Chapter 1: Introduction

Background to the Guidelines for Performing Economic Analyses

In December of 1983, the U.S. Environmental Protection Agency issued its *Guidelines for Performing Regulatory Impact Analysis*[1] *(RIA Guidelines)*.

Since their promulgation, the original RIA Guidelines have remained largely unaltered, experiencing only a few modifications and additions to specific sections during the 1980s.

Much has changed since 1983, however, so EPA has prepared these revised and updated *Guidelines for Preparing Economic Analyses (EA Guidelines)*. The revised *EA Guidelines* reflect the evolution of environmental policy making and economic analysis over the past decade and a half.

Recent years have seen an expansion of the universe of economic and social issues that are potentially affected by environmental policies. In 1983, the content of the analyses required for RIAs was driven mostly by Executive Order 12291, which directed federal agencies to assess the costs, benefits, and economic impacts of their rules, and established a formal review process by the Office of Management and Budget (OMB). This process and its goals were reaffirmed in 1992 with the issuance of Executive Order 12866 on regulatory planning and review. OMB subsequently released the document *Economic Analysis of Federal Regulations Under Executive Order 12866*[2] (or *Best Practices*), which served to illustrate specific techniques and issues concerning the conduct of economic analysis in support of EO 12866. More recently, OMB released the document *Guidelines to Standardize Measures of Costs and Benefits and the Format of Accounting Statements*[3] (or *OMB Guidelines*) which currently serves as guidelines to federal agencies on economic analysis.

In addition to requirements to prepare economic analyses set forth by Executive Order, economic assessments are also called for under various administrative statutes. For example, agencies are explicitly directed to examine whether their policies impose new "unfunded mandates" on state, local, and tribal governments, and to review economic impacts on small businesses, governments, and nonprofit enterprises under the Unfunded Mandates Reform Act of 1995 (P.L. 104-4) and the Regulatory Flexibility Act, as amended by the Small Business Regulatory Enforcement Fairness Act (5 U.S.C. 601-612).

Policy makers have also extended the scope of relevant effects to be considered beyond these mandatory

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[1] U.S. Environmental Protection Agency, *Guidelines for Performing Regulatory Impact Analyses*. EPA-230-84-003, December 1983. Reprinted with Appendices in March 1991.

[2] U.S. Office of Management and Budget, *Economic Analysis of Federal Regulations Under Executive Order 12866*, January 11, 1996. This "*Best Practices*" document can be found at the U.S. White House, Office of Management and Budget website: http://www.whitehouse.gov/OMB/inforeg/riaguide.html under the section titled "Regulatory Policy" (accessed 8/28/2000).

[3] U.S. Office of Management and Budget, M-00-08 *Guidelines to Standardize Measures of Costs and Benefits and the Format of Accounting Statements*, March 22, 2000. The *OMB Guidelines* serves to implement Section 638(c) of the 1999 Omnibus Consolidated and Emergency Supplemental Appropriations Act and Section 628(c) of the Fiscal Year 2000 Treasury and General Government Appropriations Act. They require OMB to issue guidelines to help agencies estimate the benefits and costs of federal regulations and paperwork and summarize the results of the associated analysis. The *OMB Guidelines* can be found at the U.S. White House, Office of Management and Budget website: http://www.whitehouse.gov/OMB/memoranda/index.html under the section titled "Selected Memorandum to Heads of Federal Departments and Agencies" (accessed 8/28/2000).

assessments. For example, the Pollution Prevention Act was passed in 1990 and the Agency has undertaken new initiatives that explored voluntary, non-regulatory approaches to address past and potential future pollution sources. Economic assessment of these types of actions can provide useful information on the economic efficiency of allocating society's resources in these ways.

The *EA Guidelines* have been updated to keep pace with the evolving emphases policy makers place on different economic and social concerns affected by environmental policies. Underlying this exercise is the recognition that a thorough and careful economic analysis is an important component in designing sound environmental policies. Preparing high quality economic analyses can greatly enhance the effectiveness of environmental policies by providing policy makers with the ability to systematically assess the consequences of regulatory and non-regulatory actions. An economic analysis can describe the implications of policy alternatives not just for economic efficiency, but for the magnitude and distribution of an array of impacts. Economic analyses also serve as a mechanism for organizing information carefully. Thus, even when data are insufficient to support particular types of economic analyses, the conceptual scoping exercise may provide useful insights.

The *RIA Guidelines* focused appropriately not only on what was required for assessing costs, benefits, and economic impacts of policies, but also on the basic technical procedures for doing so. Over the past 15 years, however, economic science has developed new techniques for benefits estimation, different economic models for assessing costs and other effects, and greatly expanded data sources and related guidance materials. These are all reflected in this document.

As a result of these modifications and updates, the new *EA Guidelines* will continue to serve, as always, to ensure that the EPA's economic analyses are prepared to inform its policy making processes and satisfy OMB's requirements for regulatory review. The new *EA Guidelines* also seek to establish an interactive policy development process between analysts and decision makers through an expanded set of cost, benefit, economic impacts, and equity effects assessments, an up-to-date encapsulation of environmental economics theory and practice, and an enhanced emphasis on practical applications.

The Scope of the EA Guidelines

The focus of the *EA Guidelines* is on the economic analyses typically conducted for environmental policies using regulatory or non-regulatory management strategies. Other guidance documents exist for related analyses, some of which are inputs to economic assessments. No attempt is made here to summarize these other guidance materials. Instead, their existence and content are noted in the appropriate sections. The *EA Guidelines* follow generally the outline of OMB's *Best Practices* and the *OMB Guidelines*, except insofar as these guidelines embody assessment principles and policy advice developed recently by EPA for its economic analyses.

As with the previous *RIA Guidelines*, the presentation of economic concepts and applications in this document assumes the reader has some background in microeconomics as applied to environmental and natural resource policies. Thus, to fully understand and apply the approaches and recommendations presented in the *EA Guidelines* readers should be familiar with basic applied microeconomic analysis, the concepts and measurement of consumer and producer surplus, and the economic foundations of benefit-cost evaluation. Persons lacking these skills, but seeking to better understand economics, will require an alternative presentation of the materials contained in this document. Supplemental written material will be prepared to accompany this document, including training materials developed to reach a wider audience of individuals responsible for using the types of economic tools and information described here.

The *EA Guidelines* are designed to provide assistance to analysts in the economic analysis of environmental policies, but they do not provide a rigid blueprint or a "cookbook" for all policy assessments. The most productive and illuminating approaches for particular situations will depend on a variety of case-specific factors and will require professional judgment to apply. The *EA Guidelines* should be viewed as a summary of analytical methodologies, empirical techniques, and data sources that can assist in performing economic analyses of environmental policies. When drawing upon these resources, there is no substitute for reviewing the original source materials.

In all cases, the *EA Guidelines* recommend adhering to the following general principles as stated by OMB (EO 12866, Introduction):

> "'Analysis of the risks, benefits, and costs associated with regulation must be guided by the principles of full disclosure and transparency. Data, models, inferences, and assumptions should be identified and evaluated explicitly, together with adequate justifications of choices made, and assessments of the effects of these choices on the analysis. The existence of plausible alternative models or assumptions, and their implications, should be identified. In the absence of adequate valid data, properly identified assumptions are necessary for conducting an assessment."
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> "Analysis of the risks, benefits, and costs associated with regulation inevitably also involves uncertainties and requires informed professional judgments. There should be balance between thoroughness of analysis and practical limits to the agency's capacity to carry out analysis. The amount of analysis (whether scientific, statistical, or economic) that a particular issue requires depends on the need for more thorough analysis because of the importance and complexity of the issue, the need for expedition, the nature of the statutory language and the extent of statutory discretion, and the sensitivity of net benefits to the choice of regulatory alternatives.'"

Thus, economic analyses should always acknowledge and characterize important uncertainties that arise throughout the analysis. Economic analyses should clearly state the judgments and decisions associated with these uncertainties and should identify the implications of these choices. When assumptions are necessary in order to carry out the analysis, the reasons for those assumptions must be stated explicitly and clearly. Further, economic analyses of environmental policies should be flexible enough to be tailored to the specific circumstances of a particular policy, and to incorporate new information and advances in the theory and practice of environmental policy analysis.

Organization of the EA Guidelines

The remainder of this document is organized into nine main chapters as follows:

- Chapter 2: Statutory and Executive Order Requirements for Conducting Economic Analyses reviews the major statutes and other directives mandating certain assessments of the consequences of policy actions;
- Chapter 3: Statement of Need for the Proposal provides guidance on procedures and analyses for clearly identifying the environmental problem to be addressed and for justifying federal intervention to correct it;
- Chapter 4: Regulatory and Non-Regulatory Approaches to Consider discusses the variety of regulatory and non-regulatory approaches analysts and policy makers ought to consider in developing strategies for environmental improvement;
- Chapter 5: Overview of Economic Analysis of Environmental Policy provides a theoretical overview of environmental economic analyses, as well as guidance concerning baseline specification and the treatment of uncertainty;
- Chapter 6: Analysis of Social Discounting presents a review of discounting procedures and provides guidance on social discounting in conventional contexts and over very long time horizons;
- Chapter 7: Analyzing Benefits provides guidance for assessing the benefits of environmental policies including various techniques of valuing risk-reduction and other benefits;
- Chapter 8: Analyzing Social Costs presents the basic theoretical approach for assessing the social costs of environmental policies and describes how this can be applied in practice;
- Chapter 9: Distributional Analyses provides guidance for performing a variety of different assessments of the economic impacts and equity effects of environmental policies; and

- Chapter 10: Using Economic Analyses in Decision Making concludes the main body of the *EA Guidelines* with suggestions for evaluating different policy approaches and options, and for presenting the quantified and unquantified results of the various economic analyses to policy makers.

Chapter 2: Statutory and Executive Order Requirements for Conducting Economic Analyses

Policy makers need information on the benefits, costs, and other effects of alternative options for addressing a particular environmental problem in order to make sound policy decisions. In addition, various statutes specifically require economic analyses of policy actions. General mandates may also direct agencies to conduct specific types of economic analyses. In some cases, agencies have established their own requirements for certain types of assessments of their policies. This chapter discusses specific requirements that apply to all of EPA's programs.[1]

OMB's basic requirements for regulatory review, including their *Best Practices* and *OMB Guidelines* documents, have helped to shape EPA's methodological and empirical approaches for conducting economic analyses. Several new mandates to conduct specific economic assessments of environmental policies have also recently been enacted. Many of the mandates that introduce economic analyses requirements of policies are briefly reviewed here.[2] In each case, citations for the relevant mandates or statutes and references to applicable EPA guidelines are provided.[3]

- **Executive Order 12866, "Regulatory Planning and Review"** requires analysis of benefits and costs for all significant regulatory actions. The Regulatory Working Group has prepared general guidance for complying with the requirements of EO 12866.[4] EO 12866 requires a statement of the need for the proposed action, examination of alternative approaches, and analysis of social benefits and costs. Chapters 3 through 8 of this document describe methods for meeting these requirements. EO 12866 also states that the distributional and equity effects of a rule should be considered. Chapter 9 describes methods for analyzing and assessing these effects.
- **The Unfunded Mandates Reform Act of 1995 (P.L. 104-4)** directs agencies to assess the effects of federal regulatory actions on state, local, and tribal governments, and the private sector. Agencies are to obtain meaningful input from state, local, and tribal governments for rules containing "significant federal intergovernmental mandates." These are federal mandates which may result in the expenditure by state,

[1] EPA personnel seeking information on EPA's policies and guidelines applicable to rule development can be found at the following EPA Intranet website http://intranet.epa.gov/rapids (accessed 8/18/2000, internal EPA document). Many of the citations included in this section can be found at this site. Note, this website and other additional websites referenced in this document are located on EPA's Intranet website and are limited to use by EPA personnel. When cited in this document, EPA Intranet websites will be labeled as "internal EPA document."

[2] Statutory provisions that require economic analysis but that apply only to specific EPA programs are not described here. However, analysts should carefully consider the relevant program-specific statutory requirements when designing and conducting economic analyses, recognizing that these requirements may mandate specific economic analyses.

[3] More information on some of these program-specific mandates can be found in Chapter 9 of this document.

[4] U.S. Office of Management and Budget, "Memorandum for Members of the Regulatory Working Group: Economic Analysis of Federal Regulations Under Executive Order No. 12866," January 11, 1996. The guidance also addresses the requirements of the Unfunded Mandates Reform Act and the Regulatory Flexibility Act.

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local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more in any one year.[5] UMRA also directs agencies to assess the effects of federal regulatory actions that will have a significant or unique effect on small governments. OMB has provided general guidance on complying with UMRA.[6]

- **Executive Order 13132, "Federalism"** requires consultation with affected state and local governments on rules that have federalism implications—that is regulations and policy statements "that have substantial direct effects on states (and local governments), on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government." EO 13132 also imposes additional consultation obligations on agencies if they promulgate regulations with federalism implications that either: (1) impose substantial direct compliance costs on state and local governments not required by statute and do not provide funds to cover these costs, or (2) preempt state or local laws.[7]

- **The Regulatory Flexibility Act of 1980 (5 U.S.C. 610-612) (RFA)**, as amended by **The Small Business Regulatory Enforcement Fairness Act of 1996 (P.L. 96-354) (SBREFA)** requires that federal agencies determine if a regulation will have a significant economic impact on a substantial number of small entities (including small businesses, governments, and non-profit organizations.) If a regulation will have such an impact, agencies must prepare a Regulatory Flexibility Analysis and comply with a number of procedural requirements to solicit and consider flexible regulatory options that minimize adverse economic impacts on small entities. EPA has prepared Revised Guidance on complying with the RFA and SBREFA requirements.[8] Chapter 1 of that document provides guidance on the analytical requirements, including thresholds for determining "significant impact," "substantial number," and "small entities," and recommended quantitative measures for evaluating economic impacts on small entities.

- **Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations"** requires federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations. EO 12898 also requires the same consideration for Native American programs. EPA and the Council on Environmental Quality (CEQ) have prepared guidance for addressing environmental justice concerns in the context of NEPA requirements.[9] These materials provide definitions of key phrases in the Executive Order, which draw on draft guidance prepared by an interagency task force.[10]

- **Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks"** requires agencies to evaluate the health or safety effects of planned regulations on children. For economically significant rules that are subject to EO 13045, agencies are required to explain why the planned regulation is preferable to other potentially

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[5] U.S. Environmental Protection Agency, *EPA Guidance - Unfunded Mandates Reform Act of 1995, Interim Guidance*, March 23, 1995.

[6] U.S. Office of Management and Budget, "Guidance for Implementing Title II of S.1." Memorandum from Sally Katzen, Administrator, Office of Information and Regulatory Affairs, March 31, 1995.

[7] U.S. Environmental Protection Agency, *Interim Guidance on Executive Order 13132: Federalism*, February 2000.

[8] U.S. Environmental Protection Agency, *EPA Revised Interim Guidance for EPA Rulewriters: Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act*, March 29, 1999.

[9] For more information see U.S. Environmental Protection Agency, *Interim Final Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses*, Office of Federal Activities, April 1998, and Council on Environmental Quality, *Guidance for Addressing Environmental Justice under the National Environmental Policy Act (NEPA)*, March 1998.

[10] Interagency Working Group on Environmental Justice, *Final Guidance for Federal Agencies on Key Terms in Executive Order 12898*, August 8, 1995.

effective and reasonably feasible alternatives considered by the agency. EPA has prepared guidance on compliance with EO 13045.[11] Materials in Chapter 9 provide suggestions for the types of questions analysts could ask to characterize risks to children, and refers analysts to the various EPA guidance documents on risk assessment for information on analytic methodologies. While EO 13045 primarily addresses risk rather than economic analyses, economic analyses may be needed to determine whether EO 13045 requirements apply to a specific rule.

- **Executive Order 13084, "Consultation and Coordination with Indian Tribal Governments"** requires agencies to recognize the unique legal relationship with Indian tribal governments set forth in the Constitution and other treaties and documents. The order seeks to establish a regular and meaningful consultation and collaboration with Indian tribal governments in the development of regulations, imposition of unfunded mandates, and process for seeking waivers from federal requirements. The order seeks to encourage cooperation of tribal governments in development of regulations that significantly or uniquely affect their communities, including use of consensual mechanisms and negotiated rulemaking.

[11] U.S. Environmental Protection Agency, *EPA Rule Writer's Guide to Executive Order 13045: Guidance for Considering Risks to Children During the Establishment of Public Health-Related and Risk-Related Standards*, Interim Final Guidance, April 30, 1998.

Chapter 3: Statement of Need for the Proposal

3.1 Introduction

An appropriate point of departure for economic analyses of an environmental policy is a clear statement of the need for policy action. Key components of this discussion include an examination of the nature of the pollution problem to be addressed, an analysis of the reasons existing legal and other institutions have failed to correct the problem, and a justification for federal intervention instead of other alternatives. Statutory and judicial requirements that mandate the promulgation of particular policies or the evaluation of specific effects are also key factors in motivating certain analyses and policy actions. In some instances statutes prohibit the use of certain types of analyses in policy making. In these cases, the guidance presented in this document should be applied selectively to be consistent with such mandates.

3.2 Problem Definition

The initial problem definition discussion should briefly review the nature of the environmental problem to be addressed. The following considerations are often relevant:

- primary pollutants causing the problem and their magnitude;
- media through which exposures or damages take place;
- private and public sector sources responsible for creating the problem;
- human exposures involved and the health effects due to those exposures;
- non-human resources affected and the harm that results;
- expected evolution of the pollution problem over the time horizon of the analysis;
- current control and mitigation techniques; and
- the amount or proportion (or both) of the environmental problem likely to be corrected by federal action.

3.3 Reasons for Market or Institutional Failure

Following this concise problem definition summary should be an examination of the reasons why the market and other public and private sector institutions have failed to correct the problem. This component should be viewed as a key part of the process of environmental policy development because the underlying failure itself often suggests the most appropriate remedy for the problem.

Four categories of "market failure" are discussed in OMB's *Best Practices* in the sections titled externalities, market power, natural monopoly, and information asymmetry. For environmental conditions, externalities are the most likely causes of the failure of private and public sector institutions to correct pollution damages. However, information asymmetries and even pre-existing government-induced distortions can also be responsible for these problems.

Externalities can occur for many reasons. Transactions costs, for example, can make it difficult for injured parties to use legal or other means to

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cause polluters to internalize the damages they cause. A similar result can occur when property rights to the media or resources harmed are held in common or are poorly defined. Externalities can also arise because tracing the causal connections from activities that pose environmental risks to the resulting damages can be very difficult and often involve long time periods.

A comprehensive examination of the market's failure to address a specific environmental problem involves more than a statement that harms exist. Economic analyses should explore, for example, why transactions costs are high or why property rights are difficult to assign clearly. Similar analyses are appropriate for situations in which other factors are responsible for the failure of the market or other public and private sector institutions to address environmental problems.

3.4 Need for Federal Action

The final component of this initial statement of the need for the proposal is an analysis of why a federal remedy is necessary instead of actions by private and other public sector entities, such as the judicial system and state and local governments. Federal involvement is often required by pollution that crosses jurisdictional boundaries, by international environmental problems, and by statutory and other authorities. Economic analyses should make clear the basis for federal involvement by comparing it with the performance of a variety of realistic alternatives that rely on other institutions and arrangements. This discussion should also verify that the proposed action is within the relevant statutory authorities and that the results of the policy will be preferable to no action. Aspects of the regulations being proposed and promulgated that are not discretionary, but are dictated by statutory requirements, should be identified, as this may have an influence on the development of the economic analysis and presentation of the results.[1]

[1] The reader is also referred to Executive Order 13132 on "Federalism" for the introductory statements regarding principles of federalism and the section describing the doctrines of preemption.

Chapter 4: Regulatory and Non-Regulatory Approaches to Consider

4.1 Introduction

Once the need for federal policy action to address an environmental problem has been established, economic analyses should define and evaluate a range of possible regulatory and non-regulatory approaches. Many different approaches may help achieve efficient environmental protection. It is largely the analyst's responsibility to consider and characterize these approaches and then to present feasible alternatives for decision makers to consider early in the policy making process. The analyst should also be cognizant of constraints that may be placed on the use of non-regulatory approaches for addressing a specific environmental problem. Market-oriented options, for example, may not be consistent with statutory mandates and the best response to an environmental problem might require action outside the authority of the relevant statute.

This chapter briefly describes several of these approaches, but it does not attempt to detail the relative merits of putting them into practice for particular EPA policy initiatives. The goal here is to introduce several of the terms and concepts to analysts and to provide references that describe the conceptual foundations of each approach.[1] For some approaches, this chapter provides references on existing applications to environmental regulatory programs. Four general types of approaches are described below. The chapter concludes with some notes on fine-tuning policy approaches.

4.2 Traditional Design-Based Command and Control

Design-based command and control regulations have a long history in environmental policy, generally taking the form of specifying certain technologies or designs. These regulations usually impose the same requirements on all sources, although new and existing sources as groups are frequently subject to different standards.[2] An advantage of the approach is its relative ease of compliance monitoring and enforcement. Nonetheless, command and control regulations may be less cost-effective than other approaches, meaning that the same environmental protection might be achieved at a lower cost or more environmental protection might be secured for the same cost. Also, command and control regulations may not readily accommodate or encourage technological innovation or may fail to provide incentives to reduce pollution beyond what would be undertaken to comply with the standard.[3]

4.3 Performance-Oriented Approaches

Rather than mandating a particular technology for compliance, *performance-based standards* specify a source's maximum allowable level of pollution and

[1] Baumol and Oates (1993), particularly Chapters 10-14, is a useful general reference on the economic foundations of many of these approaches.

[2] For a discussion on this subject and ways these types of programs lead to this result, see Helfand (1992).

[3] For some theoretical analyses of this point, see Malueg (1989), Milliman and Prince (1989), and Jung et al. (1996). A recent review of empirical literature can be found in Jaffe and Stavins (1995).

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then allows the source to meet this target in whatever manner it chooses (e.g., the least costly and most flexible manner available). This approach has the advantage of allowing sources to effectively tailor pollution control requirements to their particular circumstances and encourages and accommodates technological innovation. Often, performance-based standards provide the opportunity to achieve the same goals more cost-effectively than command and control approaches. However, these approaches may place additional burdens on monitoring to ensure compliance and do not introduce incentives to reduce emissions or hazard levels beyond prescribed requirements.

4.4 Market-Oriented Approaches

A wide variety of methods for environmental protection fall under the general classification of *market-oriented approaches*. In one manner or another, each of these makes use of private sector incentives, information, and decision making in the pursuit of environmental improvement. Market-oriented approaches can differ from more traditional regulatory methods with regard to their economic efficiency and distribution of benefits and costs within the economy. These approaches include, for example:

- taxes, fees, or charges;
- subsidies;
- marketable permit systems;
- deposit-refund systems;
- offsets and bubbling;
- insurance/financial assurance requirements;
- liability rules; and
- information provision.

Some aspects to consider when choosing among these approaches as potential regulatory options are briefly described below.[4]

4.4.1 Descriptions of Market-Based Approaches

Taxes, fees, charges, and subsidies generally "price" pollution and leave decisions about the level of emissions to each source. For example, emissions of a toxic substance might be subject to an environmental charge based on the damages these emissions cause. Sources would individually decide how much to control these emissions based on the costs of the control and the magnitude of the charge. Taxes, fees, and charges have some highly desirable theoretic properties, including encouraging pollution control activities. However, they also sometimes impose substantially different burdens on pollution sources than do other approaches. One example is the potential liability that taxes, fees, and charges impose for residual pollution, which other approaches allow without charge. Issues surrounding the use of these approaches concern the collection of revenues and the distribution of economic "rents" from these programs, including deciding who should collect these fees (e.g., government or private sector) and what to do with revenues raised by these mechanisms (e.g., reduce other types of taxes on the regulated entities or redistribute the funds to finance other public services).

Marketable permit systems provide environmental improvements similar to those provided by taxes, fees, and charges. They function differently, however, in that the marketable permits approach sets the total quantity of emissions, while taxes, fees, and charges set the effective "price" of emitting pollutants.[5] If the permits are auctioned or otherwise sold to pollution sources, the

[4] This document does not go into the level of detail necessary to fully describe and provide a means of evaluating the relative merits of different regulatory and non-regulatory approaches. Instead, there is a growing literature on applied market-oriented approaches for environmental protection that should be reviewed prior to considering these regulatory approaches. For example, Anderson and Lohof (1997) and Stavins (1998a, 1998b) provide recent compilations of information on the theory behind and empirical use of economic incentives systems applied to environmental protection. Additional sources for details on incentive systems include Moore (1989), Tietenberg (1985, 1992), EPA (1991), OECD (1989, 1991), and proceedings published under the "Project 88" forum sponsored by the Center for Science and International Affairs, Harvard University (Stavins (1988, 1991)). These sources, and the references they contain, should be consulted for additional information concerning the design, operation, and performance of many of these instruments.

[5] The U.S. Acid Rain Program established under Title IV of the 1990 Clean Air Act Amendments is a good example of a marketable permit program. For recent economic analyses of this program see Joskow et al (1998) and Stavins (1998c). For more information on the program itself visit EPA's Acid Rain website at http://www.epa.gov/acidrain (accessed 8/28/00).

distributional consequences of this approach are similar to those experienced when using taxes, fees, and charges. However, if new entrants must obtain permits from existing sources, then the distributional consequences of permit systems will differ from those likely to arise after the introduction of technology-based standards. The potential to establish a barrier to entry on the basis of limiting quantities (e.g., if "grandfathering" of current emission sources is part of the program) can affect the eventual distribution of revenues, expenses, and "rents" within the economy. The ultimate distribution of "rents" under these programs can be an important feature of market-based approaches and, therefore, should be considered when comparing these with more traditional regulatory approaches.

Deposit-refund systems are like specialized forms of taxes. The deposit operates as a tax and the refund serves as an offsetting subsidy. Many good examples of deposit-refund systems exist, most of which are geared toward reducing litter and increasing the recycling rates of certain components of municipal solid waste.[6] Perhaps the most prominent examples are those programs associated with newspapers, plastic, and glass bottles.

Offsets and bubbling allow restricted forms of emissions trading across or within sources. This approach has seen widespread use, mostly in controlling air pollution in non-attainment areas. An offset, for example, would allow a new source of emissions in an airshed to negotiate with an existing source to secure reduction in the latter's emissions. This reduction would then be used to accommodate the emissions from the new source. Bubbling can allow a facility to consider all sources of emissions of a particular pollutant within the facility in achieving an overall target level of emission control or environmental improvement.

Insurance and financial assurance arrangements generally require those engaged in environmentally risky activities to ensure, typically through a third party, that sufficient resources will be available to remedy future damages. This arrangement harnesses the financial incentives of private sector companies to promote and maintain environmentally safer practices. An example of this approach to environmental protection is the financial assurance requirements related to closure and post-closure care for hazardous waste treatment, storage, and disposal facilities.

Liability rules are legal tools that allow victims (or the government) to force polluters that cause damages to pay for those damages after they occur.[7] They are typically applied to infrequent events such as cleanup of hazardous waste sites under CERCLA or cleanup after oil spills under the Oil Pollution Control Act. There are a variety of types of liability rules and in some situations these rules can mimic the desirable properties of taxes. However, this is not the case in all situations and even in those specific cases proper functioning of liability rules depends on a legal system which may not perfectly implement the rules.

Finally, **information provision** operates by ensuring that production and consumption decisions are adequately informed about the environmental and human health consequences of certain choices. In some cases, shifts in these decisions can encourage environmentally benign activities and discourage environmentally detrimental ones. The Toxics Release Inventory, consumer-based programs on the risks of radon in homes, and pesticide labeling programs are examples of efforts by EPA to implement information-based policy approaches.

4.4.2 Selecting Market-Oriented Approaches

The most appropriate market-oriented regulatory approach depends on a wide variety of factors, such as the nature of the market failure, the specific circumstances of the pollution problem, and the ultimate goals of policy makers.[8] The choice between taxes (or fees and charges) and marketable permits, for example, rests theoretically on such matters as the degree of uncertainty surrounding the estimated benefits and costs of pollution control as

[6] For example, Arnold (1995) analyses the merits of a deposit-refund system in a case study focusing on enhancing used-oil recycling and Sigman (1995) reviews policy options to address lead recycling.

[7] See Segerson (1995) for a discussion of the various types of liability rules, the efficiency properties of each type of rule, and an extensive bibliography.

[8] Helpful references that discuss aspects to consider when comparing among different approaches include EPA (1980), Hahn (1990), Hahn and Stavins (1992), and OECD (1994a, 1994b).

well as how marginal benefits and costs change with the stringency of the pollution control target. This choice also depends on distributional considerations and the extent to which policy makers are willing to allow the market to determine exact outcomes. Marketable permits, for example, set the total level of pollution control, but the market determines which sources reduce emissions and to what extent. Taxes, however, leave both the extent of control by individual sources and the total level of control to market determination.

Consideration should also be given to potential differences among economic instruments that have implications for the revenues collected under alternative mechanisms. The opportunities to direct collected resources at reductions in other inefficiencies introduced in markets that have consequences for economic welfare will affect the assessment of market-oriented approaches.[9]

The use of a particular market-oriented approach is often suggested directly by the cause of the pollution problem and constraints on the efficacy of other traditional policy instruments. For example, subsidies and deposit-refund systems place some enforcement burden on the regulated entities. This feature makes these approaches attractive if large numbers of small pollution sources exist and attempts to prohibit their actions are likely to fail due to risk of widespread noncompliance and costly enforcement. A positive incentive in these cases can solve both the original market failure and the enforcement problem.

Offsets and bubbles tend to be more appropriate when policy makers seek to help sources reduce compliance costs, while still attaining the environmental improvement embodied in a more traditional standards-based, source-by-source approach. Similarly, insurance and financial assurance mechanisms are useful instruments to supplement existing standards and rules when there is a significant risk that sources of future pollution might be incapable of financing the required pollution control or damage mitigation.

Finally, information remedies are often suggested when a market has failed to provide information and policy makers believe that private and public sector decisionmakers will act to address an environmental problem once the information has been disseminated. Voluntary approaches are closely related to information remedies and are most useful when they bring to bear the market's knowledge and innovation efforts on a particular environmental problem, and when direct standards-based methods would be very time-consuming and costly to develop.

4.5 Non-Regulatory Approaches

In addition to regulatory approaches, EPA has pursued a number of non-regulatory initiatives that rely heavily on *voluntary approaches* to achieve improvements in emissions controls and management of environmental hazards. Much of the foundation for these initiatives rests with the concepts underlying a "Pollution Prevention" approach to environmental management choices. In the Pollution Prevention Act of 1990, Congress established as a national policy that:

- pollution should be prevented or reduced at the source whenever feasible;
- pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible;
- pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and
- disposal or other release into the environment should be employed as a last resort and should be conducted in an environmentally safe manner.

Working directly with a broad array of institutions that participate in decisions affecting the environment (e.g., consumers, regulatory agencies, industry), an effort is made to reach "common sense" understanding of the benefits and costs of management strategies that prevent damages from occurring, versus strategies aimed at reacting to the consequences of realized environmental hazards. Furthermore, some preventive measures can be instituted without establishing a regulatory program, but instead through a facilitated process of identifying problems and

[9] For useful references on the emerging issues concerning the uses of revenues from pollution charges (e.g., applying environmental tax revenues so as to reduce other taxes and fees in the economy) and ways to analyze these policies, see Bovenberg and de Moojii (1994), Goulder (1996), Bovenberg and Goulder 1996), Goulder et. al. (1997), and Jorgenson (1998a, 1998b).

solutions. This can involve sharing information and experiences among participants on the use of procedures, practices, or processes that reduce or eliminate the generation of pollutants and waste at the source. Examples within the manufacturing sector include developing and distributing information on input substitution or modification, product reformulation, process modifications, improved housekeeping, and on-site closed-loop recycling. Further, pollution prevention includes other practices that reduce or eliminate pollutants through the protection of material resources by conservation and increased efficiency in the uses of raw materials, energy, water, or other resources.

Examples of voluntary programs include: (1) the 33/50 toxic substances program under which many companies have established voluntary targets for reducing the use of various toxic chemicals, (2) the "ENERGY STAR" energy efficiency labeling program, and (3) the "Design for the Environment" program. The last of these programs seeks to form voluntary partnerships with industry and other stakeholders in order to develop environmentally safer alternatives to existing products and processes that prevent the need to cleanup pollution created as by-products in manufacturing processes. Much of the literature developed to document these changes can be found in public policy and industrial ecology literature sources.[10]

4.6 Fine-Tuning Policy Approaches

In addition to considering a wide variety of possible approaches for environmental protection, analysts and policy makers should also examine other characteristics of regulatory or non-regulatory policies that affect their costs and effectiveness. For example, evaluating benefits, costs, and other effects at different levels of stringency for a given policy can help to determine settings that provide the greatest net benefits to society. Similarly, tailoring pollution control requirements to account for geographical differences in environmental effects and source differences in pollution control costs will tend to achieve greater environmental protection at lower costs. Finally, phasing in policies over time to allow new requirements to be embedded in new investments can often substantially reduce a policy's costs while sacrificing relatively few of its benefits, especially when large-scale premature retirement of capital equipment can be avoided.

Constraints, such as statutory provisions, can limit the number of available regulatory and non-regulatory approaches for addressing a specific environmental problem. Market-oriented options, for example, may not be consistent with statutory mandates and the best response to an environmental problem might require action outside the authority of the relevant statute. Nevertheless, the strategy that best informs policy makers is generally one that adopts an expansive view of a problem's possible solutions and then provides cogent and detailed economic analysis of their benefits, costs, and other effects.

[10] For more illustrations of ongoing programs and policies, the following websites offer useful information: http://www.epa.gov/opei/ (accessed 8/28/2000) and http://www.epa.gov/p2/ (accessed 8/28/2000).

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Chapter 5: Overview of Economic Analysis of Environmental Policy

5.1 Introduction

This chapter provides a brief overview of several different analyses and assessments that are normally conducted in the course of evaluating environmental policies. It also presents background and guidance on several cross-cutting methodological topics. The suggestions in this chapter, and throughout this document, are not intended to be rigid rules to be applied uniformly for each and every economic analysis. Instead, they are intended to produce a consistent, well-reasoned, and transparent process for framing economic analyses regardless of the specific characteristics and features of any given policy.

The next section outlines a conceptual perspective for economic analysis and identifies the component assessments that together form an economic analysis in practice. This section also defines certain terms that are used throughout this and the remaining chapters of the *EA Guidelines*. The remaining sections of this chapter explore some common methodological elements that are shared by virtually all economic analyses of environmental policies. The third section of this chapter addresses the choice of analytic baseline and the fourth discusses predicting responses to new policies. Treatment of uncertainty is addressed in the fifth section and the final section addresses some emerging analytical issues. Each section first reviews the nature of the methodological topic and its impact on the economic analyses, and then provides general guidelines for incorporating or addressing associated issues in practice.

5.2 Economic Framework and Definition of Terms

A Conceptual Perspective for Economic Analysis

The conceptually appropriate framework for assessing all the impacts of an environmental regulation is an economic model of general equilibrium. The starting point of such a model is to define the allocation of resources and interrelationships for an entire economy with all its diverse components (households, firms, government). Potential regulatory alternatives are then modeled as economic changes that move the economy from a state of equilibrium absent the regulation to a new state of equilibrium with the regulation in effect. The differences between the old and new states—measured as changes in prices, quantities produced and consumed, income and other economic quantities—can be used to characterize the net welfare changes for each affected group identified in the model.

Analysts can rely on different outputs and conclusions from the general equilibrium framework to assess issues of both *efficiency* and *distribution*. At EPA these issues often take the form of three distinct questions:

- Is it theoretically possible for the "gainers" from the policy to fully compensate the "losers" and still remain better off?
- Who are the gainers and losers from the policy and associated economic changes?
- And how did a particular group—especially a group that may be considered to be disadvantaged—fare as a result of the policy change?

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The first question is directed at the measurement of efficiency, and is based on the *Potential Pareto criterion*. This criterion is the foundation of benefit-cost analysis, requiring that a policy's net benefits to society be positive. Measuring net benefits by summing all of the welfare changes for all groups provides an answer to this question.

The last two questions are related to the distributional consequences of the policy. Because a general equilibrium framework provides for the ability to estimate welfare changes for particular groups, these questions can be pursued using the same approach taken to answer the efficiency question, provided that the general equilibrium model is developed at an appropriate level of disaggregation.

Practical Compromises: Benefit Cost Analysis, Economic Impacts Analysis, and Equity Assessments

Although a general equilibrium framework can, in principle, provide the information needed to address all three questions, in practice analysts have limited access to the tools and resources needed to adopt a general equilibrium approach[1]. More often, EPA must resort to assembling a set of different models to address issues of efficiency and distribution separately. However, the limitations on employing general equilibrium models have greatly diminished in recent years with advances in the theory, tools, and data needed to use the approach. Chapter 8 contains additional information on general equilibrium models.

The *EA Guidelines* follow more traditional practices and adopt conventional labels to distinguish models or approaches used to answer questions on the efficiency and distribution of environmental regulations. For purposes of this document, the presentation separates the concepts and approaches into the following three general categories:

- the examination of net social benefits using a *benefit-cost analysis* (BCA);
- the examination of gainers and losers using an *economic impacts analysis* (EIA); and
- the examination of particular sub-populations, especially those considered to be disadvantaged, using an *equity assessment*.

This division is necessary not only because of data and resource limitations, but because analysts often lack models that are sufficiently comprehensive to address all of these dimensions concurrently. Within a BCA, for example, EPA is generally unable to measure benefits with the same models used for estimating costs, necessitating separate treatment of costs and benefits. Further, when estimating social costs there are cases in which some direct expenditures can be identified, but data and models are unavailable to track the "ripple" effects of these expenditures through the economy. For most practical applications, therefore, a complete economic analysis comprises a benefit-cost analysis, an economic impacts analysis, and an equity assessment.

Benefit-cost analysis evaluates the favorable effects of policy actions and the associated opportunity costs of those actions. The favorable effects are defined as benefits and the opportunities foregone define economic costs. While conceptually symmetric, benefits and costs must often be evaluated separately due to practical considerations. Analysts may even organize the analysis of benefits differently from the analysis of costs, but they should be aware of the conceptual relationship between the two. Using estimates of health and other risk-reduction effects provided by risk assessors, benefits analyses apply a variety of economic methodologies to estimate the value of anticipated health improvements and other sources of environmental benefits. Social cost analyses attempt to estimate the total welfare costs, net of any transfers, imposed by environmental policies. In most instances, these costs are measured by higher costs of consumption goods for consumers and lower earnings for producers and other factors of production. Some of the findings of a social cost analysis are inputs for benefits analyses, such as predicted changes in the outputs of goods associated with a pollution problem.

The assumptions and modeling framework developed for the BCA, constrain and limit the estimation techniques used to examine gainers and losers (in an EIA) or to examine impacts on disadvantaged sub-populations (in an

[1] The general equilibrium framework will at least capture all “market” benefits and costs, but may not include non-market benefits, such as those associated with existence value. In practice, models of general equilibrium may also be unable to analyze relatively small sectors of the economy. For more on general equilibrium analysis see Chapter 8, section 4.5.

equity assessment). To estimate these two categories of impacts we rely on a multiplicity of estimation techniques. The constraints faced by these analyses as well as details regarding estimation techniques are given by Chapter 9.

5.3 Baseline Specification

An economic analysis of a policy or regulation compares "the world with the policy or regulation" (the policy scenario) with "the world absent the policy or regulation" (the baseline scenario). Impacts of policies or regulations are measured by the resulting differences between these two scenarios. Measured differences may include changes in pollutant emissions and ambient concentrations, changes in usage or production of toxic substances, and incidence rates for adverse health effects associated with exposure to pollutants.

Specification of baseline conditions can have profound influence on the measurement and interpretation of analytic results. The complexity of the regulatory and policy-making stipulations may not yield a clear-cut decision on the specification of baseline conditions. The honesty and integrity of the analysis depend on the ability of the analyst to provide well-defined and defensible choices in the selection and estimation of baseline conditions. Analysts uncertain about the selection of baseline conditions are advised to review the guiding principles listed below. In the development of the rule, the analyst is responsible for raising questions about baseline definitions early within the regulatory development process, and should receive the views of enforcement and general counsel staff. Doing so can facilitate the consistent treatment of this issue in EPA analyses.

5.3.1 Guiding Principles for Baseline Specification

Baseline specification can be thought of as having two steps—selection and quantification. The first step is to select a baseline that is appropriate to the question the analysis is intended to address. The second step is to estimate the values of the relevant factors in the selected baseline scenario. Several guiding principles to assist in the treatment of baselines in an analysis are listed below. Though they exhibit a common sense approach to the issue, the analyst is advised to provide explicit statements within the analysis on each point. Failure to do so may result in a confusing analytic presentation, inefficient use of time and resources, and misinterpretation of the economic results.

- **Clearly state the question the analysis is addressing.** The type of regulatory question facing an analyst will affect the selection of the baseline in an analysis. A baseline definition appropriate to many analyses will be "reality in the absence of the regulation." However, to ensure provisions contained in statutes or policies precipitating the regulatory action are appropriately addressed, it is useful to assume full compliance with regulatory requirements in most cases.[2] Clearly stating the questions to be answered by the analysis will help not only in choosing an appropriate baseline, but also in communicating this information to persons using the results of the analysis.

- **Clearly identify all aspects of the baseline conditions that are uncertain and all assumptions made in specifying the baseline.** If the analyst had complete information about current values and perfect foresight about the future, the appropriate baseline conditions could be characterized with certainty. This, of course, is never the case. Current values of factors are often uncertain, and future values of factors are always uncertain. Estimates of uncertain factors should be based on actual data, to the extent possible. Uncertainties underlying the baseline conditions should be treated as other types of uncertainties are handled throughout the analysis. If, in the face of uncertainty, assumptions about baseline components are made, these should be the most realistic assumptions possible. For example, where reliable projections of future economic activity and

[2] Analysts should refer later sections of these guidelines (Section 5.3.2) and other cited EPA documents prepared in support of implementing these statutes, for more detailed guidance on the treatment of baseline definitions and compliance assumptions used for economic analyses required under these statutes. Much of the information on EPA's policies and guidelines applicable to rule development can be found at the following EPA Intranet website http://intranet.epa.gov/rapids (accessed 8/02/2000, internal EPA document).

demographics are available, this information should be accounted for in defining the baseline. All assumptions should be clearly stated, with particular attention given to situations calling for more than one baseline to be included in the analysis.

- **Be consistent throughout the analysis in the use of baselines.** The same baseline should be carried through for all components of the analysis. For example, the comparison of costs and benefits in a benefit-cost analysis should draw upon estimates derived using the same baseline, so that the calculation of net economic benefits yields a meaningful economic measure. Likewise, when comparing and ranking alternative regulatory options, the same baseline should be used for all options under consideration. When use of more than one baseline scenario is warranted, the analyst must avoid the mistake of combining analytic results obtained from different baseline scenarios. To limit confusion on this point, if multiple baseline scenarios are included in an analysis, presentations of economic information should clearly describe and refer to which baseline scenario is being used.

- **Determine the appropriate level of effort for baseline specification.** Every analysis is limited by finite resources. Analytical efforts should be concentrated on those components of the baseline that are most important to the analysis. If several components of the baseline are uncertain, the analysis should concentrate its limited resources on refining the estimates of those components that have the greatest effect on interpretation of the results.

- **Clearly state the "starting point" of baseline and policy scenarios.** A starting point of an analysis is the point in time at which the comparison between the baseline and policy scenarios begins. This is conceptually a point in time when the two scenarios are believed to diverge. For example, one approach is to organize the analysis presuming that the policy scenario conditions diverge from those in the baseline at the time an enforceable requirement becomes effective. Another convenient approach is to set the starting point to be coincident with promulgation of the final rule. These dates may be appropriate to use, as they are clearly defined under monitored administrative procedures, or represent deadlines that compliance progress can be measured against.

  However, where behavioral changes are motivated by the expected outcome of the regulatory process, the actual timing of the formal issuance of an enforceable requirement should not be used to define differences between the baseline and policy scenarios. Earlier starting points, such as the date authorizing legislation is signed into law, the date the rule is first published in a Notice of Proposed Rule Making, or other regulatory development process milestones, may be supported if divergence from the baseline occurs due to anticipation of promulgation. In some instances, parties anticipating the outcome of a regulatory initiative may change their economic behavior, including spending resources to meet expected emission or hazard reductions prior to the compliance deadline set by enforceable requirements. The same issues arise in the treatment of non-regulatory programs, in which voluntary or negotiated environmental goals may be established, leading parties to take steps to achieve these goals at rates different from those expected in the absence of the program. In these cases, it may be appropriate to include these costs and benefits into the analysis of the policy action, and not subsume these into the baseline scenario. The dynamic aspects of market and consumer behavior, and the many motivations leading to change, can make it more difficult to attribute economic costs and benefits to specific regulations. Looking at the sensitivity of the outcome of the analysis to these conditions and assumptions will be useful.

- **Let the duration of important effects of a policy dictate the structure of the analysis and baseline.** To consider how the benefits of a proposed policy compare with the costs of the policy, the analyst will assemble estimates of the present discounted values of the total costs and benefits attributable to the policy. How one defines the baseline is particularly important in situations in which the accrual of costs and/or benefits do not coincide due to lagged effects, or occur over an extended period of time. For example, the human health benefits of a policy that reduces leachate from landfills may not be manifest for many years, if the potential for human exposure through contaminated groundwater may occur

decades after closure of the landfill. In theory, then, the longer the time frame, the more likely the analysis will depict all the benefits and costs of the policy that are expected to occur. However, forecasts of economic, demographic, and technological trends necessary for baseline specification must also span the entire period of the analysis. Because the reliability of many forecasts diminishes into the future, the analyst must balance the advantages of structuring the analysis to include a longer time span against the disadvantages of the decreasing reliability of the analytic results.

Defining the baseline and policy scenarios will often require information and assumptions on trends in behavior, and how these trends may be affected by regulatory management options. For example, the analyst may observe trends in economic activity or pollution control technologies that occur for reasons other than direct environmental regulations. For example, as the purchasing power of consumer income increases over time, demand for different commodities can change. Demand for some commodities may grow at rates faster than the rate of change in income, while demand for other goods may decrease. Therefore, where these trends are highly uncertain or are expected to have significant influence on the evaluation of regulatory alternatives (including a "no-regulatory control" alternative), the analyst should clearly explain and identify their choices in the analysis.

Lastly, in some cases the benefits of a policy will be expected to increase over time. Some analyses must therefore look far enough into the future to assure that benefits are not substantially underestimated. For example, suppose a policy that would greatly reduce greenhouse gas emissions were being proposed. In the baseline scenario, the level of greenhouse gases in the atmosphere would steadily increase over time, with a corresponding increase in expected human health and welfare and ecological changes. A benefit-cost analysis limited to the first decade after initiation of the policy would be likely to distort the relationship of benefits and costs associated with the policy. In this case, the conflict between the need to consider a long time frame and the decreasing reliability of forecasting far into the future may be substantial. In most cases, primary considerations in determining the time horizon of the analysis will be the time span of the physical effects that drive the benefits estimates, and capital investment cycles associated with environmental expenditures.

5.3.2 Compliance Rate Issues and Baseline Specification

One aspect of baseline specification that is particularly complex, and for which assumptions are typically necessary, is that of compliance rates. The treatment of compliance in the baseline scenario can significantly affect the results of the analysis. Therefore, it is important to be clear to persons using the analysis how assumptions about compliance behavior are incorporated into the analysis, and how sensitive the results are to the handling of compliance rates.

It can be challenging to clearly demonstrate the economic effects attributable to a new regulation or policy, while avoiding the potential for double-counting of benefits, costs, and impacts associated with separate existing regulations. To aid in preparation of the economic analysis and presentation of results, it is common to establish baseline conditions so that the affected regulated entities are in full compliance with other separate existing regulations. Assuming full compliance with existing regulations will enable the analysis to focus on the incremental economic effects of the new rule or policy, the results of which are used to evaluate the predicted economic changes. This information also meets the requirements contained in many of the statutes and administrative orders that use economic information as evidence that further steps need to be taken to address the effects on regulated parties (described in Chapters 2 and 9).

Defining the baseline in this fashion may pose some challenges to the analyst, since current observed or reported economic behavior may represent the consequences of either under-compliance or over-compliance with existing regulations. For example, it is possible to observe over-compliance by regulated entities with enforceable standards. One can find industries whose current effluent discharge concentrations for regulated pollutants are measured below concentrations legally required by existing effluent guideline regulations. On the

other hand, evidence for under-compliance is evident in the resources devoted by EPA and other state and local regulatory agencies to enforce rules through orders, fines, and negotiated settlements. As a result, it will be important that the analysis separates the changes associated with a new regulation from actions taken to meet existing requirements. This is of particular importance if actions taken to meet existing requirements are coincident with, but not caused by, changes introduced by the new regulation.[3]

For some types of analyses it is sensible to establish a baseline of "current practice" (i.e., what is believed to be the actual degree of compliance, rather than assumed full compliance). For example, when a new action under review is intended to address or "fix-up" compliance problems associated with existing policies, information on current practices belongs in the baseline. Otherwise, defining the baseline in a manner that disregards this behavior will obscure the value of investigating whether further or alternative regulatory actions are necessary (e.g., as was the case in a review of banning lead from gasoline, which was precipitated in part by the noncompliance of consumers misfueling their non-leaded gasoline automobiles (EPA, 1985)). For a deregulatory rule (e.g., a rule designed to address potential changes in or clarify definitions of regulatory performance that frees entities from enforceable requirements contained in an existing rule), it may be sensible to perform the analysis using both a full compliance and "current practices" baseline. A full compliance scenario in this instance introduces some added complications to the analysis, but it may be important to report on the economic effects of failing to take the deregulatory action.

In cases of over-compliance with existing policies, or actions already taken in the economic interests of the affected parties, current practices can be used to define baseline conditions unless these practices are expected to change or are highly uncertain in ways that are directly associated with the rule being analyzed. For example, observed over-compliance by a regulated entity may be the result of choices it has made to anticipate forthcoming more stringent federal regulatory requirements. If there should be a decision not to follow through with the anticipated federal regulation, the analysis will need to establish whether the current observed over-compliance behavior by the regulated entity may be curtailed to meet existing (i.e., relatively less stringent) requirements. If the regulated entity in this example is expected to continue to over-comply despite the absence of the more stringent regulation, then the policy scenario should not contain the costs and benefits attributable to this behavior, and it is appropriate to account for them in the baseline scenario that describes the "world without the regulation." However, if the regulated entity will relax its pollution control practices to meet current requirements after the stricter regulation fails to emerge, then the costs and benefits of the over-compliance behavior should be attributed to the policy scenario. In these situations, it may be useful to consider performing the analysis with alternative baseline scenarios, and demonstrate the potential economic consequences of different assumptions associated with the expected changes in this type of behavior.

Analysts may also elect to incorporate predicted differences in compliance rates within policy options considered for new rules, in cases where compliance behavior is known to vary systematically with the regulatory options being considered (e.g., if the expected compliance rate with a rule may differ if entities are regulated using economic incentives as compared with prescribed control technologies).

Despite the above possible complexities, it is prudent for most analyses of regulations to develop baseline and policy scenarios that assume full compliance with existing and newly enacted regulations. One rationale for adopting these assumptions is that the analytic results will provide information on the unique role the action under consideration is expected to have on the economy, which may be required under the authorizing statute, or administrative laws and policies. As a practical matter, noncompliant behavior will need to be known, estimable, and occurring at rates that can affect the evaluation of policy options before totally rejecting assumptions of "full

[3] For example, assigning costs between an existing and new regulation could be further complicated, if, as a result of under-compliance with the existing regulation, the estimated "joint" cost of meeting both regulations differs from the summed marginal costs of first meeting the existing regulation, followed by implementing the new regulation. The same concern equally applies to the attribution of benefits and economic impacts to each regulation. Under these circumstances, the analyst should seek further directions provided by the authorizing legislation for the regulation, or instructions contained in other operative laws and policies.

compliance" for existing and new policies. In the end, assumptions on compliance behavior for current and new requirements should be clearly presented in the description of the analytic approach and assumption used for the analysis. Care should be taken to describe the importance of these assumptions when comparing regulatory options for which social costs and benefits, and economic impacts have been estimated.

5.3.3 Multiple Rules or Regulations and Baseline Specification

If conditions exist where there are no other relevant regulations, specifying a baseline is not complicated by questions of whether other regulations are being implemented and, if so, which regulations are responsible for environmental improvements and can "take credit" for reductions in risks. That is, there is no need to be concerned with which environmental improvements are in the baseline. Nor is it necessary to try to determine how these other regulations affect market conditions that directly influence the costs or the benefits associated with the policy of interest.

But actual conditions in the regulation of environmental risks are much more complex, and it is an unusual case where the above holds true. There are many regulatory agencies (i.e., federal, state, local) affecting environmental behavior, and several forms of consumer and industrial behavior are regulated by agencies whose agendas can overlap with EPA's (e.g., OSHA, DOT, DOE). Absent an orderly sequence of events that allows attributing changes in behavior to a unique regulatory source, in practice, there is no non-arbitrary way to allocate the costs and the benefits of a package of overlapping policies to each individual policy. Whether any one of these policies is "in the baseline" of the benefit-cost analysis of another policy is, to a large degree, a matter of choice. There is no theoretically correct order for conducting a sequential analysis of multiple overlapping policies that are promulgated simultaneously.

An idealized approach would attempt to analyze all of the policies together when assessing the total costs and benefits resulting from the package of policies. However, this kind of comprehensive analysis is usually not feasible. A practical alternative may be to consider the actual or statutory timing of the promulgation and/or implementation of the policies, and use this to establish a sequence with which to analyze related rules. But even when the temporal order of policies makes it clearer which policies are "in the baseline" and which are not, different depictions of the timing and impacts of pre-existing or overlapping policies can still have a substantial effect on the outcome of a benefit-cost analysis. An example of this, offered by Arnold (1995), concerns regulations designed to reduce the production of chlorofluorocarbons (CFCs) and other ozone-depleting substances. In this case, the impacts of multiple regulations on production decisions were not separable or independent of the order of their issuance, so that the costs and benefits of requirements estimated for each regulation were dependent on which preexisting rules were considered binding in the analysis. A similar illustration concerning hazardous waste regulations is also provided by Arnold (1995), wherein an assessment of the costs and benefits associated with several regulations is performed, demonstrating that the result of evaluating each individual regulation varies significantly depending on which of the other regulations are included in the baseline.

Therefore, the best practice is to be clear as to the baseline selected for the analysis, and to present a justification for making this choice. This can include providing information on the status of other regulatory actions that may have some effect on the baseline, and conducting sensitivity analyses that test for the implications of including or omitting other regulations. Some regulatory actions have attempted to directly link rules together that affect the same industrial category (e.g., the pulp and paper effluent guidelines and NESHAP rules (EPA, 1997)). While statutory and judicial deadlines may inhibit the linking of rules that fall on the same regulated entities (e.g., UMRA and RFA require analyses be performed for each rule), coordination between rulemaking groups is advocated in EPA's regulatory development process, and sharing of data, models, and joint decisions on analytic approaches is strongly recommended.

5.3.4 Summary

The specification of the baseline for an economic analysis can have a profound influence on the outcome of the

analysis. The estimated costs and/or benefits of a proposed policy can change by an order of magnitude under different baseline assumptions. Careful thought in specifying the baseline is therefore crucial to a defensible analysis.

The first step is to be clear about the question being asked and therefore what baseline the analyst would like to specify. The second step is to characterize that baseline as well as possible within the constraints of the analysis. This involves determining which baseline parameters are most important to the analysis, assessing the advisability of expending resources to improve the estimates of those parameters, and making reasonable assumptions when necessary. In all cases, assumptions and uncertainties should be clearly stated as part of the analysis, along with a discussion of how alternative, plausible assumptions would be likely to affect the outcome of the analysis. Within the resources available, sensitivity analysis and uncertainty analysis are valuable tools for illustrating the potential impacts of assumptions made and quantifying, to the degree possible, the extent of the uncertainty underlying the specified baseline. Finally, the estimation of the costs and benefits attributable to individual policies in a package of policies is a problem for which there simply is no "correct answer."

Many factors will affect the configuration of the baseline in EPA's economic analyses. This means that even though analytical choices are well-constructed and logical, the consequences of these differences may frustrate efforts to attain comparability of baselines across different regulatory activities. Still, in any effort to evaluate regulatory options and assess benefits, costs, and economic impacts attributable to an individual rule, the analysis should be internally consistent in its definition and use of baseline assumptions. This is imperative when more than one baseline scenario is introduced, since this provides more possibilities to erroneously compare costs and benefits across different baselines. A decision to include multiple baselines into an analysis can result in a complex set of modeling choices, and an abundance of analytic results to interpret and communicate to decision makers. Therefore, analysts are advised to seek clear direction from management about baseline definitions early during the development of a rule.

5.4 Predicting Responses to a New Environmental Policy

It is impossible to measure an environmental policy's costs and benefits without a clear characterization of actions taken in response to the policy. Some policies are prescriptive in specifying what actions are required—for example, mandating the use of a specific type of pollution control equipment. It can be difficult, however, to predict responses to less-direct performance standards, such as bans on the production or use of certain products or processes, and market-based incentive programs. Analysts should make explicit all assumptions about responses, and should consider plausible alternative compliance options. Alternatively, when the number of conceivable options is essentially infinite, the analysis should at least span the range of possibilities. Cost-effectiveness analysis can often be used to identify and map out dominant regulatory options and responses. When it is not possible to characterize compliance responses with a high degree of certainty, the analysis should include a description of the likely direction of bias in the estimates—whether costs and benefits are over- or understated—if this is known.

Predicting responses starts with a comprehensive list of possible response options. These may include the use of different compliance technologies (if the technology is not specified by the policy itself) or waste management methods; changes in operations to avoid or reduce the need for new controls or the utilization of materials whose use is restricted by a policy (including various types of pollution prevention); shutting down a production line or plant to avoid the investments required to achieve compliance; or even noncompliance.[4] Typically, parties affected by a policy are assumed to choose the compliance option that minimizes their costs. In some cases, however, it may be reasonable to select a more costly option as the most likely response. Sometimes a higher

[4] As in the case of baseline specification, most analyses will assume full compliance by all entities that continue to operate. For some policies that present significant enforcement challenges, or for options that differ in ways that are likely to affect compliance rates, it may be useful to calculate how costs and benefits compare when using estimates of compliance rates less than 100 percent.

cost option may significantly reduce future legal liabilities, or achieve compliance with other rules being implemented at either the same time, or those expected to be promulgated in the future. However, the additional costs of compliance responses in excess of least-cost strategy costs should be attributed to these other causes.

Estimating responses is often the most difficult for pollution prevention policies because these options are generally more site- and process-specific than end-of-pipe control technologies. Predicting the costs and environmental effects of pollution prevention policies may require detailed information on industrial processes. As a result, the costs of a pollution prevention policy may be overstated and the benefits either over- or understated (depending on the nature of the process changes involved). Nevertheless, economic analyses should at least include qualitative discussion of potential pollution prevention responses and their effects on costs and benefits.

Predicting reductions in output (e.g., production line or plant closures) in response to a policy requires analysis of market characteristics that determine the allocation of cost increases among directly affected entities and their suppliers, customers, and competitors. This subject is discussed in the economic impact analysis section of Chapter 9.

5.5 Analyzing and Presenting Uncertainty

This section contains guidance on dealing with uncertainty in regulatory economic analyses, focusing on characterizing the precision of estimated economic outcomes such as net benefits. It provides specific recommendations for describing and presenting problems arising from uncertainty, and suggestions for carrying out sensitivity analyses.

This section concludes with a discussion of the welfare considerations related to risk and uncertainty.[5] These considerations are largely distinct from those associated with characterizing precision. The use of certainty equivalents for addressing these problems is addressed briefly, but detailed treatment is beyond the scope of this discussion.[6] Issues related to differences in risk perceptions and the provision of information are described, and the role of quasi-option values in decisions characterized by irreversible consequences is addressed briefly.

5.5.1 Guiding Principles for Uncertainty Analysis

Uncertainty is inherent in economic analyses, particularly those associated with environmental benefits for which there are no existing markets. The issue for the analyst is not how to avoid uncertainty, but how to account for it and present useful conclusions to those making policy decisions. Treatment of uncertainty, therefore, should be considered part of the communication process between analysts and policy makers.

Transparency and clarity of presentation are the guiding principles for assessing and describing uncertainty in economic analyses. Although the extent to which uncertainty is treated and presented will vary according to the specific needs of the economic analysis, some general minimum requirements apply to most economic analyses. In assessing and presenting uncertainty the analyst should, if feasible:

- present outcomes or conclusions based on expected or most plausible values;
- provide descriptions of all known key assumptions, biases, and omissions;
- perform sensitivity analysis on key assumptions; and
- justify the assumptions used in the sensitivity analysis.

The outcome of the initial assessment of uncertainty may be sufficient to support the policy decisions. If, however, the implications of uncertainty are not adequately captured in the initial assessment then a more sophisticated

[5] Stemming from definitions given in Knight (1921) economists have distinguished risk and uncertainty according to how well one can characterize the probabilities associated with potential outcomes. Risk applies to situations or circumstances in which a probability distribution is known or assumed, while uncertainty applies to cases where knowledge of probabilities is absent. Note that the economic definitions for these terms may differ from those used in other disciplines.

[6] Several other issues associated with uncertainty are also beyond the scope of this brief discussion, including verification, validation, and plausibility checks. Analysts will need to consult other sources for additional information on these topics.

analysis should be undertaken. The need for additional analysis should be clearly stated, along with a description of the other methods used for assessing uncertainty. These methods include decision trees, Delphi-type methods[7], and meta-analysis. Probabilistic methods, including Monte Carlo analysis, can be particularly useful because they explicitly characterize analytical uncertainty and variability. However, these methods can be difficult to implement, often requiring more data than are available to the analyst.[8]

Confidence intervals are generally useful to describe the uncertainty associated with particular variables. When data are available to estimate confidence intervals they can serve to characterize the precision of estimates and to bound the values used in sensitivity analysis.

5.5.2 Performing Sensitivity Analysis

Most analytical base cases, or primary analyses, generally do not address uncertainty and present expected or most plausible outcomes. Regardless of the basis for the primary analysis, point estimates alone do not provide policy makers with information about the full range of potential outcomes. Additional information is needed if the decision-maker is to have a more complete view of the potential impacts of the policy alternatives. It is always useful to see how net benefit estimates or other outputs of the economic analysis change with assumptions about input parameters. Sensitivity analysis provides a systematic method for making these determinations. Keeping in mind some basic principles can enhance sensitivity analysis.

- **Focus on key variables.** For most applied economic analyses, a full sensitivity analysis that includes every variable is not feasible. Instead the analyst must limit the sensitivity analysis to those input parameters that are considered to be key or particularly important. In determining which parameters are key, the analyst should carefully consider both the range of possible values for input parameters and each one's functional relationship to the output of analysis. The analyst should specify a plausible range of values for each key variable, including the rationale for the range of values tested.

- **Present the results clearly.** Results of the sensitivity analysis should be presented clearly and accompanied with descriptive text. The most common approach to this sort of partial sensitivity analysis is to estimate the change in net benefits (for a benefit-cost analysis) or other economic outcome while varying a single parameter, leaving other parameters at their base value. A more complete analysis will present the marginal changes in the economic outcome as the input parameter takes on progressively higher or lower values. Varying two parameters simultaneously can often provide a richer picture of the implications of base values and the robustness of the analysis. Analysts should consider using graphs to present these combined sensitivity analyses by plotting one parameter on the x-axis, the economic outcome on the y-axis, and treating the second parameter as a shift variable.[9]

- **Identify switch points.** "Switch point" values for key input parameters can be very informative, especially in benefit-cost analyses. Switch points are defined as those conditions at which the recommended policy decision changes (e.g., when the estimation of net benefits changes sign). While switch points are not tests of confidence in the statistical sense, they can help provide decision-makers with an understanding of how robust the analysis is.

- **Assess the need for more detailed analysis.** Finally, sensitivity analyses can also be useful as a screening device to determine where more extensive treatment of uncertainty may be needed. In some cases the plausible range of values for the parameter may be narrowed with further research or data gathering, or the analyst may be able to better characterize the parameter's uncertainty. If several parameters

[7] There a number of such techniques, but all of these methods focus on the use of eliciting and combining expert judgment to inform analysis. See Chapter 7 of Morgan and Henrion (1990) for more detail on the use of these methods.

[8] Morgan and Henrion (1990) is a useful general reference that includes descriptions of many methods to assess uncertainty.

[9] When the analysis contains many highly uncertain variables, presentation may be facilitated by noting the uncertainty of each in footnotes and carrying through the central analysis using best point estimates.

appear to have a large impact on the results of the analysis then a more sophisticated treatment of uncertainty may be necessary.

5.5.3 Welfare Considerations Related to Uncertainty and Risk

So far this discussion has focused upon uncertainty as it must be accommodated by the analyst charged with performing an economic assessment and the decision-maker who receives this information. A separate but related issue is how individuals affected by environmental policies respond to uncertainty in outcomes and imperfect information. These responses may have an impact on how individuals respond to policy alternatives and how they value policy outcomes. Some of these considerations are noted here, but this treatment is not detailed or exhaustive. It is important to note that analytical precision and welfare effects are distinct concepts. Certainty equivalents, for example, address welfare effects and are appropriate for assessing efficiency in a benefit-cost analysis, but they do not assess analytical precision or mitigate the usefulness of sensitivity analyses and bounding cases.

- **Risk attitudes and certainty equivalents:** Individuals and other entities are generally not neutral when faced with situations of uncertainty or risk. In most cases related to environment and health they are considered to be *risk averse*, favoring a certain outcome to one that is uncertain even if the expected value of the risky outcome is equal to the value of the certain one. The theoretically preferred manner of incorporating risk attitudes is to use *certainty equivalents*, sometimes termed certain monetary equivalents. Certainty equivalents are defined as the minimum amount that an individual would be willing to accept with certainty instead of facing the uncertain outcomes.[10]

  While certainty equivalents have theoretic appeal, they are difficult to put into practice for economic analyses of environmental policies. Estimation of certainty equivalents requires detailed knowledge of (or assumptions about) risk preferences, and analysts are unlikely to have these data. To estimate certainty equivalents one must also be able to assign probabilities to the set of potential outcomes. It is often very difficult or impossible to make these assignments.

- **Lay and expert risk perceptions:** Lay perceptions of risk may differ significantly from scientific assessments of the same risk, and an extensive literature has developed on the topic.[11] Because individuals respond according to their own risk perceptions, it is important for the analyst to be attentive to situations where there is an obvious divergence in these two measures. In such cases, analysts should consider evaluating policy options under both sets of information, clearly stating the basis for economic value estimates used or developed in their analysis. Because providing information to the public may reduce differences between lay and expert perceptions of risk, and may allay public concerns, analysts should consider including these strategies in their analysis of potential policy options.

- **Provision of information:** Some policy actions focus on providing information on risks to health and welfare. Inasmuch as this information allows consumers to make better decisions regarding their households' welfare there is an economic benefit to providing this information. Revealed preference benefit analyses, however, can make new information appear to have a net negative effect on household welfare because households may undertake new (and costly) activities in response. An appropriate framework for evaluating the benefits of information provision under these circumstances is to assess the costs of sub-optimal household decisions under the less-complete information.[12] Analysts should carefully consider these issues when they evaluate policies that focus on information provision.

[10] Some researchers have suggested risk-adjusted discount rates as an alternative device for incorporating information on the uncertainty future benefits and costs. Most economists now conclude, however, that the discount rate should *not* be adjusted to account for uncertainty in benefit-cost analysis.

[11] Useful general sources include Slovic (1987) and Fischhoff et al. (1978).

[12] Foster and Just (1989) describes this approach more fully, demonstrating that compensating surplus is an appropriate measure of willingness-to-pay under these conditions. The authors illustrate this with an empirical application to food safety.

- **Quasi-option value:** Another relevant issue in decision-making under uncertainty is that of quasi-option value as identified by Arrow and Fisher (1974). Some environmental policies involve irreversible decisions that must be made in the face of uncertainty. If information that reduces this uncertainty can be expected to develop over time, then there is a positive "quasi-option" value to waiting until this information is available. In this case, the value originates from possessing the option to hold off on making the decision until uncertainties are resolved. Generally, it is difficult to quantitatively include quasi-option values in an economic analysis of environmental policy, but the concept is useful and may be highlighted qualitatively if circumstances warrant. For more on this issue see Freeman (1984, 1993), Fisher and Hanemann (1987), and Cochrane and Cutler (1990).

5.6 Emerging Cross-Cutting Issues

Many other cross-cutting issues are not detailed in the *EA Guidelines*. Some of these issues are difficult or impossible to incorporate fully into economic analyses at this time, but may become either more important or more tractable as the economic literature develops. Although the relevance of these considerations depends on the specifics of the policy being considered, analysts may want to at least consider these issues qualitatively. Three emerging issues are identified here: tax interaction effects, the pace of exogenous technological change, and the effects of regulation on innovation.

- **Tax Interaction effects:** Although evaluations of environmental policies typically assume a first-best regulatory setting, preexisting taxes such as those on labor income create a second-best setting. This difference can affect the estimated costs of policy actions. Recent advances in applied general equilibrium analysis have led to generally replicable qualitative results. These studies indicate that ignoring these effects may result in underestimating the cost of compliance, from a social perspective.[13] However, the magnitude of the effect—and perhaps the direction—will vary across policies. Although the analytical emphasis on this issue has been on estimating costs, benefits analysis can conceivably suffer a similar bias.

- **Pace of exogenous technological change:** Economic analysis of environmental policies may be affected by the pace of exogenous technological change. In principal, accounting for this can either increase or decrease marginal and total abatement costs, depending on the direction of change. Generally, however, the expectation is that accounting for exogenous technological change would decrease estimated abatement costs. Recent analyses have indicated that even for mature technologies the magnitude of this effect can be large.[14]

- **Regulation and innovation:** More extensive research is being developed to examine the impact of various regulatory approaches on firms' research and development decisions for abatement technology.[15] As suggested in the descriptions of alternative regulatory approaches in Chapter 4, this impact may be positive or negative depending on the regulatory approach and setting. Generally, economists expect that incentive-based instruments will provide greater incentive for cost-reducing innovations than will command and control regulatory approaches. Policies that provide information to firms and consumers may also affect technological innovation. Chapter 8 provides some additional information on the subject of regulation, innovation, and the implications for estimating social costs.

[13] For an example see Bovenberg and Goulder (1997).

[14] See, for example, Ellerman and Montero (1998) and Carlson et al (1998).

[15] See, for example, Milliman and Prince (1989) and Biglaiser and Horowitz (1995).

5.7 References

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