Sixth Joint Conference on

Food, Agriculture and the Environment

(in honor of Professor Emeritus Philip M. Raup)

Minneapolis, Minnesota

August 31 - September 2, 1998

Hosted by the

Center for International Food and Agricultural Policy
University of Minnesota
Department of Applied Economics
1994 Buford Avenue\332 ClaOff Building
St. Paul, Minnesota 55108-6040 U.S.A.

BENEFIT-COST ANALYSIS IN U.S. ENVIRONMENTAL REGULATORY DECISIONS

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Abstract

As the number and cost of environmental regulations have increased over the last thirty years, the regulated community, taxpayers, and policy makers have begun to demand that the benefits of regulations justify their costs. The use of benefit-cost analysis as an integral part of developing new regulations is increasing and the demands and expectations being placed on the method have expanded. Although benefit-cost analysis is expected to play an even greater role in environmental decision making in the years ahead, questions remain concerning whether benefit-cost analysis can meet these expectations.

This paper explores the role of benefit-cost analysis in US public investment and environmental decision making and examines how benefit-cost methods are responding to new analytic demands. It reviews the US experience with benefit-cost analysis at the Federal and State levels of government and discusses several applications to environmental regulations, illustrating how such analysis can contribute to decision-making as well as pointing out some of the method's pitfalls. The paper also discusses how several important (and sometimes controversial) methodological issues—including intergenerational equity, the distribution of benefits and costs, uncertainty and risk, and the measurement of the value of non-market goods and services—might be addressed practically as benefit-cost analysis is further extended into environmental policy and regulation. Finally, the paper concludes with recommendations for the future use of benefit-cost analysis in environmental decision making.

October 28, 1998

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1. Introduction

As the number and cost of environmental regulations have increased over the last thirty years, the regulated community, taxpayers, and policy makers have begun to demand that the benefits of regulations justify their costs. As a result, calls for using benefit-cost analysis as an integral part of developing new regulations have increased, as have the demands and expectations being placed on the method. A recent spate of proposed legislation has focused on increasing and improving benefit-cost analysis in environmental decision making. Although benefit-cost analysis is expected to play an even greater role in environmental decision making in the years ahead, questions remain concerning whether benefit-cost analysis can meet these expectations.

This paper explores the historical role of benefit-cost analysis in US public investment and environmental decision making and examines how benefit-cost methods are responding to new analytic demands. It reviews the US experience with benefit-cost analysis at the Federal and State levels of government and discusses several applications to environmental regulations, illustrating how such analysis can contribute to decision-making as well as pointing out some of the method's pitfalls. Although the primary use of benefit-cost analysis has been in the US Federal government, a number of individual states are now using benefit-cost analysis to evaluate regulations. The paper also discusses how several important (and sometimes controversial) methodological issues—including intergenerational equity, the distribution of benefits and costs, uncertainty and risk, and the measurement of the value of non-market goods and services—might be addressed as benefit-cost analysis is further extended into environmental

policy and regulation. Finally, the paper concludes with recommendations for the future use of benefit-cost analysis in environmental decision making.

2. The Government's Use of Benefit-Cost Analysis

For more than a century, benefit-cost principles have been used as a guide for some federal investment decisions. Initial applications were to publicly financed water projects, with subsequent application to public investments in transportation, health, defense, and education. Importantly, all of these investments involved commodities or services whose value largely could be determined by market prices or from economic models related to firm or consumer behavior. Until the 1970s, benefit-cost cost analysis did not typically strive to account for economic gains or losses external to the public investment under consideration. Even when physical harm to the environment from a project or policy was apparent; policy analysts were often unable to quantify the damages with available economic tools. The analysis of public projects was broadened to incorporate values for non-market goods and services, such as recreation and improved water quality, as policy makers were able to draw on a growing body of academic research on valuation of environmental benefits and associated measurement techniques.[1]

Congress, however, has been less than consistent in its application of benefit-cost principles to environmental policy and regulation. Some statutes explicitly preclude the weighing of costs and benefits in setting environmental regulatory standards[2] while others require that the benefits of regulations be weighed against the costs, with a decision to proceed only if net benefits exceed costs.[3] Despite these legal inconsistencies in environmental statutes, for the past 25 years the US executive branch has pursued formal processes for introducing benefit-cost concepts into regulatory decisions including those related to the environment. These

efforts recognize the large investments being made to improve the environment and health and safety, and seek ways of assuring that scarce resources are well spent.

Over the past decade, federal legislation, revisions to Executive Orders, and federal agency guidelines have established new requirements for extending benefit-cost analysis into environmental and health and safety decision making, with the goal of assuring sound science, transparent assumptions, and identification of uncertainty (OMB, 1997). Thus, it appears to be the intention of public policy makers to more fully incorporate benefit-cost analysis into environmental decision making.

An Historical Perspective

There is a long history of the application of benefit-cost analysis to public investments. Benefit-cost principles were first employed in the public water sector as early as 1808 when Albert Gallatin, US Secretary of the Treasury, recommended the comparison of costs and benefits for water related transportation projects. About 35 years later, the French scholar Jules Dupruit in 1844 wrote that all costs and benefits, including those that are not actually paid, should be considered before investing in a public project. The 1902 US Federal River and Harbor Act and the US Reclamation Act of that same year both required economic analyses. The former established a board to investigate the engineering and economic feasibility of waterway projects proposed by the US Corps of Engineers by accounting for both benefits and costs. The Reclamation Act required that the users of reclamation (water) projects be able to repay construction costs in ten years (although no interest on capital was charged). Similarly, the Flood Control Act of 1936 required that federally supported navigation and flood control projects meet an economic feasibility test, by considering benefits and costs "to whomever they accrue." The first major effort to rigorously develop and apply benefit-cost analysis in the United States was in response to the legal requirements of this 1936 act.

By the end of World War II, federal agencies had broadened their analysis to include secondary (indirect) benefits and costs as well as "intangibles." These intangibles are what we would now consider "environmental assets" such as improved water quality (NOAA, 1995). A US Federal interagency river basin committee composed of representatives of the major water resource agencies put together the "Green Book" (1950) which codified the general principles of economic analysis as they were to be applied in formulating and evaluating US Federal water resource projects (Hufschmidt, et al., 1983). The underlying economic concept was that projects should be constructed only if the winners (benefits) could compensate the losers (costs) that result from a particular project or action. This Hicksian principle, of course, implies that all benefits and costs are counted the same regardless of who bears them. Historically, the winners seldom compensate the losers and the potential income distribution impacts (those who pay for the project may have different income levels than those who receive the benefits) are typically ignored.

US Budget Bureau Circular A-47 replaced the Green Book economic guidelines in 1952 and established formal procedures for evaluating projects. Ten years later, A-47 was replaced by Senate Document 97, which required an even more rigorous application of economic principles to project evaluation. In 1973, the US Water Resources Council's "Principles and Standards" became the established US Federal procedure for evaluating water projects with the then new idea of incorporating environmental accounts with accounts for economic development (benefit-cost analysis) along with accounts for two other objectives, regional development and improvements in the quality of life. In 1983, the US Water Resources Council was abolished. Currently, no consistent set of principles to guide benefit-cost analysis exists. Individual agencies have developed their own guidelines under general "best practices" guidance for assessing the

impacts of regulation developed by the Office of Management and Budget in the Executive Branch.

Growing Role in Environmental Regulation

Further impetus for the use of benefit-cost analysis has come both from environmental legislation and general efforts to improve regulatory efficiency. The National Environmental Policy Act (NEPA) of 1969 requires the use of benefit-cost analysis in the preparation of Environmental Impact Statements. The 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Superfund legislation allows natural resource trustees to recover damages for any injury to natural resources and requires natural resource damage (lost benefits) assessments. This legislation extended economic analysis to "non-use" values for the first time.

In response to a growing concern over the cost and productivity impacts of regulations generally but environmental regulations specifically, Presidents Ford and Carter both issued executive orders in the 1970s requiring an assessment of regulatory costs. This lead the way for President Reagan's Executive Order 12291 in 1981 requiring cabinet-level departments to conduct regulatory impact analyses of all major proposed regulations. President Clinton's 1993 Executive Order 12866 endorsed benefit-cost analysis as a tool for designing and implementing environmental policy. It requires agencies to "select those approaches that maximize net benefits unless a statute requires another regulatory approach." The current order requires incorporation of "quantifiable and non-quantifiable benefits" as well as assessments of "equity" and distributional impacts further broadening the focus of benefit-cost analysis.[4] The last two US Congresses have passed additional legislation to encourage regulatory efficiency that reaffirms the role of benefit-cost analysis in these decisions (e.g., the "Unfunded Mandates Act" and the 1995 "Risk Assessment and Cost-Benefit Act.")[5]

Since 1990, environmental legislation has incorporated benefit-cost analysis more directly. The Oil Pollution Act of 1990 requires natural resource damage assessments. The 1990 amendments to the Clean Water Act and the Clean Air Act reaffirmed the concept of health-based standards but also require that implementation of standards be based on a consideration of benefits and costs.[6] The Safe Drinking Water Act of 1996 explicitly requires that whenever EPA proposes a national primary drinking water regulation, it must publish a benefit-cost analysis of the proposed rule.

Greater responsibility for implementing and monitoring environmental policy is being delegated to the States and pressure at the State level for increased levels of environmental protection is growing as well. In response, eight States have formally incorporated benefit-cost analysis in their regulatory decision making.[7] The State of Washington's law requires selected agencies to "determine that the rule's probable benefits—both quantifiable and non-quantifiable—are greater than its costs." (Washington Regulatory Reform Act, Washington Laws, Chapter 403) California's regulatory reform legislation (California Code, Statues. 1994, Chapter 1039) requires all state agencies proposing major regulations to make specific "findings" including evidence that the regulation "significantly reduces risk to human health or the environment", is cost-effective, and that the "benefits justify the costs." Other states, including Minnesota, are beginning to explore adoption of benefit-cost frameworks to guide the development and implementation of increasingly expensive environmental regulations.

3. EPA's Use of Benefit-Cost analysis

Benefit-cost analysis, including cost effectiveness analysis, can inform EPA's regulatory process. A recent study by the US General Accounting Office of EPA's benefit-cost analyses conducted under the requirements of the 1990 Clean Air Act Amendments found that four of

fifteen assessments indicated that less costly regulations could achieve the same or higher net benefits (GAO, 1997). In practice, complete benefit-cost analyses are not typical, are not always required, and are not always cost-effective. Legal statutes, the relative importance of the problem, data constraints, lack of scientific information and time, and monetary constraints limit application of benefit-cost analyses.

The actual use of benefit-cost analysis in EPA's decision making has been very limited (Morgenstern, 1998) although several examples of how it can effectively guide policy design and implementation are discussed below. The limited use of benefit-cost analysis by EPA has occurred for a variety of reasons including a lack of economic expertise at the program level, a strong legalistic culture as well as a set of historical statutes that prohibit consideration of economics in standard setting. Paradoxically, the Agency has been a strong supporter of academic research in benefit-cost methods, but to date has been unable to translate that expertise to the individual regulatory programs.

Although EPA has been required to perform benefit-cost analysis to support its regulatory actions since the 1970's, EPA's own analysis of the regulatory impact analyses conducted over the period 1981-1986 indicated that only five regulations out of 18 monetized benefits and compared benefits and costs while the others provided some qualitative accounting of benefits (Cropper and Oates, 1992). OMB's Draft Report to Congress on the Costs and Benefits of Federal Regulations (OMB, August 17, 1998) cover nine EPA regulations passed over the one-year period ending March 1998. This analysis indicates that of the nine final rules promulgated by EPA, six developed monetized estimates of benefits and costs with the others enumerating benefits qualitatively. All studies reported significant benefits omitted from the analyses. This may explain why of the six reporting both monetized benefits and costs, only in three cases were estimated benefits in excess of costs.

It is not surprising that valuation and other methodological problems have arisen as EPA has begun to apply benefit-cost analysis to evaluate pollution control alternatives. Many issues now being addressed are similar to those raised earlier for water resource projects. Initially, there were extensive debates about the appropriate discount rate, the objectives to be included in the analysis, whether individual well-being can be measured by preference satisfaction, the monetary valuation of non-market goods, the treatment of risk and uncertainty, and the impact of projects on income distribution. These same suspects have been rounded up for the debate concerning the application of benefit-cost analysis in environmental regulations.

It is clear that the federal and state environmental agencies will need to make investments to improve their capacity to do benefit-cost analysis of environmental regulations. Studies are expensive and federal and state agencies have relied too much on industry and environmentalists to do the work. The federal and state governments have the responsibility to develop needed internal capacity to conduct analysis to adequately fund benefit-cost analyses and to help keep bias out of the analysis. OMB (1998) points out that there is a strong and growing base of experience and relative comfort among State agencies in valuing non-market benefits, specifically with respect to valuation of the recreational benefits of water and other natural resources. Much of this experience stems from traditional benefit-cost studies for proposed dams and other major water projects. In addition, a long tradition of Federally supported studies of the economic benefits of recreational fishing and hunting has helped build State expertise.

Past benefit-cost analyses suggest they are good investments. EPA estimated that for 15 analyses conducted on major environmental rules, the average cost was approximately $700,000, or less than one percent of the cost of the rule over five years (a “major” rule costs $100 million by definition). Below are several examples where EPA’s application of benefit-cost analyses has resulted in significant economic savings.

4. Applications of Benefit-Cost Analysis in Decision Making

EPA has effectively applied benefit-cost analyses as a guide to some regulatory decisions. Three examples illustrate its role and usefulness in actual applications by EPA and lead us to a later discussion of methodological issues.

Reducing Lead in Gasoline

The classic example of the effective role that benefit-cost analysis has played in policy analysis is in the adoption of regulations governing lead in gasoline. Ambient lead concentrations were thought to be linked to serious health effects. The EPA conducted a benefit-cost study of a proposed regulation to reduce lead in gasoline from 1.1 grams per gallon (gpg) to 0.1 gpg. The cost of the rule was increased refining costs; the benefits included improved children's health, improved (lowered) blood pressure in adults, reduced damages from NO_X and CO automobile emissions, and efficiencies in car maintenance and fuel economy. A complete schedule of monetized benefits and costs was determined for the period 1985-1992. Total net benefits far outweighed increased costs, by a factor of 20:1 in the initial year and declined to 15:1 in year five. Industry challenged the benefits calculation arguing that 75 to 85 percent of total benefits was derived from avoided mortality and morbidity costs. They argued that these high avoided costs from lead reduction were a consequence of the $1 million per avoided heart attack and stroke assumed in the study. In this case, the rule on lead in gasoline was adopted on the basis of the benefit-cost analysis without having to debate the value attached to reduced mortality. The Environmental Protection Agency was able to demonstrate that net benefits attributable to a stricter standard were positive – although significantly lower (less than 3:1 as compared to 20:1) – even without the benefits from reduced mortality (Pearce, 1993).

Nonetheless, the appropriate value to assign to reduced mortality continues to be in dispute in applications of benefit-cost analysis.

Revising the Ozone Standard

In 1978, EPA proposed a revision of the 1971 Ozone standard increasing. The initial proposal increased the standard from .08 PPM to .10 PPM to reflect new information regarding health effects.[8] As policy required, OMB reviewed the proposed standard for its economic impacts. The OMB report indicated that EPA had underestimated the costs of achieving the recommended standard and overestimated the benefits. Most of the published health studies indicated no evidence of health effects, even in the most sensitive groups, below levels of .15 PPM and irreversible effects were not evident below .25 PPM.

Since a threshold of health effects had not been demonstrated scientifically, OMB recommended that the standard be set based on the point at which marginal costs increased sharply. This, they believed, was a rational step toward equalizing the marginal costs of protecting health across different health and safety programs. OMB noted that the marginal costs per reduced person hour of exposure in moving from a standard of .18 PPM to 0.16 PPM (between $170 and $440) relative to the cost of going from 0.12 to 0.10 PPM (between $2,100 and $4,100) were over ten times higher. EPA interpreted the OMB report as recommending a standard of 16 PPM on the basis of costs and insisted that the Clean Air act forbade consideration of costs in setting standards. The President's staff argued that since no threshold effects had been demonstrated scientifically, the standard should consider both costs and benefits. A compromise, which produced the same control level but with substantial cost savings, was proposed. The EPA Administrator rejected the proposal, but did revise the proposed standard "on the basis of the health effects evidence" increasing it in the final decision to .12 PPM.

Publicly, the Administrator announced that he had "discussed the standard with the economists only after he had made his decision. And then only to explain." White House economists were disappointed that they had not had a greater effect while some members of Congress argued that the economic point of view had a disproportionate amount of weight in the decision process. EPA announced that the choice of the standard was said to be "a judgment of prudent public health practice" and furthermore that it acknowledged that "although the Administrator cannot take costs into account controlling ozone to very low levels will have significant impact on social and economic activity. It is thus important that the standard not be any more stringent than protection of public health demands." The cost savings of moving from .08 PPM to .10 PPM were estimated at one billion dollars per year with even larger savings (an apparently no loss of benefits) resulting from the final .12 PPM standard. Despite the health-based statutes, economics did impact the outcome as a consequence of regulatory review's benefit-cost assessment, although not to the degree that a formal benefit-cost analysis would indicate.

SO2 Allowance Trading

The cost of air pollution control in the US was estimated at $125 billion annually in 1990. These high costs combined with the availability of sound benefit-cost studies and a favorable political climate to bring about significant changes in some portions of the Clean Air Act in the 1990 Amendments. In the mid 1980's, EPA conducted a benefit-cost analysis of alternative air pollution control mechanisms to achieve air quality standards. The study explored the relative benefits and costs of achieving pollution control standards with the then dominant technological mechanisms to market-based ones. The EPA analysis estimated that a well-functioning tradable permit system, in which firms could buy and sell allowances to emit SO2, would save 50 percent or over $6 billion annually over the costs of continuing the technology

based program then in place. The SO2 allowance trading program was adopted and has provided significant empirical evidence to support economists' claims that market-based regulatory approaches can achieve significant cost savings. By 1996, actual savings have amounted to $1 billion dollars annually over the alternative control mechanisms (Stavins, 1998).[9]

The SO2 allowance trading program demonstrated that benefit-cost analysis can be useful in helping to select the most efficient means of achieving environmental goals even if benefit-cost calculations are not the basis for setting the standard itself. Instead of applying benefit-cost analysis to determine the appropriate regulatory standard (as was tried with the 1978 revision to ozone standard discussed above) economists separated the benefit-cost calculation from the determination of the appropriate level of SO2 reduction. The standard was health based and benefit-cost analysis was used to determine the best implementing mechanism.

5. Methodological Challenges

Five basic issues have plagued benefit-cost studies in the evaluation of regulatory decisions: estimating non-market values, accounting for risk and uncertainly, taking account of impacts on income distribution, selecting the discount rate (intergenerational issues), and concerns about values not captured by measuring individual preference satisfaction.

Non-Market Values

In any evaluation of environmental regulations, one of the critical issues is assigning a value to non-market goods. Available valuation procedures such as travel cost, hedonic pricing, and contingent valuation each have their strengths and weaknesses; some are more relevant for valuing specific environmental goods and services than others. As with any other estimate, they are subject to error. The size of the error, however, depends on how well the study is done and how well its assumptions match future events such as population and industrial growth. Even

estimates based on market values are subject to error since predicting future economic conditions is fraught with well-know uncertainties. In any analysis, it is essential to make clear to the decision-maker the underlying assumptions, the limitations of the model, and the accuracy of the data.

Both the hedonic pricing and travel cost techniques use changes in the value of market goods as a means to determine the value of changes in environmental quality associated with the market good. For hedonic pricing, the market goods could be houses, land, or the change in the cost of labor. In the travel cost technique, values are based on the cost of travel to a particular recreation site. The travel cost is assumed to have the same impact on use as an admissions fee and the difference in travel cost among users is used to derive a demand for a particular recreation site.

A challenge with the hedonic approach is to isolate the effect of the environmental quality change on the price of land, houses, or labor. Hedonic analysis can be used only where land, housing, or labor markets are reasonably well developed and not in sparsely populated areas where few market transactions occur. For example, an active housing market in and around a lake would provide a good basis for determining how much an improvement in water quality has added to the value of houses around the lake.

Contingent valuation is potentially the most comprehensive and flexible of the non-market valuation methods. Under appropriate conditions, it can provide estimates of both "use values" and "non-use values" associated with changes in environmental regulations. Non-use values are related to individuals' desire to know that a certain environmental asset exists and will continue to exist in the future even though they may never use them. Contingent valuation is the only widely used procedure for estimating these non-use values.

On the other hand, contingent valuation remains controversial primarily because it is based on stated preferences rather than revealed preferences. This concern is not about to disappear but it can be partially addressed by continued efforts to improve its application (Bishop and Welsh, 1998). In some cases, it is also possible to combine revealed and stated preference models. This can provide a more comprehensive view of consumer preferences, allow one to determine if nonusers and users have the same preferences, and improve estimates.

Since regulations generally have impacts on human health, there is a need to value changes in sickness and mortality rates. Estimating the value of reductions in adult sickness is probably the easiest because, at a minimum, one can use the associated gain in productivity as a lower bound estimate. However, this leaves out some of the individual's willingness to pay to avoid sickness. For children and the aged, such measures do not work since they are not employed. Some policy makers would argue that changes in mortality should be estimated by changes in earnings or income. But again, this ignores an individual's willingness to pay to reduce the probability of death. It also ignores other peoples' willingness to pay positive or negative amounts towards the change in the probability of some particular individual's death.

Another problem in the valuation of mortality rates in the U.S. Federal government has been the lack of consistency in estimates.[10] A succession of administrations has failed to establish even a range of values for a mortality risk reduction.

> For agencies that explicitly value mortality risk reductions, the implied "value of a statistical life" ranges from $1 to $10 million. Although EPA's regulatory-impact analyses (RIAs) occasionally value statistical lives saved, each office uses different values. DOT requires that all its agencies compare their cost-per-life estimates to a single benchmark of around $2.8 million. OSHA has a policy of not considering values of lives saved either explicitly or with reference to a benchmark in its assessments.
>
> When agencies do not explicitly value death-risk reductions but instead make decisions based on an "acceptable cost-per-life saved," the implicit value of a statistical life can be far higher. One study of EPA regulatory decisions affecting cancer risks found regulations promulgated that cost over $50 million per "life saved." OMB's own study of such behavior involving a broader range of causes of death found even higher costs per life saved, as did a recent CBO study of drinking water standards" (Kopp, Krupnick and Toman, 1997, p. 52).

Economists should not be defensive about proposing a range of monetary values for a statistical life. Courts decisions create these values regularly without much challenge. Estimates concerning the levels of sickness based on experiments with mice are not necessarily any better than the monetary values estimated for avoiding sickness or death based on contingent valuation studies.

Finally, because it may not be possible to monetize some environmental effects, there is general agreement that monetary results should be supplemented with estimates of non-monetized benefits where appropriate (OMB, 1997). In such cases, net benefits for the monetized effects can be estimated and one can then determine how large the non-monetized effects would have to be to reverse the conclusions of the analysis. This will provide the decision-makers with information beyond the description of the non-monetized effects.

Uncertainty and Risk

Uncertainty and risk concerning nonmarket and market values are addressed by sensitivity analysis. The results of any study should be tested to see if they are sensitive to ten to twenty percent changes in these values. If this variation does not change the initial positive or negative result of the benefit-cost analysis, the results are considered robust. In such cases, the decision-maker can be reasonably confident in using the results.

Risk can be brought directly into the analysis if estimates are available for the distribution of risk for the population in question. This is where risk assessment could complement benefit-cost analysis by providing such estimates. Yet currently risk assessment tends to focus on individual risk and tries to determine acceptable risk targets instead of determining the risk distribution for a population. While the dose-response description of risk is needed for benefit-cost analysis, risk assessment tries to establish a target concentration that provides an acceptably small level of risk. Thus, an expansion of the process of risk assessment to look at the

distribution of risk could provide an important input and strengthen benefit-cost analysis (Kopp, Krupnick, and Toman, 1997).

Income Distribution

Policy makers are often concerned about the possible negative effects a regulation may have on income distribution (and specifically, whether low-income groups are disadvantaged). To test for this, alternative regulations could be studied to see if some have less negative impacts on income distribution than others. Next, the regulations with the least negative income distribution impacts could be compared to the others using benefit-cost analysis. If the benefit-cost analysis shows that, from the perspective of economic efficiency, the regulation with the least adverse income distribution effects is not significantly different from the others then it would be the preferred regulation.

Effects on income distribution can also be addressed by giving special weight to certain benefits and costs. For example, different weights could be given to various areas of the country, depending on their income levels. Benefits accruing in low-income areas might receive a weight of 1.5, while those in high-income areas might be given a weight of 0.5 and those in middle income areas a weight of 1. This would mean that programs and projects benefiting low-income areas would be more likely to be approved then if there were no distributional weights. However, care must be exercised in using such an approach since weights greater than one may make a regulation look better than it really is.

It is also important to recognize that if a regulation has significant income distribution effects, it is likely to change economic values. In other words, when incomes change, so do demands. A shift in demands could mean a significant change in either the costs or the benefits from a regulation. When these changes are large, they should be used to revise the benefit-cost estimates so that they are consistent with expected changes in income distribution. This

illustrates the need for a general equilibrium analysis, probably using a CGE model, when the secondary effects are expected to be large due to regulatory changes.

Discounting

Discounting is another critical measurement problem that can have a major impact on the outcome of benefit-cost analyses. The main problem is determining what rate or rates to use, especially in the evaluation of regulations that have impacts that occur over a long period of time. Some policy makers argue that regulatory decisions will likely have long term impacts which affect future generations, and consequently we should not be foreclosing options by placing low weights on benefits and costs that occur in the distant future. Others point out that the use of low discount rates encourages public investment with low pay-offs compared to the private capital market and that if the investments had high returns (higher discount rate) the extra earning could be reinvested making future generations better off.

Given this debate, which has been raging for decades, the best solution is to use sensitivity analysis to test the decision under a range of discount rates. The vast majority of the public decisions should be analyzed using real discount rates ranging from about 3 to 9 percent. Lower discount rates might be justified if the regulatory policy would create important irreversible changes that have significant impacts on future generations.

Values and Preference Satisfaction

Although there is little debate among most economists concerning values based on the satisfaction of individual preferences, others argue that preferences might be satisfied even though the individuals' true interests were far from being served. The other concern is about the simple summation of individual well being to obtain the aggregate social well being. The latter is really a concern about possible income distribution impacts. To address this concern requires

the benefit-cost analysis to actually determine what groups benefit and which lose and by how much. This can be done but it is more expensive and, in some cases, considered too intrusive.

Whether or not preference satisfaction appropriately captures all the important benefits and costs associated with a regulation is a more difficult question. Clearly some interests may not be appropriately reflected in the analysis, explaining why benefit-cost analysis is hardly ever the only information considered in making environmental regulatory decisions. Still, benefit-cost analysis should be considered an important input into regulatory decisions. To ignore the results of the benefit-cost analysis would mean that economic efficiency in government spending is not important – which seems contrary to current U.S. government policy declarations.

6. Conclusions

In a time of increasing debate about budgets, there is and will likely continue to be a concern about the cost of environmental regulations. Although there are a number of alternative mechanisms to reduce and control environmental pollution, those that provide market incentives are likely to be lower cost. The search for lower cost regulations will continue to push agencies such as EPA to increase their use of benefit-cost and cost-effectiveness analyses, and to develop control mechanisms that rely on market-based incentives. Still, EPA currently devotes few of its resources to economic analysis (Morgenstern, 1998).

The important question is whether or not the concern about budget levels for environmental regulations and pollution control will translate into greater expenditures on economic analysis of regulatory decisions. Good benefit-cost analyses require expenditures of resources but are typically good investments. While the need for scientific studies is well recognized, too often benefit-cost studies are underfunded, resulting in poor studies that are easily criticized. A willingness of the U.S. Federal and State governments to devote the

resources necessary to produce good benefit-cost analyses would satisfy some of the critics of non-market valuation and benefit-cost analysis as a whole. Yet enhancing EPA's internal capacity to do extensive benefit-cost analysis has developed fairly slowly and as a result, the Federal government has had to go elsewhere for some of its economic analysis of environmental regulations and may have to continue this practice.

Although we need to be mindful to avoid what Paul Portney refers to as the "perils of excessive quantification" (FDCH Congressional Testimony, 1995), we would be wise to work toward a uniform set of economic assumptions regarding the value of non-market goods, such as reductions in mortality and morbidity, and other economic assumptions, and adopt a standard format for reporting results of benefit-cost analyses (Arrow et al., 1996). At the same time, we need to be aware that we are presently limited in our ability to make predictions about ecosystem damage similar in quality to those we can now make regarding expected health risks associated with reductions in ambient concentrations of pollutants.

Given the stated public policy objective of relying on benefit-cost principles to guide environmental regulatory decisions and the methodological challenges remaining, it seems clear that investments in research advancements in valuation techniques and methods of dealing more consistently with uncertainty and risk would yield substantial returns. Yet we are now much better able to deal with many of the valuation questions than previously. Where initially, we could only suggest physical measures of non-market goods, we can now include a range of economic values that can be attached to these physical units. Further improvements in valuation methods will enhance the contributions of benefit-cost analyses to future environmental regulatory decision making.

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Endnotes

[1] In the mid 1960s academic research began to focus on measurement of non-market benefits in analyzing water quality problems. Notable among these first studies was that by Clawson and Knetsch (1966) in which the benefits of environmental improvements were calculated using the travel cost method first suggested by Hoteling in 1940. In the 1970s and 1980s, the interest in water quality expanded and other valuation techniques such as hedonic pricing and contingent valuation were developed. Research was further expanded to recognize non-use values (Krutilla, 1987). During this period these methodological advancements were applied to problems of air pollution.

[2] Two major pieces of environmental legislation – the Clean Air Act (1970) and the Clean Water Act (1972) – set standards based on public health criteria and specifically prohibited weighing of benefits and costs in setting these standards (NOAA, 1995).

[3] In 1979, the US Environmental Protection Agency (EPA) published "Methods Development for Assessing Air Pollution Control Benefits." It directed regulators to choose the alternative that, within the extent of the law, would "maximize net benefits" to society. It further stated that "regulatory actions shall not be undertaken unless the potential benefits to society from the regulation outweigh the potential costs." The 1980 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) required environmental damage assessment for projects such as the disposal of mining wastes and the discharge of hazardous substances into public water.

[4] Executive Order 12866 superseded Reagan's criterion that the benefits of regulation must "outweigh" costs with a more complex set of decision criteria. Under Section 1(a) of E.O. 12866, agencies are to "include both quantifiable measures (to the fullest extent that these can be usefully measured) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider."

[5] Zerbe (1998) points out that the discussion surrounding this legislation clearly indicated a desire to adopt benefit-cost analysis as a decision criterion rather than as a guide to decision-making.

[6] Section 312 of the Clean Air Act Amendments requires EPA to conduct a comprehensive analysis of the Act including the benefits and costs associated with compliance. EPA must also provide guidance to the States in evaluating the cost-effectiveness of various emissions control options.

[7] These include Arizona, California, Colorado, Florida, Illinois, Oregon, Virginia, and Washington.

[8] Health studies indicated that exposures below .15 PPM were reversible with irreversible effects likely above .25 PPM. State and local air pollution control agencies endorsed .12 PPM or higher given the costs; industry urged .15 PPM or higher on the basis of uncertain benefits below that level while environmental groups wanted to retain .08 PPM. There was also a lack of consensus within EPA on the appropriate standard to protect health.

[9] This cost-saving estimate is lower than that predicted by EPA's benefit-cost analysis. The numbers cannot be directly compared, as the underlying assumptions in EPA's original study are not available.

[10] GAO found that eight of the 23 analyses did not identify either the discount rate or the value of life as important underlying assumptions. The value of life employed in measuring improvements varied significantly between studies and even quite broadly within a given study. For example, one study assumed a range of $1.6m to $8.5m while another conducted the same year assumed a range of $3m-$12m. Thirteen of the 23 studies employed only one discount rate in their analysis; 18 identified what discount rates were used and of those five showed sensitivity of the results to discount rates in the range of 2-10 percent.