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Policy changes result in benefits for some groups and costs for others; often the costs of a project are costs to society, not to the individual or firm undertaking the project. Social cost-benefit analysis entails transforming costs and benefits into monetary units to assess the desirability of a project. This paper reviews several ways in which economic theory accounts for environmental damage.

MONEY MEASURES: AN EXAMPLE

The *willingness-to-pay* concept measures the maximum amount of money that individuals are willing to pay so as to undertake a project. The total that all individuals are willing to pay is a measure of the benefits of the project. This is compared to the costs of the project to determine its profitability. An alternative monetary measure is the concept of *monetary compensation*, which measures the minimum amount of money that individuals must be paid to agree that the project not be undertaken. Two other related concepts are *compensating variation* and *equivalent variation*. In the former, the individual is kept at his pre-project level of satisfaction, and his willingness-to-pay for environmental improvements or his required compensation for environmental degradation resulting from the project are calculated. To calculate equivalent variation, the individual is held at the level of satisfaction he would attain if the project was carried out. In this case, we measure his willingness-to-pay to avoid environmental deterioration or the compensation he requires to accept that environmental improvements are not carried out.

A useful alternative interpretation of the willingness-to-pay approach is the referendum. Voters can be asked to vote on whether they are willing to pay a certain amount for a project, say £1000 per individual. If the majority vote yes, then it is fair to assume that the average voter is actually willing to pay more than £1000.

ON THE TOTAL VALUE OF A RESOURCE

Four values can be attributed to environmental resources:

1) consumptive use values, e .g., fishing and hunting;
2) non-consumptive use values, e.g., bird-watching;
3) indirect services, e.g., services provided through books, movies, etc.; and
4) existence values, e.g., satisfaction derived simply because a resource exists.

The total value of a resource is the sum of the four values, where all are expressed in monetary terms. Environmental damage affects the total value of a resource. Non-consumptive uses and indirect uses can be thought of as public goods, and reductions in their supply cause reductions in welfare across a number of individuals. Existence values depend on both the stock and quality of a resource, so environmental degradation could affect the existence value of a resource by decreasing its quality, even if the stock remains the same. Environmental damage can affect the price of a resource and of commodities related to it, causing a loss in consumer surplus.

VALUATION UNDER CERTAINTY: OPTION VALUE

The discussion of changes in consumer surplus can be extended over many time periods. However, economic agents do not have perfect information about the future, and this uncertainty about the future value of resources gives rise to the concept of *option value.* There are two interpretations of the precise definition of an option value. The first sees option value as a risk premium arising from uncertainty. In this case, the option value is the difference between the option price and the expected consumer surplus. The expected consumer surplus is obtained by multiplying the consumer surplus by the probability that the resource will be destroyed, while the option price is the maximum the consumer is willing to pay to ensure that the resource is available. In some cases, the calculation of option values may be more complicated.

The second interpretation of the option value concept has been labeled the quasi-option value. For example, the decision on whether to develop a tract of land may lead to the destruction of plant and animal populations that may have economic uses in the future. Furthermore, the destruction of any one species may lead to the destruction of some ecosystems. The quasi-option value, then, is the increase in expected benefits of preserving rather than developing an area until the uncertainty is resolved. It can be calculated based on appropriate biological, engineering and economic data.

SOME PRACTICAL METHODOLOGIES

There are a number of methods used to estimate the willingness-to-pay for public goods, three of which are described briefly:

1) **Survey Data:** This method entails asking individuals how much they will be willing to pay for a change in the provision of a public good, or how much they should be paid not to undertake a change. The problem with this method is that there is an incentive for some people to understate their willingness-to-pay if they believe will be asked to pay the stated amount. On the other hand, some people may overstate their willingness-to-pay if they believe that the amount they claim will not affect what they must actually pay.

2) **Travel Cost Method:** While a number of services (e.g., fishing or recreational services) are free or priced very low, the travel cost that individuals pay to undertake these activities can be recorded. The service will be used less by those from regions with greater travel costs. This information can be used to derive a demand curve for the service, and consumer surpluses can be calculated for different groups. One problem with the travel cost method is that it does not capture the existence value for those people who do not travel to use the service.

3) **Hedonic Prices:** This method attempts to calculate the willingness-to-pay for environmental services by comparing property values across regions. For example, if there are two similar houses in two different areas, and the only difference is the air quality, then the difference in their values is assumed to be due to the difference in air quality. The main drawback with this method is that public goods such as parks and endangered species do not have prices attached to them, so this method cannot be used in these cases.

GENERAL REMARKS AND PROBLEMS

In theory, the same monetary measure should result regardless of the method used for valuing environmental damage. However, in practice this does not happen. Work therefore needs to be done to compare the relative reliability of different methods. In addition, in many studies there is a large difference between the willingness-to-pay and the willingness-to-accept measures. In this case the problem is not with the existence of differences, but with their magnitude. A third problem in social cost-benefit analysis is that even if the benefits are greater than the costs, those who gain may not be able to compensate the losers. Fourth, in expressing their willingness-to-pay, respondents may not understand all of the consequences of a complicated policy change.