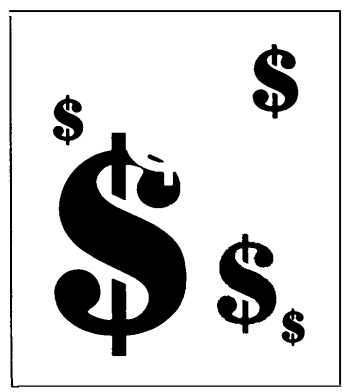
Methods for Valuing Environmental costs 3

Valuation is a method used in environmental cost studies to assign monetary values to the environmental **effects** of electricity production. Examples include finding the value individuals attach **to** reducing the risks of coal mining, improving urban air quality, **or** assuring clear visibility.

Valuation is **a** particularly important method to understand. Although environmental cost studies raise many other important methodological issues in addition to valuation (e.g., human risk assessment, extrapolation from animal studies, and estimates of transport and deposition of environmental pollutants), these methods have been well reviewed by other reports and are amenable to further scientific research. In contrast, disputes about valuation methods are relatively new to policy makers and appear less amenable to resolution by additional research. Differing assumptions of analysts strongly affect the choice to use monetary valuation at all, the choice of valuation method, and the way that method is applied. Because there is little or no consensus on these assumptions, valuation lies at the root of much of the controversy over the study and use of environmental costs.



At least five valuation methods are used in current environmental cost studies. [1] *Market valuation* uses existing market prices to estimate damages. *Contingent valuation* elicits estimates from consumers by the use of survey techniques. *Hedonic valuation* examines existing market prices to detect implicit valu-

1 All of these techniques assume a goal of *monetary* valuation. This almost always has been the goal of environmental cost studies. In theory, however, a study could analyze the "costs" of electricity generation in a more general, noneconomic sense. For additional discussion, see the section in chapter 4 on quantification and monetization.

ation of environmental factors by consumers. *Control cost valuation* examines existing regulatory decisions to detect implicit valuation of environmental factors by government regulators. *Mitigation cost valuation* examines the cost of repairing environmental damages to estimate the value of preventing such damages from occurring. Each valuation method is detailed in the following sections.[2]

MARKET VALUATION

In some cases, environmental impacts from energy production affect things that are bought and sold, and thus have a market price. For example, hydroelectric facilities can reduce salmon populations by hindering the upstream migration of adult salmon to spawn and the downstream migration of juvenile salmon toward the ocean. One method of estimating the cost of a reduced salmon population is to multiply the reduction by the market price of salmon.

Market valuation is used in several studies. For example, the Pace study uses market prices to value the corrosive impact of air pollution on materials and the potential property damage from a large nuclear accident. Similarly, the Bonneville Power Administration (BPA) studies use market valuation in several contexts, including valuing impacts on agriculture, fur trapping, and commercial forestry.

Market valuation has the advantage of relying on data that are readily available and fairly uncontroversial. Care must be taken to find prices that apply to the specific losses associated with energy generation (e.g., prices appropriate to the specific crops grown where emissions have their greatest impacts), but this difficulty is fairly easy to overcome.

Market valuation also has some subtle pitfalls. Market costs may be distorted because, like energy prices, they may not include all relevant costs. Many individuals would contend that forests have higher value than the commercial value of the timber, and that the value of some animal life is higher than the market price of their pelts. There is no generally accepted method to account for these effects, and attempting to do so could involve an analysis as large as the original environmental cost study. As a result, most studies that use market valuation do not attempt to adjust market price data to account for them.

The major limitation of market valuation is that not all environmental impacts of energy affect things that are bought and sold in markets. The value of items such as visibility, preservation of endangered species, and health impacts cannot be estimated using market valuation.[3] This limitation has led to the use of several other valuation techniques.

HEDONIC VALUATION

Hedonic valuation examines existing market prices for evidence of the value placed on particular environmental effects. For example, one way to estimate the value of a recreational area is to examine the travel costs borne voluntarily by those who visit the area. Similarly, one way to estimate the value associated with personal safety is to compare the wages of workers in hazardous occupations with those in occupations that are safer, but otherwise similar.

Several studies use hedonic valuation to estimate the value of environmental impacts. For example, the BPA studies for coal, oil, and gas use estimates that infer the value of visibility from property values. Pace uses those estimates as well. Similarly, the BPA hydroelectric study uses estimates based on the travel costs of hunters to value the loss of deer in the area to be flooded by a dam.

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[2] This chapter is meant to introduce readers to various valuation techniques, not to be a detailed methodological critique. Detailed examinations of each method can be found in footnoted references in each section.

[3] "Visibility" refers t. the presence or absence of haze often produced by burning fossil fuel. Visibility problems are most commonly encountered over urban areas, but also have become an issue in scenic vistas such as those around the Grand Canyon.

Like market valuation, hedonic methods have the advantage of deriving from choices made by consumers. This avoids problems that may stem from inaccurate self-reporting--i.e., problems caused by individuals who say they place a particular value on an environmental impact, but who do not act consistently with that belief (seethe discussion of contingent valuation below).

Unlike market valuation, however, hedonic methods must adjust for all factors that influence price other than the object of study. For example, to determine the value of visibility by using property values, analysts must account for all the other reasons property values may vary (e.g., quality of home, access to services, proximity to workplaces). Although statistical techniques exist to account for these other influences, there are a great many practical and theoretical pitfalls to avoid.

In addition, prices may not accurately reflect how people value environmental effects. For example, wage differentials may not accurately reflect risks to workers. First, workers may be unaware of risks they face, and they may not demand higher wages to account for increased risk. Second, workers may be unable to bargain effectively to make their wages adequately compensate them for their risks. Barriers to job mobility may limit the opportunities of high-risk workers to change positions or occupations.[4]

CONTINGENT VALUATION

Contingent valuation (CV) consists of surveying individuals directly about the value they attach to environmental damages. A typical survey provides a respondent with information about a hypothetical program that will prevent future harm to the environment. The respondent then is asked how much he or she would be willing to pay, individually, to bring the program into existence. The questions can be couched in several different forms, such as a direct question, a series of questions about hypothetical economic tradeoffs, or a referendum—asking respondents whether they would vote for a particular tax increase to fund the program. In each case, the goal is to elicit an economic value that the individual attaches to the program, in as realistic a way as possible.

CV could be used to estimate willingness to pay for almost anything, including goods that are actively bought and sold in markets. However, the technique's greatest use is for estimating the value of goods and services that are not bought and sold in markets. Specifically, CV can be used to estimate what are called *non-use values (see* box 3-1).

CV has been actively studied for about 20 years. In the past five years there has been a dramatic increase in the number of academic studies and presentations on the topic,[5] and several comprehensive texts exist.[6] CV also has been employed in a variety of environmental cost studies. For example, the BPA hydroelectric study estimates the value of old-growth forest impacts by contingent valuation. The BPA oil and gas study uses evidence from contingent valuation studies to estimate the value of visibility. This estimate, in turn, is used by Pace. Finally, both the DOE/EC and the New York State studies expect to make use of CV to estimate the value of several environmental impacts that cannot be valued easily in other ways.

CV has some distinct advantages over other methods. First, it is the only method that can evaluate non-use values. As noted in box 3-1, non-use values can bean important source of environmental cost data. Second, citizens, not experts, produce the evaluation. Proponents of CV are quick to point out that the method has a strong undercurrent of democratic decisionmaking. Private citi-

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[4]John P. Holdren, *Integrated Assessment for Energy-Related Environmental Standards: A Summary of Issues and Findings*, LBL-12779 (Berkeley, CA: Lawrence Berkeley Laboratory, October 1980).

[5]Kenneth Arrow et al., "Report of the NOAA Panel on Contingent Valuation," Jan. 11, 1993.

6 For example, see Robert C. Mitchell and Richard T. Carson, *Using Surveys To Value Public Goods: The Contingent Valuation Method* (Washington, DC: Resources for the Future, 1989).

BOX 3-1: Non-Use Values

Some environmental resources are regularly used by individuals or groups. For example, wilderness **areas provide recreation for hikers and hunters—recreation that may be curtailed if the areas are harmed. The worth of this recreation is referred to as a "use value, " because individuals benefit from actually** using the wilderness area. Attaching monetary figures to use values can be challenging, but involves well-recognized principles in economics.

In addition to use values, economists have come to recognize that a person may value something, even if he or she does not intend to use it. This "non-use" value, also known as "passive-use" value, measures the worth ascribed to something that is *not* used. Non-use values have been divided into at least three categories: 1) option value-the value of preserving a resource for potential future use. For example, even though someone may not be considering an immediate visit to the Grand Canyon, he or she may wish to preserve the option for a future visit; 2) bequest value-the value of preserving a resource for future generations. Even though an individual may never expect to visit the Grand Canyon, he or she may wish to preserve that option for future generations; 3) existence value-the value of "knowing the resource exists. " Some individuals attach a value to the existence and protection of a resource, even if they never expect anyone to use it.

Non-use values have engendered substantial controversy, One reason is the difficulty of assessing them. Use values can be measured by an individual's behavior-how far a person travels to use a recreation area, for example. By definition, non-use values involve few outward signs. Surveying individuals about the value they place on environmental resources-called *contingent valauation* (CV)-generally is recognized as the only method of assessing all types of non-use values. Because the results of CV are difficult to check against behavior, observers are skeptical of their results

Another focus of controversy is the claim that non-use values can represent moral and ethical concerns. Some economists claim that individuals' responses to CV surveys represent more than just preferences that are commonly linked with market choices (e.g., tastes and fashion); in addition, they also represent moral and ethical beliefs of the individual. Others, such as philosopher Mark Sagoff, argue that such ethical and political choices are distinct from the preferences considered by economists and cannot be treated in the same way. These writers argue that economic preferences are concerned with personal benefit and are best resolved within markets; ethical choices are concerned with community good and are best resolved in a more public forum.

To summarize, few participants in environmental cost debates deny that non-use values exist, but there is substantial disagreement about how to measure non-use values reliably and about their proper role in public decisions.

SOURCES: Mark Sagoff, "Environmental Economics: An Epitaph," Resources, No. 111, spring 1993, pp. 2-7; Raymond J. Kopp, "Environmental Economics: Not Dead But Thriving, " Resources, No. 111, spring 1993, pp. 7-1 2; Oak Ridge National Laboratory and Resources for the Future, *U. S.-EC Fuel Cycle Study: Background Document to the Approach and Issues*, Report No. 1 on the External Costs and Benefits of Fuel Cycles: A Study by the U.S. Department of Energy and the Commission of the European Communities, ORNL/M-2500 (Oak Ridge, TN: Oak Ridge National Laboratory, November 1992).

zens, not experts who may be detached from the interests of the public, are asked to value the programs. This puts some of the decisionmaking power in the hands of those who ultimately will pay for the environmental control and mitigation programs (through taxes and/or higher product prices).

CV is far from universally accepted, however, and several criticisms have been made. First, results vary with how the questions are asked. Relatively subtle differences in wording, in the order questions are asked, or in the supporting evidence given, can substantially affect the answers of respondents. Second, some results are not consistent with basic tenets of economic theory. Economists expect that the value of a certain quantity of goods will increase as that quantity increases. For example, if someone is willing to pay a dollar for an apple, they should be willing to pay substantially more than a dollar for two apples. Respondents in CV studies have not always behaved as economists expect. In one study, the average willingness to pay to prevent 2,000 migratory birds from dying was as great as that for preventing 20,000 or 200,000 birds from dying.[7]

Third, studies sometimes appear to produce unreasonable answers. Some critics have argued that CV results should be dismissed merely because the implied value of environmental damages, when aggregated on a national level, are unreasonably large.[8] One reason for these large values is that respondents lack a meaningful budget constraint and the need to consider tradeoffs. Although respondents might report they are willing to spend $100 to prevent future oil spills, they may fail to account for all the other environmental programs they might be asked to fund or other, nonenvironmental uses for their funds. Particularly when such responses are hypothetical, as they are in CV, respondents may not meaningfully consider what expense they will forego to pay for such a contribution. One study estimating willingness to pay for protecting the Alaskan coast from oil spills showed that estimates varied substantially depending on whether such values were discussed independently ($85) or in the context of overall government spending ($0.29).9

Fourth, respondents may give "strategic" answers to survey questions that are intended to influence public agencies. A respondent might believe that, by stating a high value, he or she can encourage state or federal agencies to undertake the programs described in the survey. Alternatively, respondents may believe that, by stating a low value, they will reduce or avoid a future tax increase to pay for such programs.[10]

Finally, respondents may not fully understand or trust the information provided by the survey. The responses requested on CV surveys are unlike typical choices made by consumers. Environmental effects have impacts that go far beyond the respondent in both time and space. Evaluating environmental effects deals with topics (e.g., ecology, biology, atmospheric science) that are unfamiliar to most respondents, and few respondents have had the opportunity to see the effects of previous choices. Respondents also may not trust the given information. They may react based on an overall belief about environmental reporting (e.g., "those environmental problems are always exaggerated" or "the damage always ends up to be worse then we're initially led to believe"). In any of these cases, respondents may not be answering the question given, and they may not produce an accurate assessment of their willingness to pay.

To summarize, CV studies are subject to a variety of biases that are potentially troubling, and care needs to be taken in the design, conduct and reporting of studies. However, CV studies can

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7 A. mow et al., op. cit., footnote 5.

8 For example, see Charles J. DiBona, "Assessing Environmental Damage," *Issues in Science and Technology,* fall 1992, pp. 50-54.

9 Charles River Associates, "Methodological Biases in Valuing Environmental Resource Damage," *CRA Review, December* 1992, pp. 1-4.

10 Arrow et al., op. cit., footnote 5.

produce useful information for evaluating environmental costs, and CV appears to be the only method to assess non-use values, a potentially important component of these costs.[11]

CONTROL COST VALUATION

Control cost valuation infers the value of environmental impacts by examining the pattern of public decisions recorded in regulations, laws, and court rulings. By determining the cost of the controls mandated by these decisions, and their benefits in terms of environmental effects, the dollar value of those effects can be estimated. Control cost valuation is also termed "shadow pricing" or "revealed preference" valuation.

For example, the Tellus study uses control cost valuation to estimate the environmental cost associated with various air emissions, including NO_x, SO_x, and $C0_2$. To estimate each of these costs, the Tellus study takes cost estimates for various pollution control technologies whose use is mandated by federal or state regulation. The study then divides these costs by the emissions reductions (in pounds) that the technologies achieve. This calculation produces a cost per pound figure that is used as an estimate of the environmental cost per pound of emissions.

The major advantage of control cost valuation is its simplicity. Control costs can be calculated merely by dividing the cost of mandated controls by the emissions reduction achieved by the controls. The data for these two numbers are relatively uncontroversial and easy to obtain. In contrast, alternative methods require tracing emissions from generation (e.g., $S0_2$ from a coal plant), through intermediate pathways (acid rain), to eventual environmental impacts (forest damage). Then the impacts must be valued. That process introduces many uncertainties and potential analysis problems.

However, analysts point to a variety of failings associated with control cost valuation. First, it is criticized as representing circular reasoning. Many analysts believe one important goal of environmental cost analysis is to compare the costs and benefits of environmental regulations. If the cost of regulations (i.e., cost of environmental control technologies) is used to estimate the benefits (i.e., environmental costs avoided), then a meaningful comparison of costs and benefits is impossible. This argument is explored in more detail in chapter 4.

Second, control costs can vary widely. Studies of cost per life saved have indicated large variations in the values implied by the costs and benefits of different regulations. Critics of control cost valuation use this variation as evidence of problems with the method. If the values vary so widely, then regulations clearly do not represent a rigorous weighing of costs and benefits. However, some supporters of control cost valuation are not so troubled by these variations. Supporters argue that control costs indicate the *minimum* costs regulators are willing to impose. Because of this belief, studies that use control costs valuation often use the *highest* cost of control. 12

MITIGATION COST VALUATION

Like control cost valuation, mitigation cost valuation attempts to infer environmental costs from the costs of responses to environmental damage. In contrast to control cost valuation, however, mitigation cost valuation does not examine costs imposed by current regulations. Instead, it ex*amines prospective* mitigation costs under the presumption that additional environmental impacts

[11] These conclusions are supported *by* a review by the National Oceanographic and Atmospheric Administration's (NOAA) Panel on Contingent Valuation. The NOAA Panel's report gives a variety of guidelines for conducting accurate and useful CV studies. Arrow et al., op. cit., footnote 5.

[12] Paul Chernick and Emily Caverhill, PLC, Inc., "The Valuation of Externalities from Energy Production, Delivery, and Use: Fall 1989 Update," A Report to the Boston Gas Co., Dec. 22, 1989, p. 7.

should be avoided. Mitigation can involve reversing damages (e.g., treating diseases or replacing damaged goods) or intervening between intermediate and final environmental effects (e.g., "liming" mountain lakes to reverse the effects of acid rain).

Several studies use mitigation costs to estimate environmental costs. The Pace study uses mitigation costs to estimate the costs of $C0_2$ emissions—an area where cost estimates are notoriously difficult. It examines the costs associated with growing forests to capture and sequester carbon. Similarly, the Hohmeyer study uses mitigation costs to estimate the cost of $C0_2$ emissions. It estimates the costs of bolstering Germany's coastal defense works (e.g., dams and locks) to avoid the effects of an increase in worldwide sea levels that are thought to be one effect of global warming.

Mitigation cost and control cost valuation both have the advantage of simplicity and the disadvantage of being viewed as involving circular reasoning (see chapter 4 for details) .13

CONCLUSION

The differences among valuation techniques have been a source of substantial debate and controversy in the analytical community. The differences involve the types of evidence considered. Market and hedonic methods look at the purchasing decisions of individual consumers in actual markets, control cost valuation examines the decisions of government regulators, and contingent valuation examines the answers of survey respondents.

Perhaps the most contentious and long-standing debate over valuation methodology has been between supporters of valuation methods that are grouped under the label of *damage costing (i.e.,* market, hedonic, and contingent valuation) and valuation methods grouped under the label of *control costing* (i.e., control cost and mitigation cost valuation). This debate continues to dominate many discussions of environmental cost studies. It is covered in greater detail in chapter 4.

The debate over these differences sometimes obscures a basic fact: all valuation approaches involve assumptions about the legitimacy and appropriateness of different types of evidence. These decisions often depend on questions that are beyond the scope of an individual study, and instead depend on broad policy goals and how environmental cost studies are used to support those goals. This is the topic of the next chapter.

[13] One form of mitigation costing avoids the problem of circular reasoning. Studies that examine consumer behaviors intended to mitigate environmental effects (e.g., purchasing bottled water to avoid drinking potentially contaminated water) can indicate the value they assign to avoiding the environmental effect. However, most use of mitigation costing involves prospective actions intended to keep environmental resources in their current condition.