BLUEPRINT FOR A GREEN ECONOMY

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3. VALUING THE ENVIRONMENT

Chapters 1 and 2 showed that however sustainable development is interpreted it requires that we raise the political and economic profile of the environment. But there is an implicit bias in the way in which economies work. Many goods and services have prices which can be observed in the marketplace. Environmental goods and services and the general functions which environments serve (e.g. as a waste sink) are not invariably bought and sold in the marketplace. Thus if we leave the allocation of resources to the unfettered market, it will tend to *over-use* the services of natural environments.

This observation is elaborated upon in Chapter 7 and is a fundamental feature of economic science. In order to ensure a better allocation of resources, one that at least tries to correct the bias implicit in the unfettered marketplace, it is important to have some idea of what the environment is "worth". Chapter 1 stressed the importance of a proper *valuation* of the environment as a major feature of sustainable development. This notion offends some conservationists. It is therefore worthwhile explaining the basics of the economic valuation of environmental services.

Economics and environmental values

Care and concern for the environment can be thought of as positive preferences for cleaner air and water, less noise, protection of wildlife, and so on. Economics is about choice, and choice relates to situations in which we have preferences for certain things but in which we cannot choose everything we like because of income limitations. Very simply, given limited resources, the rational thing to do is to choose between our preferences in an effort to get the most satisfaction – or "welfare", to use the economist's term – we can. If we apply economics to environmental issues, then, we should expect to obtain some insights into the desirability of improving the environment further, taking the social objective of increasing people's overall satisfaction (or welfare) as given. This assumption about the social objective used to derive measures of gains and losses is important.

To be clear, what is being said is that an improvement in environmental quality is also an economic improvement if it increases social satisfaction or welfare.

Such a definition raises a host of questions and problems. For example, whose welfare are we talking about? It could readily be the case that we can improve this generation's welfare but only at the cost of the next generation's. Should we take this into account, and, if so, how? How far into the future should we look – a few generations, hundreds of years, or maybe thousands? Another problem concerns the legitimacy of measuring gains and losses according to how they impinge on human welfare alone. There is an extensive philosophical debate on the moral rights and standing of living creatures other than man: if they are ascribed rights, what relation do these rights have to human rights – are they equal, superior or less? A third problem (there are many more) is that a social objective based on mankind's more immediate wellbeing need not be consistent with long-run welfare or even human survival: while it is tempting to think that economic systems should contain some in-built mechanisms for sustainability, there is no evidence that they do. Some care needs to be exercised, then, that the use of social objectives such as gains in welfare does not dictate or support policies which are inconsistent with the ecological preconditions for existence or, at least, some minimal quality of life.

The preferences for the environment, which show up as gains in welfare to human beings, need to be measured. It may seem odd to speak of "measuring preferences" but this is exactly what that branch of environmental economics devoted to *benefit measurement* does. A benefit is any gain in welfare

(or satisfaction or "utility"). A cost is any loss in welfare. We are concerned then with the measurement of the benefits from improvements in, or the costs of reductions in, environmental quality. If we prefer clean air, we place a value on it. But since clean air is not bought and sold in the marketplace, at least not directly, money is not directly involved. None the less, the benefit of clean air is an economic benefit – it improves the welfare of people.

In benefit estimation money is used as a measuring rod, a way of measuring preferences. There are very good reasons for supposing that money is a good measure of the gains and losses to people from environmental change. What is important is that money just happens to be a convenient measuring rod. As long as we do not forget that there will be some immeasurable gains and losses, the measurement of gains and losses in money terms will turn out to be revealing and, we shall argue, supportive of environmental values and environmental policy.

Although we limit money to being just a measuring rod, even this limited role for it still causes many people problems. For example, what does it mean to place a money value on the benefit of preserving the Californian condor or the African rhinoceros? The temptation is to say that such creatures are "beyond price".

There are, however, two interpretations that might be placed on the idea that something is priceless. The first is that priceless objects are of infinite money value. When art experts speak of priceless works of art, however, they do not mean that they have infinite values. They mean that they are unique and irreplaceable, but that, in auction they would fetch very high prices indeed. A moment's reflection will indicate that no one can or would pay an infinite price for them. So it is with the condor and the rhinoceros: their preservation is worth very large sums of money – many of us would pay substantial sums to see them preserved – but none of us values them at an infinite price. The equation of "priceless" with "infinite value" is illicit. The second interpretation is more appealing. This says that there are some things in life which simply cannot be valued in money terms – there is somehow a compartment of our thinking that refuses to place money values on, say, human life. While this is a more reasonable interpretation of phrases such as "beyond price" care needs to be taken in applying it. We do not act as if human life, for example, is outside our capacity to value things in money terms. We quite explicitly draw boundaries round the kinds of expenditures that we are prepared to make to save life. Thus, while there remains a quite warranted suspicion that the process of money valuation is illicit in some contexts, the reality is that choices have to be made in contexts of scarce resources. Money as a measuring rod is a satisfactory means of proceeding.

Environmental improvements can show up in the form of effects which have *direct money values*. Improving a beach or river or wetland area, for example, can increase the number of visitors and, if the area has entrance charges, the revenue from those charges will increase. Reducing air pollution can improve the growth and quality of agricultural crops and there is obviously a direct monetary counterpart to such gains. Reducing sulphur emissions may lower the rate at which buildings or metal structures corrode. The direct market value of such reduced corrosion can be estimated by looking at the prolonged life of the structures and hence the reduced cost of protecting them or replacing them. Slightly less obvious is the effect that improving human health has on the saving of marketed resources. Reductions in respiratory disease from reducing air pollution, for example, will show up in a reduced demand for health care, thus saving on health service costs, and in less days lost from work due to illness. Notice, however, that these gains in reduced resource costs and increased productivity are not adequate measures of the welfare gain. This can only be measured by the value placed on improved health by the person at risk, and, typically, this will bear little relation to the resource costs that are saved. We shall return to this issue later.

The above examples indicate some of the ways that we can approach the monetary evaluation of the welfare gains from environmental improvement. But many of the gains will not show up even in such an indirect fashion. Suppose for example that the improved wilderness area is not subject to entrance charges but that because of the improvements more people

do visit it. There is no apparent "market" in the environmental improvement: the gain is not bought and sold by anyone.

It is important to realize that, while the absence of markets or indirect markets makes the process of economic evaluation more difficult, it by no means renders it impossible. Even more important, the absence of a market or indirect market does not mean that economic gains are not present. There are still welfare improvements – people prefer the wilderness area to be improved. This preference has to be measured.

The uses of monetary measures

Why is it important to place monetary measures on environmental gains and losses? There are several reasons.

Preferences for environmental improvement can show up in various ways. We have already noted, for example, that membership of environmental bodies responds to increased awareness. Political lobbies are another mechanism, not unrelated to membership of pro-environment organizations, and the concern of political parties to secure the "green vote" is another manifestation of the importance of environmentalism. Both expressions of concern capture to some extent the intensity of preference for the environment, but the attraction of placing money values on these preferences is that they measure the *degree* of concern. The way in which this is done is by using, as the means of "monetization", the willingness of individuals to pay for the environment.

At its simplest, what we seek is some expression of how much people are willing to pay to preserve or improve the environment. Such measures automatically express not just the fact of a preference for the environment, but also the intensity of that preference. Instead of "one man one vote", then, monetization quite explicitly reflects the depth of feeling contained in each vote.

If, of course, the issue is one of losing an environmental benefit, we may wish to rephrase the problem in terms of individuals' willingness to accept monetary compensation for the loss, rather than their willingness to pay to prevent the loss. This can result in very large implied values of environmental quality. Our first reason for seeking a monetary measure, then, is that it will, to some considerable extent, reflect the strength of feeling for the environmental asset in question.

The second reason arises out of the first: provided the monetary measures that are revealed are sufficiently large, they offer a supportive argument for environmental quality. The usefulness of such arguments in turn arises from the fact that voters, politicians and civil servants are readily used to the meaning of gains and losses that are expressed in pounds or dollars.

To say that a particular species in danger from some development is valued very highly because of the vocal expression of concern is one thing. To support that argument with a monetary expression of that concern makes the case for preservation stronger than if any one argument is used alone.

The third reason for wanting to make the effort at monetization is that it may permit comparison with other monetary benefits arising from alternative uses of funds.

The point here is that preserving and improving the environment is never a free option: it costs money and uses up real resources. This is true whether actual expenditures are incurred to preserve a habitat or insulate houses against noise or introduce sulphur emission reductions, or whether the cost of preservation is in terms of some benefit forgone. Preserving a wetlands area, for example, may well be at the cost of agricultural output had the land been drained. If a monetary measure of environmental benefits can be secured, it can be compared to the monetary benefits of the agricultural output. This will help in any analysis of the extent to which it is socially worthwhile to preserve the land. The option with the biggest net benefit – i.e. the excess of benefits over costs – will be the one that is preferred, subject to any other considerations relating, say, to the interests of future generations.

The reasoning above may be formalized. The exercise of comparing the costs and benefits of two or more options of the use of land in the manner discussed is known as cost–benefit analysis.

Cost-benefit analysis (or CBA for short) makes operational the very simple, and rational, idea that decisions should be based

on some weighing up of the advantages and disadvantages of an action.

At the moment, it is important to stress that CBA is not the only way to assist in decisions of the kind under consideration. There are other approaches which may be preferred. But CBA is the only one which explicitly makes the effort to compare like with like using a single measuring rod of benefits and costs, money.

Monetary value of national environmental damage and benefits

It is possible to illustrate the way in which benefit estimation techniques have been used to measure the importance of damage to the environment and, the converse, the benefits of environmental policy.

Box 3.1 **Pollution damage in the Netherlands** (all figures are in billions)

	Cumulative Damage to 1985		Annual Damage 1986	
	Dfl	*US$*	*Dfl*	*US$*
Air pollution	4.0–11.4	1.2–3.0	1.7–2.8	0.5–0.8
Water pollution	n.a.	n.a.	0.3–0.9	0.1–0.3
Noise nuisance	1.7	0.5	0.1	0.0
Total	5.7–13.0	1.7–3.5	2.1–3.8	0.6–1.1

Source: Netherlands Ministry of Public Housing, Physical Planning and Environmental Management, *Environmental Program of the Netherlands 1986–1990* (The Hague, 1985); and J. B. Opschoor, "A Review of Monetary Estimates of Benefits of Environmental Improvements in the Netherlands", OECD Workshop on the Benefits of Environmental Policy and Decision-Making, Avignon, France, October 1986.

Box 3.1 shows estimates for the costs of environmental damage in the Netherlands. Note that these are damage estimates arising from pollution. A good many types of damage were not capable of "monetization", so that, if the monetized figures are accepted, actual damage exceeds the estimates shown. Various techniques were used to derive the figures and considerable caution should be exercised in using them. They are, at best, "ball-park" numbers. None the less, they show that even measured damage is a significant cost to the economy – the totals shown are 0.5–0.9 per cent of Netherlands GNP.

Box 3.2 present similar estimates for Germany. Again, many items have not been valued and differing techniques are used to derive the estimates. The figures shown total over 100 billion

Box 3.2 **Pollution damage in Germany**

	1983/5	
	DM billion	*US$ billion*
Air pollution		
Health (respiratory disease)	2.3–5.8	0.8–1.9
Materials damage	2.3	0.8
Agriculture	0.2	0.1
Forestry losses	2.3–2.9	0.8–1.0
Forestry recreation	2.9–5.4	1.0–1.8
Forestry – other	0.3–0.5	0.1–0.2
Disamenity	48.0	15.7
Water pollution		
Freshwater fishing	0.3	0.1
Groundwater damage	9.0	2.9
Recreation	n.a.	n.a.
Noise		
Workplace noise	3.4	1.1
House price depreciation	30.0	9.8
Other	2.0	0.7
Total	103.0	33.9

Source: adapted from data given in W. Schulz, "A Survey on the Status of Research Concerning the Evaluation of Benefits of Environmental Policy in the Federal Republic of Germany", OECD Workshop on the Benefits of Environmental Policy and Decision Making, Avignon, France, 1986.

Deutschmarks annual damage (about US$ 34 billion), the major part of which is accounted for by the disamenity effects of air pollution (which is likely to include some of the separately listed air pollution costs), and the effects of noise nuisance on house values. The important point is that, if the estimates can be accepted as being broadly in the area of the true costs, pollution damage was costing an amount equal to 6 per cent of Germany's GNP in 1985.

Box 3.3 shows estimates for the USA for the year 1978. However, in this case the figures are for *damage avoided* by environmental policy. That is, taking the total of $26.5 billion, the argument is that, in the absence of environmental policy,

Box 3.3 **The benefits of pollution control in the USA 1978**

	US$ billion
Air pollution	
Health	17.0
Soiling and cleaning	3.0
Vegetation	0.3
Materials	0.7
Property values[1]	0.7
Water pollution[2]	
Recreational fishing	1.0
Boating	0.8
Swimming	0.5
Waterfowl hunting	0.1
Non-user benefits	0.6
Commercial fishing	0.4
Diversionary uses	1.4
Total	26.5

Source: M. Freeman, *Air and Water Pollution Control: a Benefit-Cost Assessment* (New York: Wiley, 1982).

Notes: 1. Net of property value changes thought to be included in other items.
2. At one half the values estimated for 1985.

pollution damage would have been $26.5 billion higher in 1978 than it actually was. The total shown in Box 3.3 would be 1.25 per cent of GNP in 1978. The marked divergence between this figure and the percentage suggested for Germany is partly explained by the absence of estimates for noise nuisance, and by the very low figure for property value changes.

Total economic value

While the terminology is still not agreed, environmental economists have gone some considerable way towards a taxonomy of economic values as they relate to natural environments. Interestingly, this taxonomy embraces some of the concerns of the environmentalist. It begins by distinguishing user values from "intrinsic" values. User values, or user benefits, derive from the actual use of the environment. An angler, wildfowl hunter, fell walker, ornithologist, all use the natural environment and derive benefit from it. Those who like to view the countryside, directly or through other media such as photograph and film, also "use" the environment and secure benefit. The values so expressed are economic values in the sense we have defined. Slightly more complex are values expressed through *options* to use the environment, that is, the value of the environment as a potential benefit as opposed to actual present use value. Economists refer to this as *option value*. It is essentially an expression of preference, a willingness to pay, for the preservation of an environment against some probability that the individual will make use of it at a later date. Provided the uncertainty about future use relates to the availability, or "supply", of the environment, the theory tells us that this option value is *likely* to be positive. In this way we obtain the first part of an overall equation for total economic value (TEV). This equation says:

TOTAL USER VALUE = ACTUAL USE VALUE + OPTION VALUE

Intrinsic values present more problems. They suggest values which are in the real nature of the thing and unassociated with

actual use, or even the option to use the thing. "Intrinsic" value is a value that resides "in" something *and that is unrelated to human beings altogether*. Put another way, if there were no humans, some people would argue that animals, habitats etc. would still have "intrinsic" value. There is a separate, but not wholly independent, concept of intrinsic value, namely value that resides "in" something but which is captured by people through their preferences in the form of non-use value. It is this second definition of intrinsic value that we use. That is, values are taken to be entities that reflect people's preferences, but those values *include* concern for, sympathy with and respect for the rights or welfare of non-human beings. The briefest introspection will confirm that there are such values. A great many people value the remaining stocks of blue, humpback and fin whales. Very few of those people value them in order to maintain the option of seeing them for themselves. What they value is the *existence* of whales, a value unrelated to use, although, to be sure, the vehicle by which they secure the knowledge for that value to exist may well be a film or photograph or the recounted story. The example of the whales can be repeated many thousands of times for other species, threatened or otherwise, and for whole ecosystems such as rainforests, wetlands, lakes, rivers, mountains and so on.

The *existence values* are certainly fuzzy values. It is not very clear how they are best defined. They are not related to vicarious benefit, i.e. securing pleasure because others derive a use value. Vicarious benefit belongs in the class of option values, in this case a willingness to pay to preserve the environment for the benefit of others. Nor are existence values what the literature calls *bequest values*, a willingness to pay to preserve the environment for the benefit of our children and grandchildren. That motive also belongs with option value. Note that if the bequest is for our immediate descendants we shall be fairly confident at guessing the nature of their preferences. If we extend the bequest motive to future generations in general, as many environmentalists would urge us to, we face the difficulty of not knowing their preferences. This kind of uncertainty is different to the uncertainty about availability of the environment in the future which made option value positive. Assuming it is legitimate to include the preferences of as yet unborn individuals, uncertainty about future preferences could make option value negative.

Provisionally, we state that:

INTRINSIC VALUE = EXISTENCE VALUE

Thus we can write our formula for total economic value as:

TOTAL ECONOMIC VALUE = ACTUAL USE VALUE + OPTION VALUE + EXISTENCE VALUE

Within this equation we might also state that:

OPTION VALUE = VALUE IN USE (by the individual) + VALUE IN USE BY FUTURE INDIVIDUALS (descendants and future generations) + VALUE IN USE BY OTHERS (vicarious value to the individual)

The context in which we tend to look for total economic values should also not be forgotten. As discussed in Chapter 2, in many of those contexts three important features are present. The first is *irreversibility*. If the asset in question is not preserved it is likely to be eliminated with little or no chance of regeneration. The second is *uncertainty*: the future is not known, and hence there are potential costs if the asset is eliminated and a future choice is forgone. A dominant form of such uncertainty is our ignorance about how ecosystems work: in sacrificing one asset we do not know what else we are likely to lose. The third feature is *uniqueness*. Some empirical attempts to measure existence values tend to relate to endangered species and unique scenic views. Economic theory tells us that this combination of attributes will dictate preferences which err on the cautious side of exploitation. That is, preservation will be relatively more favoured in comparison to development.

Total economic value and decision-making

The relevant comparison when looking at a decision on a development project is between the cost of the project, the benefits of the project, and the TEV that is lost by the development. More formally, we can write the basic rules as:

(i) proceed with the development if

$$(B_D - C_D - B_P) > 0$$

and

(ii) do not develop if

$$(B_D - C_D - B_P) < 0$$

where

B_D refers to the benefits of development
C_D refers to the costs of the development, and
B_P refers to the benefits of preserving the environment by not developing the area.

TEV is in fact a measure of B_P, the total value of the asset left as a natural environment. The benefits and costs of the development will be relatively simple to measure, primarily because they are likely to be in the form of marketed inputs and outputs which have observable prices. This is clearly not going to be the case with TEV, so we need now to investigate ways in which we can measure the component parts of TEV.

Direct and indirect valuation

The approaches to the economic measurement of environmental benefits can be broadly classified as *direct* and *indirect* techniques. The former considers environmental gains – an improved scenic view, better levels of air quality or water quality, etc. – and seeks directly to measure the money value of those gains. This may be done by looking for a *surrogate market* or by using *experimental* techniques.

The surrogate market approach looks for a market in which goods or factors of production (especially labour services) are bought and sold, and observes that environmental benefits or costs are frequently attributes of those goods or factors. Thus, a fine view or the level of air quality is an attribute or feature of a house, a risky environment may be features of certain jobs, and so on. The experimental approach simulates a market by placing respondents in a position in which they can express their hypothetical valuations of real improvements in specific environments. In this second case, the aim is to make the hypothetical valuations as real as possible.

Indirect procedures for benefit estimation do not seek to measure direct revealed preferences for the environmental good in question. Instead, they calculate a "dose-response" relationship between pollution and some effect, and only then is some measure of preference for that effect applied. Examples of dose-response relationships include the effect of pollution on health; the effect of pollution on the physical depreciation of material assets such as metals and buildings; the effect of pollution on aquatic ecosystems, and the effect of pollution on vegetation.

However, indirect procedures do not constitute a method of finding willingness to pay (WTP) for the environmental benefit (or the willingness to accept (WTA) compensation for environmental damage suffered). What they do is to estimate the relationship between the "dose" (pollution) and the non-monetary effect (health impairment, for example). Only then do they apply WTP measures taken from direct valuation approaches. Accordingly, we do not discuss indirect procedures further in this chapter.

The hedonic price approach

The value of a piece of land is related to the stream of benefits to be derived from that land. Agricultural output and shelter are the most obvious of such benefits, but access to the workplace, to commercial amenities and to environmental facilities such as parks, and the environmental quality of the neighbourhood in which the land is located, are also important benefits which

accrue to the person who has the right to use a particular piece of land. The property value approach to the measurement of benefit estimation is based on this simple underlying assumption. Given that different locations have varied environmental attributes, such variations will result in differences in property values. With the use of appropriate statistical techniques the hedonic approach attempts to (a) *identify* how much of a property differential is due to a particular environmental difference between properties and (b) *infer* how much people are willing to pay for an improvement in the environmental quality that they face and what the social value of the improvement is. Both the identification and the inference involve a number of issues which are discussed in some detail below.

The identification of a property price effect due to a difference in pollution levels is usually done by means of a *multiple regression* technique in which data are taken either on a small number of similar residential properties over a period of years (time series), or on a larger number of diverse properties at a point in time (cross section), or on both (pooled data). In practice almost all property value studies have used cross section data, as controlling for other influences over time is much more difficult.

It is well known of course that differences in residential property values can arise from many sources, such as the amount and quality of accommodation available, the accessibility of the central business district, the level and quality of local public facilities, the level of taxes that have to be paid on the property, and the environmental characteristics of the neighbourhood, as measured by the levels of air pollution, traffic and aircraft noise, and access to parks and water facilities. In order to pick up the effects of any of these variables on the value of a property, they *all* have to be included in the analysis. Hence such studies usually involve a number of *property* variables, a number of *neighbourhood* variables, a number of *accessibility* variables and finally the *environmental* variables of interest. If any variable that is relevant is *excluded* from the analysis then the estimated effects on property value of the included variables could be biased. Whether the bias is upward or downward will depend on how

Box 3.4 Impact of air pollution on property values

City	*Year of: (a) property data (b) pollution measure*	*Pollution*	*% fall in property value per % increase in pollution*
St Louis	1960-	Sulphation	0.06–0.10
	1963	Particulates	0.12–0.14
Chicago	1964–7	Particulates	0.20–0.50
	1964–7	and Sulphation	
Washington	1970	Particulates	0.05–0.12
	1961–7	Oxidants	0.01–0.02
Toronto-Hamilton	1961	Sulphation	0.06–0.12
	1961–7		
Philadelphia	1960	Sulphation	0.10
	1969	Particulates	0.12
Pittsburg	1970	Dustfall and	0.09–0.15
	1969	Sulphation	
Los Angeles	1977–8	Particulates	
	1977–8	and Oxidants	0.22

Source: D. W. Pearce and A. Markandya, *Environmental Policy, Benefits: Monetary Evaluation* (Paris: OECD, 1989).

the included and excluded variables relate to each other and to the value of the property.

On the other hand if a variable that is irrelevant is included in the analysis then no such systematic bias results, although the estimates of the effects of the included variables are rendered somewhat less reliable. This would suggest then that we include as many variables as possible. However, doing so creates another difficulty. Typically many of the variables of interest are themselves very closely correlated. So, for example, accessibility to the town centre is often closely related to some measures of air pollution, and one measure of air pollution, such as total suspended particulate matter, is very closely correlated to other measures such as sulphur dioxide. To overcome this, many studies use only one "representative" measure of pollution.

Examples of hedonic price estimates of environmental quality

Box 3.4 reports the results of hedonic price air pollution studies where significant effects of air pollution on property values have been found and where these effects can be expressed irrespective of the units of measurement of pollution or property values (i.e. in percentage terms). As stated earlier, many such studies find it difficult to distinguish between different forms of air pollution because of their strong inter-correlation. In these

Box 3.5 The impact of aircraft noise on house prices (per cent of house price)

Location	*Impact of one unit change in NEF*	*Impact of one unit change in NNI*
USA		
Los Angeles	–	0.78
Englewood	–	0.78
New York	1.60–2.00	0.78
Minneapolis	0.40	0.62
San Francisco	0.50	0.45–0.90
Boston	0.40	–
Washington, DC	1.00	–
Dallas	0.58–0.80	–
Rochester	0.55–0.68	–
UK		
Heathrow (a)	0.56–0.68	–
(b)	–	1.12
Gatwick	–	1.46
Canada		
Toronto	–	0.18–0.60
Edmonton	0.50	–
Australia		
Sydney	0.00–0.40	–

Source: Pearce and Markandya, op. cit.

cases the one pollution measure included inevitably picks up the effects of all forms of air pollution with which it is strongly correlated. The results suggest that a one per cent increase in sulphation levels will result in falls in property values between 0.06 and 0.12 per cent. A similar increase in particulates lowers property values by between 0.05 and 0.14 per cent. Where the pollution variable is picking up more than one measure of air pollution, property value falls of between 0.09 and 0.5 per cent are recorded. Again we should note that the fall in property values per unit increase in pollution could vary with the level of pollution.

Boxes 3.5 and 3.6 show similar valuation approaches for noise nuisance. From Box 3.5 we would conclude that a unit increase in noise exposure frequency (NEF) will cause a 0.6 per cent reduction in the price of a house. (This is the average

Box 3.6 **The impact of traffic noise on house prices** (per cent of house price)

Location	*Impact of one unit change in Leq*
USA	
North Virginia	0.15
Tidewater	0.14
North Springfield	0.18–0.50
Towson	0.54
Washington DC	0.88
Kingsgate	0.48
North King County	0.30
Spokane	0.08
Chicago	0.85
Canada	
Toronto	1.05

Source: Pearce and Markandya, op. cit.

of the results reported in the NEF column.) Using a different measure of noise exposure, the noise and number index (NNI), the depreciation is just over 0.75 per cent for each unit of NNI. If these results applied today, what we would be saying is that aircraft noise causing a single unit change in the NNI measure of noise would "cause" a £3,750 reduction in the price of a house costing £50,000. From Box 3.6 we would conclude that an increase in traffic noise of one decibel will lower house prices by half of one per cent. Thus a house over £50,000 would lose £250 in value for every one-decibel increase in traffic noise.

Are hedonic price valuations reliable and accurate? The difficulty, of course, is that we have no absolutely correct yardstick against which to measure their reliability. If we had such a yardstick we would not need to engage in hedonic price approaches! It is thus in the *nature* of non-market valuation that accuracy and reliability have to be tested by other means. The main tests are:

(i) consistency of results in similar contexts;
(ii) consistency of results with *other* benefit estimation techniques;
(iii) consistency of results with "real market" experience.

On the basis of these tests, hedonic price valuation, properly executed, provides reasonably reliable benefit estimates.

Contingent valuation

The contingent valuation method (CVM) uses a direct approach – it basically asks people what they are willing to pay for a benefit, and/or what they are willing to receive by way of compensation to tolerate a cost. This process of "asking" may be either through a direct questionnaire/survey or by experimental techniques in which subjects respond to various stimuli in "laboratory" conditions. What is sought are the personal valuations of the respondent for increases or decreases in the quantity of some good, contingent upon an hypothetical market. Respondents say what they would be willing to pay or willing to accept *if* a market existed for the good in question. A contingent market is taken to include not just the good itself (an improved view, better water quality etc.), but also the institutional context in which it would be provided, and the way in which it would be financed.

One major attraction of CVM is that it should, technically, be applicable to all circumstances and thus has two important features:

- it will frequently be the *only* technique of benefit estimation;
- it should be applicable to most contexts of environmental policy.

The aim of the CVM is to elicit valuations – or "bids" – which are close to those that would be revealed if an actual market existed. The hypothetical market – the questioner, questionnaire and respondent – must therefore be as close as possible to a real market. The respondent must, for example, be familiar with the good in question. If the good is improved scenic visibility, this might be achieved by showing the respondent photographs of the view with and without particular levels of pollution. The respondent must also be familiar with the hypothetical means of payment – say a local tax or direct entry charge – known as the payment *vehicle*.

The questioner suggests the first bid (the "starting-point bid (price)") and the respondent agrees or denies that he/she would be willing to pay it. An iterative procedure follows: the starting-point price is increased to see if the respondent would still be willing to pay it, and so on until the respondent declares he/she is not willing to pay the extra increment in the bid. The last accepted bid, then, is the maximum willingness to pay (MWTP). The process works in reverse if the aim is to elicit *willingness to accept* (WTA): bids are systematically lowered until the respondent's minimum WTA is reached.

A very large part of the literature on CVM is taken up with discussion about the "accuracy" of CVM. Accuracy is not easy to define. But since the basic aim of CVM is to elicit "real" values, a bid will be accurate if it coincides (within reason) with one that would result if an actual market existed. But since actual markets do not exist *ex hypothesi* (otherwise there would be no reason to use the technique), accuracy must be tested by seeing that:

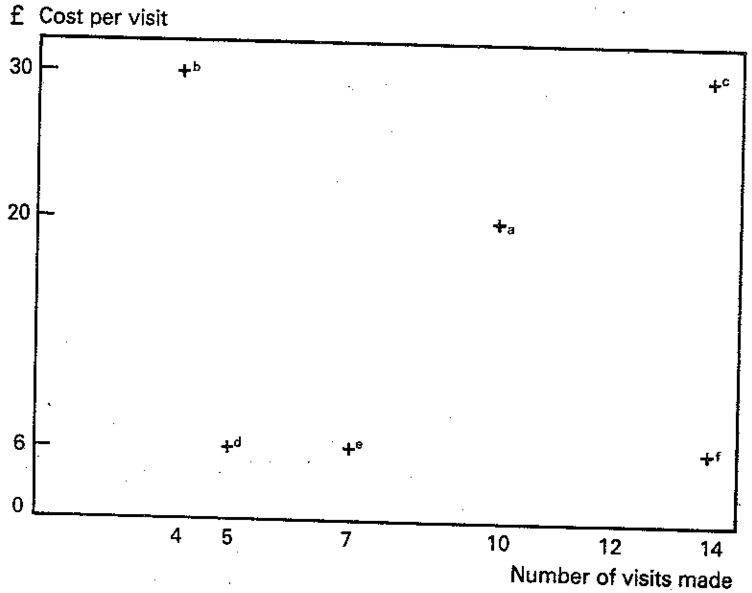
- the resulting bid is similar to that achieved by other techniques based on surrogate markets (house price approach, wage studies, etc.);
- the resulting bid is similar to one achieved by introducing the kinds of incentives that exist in real markets to reveal preference.

One significant feature of the CVM literature has been its use to elicit the different kinds of valuation that people place on environmental goods. In particular, CVM has suggested that existence values may be very important, as we shall see.

Travel-cost approaches

Travel-cost models are based on an extension of the theory of consumer demand in which special attention is paid to the value of time. That time is valuable is self-evident. What precisely its value is remains a question on which there is some disagreement, as will become clear later. However, as a starting point let us imagine a household consisting of a single person who works as a driver. He can work as many or as few hours as he wishes and he earns £5 an hour. He is fortunate enough not to pay taxes, and enjoys (or dislikes) driving for work or for recreation equally much. On a particular day he can either drive to a park that takes an hour to get to, and spend some time there, or he can go to work. In these circumstances he is faced with possibly two decisions. The first is whether to go to the park or to go to work. The second is, if he goes to the park, how much time to spend there. Suppose that the cost of the journey in terms of petrol and wear and tear is £3 and there is an entry fee of £1. If he goes to the park and spends a couple of hours there, then it will have cost him £4 in cash

Box 3.7 Hypothetical relationship between recreational visits and visiting costs



plus the loss of income £20. The true cost of the visit consists of the entry fee, plus the monetary costs of getting there, plus the forgone earnings. If we had information on all these variables, and we could obtain it for a large number of individuals, along with the information on the number of visits that each had made (and would make) during the season, then we could attempt to estimate the household's willingness to pay for a given number of visits. However, at first glance the data would not look very orderly. Box 3.7 shows the kind of data that we might find. Our single-earner household, for example, could be represented by the point **a**: he makes 10 visits at a cost per visit of £20. Points **b** and **c** represent two households, each of whom face a very high cost (£30). Of these **b** makes very few visits because it is

a poor household living far from the recreational site, and **c** is a high-earning household located near the park that makes a lot of short visits (being a high earner it has a high forgone earnings component to its costs). Points **d**, **e** and **f** also represent households with the same costs per visit. Whereas both **d** and **e** make few visits, **d** does so because it has no attraction to the facilities offered, but **e** does so because it has access to another park close to its residential location. Household **f**, on the other hand, makes a lot of visits. Although it is identical to **e** in every other respect, it is not located close to another recreational area. It is clear from the above that if we are to trace out how a particular household, such as **a**, would react to changes in the cost per visit, then we need to group together households that are similar to **a**. The locus of points linking such households would then constitute their *demand curve* for the recreational facilities that the site has to offer. Similarity here means grouping our observations according to income, preference for recreation and access to other recreational facilities. Given the demand curves we can calculate the benefits of the site by taking the area under these curves. Adding up the consumer surpluses for different categories of households gives us the overall benefit of the site.

If the model developed here is to be used to evaluate the benefits of environmental *improvements*, then further work has to be done. It is no longer enough to separate out the groups according to what other recreational facilities they may have access to. We now need to know how much of the willingness to pay of a category of households will increase if the facility at a particular site is improved to allow, for example, the possibility of fishing in a lake where none was possible before. This in turn requires knowledge of how much of the willingness to pay for each site is due to each of its specific facilities. Then by looking across sites we will be able to trace out changes in this willingness to pay as facilities change. The data required for such an exercise would include the facilities of each site and the location of each household relative to all the sites. This is clearly a very large amount of information and so some simplifying assumptions will be necessary in many cases. What these are and how they affect the result is discussed later in this section. If we can derive the demand curve for recreation for a particular category of households defined by household characteristics such as income, education and the liking for recreational facilities, and we can show how this demand curve would shift if facilities improved, then the benefit of the improvement can be derived. Box 3.8 illustrates some results obtained by travel-cost approaches in comparison to contingent valuation.

Box 3.8 **A comparison of the simple travel cost and contingent valuation estimates of water-quality benefits**

	Water quality change		
Approach	*Loss of area* (1981$)	*Boatable to game fishing* (1981$)	*Boatable to swimming* (1981$)
Contingent valuation			
Direct question	19.71	21.18	31.18
	(17)	(17)	(17)
Payment card	19.71	30.88	51.18
	(17)	(17)	(17)
Iterative bidding ($25)	6.58	4.21	10.53
	(19)	(19)	(19)
Iterative bidding ($125)	36.25	20.13	48.75
	(16)	(16)	(16)
Simple travel cost	3.53	7.16	28.86
	(69)	(69)	(69)

The analysis relates to several sites at the Monongahela River basin in Pennsylvania. The water-quality changes involve (a) water-quality changes that would preclude all recreational use ("loss of area"), (b) improving water quality, and (c) improving to the level where swimming could occur. The two approaches (CVM and TCM) are seen to be broadly consistent. See V. K. Smith and W. Desvousges, *Measuring Water Quality Benefits* (Boston: Kluwer, 1987), pp. 170–74.

More on existence value

The introduction indicated that existence value is a value placed on an environmental good and which is *unrelated to any actual or potential use of the good.* At first sight this may seem an odd category of economic value, for, surely, value derives from use? To see how existence values can be positive, consider the many environmental funds and organisations in existence to protect endangered species. The subject of these campaigns could be a readily identifiable and used habitat near to the person supporting the campaign. It is very often a remote environment, however, so much so that it is not realistic to expect the campaigner to use it now, or even in the future. Many people none the

Box 3.9 **Membership of conservation and nature appreciation groups in the UK**

	1989
National Trust	1,700,000
Royal Society for the Protection of Birds	540,000
Greenpeace	282,000
Royal Society for Nature Conservation	204,000
Worldwide Fund for Nature	125,000
Friends of the Earth	100,000
Ramblers Association	70,800
Woodland Trust	62,000
Council for the Protection of Rural England	38,000
Men of the Trees	6,000
London Wildlife Trust	5,000
Soil Association	5,000
Marine Conservation Society	4,000
Flora and Fauna Preservation Society	3,500
British Association for Nature Conservation	900

Source: Susan Pearce, London Environmental Economics Centre less support campaigns to protect tropical forests, to ban the hunting of whales, to protect giant pandas, rhinoceros, and so on. All are consumable vicariously through film and television, but vicarious demand cannot explain the substantial support for such campaigns and activities (see Box 3.9). This type of value, unrelated to use, is existence value.

Economists have suggested a number of motives, all of which reduce to some form of *altruism* – caring for other people or other beings:

(i) *Bequest* motives relate to the idea of willing a supply of natural environments to one's heirs or to future generations in general. It is no different to passing on accumulated personal assets. As noted above, however, we prefer to see bequest motives as part of a *use* value, the user being the heir or future generation. It is possible, of course, to think of a bequest as relating to the satisfaction that we believe will be given to future generations from the mere existence of the asset, but the very notion of bequest tends to imply that the inheritor makes some use of the asset;
(ii) *Gift* motives are very similar but the object of the gift tends to be a current person – a friend, say, or a relative. Once again, gift motives are more likely to be for use by the recipient. We do not therefore count the gift motive as explaining existence value – it is one more use value based on altruism.
(iii) *Sympathy* for people or animals. This motive is more relevant to existence value. Sympathy for animals tends to vary by culture and nation, but in a great many nations it is the norm, not the exception. It is consistent with this motive that we are willing to pay to preserve habitats out of sympathy for the sentient beings, including humans, that occupy them.

Much of the literature on existence value stops here. The reason for this is that altruistic motives are familiar to economists. They make economic analysis more complex but, by and large, altruism can be conveniently subsumed in the conventional model of rational economic behaviour. Essentially, it says that the wellbeing of one individual depends on the wellbeing of another

individual. There may, however, be other motives at work. Existence values may, for example, reflect some judgement about the "rights" of other non-human beings, or a feeling of "stewardship" about the global or local environment.

Genuine motives for environmental concern are likely to be many and varied. For current purposes what matters is that economic valuation of environmental gains and losses needs to take account of those motives.

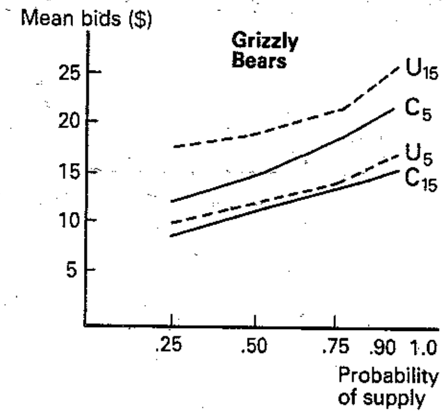
Empirical measures of option and existence value

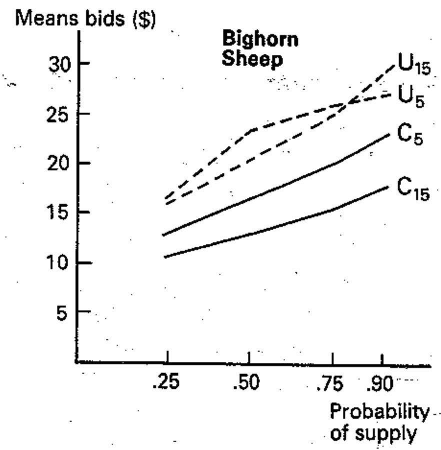
It is possible to secure empirical estimates of option and existence value by the use of methods which adopt a *contingent valuation* approach. In this section we report several studies which have attempted to obtain actual measures.

David Brookshire, Larry Eubanks and Alan Randall measured the *option price* (option value plus expected consumer surplus) and *existence value* of grizzly bears and bighorn sheep in Wyoming, both species being subject to threats to their existence. By asking hunters for their WTP in a context where the probability of there being adequate supplies of these species was variable, the authors were able to uncover different types of economic value. A hunter who was certain of his own intentions none the less faced uncertain supply. The pattern of bids is shown in Box 3.10. The **U** refers to respondents who were uncertain if they would hunt, the **C** to respondents who were certain they would. This captures an element of demand uncertainty. The subscripts **5** and **15** refer to the number of years before a programme being hypothetically paid for by the licences for which the respondents were bidding.

The overall option price should increase as the probability of supply increases. This was the result predicted by the theory and it is seen to hold in this case. One might also expect the bids based on certain demand to exceed those based on uncertain demand, but the diagrams show that there is no systematic relationship. Respondents who indicated they would never hunt the bears or sheep were asked what they would none the less pay to preserve the species. They were further divided into

Box 3.10 Option values and existence values





Mean grizzly and bighorn bids for certain (C) and uncertain (U) hunting demands over alternative time horizons (5 and 15 years).

Source: D. Brookshire, L. Eubanks and A. Randall, "Estimating option prices and existence values for wildlife resources", *Land Economics*, Vol. 9, no. 1, February 1983.

observers (a form of use value) and *non-observers* ("pure" existence value). The results provided estimates of "observer option price" – i.e. the option price associated with keeping the species for recreational observation – and existence value. The results were:

	Bears		Sheep	
	5 years	*15 years*	*5 years*	*15 years*
Average observer option price ($)	21.8	21.0	23.0	18.0
Average existence value	24.0	15.2	7.4	6.9

Clearly, these are significant sums. To see this compare them to the average option prices for hunting under, say, 90 per cent probability of future supply. For grizzly bears and the 5-year time horizon the sequence would be $21.5 option hunting price compared to $21.8 option observer price and $24.0 for existence value. Average existence value is on a par with the bids to maintain the population for hunting and observation.

In a later paper, Brookshire *et al.*[1] detail findings relating to the Grand Canyon. By looking at the bids made by respondents to experience improved visibility (regardless of whether visits take place or not), the authors find that the total "preservation bid" for the Grand Canyon's visibility was $4.43 per month, compared to a "user bid" of $0.07 per month. Interpreting existence value as the difference between total preservation value and use value, the finding is thus that existence value dominates preservation in this case. Existence value stands in the ratio of 66:1 to user values. (Note that what is being preserved is visibility, not the site itself.) The explanation for such a large ratio is that the resource in question is unique – it has no substitutes. Where substitutes exist one would expect existence values to be lower, and this tends to be the picture in other studies on existence value.

Jon Strand [2] reports a CVM-type study of acid rain for Norway. After indicating the nature of the environmental problem – damage to freshwater fish from acid rain – respondents were given a starting-point figure for the global cost of stopping acid pollution which was translated into a special income tax. They were then asked if they were willing to pay this sum. The approach was thus of the "take-it-or-leave-it" kind rather than one involving iterative bids in which respondents could vary their bid according to different levels of clean-up. But the hypothetical tax rates were varied across the four samples of respondents interviewed – i.e. the tax rate was the same for each sample but varied between samples. The "yes" responses were found for the lower taxes. Strand then estimates "bid curves" using this information in a conditional probability framework – i.e. estimating the probability that a respondent would pay a particular tax given a certain income. Strand estimates that the average bid was 800 Norwegian Krone per capita. Given a population of 3.1 million, this translates to a "national" benefit of 2.5 billion Krone per annum. Earlier work by Strand suggests that user values are about 1 billion Krone, so that subtracting this from the implied total preservation value of 2.5 billion Krone gives an existence value of 1.5 billion Krone. In 1982 terms this translates to some $270 million per annum or about 1 per cent of the Norwegian GNP. Note that, by asking WTP, the Strand study probably underestimates the true value of benefits of reduced aquatic acidification. The reason for this is that a good deal of the acidity arises from "imported" pollution and respondents will generally have been aware of this. Accordingly, they may well have had the attitude that others besides themselves should pay for the clean-up.

Conclusions on valuing the environment

It is not essential to be persuaded that the monetary valuations illustrated in this chapter are "accurate". Economics is not, and cannot be, a science in the sense of a laboratory subject or an analysis of physical objects. Its laboratory, after all, is human society itself. What does matter is that the implications of the valuation procedures outlined here are understood. These are:

(i) By at least trying to put money values on some aspects of environmental quality we are underlining the fact that

environmental services are *not* free. They do have values in the same sense as marketed goods and services have values. The absence of markets must not be allowed to disguise this important fact.

(ii) By trying to value environmental services we are forced into a rational decision-making frame of mind. Quite simply, we are forced to think about the gains and losses, the benefits and costs of what we do. If nothing else, economic valuation has made a great advance in that respect.

(iii) Many things *cannot* be valued in money terms. That is altogether different from saying they are "priceless" in the sense of having infinite values.

(iv) The fact that we find *positive* values for so many environmental functions means that an economic system which allocates resources according to economic values (i.e. consumer preferences) *must* take account of the positive economic values for environmental quality. Yet the actual values (as opposed to those imputed by the techniques discussed in this chapter) are zero in many cases. We return to this point in Chapter 7.

Notes

1. D. Brookshire, W. Schulze, M. Thayer, "Some unusual aspects of valuing a unique natural resource", mimeo, University of Wyoming, 1985.

2. J. Strand, "Valuation of fresh-water fish as a public food in Norway", Institute of Economics, Oslo University, mimeo, 1981.