishing equipment. Varying such costs and predicting fishing activity changes can then be used to derive surrogate demand functions for fishing at a specific location. TCM is normally applied to site-specific locations and the cost of travel tends to be road based, via cars. The basic problems are: whether to use zonal or individual visits, how to treat visits to other sites, deciding the treatment of costs, and statistical problems. On theoretical grounds neither zonal nor individual visits ranks above the other. Unfortunately consumers' surplus estimates for a given site or class of sites have been shown to vary substantially with the choice of measure. A visit to a specific site may be only part of the purpose for an individual's journey. This is problematic because the full travel costs cannot be attributed to the site in question. Mendelsohn *et al.* (1992) regard most TCM studies as having either ignored multiple destination trips or arbitrarily allocating trip costs across visited sites. Calculating the cost of distance travelled involves setting a price per mile. This requires either using petrol costs only, as an estimate of marginal cost, or allowing for all the costs of motoring by including an allowance for sunk costs such as depreciation and insurance. Individuals, in maximising utility, are assumed to compare the marginal utility with the marginal costs of consumption to achieve an economically efficient outcome. This process implies marginal costs should be used, since including all costs will result in a measure of price per mile using average costs. The choice will influence the consumers' surplus figures. Similarly, time is expended both in travelling to a site and whilst enjoying the site itself. As a scarce commodity, time clearly has an implicit (or shadow) price. If individuals are giving up working time, in order to visit a site, the wage rate is the correct opportunity cost; if a site visit occurs while on holiday leave, the opportunity cost will be measured with reference to the value, at the margin, of other recreation activities foregone. Ideally, a separate value would be calculated for each individual to reflect their set of leisure activities and valuations. In practice, such data is too difficult and expensive to collect. Debate on the appropriate approach continues.

The general conclusion would seem to be that TCM researchers are forced to assign their own subjective estimation of visit costs. Randall (1994) has argued that visit costs are inherently subjective, but give an ordinal measure if the cost increases with distance travelled. Thus, the traditional TCM yields an ordinal measure of welfare. However TCM cannot then serve as an independent technique for estimating recreation benefits. Randall (1994) has suggested the subjective treatment of costs means that TCM must be calibrated using information generated from fundamentally different methods so that TCM is no longer an independent tool. This might follow the example of Cameron (1992) who combined TCM with CVM, an approach successfully followed by Kling (1997).

As part of the process of calculating welfare changes via TCM a regression analysis will be undertaken to predict visits, e.g. visits per capita are a function of travel costs. Loomis (1995) has argued that regional economic effects associated with the improvement of a recreation site will be underestimated unless all aspects of the decisions to undertake recreation are included. He identifies four recreation aspects of choices: participation in a given recreation activity, the site(s) to visit, the frequency of trips to a given site, and the length of stay. He goes on to explain recent advances in statistical techniques for modelling each recreational choice, and illustrates (using deer hunting) how linking two of the four recreation choices yields more complete estimates of the change in number of trips, income and employment.

Another more general problem is the extent to which aggregating preferences reflects the type and range of values of concern. For example, the presence and size of human settlements in areas bordering a site or national park may play a decisive role in determining attributed monetary values. The closer an ecosystem is to large human settlements the more there are likely to be frequent visitors and hence a larger aggregate monetary value may be calculated as being associated with the site. Those coming from further away to a remote site will have a higher willingness to pay which can counter this impact on total site value, but a green space in the city may easily prove to have a higher monetary value on the basis of low cost but frequent visits. In the extreme a wilderness area which restricted all access would be regarded as having no value under the TCM. Thus, contrary to a criterion of environmental prioritisation based upon the pristine or virgin status or biodiversity of an ecosystem , an altered and ecologically degraded site can appear socially preferable and of more value under the TCM. Using TCM in Europe to indicate which ecosystems should be protected as rare habitats may therefore lead to the loss of ecosystems in remote regions, regardless of their ecological quality or significance.

The extent to which TCM might help assess the environmental externalities can be summarised as follows. Recreation and tourism cover several activities such as hiking, painting, photography and bird watching. TCM was developed with the site specific recreational visitor in mind and is therefore well suited to assessing these values, but the qualifications mentioned above (e.g. non-site benefits) must be taken into account. The extent to which TCM can address other aspects of environmental value is often limited.

Aesthetic changes (such as 'wilderness' aspects) are only likely to be discernible in TCMs where the site has special features creating a recreational demand, and even then they may be difficult to define or measure. Cultural and historical values would only be part of TCM estimate of demand where they are associated with site specific features, and require site visits for enjoyment or evaluation. Peace and quiet, as part of a site's recreational experience, might be included under TCM, but the impact on the wider community of noise pollution (e.g. from farming machinery or aggregates extraction) would be excluded. Health and safety concerns associated with certain rural land uses would fall beyond the scope of TCM to evaluate. In general the site characteristics valued by TCM are only those recognised by visitors as important. That is, the values are implicit in the preferences of the visitors. This means, if visitors fail to recognise the importance or even existence of a characteristic of a site (e.g. biodiversity) then this characteristic will be absent from the valuation via TCM. In particular, genetic diversity and ecosystem functions are unlikely to form part of site values obtained under TCM.

3.2 Production function approach

The production function approach (PFA) generally uses scientific knowledge on cause-effect or dose-response relationships, i.e. the relationship between environmental quality variables and the output level of a marketed commodity. The PFA has been popular in studying air pollution impacts on agricultural crops (Spash 2001), but has also been applied elsewhere, for example pollution impacts on fisheries, e.g. Kahn (1991) and Silvander and Drake (1991). The PFA requires a quantifiable definition of the environmental change of concern, linking this change to a receptor response function, and then applying the results to an economic model for a related market good. Thus, applications have been determined by the availability of existing scientific information on dose-response functions.

Physical characterisation of environmental quality change requires the analysis of biological processes, technical possibilities, their interactions with producer decisions and the effect of resulting production changes on consumer and producer welfare. Biological or production response data provide a link between an environmental variable (e.g. water or air quality) and the performance parameters of an ecosystem. The response relationship may be quantified directly from biological experimentation, indirectly from observed producer output and behavioural data (secondary data) or from some combination of data sources. Procedures based upon producer data (e.g. production or cost functions) are preferable from the viewpoint of economic analysis (Adams 1983) and can avoid the need for explicit cause-effect functions. However data and statistical difficulties have restricted their applicability. Scientifically derived cause-effect functions have been most commonly applied in economic assessments. Cause-effect models offer a means of measuring the economic costs of several important environmental quality changes. However controversies over the appropriate way in which to model responses mean that widely varying estimates of economic damages can emerge. In addition, the model must be linked to data on the physical environment (e.g. water or air quality) in order to make accurate impact predictions. Such data needs to be locally or regionally disaggregated and is normally unavailable.

The choice of the economic model brings its own set of problems. Three main categories of economic approach can be defined: traditional models, optimisation models and econometric models. The traditional approach takes given market prices and multiples these by losses in output. Thus the latter two approaches are to be preferred as they avoid this crude approximation of economic impacts in an oversimplified market structure. The main requirement for easy assessment of consumer and producer welfare is the existence of well established economic models. In their absence the analyst must construct a model and test its validity.

In the case of the environmental externalities from environmental changes the main areas in which a PFA could operate would be in looking at impacts on market products, materials damage and health effects related to labour markets. The PFA is unsuitable for estimating the benefits from wildlife conservation, or recreation and tourism unless there is an associated market good or service with which to link dose-response functions. For example, if wildlife conservation increased or reduced production costs (or increased or reduced marketed output), then a link could be feasible with the impacts on existing product supply, cost and/or profit functions. Cultural and historical values which might be lost due to land use practices could only be assessed via physical impacts on materials (e.g. the rate at which chemical applications might cause erosion) which would relate only to maintenance costs rather than the socio-economic aspects of culture.

Ecosystems functions are commonly ignored by consumers and producers and therefore difficult to value in economic terms. The PFA is the only method which seems appropriate here because of its basis in

scientific knowledge which can then be linked into economic processes, although the values it will be able to assess would still be limited. A more general problem is the lack of suitable scientific information.

3.3 Hedonic pricing

In this section reference is made to house prices as an example of how hedonic pricing (HP) could be applied to rural land use change, although similar models have been applied in labour markets where environmental risks are internalised in the wage rate. Aspects of the environment can be valued via their impact on the price of housing by being one of the characteristics which contribute to the definition of the commodity which a particular house and location represent. Thus, proximity to clean water and air, recreational opportunities, peace and quiet can all be expected to be factors increasing prices of housing in certain markets. Conversely, the existence of pollution or environmental nuisance may reduce the price of housing in the vicinity. The problems with implementing the HP approach include choosing the variables to include and the functional form.

The analyst must decide which factors to include as explanatory variables in the HP equation and the demand curve. Excluding a variable which has a significant effect on house prices, and which is correlated with some or all of the other variables in the model, will influence the estimation of coefficients. This leads to biased estimates for these coefficients and for the implicit prices (see Atkinson and Crocker 1992). Several of the independent variables included in the HP equation may be closely correlated with each other. This is the problem of multi-collinearity. The HP equation is non-linear so as to allow derivation of a demand equation. However there is no universally preferred functional form. Criteria which might be used to select the functional form include: restricting the number of parameters, selecting parameters justified by economic theory, choosing the form which economises on computing time, finding a form which provides a good explanation of the observed data and gives correct predictions, e.g. house prices falling with increased pollution (see Garrod and Allinson 1991). Housing markets are often segmented on grounds such as ethnic composition, rental versus owner-occupied, and price bracket. This can bias coefficients in the price function because segmentation implies that demand parameters vary across sectors. The HP analyst must then estimate separate price equations for each segment of the market. In a study of Boston, Michaels and Smith (1990) asked estate agents to segment the housing market and so identified four distinct sub-markets. Separate HP equations were then estimated for each segment in order to value the disutility of living close to hazardous waste sites.

HP assumes that current levels of environmental quality are the main influence on house prices, but they can also be influenced by expected changes in environmental quality. For example, the prospect of strict dust and noise regulations relating to quarries can keep prices higher in zones near such sites than in the absence of such expectations. The implicit price would fail to measure the valuation of current noise and air quality levels alone. Similarly, the expectation that a quarry will close in the near future, and the site will be restored, can raise prices where they had been depressed by the quarrying activities.

The HP approach is related to regional or site-specific characteristic but can be used to gain aggregate estimates of demand on the basis of site data. Where recreation and tourism are recognised components of the housing market HP could be used to value changes in their quality, subject to the qualifications above. Aesthetics, or aspects thereof, have been subject to benefit estimation using HP, although CVM (discussed below) is seen to have several advantages. The extent to which the aesthetic concept is seen to be captured will depend upon how it is defined, e.g. beauty versus water quality. Providing a disaggregation of aesthetic values seems unlikely due to the difficulty of finding and agreeing upon any measure of aesthetic variation. On a more practical level, Graves (1991) points out that data is severely limited, not only due to a lack of measurement but also, because many important aesthetic features are located away from well developed markets. Cultural and historical values could also, in theory, be derived from HP where the characteristics associated with these values are identifiable, e.g. a particular geographical location or building. However the extent to which such values are capitalised into land or house prices is questionable; for example, house location can be unrelated to the enjoyment of cultural and historical sites. In general HP would be useless due to the inability to provide data measuring quantity or quality variations of these concepts by location. Health and safety, noise and air pollution may be assessed via HP. For example, Hughes and Sirmans (1992) have used a standard HP model to show a substantial negative effect of traffic externalities on single-family house prices. Similarly, house prices have been shown to be influenced by the positive externalities from urban forests which include benefits derived from pleasant landscape, clean air, peace and quiet and screening, as well as recreation (Tyrvainen 1997). However HP studies do not generally disaggregate these estimates but rather tend to assess the total (positive or negative) externality.

The theoretical assumptions underlying HP mean it will give inaccurate estimates of environmental externalities if buyers lack perfect information about relevant environmental quality variables, buyers are unable to attain their utility maximising position, or the housing market is in disequilibrium. Furthermore, HP requires weak complementarity which means only those environmental externalities of rural land uses that have an impact on the property market will be measured. Finding suitable variables to measure environmental quality attributes can be problematic.

3.4 Stated preference methods

Stated preference methods directly survey individuals to obtain their preferences rather than analysing their actual behaviour as revealed in the market place. This has led to some criticism from those economists who prefer to use secondary data collected by government agencies but which is related to actual behaviour. Research collecting primary data on intended behaviour is common in other social sciences and the conditions for convergence with actual behaviour have been studied extensively (see Fishbein and Ajzen 1975). In terms of the CVM there have also been tests comparing actual with stated willingness to pay. The apparent advantage attributed to methods such as TCM and HP is that they relate to actual behaviour, but as has been explained above the links being drawn between observational data and the underlying motives are often weak or purely speculative. This suggests the need for economists to pay far more attention to motives for behaviour, whether intended or actual.

CVM is the principal stated preference method although both conjoint analysis and choice experiments have received some recent attention. In contrast to the other three methods reviewed above, CVM has received considerable and increasing attention in the literature with academic journal articles on the subject in excess of 1000 studies world-wide. The main advantage attracting this attention is the ability of CVM to estimate what are termed option, 'existence' and bequest values in addition to direct use values. The combination of these indirect or passive use values can be large compared to the direct use values associated with non-market goods to which the other methods are solely restricted.

There are several stages to conducting a CVM study: survey design, pre-testing, carrying out the main survey, estimating willingness to pay (WTP) and/or willingness to accept (WTA), bid curve analysis, data aggregation, and final assessment. In particular application of the technique requires careful survey design, awareness of potential biases and a decision on whether to use WTP or WTA. The design of a CVM study includes the amount, type and way information is presented to individuals, the order in which it is presented and the question format. There is a wide body of evidence to suggest that survey design can affect responses. Survey design requires framing a realistic decision concerning the environment where the monetary question to be asked is accepted as a possible state of the world in which individual respondents might find themselves. Important decision by the analyst include a reason for the payment and how, including how often, funds will be raised (the bid vehicle). The technique for bid elicitation may be an open-ended question, a dichotomous choice, or a bidding game. Also, at this stage information on physical changes will be summarised and the method of their description chosen (e.g. text, graphics, maps).

Due to the sensitivity of responses to the information supplied the pre-testing of the survey has become of increasing importance. This can be conducted via a small sample test run of the survey or a focus group. The pre-test will enable the identification of problems with regard to the framing of the decision problem as well as divergence between encoding and decoding of information. The conduct of the main survey can use several variations. The in-house interview is now most favoured, although the expense of this approach often means surveys are completed in the street, by telephone interviewing or mail. The sample is often weighted in terms of the local or regional population which is seen as politically more important to the decision and likely to have strong direct economic connections to the outcome.

WTP and WTA are the two welfare measures available for a CVM survey. Willig (1976) showed that the two measures would be close if the ratio of consumer's surplus to income (expenditure) was sufficiently small, and if the income elasticity of demand for the good in question was sufficiently low. Where these conditions failed to hold, precise limits on the difference between the two measures could be calculated. Whilst Bockstael and McConnell (1980) criticised the applicability of Willig's findings to environmental benefits, Randall and Stoll (1980) extended Willig's theorem (which was derived for price changes) to the quantity changes more commonly encountered in environmental valuation. Despite this stated WTP has still been found to be significantly lower than stated WTA (e.g. Rowe *et al.* 1980; Hammack and Brown 1974), and lower than the Willig approximation would suggest. In addition, experimental work by Knetsch and Sinden (1984) and Gregory (1986) has also found that WTA exceeds WTP. On practical grounds, the status quo

reference position is preferable in terms of the property rights structure. If an alternative is imposed by the blanket imposition of WTP formats in all CVM surveys, the result can be to create an unrealistic trade-off, hypothetical market bias and protest bids. Thus, rather than follow a generic prescription to always use WTP formats as a conservative estimate of values (e.g. guidelines suggested by NOAA 1994), the property rights prevalent in a given situation should be used as guidance. This reinforces the theoretical argument for using WTA to measure a loss and WTP for a gain (Knetsch 1994).

Typically, median bids are less than mean bids so both are reported. At this stage the treatment of 'protest bids' becomes problematic and these are often omitted from the mean calculation. Protest bids are zero bids given for reasons other than a zero value being placed on the resource in question. For example, a respondent may refuse any amount of compensation for loss of an environmental asset which they regard as unique or a species which they feel should be protected at all costs. Respondents may refuse to state a WTP/WTA amount because they reject the survey as an institutional approach to the problem, or because they have an ethical objection to the trade-off being requested, e.g. a lexicographic preference. Analysis of the bid curve is used to test construct validity, i.e. that the socio-economic variables have the expected signs, and the regression is statistically significant. Other relationships can also be investigated at this stage. In general bid curve analysis has tended to be of academic, as opposed to policy, interest despite the relevance for judging whether the exercise has produced the expected results in accordance with economic theory.

The method of aggregating data, both across time and space, requires deciding on the relevant population, the method of aggregating from the sample bid, and the time period or discounting procedure for aggregation. These are major concerns in CBA and have serious impacts on any resulting monetary values. The sensitivity of the results to variations in such factors should be tested and presented as a central aspect of the findings, however this is rarely the case. Sensitivity analysis in CBA is generally ignored or extremely limited.

Final reflection upon the CVM study can include convergent validity and success of repeatability where there exist other similar studies. The overall success of the exercise will also become apparent as the results are being analysed, e.g. a high number of protest bids. There are several specific problems which are recognised as possible causes of bias, some of which have been mentioned: strategic bias, design bias (choice of bid vehicle, prompting a bid). More problematic are the impact of information, as this is by necessity restricted but can have serious influence upon the resulting bids, and the problem of embedding as raised by Kahneman and Knetsch (1992). These two issues are discussed next.

In a hypothetical market, respondents combine information provided to them regarding the good to be valued, and how the market will work, with information they already hold on that good. Their responses may be influenced by either hypothetical market or commodity-specific information given to them in the survey. This phenomenon implies that WTP/WTA values are endogenous to the valuation process. Samples *et al.* (1986) found bids to preserve different animal species varied significantly according to the information provided by researchers. Ajzen *et al.* (1996) concluded from experimental research that the nature of the information provided in CVM surveys can profoundly affect WTP estimates, and that subtle contextual cues can seriously bias these estimates under conditions where the good is of low personal relevance. Whitehead and Blomquist (1991) show both theoretically and empirically how information on environmental substitutes changes the value of related goods. In their research, telling respondents about alternative wetland sites significantly altered WTP to protect the Clear Creek wetland in Kentucky. However Randall (1986) has argued that CVM answers should vary under different information sets, otherwise the technique would be insensitive to significant changes in commodity framing. The divergence of opinion here relates to information provided which economists regard as important to the decision and should therefore have an impact but fails to do so, and information which would be regarded as peripheral or irrelevant by economists but which does have an impact on stated behaviour. Indeed, the effects of information may be inappropriately labelled as bias, depending on the way in which WTP/WTA is changed. Information which improves the knowledge of an individual concerning the characteristics of a good can be regarded as informing a consumption decision. Information which alters the preferences is more problematic in the neo-classical framework and could be regarded as creating a bias. For example, Baron and Maxwell (1996) show that individuals' WTP can be biased by information on the cost of provision of public goods and suggest eliminating information from which costs could be inferred, so that respondents can focus more easily on benefits alone. While such redesign may avoid some types of bias, a more general issue, which remains, is how far individual preferences can be regarded as exogenous to the valuation process and especially so when goods are unfamiliar and/or never traded in a market.

This problem arises when the component parts of an individual's valuation are evaluated separately and when summed found to exceed the valuation placed upon the whole. Evidence that such behaviour exists was provided by Seip and Strand (1990). CVM studies have found part-whole bias, also termed embedding, and this has been attributed by some to valuation of the moral satisfaction from contributing to a worthy cause ('warm glow') rather than the good itself (Kahneman and Knetsch 1992). The counter reaction has been that CVM surveys finding embedding are flawed in some way which creates the part-whole bias, and that this can be corrected by careful survey design (Carson and Mitchell 1993, 1995; Hanemann 1994). However Bateman *et al.* (1997) have provided experimental evidence for the existence of part-whole bias for private goods outside of the CVM context. They therefore suggest the problem lies with economic preference theory rather than the CVM approach.

CVM can in theory, although to varying degrees, address most of the non-market value categories related to environmental change, with the exception of biodiversity and ecosystems functions. Biodiversity itself has rarely been valued in CVM, instead individual species (rather than their diversity) have been a focus of research. Aesthetics have been subject to benefit estimation by HP and CVM, with Graves (1991 p. 225) regarding CVM as having several advantages, i.e. distinguishing the aesthetic dimension of a policy change; generating data rather than relying on remote proxies; imposing fewer behavioural assumptions; and yielding plausible results, particularly in applications to visibility. However defining aesthetic qualities and conveying them to individuals so they become familiar with the concepts in a commodity framework can be difficult or impossible. Also, the description of an aesthetic quality may itself introduce distortions.

One practical issue in terms of applying CVM concerns the disaggregation of benefit categories. Whilst the CVM survey can, in theory and as mentioned, be applied to a range of value categories any one survey will be limited in scope and is normally restricted to an aggregate assessment of total benefits, as with the other methods. The most common disaggregation is by direct use and passive use (i.e. two categories) and in some cases by use, option, existence and bequest values (i.e. four categories). This kind of disaggregation could be carried out for classes of an externality by one of three main methods. First, obtain a total bid and then ask respondents to split the total, e.g. state the percentage attributable to each category. Second, ask for an evaluation of each externality either by the same individual or, if a large enough sample is available, by different individuals (i.e. sub-samples for each externality). Both these approaches may be difficult for individuals to comprehend. Third, develop alternative scenarios so that aspects of the externality are removed (e.g. noise/no noise) for different sub-samples. The problem here is to develop realistic scenarios responsible for creating the change in the externality. The issue of disaggregating benefits by externality and the preceding discussion highlights the continuing experimental nature of the CVM approach.

In areas where an environmental change can be easily described and understood in terms of a choice based upon individual preferences, and the market trade-off implied is accepted as appropriate to the decision then CVM seems applicable. However where aesthetics, cultural & historical values and ecosystems functions & biodiversity are concerned these conditions often seem unlikely to hold. Where only certain aspects of such environmental concepts are easily explained and/or captured in commodity terms the resulting monetary valuation will be a poor reflection of the environmental values they encapsulate.

4. Conclusions

Table 1 provides a summary of the methods discussed so that the economic valuation techniques suitable for use in the context of several categories of environmental change can be easily identified. There is some danger in presenting such a simplified table and the qualifications and limitations of methods must be kept in mind. In addition there are general qualifications to the use of CBA. For example, income distribution is taken as given so that prices and monetary estimates will reflect relative purchasing power in society. Adjustments could be made to the results to test for the impact of changing income distribution, but, as with other sensitivity analysis, this is rarely done in practice.

HP can assess certain aspects of externalities after they have occurred and have been capitalised. The PFA is generally inapplicable due to a lack of scientific data. TCM is primarily concerned with recreation and tourism values at a site prior to any development. As can be seen CVM provides the most potential for comprehensive coverage of externalities and could be conducted before or after an environmental change. In terms of including option, existence and bequest values only CVM can attempt to do so. CVM also provides considerable flexibility in the types of non-market value which can be addressed in the survey. However there are several aspects of implementing CVM which restrict the extent to which it will be able to assess environmental values. In practical terms, the cost of and time needed for conducting a CVM survey can be relatively high and have increased due to the extent to which various design features are now regarded as required practice. However, CVM remains an experimental technique which has been accelerated into public policy use by legal action in the USA over natural resource damages. Perhaps the greatest contribution the

technique is now making is in terms of forcing economists to reconsider the content and meaning of both observed and intended human behaviour with regard to a plurality of environmental values.

The extent to which societal well-being is related to the monetary estimates obtained by the methods outlined is highly context dependent. Thus, where there are large scale changes across space and time the micro-economic assumptions underlying welfare measures are unlikely to hold. Similarly, where there are diverse cultures or differences in agreement over the role of markets there will be rejection of the value basis of the measures. Economists have tended to overlook such issues but in applied policy arenas this merely means economic prescription become unrealistic and academically abstract. If an ethical concern or income distribution issue is key to the valuation of an environmental change then a more pluralistic approach is required than offered by standard monetary valuation methods. This means explicitly considering the role of monetary estimates in an openly discussed decision process rather than assuming CBA is merely one input into an undisclosed process of politics.

Table 1: Current suitability of CBA methods for assessing the economic externalities of environmental change

	Method			
Non-Market Value Category	TCM	PFA	HP	CVM
Aesthetics	?	-	?	?
Cultural & Historical Values	?	-	-	?
Health & Safety	-	+	?	+
Ecosystems Functions & Biodiversity	-	?	-	?
Peace & Quiet	?	-	+	+
Recreation & Tourism	+	-	?	+
Water & Air Quality	?	+	+	+

Key:
- \- Of little or no use
- ? Sometimes useful
- \+ Potential for application strongest

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