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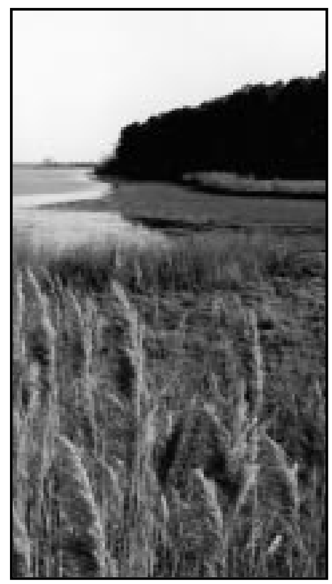
THEORY AND APPLICATION: RECONCILING DIFFERENCES

In the practical application of environmental valuation, issues such as choosing a discount rate, dealing with intergenerational transers and equity, and decision-making under risk and uncertainty can become important to the outcome and interpretation of the analysis. This chapter provides a brief introduction to these topics. Arguments about the appropriate discount rate can unduly obscure the underlying message that there is an economic value to natural resources and the environment.



Valuation of natural resources and environmental amenities can meet with difficulty under certain conditions. For example, if the use of a particular resource is impossible to reverse, the economic and social impacts over a long period of time must be considered. Such a consideraton in turn raises the question of discounting or, more generally, the efficiency and equity of resource use in the long run. Moreover, where information about the costs and benefits of alternative uses is particularly poor, perhaps because of the long period to which it must apply and the non-market character of some of the uses, decisions should take this uncertainty into account.

This section briefly examines these issues from a conceptual view. Unfortunately, theory does not spell out the precise quantitative adjustments that would be required in applying these issues to estimate benefits and costs in empirical work. The major point is this: the traditional benefit analysis of resource use and allocation as a basis for public decision-making is only one part of the decision process which must be accompanied by subjective notions of risk-taking and equity. A benefit-cost analysis in isolation should not be the sole basis for decision-making.

DISCOUNT RATES

When gains or losses from either a program or action accrue to individuals over time, discounting methods are typically used. Discounting is a procedure that deducts future values of a particular good — the aim is to determine the present value of the stream of benefits or costs in relation to the benefit or costs at different times in the future, i.e., benefits or costs occurring in different magnitudes at different dates in the future.

The basic principle of discounting is that a dollar received or paid next year is worth less than a dollar received or paid this year. For example, a dollar received this year may be deposited in a savings account earning, for example, 5 percent interest. On the one hand, at 5 percent interest, the dollar will be worth $1.05 the next year. Looked at from the discounting perspective, one dollar received or paid next year is only worth approximately $0.95 today. The *discount rate* in this situation is 5 percent, the interest on savings accounts. Other market interest rates, such as interest on bonds or corporate portfolios, may be used as discount rates as well. Such rates are based on the *private opportunity cost principle* or *private time preference*.

Discounting may reflect other social or psychological considerations. For example, many people exhibit "impatience." Understandably, they may value recreational experience more highly now than if they were promised the same experience ten years from now. The reasons are many — the immediate desire for pleasure and the relief from stress are only two. The result of preferring present consumption or change in the state of the world is positive discount rates. Alternatively, a concern for future generations might lead to the opinion that values in the future are worth as much as values today, implying a zero discount rate.

In general, the application of discounting in a social value context incorporates the more complex concept of *social time preference* and is often very difficult to determine. The problem of measurement parallels that of market and non-market goods. The private rate of time preference is revealed in markets, but the social rate is not. With respect to natural resources, the fundamental issue is one of defining a discount rate which reflects society's collective preferences regarding resource utilization or retention. The discount rate in the natural resource or environmental arena can be thought of as a measure of the opportunity cost of not having immediate access to a resource.

Suppose a decision must be made on whether or not to implement an oyster reef program in Chesapeake Bay. Assume a one-time startup cost of $100,000 (Table 7.1). The benefits associated with the program are projected for three years in increased returns to the local oyster industry: $15,000 in 1994, $80,000 in 1995, and $25,000 in 1996. Discounting will be crucial in determining whether the reef program is an efficient use of society's resources.

Table 7.1. Discounted Net Present Value (NPV) of Oyster Reef Program.

Year	1993	1994	1995	1996	NPV
Benefits of Reef Program	$0	$15,000	$80,000	$25,000	–
Reef Development Cost	–	$0	$0	$0	–
0% Discount Rate	–	–	–	–	$20,000
3% Discount Rate	–	–	–	–	$14,041
5% Discount Rate	–	–	–	–	$9,775
7% Discount Rate	–	–	–	–	$5,269
10% Discount Rate	–	–	–	–	–$1,950

Without discounting (or a zero discount rate), the net present value of the reef program is $20,000 and the program may be considered economically efficient. With a 5 percent discount rate, the net present value is $9,775. However, with a 10 percent discount rate the program results in a net loss of $1,950, suggesting an inefficient use of resources. Which discount rate is "correct"? The answer depends.

Difficulties arise in choosing the "correct" rate of discount. From the example, it is clear that the larger the discount rate, the more weight that is put on the present relative to the future. Large discount rates give less weight to environmental benefits or damages that don't accrue immediately but only in the long term. Real rates of between 0 and 8 percent appear regularly in the economics literature. Some have even argued for negative discount rates to reflect the implicit interest of future generations in resource management decisions.

Despite the extensive literature, a consensus does not yet exist on an appropriate procedure for discounting costs and benefits of public programs and regulations. It is clear, however, that the characteristics of natural resources (e.g., slow-growing, renewable, and typically held in public trust) necessarily imply that they should be treated differently than other private capital assets.

IMPACTS ACROSS GENERATIONS

We referred earlier to distributional implications of different outcomes. What happens when the distributional implications span generations? How do we compare situations when one generation gains and another loses? Discounting at some market-based rate of interest is commonly used to express future costs and benefits in terms of present monetary value, assuming that a value received now is worth more than the same value provided at some future date. Obviously, standard discounting procedures will weight the effect on the current generation far more heavily. Thus, some critics feel that discounting results in greater resource exploitation or use of natural capital now, at the expense of future generations. Is there an ethical basis for this discrimination against future generations?

Some economists have proposed that decisions affecting the future should be made with decision-makers placed behind a "veil of ignorance" about which generation they belong to. This impartiality criterion suggests equal use of irreplaceable resources across generations, implying a zero discount rate. But with a zero discount rate, if enough generations are involved, use of non-renewable resources (such as oil) approaches zero for any given generation. Likewise, irreversible development (such as building a dam in a unique natural area) is essentially precluded. Furthermore, a zero discount rate may foreclose future options by undervaluing investments that produce wealth and new technology that would be of great value to future generations.

Clearly, some compromise is needed between a zero discount rate, which would preclude many resource uses and perhaps prevent valuable technological advances, and a typical market rate that reflects only the atomistic time preferences of the current generation. This compromise has been called a *social rate of discount*; its argument is that the government in this role should consider the wishes (the values) of both current and future generations. Because the welfare of future generations depends on current consumption patterns, the government should assure protection of future welfare by policies that force sufficient resource conservation. In essence, the government would proclaim what it deemed to be an appropriate discount rate.

Another argument takes a more democratic approach, recognizing that the government is run by and for the current generation; thus, any saving for the future must rely on the values of the current generation. The basis of this argument is that most citizens have a set of held values that include a concern for the larger group (including the future) as well as concern for self. If people do value the welfare of the future, then what is needed is a way for that value to be expressed and measured — a way that avoids the singular context of the marketplace.

UNCERTAINTY AND RISK

In practice, environmental valuation must contend with a great deal of uncertainty. One source of uncertainty is in the problem of predicting the consequences of today's environmental policies and actions. Will the reduction in nutrients that enter coastal waters lead to increased fish populations? Will controls on development lead to cleaner estuaries? Another source of uncertainty results from the increasing use of models, both biological and economic, to predict outcomes. Modeling is inherently a source of error, as is the measurement error of data used to calibrate the models.

There is a branch of economics that deals with decision-making under uncertainty that should be an integral part of any environmental valuation exercise. Uncertainty surrounding environmental mea-

Models are like maps that try to chart a complex territory in which the landscape cannot be completely known — they depend on variabilities in human nature and ecosystems themselves.

surements can be introduced explicitly into background analyses by three methods:

- Direct enumeration, which requires us to list all possible outcomes

- Probability calculus, which employs formulae for the computation of such statistics as the means and variance of a probability distribution

- Stochastic simulation, which is also known as Monte Carlo simulation or model sampling

While it is clear that the decision-maker should be given as much information as possible about the probability distribution of potential outcomes of environmental actions, there are no hard and fast rules as to the "correct" way to incorporate this information.

Risk is closely related to the notion of uncertainty, focusing on the outcome that is affected by uncertainty. Every project or policy decision has risk associated with it. There is always some probability that costs and benefits will not be exactly what are expected. For example, the major risk factors inherent in coastal wetlands projects are attributable to imperfect scientific knowledge of biophysical relationships, such as uncertainty about salinity effects on cordgrass growth, and probabilistic natural phenomena, such as varying meteorological and hydrological events.

A typical method of accounting for risk is to adjust discount rates upward for projects or decisions with more risk. An alternative is to establish risk rankings of projects or decisions, along with other measures of anticipated benefits. Decision-makers may select actions with lower net benefits, if they are more certain of the outcome. This is an example of risk aversion which enters into the decision process.

IRREVERSIBILITY

For many environmental risks, the possible negative impacts are irreversible in the sense that they cannot be undone by subsequent actions, for instance, the possible ecological effects of global warming and species extinction.

The possibility of irreversible effects makes current policy decisions particularly important, since recovery from poor decisions is not possible. In other words, we must live with the consequences of current policy choices without the possibility of future rectification. In general, the benefits of risk reduction are likely to be greater, if the possible negative effects of a risky activity are irreversible, than they would be if those effects could be offset, or reversed, by subsequent actions. For example, the introduction of a non-indigenous species such as the Pacific oyster to an estuary or bay in the Mid-Atlantic is riskier when the consequences are irreversible than when they are not.

The major implications of the existence of intertemporal conflict and uncertainty with respect to the use of the natural environment is that it will be most efficient to proceed very cautiously with any irreversible action.